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for Asia and the Pacific

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Preface

The *Energy Outlook for Asia and the Pacific* aims to support ADB energy sector operations by providing stakeholders with an energy outlook for the region up to the year 2035. It attempts to identify policy, social, infrastructure, and technology issues that must be addressed to meet future energy need of ADB members in Asia and the Pacific.

The first edition of the *Energy Outlook for Asia and the Pacific*, which provided an energy supply and demand outlook for the region up to 2030, was published by ADB in 2009. Since then however, there have been various developments affecting the energy sectors of both developed and developing economies that justify this update, including (i) the lasting economic recession in major developed energy-consuming countries and its impact on other parts of the world, (ii) geopolitical and social unrest in the Middle East and Africa, (iii) repercussions of the Fukushima nuclear incident on nuclear energy development programs, (iv) aging energy infrastructure in Asia and the Pacific, and (v) expansion in renewable energy development and energy efficiency improvements within the region.

In contrast to other energy outlooks that deal solely with whole regions, this report also focuses on the local characteristics of the ADB members in Asia and the Pacific, with the intention of providing critical and strategic insights into the energy sector of individual ADB members. This report presents two cases of energy demand and supply for the ADB member economies in Asia and the Pacific: (i) a business-as-usual case, which reflects the impact of existing policies and current technology levels on future energy demand and energy choice, as well as assumes that current trends in the development of new and renewable energy sources will continue into the future; and (ii) an alternative case that considers the potential for energy savings on both the demand and the supply sides from the deployment of advanced and low-carbon technologies to increase energy security in the region. The study also presents the results of analyses made to estimate carbon dioxide emissions and investments required on the supply and demand sides for both the business-as-usual and the alternative cases. Also identified and discussed are major issues that are likely to affect the energy demand and supply in Asia and the Pacific, including electricity trade among members of the Association of Southeast Asian Nations (ASEAN), shale gas development in North America, electrification, fuel subsidies, subregional cooperation on oil and natural gas supply, biofuels in Asia, energy efficiency, low-carbon city development, modal shifts in transportation, renewable energy development, and carbon capture and storage.

This report is not meant to predict the future trajectory of the energy sector in Asia and the Pacific. Rather, it is meant solely to provide scenarios of what could happen should the ADB economies take particular courses of action, as defined by the scenario assumptions. Not all issues relevant to the energy sector in Asia and the Pacific have been addressed in this study. The energy outlook projected in this volume does not necessarily reflect the views of the governments of the ADB members.

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Abbreviations

AAGR	average annual growth rate
ACG	Azeri-Chirag-Gunashli
ADB	Asian Development Bank
ALT	alternative case
APEC	Asia-Pacific Economic Cooperation
APERC	Asia Pacific Energy Research Centre
APG	ASEAN Power Grid
ASEAN	Association of Southeast Asian Nations
BAU	business-as-usual
BRT	bus rapid transit
CCS	carbon capture and storage
CHP	combined heat and power
CNG	compressed natural gas
CO_2	carbon dioxide
COP	coefficient of performance
CPC	Chinese Petroleum Corporation
DMC	developing member country
EE&C	energy efficiency and conservation
EIA	US Energy Information Administration
FIT	feed-in tariff
GCV	gross calorific value
GDP	gross domestic product
IEA	International Energy Agency
IEEJ	Institute of Energy Economics, Japan
IPCC	Intergovernmental Panel on Climate Change
Lao PDR	Lao People's Democratic Republic
LEAP	Long-Range Energy Alternatives Planning System
LNG	liquefied natural gas
LPG	liquefied petroleum gas
NRE	new and renewable energy
OECD	Organisation for Economic Co-operation and Development
OPI	Other Pacific islands
PNG	Papua New Guinea
PRC	People's Republic of China
RPS	renewable portfolio standard
TAPI	Turkmenistan-Afghanistan-Pakistan-India
TPED	total primary energy demand
UNSD	United Nations Statistics Division

Weights and Measures

BCM	billion cubic meters
GW	gigawatt
GWh	gigawatt-hour
kg	kilogram
ktoe	thousand tons of oil equivalent
kWh	kilowatt-hour
kWp	kilowatt-peak
mb/d	million barrels per day
Mt CO_2	metric ton of carbon dioxide
Mtce	million tons of coal equivalent
Mtoe	million tons of oil equivalent
MW	megawatt
TCM	trillion cubic meters
t C	ton of carbon
t CO_2	ton of carbon dioxide
TJ	terajoule
toe	ton of oil equivalent
TWh	terawatt-hour

Definitions

The economies analyzed in this report are classified by geographic grouping. But the developed regional members (Australia, Japan, and New Zealand) are classified as the Developed Group for the purposes of this report.

Central and West Asia comprises Afghanistan, Armenia, Azerbaijan, Georgia, Kazakhstan, the Kyrgyz Republic, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan.

East Asia comprises the People's Republic of China; Hong Kong, China; the Republic of Korea; Mongolia; and Taipei,China.

The Pacific is made up of the Cook Islands, Fiji, Kiribati, the Marshall Islands, the Federated States of Micronesia, Nauru, Palau, Papua New Guinea, Samoa, Solomon Islands, Timor-Leste, Tonga, and Vanuatu.

South Asia comprises Bangladesh, Bhutan, India, the Maldives, Nepal, and Sri Lanka.

Southeast Asia is composed of Brunei Darussalam, Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Viet Nam.

The countries in the **Developed Group** are Australia, Japan, and New Zealand.

Executive Summary

Key Findings and Energy Policy Implications

This executive summary presents the key findings from the energy demand and supply outlook analysis for Asia and the Pacific for both the business-as-usual (BAU) case and the alternative case. It also presents the implications arising from the analysis focusing on energy security enhancement, the environment, energy efficiency, and financing energy projects.

Energy Demand and Supply Outlook: Business-as-Usual

Asia and the Pacific's primary energy demand is projected to increase at 2.1% per year over the outlook period (2010–2035)—faster than the projected world average growth rate of 1.5% per year during the same period. With this growth, primary energy demand of Asia and the Pacific will reach 8,358.3 million tons of oil equivalent (Mtoe) by 2035, up from 4,985.2 Mtoe in 2010.

While Asia and the Pacific's projected primary energy demand growth will be faster than the world average, the trend will be slower than the historical one, and energy intensity (energy needed to produce one unit of gross domestic product [GDP]) will be decoupled from the GDP growth through 2035, in view of the assumed steady improvement in energy efficiency and some shifts in economic structure.

Growth in primary energy demand will differ by region and by member economy, reflecting the regional diversity in economic development and population growth. In fact, primary energy demand is projected to increase faster among developing members than among developed members, growing at 2.3% per year through 2035, sustained by the assumed economic growth rate of 5.6% per year (2010–2035). By contrast, the Developed Group's primary energy demand will decline at an annual rate of –0.01% through 2035 because the relatively slow growth in Australia and New Zealand will be offset by the projected decline in Japan's primary energy demand. As a result, members will increase their share of primary energy demand in Asia and the Pacific to 92.4% in 2035 from 87.2% in 2010. In contrast, the share of the Developed Group will be reduced to 7.6% in 2035, from 12.8% in 2010.

Fossil fuels will dominate the primary energy mix in Asia and the Pacific through 2035, increasing their share from 82.4% in 2010 to 83.2% by 2035. But growth trends will differ among fossil fuel types. Demand for coal will increase by 1.7% yearly through 2035, slower than the growth in overall primary energy demand (2.1%), and will reduce its share of overall demand to 42.1% by 2035 from 46.2% in 2010. Demand for oil will also increase more slowly, at 1.9% per year, and have a lower share of overall primary energy demand, at 26.3%, compared with 24.8% in 2010. By contrast, demand for natural gas will increase at a brisk 3.9% per year because of increased use for power generation, and increase its share to 17.5% by 2035 from 11.4% in 2010.

Coal

Demand for coal in Asia and the Pacific will increase by 52.8% from 2010 to 2035, reaching 3,516.3 million tons of oil equivalent (Mtoe) by 2035. The yearly rate of increase will be slower for coal (1.7%) than for total primary energy demand (2.1%). The People's Republic of China (PRC), with its 63.7% share, will continue to dominate the demand for coal in Asia and the Pacific, but its growth in demand is projected to slow down to 1.4% per year through 2035 because of the combined impact of improvements in energy efficiency and the shift toward other sources of energy, mainly in the industry and power sectors. India, on the other hand, will see a steady increase in demand for coal, at 3.1% per year until 2035, and maintain the second-largest share of demand in Asia and the Pacific (17.5%) through continued growth driven by the power sector.

Some members in Southeast Asia (such as Indonesia, the Philippines, and Viet Nam) will encourage the use of coal, particularly in the power sector, to diversify the energy supply structure and to enhance energy security. In fact, Southeast Asia will outpace the other regions in growth of coal demand, at 4.8% per year through 2035. Indonesia, in particular, will substantially increase its demand for coal to 128.3 Mtoe by 2035 (equal to Japan's level of demand) to become the fourth-largest coal user in Asia and the Pacific.

Asia and the Pacific as a whole was a net coal exporter in 2010. It is projected to become a net coal importer sometime after 2015, and a net exporter again by 2035 because of the projected increase in production in Australia and Indonesia.

Despite its energy security benefits, the use of coal produces carbon dioxide (CO_2) emissions and other adverse effects on the environment. Therefore, advanced coal-fired generation technologies (ultra-supercritical and supercritical power generation technologies) that are commercially available will have to be deployed, hand in hand with innovations in clean coal technologies.

Oil

Oil demand in Asia and the Pacific is projected to increase by 1.9% yearly over the outlook period and reach 1,973.0 Mtoe by 2035, 59.3% higher than the 1,238.2 Mtoe in 2010. The demand will be driven by the transport sector, which will account for 60.5% of incremental growth in oil demand between 2010 and 2035. Among the members, the PRC, India, Indonesia, Japan, the Republic of Korea, and Thailand will dominate the demand for oil in Asia and the Pacific; while these countries will differ in the rate of demand growth, as a group they will account for 81.0% of the demand for oil in Asia and the Pacific in 2035. Dwindling populations and deployment of fuel-efficient vehicles will reduce oil demand in Japan (by –1.2% yearly) and the Republic of Korea (by –0.1% yearly) through 2035. Meanwhile, motorization made possible by higher incomes will increase oil demand through 2035 in the PRC (by 2.4% yearly), India (3.1%), and Indonesia (2.8%).

Among the fossil fuels, oil imports will have the biggest share through 2035. In the BAU case, 64.9% of the demand for oil in 2035 in Asia and the Pacific will have to be met by imports. Central and West Asia will remain a net exporter of crude oil as the region includes major exporters such as Azerbaijan, Kazakhstan, and Turkmenistan. All the other regions will become net oil importers by 2035. East Asia will be the biggest importer (14.8 million barrels per day [mb/d] in 2035), followed by South Asia (6.3 mb/d), Southeast Asia (4.4 mb/d), and the Developed Group (3.4 mb/d).

In terms of volume, the net oil imports of Asia and the Pacific (including crude oil and petroleum products) will increase from 773.6 Mtoe (15.5 mb/d) in 2010 to 1,278.0 Mtoe (25.7 mb/d) by 2035. This is comparable to the current crude oil production of the Middle East countries (including Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, Syria, the United Arab Emirates, and Yemen) at 27.7 mb/d of crude oil in 2011, suggesting major challenges for the members of Asia and the Pacific to find and secure, stable, and affordable supply sources outside the region.

A variety of options on the supply and the demand sides will have to be pursued. On the supply side, the continued involvement of Asia and the Pacific members in upstream development outside the region should be encouraged. Joint efforts among the ADB members to explore and produce oil within the region will be highly beneficial to Asia and the Pacific as a whole. Demand-side efforts should focus on the transport sector by encouraging the use of fuel-efficient vehicles and modal shifts in transport.

Natural Gas

Demand for natural gas is projected to increase at 3.9% per year, reaching 1,463.2 Mtoe in 2035, 2.6 times the 2010 level of 566.7 Mtoe. This projected growth will be the fastest among the fossil fuels because of the lower environmental burden and ease of use. The transformation sector—power generation, gas processing, refineries, and other transformation processes—will contribute the most to incremental growth between 2010 and 2035, accounting for 55.6%, followed by other sectors (mainly the residential and commercial sectors) at 24.3% and the industry sector at 14.7%.

Nearly half (51.7%) of the entire growth in natural gas demand between 2010 and 2035 in Asia and the Pacific will come from the PRC, followed by India (13.0%), Indonesia (6.0%), and Japan (4.8%).

Asia and the Pacific includes natural gas resource-rich members such as Australia, Azerbaijan, Turkmenistan, and Uzbekistan. The regional members' interdependence will enhance the security of energy supplies in Asia and the Pacific.

However, bringing the natural gas supply from landlocked locations to the demand centers via pipeline may present difficulties, particularly in Central and West Asia. Financing such supply projects will require strong commitment from both exporters and importers to guarantee long-term demand for, and supply of, natural gas.

Moreover, some economies—the PRC, Republic of Korea, and Taipei,China in East Asia; Japan; and Singapore and Thailand in Southeast Asia—may increasingly depend on liquefied natural gas (LNG) imports. As the construction of LNG facilities (terminals, etc.) requires large amounts of capital, LNG will continue to be traded under long-term contracts, which often involve arduous contract negotiation. Member governments in Asia and the Pacific could work together to facilitate upstream investment and ensure the long-term commitment of exporters and importers.

Sectoral Energy Demand Outlook

In the BAU case, the sectoral energy demand (or final energy demand) in Asia and the Pacific is projected to increase by 2.1% yearly from 3,238.5 Mtoe in 2010 to 5,400.9 Mtoe by 2035. While energy demand in the industry sector is projected to increase relatively slowly, at 1.5%, reflecting shifts the industry structure in some members, the growth in energy demand will be relatively fast in the other sectors (including residential, commercial, agriculture, and fishery) at 2.5% yearly through 2035, and in the transport sector at 2.7%, mainly because of income growth and the subsequent need for convenience and comfort (other sectors) and mobility (transport).

Industry

The energy demand of the industry sector in Asia and the Pacific is projected to increase relatively slowly, at 1.5% per year through 2035, reflecting the projected slow rate of growth (1.0% yearly) of the PRC. Energy demand in the PRC's industry sector will account for more than 50.0% of the total final energy demand in Asia and the Pacific during the outlook period. In the second half of the period (2020–2035), growth in the energy-intensive industries in the PRC will decelerate, and the production of basic materials, such as crude steel and cement, will peak out as new home construction stabilizes and industrial production shifts toward high-value-added products. By contrast, the energy demand of the industry sector in India and Southeast Asia will continue rising steadily at annual rates of 2.4% and 3.4%, respectively, as their industrialization progresses; nevertheless, the combined industry energy demand of India and Southeast Asia in 2035 will account for only 30.2% of the total industry energy demand of Asia and the Pacific, compared with that of the PRC at 51.0%.

Transport

Among the final energy-consuming sectors in Asia and the Pacific, the transport sector is projected to have the fastest increase in energy demand, at 2.7% per year through 2035. The transport sector's share of final energy demand will increase from 16.0% in 2010 to 18.6% by 2035. The growth in energy demand will differ by member and by region, depending on income levels and infrastructure development. Driven by India's motorization, where passenger vehicles will reach 117.8 million units in 2035, up from 16.7 million units in 2010, South Asia's transport energy demand is projected to more than triple from 61.7 Mtoe in 2010 to 192.8 Mtoe in 2035. In contrast, the Developed Group's transport energy demand is projected to decline from 110.2 Mtoe in 2010 to 96.0 Mtoe in 2035, at an annual rate of –0.5%. This is affected by the decline in transport energy demand in Japan as a result of a shift toward fuel-efficient vehicles (mainly hybrids) and the decline in the country's population.

Other Sectors

The category "other sectors" includes the residential, commercial, agriculture, and fishery sectors. Most of the energy consumption in the other sectors is taken up by the residential and the commercial sectors. The final energy demand of the other sectors in Asia and the Pacific is projected to increase from 1,176.7 Mtoe in 2010 to 2,196.4 Mtoe by 2035, at an annual rate of 2.5%. The energy demand of the other sectors in East Asia and South Asia will continue to dominate the energy demand of those in Asia and the Pacific, accounting for 75.9% in 2035, up from 67.0% in 2010. The main drivers of growth include population growth, urbanization (which would result in lifestyle changes), and the diffusion of electric appliances. In contrast, energy demand in other sectors in the Developed Group will increase at a mere 0.1% yearly through 2035.

Energy Demand and Supply Outlook: Alternative Case

The alternative case considers potential for energy savings and CO_2 emissions reduction. In the alternative case, with the deployment of advanced technologies, primary energy demand of Asia and the Pacific will increase at an annual rate of 1.4% through 2035—a slower rate compared with the growth rate of primary energy demand in the BAU case at 2.1% per year. Given the projected growth, the primary energy demand of Asia and the Pacific in the alternative case will be 1,295.2 Mtoe lower than that in the BAU case in 2035. This estimated reduction in primary energy demand exceeds the total industry demand in Asia and the Pacific in 2010, which is equal to 1,216.5 Mtoe.

The assumed shift toward low-carbon-emitting sources in the alternative case will reduce the share of fossil fuels in total primary energy demand to 74.3% by 2035, from 83.2% in the BAU case. Nevertheless, fossil fuel will still have the majority share even in the alternative case.

The regions' potential for primary energy savings (that is, the difference between the primary energy demand in the BAU and alternative cases) correspond to the size of primary energy demand in 2035. East Asia will have the biggest savings potential (853.8 Mtoe), followed by South Asia (214.7 Mtoe), Southeast Asia (114.6 Mtoe), Central and West Asia (37.6 Mtoe), and the Pacific region (0.5 Mtoe).

Energy transformation (including power generation and other transformation processes such as oil refining and gas processing) will represent the biggest energy savings potential, estimated to amount to 734.6 Mtoe in 2035. Demand-side electricity savings account for nearly half of the reduction in energy inputs to energy transformation. The rest will come from thermal efficiency improvements resulting from the use of advanced coal-fired and natural gas-fired generation units. This finding stresses the importance of introducing both energy saving efforts on the demand side and the use of high efficiency technologies on the supply side. Policies and measures encouraging demand-side savings could improve energy security in Asia and the Pacific.

Regarding final energy consumption, the savings potential through 2035 is greatest in the industry sector. In fact, reducing final energy demand of the industry sector by shifting from the BAU case to the alternative case (estimated to amount to 234.7 Mtoe in 2035) will require a relatively small investment. Priority should therefore be placed on the industry sector as it offers cost-effective energy savings options.

The energy savings potential in the residential and commercial sectors (216.5 Mtoe in 2035) will follow that of the industry sector. Members in Asia and the Pacific, particularly developing members whose electricity demand is driven by the residential and commercial sectors, must implement policies and measures that can handle such demand growth. Effective policy options include setting standards, appliance labeling, and enhancing laboratory capacities in testing the energy efficiencies of appliances sold in the market. Based on the energy savings estimates, lighting offers the greatest savings potential for some members; this could be a starting point for energy efficiency policies in the developing members.

The alternative case analysis shows smaller energy savings in the transport sector (109.4 Mtoe in 2035) than in the other final energy demand sectors, despite the assumed introduction of fuel-efficient vehicles, including hybrid, plug-in hybrid, and electric vehicles. The diffusion of these vehicle technologies will be constrained by the infrastructure requirements for fuel charging stations; therefore, more widespread use of these technologies is assumed to take place in the developed members or emerging economies whose policy and plans encourage their introduction. This result suggests that the members need to undergo a modal shift toward public transport such as buses and mass rapid transit (including rail and subway). Such efforts should focus on the urban areas of Asia and the Pacific, where vehicle dependence will grow faster than the country average. Nevertheless, it is important to note that an effective modal shift toward public transport can be realized only when the full-fledged infrastructure is in place to integrate the residential suburbs and the city center.

Electricity Outlook

Driven by economic and industrial development and higher living standards, electricity demand in Asia and the Pacific is projected to more than double between 2010 and 2035, reaching 16,169.2 terawatt-hours (TWh) in 2035. Accordingly, electricity generation is projected to increase from 8,407.8 TWh in 2010 to 18,531.9 TWh in 2035, at an average annual growth rate of 3.2%. Coal will continue to dominate the electricity generation mix, followed by natural gas, which is likely to expand its share moderately. New and renewable energy will also increase its share in electricity generation to 7.1% in 2035, up from 1.9% in 2010. In the alternative case, total electricity generation will be reduced by 3,103.3 TWh to 15,428.6 TWh in 2035 compared with the BAU case. These potential savings can be realized as a result of energy savings in the final energy demand sectors (mainly in the industry, residential, and commercial sectors).

In the alternative case, there will be a significant addition to the installed generating capacity of new and renewable energy, a reduction in the capacity of coal-fired power plants, and expanded nuclear power capacity in 2035. The expected increase in nuclear power capacity in some members, such as the PRC and India, will be offset by substantial capacity reductions in Japan. In the alternative case, the installed capacity of new and renewable energy, such as wind and solar power, could be further increased in Asia and the Pacific, especially in East Asia, South Asia, and the Developed Group.

Electricity generation in the developing member countries (DMCs) will account for 91.0% of the total for Asia and the Pacific in 2035. In particular, East Asia and South Asia will lead an increase in electricity gene ration, as the PRC and India will represent 70.0% of total electricity generation in 2035. The electricity generation mix will vary substantially among the regions. Coal will be the dominant energy source in power generation in East Asia, South Asia, and Southeast Asia, whereas natural gas-fired generation will still have the largest share of the electricity generation mix in Central and West Asia and the Pacific, as they are endowed with vast natural gas resources. Although there is a tendency to reduce coal use in power generation in most regions, coal will replace natural gas as a major fuel for electricity generation in Southeast Asia.

New and renewable energy will have an increasingly important role in meeting the rising electricity needs in Asia and the Pacific. The share of new and renewable energy in the power generation mix will reach 7.1% (BAU case) or 15.8% (alternative case) in 2035, up from 1.9% in 2010. The substantial new and renewable energy capacity expansion will have to be accompanied by the introduction of systems that can enhance grid stability, and by additional investments.

Dwindling domestic fossil fuel production in some members in Asia and the Pacific will become the primary driver—alongside climate change mitigation—for nuclear power generation. Substantial expansion is expected to take place mainly in the PRC and India, whose nuclear capacity may reach 95.0 GW and 34.9 GW, respectively, even in the BAU case. Enhancing the security of nuclear operation will continue to be an important agenda, and international cooperation is encouraged.

Since heavy reliance on fossil fuels for power generation is likely to continue over the outlook period, it is necessary to diversify fuel input for power generation. Reducing dependence on fossil fuels will help improve energy security for energy-importing members and curb CO_2 emissions. For instance, new and renewable energy such as wind and solar power could be an alternative. However, cost competitiveness and technology availability will affect the deployment level for new and renewable energy.

Carbon Dioxide Emissions Outlook

CO_2 emissions in Asia and the Pacific as a whole will increase from 13,404.0 million tons of CO_2 in 2010 to 22,112.6 million tons of CO_2 in 2035 at a growth rate of 2.0% per year, slightly slower than the projected growth in energy demand of 2.1% per year. CO_2 emissions in Asia and the Pacific, which accounted for about 42.8% of world CO_2 emissions in 2010, are projected to reach more than half of world CO_2 emissions in 2035.

East Asia will contribute the largest share of the increase because of strong economic growth, while its CO_2 intensity (CO_2 emissions per total primary energy demand) will decrease at 0.3%

per year, mainly as a result of the shift to less carbon-intensive energy, such as nuclear, natural gas, and renewable energy. In contrast, CO_2 intensities in South Asia and Southeast Asia are projected to increase at annual rates of 0.4% and 0.8%, respectively, as a result of the expected increase in coal demand, especially for power generation.

Per capita CO_2 emissions will vary by region because of the diversity in fuel choice, level of electrification, economic development, industry structure, and living standards. Per capita CO_2 emissions of DMCs are expected to increase at 1.6% per year, while that of the Developed Group is expected to decrease at 0.2% per year.

CO_2 emissions in Asia and the Pacific in the alternative case will be 27.6% lower than in the BAU case. This reduction can be achieved through (i) improvements in energy efficiency (52.6%) and (ii) a shift toward lower-carbon-emitting energy sources (47.4%). Specifically, energy efficiency improvements on both the supply and demand sides will contribute significantly to the overall reduction in CO_2 emissions in Asia and the Pacific.

This finding suggests the importance of improving energy efficiency not only to cope with the challenges to energy security within the region, but also to manage the global challenges of climate change. In other words, Asia and the Pacific has the greatest potential to contribute to global efforts to mitigate the challenges of climate change by reinforcing its policies and measures on energy efficiency.

Energy Investment Outlook

To meet energy demand in the BAU case, Asia and the Pacific as a whole will need a cumulative investment of about $11.7 trillion in the energy sector (2010–2035), from upstream energy extraction and production to midstream energy transformation and transportation to downstream energy distribution.

By type of energy source, electricity and heat will account for the biggest share of total investment requirements in the BAU case (72.5%), followed by natural gas (including its extraction, production, and the construction of infrastructure for international trading) (10.9%), oil (8.5%), and coal (8.1%).

The estimated regional investments in the energy sector in the BAU case depend on the amount of new infrastructure that needs to be built. Driven primarily by the energy needs in the PRC, East Asia's estimated energy sector investments will amount to the biggest share in Asia and the Pacific, at $5.8 trillion (2010–2035). This will be followed by South Asia at $2.4 trillion, which is driven by the energy needs in India. Meanwhile, despite the projected decline in its primary energy demand, the Developed Group is expected to have the third-largest share of investments, at $1.7 trillion, as a result of the investment needs for the assumed deployment of new natural gas-fired and new and renewable power plants in Japan, in addition to assumed expansion in Australia's LNG export capacity.

Diversity in the energy demand and energy exports and imports in Asia and the Pacific will translate into diverse levels of energy investments by members. The estimated burden of energy investments in the BAU case tends to be high for rapidly developing members. These members will have to introduce new infrastructure and energy transformation facilities, and upgrade existing ones.

Nevertheless, the governments of rapidly developing members or their energy utilities tend to suffer from financial constraints and cannot allocate enough investments into energy infrastructure development and renovation. Many of the ADB members have undertaken market reform to increase the energy supply tariffs for electricity, gas, and petroleum products to cover the cost of investment, although sometimes such efforts face political difficulties. Steady progress in this regard is necessary to improve the financial balance of utilities and to enable them to cope with future investment requirements.

Additionally, in view of the higher burden of investments needed for DMCs to develop and upgrade infrastructure and save energy, cooperation among members—particularly the developed members—will be encouraged for financing and technology transfer. Lending institutions will continue to have an important role in guaranteeing such financing to DMCs for the region's sustainable development and mutual prosperity.

The alternative case will require about $19.9 trillion in investments for both the supply and the demand sides. The demand-side investments (additional to the BAU case) will amount to $7.3 trillion that will be needed to deploy advanced energy-efficient technologies for the transport, residential, commercial, and industry sectors. The supply-side investments will amount to $12.6 trillion—higher than the BAU investment needs. This is a result of the additional investments required to deploy advanced coal- and natural gas-fired power generation technologies for improved thermal efficiency as well as for low-carbon-emitting power generation (nuclear, wind, and photovoltaic). The estimated additional investments outweigh the estimated benefits arising from the savings from fossil fuels. This finding suggests that members in Asia and the Pacific should place priority on investments for energy savings, starting with cost-effective options for maximizing energy savings benefits at minimal cost.

Chapter 1

Introduction

Background of the Study

The 48 regional members of the Asian Development Bank (ADB) in Asia and the Pacific are a diverse group, with differing levels of economic development, economic structure, and energy resource endowment. Economic disparities are very wide, ranging from 31 members with a low per capita gross domestic product (GDP) of $800–$5,000 (purchasing power parity, in current international dollars) to 7 members with a per capita GDP of $5,000–$15,000 and the remaining 10 members with a high per capita GDP of $20,000–$50,000.

Collectively, Asia and the Pacific has been the world's center of economic development. The GDP of ADB members in Asia and the Pacific increased 3.4% per year between 2000 and 2010, while the world average was 2.5%. The developing members exhibited much faster growth at 6.6% per year during the same period. As economies of the developing members recovered from the Asian financial crisis in 1998 and industrialization progressed, the total size of their economies nearly doubled by 2010 compared with the 2000 level.

Economic growth translated into substantial growth in energy demand. From 2000 to 2010, the total primary energy demand of Asia and the Pacific grew from 3,101.2 million tons of oil equivalent (Mtoe) in 2000 to 4,985.2 Mtoe in 2010 at 4.9% per year. With this growth, the share of Asia and the Pacific in the world's total primary energy demand reached 39.2% in 2010, up from 30.7% in 2000. Above all, Asia and the Pacific accounted for as much as 71.9% of the world's incremental growth in total primary energy demand during the same period.

This considerable growth in energy demand has a number of implications both regionally and globally. These revolve around various issues, such as sustained high international energy prices, greater investment requirements for infrastructure development, and local and global environmental impacts from increased fossil fuel use.

Energy policy shifts took place as a result of the substantial rise in energy demand in Asia and the Pacific. For many of the regional members, the rise in energy demand for oil and natural gas needs to be met increasingly by imports, and the sustained international high energy prices brought on economic impacts. This called for energy policy shifts toward a greater emphasis on rational energy use through deployment of more efficient technologies, and improvements in the operational efficiency of energy-consuming technologies and production processes. Furthermore, energy source diversification has become an important policy agenda to cope with dwindling domestic fossil fuel production and move toward the promotion of alternative sources such as new and renewable energy and nuclear power.

Many of the regional members face the difficult challenge of removal of energy subsidies. In contrast to high international energy prices, domestic energy prices in some of the regional members remain low, and raising them overnight would not be possible as there is a need to keep energy prices at levels that the poor can afford. Nevertheless, fiscal balance tightening as a result of increased reliance on imports has necessitated governments to consider overcoming difficult political challenges toward subsidy removal. Intentions by some members to remove subsidies do not materialize in anticipation of inflationary pressures.

With continued progress in industrialization, urbanization, and motorization, mainly among the developing regional members, energy demand in Asia and the Pacific is expected to increase steadily in the coming decades. In view of this situation, it is important to understand the future trajectory of energy demand growth with respect to economic development, future energy choice, and the subsequent investment requirements for new capacity expansion and replacement of old facilities. This will help policy makers and business planners better prepare for the future.

Study Objectives

This study, which was prepared by a team of consultants from the Asia Pacific Energy Research Centre (APERC) of the Institute of Energy Economics, Japan (IEEJ) under an ADB regional technical assistance project, aims to estimate the policy-neutral future demand as the business-as-usual (BAU) case for energy of all ADB members, the investment requirements to meet this demand, and the resulting carbon dioxide (CO_2) emissions potential associated with increasing energy demand. The study also attempts to identify policy and technological issues that need to be considered to mitigate the adverse impacts of increasing energy demand. The study is uniquely prepared to cover each member's energy demand and supply in two cases (BAU case and alternative case) and to draw policy implications. Two cases with different assumptions surrounding technology deployment and diffusion and energy choice are presented.

The key questions addressed in this study are:

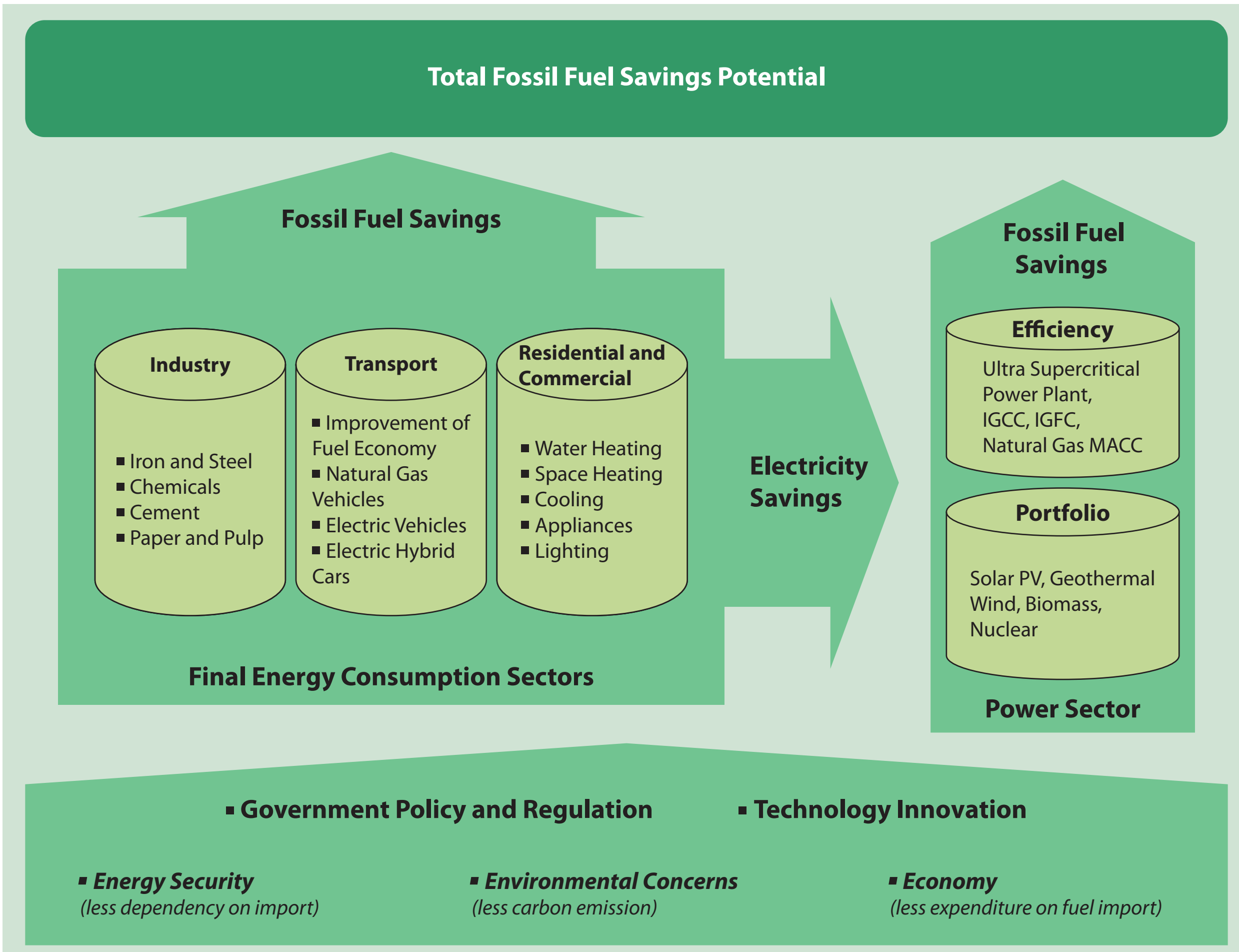
- **Speed of energy demand growth:** Will the current pace of energy demand growth continue in the future? When and what would be the factors that can change the future trajectory of energy demand growth from the current robust growth in Asia and the Pacific?
- **Choice of energy source:** How would the choice of energy in Asia and the Pacific change from the current energy mix? What are the factors that affect such a transformation?
- **Investment requirements for upstream, midstream, and downstream:** How much money will be required to develop energy supply infrastructure to meet the energy demand growth in the future? How will the regional member countries' energy investment burdens differ? What are the factors affecting the difference in these burdens?
- **Technology and energy savings potential:** What is the technical potential for the regional member countries to save energy through the deployment of advanced technologies? What is the additional cost that regional members have to bear to deploy advanced technologies?

Outlook Cases

This study tries to determine a long-term energy demand and supply outlook for the regional members of ADB through 2035 in two cases. On the one hand, the BAU case considers the continued implementation of current policies and the use of current levels of technology applications. On the other hand, the primary objective of the alternative case analysis is to estimate the potential for fossil fuel savings (compared with the BAU case) as the measure to enhance energy security through the maximum deployment of advanced technologies and shifts to low-carbon technologies on both the energy demand and energy supply sides. In the alternative case, it is assumed that policies will be put in place to ensure that maximum use is made of the currently available best performance energy efficiency technologies and renewable power generation technologies. Moreover, governments are assumed to be more aggressive on the installation of nuclear power generation as a substitute for thermal power generation. The members' national plans or targets for new and renewable energy and nuclear power are reviewed and reflected in the alternative case.

The total fossil fuel savings potential is estimated by analyzing the energy savings potential from final energy demand and from the energy transformation process (power generation, refinery, and gas processing). The potential for energy savings in the final energy demand of the

Figure 1.1 Estimation of Fossil Fuel Savings Potential in the Alternative Case



IGCC = integrated gasification combined cycle, IGFC = integrated gasification fuel cell, MACC = more advanced combined cycle, PV = photovoltaic.

industry, transport, and residential and commercial sectors is estimated. For the industry sector, the energy savings potential is estimated by analyzing the improvements in energy intensity resulting from the installation of best technologies and practices in subsectors including iron and steel, chemical, cement, pulp and paper, and others. In the transport sector, a bottom–up analysis of the market diffusion of technologies, including high-efficiency vehicles, natural gas vehicles, electric vehicles, electric hybrid vehicles, and fuel cell cars, is carried out to estimate the energy savings potential. The approach used in estimating the energy savings potential in the residential and the commercial sectors is similar to that used in the transport sector; that is, by a bottom–up analysis of the market diffusion of energy-efficient technologies in the end uses covering water heating, space heating, cooling, electric appliances, and lighting. Compared with the BAU case, energy efficiency improvements on the demand side could lead to savings of fossil fuels and electricity, the latter being translated into savings of fossil fuel inputs for power generation, refinery, and gas processing.

Fossil fuel savings by power generation would result from three dimensions. One is electricity savings as a result of energy-saving efforts on the energy demand side. Another is the installation of highly efficient thermal power technologies such as ultra-supercritical coal power plants, integrated gasification combined cycle power plants, integrated gasification fuel cel power plants, and more advanced combined cycle natural gas power plants, among others. The third is the introduction of low-carbon-emitting power generation technologies including solar photovoltaic, geothermal, wind, biomass, and nuclear power.

Report Structure

The outlook report comprises the following:

- an overview of the BAU case of energy demand and supply outlook;
- an overview of the energy outlook by sector in the BAU case;
- analysis of the alternative case to estimate the energy savings potential from advanced technology deployment in the industry, transport, residential, and commercial sectors, and from energy savings potential and energy source diversification in the power sector;
- electricity outlook for BAU and the alternative cases;
- CO_2 emissions outlook for BAU and the alternative cases;
- energy investment outlook for both BAU and the alternative cases;
- analysis of the major issues that are likely to affect the energy demand and supply in Asia and the Pacific, with a focus on the electricity trade in the Association of Southeast Asian Nations (ASEAN) region, shale gas development in North America and its impacts on Asia, electrification, fuel subsidies, subregional cooperation on oil and natural gas supply, biofuel in Asia, energy efficiency, low-carbon city development, impacts of mass rapid transit systems, renewable energy, and carbon capture and storage;
- energy demand and supply outlook for each of the 48 ADB members in Asia and the Pacific; and
- the energy outlook in table format.

Macroeconomic Assumptions

Gross Domestic Product

GDP assumptions were derived from both APERC and ADB.

APERC provided the GDP assumptions for the following 15 Asia-Pacific Economic Cooperation (APEC) member economies:

- East Asia: the People's Republic of China; Hong Kong, China; the Republic of Korea; and Taipei,China.
- Southeast Asia: Brunei Darussalam, Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam.
- The Pacific: Papua New Guinea.
- Developed Group: Australia, Japan, and New Zealand.

For the other countries, the GDP assumptions were obtained from ADB:

- Central and West Asia: Afghanistan, Armenia, Azerbaijan, Georgia, Kazakhstan, the Kyrgyz Republic, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan.
- East Asia: Mongolia.

- The Pacific: Fiji, Timor-Leste, and other Pacific islands (Cook Islands, Kiribati, the Marshall Islands, the Federated States of Micronesia, Nauru, Palau, Samoa, Solomon Islands, Tonga, and Vanuatu).
- South Asia: Bangladesh, Bhutan, India, the Maldives, Nepal, and Sri Lanka.
- Southeast Asia: Cambodia, the Lao People's Democratic Republic, and Myanmar.

For historical GDP data, the World Bank's *World Development Indicators* (2008) was used for all members except Turkmenistan, for which ADB estimates were used. GDP values in this report are expressed in US dollars at 2000 constant prices, while the GDP values in the investment chapter are expressed in US dollars at 2010 constant prices.

Table 1.1 Overview of Business-as-Usual Case vs. Alternative Case

	Business-as-Usual Case	Alternative Case
Macroeconomic Assumptions	• Gross domestic product: Asian Development Bank or Asia Pacific Energy Research Centre assumptions • Population: *United Nations World 2011 Urbanization Prospects: The 2011 Revision* (medium case) • Oil prices: International Energy Agency's *World Energy Outlook 2010*	
Final Energy Demand	• Current level of technology applications • Reflects existing policies on future energy demand and energy choice	• Deployment of advanced technologies[a] o Industry sector: installation of best technologies and practices by energy-intensive subsectors (including iron and steel, cement, mineral, paper and pulp, and chemical industries) o Transport sector: market diffusion of highly efficient vehicles, and hybrid, plug-in hybrid, and electric vehicles[b] o Other sectors (including residential, commercial, agriculture, and fishery sectors): market diffusion of highly efficient technologies for uses such as water heating, space heating, cooling, and lighting[c]
Transformation	• Current trends in the development of new and renewable energy sources to continue • Nuclear development considered for those for which at least preparatory work for construction of nuclear power plants is being done	• Deployment of new and renewable energy sources (such as wind and photovoltaic) based on current government plans • Deployment of nuclear power plants based on current government plans • Installation/deployment of highly efficient/advanced thermal power technologies such as ultra-supercritical coal power plants, integrated gasification combined cycle power plants, integrated gasification fuel cell power plants, and more advanced combined cycle natural gas power plants
Primary Energy Demand	Determined based on final energy demand and transformation quantities	
Carbon Dioxide Emissions	Calculated based on primary energy demand minus non-energy demand	
Investment Requirements	Investment requirements needed on the supply side (energy extraction, energy transportation, transformation, and distribution)	Investment requirements needed on the supply side (energy extraction, energy transportation, transformation, and distribution), and for the deployment of advanced technologies for final energy end uses

[a] It is assumed that polices that allow currently available best performance/highly efficient technologies will be in place.
[b] Number of passenger vehicle stocks are the same in both business-as-usual and the alternative case. However, it is assumed that the deployment of energy-efficient vehicles is aggressive in the alternative case.
[c] The diffusion/penetration and operational hours of each end use appliance are the same in both business-as-usual and the alternative case. However, more energy-efficient end-use devices are deployed in the alternative case.

Source: Asian Development Bank, Regional and Sustainable Development Department—Infrastructure Division.

Population Data

The United Nations' *2011 World Urbanization Prospects* was used for both historical data and projections for all the regional members. The urban and rural population data were obtained from the same source. Taipei,China's population projection was obtained from the Council for Economic Planning and Development, Taipei,China (2012).

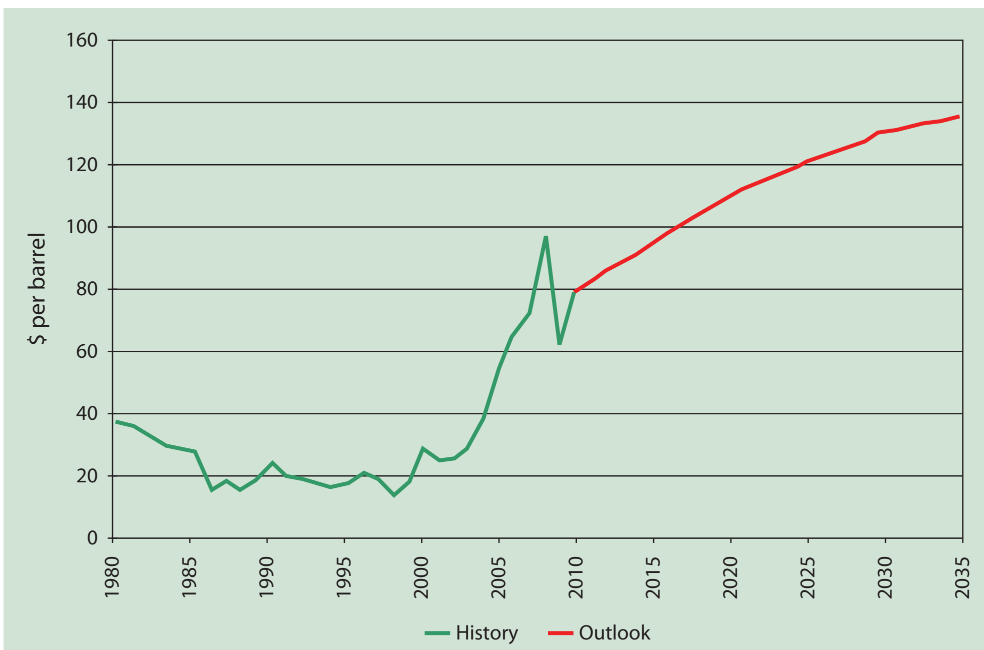
Crude Oil Price

The crude oil price assumption was obtained from the International Energy Agency (IEA) *World Energy Outlook 2010*. With this assumption, the average IEA crude oil import price is assumed to reach $110 per barrel (constant 2009 prices) by 2020 and then rise to $135 per barrel in 2035 (Figure 1.2).

Energy Data

To maintain internal consistency, the IEA's *Energy Balances of Organisation for Economic Co-operation and Development (OECD) Countries and Non-OECD Countries* (IEA 2012) was used as the energy data source for the historical trend analysis of 31 regional members. These members represent more than 99.9% of the total primary energy demand of Asia and the Pacific. Energy data for Papua New Guinea were sourced from the APEC energy database.[1]

Figure 1.2 Crude Oil Price Assumption



Source: International Energy Agency. 2010. *World Energy Outlook*. Paris.

[1] Energy data for economies that belong to APEC are also available from the APEC energy database. However, these data were not used to maintain internal consistency, except in the case of Papua New Guinea, for which energy data were not available from the IEA.

For the following members whose data are not included in IEA (2012), the United Nations Energy Statistics Database was the source of energy data: Afghanistan, Bhutan, the Cook Islands, Fiji, Kiribati, the Maldives, Nauru, Palau, Samoa, Solomon Islands, Timor-Leste, Tonga, and Vanuatu. Energy data for the Marshall Islands and the Federated States of Micronesia were sourced from an ADB survey.

Energy data for the Lao People's Democratic Republic (Lao PDR) were obtained from the Ministry of Energy and Mines.

The outlook exercise was not conducted for Tuvalu due to unavailability of energy data.

Outlook Time Periods

The base year is set at 2010. The outlook period is from 2010 to 2035.

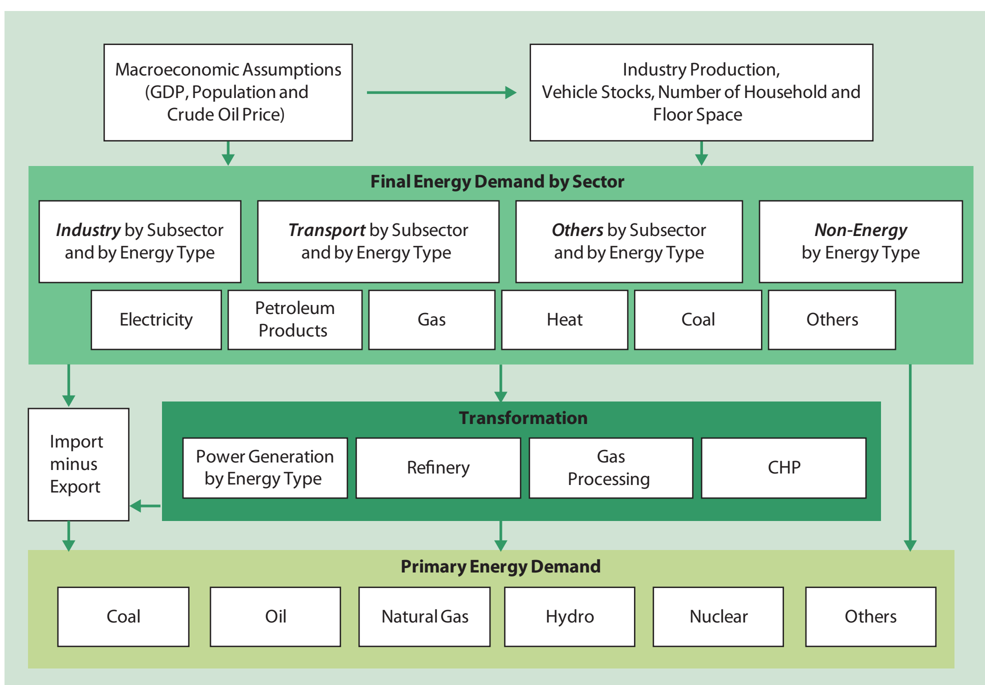
Energy Outlook Methodologies

To forecast energy demand, an econometric approach was applied. The IEEJ model is used in the majority of the country analyses. Demand equations are econometrically estimated using historical data, while future values are projected using the explanatory variables. The IEEJ model allows a historical trend analysis of socioeconomic variables and their correlation with energy trends.

The steps taken to forecast energy demand and supply are explained in Figure 1.3.

- For those countries for which socioeconomic data such as industrial production, vehicle stocks, household numbers, and floor space are available, the future assumptions are

Figure 1.3 Model Framework, Institute of Energy Economics, Japan



CHP = combined heat and power, GDP = gross domestic product.

derived by using the key macroeconomic assumptions—including GDP, population, and crude oil price. These socioeconomic variables offer the basis for analyzing final energy demand. For those countries for which socioeconomic data are not available, the key macroeconomic indicators are used as the underlying driver for final energy demand.

- Once the final energy demand projections by type of energy are ready, the transformation analysis—including electricity generation, oil refining, gas processing, and coal transformation—follows. In addition, international electricity trade is analyzed as a source of electricity supply.
- Using the outcomes from the analyses of final energy demand, energy requirements, and transformation, the primary energy demand outlook by energy type is estimated.
- Given the projected primary energy demand, energy imports and exports are analyzed by type of energy based on domestic energy reserves information, and assessment of energy supply infrastructure development for pipelines, tankers, and receiving terminals.

The level of disaggregation in the analysis by sector and by energy type depends on data availability. An extensive literature survey was naturally conducted to reflect policy shifts in the outlook results. For example, in a case where the historical trends do not necessarily offer an accurate assessment of future energy demand due to a change in policy, the analysis is conducted outside of the model, and the results are reflected in the model as exogenous variables.

For the countries with relatively short data periods, the Long-Range Energy Alternatives Planning System (LEAP) software was used to project future energy demand and supply using the intensity approach. The intensity approach is based on historical trend analysis in combination with literature survey to determine the level of energy intensities (energy requirement per unit of GDP or per unit of population). An inter-country comparison was carried out to appropriately assess future energy intensity levels.

Submodels for the industry, residential, commercial, and transport sectors were developed to analyze the energy savings potential for the alternative case. The estimated energy savings potentials in the final energy demand sectors are integrated into the IEEJ Model and LEAP Model. The power generation mix assumptions for the alternative case consider each member's future plan regarding nuclear power and new and renewable energy, and are reflected in the IEEJ Model and LEAP Model (Figure 1.4).

Calculations of Carbon Dioxide Emissions

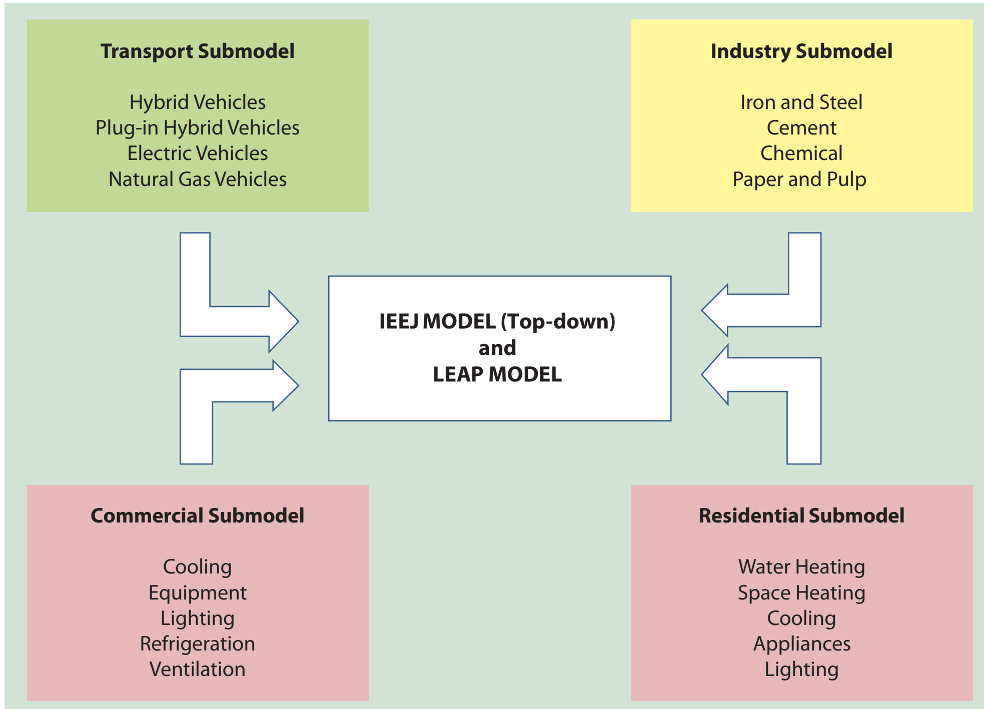
Carbon dioxide (CO_2) emissions were calculated following the *Revised 1996 Guidelines for National Greenhouse Gas Inventories* of the Intergovernmental Panel on Climate Change (IPCC). As such, only emissions from fossil fuels were calculated. However, fugitive emissions were not taken into account—only the emissions from fuel combustion of both stationary and mobile sources.

Emissions from the following sectors are included:

- transformation;
- energy; and
- final consumption sectors, which include the industry, transportation, commercial, residential, agriculture, and other sectors.

Fuel combustion occurs in the transformation, energy, and final consumption sectors. In the transformation sector, fuel is combusted in heat and electricity generation, as well as in the operation of machinery in other transformation processes. It should be noted that crude oil that is refined into petroleum products is not combusted. Hence, there are no emissions

Figure 1.4 Modeling Framework for the Alternative Case



IEEJ = Institute of Energy Economics, Japan; LEAP = Long-Range Energy Alternatives Planning System.

calculated for refinery throughputs, but refinery gas and other fuels combusted to operate crude oil distillation units are included in the calculation of CO_2 emissions. Fuels combusted for heating, pumping, traction, and lighting purposes in energy extraction and other energy transformation processes are also included.

In final energy consumption, the estimated demand for fossil fuels—which excludes non-energy demand in the industry, transport, residential, commercial, agriculture, and other sectors—is also included for the calculation of CO_2 emissions.

The energy content of fossil fuels are reported in net calorific value which is lower than the gross calorific value (GCV) by the following factors:

- Coal and coal products: 95% of GCV
- Oil and oil products: 95% of GCV
- Natural gas: 90% of GCV

The carbon emissions conversion factors used in the calculation are the average conversion factors from the 1996 revised IPCC guidelines as shown in Table 1.2. Members may have different emission factors for each of the products, but in this outlook, the average values shown in the table are used for comparability and consistency.

Corrections for unoxidized carbon are also applied, using the following multipliers:

- Coal: 0.98
- Peat: 0.99
- Oil: 0.99
- Gas: 0.995

Table 1.2 1996 Intergovernmental Panel on Climate Change Average Carbon Emission Factors

Oil and Oil Products	t C/TJ	Coal and Coal Products	t C/TJ
Crude oil	20.0	Anthracite	26.8
Orimulsion	22.0	Coking coal	25.8
Natural gas liquids	17.2	Other bituminous coal	25.8
Gasoline	18.9	Subbituminous coal	26.2
Jet kerosene	19.5	Lignite	27.6
Other kerosene	19.6	Oil shale	29.1
Shale oil	20.0	Peat	28.9
Gas/diesel oil	20.2	Coal briquettes	25.8
Residual fuel oil	21.1	Coke oven/gas coke	29.5
LPG	17.2	Coke oven gas	13.0
Ethane	16.8	Blast furnace gas	66.0
Naphtha	20.0		
Bitumen	22.0	**Gaseous Fossil Products**	**t C/TJ**
Lubricants	20.0	Natural Gas (Dry)	15.3
Petroleum coke	27.5		
Refinery feedstocks	20.0		
Refinery gas	18.2		
Other oil products	20.0		

LPG = liquefied petroleum gas, t C = ton of carbon, TJ = terajoule.
Source: International Energy Agency. 2011. *CO_2 Emissions from Fuel Combustion*. Paris.

Following this, the results are multiplied by 44/12 (the molecular ratio of CO_2 to carbon) to convert the numbers from tons of carbon to tons of CO_2 equivalent.

Special Notes

Readers of this *Energy Outlook* should take note of the following:

- Final energy demand is the sum of demand by the different end-use sectors, including industry, transport, non-energy, and others (including residential, commercial, agriculture, and fishery). Sectoral energy demand is defined to express the same as that of final energy demand.
- Energy demand in the other sectors includes those for residential, commercial, and other non-specified sectors, such as agriculture and fishery.
- Primary energy demand is the sum of final energy demand and transformation energy requirements for power generation, heat production, gas processing, and refineries.
- Energy type called "others" is defined to include noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, concentrating solar power, and others). Small hydro is excluded from new and renewable energy sources. Electricity imports and exports are included in "others" as well, although their shares in the total are small.
- Net imports of energy are defined as imports minus exports.
- Tuvalu was not included in this study due to unavailability of data.

Chapter 2

Energy Demand and Supply Outlook: Business-as-Usual Case

Energy Demand and Supply Outlook: Business-as-Usual Case

- *Asia and the Pacific's primary energy demand is projected to increase at 2.1% per year over the outlook period (2010–2035)—a pace faster than the projected world average growth rate of 1.5% per year during the same period. With this growth, the primary energy demand of Asia and the Pacific will reach 8,358.3 Mtoe in 2035 up from 4,985.2 Mtoe in 2010.*
- *While Asia and the Pacific's projected primary energy demand growth is faster than the world average, the trend would be slower than the historical one, and energy intensity (energy requirements to produce one unit of GDP) would be decoupled from the growth in GDP through 2035, in view of the assumed steady energy efficiency improvements and some shifts in economic structure.*
- *The mix of total primary energy will be dominated by coal in 2035; nevertheless, its share will be reduced from 46.2% in 2010 to 42.1% in 2035 as the region as a whole will shift toward less-carbon-emitting sources, such as natural gas and nuclear energy.*
- *Asia and the Pacific's growth in fossil fuel sources (coal, oil, and natural gas) would be increasingly met by imports. Net imports of fossil fuels would nearly double from 830.5 Mtoe in 2010 to 1,515.5 Mtoe in 2035. While Asia and the Pacific as a whole would marginally be able to meet the demand for coal through 2035, the net imports ratio of natural gas would reach 22.1% in 2035. The region's oil imports ratio would account for 64.9% in 2035, up from 62.5% in 2010. The projected oil imports in 2035 would be comparable to the current crude oil production in the Middle East, and this suggests a difficult challenge for Asia and the Pacific of how to find and secure stable supply sources at a reasonable price.*

2.1 Main Assumptions

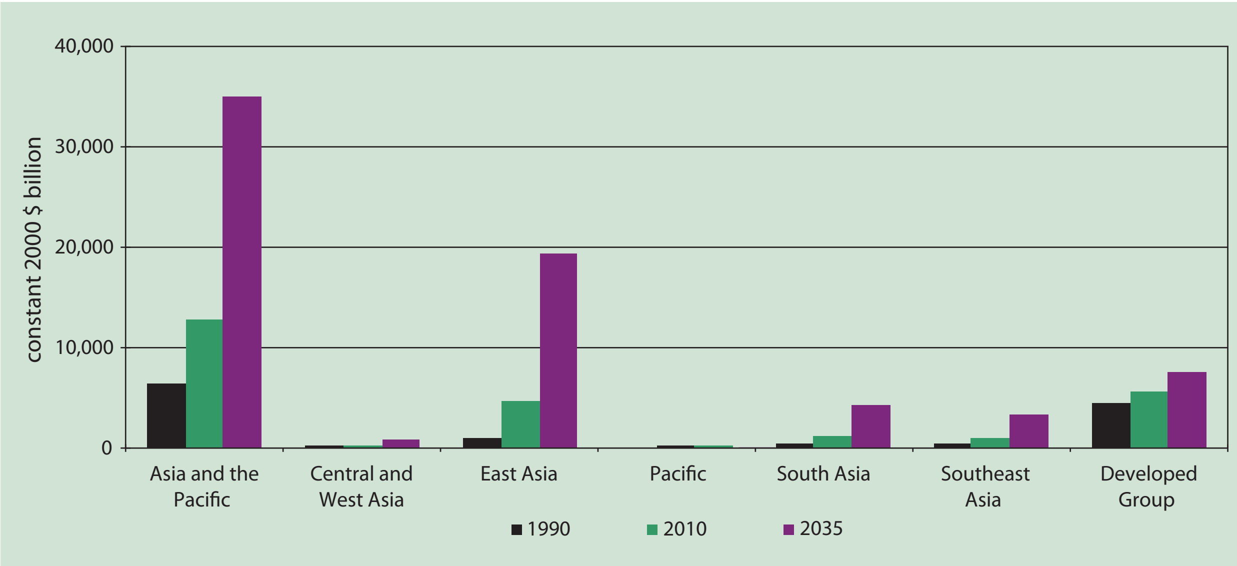
2.1.1 Gross Domestic Product

Gross domestic product (GDP) assumptions were derived from both the Asia Pacific Energy Research Centre (APERC) and the Asian Development Bank (ADB). APERC provided the GDP assumptions for the 15 Asia-Pacific Economic Cooperation (APEC) member economies and ADB estimated them for the other members. For historical GDP data, the World Bank's *World Development Indicators* (2012) was used for all members. GDP values in this report are expressed in US dollars at 2000 constant prices.

When the global recession triggered by the Lehman shock in 2008 hit the major industrial countries severely, its impacts were felt across the economies in Asia and the Pacific, though the economy of Asia and the Pacific as a whole returned to a recovery track faster than anticipated. Although the members of Asia and the Pacific are still vulnerable to the weak economic prospects of the United States and the eurozone in terms of trade, investment, and commodity prices, the economy of Asia and the Pacific is expected to grow robustly and lead the world economy through 2035.

The GDP of Asia and the Pacific is projected to reach $35,035.6 billion (constant 2000 $) in 2035 with an annual growth rate of 4.1% between 2010 and 2035, which is higher than that of the historical trend at 3.6% between 1990 and 2010 (Figure 2.1). Overall, developing members are

Figure 2.1 Gross Domestic Product in 1990, 2010, and 2035



likely to register a strong economic performance as their share in the total GDP will increase substantially from 29.0% in 2010 to 78.7% in 2035. In particular, East Asia's GDP, mainly led by the PRC, will stand out with a projected annual growth rate of 5.8% over the outlook period, followed by South Asia at 5.6%, Southeast Asia at 4.9%, Central and West Asia at 4.5%, and the Pacific at 3.7%.

Among the developing members, the PRC, India, and the member states of the Association of Southeast Asian Nations (ASEAN) will play a major role to boost the economic growth of Asia and the Pacific. The PRC, the world's second-largest economy, is expected to achieve robust economic growth with an annual growth rate of 6.6% over the outlook period. Since the aging of the PRC's society is likely to be accelerated, however, the abundant and inexpensive labor force—one of the advantages that have buttressed the country's rapid economic development—will gradually decline, consequently slowing down its economic growth toward 2035. Still, the PRC's GDP per capita will reach $11,488 in 2035.

By contrast, India's GDP per capita will be relatively low at $2,454 in 2035, which is approximately one-third of Asia and the Pacific's GDP per capita in the same year. Nevertheless, India has the potential to maintain a strong economic performance. For instance, India's share of the base of the economic pyramid (BOP) in total population at 98.6% indicates great opportunities for the market if the BOP's needs are better met and their productivity and incomes are increased (IFC and WRI 2007).[2] In addition, unlike the PRC's situation, the relatively high proportion of younger people in India's population will ensure a continued labor force and help productivity to be enhanced in the long term. On the other hand, India's economic development may be hindered by such concerns as the country's need to deal with barriers in the form of insufficient infrastructure development and power shortages. If India were to overcome these obstacles successfully, it could experience robust economic growth through 2035.

[2] People with incomes of $3,000 and below (in 2002 international dollars, adjusted for purchasing power parity) are defined as the base of the economic pyramid.

Box 2.1 Electricity Import and Export within the Association of Southeast Asian Nations Member States for Regional Cooperation

The Association of Southeast Asian Nations (ASEAN) prioritizes energy integration to enhance energy security. To this end, electricity infrastructure development is considered important to enable electricity trade in the integrated market. An operational benefit of such a large-scale power grid is flexibility added to the market. For instance, the connected grid helps balance supply and demand of electricity through trade among the regions.

The ASEAN Power Grid (APG) is a flagship program mandated in 1997 by the ASEAN government leaders under the ASEAN Vision 2020. The ASEAN Plan of Action for Energy Cooperation 2010–2015 highlights this program as one of seven program areas to be accelerated for implementation. The APG consists of 16 interconnection projects as listed in Box Table 2.1.1. The project is expected to expand from a bilateral to a subregional basis, and finally aims to achieve a totally integrated system.

Securing electricity supply is critical for fast-developing economies in ASEAN to sustain their economic activity. The electricity demand of the region is projected to grow at 4.3% per annum between 2010 and 2035, which is higher than that of Asia and the Pacific.

ASEAN expects economic benefits from the APG. First, the project is pursued to optimize energy resources of the region. Although ASEAN as a whole is endowed with energy resources, they are distributed unevenly, which will result in a difference in power generation costs. The interconnected power grid, however, will reduce the gap by transferring power from energy-rich or lower-cost power countries to energy-poor or high-cost power countries. For instance, the Lao People's Democratic Republic (Lao PDR), rich in hydro, exports power to Thailand, which is facing rapid electricity demand growth and high electricity costs due to dependence on fossil fuels for power generation.

Second, it will be cost-effective if remote rural areas are closer to the power grid at the border in neighboring countries than to in-country transmission lines. This means that transmission costs would be saved and transmission loss reduced. In addition, secured accessibility to the power center in adjacent countries would help increase the electrification rate. Since ASEAN includes countries where the electrification rate is substantially low (such as Cambodia and Myanmar, although there is a great disparity in the figure throughout the region), the cross-border interconnections will render remote rural areas access to electricity.

Box Table 2.1.1 ASEAN Power Grid Network

	Earliest Commercial Operation Date
1) Peninsular Malaysia – Singapore	2018
2) Thailand – Peninsular Malaysia	
• Sadao – Bukit Keteri	Existing
• Khlong Ngae – Gurun	Existing
• Su Ngai Kolok – Rantau Panjang	2015
• Khlong Ngae – Gurun (2nd Phase)	2016
3) Sarawak – Peninsular Malaysia	2015–2021
4) Sumatra – Peninsular Malaysia	2017
5) Batam – Singapore	2015–2017
6) Sarawak – West Kalimantan	2015
7) Philippines – Sabah	2020
8) Sarawak – Sabah – Brunei Darussalam	
• Sarawak – Sabah	2020
• Sabah – Brunei Darussalam	Not selected
• Sarawak – Brunei Darussalam	2012–2016
9) Thailand – Lao PDR	
• Roi Et 2 – Nam Theun 2	Existing
• Sakon Nakhon 2 – Thakhek – Theun Hinboun (Expansion)	Existing
• Mae Moh 3 – Nan – Hong Sa	2015
• Udon Thani 3 – Nabong	2018
• Udon – Ratchathani 3 Pakse – Xe Pian Xe Namnoy	2018
• Khon Kaen 4 – Loei 2 – Xayaburi	2019
• Thailand – Lao PDR (New)	2015–2023
10) Lao PDR – Viet Nam	2011–2016
11) Thailand – Myanmar	2016–2025
12) Viet Nam – Cambodia (new)	2017
13) Lao PDR – Cambodia	2016
14) Thailand – Cambodia (new)	2015–2020
15) East Sabah – East Kalimantan	2020
16) Singapore – Sumatra	2020

Lao PDR = Lao People's Democratic Republic.
Source: H. Situmeang. 2013 Towards ASEAN Energy Security System. Presented at the First APEC Oil and Gas Security Forum. Tokyo. 18–19 April.

Nevertheless, there are issues that ASEAN needs to resolve in order to facilitate implementation of the APG. As ASEAN is a group of countries with different levels of development and diverse legal systems, it is necessary to harmonize regulatory and institutional frameworks as well as technical standards codes. The coordinated legal structure is important in calling for investment as well. The investment requirement for the APG is estimated at $5.9 billion. To secure financial sources, it is necessary not only to receive support from international organizations and bilateral donor countries but also to engage

continued on next page

Box 2.1 *continued*

the private sector. The establishment of a fair and transparent regulatory framework would lower the barrier for the private sector to make investments. These challenges necessitate further cooperation of the member states.

Currently, countries in the Greater Mekong Subregion (GMS) mainly engage in electricity trade in ASEAN (Box Table 2.1.2). For net power export countries such as the Lao PDR and Myanmar, electricity export is a major component in export earnings. The Lao PDR signed a memorandum of understanding to supply electricity of 7,000 megawatts by 2015 to Thailand and 5,000 megawatts by 2020 to Viet Nam.

Electricity trade is likely to continue expanding to increase the economic benefits to ASEAN countries. In this study, electricity imports of Thailand and Viet Nam are estimated to rise to approximately 8,000 gigawatt-hours in 2035. As each country has different conditions in terms of technology and regulatory framework, efforts to coordinate them are crucial to draw investment from the private sector and expedite the integration of the electricity market.

Box Table 2.1.2 Greater Mekong Subregion Power Trade and Net Imports, 2010 (GWh)

	Imports	Exports	Net Imports
Cambodia	1,546	–	1,546
Lao PDR	1,265	6,944	(5,679)
Myanmar	–	1,720	(1,720)
Thailand	6,938	1,427	5,511
Viet Nam	5,599	1,318	4,281
PRC	1,720	5,659	(3,939)
Total	17,069	17,069	–

( ) = negative number, GWh = gigawatt-hour, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Note: The table refers to trade within the Greater Mekong Subregion only and does not consider power flows from Guangxi Zhuang Autonomous Region and Yunnan Province to the rest of the PRC, nor Thailand's power imports from Malaysia.
Source: ADB. 2012. *Greater Mekong Subregion Power Trade and Interconnection – 2 Decades of Cooperation*. Manila.

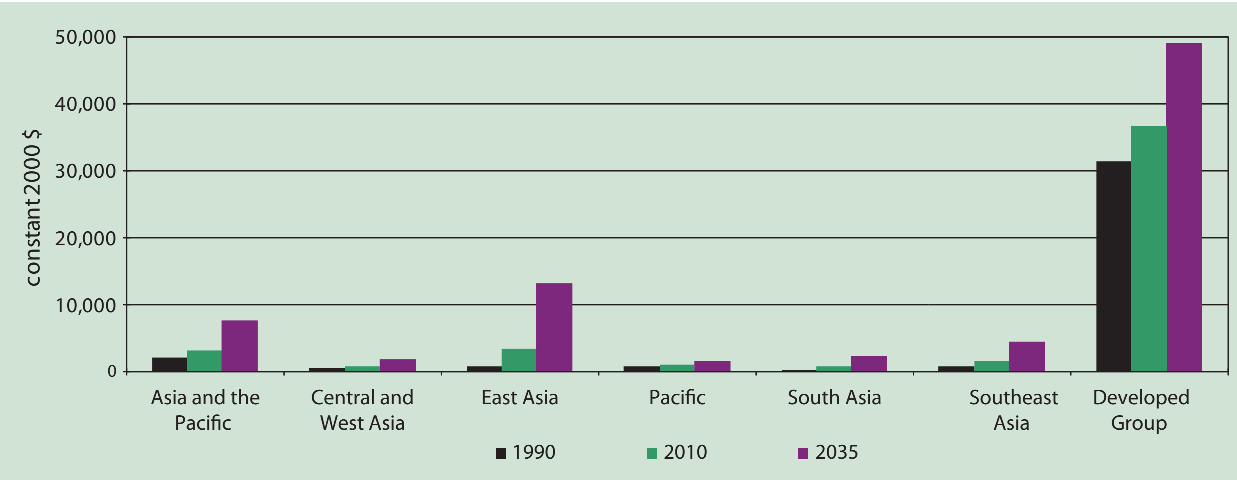
Sources:
Asian Development Bank. 2012. *Greater Mekong Subregion Power Trade and Interconnection—2 Decades of Cooperation*. Manila.
Association of Southeast Asian Nations (ASEAN). 2009. *ASEAN Plan of Action for Energy Cooperation 2010–2015*. http://aseanenergy.org/media/filemanager/2012/10/11/f/i/file_1.pdf
ASEAN. 2010. *Master Plan on ASEAN Connectivity*. Jakarta.

ASEAN member states are also expected to demonstrate robust growth, especially after a competitive market of over 600 million people in ASEAN is established through regional integration in 2015. The ASEAN Economic Community will be a single regional common market with zero tariffs and free flow of goods, services, and workers between the member states. ASEAN's abundant and low-cost labor market may gradually catch up with the PRC's role of providing such a labor force as the country has recently been faced with rising personnel costs. Along with a creeping shift of focus on labor markets from the PRC to ASEAN, the manufacturing industry is likely to look for a foothold in ASEAN. Among the ASEAN member states, Myanmar has drawn interest from the world as a potential market since economic sanctions against the country have most recently been removed.

Central and West Asia's GDP is projected to almost triple from $244.7 billion in 2010 to $732.3 billion in 2035, with an annual growth rate of 4.5% over the outlook period. Nevertheless, a substantial gap in GDP is observed among the members in Central and West Asia. In terms of economic scale, Pakistan's GDP would be the largest, reaching $269.6 billion in 2035. However, Pakistan's annual GDP growth rate would be rather moderate at 3.4% between 2010 and 2035 unless infrastructure development is sufficient to facilitate economic activity. On the other hand, the objective of infrastructure development in resource-rich members such as Azerbaijan and Turkmenistan is to export their hydrocarbons, which is expected to promote their economic expansion, respectively achieving an annual growth of 6.2% and 4.4% through 2035. Resource-rich members in this subregion also aim to change their economic structure by encouraging the manufacturing sector to reduce its heavy dependence on the resource industry.

Compared to the developing members, the GDP growth rate of the Developed Group will be relatively low at 1.1% per year between 2010 and 2035, mainly due to Japan's decelerated economic

Figure 2.2 Gross Domestic Product per Capita in 1990, 2010, and 2035



growth. Since Japan accounts for most of this group's GDP, Japan's economic performance could significantly impact the total GDP of the Developed Group. Japan's ongoing depopulation and the aging of its society will lead to the decline in the proportion of the population that is of productive age, thereby making it difficult for Japan to expand its economy. The GDP of Australia and of New Zealand are expected to grow steadily at 2.8% and 2.6%, respectively, over the outlook period.

The GDP per capita of Asia and the Pacific is projected to reach $7,633.6 billion (constant 2000 $) with a faster annual growth rate of 3.4% between 2010 and 2035 compared to that of the historical trend at 2.2% between 1990 and 2010 (Figure 2.2). The GDP per capita of the Developed Group stands out although its annual growth rate of the outlook period will be the lowest among the regions. Following the Developed Group, only East Asia's GDP per capita is likely to surpass that of Asia and the Pacific by 2035.

2.1.2 Population

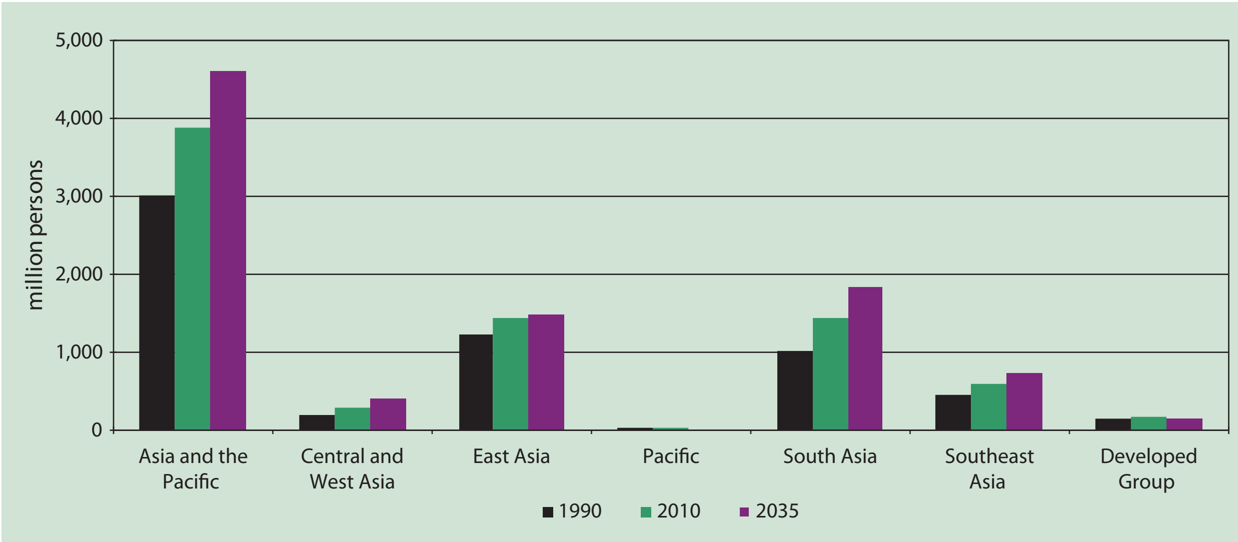
The United Nations' *World Urbanization Prospects: The 2011 Revision* was used for both historical data and projections for all the members. The applied projections are based on the medium case. Taipei,China's population projection was obtained from the Council for Economic Planning and Development (2012).

The population of Asia and the Pacific will increase from 3.9 billion in 2010 to 4.6 billion in 2035 (Figure 2.3). Its annual growth rate will slow down from 1.3% between 1990 and 2010 to 0.7% between 2010 and 2035. Compared to the historical trend, a moderate growth rate will be observed over the outlook period among all the regions. The PRC and India will account for 64.5% of the region's total population in 2035. However, the PRC's population is projected to peak in 2025 and then gradually decline, whereas India's population is likely to exceed that of the PRC around 2020 and reach 1.6 billion in 2035.

2.2 Primary Energy Demand by Type

In the business-as-usual (BAU) case, the total primary energy demand (TPED) of Asia and the Pacific is projected to increase steadily from 4,985.2 million tons of oil equivalent (Mtoe) in 2010

Figure 2.3 Population in 1990, 2010, and 2035



to 8,358.3 Mtoe in 2035, growing at an annual rate of 2.1%. The projected growth is slower compared with past trends observed between 1990 and 2010, which averaged 3.8% per year (Figure 2.4). However, Asia and the Pacific's projected growth trends would be faster compared with world TPED, which is projected to increase at 1.5% during the same period.[3] Primary energy demand per capita of Asia and the Pacific will increase to 1.82 tons of oil equivalent (toe) per person in 2035, from 1.28 toe per person in 2010.

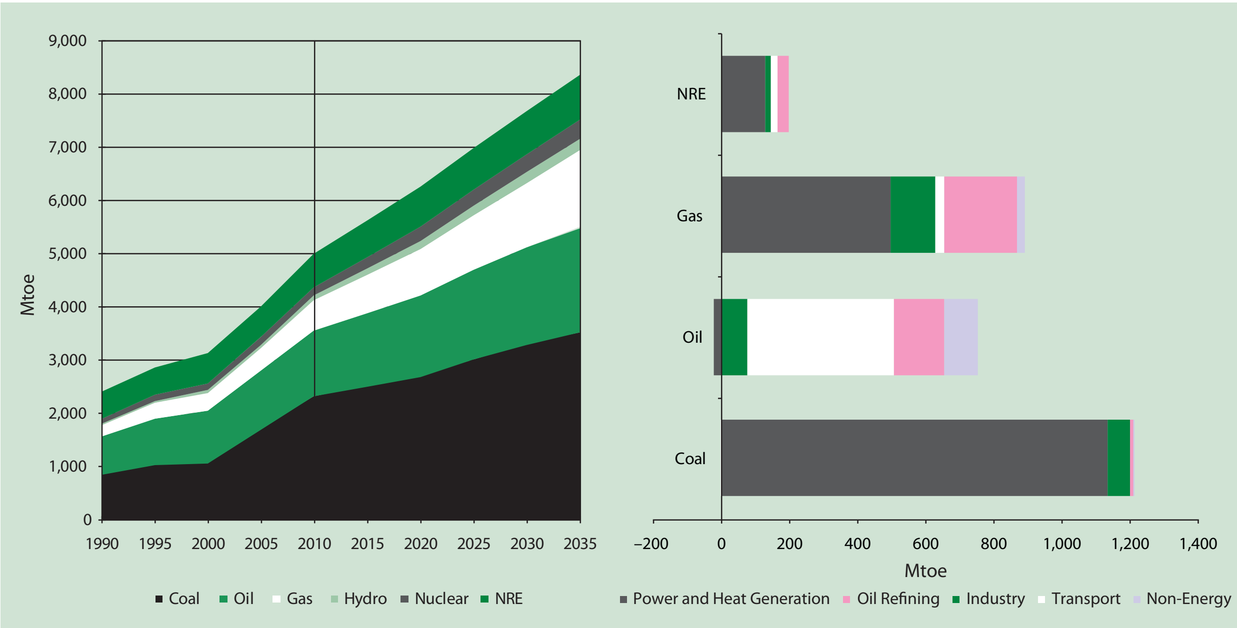
The TPED of developing member countries (DMCs) is projected to increase slightly faster at 2.3% from 2010 to 2035 compared with the growth rate of Asia and the Pacific as a whole (Table 2.1). The DMCs' near-term growth is faster at 2.5% per year (2010–2020) compared with that of long-term growth at 2.2% per year (2020–2035). With this growth, the share of DMC TPED in total Asia and the Pacific TPED will increase to 92.4% in 2035, up from 87.2% in 2010.

By energy type, **coal** will maintain the dominant share in the primary energy demand of Asia and the Pacific, accounting for 42.1% in 2035. Despite its biggest share, it will decrease from 46.2% in 2010 as demand for coal is projected to proceed at a slower rate of 1.7% compared with that of TPED at 2.1% (2010–2035). The projected slow growth of coal demand is largely affected by the trends in the PRC, which in 2010 accounted for 69.3% of coal demand in Asia and the Pacific. Due to the deployment of efficient coal-fired generation units and shifts to other energy sources (natural gas, nuclear, and new and renewable energy), the PRC's coal demand will increase slowly at an average annual rate of 1.4% from 2010 to 2035. In contrast, coal demand in other regions, mainly in South Asia and Southeast Asia, will grow faster than what was experienced historically because of the cost competitiveness of coal supported by the plentiful domestic resources endowment.

Oil will maintain its position of having the second-largest share in TPED, accounting for 23.6% of TPED in 2035. Similar to coal, oil's demand is projected to register a slower rate at 1.9% per year (2010–2035), compared with that of TPED. Motorization-led oil demand growth in the

[3] The comparison is made with the current policy scenario result from the IEA (2012).

Figure 2.4 Primary Energy Demand by Source (left), and Incremental Growth in Primary Energy Demand by Source and by Sector (right)



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.

developing member countries will be offset by a decrease among the developed members as well as shifts away from oil in the power sector, resulting in a relatively slow growth of oil demand in Asia and the Pacific as a whole.

Natural gas will register the fastest growth rate among the fossil fuels at 3.9% per year. Lower environmental burden and ease of use are the key factors that drive the demand for natural gas. With the fast growth, the share of natural gas will account for 17.5% of TPED in 2035, up from 11.4% in 2010. By sector, growth in the transformation sector (which includes power generation and other transformation) will be the biggest contributor to the incremental growth in natural gas demand from 2010 to 2035 accounting for 55.6%, followed by the other sectors (residential, commercial, agriculture, and fishery) at 24.3% and the industry sector at 14.7%.

Nuclear is projected to increase at 3.5% per year through 2035. Currently, nuclear power is operational in seven members of Asia and the Pacific, including Armenia, the PRC, India, Japan, the Republic of Korea, Pakistan, and Taipei,China, with a total installed capacity of 87.7 gigawatts (GW) in 2010. The PRC and India are projected to expand their nuclear power capacities to cope with the rise in electricity demand and to diversify their energy mixes. Malaysia, Thailand, and Viet Nam are assumed to start nuclear operations over the outlook period. In contrast, it is expected that the suspended operation of Japan's nuclear power plant after the Fukushima accident[4] will gradually restart from 2014, while no new plant additions will be made through 2035 and result in a decline of total capacity to 9.3 GW in 2035. In addition, the three existing nuclear power plants of Taipei,China (with a total capacity of 5.1 GW) will be phased out over the outlook period to be replaced by two nuclear power units (each 1.4 GW). The declining

4 Japan's nuclear installed capacity was 49.0 GW in 2010, while only two units were operational at the time of writing as the operation of other units were suspended after the accident at the Fukushima nuclear power plant.

Table 2.1 Primary Energy Demand: Business-as-Usual

		Primary Energy Demand (Mtoe)			Annual Growth Rates (%)		
		2010	2020	2035	2010–2020	2020–2035	2010–2035
Coal	DMCs	2,133.8	2,520.7	3,349.6	1.7	1.9	1.8
	Developed Group	167.6	167.5	166.7	0.0	0.0	0.0
	Asia and the Pacific Total	2,301.4	2,688.2	3,516.3	1.6	1.8	1.7
Oil	DMCs	989.3	1,299.1	1,775.2	2.8	2.1	2.4
	Developed Group	248.9	215.5	197.8	(1.4)	(0.6)	(0.9)
	Asia and the Pacific Total	1,238.2	1,514.6	1,973.0	2.0	1.8	1.9
Natural Gas	DMCs	450.4	708.2	1,271.3	4.6	4.0	4.2
	Developed Group	116.2	147.0	191.9	2.4	1.8	2.0
	Asia and the Pacific Total	566.7	855.2	1,463.2	4.2	3.6	3.9
Nuclear	DMCs	77.2	220.4	347.3	11.1	3.1	6.2
	Developed Group	75.1	57.0	14.9	(2.7)	(8.5)	(6.3)
	Asia and the Pacific Total	152.3	277.3	362.3	6.2	1.8	3.5
Hydro	DMCs	89.2	155.8	192.5	5.7	1.4	3.1
	Developed Group	10.3	12.3	12.9	1.8	0.3	0.9
	Asia and the Pacific Total	99.5	168.1	205.3	5.4	1.3	2.9
Others	DMCs	603.3	684.1	783.9	1.3	0.9	1.1
	Developed Group	21.3	41.7	54.5	6.9	1.8	3.8
	Asia and the Pacific Total	624.6	725.8	838.4	1.5	1.0	1.2
Total	DMCs	4,345.4	5,588.2	7,719.6	2.5	2.2	2.3
	Developed Group	639.8	641.0	638.7	0.0	0.0	0.0
	Asia and the Pacific Total	4,985.2	6,229.1	8,358.3	2.3	2.0	2.1

( ) = negative number, DMC = developing member country, Mtoe = million tons of oil equivalent.

nuclear utilization in Japan and Taipei,China will offset the new capacity additions by the other ADB members in Asia and the Pacific.

Hydro is projected to represent the fastest annual growth of 2.9% per year through 2035—faster than the growth rate of TPED. The expansion of hydro capacity in the PRC, reaching 346.8 GW in 2035 compared with 212.5 GW in 2010, is the key driver affecting the overall growth in hydro energy demand.

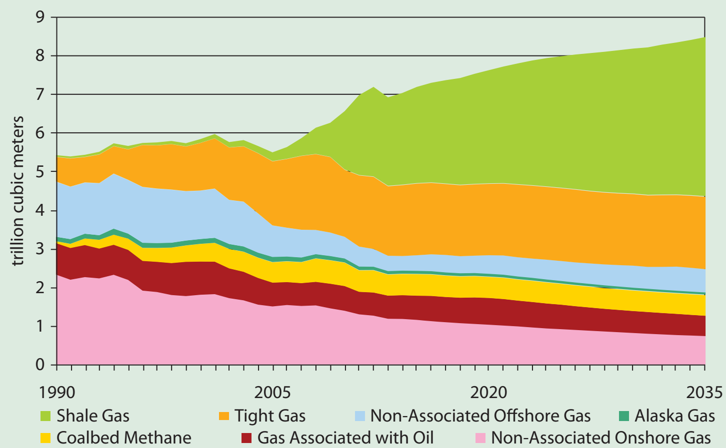
Others including new and renewable energy (NRE) are projected to increase relatively slowly at 1.3% per year through 2035. "Others" are defined to include noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, and solar, among others). In addition, electricity imports and exports are included in this category. In the case of Asia and the Pacific, noncommercial biomass accounts for the bulk of NRE and a gradual shift toward commercial energy source is expected. This offsets the expected fast growth of other NRE sources in Asia and the Pacific.

Box 2.2 North American Shale Gas Development and Impacts on Asia

The production of shale gas, which is trapped within shale formations, has been increasing rapidly in the United States since the mid-2000s. The development of shale gas production has been driven by various factors, including plentiful reserves, favorable geographical conditions for exploration, a stable political and economic situation, cultivated technical capabilities for the combination of horizontal drilling and hydraulic fracturing, sufficient financial support by the government, and good investments and market conditions for profitability. These driving factors have allowed access to large volumes of shale gas that were previously uneconomical to produce. As a result, shale gas production in the United States increased from 0.4 trillion cubic meters (TCM) in 2007 to 1.6 TCM in 2010. Shale gas production is expected to increase to 4.1 TCM in 2035 and will account for the dominant share of domestic natural gas production (EIA 2012).

In contrast to the rapid growth in production, domestic natural gas demand in the United States will experience modest growth up to 2035 (EIA 2012). In other words, domestic natural gas production will exceed demand, making the United States a net exporter of natural gas. In 2035, net natural gas exports by the United States will reach 39.2 billion cubic meters (BCM) (EIA 2012). In addition, Canada has recently begun to develop shale gas and is planning to construct a liquefied natural gas (LNG) terminal on the west coast to export excess gas supply to Asia. The North American LNG export amount as a whole is expected to be 35 BCM in 2020 and 40 BCM in 2035, with two-thirds being exported to Asia (IEA 2012). However, the projected export amount is affected by various factors, including international natural gas prices, balance between natural gas production and demand in the global market, and international trade conditions such as the negotiation of free trade agreements with importing countries. The decisions on nuclear power in Japan regarding the restarting of suspended plant operations as well as new construction will also affect the future of shale gas exports from North America. This is because suspended nuclear power plant operations in 2011 necessitated about 107 BCM (or 80 million tons) of LNG imports as a substitute, which accounted for almost one-third of the world LNG trade, increasing from 94 BCM (or 70 million tons) of LNG in 2010 (BP 2012).

Box Figure 2.2.1 Natural Gas Production in the United States (1990–2035)



Source: United States Energy Information Administration. 2012. *The Annual Energy Outlook 2012.* Washington, D.C..

Shale gas development in North America may have other impacts on the Asian natural gas market. First, Asia can diversify the supply source of natural gas. Asia can reinforce its bargaining power against exporters with diversified supply. Currently, there is strong demand from countries with limited LNG supply. This and oil-linked LNG pricing have driven prices higher in Asia and the Pacific—the so-called "Asian premium"—to \$17 per million British thermal units of LNG, while at Henry Hub, which is a distribution hub on the United States' natural gas pipeline system, the price was \$3.5 per million British thermal units as of November 2012. With the new supply sources, there will be a possibility to reconsider a new price mechanism for LNG for Asian countries. Second, the North American experience in shale gas development will help Asia's attempts to explore, develop, and produce shale gas within its own territory. In the People's Republic of China (PRC), for instance, large shale gas reserves remain undeveloped because of lack of transport infrastructure and shale gas development technology. In the PRC's Twelfth Five-Year Plan (2011–2015), shale gas production of 6.5 BCM by 2015 was set as the target. To meet this target, the PRC government encourages domestic companies to work with foreign partners. Although limitations of water resources at the shale gas fields—required for hydrofracturing—may need to be overcome, North America's successful experience in shale gas development will help the PRC's efforts.

continued on next page

Box 2.2 *continued*

Despite the expected benefits incurred from the increases in shale gas production, some risks—mainly environmental—need to be understood. Although over the past 10 years the records of more than 20,000 shale wells in the United States have shown good environmental performance, it is important to understand the potential risks. These are the impacts on air quality, greenhouse gas emissions, and contamination of aquifers and water treatment and disposal (Inglesby et al. 2012). Air quality may be affected by the emissions from diesel-fired equipment used in the drilling process. While natural gas combustion results in lower CO_2 emissions compared with other fossil fuels, methane gas emissions, which are 25 times more powerful than CO_2 in terms of global warming potential, may offset the carbon dioxide emissions reduction benefits. Risks of contamination of aquifers are associated with the drilling and hydraulic fracturing process, and its water treatment and disposal.

The hydraulic fracturing process requires about 5 million gallons of water per well, and this water involves injection of chemical additives that account for 1% of the total fracturing fluid. The fracturing process offers minimal risks to the shallow groundwater zone, because of multiple layers of cement protection and casing on the freshwater zone (MIT 2012). Nevertheless, there are inherent risks associated with the contamination of groundwater aquifers because of (i) leakage of drilling fluids or natural gas and (ii) onsite surface spills of drilling fluids, fracturing fluids, and wastewater from fracture flow-backs. Furthermore, contamination might occur as a result of inappropriate off-site wastewater disposal. After the completion of the fracturing operation, the fracturing fluid and water are returned from the well, and this needs to be disposed of appropriately (MIT 2012). Meanwhile, the United States Environmental Protection Agency introduced the Fracturing Responsibility and Awareness of Chemicals Act, and each state has developed its own regulations on water management and disposal. The enforcement of these regulations is important to reduce the environmental risks associated with the drilling and fracturing process.

Sources:
BP. 2012. *Statistical Review of World Energy*. London.
Government of the People's Republic of China. 2010. *The Five-Year Plans of the People's Republic of China Twelfth Guideline (2011–2015)*. Beijing.
Inglesby, T. et al. 2012. Shale Gas and Tight Oil: Framing the Opportunities and Risks. *McKinsey on Sustainability & Resource Productivity*. No. 1, Summer 2012. McKinsey & Company.
International Energy Agency (IEA). 2012. *World Energy Outlook 2012*. Paris.
Massachusetts Institute of Technology (MIT). 2012. *The Future of Natural Gas—An Interdisciplinary MIT Study*. Cambridge.
United States Energy Information Administration (EIA). 2012. *The Annual Energy Outlook 2012*. Washington, D.C..

2.3 Primary Energy Demand by Region

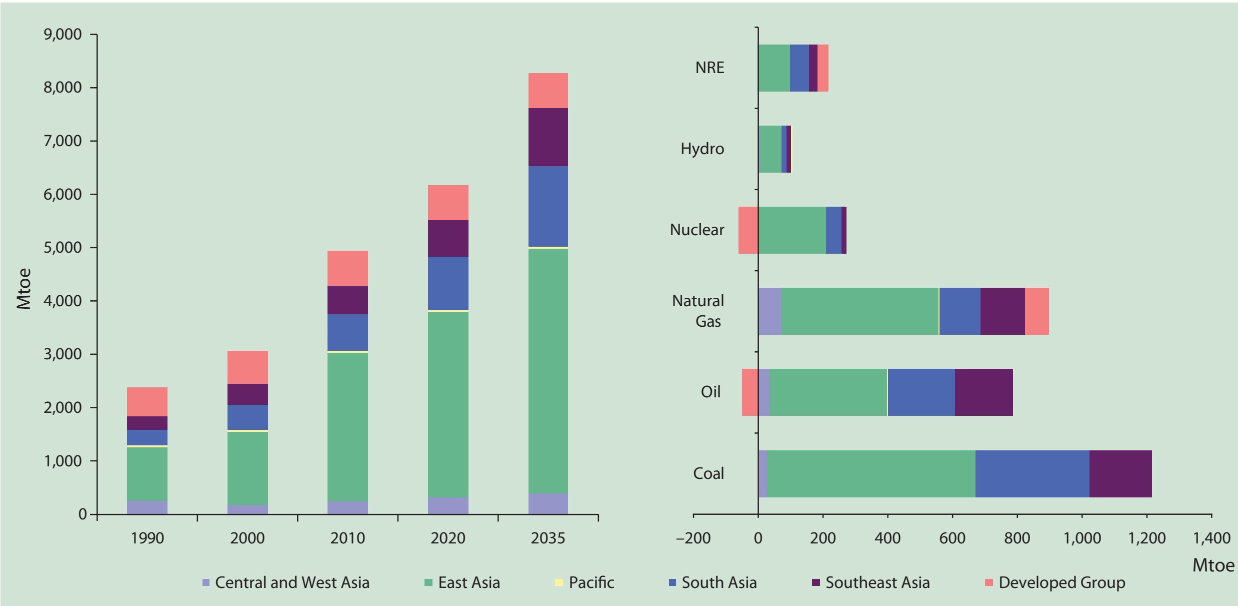
Growth trends in TPED differ by region of Asia and the Pacific (Figure 2.5). The Pacific represents the fastest annual TPED growth of 3.7% (2010–2035), followed by South Asia (3.0%), Southeast Asia (2.8%), East Asia (2.1%), and Central and West Asia (1.8%) (Table 2.2). In contrast, the Developed Group's TPED is projected to register a negative annual growth of 0.01%. The diversity in Asia and the Pacific's economic growth trends, population growth, pace of industrialization, infrastructure development, and technology diffusion will affect the diverse growth trends in TPED by subregion.

The Pacific's fast growth at 3.7% is mainly a result of the improved access to energy supply and increased vehicle ownership assisted by income growth and road infrastructure development. Despite the projected fast growth, this region's TPED will account for a small share in Asia and the Pacific at 0.1% in 2035.

South Asia's TPED is projected to increase from 745.5 Mtoe in 2010 to 1,558.6 Mtoe in 2035, growing at an annual rate of 3.0%. This region's growth trend is much affected by India's TPED growth trends as it accounts for a bulk of the region's TPED (around 92.1% over the outlook period). Population growth, industrialization, and improved energy access will be combined to drive the energy demand growth.

Southeast Asia will also exhibit a steady increase in TPED from 554.8 Mtoe in 2010 to 1,110.2 Mtoe in 2035, growing at 2.8% per year. Although the growth trends vary among the members of

Figure 2.5 Total Primary Energy Demand by Region (left), and Incremental Growth in Primary Energy by Energy Type and by Region (2010–2035) (right)



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.

Table 2.2 Primary Energy Demand by Region

	Primary Energy Demand (Mtoe)					Annual Growth Rate (%)			
	1990	2000	2010	2020	2035	2000–2010	2010–2020	2020–2035	2010–2035
DMCs	1,843.9	2,457.4	4,345.4	5,588.2	7,719.6	5.9	2.5	2.2	2.3
Central and West Asia	240.6	185.7	248.5	298.7	385.8	3.0	1.9	1.7	1.8
East Asia	1,016.4	1,383.8	2,793.0	3,509.5	4,656.3	7.3	2.3	1.9	2.1
Pacific	1.7	2.1	3.6	5.9	8.8	5.4	5.2	2.7	3.7
South Asia	341.7	493.5	745.5	1,072.4	1,558.6	4.2	3.7	2.5	3.0
Southeast Asia	243.5	392.3	554.8	701.5	1,110.2	3.5	2.4	3.1	2.8
Developed Group	538.3	643.8	639.8	641.0	638.7	(0.1)	0.0	0.0	0.0
Asia and the Pacific Total	2,382.2	3,101.2	4,985.2	6,229.1	8,358.3	4.9	2.3	2.0	2.1

( ) = negative number, DMC = developing member country, Mtoe = million tons of oil equivalent.

Southeast Asia, the integration of ASEAN economies and foreign direct investment in the manufacturing sector will support the economic growth of this region (GDP is projected to grow at 4.9% per year), and this will translate into a steady growth in energy demand.

Central and West Asia's TPED is projected to increase relatively slowly from 248.5 Mtoe in 2010 to 385.8 Mtoe in 2035, growing at 1.8% per year. The slow growth reflects that this region, excluding Afghanistan and Pakistan, has already achieved high electrification (supported by subsidized low supply cost); some members, such as Azerbaijan and Georgia, have implemented pricing reforms to raise electricity tariffs; and replacement of obsolete energy supply infrastructure can improve the overall efficiency of energy supply systems.

Box 2.3 Prospects for Electrification in Asia

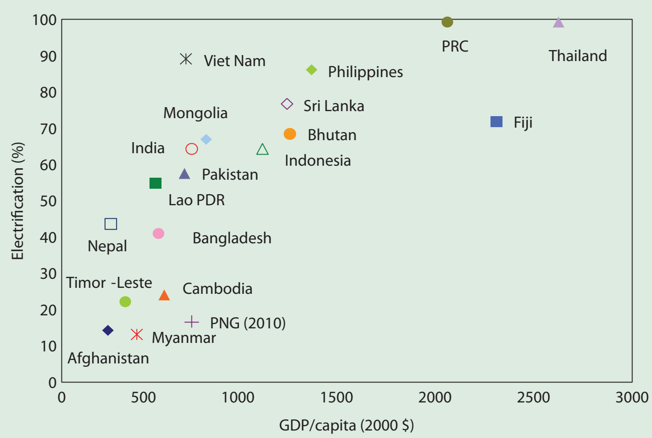
A total of 675 million people in Asia and the Pacific were estimated to have no access to electricity in 2009. This accounted for 51% of the 1.3 billion people without electricity in the world. Specifically, the electrification[a] rate is low in rural and remote areas compared with urban areas reached by the on-grid network. Many governments in Asia have promoted rural electrification programs, acknowledging that electricity access would not only help economic development but also accrue social benefits, including education and health care, as a result of better quality of living.

The electrification rate in Asia and the Pacific varies widely by member, even those with the same level of gross domestic product (GDP) per capita. As Box Figure 2.3.1 demonstrates, some members have achieved almost full electrification whereas only less than half of the population has electricity access in others. Nevertheless, there has been progress in electrification in Asia and the Pacific, though at different paces. For instance, Bhutan, Indonesia, the Lao People's Democratic Republic (Lao PDR), and Nepal increased their electrification rate by more than 10% between 2005 and 2008.[b] In contrast, the electrification rate of Papua New Guinea remained low at 16.7% in 2010, primarily because of poor administrative management, political instability, and rural remoteness.

The Government of the Lao PDR put highest priority on providing access to electricity for households and set a clear target to increase coverage to 80% of households by 2015 and to 90% by 2020. Electrification rates in the country improved from 16% of all households in 1995 to 72% in 2011.[c] The initiative of the national electricity utility, Electricité du Laos, in facilitating rural electrification contributed to the rapid increase in electrification rates. Remote rural areas were electrified using off-grid solar photovoltaic and micro-hydro systems. However, the rural electrification rate remains low at 38%.

Several factors must be in place to facilitate electrification effectively. First, a firm commitment of the government is critical. Government support would make the investment environment more attractive to investors, especially if financial incentives and measures to reduce risks are provided. Involvement of local governments and communities is also essential as their knowledge of electrification needs and their network with stakeholders would help the electrification program to be managed efficiently.

Box Figure 2.3.1 Ratio of Population with Electricity Access in 2008



GDP = gross domestic product, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China, PNG = Papua New Guinea.
Note: Data available for PNG were for 2010.
Sources:
United Nations Development Programme and World Health Organization. 2009. *The Energy Access Situation in Developing Countries: A Review Focusing on the Least Developed Countries and Sub-Saharan Africa.* New York.
National Minimum Development Indicators. http://www.spc.int/NMDI/MdiHome.aspx.

Additionally, it is important to secure financing from the private sector, international development organizations, and financial institutions. Although public finance plays a major role in infrastructure development, the national government would face difficulties in financing all projects alone, given the high up-front costs incurred for capital investment. Funding other than from public resources would be conducive to financial feasibility of the projects.

An additional factor to be noted is the proper use of on-grid and off-grid electrification, because the appropriate choice of system would differ depending on various factors such as costs, geographical features, and local needs. An on-grid network is optimal and effective in terms of costs and improvement of accessibility in areas with high population densities, while presenting preferable conditions for private investors. As a note of caution, however, the reliability of electricity supply—which seems less prioritized as there is too much focus on physical infrastructure expansion—has to be ensured. Alternatively, off-grid technologies using renewable energy may be suitable for rural areas with low population densities, but the fact that renewable energy is not sufficiently cost-competitive necessitates some form of financial assistance, such as international development aid. In addition, maintenance and operation of power generation equipment may be problematic in rural areas due to lack of appropriate skills and limited availability of equipment spare parts. For these reasons, private investors may be discouraged from participating in off-grid projects in areas with scattered populations due to the anticipated difficulty

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Box 2.3 *continued*

in recovering costs. Still, 85% of people who lack electricity access live in rural areas, thereby making off-grid electrification projects indispensable.

Effective electrification projects will require appropriate design. Due to massive up-front costs, it seems that successful electrification will depend on how the scheme is financed. Coordination among the participants—the national and local governments, local communities, international development organizations, and private companies—is necessary for the financing. In addition, affordability for low-income households needs to be kept in mind. For instance, microfinance is a helpful means for the poor, but microfinance institutions generally use short maturities and may not have enough of an understanding of renewable energy technologies, which could be an obstacle to applying microfinancing for electrification projects. Devising financial methods applicable to the parties involved would be fundamental in the course of electrification projects.

[a] Electrification indicates the process by which access to electricity is provided to households or villages.

[b] Figures from the International Energy Agency's *World Energy Outlook 2006* and *2009* are compared.

[c] See Renewable Energy & Energy Efficiency Partnership and REN 21. *Country Energy Profile*. www.reegle.info/countries (accessed 23 November 2012).

Sources:
Glemarec, Y. 2012. Financing Off- Grid Sustainable Energy Access for the Poor. *Energy Policy* 47. pp. 87–93.
International Energy Agency. 2011. *World Energy Outlook 2011*. Paris.
Rehman, I. H., A. Kara, M. Banerjeea, P. Kumara, M. Shardula, J. Mohantya, and I. Hossain. 2012. Understanding the Political Economy and Key Drivers of Energy Access in Addressing National Energy Access Priorities and Policies. *Energy Policy* 47. pp. 27–37.
United Nations Development Programme. 2011. *Towards an 'Energy Plus' Approach for the Poor – A Review of Good Practices and Lessons Learned from Asia and the Pacific.* New York.
World Bank. 2012. *Lao PDR Power to the People: Twenty Years of National Electrification.* Washington, D.C..

The Developed Group's TPED is projected to decline at 0.01% per year from 639.8 Mtoe in 2010 to 638.7 Mtoe in 2035. As a result, the share of this group's TPED in Asia and the Pacific will decline to 7.6% in 2035, down from 12.8% in 2010. The decline is a result of various factors, including change in the industry structure toward the service industry, technology diffusion, and Japan's population decline.

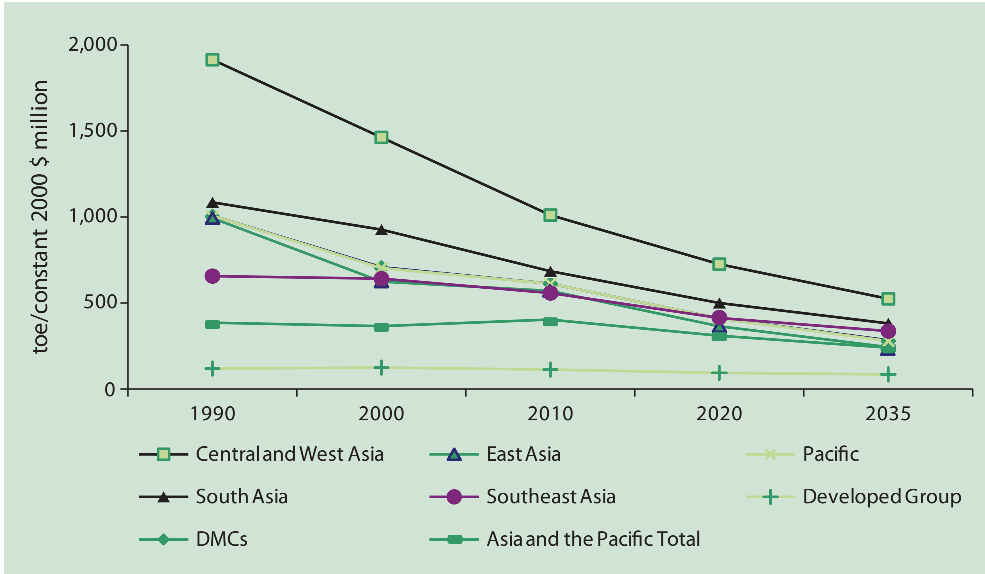
2.4 Energy Intensity

Energy intensity refers to the energy requirements to produce a unit of GDP. Energy intensity is affected by various factors, including industry structure, applied technology level, lifestyle, and climate conditions. In addition, energy prices as well as access to infrastructure can also affect energy intensity. Aside from these factors, it is important to note that the shift from a noncommercial energy source to commercial energy will greatly affect improvements in energy intensity. Meanwhile, caution needs to be taken in making international comparisons of energy intensities as the GDP of some developing member countries in US dollar terms can be undervalued if their currencies are weak against the US dollar.

Figure 2.6 shows both historical and projected energy intensities by region. The comparison shows wide variations in the energy intensity of Asia and the Pacific. In 2010, it ranged from Central and West Asia's highest level at 1,016 tons of oil equivalent (toe) per million dollars (constant 2000 dollars) to the Developed Group's lowest at 113 toe per million dollars; in other words, Central and West Asia's energy intensity in 2010 was nine times higher than that of the Developed Group in 2010. Riding on the relatively large energy reserves in some members, combined with low supply costs as well as obsolete energy supply facilities (accompanied by major losses from extraction, processing, and transportation), the energy intensity of Central and West Asia is high compared with the other regions.

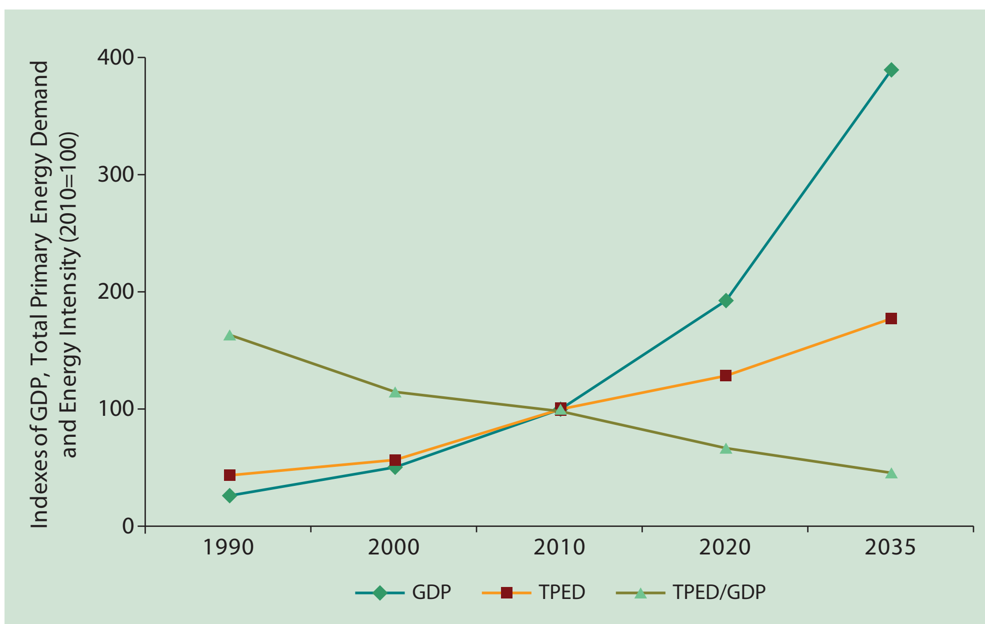
Even in the BAU case, there is a general downward trend in the projected energy intensities of Asia and the Pacific over the outlook period. The gap between the highest (Central and

Figure 2.6 Energy Intensities by Region (1990–2035)



DMC = developing member country, toe - ton of oil equivalent.

Figure 2.7 Comparisons of Indexes for GDP, TPED, and Energy Intensity in Developing Member Countries (2010 = 100)



GDP = gross domestic product, TPED = total primary energy demand.
Note: Energy intensity is depicted as TPED per GDP.

West Asia) and the lowest (Developed Group) energy intensity will be narrowed through 2035. Central and West Asia's energy intensity will decline to 527 toe per million dollars in 2035, compared with that of the Developed Group at 86 toe per million dollars in 2035.

Figure 2.7 compares the indexes of GDP, TPED, and energy intensity of DMCs. Using the GDP, TPED, and energy intensity of the DMCs of Asia and the Pacific, indexes are calculated to account for the 2010 level as 100. The comparison of the three indexes show that historically from 1990 to 2010, TPED increased almost at the same pace as GDP growth, while energy intensity has been improving steadily. Over the outlook period, because of the assumed improvements, mainly on the supply side (such as thermal efficiency improvement in power generation and energy production efficiency improvement), the growth trends in GDP and TPED are decoupled through 2035, resulting in steady improvement (almost at a similar pace as the historical trend) of energy intensity.

2.5 Energy Production and Imports

Asia and the Pacific's fossil fuel energy demand growth will increasingly be met by imports. Net imports (imports minus exports) of fossil fuels (oil, coal, and natural gas) in Asia and the Pacific are expected to nearly double from 830.5 Mtoe in 2010 to 1,515.5 Mtoe in 2035. Although the total net fossil fuel imports increase, the growth trends vary by region and by energy type (Figure 2.8).

Central and West Asia will maintain its net export position, supported by its exports of oil and natural gas (Figure 2.9). In contrast, East Asia's net imports of fossil fuels will expand from 678.2 Mtoe in 2010 to 1,338.7 Mtoe in 2035. The Pacific will maintain its net export position of fossil

Box 2.4 Fuel Subsidies

The pros and cons of fuel subsidies have been discussed since the 1980s.[a] This politically and economically sensitive issue was placed on the agenda of the 2009 Pittsburgh G20 Summit, when the world leaders pledged to phase out fuel subsidies to enhance energy security. A major justification for putting in place the fuel subsidies is as a measure to help reduce fuel costs for low-income households and for them to gain access to modern energy. However, it has brought on unintended consequences as well, most of which seem to have negative repercussions.

Lowering the fuel price encourages more demand for the fuel, which could be a disincentive for efficient energy use or result in fuel shortages. Amid dwindling domestic oil production, an upsurge in fuel demand leads to increases in energy imports. Contrary to the objective of assisting the poor, substantial benefits of the fuel subsidy program are seen to be leaking to higher-income groups; the program does not work well to cover the targeted groups unless stringent mechanisms are in place to limit the purchase of lower-cost fuel by the high-income population.

In addition, the government, producers, and consumers are all influenced one way or another by the artificially low fuel price. The government shoulders a bigger fiscal burden, especially when extra costs cannot be transferred to the end user's price at the time of rising international energy oil, coal, and natural gas prices. This drain on government expenditures squeezes the availability of budget for other programs that could otherwise be of more benefit to the consumers. For the producers, their financial ability to invest in exploration and production, infrastructure, or new technology is weakened due to the difficulty of recovering costs.

Given these negative impacts, many policy makers have recognized the necessity of fuel subsidy reforms and have tried to cut or reduce the subsidies. Yet, the progress of the reforms has been slow, as can be seen with the situation in Asia (Box Table 2.4.1). The focus is placed on subsidized oil products as they account for the majority of the fuel subsidies.

continued on next page

Box 2.4 *continued*

India offers another case of a government facing difficult challenges in removing fuel subsidies. In 2010, the government announced the deregulation of oil product prices. However, due to the widespread opposition to oil deregulation, only gasoline prices have been deregulated, and oil companies still need the government's permission to change prices. Despite the recent international oil price hike and currency depreciation, the government made only minor increases to the fuel prices out of concern regarding the reaction by the public and the industry sectors vulnerable to price changes, such as transportation, agriculture, and fishery. In September 2012, the government finally increased the gas oil price by 14%, the first time since June 2011, because the fuel subsidies tightened India's fiscal balance. The government needed to increase fuel prices to avoid financial disaster, i.e., fiscal deficits estimated to reach 6% of gross domestic product for the fiscal year 2012, breaching the limit of 5.1%, and a looming sovereign credit downgrade. The impact of the price increase is considered minor, but it is an important step toward fuel subsidy removal.

Box Table 2.4.1 Recent Fuel Subsidy Development in Asia

People's Republic of China	Under the petroleum pricing system adopted in 2008, the government has introduced a mechanism to adjust domestic prices for gasoline, diesel, and kerosene when the average of a basket of crudes (Dubai, Brent, and Cinta) moves by 4% in 22 consecutive working days. However, this has not been implemented widely, and in 2011, the state refineries had a deficit because retail prices were capped.
Indonesia	The government planned to cut fuel subsidies and raise the fuel price up to 33% in April 2012. However, since there were violent protests, Parliament did not pass the proposal. As an effort to narrow fiscal deficits, five fuel saving plans were announced in June 2012, which did not allow government-owned and plantation and mining vehicles to purchase subsidized fuel. In June 2013, the government raised the price of gasoline by 44.4% to Rp6,500 per liter ($0.65 per liter) and that of diesel by 22.2% to Rp5,500 per liter.
Malaysia	The Tenth Malaysia Plan includes gradual reductions of energy subsidies with the target of achieving market pricing by 2015. Approximately 30% of gasoline and diesel prices were subsidized in 2012.
Thailand	The fuel market was deregulated in 1991, but the government has intervened in the market through the Oil Fund, a mechanism used to subsidize diesel, liquefied petroleum gas, compressed natural gas, and biofuels, while levying gasoline sales. Although the Yingluck administration outlined plans to reform energy pricing to reflect actual costs, the details were still unclear as of 2011.
Viet Nam	The government plans to roll back fuel subsidies. In July 2012, fuel retailers increased oil product prices for the first time since they were allowed to set their retail prices and the timing of changes to prices under Decree 84 issued in 2009.

Although the necessity of a fuel subsidy phaseout is understood by policy makers, tangled interests such as populism and concerns about inflation make it difficult to implement the full reform of subsidy programs. In developing member countries of the Asian Development Bank (ADB), oil demand is projected to grow relatively fast at an annual rate of 2.4% from 2010 to 2035. Lower fuel prices are likely to boost oil demand growth in Asia and the Pacific, mainly to meet the needs in the transport sector. In general, this prospect could result in the worsening of the fiscal balances and increase the oil import dependencies of developing ADB members unless some effective action is taken to slash subsidies. Fuel subsidy reform is necessary to prevent development of unsustainable situations and to improve energy security. The effectiveness of fuel subsidy programs may be improved by complementing them with other welfare programs or by specifically targeting the poor as subsidy beneficiaries (as opposed to the universal application of subsidies).

[a] In this box, fuel subsidies indicate ones targeted at petroleum products, such as gasoline, kerosene, and liquefied petroleum gas. Discussions on electricity price subsidy are included in Chapter 4.

Sources:

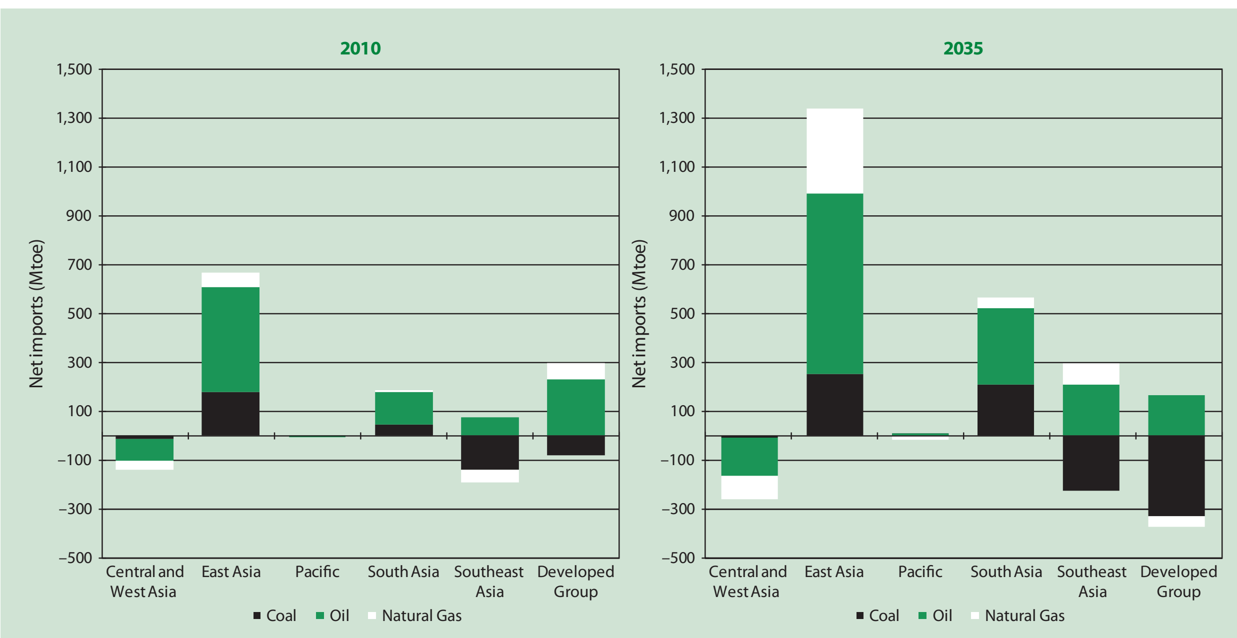
J. Arze del Granado, David Coady, and Robert Gillingham. 2010. *The Unequal Benefits of Fuel Subsidies: A Review of Evidence for Developing Countries.* IMF Working Paper WP/10/202. http://www.imf.org/external/pubs/ft/wp/2010/wp10202.pdf

Asia-Pacific Economic Cooperation. 2012. *Reforming Fossil-Fuel Subsidies to Reduce Waste and Limit CO_2 Emissions while Protecting the Poor.* Prepared by Global Subsidies Initiative of the International Institute for Sustainable Development. Singapore.

Figure 2.8 Net Fossil Fuel Imports/Exports by Region (2000, 2010, 2020, and 2035)

Mtoe = million tons of oil equivalent.

Figure 2.9 Net Fossil Fuel Imports and Exports by Energy Type and by Region (2010 and 2035)



Mtoe = million tons of oil equivalent.

fuels through 2035, owing to the LNG exports from Papua New Guinea. South Asia's net imports of fossil fuels will more than triple from 191.9 Mtoe in 2010 to 571.8 Mtoe in 2035, reflecting India's growing need for imports of coal, oil, and natural gas. Southeast Asia will turn from a net exporter to a net importer in 2035. This region's net coal exports will be offset by the increased imports of oil and natural gas. The Developed Group will become a net exporter of fossil fuels in 2035 as it reflects Australia's substantial increases in exports of coal and natural gas.

2.5.1 Oil Production and Imports

Asia and the Pacific's net oil imports (including crude oil and petroleum products) will increase substantially from 773.6 Mtoe or 15.5 million barrels per day (mb/d) in 2010 to 1,278.0 Mtoe (or 25.7 mb/d) in 2035—the biggest increase in fossil fuels. The projected volume of net oil imports at 25.7 mb/d in 2035 is comparable to the current crude oil production of the Middle East countries (including Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates, Yemen, and others) at 27.7 mb/d in 2011 (BP 2012). The size of Asia and the Pacific's oil import needs implies that it might be a challenge to find and secure stable and affordable oil supply sources externally. Nevertheless, while there are overall increases in the net oil imports of Asia and the Pacific as a whole, there is wide diversity when looking at the regions.

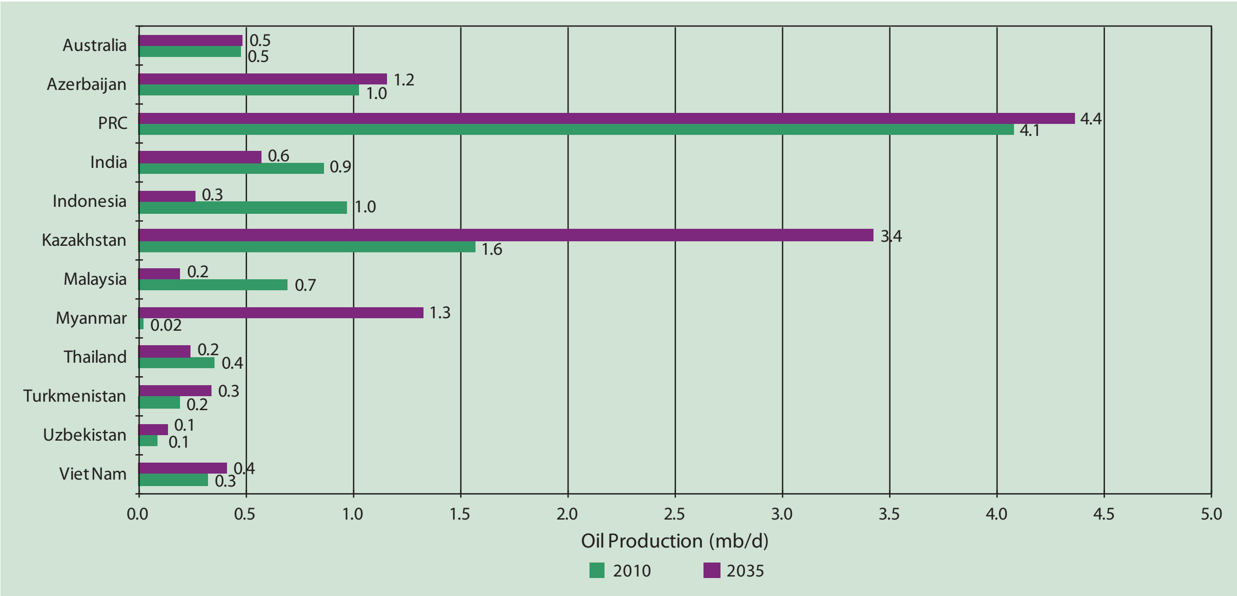
In Central and West Asia, net oil exports will expand to 3.2 mb/d in 2035, up from 1.9 mb/d in 2010 (Figure 2.10). Among the major oil producers in Central and West Asia, including Azerbaijan, Kazakhstan, Turkmenistan, and Uzbekistan, Kazakhstan's contribution will represent the biggest share. As a result of the expanded growth from Tengiz, Karachaganak, and Kashagan oil fields, Kazakhstan's oil production will reach 3.4 mb/d in 2035, up from 1.6 mb/d in 2010.

East Asia will have the biggest net oil imports of any region in Asia and the Pacific, reaching 14.8 mb/d in 2035, or a 71.9% increase from the 2010 level of 8.6 mb/d. The large imports of East Asia reflect the expected increases in the PRC's net oil imports, reaching 11.4 mb/d in 2035, more than doubling the 2010 level of 5.1 mb/d. Although the PRC's domestic crude oil

Figure 2.10 Net Oil Imports by Region (2000, 2010, 2020, and 2035)

mb/d = million barrels per day.

Figure 2.11 Top 12 Oil Producers in Asia and the Pacific (2010 and 2035)



mb/d = million barrels per day, PRC = People's Republic of China.

production will be the highest in Asia and the Pacific at 4.4 mb/d in 2035 (Figure 2.11), its net oil imports ratio will reach 72.4% in 2035, compared with 58.6% in 2010, as the pace of domestic oil demand growth will exceed that of production.

Nearly half of the Pacific's oil demand needs would be met by imports through 2035. The region's net oil imports will reach 0.04 mb/d in 2035.

South Asia's net oil imports at 6.3 mb/d in 2035 represent the second-largest level in Asia and the Pacific, increasing from 2.7 mb/d in 2010. A more than twofold increase in the net oil imports of this region are driven by India, of which net oil imports will reach 6.5 mb/d in 2035, up from 2.5 mb/d in 2010. While domestic oil demand will expand to 7.1 mb/d in 2035, domestic oil production will decline to 0.6 mb/d in 2035 from 0.9 mb/d in 2010; consequently, its oil import dependence ratio will reach 91.9% in 2035 (in contrast to 76.0% in 2010).

In Southeast Asia, net oil imports will reach 4.4 mb/d in 2035, nearly tripling the 2010 level of 1.5 mb/d. This region's oil production is projected to increase at a moderate pace of 0.1% per year through 2035, in contrast to the projected oil demand increase at 2.7% per year. Oil production declines in Indonesia and Malaysia—current major oil producers, respectively reaching 0.3 mb/d and 0.2 mb/d in 2035—will offset the increases in Myanmar's production (accounting for 1.3 mb/d in 2035) and result in slow growth in overall oil production. As a whole, the region's net oil imports ratio will reach 60.0% in 2035, up from 39.5% in 2010.

The Developed Group's net oil imports will reach 3.4 mb/d in 2035 from 4.8 mb/d in 2010. The decline is largely affected by Japan's oil demand decline (or lowered need for oil imports). Japan's oil demand is projected to reach 3.0 mb/d in 2035, down from 4.1 mb/d in 2010. Vehicle fuel economy improvements—combined with the population decline in Japan—will lead to a substantial decline in the oil demand during the outlook period.

Box 2.5 Energy Supply from Central and West Asia

Member countries of the Asian Development Bank (ADB) in Central and West Asian, including Azerbaijan, Kazakhstan, Turkmenistan, and Uzbekistan, have great potential to increase oil and gas production. The combined total reserves of the four countries are 38.2 billion barrels of oil and 29.1 trillion cubic meters of natural gas (BP 2012). These account for about 2.3% of global oil reserves and 14% of natural gas reserves. By 2035, the combined total oil production from the four countries will reach 251.9 million tons of oil equivalent (Mtoe), or 5.1 million barrels of oil per day, and 270.9 Mtoe (or 300.7 million cubic meters) of natural gas. Amid the dwindling oil and natural gas production of some members in Asia and the Pacific, the production increases in Central and West Asia could represent important alternative sources to fuel the rising energy needs in Asia and the Pacific.

The Central and West Asian member countries are located closer to the demand centers of Asia, compared with the other major energy-producing countries, such as those in the Middle East. In view of the geographical advantages, oil and gas companies in Asia are actively involved in upstream investment projects of the four countries.

There are several representative cases of Asian oil and gas companies exploring, developing, or producing oil and natural gas in the fields of Central and West Asia. These include Japan's INPEX and Itochu and their participation in the consortium operating the Azeri–Chirag–Guneshli (AGC) oil field in Azerbaijan. They are also part of the consortium operating the Baku–Tbilisi–Ceyhan pipeline that delivers ACG oil to the Mediterranean Sea through Turkey. Japan's INPEX partners with other international companies on the project in the North Caspian Sea, including the Kashagan field. Malaysia's Petronas has 2 decades of experience in the development of oil and natural gas fields in Turkmenistan, and now aims to expand its business to the downstream petrochemical industry in the country. The Republic of Korea's KNOC, KOGAS, and Daewoo are working on the exploration or feasibility studies of oil and gas fields in Uzbekistan. The People's Republic of China's (PRC) China National Petroleum Corporation (CNPC) has expanded its business operations in the four member countries (Azerbaijan, Kazakhstan, Turkmenistan, and Uzbekistan), including the South Yolotan project in Turkmenistan, which is expected to be one of the world's five largest natural gas fields.

The oil and natural gas fields of Central and West Asia are located in landlocked areas. Despite the geographical proximity to the demand centers in Asia, these resources are transported via pipelines that traverse other countries before they reach their market. Major developments have been made to export oil and natural gas from these areas to outside of the region. The PRC has made investments in the Central Asia–PRC Gas Pipeline, which has dual lines running for 1,833 kilometers. Construction started in July 2008, and Line A became operational in December 2009, followed by Line B in 2011. The pipeline starts at the border of Turkmenistan and Uzbekistan, runs through Uzbekistan and southern Kazakhstan, and finally ends in Xinjiang Uyghur Autonomous Region in the PRC. Additionally, the Kazakhstan–PRC oil pipeline, which started operations in 2005, transports Kazakhstan's oil over 962 kilometers (CNPC).

Aside from the delivery of oil and gas from Central and West Asia to the PRC, a significant first step was made in transporting natural gas southward. India's GAIL and Pakistan's Inter State Gas System signed gas sales and purchase agreements with Turkmenistan in May 2012 for Turkmenistan to supply up to 90 million cubic meters of natural gas through the Turkmenistan–Afghanistan–Pakistan–India (TAPI) natural gas pipeline. The signing of a gas sales and purchase agreement between Afghanistan and Turkmenistan is expected to take place soon. In fact, the development of the TAPI pipeline has been planned and discussed for more than 2 decades, and major strides were made in 2012 as a result of a combination of various factors, the three major reasons being (i) increasing appetite for natural gas in Pakistan and India resulting from decline in domestic production, (ii) Turkmenistan's aspirations to diversify natural gas export destinations, and (iii) Afghanistan's need to secure an energy supply source for the power generation necessary to alleviate chronic electricity shortages. To this end, the ADB has played an important role by facilitating discussions and negotiations among the four TAPI member countries. Nevertheless, some caution needs to be taken so that the realization of the TAPI pipeline does not collide with the planned transboundary pipeline from Iran to Pakistan and India (IPI gas pipeline project); likewise, the political situation of Afghanistan may also affect progress in the TAPI project.

The oil and natural gas production from the four Central and West Asian member countries can hopefully meet the growing energy appetite of Asia and the Pacific. Meanwhile, landlocked projects in these countries require development of, or access to, transport pipelines from the oil and natural gas fields to the demand centers. This requires concerted efforts among the producing country, the transit countries, and the importing countries, as well as the various stakeholders, including oil and

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Box 2.5 *continued*

gas companies and financing bodies. In this regard, the progress achieved with the gas sales and agreements among some TAPI member countries can offer a case to be followed: success requires understanding the needs of each member and finding the means to resolve conflicting issues, if any. In this respect, involving third parties, such as ADB, could have a catalytic effect on facilitating the negotiations.

[a] See http://www.cnpc.com.cn/eng/cnpcworldwide/euro-asia/Kazakhstan/?COLLCC=2942152581&

Sources:
ADB. 2012. *Historic Agreements Bring Long-Awaited TAPI Pipeline Closer to Reality*. Manila.
BP. 2012. *Statistical Review of World Energy*. London.
China National Petroleum Corporation (CNPC). *CNPC in Kazakhstan*. Available: www.cnpc.com.cn/en/cnpcworldwide/kazakhstan
Levaillant, M. 2012. India's Foreign Policy Towards Iran: Dilemmas of an Emerging Power. *NORIA Research Report November 2012*. Delhi.
Sugiura, Toshihiro (Senior researcher, Institute of Energy Economics, Japan). Personal communication on TAPI vs. IPI pipelines. December 2012.

2.5.2 Natural Gas Production and Imports

Asia and the Pacific will become self-sufficient in natural gas toward 2015; nevertheless, as a whole it will turn into a net natural gas importer sometime after 2020. In 2035, net import of natural gas in Asia and the Pacific will reach 359.0 billion cubic meters (BCM), or 24.5% of natural gas demand. Meanwhile, the balance between domestic natural gas demand and production differs substantially by member and by region as it reflects differences in resource endowment, speed of growth in demand and production, and infrastructure development for exports and imports.

Central and West Asia will maintain its net export position in natural gas. Its exports will increase from 40.6 BCM in 2010, peak at 126.0 BCM in 2020, and thereafter decline to 100.6 BCM in 2035 (Figure 2.12). Pakistan will start importing natural gas sometime after 2020 and this offsets the growth in natural gas production from major producers such as Azerbaijan, Kazakhstan, Uzbekistan, and Turkmenistan; therefore, the overall net exports of this region as a whole will decline from the peak in 2020 to 2035. Of the four major natural gas producers, Turkmenistan's natural gas production will represent the biggest share in 2035 at 120 BCM, supported by the

Figure 2.12 Net Natural Gas Imports by Region (2000, 2010, 2020, and 2035)

BCM = billion cubic meters.

production from fields such as Dauletabad–Donmez, South Yolotan–Osman, and Bagtyarlyk. Turkmenistan's natural gas production will be dedicated to pipeline exports for the PRC, the Russian Federation, the Caspian Sea, and others. In terms of production, following Turkmenistan is Uzbekistan at 80 BCM, Azerbaijan at 52.9 BCM, and Kazakhstan at 48 BCM in 2035.

Much of the increasing proportion of East Asia's natural gas demand would have to be met by imports. This region's natural gas imports will reach 382.4 BCM in 2035, up from 71.7 BCM in 2010. Excluding the PRC, this region has almost no natural gas reserves, while an increasing appetite for natural gas—because of its lower environmental burden and ease-of-use factors—may drive demand, which translates into the substantial expansion of natural gas imports. In fact, the PRC is projected to expand its natural gas production from 88.1 BCM in 2010 to 315.0 BCM in 2035 (Figure 2.14), while domestic production will be able to cover about 51.4% of the total natural gas demand in 2035 (with the remainder being covered by imports).

The Pacific region's natural gas exports would stand at 18.4 BCM (or 13.6 million tons of LNG) in 2035 because of Papua New Guinea's start-up of LNG exports. Two projects are currently under way. The initial project (led by ExxonMobil) would start exports in 2014, and InterOil's project would start exports sometime after 2016.

South Asia will also see substantial increases in natural gas imports driven by India's demand growth. Similar to the PRC, India is expected to nearly triple its domestic natural gas production, reaching 119.9 BCM in 2035; nevertheless, this will be able to cover about 63.9% of domestic demand (with the remainder being covered by imports).

Southeast Asia encompasses the major natural gas exporters, including Brunei Darussalam, Indonesia, and Malaysia. The region as a whole, meanwhile, will become a net natural gas importer in 2035 because of production decline in Indonesia and substantial demand increases from the Philippines, Thailand, and Viet Nam.

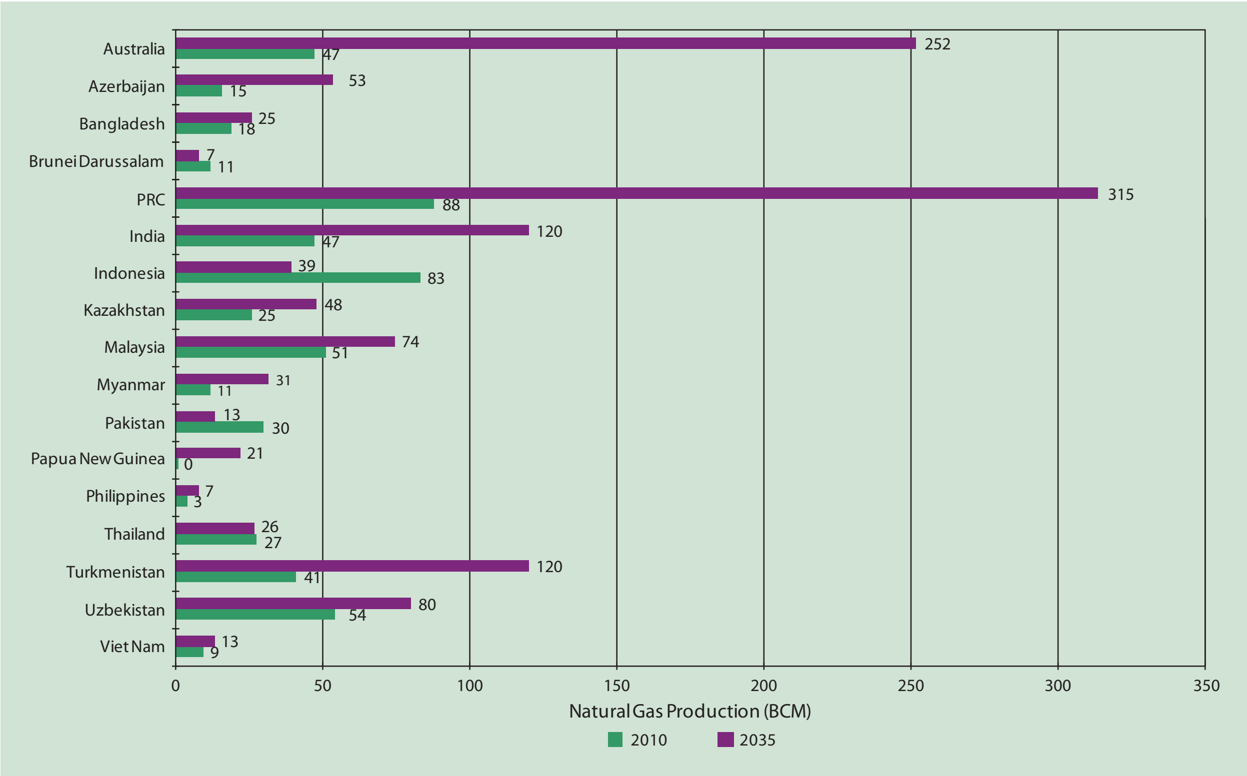
The Developed Group is expected to become a net natural gas exporter by 2035, reflecting Australia's substantial natural gas production increases. With the start-up of new projects, Australia will export about 139.1 million tons of LNG in 2035, up from 25.9 million tons of LNG in 2011.

2.5.3 Coal Production and Imports

Asia and the Pacific as a whole was a net coal exporter in 2010, while it will become a net coal importer sometime after 2015. By 2035, it is projected that Asia and the Pacific as a whole will become a net exporter.

By region, Southeast Asia and the Developed Group will maintain their net export positions in terms of coal through 2035 (Figure 2.14). Indonesia, the main coal producer in Southeast Asia, is projected to more than double its coal exports from the 2010 level of 226.0 million tons of coal equivalent (Mtce) to 458.8 Mtce in 2035. Likewise, Australia (the main coal exporter in the Developed Group) will expand coal exports, up from 275.7 Mtce in 2010 to 658.4 Mtce in 2035.

Figure 2.13 Natural Gas Production of Major Producers in Asia and the Pacific (2010 and 2035)



BCM = billion cubic meters, PRC = People's Republic of China.

Figure 2.14 Net Coal Imports by Region

Mtce = million tons of coal equivalent.

Chapter 3

Sectoral Energy Demand Outlook: Business-as-Usual Case

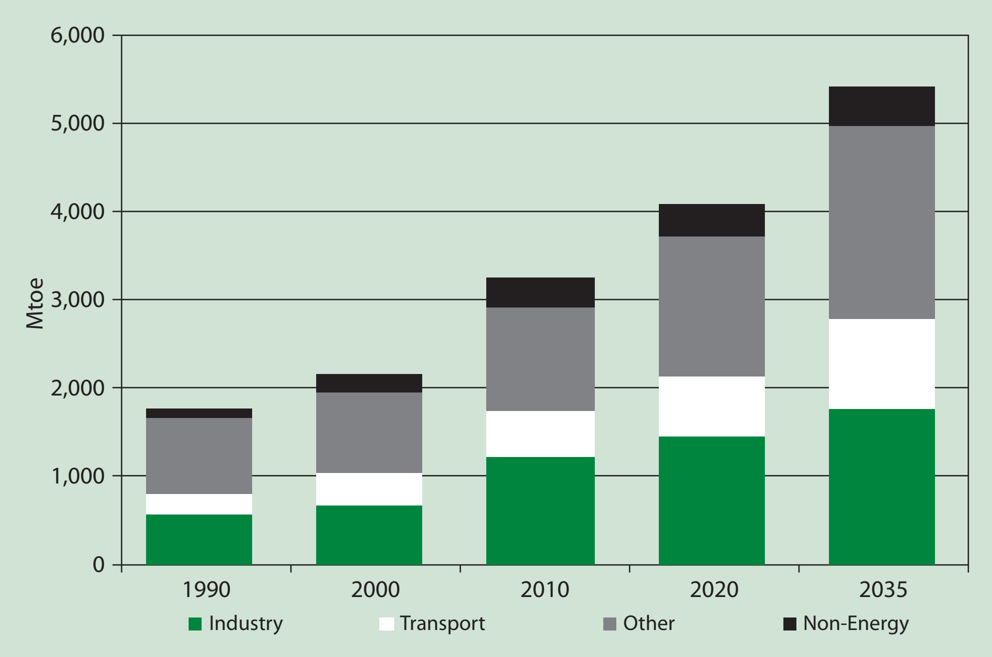
Sectoral Energy Demand Outlook: Business-as-Usual Case

- *In the business-as-usual (BAU) case, final energy demand of Asia and the Pacific is projected to increase from 3,238.5 Mtoe in 2010 to 5,400.9 Mtoe in 2035, growing at an annual rate of 2.1%.*
- *While the energy demand of the industry sector is projected to increase relatively slowly at 1.5% reflecting the sector's structural shifts in some members, energy demand of the other sectors (including residential, commercial, agriculture, and fishery) and the transport sector will grow at a relatively fast pace of 2.5% and 2.7% per year, respectively, through 2035 driven mainly by income growth and subsequent needs for convenience and comfort (other sectors) and for mobility (transport sector).*

3.1 Sectoral Energy Demand Outlook

In the BAU case, the final energy demand of Asia and the Pacific is projected to increase from 3,238.5 million tons of oil equivalent (Mtoe) in 2010 to 5,400.9 Mtoe in 2035 (Figure 3.1), growing at an annual rate of 2.1%. By sector, the industry sector's energy demand represents the largest share in 2010 at 37.6%, while its share will decrease to 32.8% in 2035, as its energy demand will grow at a slower rate than final energy demand at 1.5%. Shifts in the industry sector's structure in some members will slow this sector's growth through 2035. Meanwhile, energy demand of the other sectors (including residential, commercial, agriculture, and fishery), whose share accounted

Figure 3.1 Sectoral Energy Demand Outlook



Mtoe = million tons of oil equivalent.

Box 3.1 Challenges for Biofuels in Asia

Biofuels—mainly utilized in road transport—can offer an option for shifting to low-carbon, nonpetroleum fuels, with minimal change in the current vehicle stocks. Many ADB member countries in Asia, especially those that belong to the Association of Southeast Asian Nations (ASEAN) member states, have shown an increasing interest in domestic biofuel utilization and production for various reasons. For some members, such as Thailand and the Philippines, the major driver for biofuels is energy security enhancement as they help reduce dependence on oil imports. In Indonesia and Malaysia, which are the two largest palm oil exporters in the world, biofuel usage is mainly driven by economic considerations because biodiesel can provide additional demand for palm oil, aside from the conventional palm oil usage for food and industrial materials. For some countries like Cambodia, the Lao People's Democratic Republic (Lao PDR), and Myanmar, the production of biofuels could provide a way to mitigate rural poverty..

Brazil, Europe, and the United States are the current leading players in the world biofuels market. According to the International Energy Agency (IEA 2012), from 2000 to 2010 world biofuel consumption increased from 10.8 million tons of oil equivalent (Mtoe) to 50.6 Mtoe. In 2010, biofuels provided about 2.4% of the world's total transport fuel demand. The United States and Brazil together accounted for 82.9% of the global biogasoline consumption in 2010. Europe leads the use of biodiesel, and 67.5% of world biodiesel was consumed in Organisation for Economic Co-operation and Development (OECD) countries in Europe in 2010. Asia and the Pacific accounted for only 5.2% of world total biofuel production in 2010 and 4.9% of biofuel use. Within the region, the People's Republic of China (PRC) and India are the two biggest players, with 43.1% of the region's production and 48.4% of consumption in 2010 attributed to the two member countries.

Conventional biofuel technologies (crop-based biofuels), which are already commercially available, dominate biofuel production today. Advanced biofuel technologies are still in the research and development, demonstration, or early commercial stages. The IEA anticipates that the first commercial-scale advanced biofuel plants will be installed within the next decade (by around 2020), while some noble technologies like algae biofuels and sugar-based hydrocarbons are unlikely to be commercialized before 2020 (IEA 2011).

With the rapid expansion of biofuel use over the last 10 years, there have been debates on the sustainability of biofuel production. One such concern is the impact on food security. A World Bank study (Timilsina et al. 2010) suggested that the expansion of conventional biofuels would cause a reduction in global food supply, which will more negatively impact low- and middle-income countries than high-income countries. The study found that food availability would be reduced by 0.4% in India and 0.1% the United States. However, Japan will not suffer any reduction in food availability.

Another emerging debate surrounding biofuels is on the extent of their greenhouse gas (GHG) emissions reduction potential, especially when considering emissions associated with land-use changes (both direct and indirect) caused by biofuel production. Natural lands, such as rainforests, store carbon in their soil and biomass as plants grow each year. Direct land-use change occurs when land use is displaced for biofuel feedstock, which causes possible changes in the carbon stock of that land (Gnansounou et al. 2008). Indirect land-use change happens when the displacement of current land use for biofuels causes more intense land use elsewhere (Turner et al. 2007). To evaluate this impact requires a life cycle assessment (LCA) methodology comparing GHG emissions associated with biofuels against the fossil fuels they replaced, including the GHG emissions caused by the production, transport and distribution, and burning of the fuels. A review of a number of LCA studies made by the IEA shows that in general, producing ethanol from sugarcane has significant GHG mitigation potential, provided that no indirect land-use change occurs (IEA 2011).

Issues also exist on the utilization side. In the case of the Philippines, for instance, compliance with the mandated 10% ethanol blend in gasoline continues to be problematic because of the inadequate capacity of existing sugarcane distilleries (Corpuz 2012). Palm oil is abundant in countries such as Indonesia and Malaysia, but scaling up the domestic biodiesel market will place a bigger burden on the government budget because of existing subsidies on diesel fuels. To promote biodiesel consumption, governments need to subsidize the price difference between biodiesel and diesel if the price of biodiesel is higher than that of diesel.

Although biofuels could, with careful project design and management, contribute to the development of a low-carbon society in the region, their effectiveness is very uncertain. Given the rapidly growing population in many Asian countries, demand for food and fodder crops will also increase accordingly. This means that the region's potential for conventional biofuels will be limited. At the same time, liquid fuels are facing growing competition from electricity. Some member

continued on next page

Box 3.1 *continued*

countries, such as the PRC and Japan, have already launched policies offering incentives for purchasing cars that partly or fully run on electricity. However, in aviation, navigation, and heavy mode road transport where electrification is difficult, biofuels could play a significant role in replacing liquid fossil fuels.

Sources:

Corpuz, P. 2012. *Philippines Biofuels Industry Situation and Outlook*. Global Agricultural Information Network, USDA. Post from Manila.

Gnansounou, E. et al. 2008. Accounting for Indirect Land-Use Changes in GHG Balances of Biofuels: Review of Current Approaches. *École Polytechnique Fédérale de Lausanne. Working Paper* REF. 437.101.

International Energy Agency (IEA). 2011. *Technology Roadmap Biofuels for Transport*. Paris.

———. 2012. *World Energy Statistics and Balances 2012*. Paris.

Timilsina, G. et al. 2010. The Impacts of Biofuel Targets on Land-Use Change and Food Supply: A Global CGE Assessment. *World Bank Policy Research Working Paper* No. 5513. Washington, DC: World Bank

Turner, B. et al. 2007. *Creating Markets for Green Biofuels: Measuring and Improving Environmental Performance*. Research report UCB-ITS-TSRC-RR-2007-1. University of California Berkeley, Transportation Sustainability Research Center. April. pp. 16.

for 36.3% of total final energy demand in 2010, will register a relatively fast growth rate of 2.5% per year through 2035. Income growth and infrastructure development of developing member countries would translate into the relatively fast growth of this sector. With growth faster than final energy demand, the other sectors' energy demand would account for the largest share in 2035 at 40.7%. The transport sector's energy demand is projected to increase at the fastest pace of 2.7% per year through 2035 driven by the motorization trends in developing member countries and freight transport needs required for continued economic activities.

3.2 Industry Sector

In 2010, the industry sector's energy demand in Asia and the Pacific was 1,216.5 Mtoe. Industry's share in the total final energy demand was 37.6%, the largest among the sectors. For most ADB members, production of iron and steel, nonmetallic minerals (cement, glass, etc.), paper and pulp, and chemicals occupied more than half of the industry sector's energy demand (Figure 3.2). Particularly in East Asia, led by infrastructure construction in the People's Republic of China (PRC), the share of these four major energy-intensive industries exceeded 65% during 2007–2010.

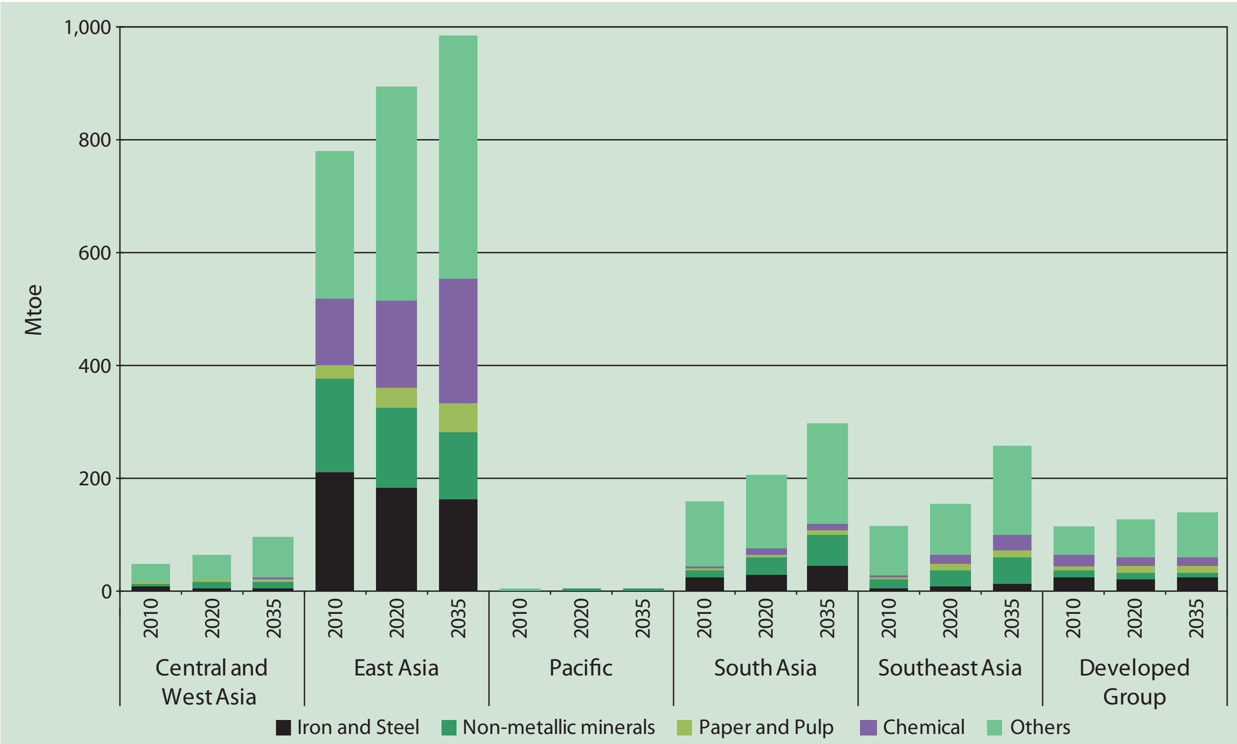
In the 2020s, the rapid expansion of the energy-intensive industries in the PRC will come to an end, and production of basic materials, such as crude steel and cement, in East Asia will peak out. In contrast, infrastructure construction and heavy industrialization will achieve more rapid growth in India and Southeast Asia (Figure 3.3).

In most members, industrialization is one of the major drivers of economic development. Industrialization brings with it an increase in the manufacturing industry's share in the total economy. Because of the higher energy intensity (which is equal to energy consumption/production) of the manufacturing industry during the rapid industrialization period, the ratio of energy elasticity to gross domestic product (GDP) may be higher than 1.0, as observed in Japan in the 1960s, the Republic of Korea in the 1970s and 1990s, and Thailand in the 2000s.

However according to the experiences of Japan and the Republic of Korea, when GDP per capita reaches $7,000–$15,000, industrialization will be almost complete, and the share of the industry sector in final energy consumption will start to move downward (Figure 3.4).

Reflecting the various stages of development of large energy consumers, the industry sector's energy demand among the ADB members will increase at moderate rate of 1.5% per year

Figure 3.2 Industry Energy Demand by Subsector



Mtoe = million tons of oil equivalent.

Figure 3.3 Production Prospects of the Major Energy-Intensive Industries

PRC = People's Republic of China.

Box 3.2 Energy Efficiency and Conservation in Asia and the Pacific

Energy efficiency and conservation (EE&C) is defined as "how to minimize energy requirements to produce certain economic output or lead to activity." Alternatively, it can also be defined as "how to maximize economic output or activity given certain constraints on energy inputs." To measure the energy efficiency level of a certain economy, energy intensity (total primary energy demand per unit of gross domestic product [GDP]) is often used as an indicator because this indicator can capture energy requirements to produce a unit of GDP.

There are two approaches through which EE&C can be achieved: (i) deployment of advanced energy-efficient technologies, and (ii) a shift in people's behavior. Careful design of policies and measures is required to facilitate technology deployment and diffusion. Behavioral shifts can take place only when the right energy price settings, regulations, and sufficient alternative infrastructure are in place to efficiently handle economic activity. Although there are sometimes complicated and politically difficult challenges in promoting EE&C, the benefits can be felt across all sectors (from upstream energy resources development, middle stream energy transformation, and downstream energy distribution) and final consumers (including residential households, commercial building owners and tenants, industrial factories, and car drivers).

EE&C is an important policy agenda item across Asia and the Pacific. For those members with few indigenous energy resources, it is considered as a means to enhance energy supply security. EE&C can be implemented within a shorter time period (in contrast to upstream oil, coal, and natural gas development), and it is a relatively low-cost option to avoid energy imports. In contrast, member countries with abundant indigenous energy resources may seek to undertake EE&C efforts as an economic option to save important resources that can contribute to export earnings. Some members consider EE&C an important means of contributing to reduced carbon dioxide (CO_2) emissions and mitigating climate change impacts resulting from fossil fuel combustion.

Progress of EE&C policies, measures, and their implementation in Asia and the Pacific vary, depending on the member's economic development level, industry structure, resources endowment, energy price levels, and technology deployment level.

The People's Republic of China (PRC) has made substantial progress in EE&C during the implementation period of its Eleventh Five-Year Plan (2005–2010) and has achieved a 19.1% energy intensity improvement. The PRC focused on energy-intensive industries (iron and steel, cement, refineries, and power generation), demolished small-scale factories and plants, installed large-scale factories and plants with advanced technologies, established energy efficiency standards and a labeling system for appliances, and provided various incentives for energy consumers. Each province or city was mandated to reach differentiated energy intensity targets, and this mandatory aspect has brought about success as it engages the central and local governments as well as industry. The Twelfth Five-Year Plan (2011–2016) continues to promote EE&C. In the long term, a more comprehensive design of the system may be required to manage energy demand in the residential, commercial, and transport sectors.

India has targeted 20%–25% CO_2 intensity (CO_2 emissions per unit of GDP) improvement between 2005 and 2020, and considers EE&C an important component for achieving this. Various measures are being carried out across all sectors. It is worth noting that India has started a market trading mechanism for energy savings certificates—the first undertaking by a developing member country. The Perform, Achieve and Trade (PAT) scheme requires energy-intensive factories and utilities to meet a predetermined energy savings target, either through their own technological improvements, operational efficiency improvements, or trading of certificates called "ESCerts" generated from factories and utilities that reach efficiency levels beyond their target. How to ensure measurable, verifiable, and reportable mechanisms would help facilitate the progress.

Dwindling domestic oil production or lack of domestic energy resources, combined with sustained high international energy prices, have impacted the economies in Southeast Asia, making it necessary for them to undertake EE&C efforts. Indonesia, the Philippines, Singapore, Thailand, and Viet Nam have their own energy conservation laws that encourage various measures, mainly for the industry sector (such as the establishment of an energy management system), the residential sector (establishment of energy efficiency standards and labeling systems for appliances), and the commercial sector (implementation of building codes and energy usage standards and the promotion of energy service companies). Despite the aspirations of each member government toward EE&C, progress is varied as some face political challenges pertaining to reforms in energy pricing (mainly phasing out energy subsidies). A step-wise approach needs to be taken to balance energy security enhancement objectives, enhance social security to enable access to energy for the poor, and minimize fiscal impacts from subsidy provisions.

Member countries of Central and West Asia recognize the importance of EE&C because of the significant energy losses from obsolete energy supply and transformation infrastructure developed during the Soviet era. Investments into replacing and

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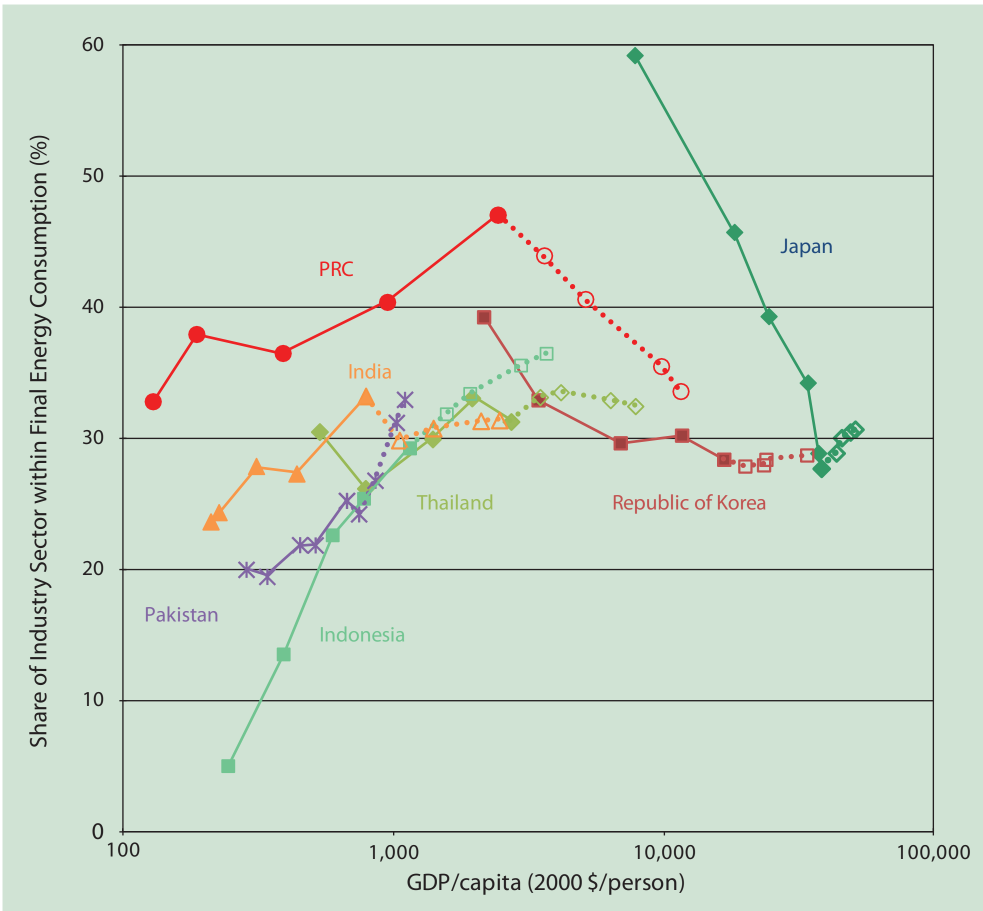
Box 3.2 *continued*

upgrading them have been slow to come because the energy suppliers or utilities could not cover costs due to weak financial performance caused by low tariff levels. Nevertheless, efforts are being made in some members. Azerbaijan and Uzbekistan have implemented pricing reform to increase electricity tariff levels, and Kazakhstan, Pakistan, and Uzbekistan have each stipulated their own EE&C laws. In view of the benefits of EE&C to assure domestic energy supply security as well as increase the potential for energy exports, it is deemed necessary for members in Central and West Asia to further engage in EE&C undertakings, preferably in cooperation with other members in Asia and the Pacific that have the necessary technological basis and operational know-how.

Source:
Institute for Global Environmental Strategies. PAT Scheme. www.iges.or.jp/en/archive/Asianfocus/asianfocus201104.html.

Figure 3.4 Share of the Industry Sector in the Total Sectoral Energy Demand



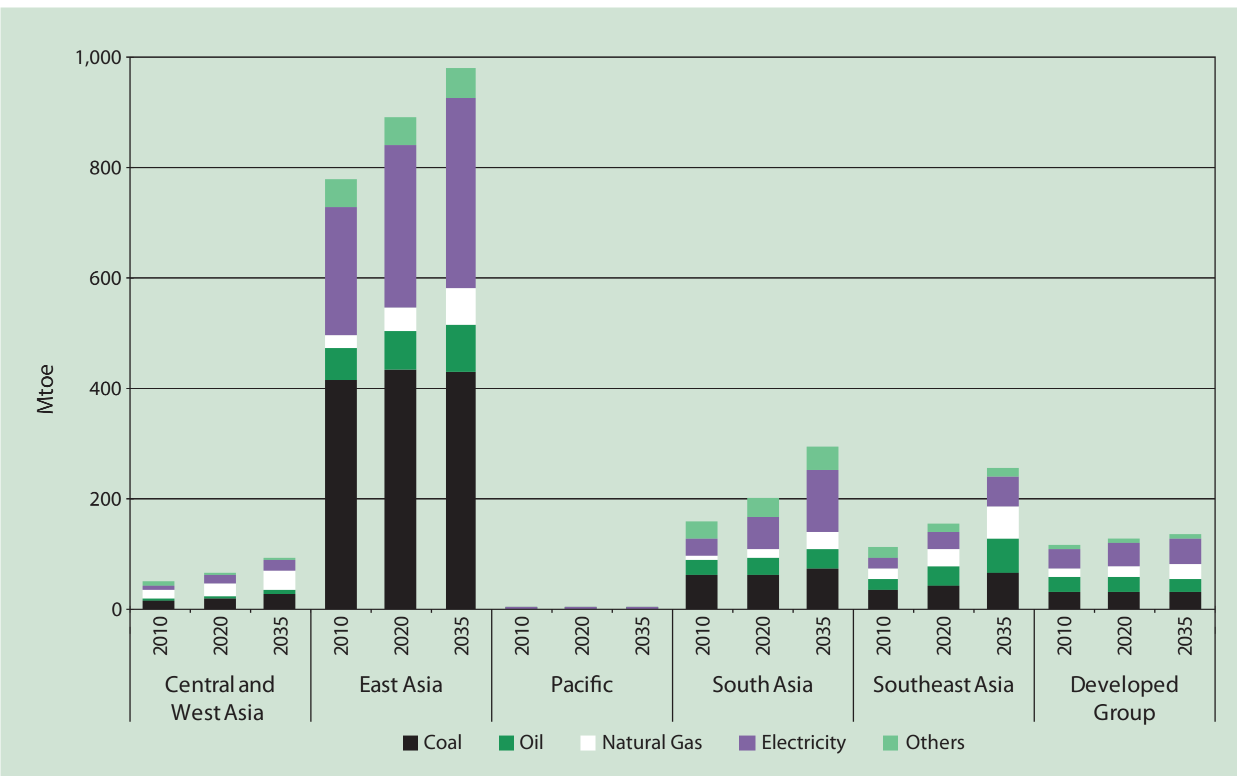
GDP = gross domestic product, PRC = People's Republic of China.
Note: Solid lines refer to actual values while broken lines refer to forecast values.

during the outlook period, reaching 1,771.4 Mtoe in 2035, and dropping its share of the total final energy demand to 32.8%, 4.8 points down from that in 2010.

During the outlook period, the final energy demand of the industry sector in most of the ADB members in Asia and the Pacific will increase, except in the Developed Group. Industry energy demand in Southeast Asia will show the fastest growth, increasing at 3.4% per year and reaching 258.0 Mtoe in 2035 from 110.7 Mtoe in 2010. Industry energy demand in South Asia will grow at 2.5% per year and reach 296.9 Mtoe in 2035, up from 158.9 Mtoe in 2010. In the two regions, both the energy-intensive and less energy-intensive industries will achieve rapid expansion. In 2010, East Asia accounted for the biggest share of the industry sector's energy demand of ADB members, at 64.1%. During 2011–2035, the industry sector in East Asia will maintain its position of holding the biggest share of the industry sector's energy demand in Asia and the Pacific. Nevertheless, due to changes in the industry sector's structure in the region, less energy-intensive industries will lead economic growth. The sector's energy demand in East Asia will increase at a moderate pace, 0.9% per year, reaching 981.9 Mtoe in 2035, up from 780.1 Mtoe in 2010. The energy demand of Central and West Asia's industry will grow at 2.7% per year, reaching 95.4 Mtoe in 2035 from 49.5 Mtoe in 2010, and its share will remain around 5% of the total of all ADB members. Industry energy demand in the Developed Group will reach 137.1 Mtoe by 2035, and its share in Asia and the Pacific will drop from 9.6% in 2010 to 7.7% in 2035.

Coal accounts for the biggest share in the industry sector's final energy demand, at 45.8% in 2010. During the outlook period, due to the slowdown of heavy industry in East Asia, industry's demand for coal in Asia and the Pacific will increase at a moderate pace of 0.5% per year, reaching 631.6 Mtoe in 2035 from 558.0 Mtoe in 2010. Electricity makes up the second-largest share of final energy demand of industry in Asia and the Pacific. Demand

Figure 3.5 Industry Energy Demand by Source



Mtoe = million tons of oil equivalent.

for electricity will grow 2.3% per year and reach 580.5 Mtoe in 2035. Consequently, its share will rise from 27.1% in 2010 to 32.8% in 2035. The demand for natural gas will increase from 84.7 Mtoe in 2010 to 216.7 Mtoe in 2035, at an average rate of 3.8% per year. The oil demand of industry will grow at 1.9% per year and reach 215.3 Mtoe in 2035, up from 135.6 Mtoe in 2010 (Figure 3.5).

3.3 Transport Sector

The analysis of the energy demand of the transport sector focuses on domestic transport (including road, air, rail, and marine subsectors) and excludes international transport (air and maritime transport). The road transport subsector's energy consumption accounts for the bulk of the energy demand of the transport sector, accounting for about 90% in 2010.

The transport sector's energy demand in Asia and the Pacific in the BAU case is expected to increase from 517.7 Mtoe in 2010 to 1,003.2 Mtoe in 2035, growing at an annual rate of 2.7%. Transport is the fastest growing sector in terms of final energy demand; its share would increase from 16.0% in 2010 to 18.6% in 2035. Drivers for the relatively fast growth in transport energy demand include (i) income growth and resulting increases in the mobility needs handled by passenger vehicles and (ii) economic activities and resulting freight transport needs.

The road transport subsector will continue dominating the energy demand of the transport sector throughout the outlook period, and its energy mix will not change substantially from 2010. Oil would account for 91.2% of the transport sector's total energy demand in 2035, followed by natural gas at 4.3% and electricity at 2.1% in 2035 (Figure 3.6).

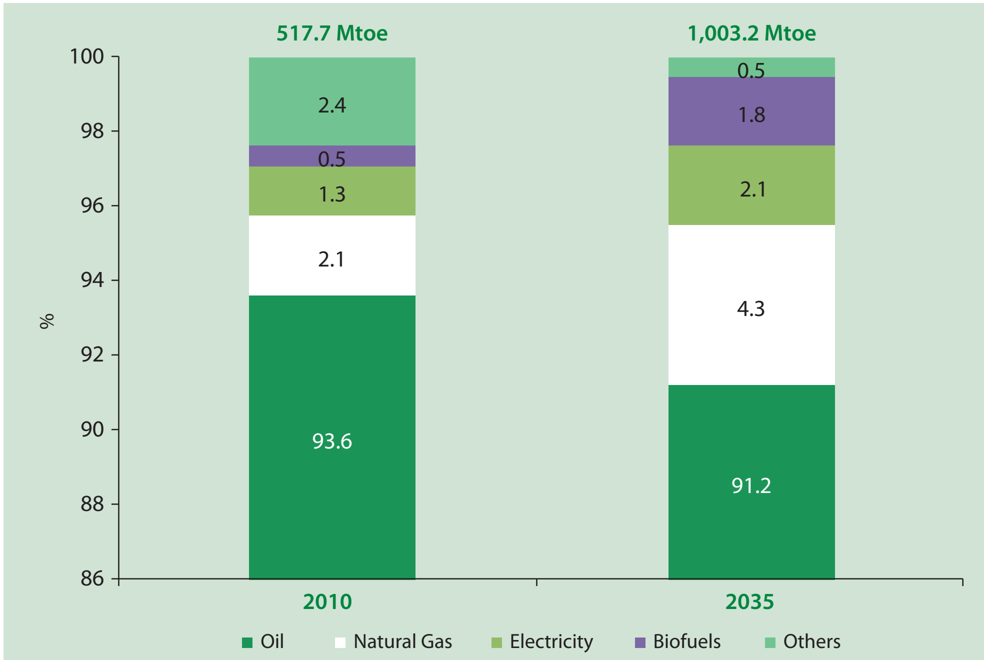
Figure 3.7 compares the transport sector's energy demand outlook by region. It shows that East Asia's transport energy demand is projected to be the biggest in Asia and the Pacific, reaching 480.9 Mtoe in 2035, more than doubling the 2010 level of 227.0 Mtoe. The PRC's economic development and resulting increases in mobility needs for both passenger and freight transport explain the substantial increases in East Asia's transport energy demand.

South Asia's transport energy demand is projected to more than triple from 61.7 Mtoe in 2010 to 192.8 Mtoe in 2035, growing at 4.7%, the fastest rate in Asia and the Pacific. India's passenger vehicle stock, which is projected to increase substantially from 16.7 million units in 2010 to 117.8 million units in 2035, will drive this threefold increase in the transport sector's energy demand in South Asia.

Southeast Asia's transport energy demand will increase at an annual rate of 2.6% from 92.5 Mtoe in 2010 to 177.6 Mtoe in 2035. Despite the substantial growth, the projected growth rate of the transport sector's energy demand in Southeast Asia is slower compared with the historical trend (5.3% per year between 1990 and 2010) due to the buildup of vehicle stocks in some members and modal shifts within the major cities of the region.

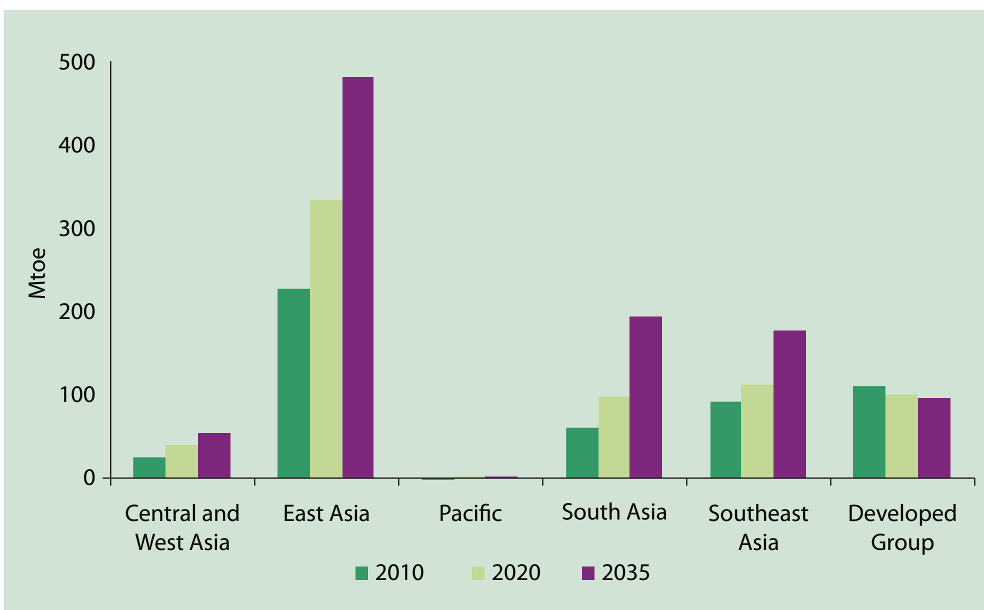
The Developed Group's transport energy demand is projected to decline from 110.2 Mtoe in 2010 to 96.0 Mtoe in 2035, at an annual rate of 0.5%. The decline in the group's energy demand is affected by the decline in the sector's energy demand in Japan as a result of a shift toward efficient vehicles (mainly hybrids). Additionally, the number of passenger vehicle stocks in Japan will decline as its population peaked in 2005.

Figure 3.6 Transport Energy Demand of Asia and the Pacific, by Source (2010 and 2035)



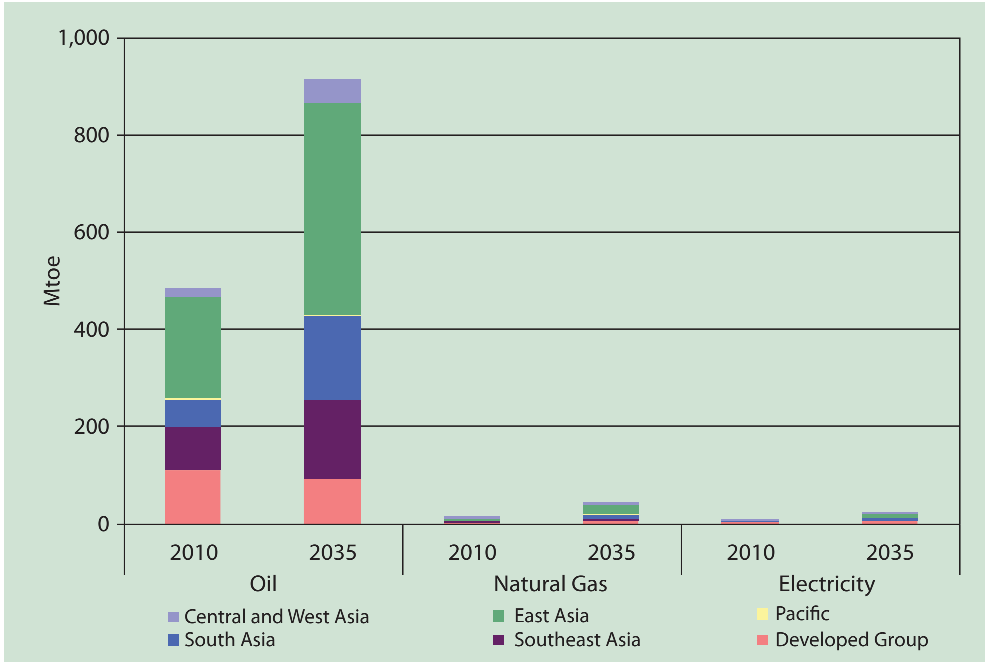
Mtoe = million tons of oil equivalent.

Figure 3.7 Transport Energy Demand by Region (2010, 2020, and 2035)



Mtoe = million tons of oil equivalent.

Figure 3.8 Transport Energy Demand Outlook by Region (2010, 2020, and 2035)



Mtoe = million tons of oil equivalent.

Central and West Asia's transport energy demand would increase at 3.1% per year through 2035, increasing from 25.4 Mtoe in 2010 to 54.5 Mtoe in 2035. The pace of growth would differ by member. The energy demand of the transport sector of Afghanistan would increase the fastest, at an average rate of 6.8% per year, spurred by road infrastructure development. By contrast, growth of the energy demand of the transport sector in Uzbekistan has slowed down due to the high saturation of vehicle ownership and is projected to increase by 1.1% per year through 2035—the slowest growth in final transport energy demand in the region.

The Pacific's transport energy demand will increase at a slower pace than the historical trend, from 0.8 Mtoe in 2010 to 1.4 Mtoe in 2035 at an annual rate of 2.1%.

Figure 3.8 shows the distribution of the demand for oil, natural gas, and electricity of the transport sector in Asia and the Pacific among the regions. The demand for oil by the transport sector of all the regions will increase, except that of the Developed Group. East Asia's transport oil demand will increase the most, from 208.7 Mtoe in 2010 to 447.7 Mtoe in 2035. The transport oil demand in South Asia, on the other hand, will triple, from 56.8 Mtoe in 2010 to 175.4 Mtoe in 2035. The combined increase in demand for natural gas and electricity by the transport sector from 2010 to 2035 in Asia and the Pacific is very small compared with the increase in oil demand for the same period. Incremental growth of transport oil demand from 2010 to 2035 will amount to 444.8 Mtoe, while the incremental growth in the combined demand for natural gas and electricity for the same period will only amount to 43.5 Mtoe.

Drivers

The transport sector's energy demand will be influenced by both personal mobility and freight transport needs driven by economic activities. Since the bulk of the transport sector's energy demand would be dominated by road transport for passenger transport (about 60% of the total road transport needs), this section reviews the driving factors for passenger transport in the road subsector looking at representative cases from selected ADB members in Asia and the Pacific.

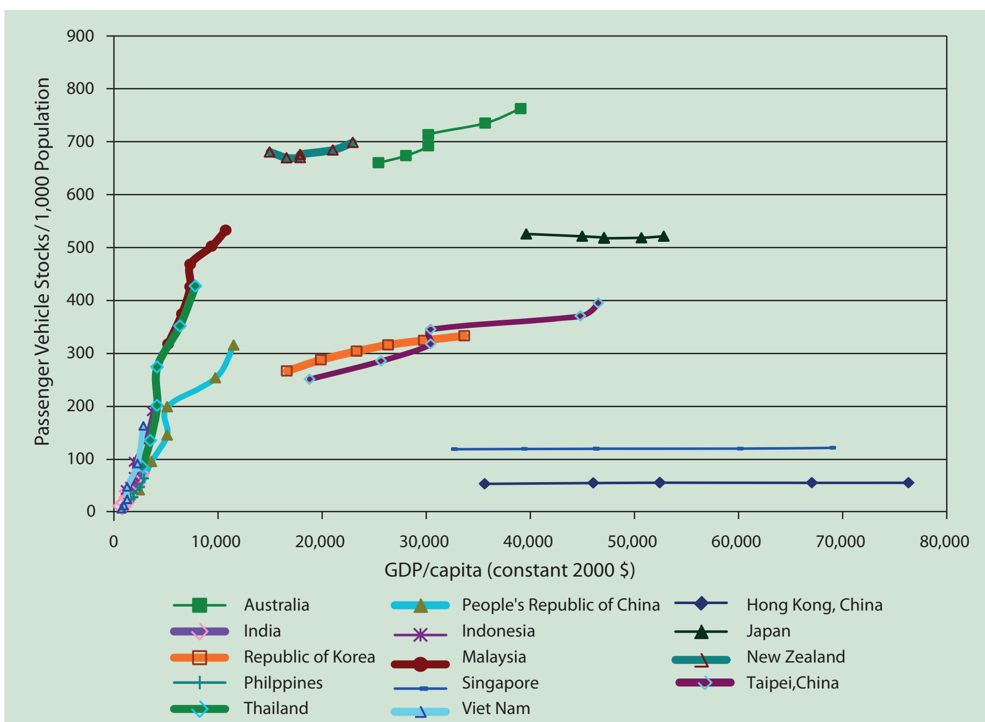
Increases in the number of passenger vehicle stocks in each member economy will be influenced by many factors, including income growth, regulations and incentives on vehicle ownership, price of oil products, and availability of public transport.

Figures 3.9 and 3.10 present the projected relationship between income growth and passenger vehicle stocks. In both figures, the x-axis shows GDP per capita between 2010 and 2035 for selected ADB members, and the y-axis shows the corresponding member's passenger vehicle stocks per 1,000 population. As the figures show, there is a general trend for passenger vehicle stocks per 1,000 population to increase rapidly in the low-income members where incomes are below $12,000 (e.g., the PRC, India, Indonesia, Malaysia, the Philippines, Thailand, and Viet Nam).

By contrast, growth trends in the number of passenger vehicle stocks per 1,000 population will stabilize when the per capita income levels surpass $12,000, although some diversity is observed. In Australia and New Zealand, passenger vehicle stocks per 1,000 population will stay around 700 units as their economy depends on road transport for mobility given the lack of public passenger transport.

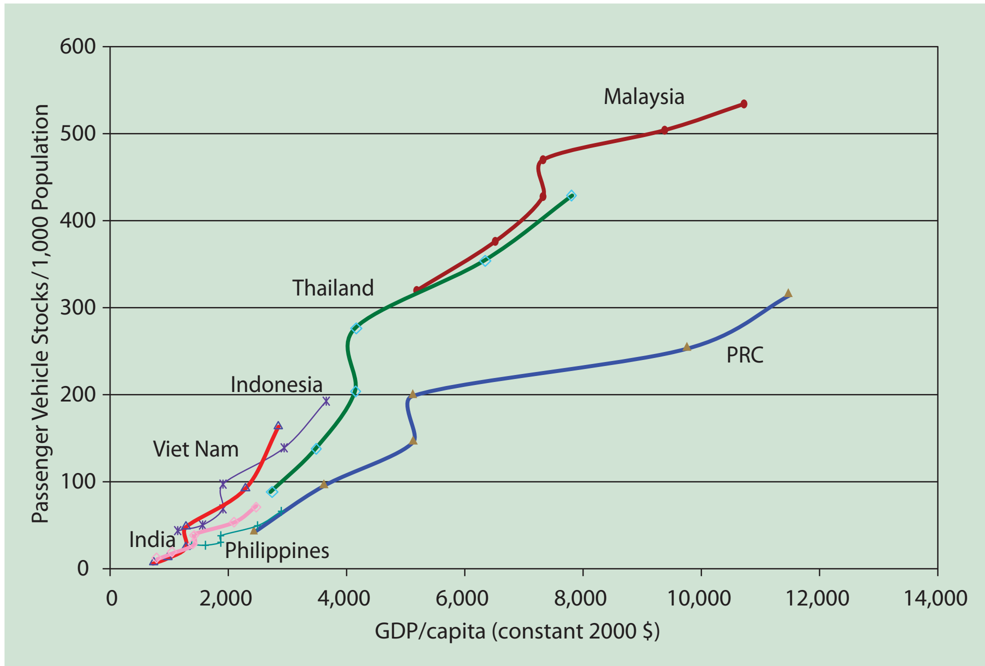
Singapore's and Hong Kong, China's passenger vehicle stocks per 1,000 population are low, although their income levels through 2035 will be among the highest in Asia and the Pacific. Over the outlook period, Singapore will continue implementing various economic

Figure 3.9 Passenger Vehicle Stocks per 1,000 Population (2010–2035)



GDP = gross domestic product.

Figure 3.10 Passenger Vehicle Stocks per 1,000 Population (2010–2035) (inset from Figure 3.9)



GDP = gross domestic product.

measures to control vehicle ownership. Meanwhile, Hong Kong, China's low vehicle stocks per 1,000 population is a result of the high cost of vehicle ownership due to small land area.

Figure 3.11 shows a comparison of the number of passenger vehicles by type for the PRC, India, Indonesia, and Thailand. The number of vehicles would rapidly increase in the PRC from 59.7 million units in 2010 to 438.4 million units in 2035—a more than sevenfold increase within 25 years from 2010 to 2035. This significant growth over the outlook period will be dominated by increases in gasoline-powered conventional engine vehicles. The PRC released its eco-car development plan (2012–2020) in 2012 to target overall improvement in the fuel economy of passenger vehicles and increase the use of energy-saving vehicles (including electric vehicles and plug-in hybrid vehicles). In view of the policy target, the introduction of electric vehicles (reaching 2.1 million units in 2035) and plug-in hybrid vehicles (gasoline: 9.9 million units and diesel: 2.3 million units) is assumed to take place through 2035 even in the BAU case.

India is projected to achieve a nearly sixfold increase in passenger vehicle stocks, from 16.7 million units in 2010 to 117.8 million units in 2035. This growth would be led by conventional gasoline-powered vehicles and diesel-powered vehicles. Meanwhile, with the rise in income levels, and increased public environmental concern and need for fuel economy improvements, hybrid vehicles are projected to make inroads into India's market, reaching 19.1 million units (hybrid gasoline) and 6.0 million units (hybrid diesel) in 2035.

Indonesia's passenger vehicle stocks would increase from 10.5 million units in 2010 to 55.1 million units in 2035. Conventional gasoline-powered vehicles will account for 75.3% of the total growth. Meanwhile, Indonesia has a policy to promote hybrid and electric vehicles in the short term through the enhancement of domestic production capacities in the long term. Economic instruments (such as removal of import tariffs) for domestic electric vehicle manufactures are provided to promote

Box 3.3 Low-Carbon City

Cities are major contributors to green house gas (GHG) emissions. A study by the United Nations (UN 2011) showed that cities and towns produce between 40% and 70% of global anthropologic GHG emissions. The urbanization rate of Asia and the Pacific is expected to increase from 42.4% in 2010 to 56.1% in 2035, with the region's urban population growing by an additional 36.9 million each year. In comparison, the world average urbanization rate is expected to reach 61.7% in 2035 from 51.6% in 2010. Therefore, low-carbon urban development is crucial to the region's GHG emissions reduction.

Box Table 3.3.1 Low-Carbon Development Indicators

Category	Indicators
Carbon Emissions	Emissions per capita and emissions intensity
Energy	Energy consumption per capita, energy intensity, and share of renewable energy in the energy mix
Green Buildings	Energy consumption per unit area
Sustainable Transport	Percentage of citizens walking, cycling, or using public transport
Smart Urban Form	Population density and mixed land use
Green Innovation	Share of green industries in the city's gross domestic product, number of green jobs

Sources: ADB (2012b) and World Bank (2012).

Although the concept of the "low-carbon city" has been receiving widespread attention, there is no universally applicable definition. One of the major reasons is that cities vary in their historical carbon footprints. Climate and natural factors are significant in shaping the character of a city's carbon footprint. For instance, cities located in high latitudes need more energy for heating than those in tropical areas, and conversely, tropical cities might consume more electricity for air conditioning than high-latitude cities. The economic base of a city is another factor. Cities with energy-intensive heavy industries have higher carbon intensities than cities focusing on the service industry. In Beijing and Shanghai, industry contributes 43% and 64% of total emissions (Ru et al. 2009), respectively, compared with Tokyo, New York, and London with 10%, 7%, and 7%, respectively (UN 2011).

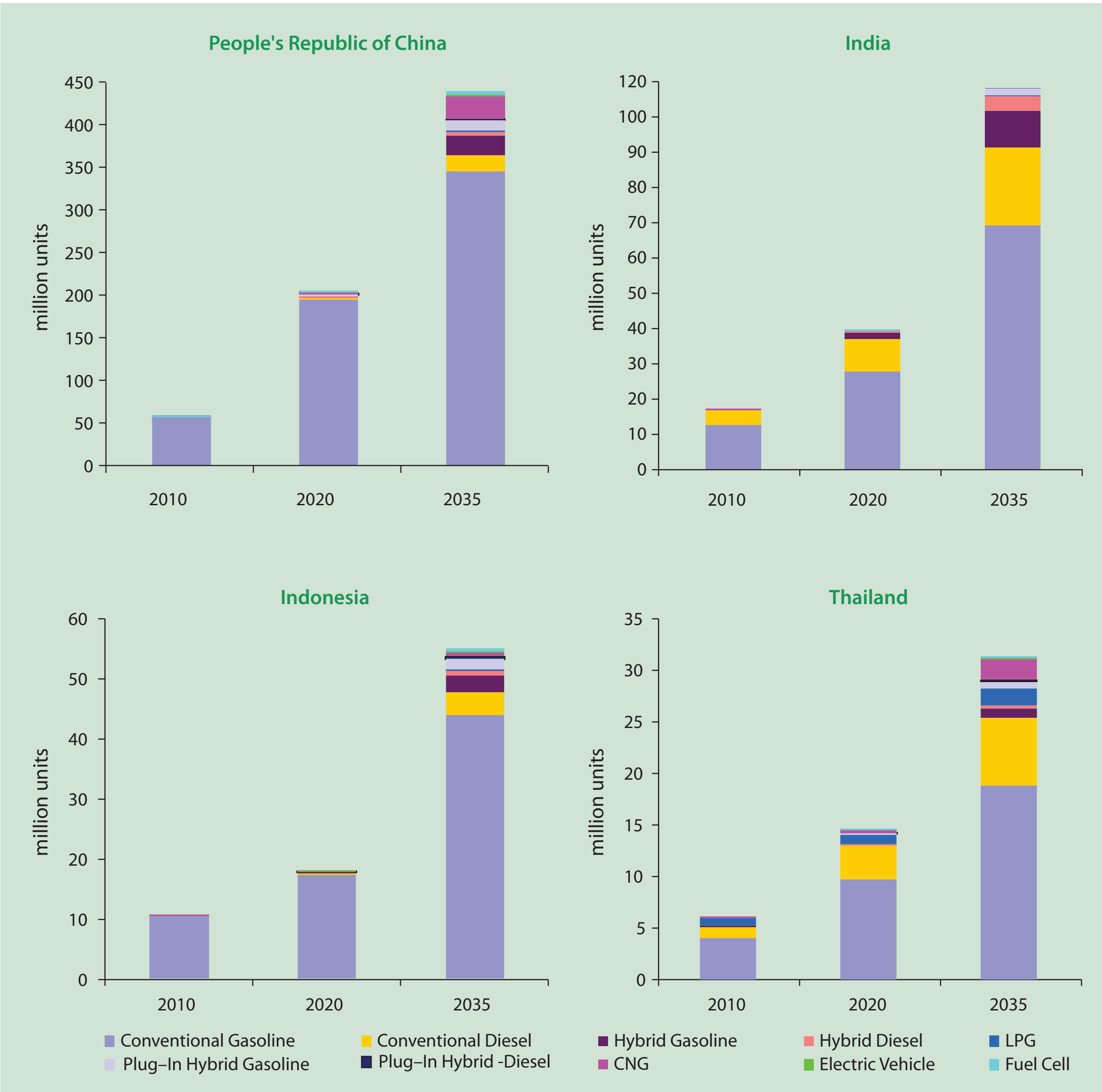
Despite variations in carbon footprints, for cities committed to low-carbon development, an important first step is setting the right indicators. Appropriate indicators are supposed to not only provide a clear measurement of cities' performance and position in low-carbon development, but also help national and municipal governments determine policy direction and measure performance. While indicators should reflect the characteristics of a city and its country, there are some common indicators that could be applied to all cities. Box Table 3.3.1 lists some indicators identified in a World Bank study (2012) and an ADB publication (2012b).

While achieving "low-carbon city" status is a local and national effort, international cooperation plays a significant role in the progress. For both developed and developing countries, an easy way of achieving a low-carbon city is through scaling up of best practice. This "best practice" could be found in the city itself, other cities in the country, or cities in other countries. For example, pedestrianized streets and car-free zones are promoted in most major cities in Europe as well as in Asia (ADB 2012a). For developing countries, the best practice with urban development often comes from developed countries. The emission standards for new vehicles in Europe, and the energy efficiency standards for factories and experience with factory operations in Japan, all set a good example for many Asian developing countries to follow suit.

Moreover, development of a low-carbon city is usually accompanied by the introduction of clean technologies, such as solar photovoltaic, wind power, and integrated gasification combined-cycle power plants, which often come with higher initial costs than their conventional counterparts. For most developing countries, both the technology and the additional initial investment are beyond their reach. Thus, support from international organizations and developed countries through international frameworks such as the Clean Development Mechanism and bilateral agreements are of great significance for developing countries. Low-carbon city development not only contributes to the developing country's sustainable development but also offers green business opportunities for supporters, which could result in a cooperative win–win setting.

Sources:
Asian Development Bank (ADB). 2012a. *Green Cities: Livable and Sustainable Cities in Asia*. Manila.
———. 2012b. *Key Indicators for Asia and Pacific 2012 43rd Edition, Special Chapter on Green Urbanization in Asia*. Manila.
Ru, Guo et al. 2009. The Strategy of Energy-Related Carbon Emission Reduction in Shanghai. *Energy Policy*. 38(1):633–638. Quoted in United Nations. 2011. *Global Report on Human Settlements 2011, Cities and Climate Change*. Washington, D.C.: United Nations Human Settlements Programme.
United Nations (UN). 2011. *Global Report on Human Settlements 2011, Cities and Climate Change*. Washington, DC: United Nations Human Settlements Programme.
World Bank. 2012. *Sustainable Low-Carbon City Development in [the People's Republic of] China*. Washington DC.

Figure 3.11 Passenger Vehicle Stocks by Type: People's Republic of China, India, Indonesia, and Thailand (2010, 2020, and 2035)



CNG = compressed natural gas, LPG = liquefied natural gas.

local production. In view of the implementation of these policies, about 11.4% of total vehicle stocks in 2035 will be composed of hybrid, plug-in hybrid, and electric vehicles.

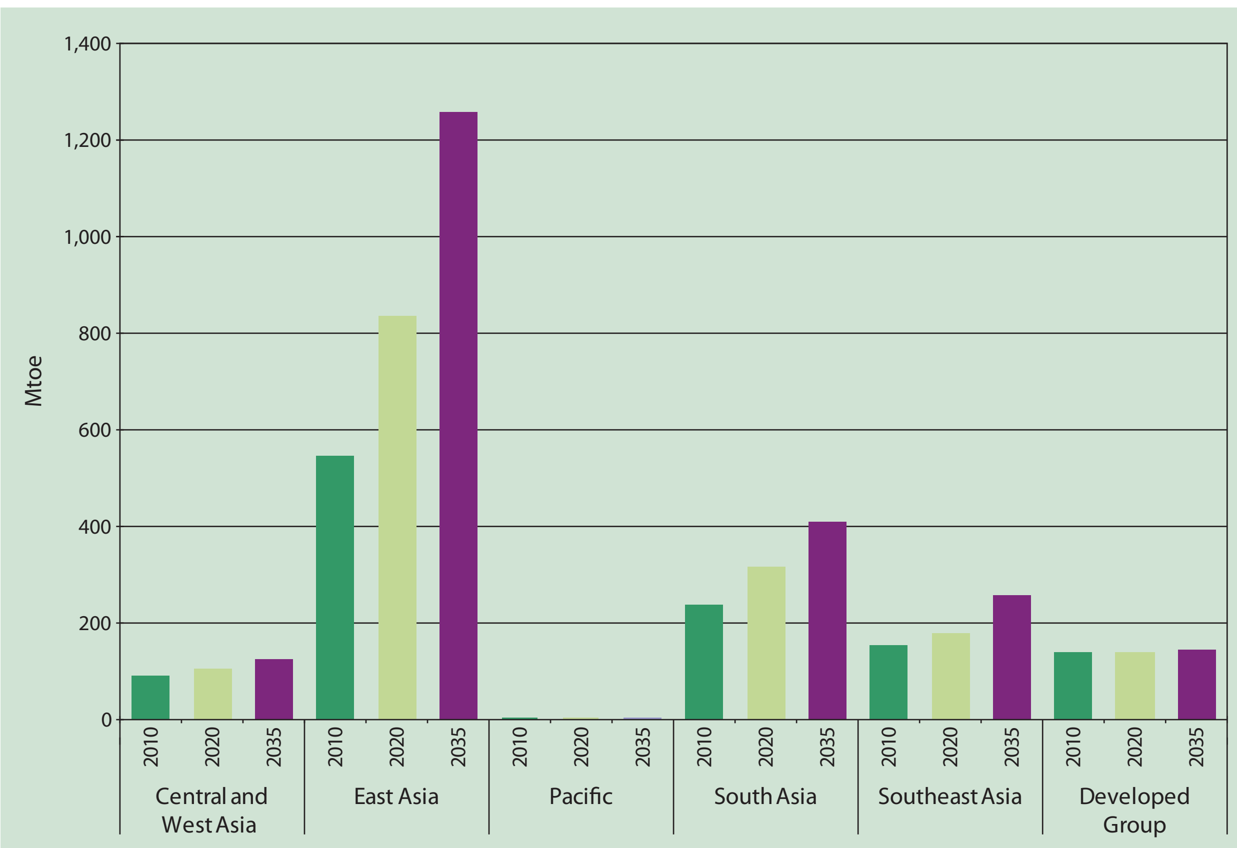
Thailand's passenger vehicle stocks will reach 31.5 million units in 2035—a fivefold increase from the 2010 level of 6.1 million units. Of the total passenger vehicle stocks in 2035, conventional gasoline and diesel vehicles will account for slightly above 80%. Similar to Indonesia, Thailand is promoting the use of next-generation vehicles, including hybrid, plug-in hybrid, and electric vehicles by lowering excise taxes to 10% (instead of the usual 17%–50%). This policy measure may spur growth in next-generation vehicles over the outlook period.

3.4 Other Sectors

The category "other sectors" includes the residential, commercial, agriculture, and fishery sectors. Most of the energy consumption by the other sectors is taken up by the residential and the commercial sectors. The final energy demand of the other sectors in Asia and the Pacific is projected to increase from 1,176.7 Mtoe in 2010 to 2,196.4 Mtoe in 2035, at an annual rate of 2.5%. As shown in Figure 3.12, because of the large population in East Asia and South Asia, the energy demand of the other sectors in these regions will continue to dominate the energy demand of the other sectors in Asia and the Pacific, accounting for 75.9% in 2035, up from 67.0% in 2010.

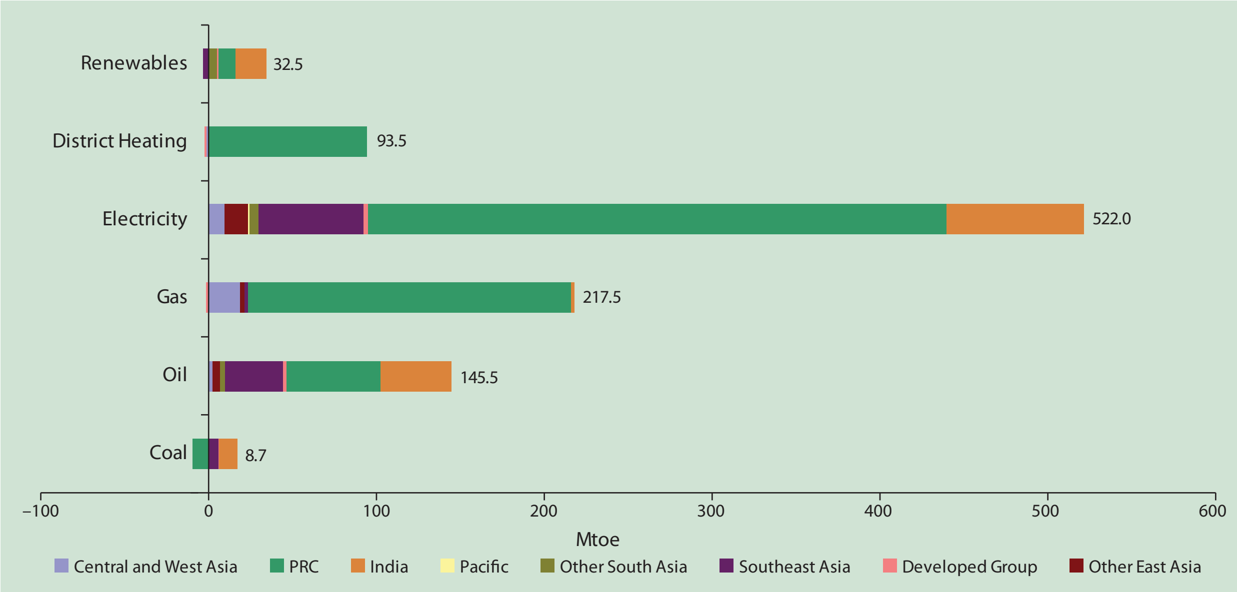
In terms of energy type, Asia and the Pacific is expected to experience substantial switching from noncommercial biomass to commercial energy sources, particularly for electricity. Demand for electricity by the other sectors will experience the biggest increase, projected to reach 787.2 Mtoe by 2035. The growth will be driven by increasing demand from developing member countries, with 66.2% of the incremental growth coming from the PRC, 15.5% from India, and 12.0% from

Figure 3.12 Energy Demand in the Other Sectors by Region



Mtoe = million tons of oil equivalent.

Figure 3.13 Energy Demand Growth by Type and by Region (2010–2035)



Mtoe = million tons of oil equivalent, PRC = People's Republic of China.

Southeast Asian members (Figure 3.13). At the end of the projection period, electricity will become the most consumed energy type by the other sectors in Asia and the Pacific, accounting for 35.8% of total energy demand of the other sectors in 2035, compared with 22.5% in 2010. On the other hand, noncommercial biomass, which currently has the largest share (42.5% in 2010) of the final energy demand of the other sectors, will decline to 24.2% in 2035. Demand for natural gas by the other sectors will also increase considerably, from 103.2 Mtoe in 2010 to 320.7 Mtoe in 2035, with 88.6% of the incremental growth coming from the PRC.

Drivers

A member economy's energy consumption in the other sectors is shaped by various factors. One is geography. Per capita energy demand in the other sectors in cold areas like Central and West Asia and East Asia tends to be larger than that in warmer places like South Asia and Southeast Asia because of the energy demand for heating (Figure 3.14).

The most important driver behind energy demand in the other sectors is economic growth. Developed members' per capita energy demand in the other sectors is much larger than that of developing members (Figure 3.14). The impact of economic growth comes from several factors, including urbanization and electrification on the macro level and individual income on the micro level. Developed members tend to have higher urbanization and electrification rates than developing members. All the developed members in the region had achieved 100% electrification as of 2010 and the average urbanization rate in these countries was 88.6% in 2010—nearly two times the average level of other countries in the region (44.4% in 2010). Electrification, urbanization, and income level have a strong correlation with diffusion of electric appliances (McNeil, Letschert, and de la Rue du Can 2008).[5] The operational hours of some electric appliances in developed members also tend to be longer than those in developing member countries because of higher

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[5] The work was supported by the Ministry of Economy, Trade and Industry of Japan and the Institute of Energy Economics, Japan.

Figure 3.14 Per Capita Energy Demand in the Other Sectors

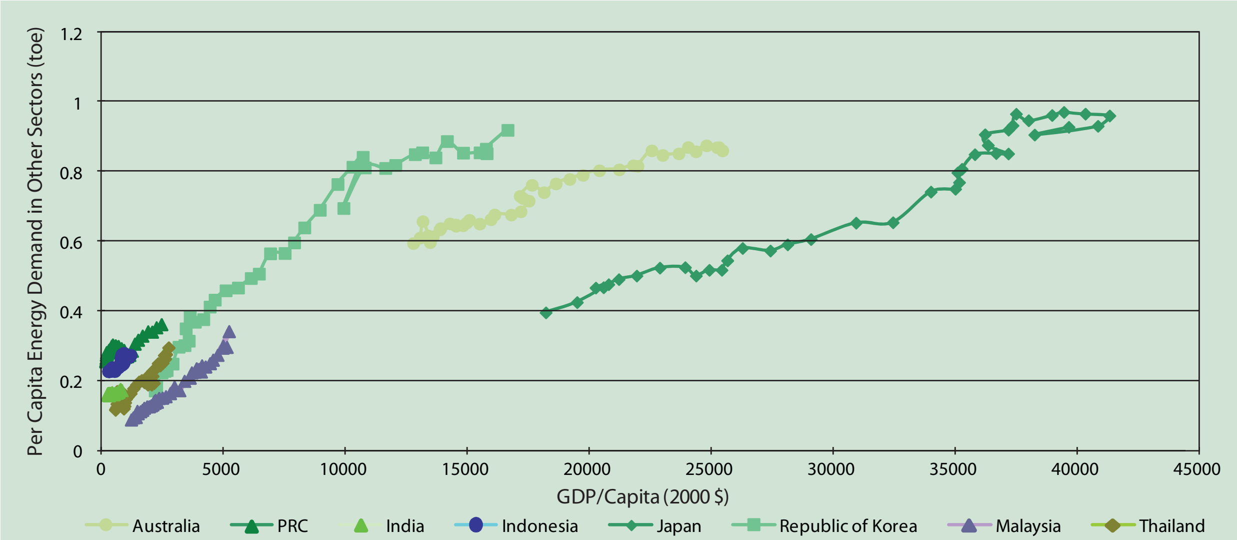
toe = ton of oil equivalent.

income levels. Furthermore, higher urbanization rate and income levels also lead to more demand for services, thus resulting in higher energy requirements in the commercial sector.

Historical data indicate that while individual demand for energy services (per capita energy demand in the other sectors) will increase with people's income (GDP per capita), the pace varies with the stage of economic development of that particular economy (Figure 3.15). Individual demand for energy services grows slowly both in the early stage of economic growth, when energy infrastructure is underdeveloped, and in the high development stage, when diffusion of electric appliances or other energy equipment are close to saturation. On the other hand, in the in-between stage, growth of individual energy demand is fast, boosted by increases in income coupled with development of energy infrastructure.

The historical trend (from 1971 to 2010) of the relationship between GDP per capita and per capita energy consumption in the other sectors is examined for several countries in Asia and the Pacific (Figure 3.15). For India and Indonesia, where GDP per capita was still around $1,000 until 2010 ($787 for India and $1,144 for Indonesia), the average annual growth of per capita energy consumption in the other sectors was lower than 0.5% (0.17% for India and 0.48% for Indonesia) between 1971 and 2010. On the other hand, per capita energy consumption in Malaysia, where GDP per capita increased from $1,177 in 1971 to $5,185 in 2010, grew at an average rate of 3.5% per year during the same period. In Thailand, individual consumption of energy expanded faster after the country's GDP per capita surpassed $1,000 ($1,037) in 1987—2.9% per year compared with 1.8% per year previously. Although the trend fluctuated, per capita energy demand in the other sectors in the PRC saw an average growth rate of 0.9% per year before its GDP per capita

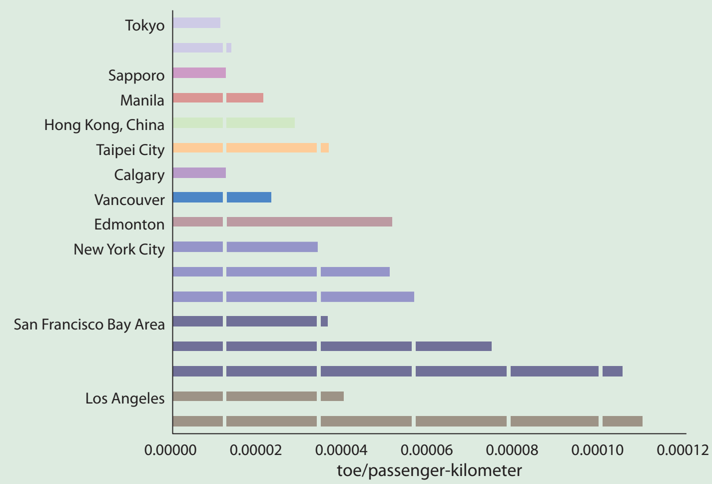
Figure 3.15 Per Capita Energy Demand in the Other Sectors and Income Level (1971–2010)



GDP = gross domestic product, PRC = People's Republic of China, toe = ton of oil equivalent.

Box 3.4 Mass Rapid Transit—Potential for Energy Savings and Carbon Dioxide Emissions Reduction

Box Figure 3.4.1 Urban Mass Transit Energy Intensity in Asian and North American Cities



toe = ton of oil equivalent.
Source: United States Energy Information Administration. 2012. *The Annual Energy Outlook 2012*. Washington, D.C..

Shifting toward urban mass transit systems[a] from passenger vehicles in principle could offer substantial energy and carbon dioxide (CO_2) savings because urban mass transit systems (i) carry a larger number of passengers at one time compared with passenger vehicles; (ii) contribute to replacing part of the existing fuel-inefficient public transport fleet (mostly buses and paratransit modes such as jeepneys in the Philippines, or auto-rickshaws in South Asia) with larger capacity energy-efficient vehicles (buses in the case of bus rapid transit [BRT], or electricity-powered vehicles in the case of mass rapid or light-rail transit systems); and (iii) ease congestion and improve average speeds in transport corridors. The Asia Pacific Energy Research Centre (APERC 2008) surveyed the energy and CO_2 intensities per passenger kilometer of 17 rail-based urban mass transit systems in Asian and North American cities.[b] The study found diversity in both the energy and CO_2 intensities of the mass transit systems analyzed. Similar findings have been found in the analysis of energy and CO_2 intensities per passenger kilometer of renowned BRT systems.[c]

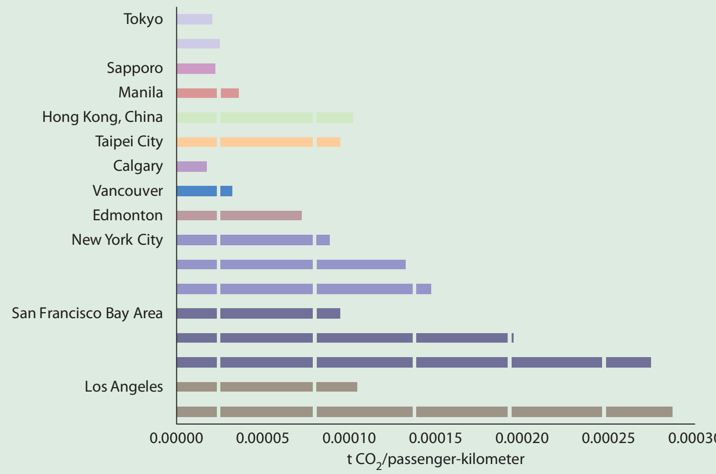
The average energy intensity of mass transit systems between 2000 and 2006 differed by a factor of 10, ranging from the lowest in Tokyo at 0.00001 tons of oil equivalent (toe) per passenger kilometer, to the highest in Los Angeles at 0.00011 toe per passenger

continued on next page

Box 3.4 *continued*

kilometer. Importantly, the energy intensities of three systems were higher than the average passenger vehicle energy intensity in Asia (Box Figure 3.4.1). Additionally, the variations in average CO_2 intensities of 17 urban mass transit systems (2000 and 2006) are wider, ranging from 0.00002 tons of CO_2 per passenger kilometer in Calgary to 0.00029 tons per passenger kilometer in Los Angeles (Box Figure 3.4.2). Likewise, three systems' CO_2 intensities were higher than the average CO_2 intensity of passenger vehicles of the analyzed cities and countries. The APERC study offers important implications for the appropriate design of mass transit systems for energy security enhancement and climate change mitigation.

Box Figure 3.4.2 Urban Mass Transit Carbon Dioxide Intensity in Asian and North American Cities



t CO_2 = ton of carbon dioxide.
Source: United States Energy Information Administration. 2012. *The Annual Energy Outlook 2012*. Washington, D.C..

First, the variations in energy intensity essentially were derived from differences in passenger kilometers or "ridership." The energy required to operate mass transit systems do not differ substantially by type of system (rail-based or bus-based). Nevertheless, the number of passengers and of kilometers traveled differ by system as they relate to various factors, including passengers' accessibility to the system and the system's frequency, capacity, reliability, comfort, and safety. In other words, city planners and urban mass transit operators should adequately design the location, frequency, and capacity of mass transit systems to ensure a high load factor.

Second, CO_2 intensity rankings among the cities analyzed differ from the ranking of energy intensity, depending on whether a rail-based or bus-based system is in use. In the case of rail-based systems, the CO_2 intensity ranking relates to the electricity generation mix. For example, Hong Kong, China's energy intensity is lower than that of Taipei,China, while the CO_2 intensity of Hong Kong, China is higher than that of Taipei,China, because of Hong Kong, China's heavy dependence on coal-fired generation, accounting for 71% of total power generation in 2009.

Third, both the energy and CO_2 intensities of the three rail-based systems outperform those of passenger vehicles. The three systems are operational in cities in the United States. Factors behind the poor performance of urban mass transit systems in both energy and CO_2 intensities relate to low ridership of mass transit systems resulting from the systems' relatively low operational frequency, and poor access resulting from land-use characteristics (dispersed suburban areas from the city center).

Unless the infrastructure for mass rapid transit is fully operational, integrating the demand center and residential suburbs, its potential for energy savings cannot be easily realized. Likewise, potential CO_2 emissions reduction from the introduction of mass rapid transit systems depends on the electricity generation mix for rail-based systems, and on the effective restructuring of the local bus industry and introduction of energy-efficient buses in the case of bus-based systems. Careful planning and coordination among various stakeholders, involving both central and local government entities, are necessary to introduce such systems in coordination with land-use planning. Concepts such as transit-oriented development can be useful tools, since such planning and coordination are essential for the mass rapid transit systems to serve the city's mobility needs, the country's energy security enhancement objectives, and the development of low-carbon societies.

[a] Mass transit systems hereby refer to rail-based systems such as mass rapid transit (MRT) or light-rail transit (LRT), as well to bus-based systems, more commonly know as bus rapid transit (BRT).

[b] From top to bottom, the mass rapid transit systems analyzed in the study are Tokyo Toei subway; Tokyo Metro; Sapporo Municipal Subway; Manila LRT 1; Hong Kong, China MTR; Taipei,China MRT; Calgary CTrain; Vancouver Sky Train; Edmonton LRT; MTA New York City Transit; Authority Trans-Hudson Corporation; Transit Corporation; San Francisco BART; MUNI Rail; VTA LRT; Los Angeles LACMTA Light Rail; and LACMTA Heavy Rail.

[c] BRT systems analyzed are in Ahmedabad (India) and in Guangzhou (People's Republic of China).

Source: Asia Pacific Energy Research Centre (APERC). 2008. *Urban Transport Energy Use in the APEC Region—Benefits and Costs*. Tokyo.

reached $1,019 in 2001. Afterward, the pace of the other sectors' energy demand growth per capita sped up to 3.3% per year through 2010. Another trend is that the growth of per capita energy demand in the other sectors tends to slow down after income reaches a certain level. In the Republic of Korea, the increase in per capita energy consumption in the other sectors slowed to 0.7% after 1996 when its GDP per capita crossed the $10,000 line, compared with an average growth rate of 5.9% per year before 1996. The per capita energy demand in the other sectors in Australia, where GDP per capita grew from $12,738 in 1971 to $25,406 in 2010, maintained an average growth rate of 1.0% per year during the same period.

The growth of individual demand for energy services is always affected by technology innovation, which leads to the introduction of new products to the market. That is why countries that already achieved a high level of individual income at an earlier time may also have experienced a relatively high growth of per capita energy consumption in the other sectors. For example, in Japan, where GDP per capita already reached $18,168 in 1971, the per capita energy demand in the other sectors grew at a rate of 2.2% per year on average through 2010. This was mainly due to the introduction of new equipment, notably electric appliances in houses and offices during the 1980s and the 1990s. The diffusion rate of domestic air conditioners was only 7.7% in 1970 in Japan, but in 2000 it was 86.2% (EDMC 2012). Personal computers did not emerge in the market until the late 1980s in Japan and in 2000 their diffusion rate in households reached 50.1%. From 1981 to 2000, Japan's individual demand for energy services (per capita energy demand in the other sectors) grew at a rate of 3.1%, slowing to 0.1% from 2001 to 2010. Australia also saw a similar trend with its per capita energy demand in the other sectors growing at a rate of 1.3% per from 1980 to 2000 followed by 0.6% per year from 2001 to 2010. Technology innovation that leads to improvement of a product's efficiency is also a major force driving energy consumption down in the other sectors. This will be discussed in Chapter 4.

Box 3.5 Renewable Energy

Driven by the will to improve energy security, to protect the environment from the burning of fossil fuels, and to create green jobs, the global renewable energy markets have evolved rapidly over recent years. Global new investment in renewable energy saw an average 27% year-on-year growth from $61 billion in 2005 to $257 billion in 2011 (Bloomberg New Energy Finance 2012). By the end of 2011, renewable energy, including hydropower, comprised more than 25% of the world's power capacity (which was estimated at 5,360 gigawatts in 2011) and supplied around 20.3% of global electricity (REN21 2012). Asian countries, particularly the People's Republic of China (PRC), India, and Japan, are among the leading players in renewable energy investment. The PRC, India, and Japan ranked among the top seven countries in renewable power capacity in 2011 (REN21 2012).

However, the development of renewable energy still faces various barriers. One is the economic barrier, which relates to the relative cost of modern renewable energy technologies compared with conventional energy technologies. The extent of this barrier varies from country to country, depending on the country's renewable energy resource characteristics and local fuel prices. For example, other conditions being equal, the same wind turbine is expected to generate more electricity in areas with higher wind speeds and thus the cost of each kilowatt-hour tends to be lower since there is no fuel cost involved. Other barriers, which are as important as the economic barrier, can be categorized as noneconomic barriers. These include regulatory and policy uncertainty; administrative barriers such as slow or nontransparent permitting processes; market barriers such as subsidies for fossil fuels; financial barriers; infrastructure barriers; and lack of awareness, skilled personnel, and public acceptance (Müller, Brown, and Ölz 2011).

The most commonly applied renewable energy support mechanisms are feed-in tariffs (FIT) and renewable portfolio standard (RPS)/electric quota obligations, which are often accompanied by tradable green certificates. Under the FIT mechanism, electricity generated by eligible renewable facilities is purchased at a guaranteed price (tariff) over the long term, typically 20 years. Since the tariff is set depending on the technology's cost, this mechanism is particularly effective in boosting a specific technology even at a higher cost, for example, solar photovoltaic in Germany. Under the RPS/electric quota policy, however, the technology with the lowest cost will be adopted. Though varying in policy design, the FIT mechanisms have been largely successful in Europe and are spreading worldwide, with at least 65 countries and 27 states and provinces having adopted the

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Box 3.5 *continued*

policy as of early 2012 (REN21 2012). The RPS/electric quota policy exists in 18 countries on the national level and in at least 58 jurisdictions at the local level, including in Canada, India, and the United States (REN21 2012). However, both the FIT and the RPS/electric quota mechanisms need to be implemented in conjunction with other support policies to deliver results.

Besides urban renewable energy use, countries, especially developing countries, could benefit from rural renewable energy utilization in several ways. One is the clean use of biomass. In some developing countries in the region, households, particularly those in rural areas, still rely heavily on conventional biomass for their basic energy needs. In the PRC, 54.1% of the final energy demand in the residential sector was supplied by solid biomass in 2010, 77.3% in India, and 70.2% in Association of Southeast Asian Nations member states. This provides a large potential to improve energy efficiency and living standards if biomass is converted to clean fuel such as biogas, rather than burnt directly. By 2010, about 40 million rural households in the PRC had biogas digesters that convert agricultural and animal waste into biogas, and the PRC government is planning to expand users to 50 million by the end of 2015. The growing need for biogas digesters has driven up the development of related businesses, including digester tank manufacturers and services for digester design, construction, and maintenance.

Renewable energy also provides an option for rural electrification. In isolated or remote rural areas with no access to electricity, extension of the national grid is often not cost-effective compared with distributed power generation. One of the technologies, solar home systems, has already been used to provide electricity to rural households among others in India, Indonesia, and Mongolia. Combined with micro grids, biomass and biogas power generation or small hydro power stations are a clean solution for electrification on the village scale.

Early in the diffusion of renewable technologies, overcoming the economic barrier is often given higher priority. With the market growing, the cost of renewable technologies will come down as a result of the experience curve effects and economies of scale. Supporting policies need to evolve accordingly as the effects of noneconomic barriers emerge. For example, the continuous decline in renewable energy costs coupled with increasing fiscal pressure on government and public spending have accelerated Germany's move away from the FIT mechanism, and the government is giving more attention to energy storage technologies to accommodate the intermittent output from wind and solar generators.

Sources:

Bloomberg New Energy Finance. Quoted in Frankfurt School – UNEP Collaborating Center for Climate & Sustainable Energy Finance. 2012. *Global Trends in Renewable Energy Investment 2012*. Frankfurt.

Müller, S., A. Brown, and S. Ölz. 2011. Renewable Energy: Policy Considerations for Deploying Renewable. IEA Information Paper. Paris.

Renewable Energy Policy Network for the 21st Century (REN21). 2012. *Renewables 2012 Global Status Report*. Paris.

Box 3.6 Deployment of Carbon Capture and Storage in Developing Members of Asia and the Pacific

Carbon capture and storage (CCS) can assist the global efforts in greenhouse gas (GHG) emissions reduction. The International Energy Agency (IEA 2012) estimated that CCS can contribute about 14% of cumulative GHG emissions reductions through 2050 from 2010 to limit global average temperature rise to 2°C. However, CCS currently remains an expensive option. There are only five fully integrated CCS projects that include carbon dioxide separation, transportation, and injection into a storage site: Sleipner and Snøhvit (Norway), In Salah (Algeria), Rangely (United States), and Weyburn-Midale (United States and Canada). Furthermore, the deployment of CCS technologies is contingent on the suitability of locations to accommodate the complexities involved in putting up such facilities, and may require public funding and government assistance to guarantee the viability of operation.

As the technology has yet to be commercialized and additional costs are required, developing countries are taking a "wait and see" approach before making any commitments to install CCS facilities. With the uncertainty surrounding the future direction of international climate change negotiations, developing countries are putting priority on energy efficiency and new and renewable energy, which can assist their efforts in energy security enhancement and CO_2 emissions abatement.

The Asian Development Bank (ADB) has undertaken a study to consider the feasibility and identification of pilot and demonstration projects for CCS in developing countries. The study focused on the analysis of four members: Indonesia, the Philippines, Thailand, and Viet Nam. Their economic growth has been rapid and future CO_2 emissions are expected to increase steadily with the prospects for energy demand growth and shifts to coal (mainly in the power sector). Aside from increases in domestic demand for fossil fuels, and in the resulting CO_2 emissions, Indonesia and Viet Nam are likely to increase natural gas production to meet domestic demand and partially to export. The natural gas fields in these countries contain high levels of CO_2, and the fields will require CO_2 separation stations. One possible use of the CO_2 separated from the natural gas could be to inject it into depleting oil fields for enhanced oil recovery.

The feasibility study found that CO_2 for enhanced oil recovery could catalyze the earlier commercialization of CCS. Revenue from oil sales can offset the incremental CCS cost; in some cases, the revenue can more than offset the cost. In terms of the application of CCS in plants, the analysis found that CCS in natural gas processing plants (facilities for CO_2 separation from natural gas) can offer the lowest abatement cost per ton of CO_2, followed by CCS with natural gas-fired power plants with combined-cycle technologies and coal-fired power plants with supercritical technologies.

Despite the potential benefits that can be obtained from CO_2 enhanced oil recovery, none of the analyzed countries have to date established a regulatory or legal framework for CCS. The study recommended that importance be given to preparation of the regulatory and legal systems in line with pilot and demonstration projects so that CCS can be deployed by the time commercial-scale CCS is ready.

Cooperation with developed countries could potentially bolster the preparation for CCS deployment in developing members. Cooperation could involve multiple aspects required for CCS installation, including regulatory and legal preparation, storage site identification, technology deployment and operation, and financing. Such cooperation can be designed to bring mutually beneficial outcomes for both parties to share the carbon credits and oil sales obtained from the project.

Sources:
Asian Development Bank (ADB). 2011. *Carbon Dioxide Capture and Storage, Demonstration in Developing Countries, Analysis of Key Policy Issues and Barriers*. TA 7278-REG. Final Report. Manila.
———. 2011. *Report to the Carbon Sequestration Leadership Forums*. Manila.
———. Forthcoming. *Prospects for Carbon Capture and Storage in Southeast Asia, Executive Summary of a Regional Analysis*. Manila.
International Energy Agency (IEA). 2012. *Energy Technology Perspectives*. Paris.

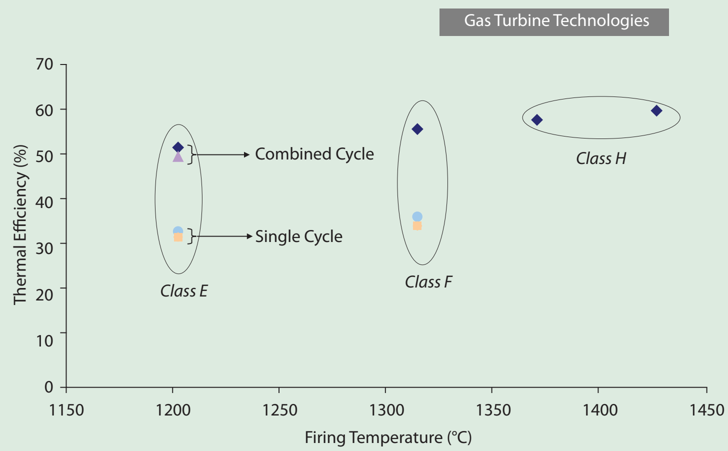
Box 3.7 Advanced Power Generation Technologies and Challenges in Deployment

Energy efficiency improvement in the power sector is an essential factor for achieving energy security and sustainable development. In the Asian Development Bank (ADB) members, the power sector is the largest energy consumer, using 37% of the total primary energy supply. In particular, fossil fuel power generation accounted for more than 79% of the generation mix in 2010. In addition, the electrification rate is expected to increase rapidly in developing ADB members. Therefore, one of the key areas for enhancing the region's energy security in view of the rise in demand and the region's need to rely more on imported fossil fuel sources is how to save fossil fuel usage in the power generation sector.

There are several types of fossil fuel power generation technologies. For coal-fired power plants, thermal efficiency increases with higher steam temperature and pressure conditions. The designed thermal efficiency of coal-fired power generation technologies ranges from 35% for subcritical pulverized coal combustion (PCC) technology to 50% for ultra-supercritical PCC technology. For energy efficiency of boiler and steam turbines, the major technical challenge is to develop materials that can withstand the elevated steam conditions. The thermal efficiency of gas-fired power generation ranges from 25% (gas turbines) to 60% (advanced combined-cycle gas turbine technology). For gas turbines, increasing the firing temperature of the combustion gas that hits the first rotating blade of the turbine is important because higher firing temperatures increase the turbine output, leading to greater electricity generation.

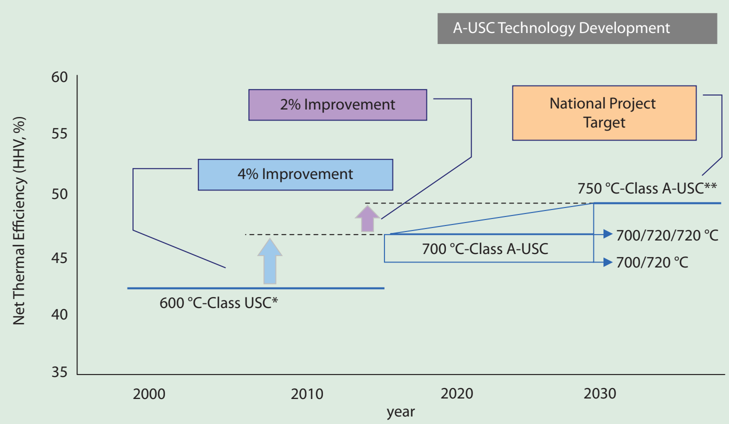
Deployment of energy-efficient power technologies is desirable for energy security and for environmental reasons. In addition, such technologies can yield substantial economic benefits for the generators in the long run as they can reduce the required fuel costs. However, less energy-efficient technologies are sometimes chosen because of their lower initial capital requirements. This can be observed not only in the emerging member countries of Asia and the Pacific but also in the developed countries in the world. The high initial investment cost of these advanced technologies is the main barrier to the introduction of such technologies.

Box Figure 3.7.1 Gas Turbine Technology Evolution



Source: Compiled information from General Electric.

Box Figure 3.7.2 Japan's Target for Ultra-Supercritical Technology



A-USC = advanced ultra-supercritical, HHV = high heating value, USC = ultra-supercritical.
Source: Hitachi (2008).

The market structure affects the technology choice as well. In a deregulated market—whether it is wholesale competition or retail competition—generators are required to produce electricity at low cost, compared with competitors. Advanced technologies can be an impractical alternative due to the high initial capital investment requirements.

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Box 3.7 *continued*

Electricity retail prices may not reflect the true cost of generation. In the emerging countries of Asia and the Pacific, electricity retail prices are often regulated to maintain prices at an affordable level for the residential customers, or to maintain the industry's international competitiveness. With low electricity retail prices, compared with the true cost of generation, generators have little incentive to invest in advanced technologies unless appropriate financial incentives are provided.

To enhance the installation of energy-efficient power plants, financial incentives and improvements in the investment climate with policies and regulations that allow long-term corporate planning are necessary. Nevertheless, some caution needs to be taken to achieve the overall energy efficiency improvement for electricity generation and consumption. Aside from these supply-side measures, demand-side measures to encourage consumers' efforts to make energy efficiency improvements need to be implemented as a package; otherwise, solely supply-side focused measures might encourage generators to increase generation at lower cost, which might increase overall energy consumption.

Sources:

Asia Pacific Energy Research Centre (APERC). 2008. *Energy Efficiency in the APEC Region*. Tokyo.
General Electric. Heavy Duty Gas Turbines & Combined Cycle. Available at http://site.ge-energy.com/prod_serv/products/gas_turbines_cc/en/index.htm
Hitachi. 2008. *Hitachi's Approach to Efficiency Improvement in Thermal Power Plant*. A presentation made at the APERC Annual Conference, 21 February 2008.

Chapter 4

Energy Demand and Supply Outlook: Alternative Case

Energy Demand and Supply Outlook: Alternative Case

- *The alternative case is developed to consider the potential for energy savings and carbon dioxide (CO_2)emissions reduction. In the alternative case, with the deployment of advanced technologies, the primary energy demand of Asia and the Pacific will increase at an annual rate of 1.4% through 2035—a slower rate compared with that of the business-as-usual (BAU) case at 2.1% per year. Given the projected growth, primary energy demand in the alternative case will be 1,295.2 million tons of oil equivalent (Mtoe) lower than in the BAU case in 2035. The estimated savings will be higher than the total industry demand of Asia and the Pacific in 2010, at 1,216.5 Mtoe.*
- *The alternative case assumes shifts toward low-carbon technologies, which result in the reduction of fossil fuels' share of total primary energy demand in 2035 from 83.2% in the BAU case to 74.3% in the alternative case.*
- *Power generation and other transformation processes (including oil refinery and gas processing) represent the biggest energy savings potential, estimated at 734.6 Mtoe in 2035, followed by industry (234.7 Mtoe), residential and commercial (216.4 Mtoe), and transport (109.4 Mtoe).*

4.1 Primary Energy Demand: Savings Potential by Source

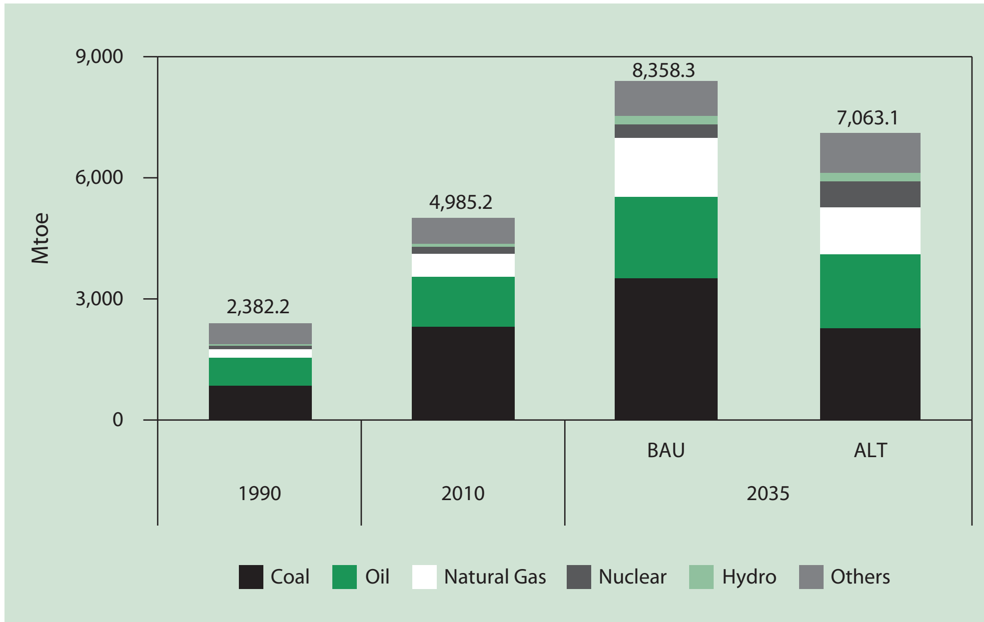
The alternative case is developed to consider the future energy savings potential as well as carbon dioxide (CO_2) emissions reduction potential in Asia and the Pacific through the deployment of advanced technologies for energy savings and a shift toward low-carbon technologies. In line with economic development, the industry, residential, commercial, and transport sectors are assumed to deploy the best available technologies, and advanced thermal technologies (such as ultra-supercritical coal-fired generation and most advanced combined-cycle natural gas-fired generation) are assumed to be deployed for power generation. The alternative case also considers shifts toward low-carbon-emitting technologies in the power sector (such as wind, photovoltaic, and nuclear), reflecting each member's national plans or targets.

Figure 4.1 shows the comparison of primary energy demand of the BAU case and the alternative case in 2035. As primary energy demand in the alternative case is projected to grow at a slower rate of 1.4% through 2035 (in contrast to the BAU case's projected annual growth rate of 2.1% per year), primary energy demand will reach 7,063.1 million tons of oil equivalent (Mtoe), or 1,295.2 Mtoe (15.5%) lower than the BAU case. In fact, these estimated primary energy savings would be higher than Asia and the Pacific's industry sector energy demand in 2010 of 1,216.5 Mtoe. This suggests that Asia and the Pacific could save more energy than the industry sector's current energy demand with the deployment of advanced technologies across the sector through 2035.

The alternative case assumes shifts toward low-carbon technologies, which would result in the reduction of the fossil share in total primary energy demand from the BAU case's 83.2% to the alternative case's 74.3% in 2035. Meanwhile, it is important to note that fossil fuels will still account for the major share in the primary energy mix in the alternative case.

Comparisons of primary energy demand by energy type between BAU and the alternative case are shown in Figure 4.2. By energy type, coal would represent the biggest savings ratio (alternative case energy savings per BAU primary energy demand in 2035) of 34.9% in 2035 reflecting mainly three factors: (i) thermal efficiency improvement in coal-fired generation,

Figure 4.1 Primary Energy Demand by Source: Business-as-Usual and the Alternative Case



ALT= alternative case, BAU = business-as-usual case, Mtoe = million tons of oil equivalent.

(ii) shifts toward low-carbon-emitting generation technologies (mainly to new and renewable sources and nuclear in some cases), and (iii) impacts from demand savings across the sector. The savings ratio of oil in 2035 is estimated at 8.9% (175.6 Mtoe savings in the alternative case compared with the BAU case), much lower than that of coal.

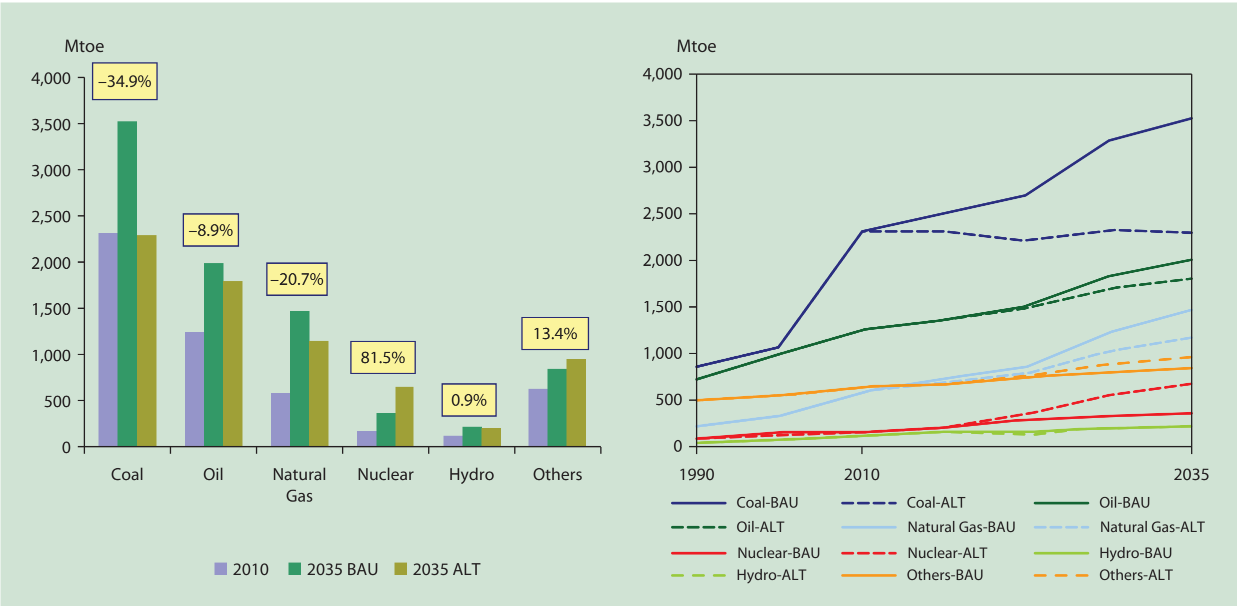
The estimated oil savings will mainly occur in the transport sector, where it is assumed in the alternative case that fuel-efficient vehicles such as hybrid vehicles will be deployed, with some shifts toward alternative technologies such as electric vehicles. As member economies in Asia and the Pacific have already made progress in fuel switching in the power sector from oil-fired generation to other energy sources, the potential for savings are concentrated in the transport sector.

Meanwhile, the savings ratio of natural gas would be 20.7% in 2035 (or 303.1 Mtoe savings in the alternative compared with the BAU case). Thermal efficiency improvements in power generation using advanced combined-cycle technologies, in addition to demand savings (mainly electricity), explain the relatively large natural gas savings potential.

Among the energy types, nuclear energy will represent the biggest increase in the primary energy demand share in 2035, from 4.3% in the BAU case to 9.3% in the alternative case. This will result from the assumed capacity expansion of the People's Republic of China (PRC), reaching 158.1 gigawatts (GW) in 2035 in the alternative case in contrast to 95.0 GW in the BAU case, and of India, amounting to 72.5 GW in 2035 compared with 34.9 GW in the BAU case. Additionally, the alternative case assumes a slower nuclear phaseout in Japan (reaching 31.5 GW in 2035) in contrast to that in the BAU case (reaching 9.3 GW in 2035).

Demand for hydro energy will maintain almost the same level in both cases, with a slight increase of 0.9% in the alternative case, while others (such as geothermal, photovoltaic, wind, and biomass generation) are assumed to expand in the alternative case, resulting in a 13.4% increase in 2035 in comparison with the BAU case.

Figure 4.2 Comparison of Primary Energy Demand by Source in 2035 (left) and Comparison of Primary Energy Demand by Source (1990–2035)



ALT = alternative case, BAU = business-as-usual case, Mtoe = million tons of oil equivalent.
Note: Numbers inside the boxes refer to reductions in the 2035 demand for the specified energy types that could be achieved by shifting from the BAU case to the alternative case, expressed as percentages of the 2035 demand for the same energy types in the BAU case.

4.2 Primary Energy Demand: Savings Potential by Region

Regional contributions to total primary energy savings are shown in Figures 4.3 and 4.4. East Asia would represent the biggest primary energy savings potential, estimated at 853.8 Mtoe in 2035. Much of the savings in East Asia would come from the PRC, which would account for 93.6% of the estimated primary energy savings potential in East Asia in 2035.

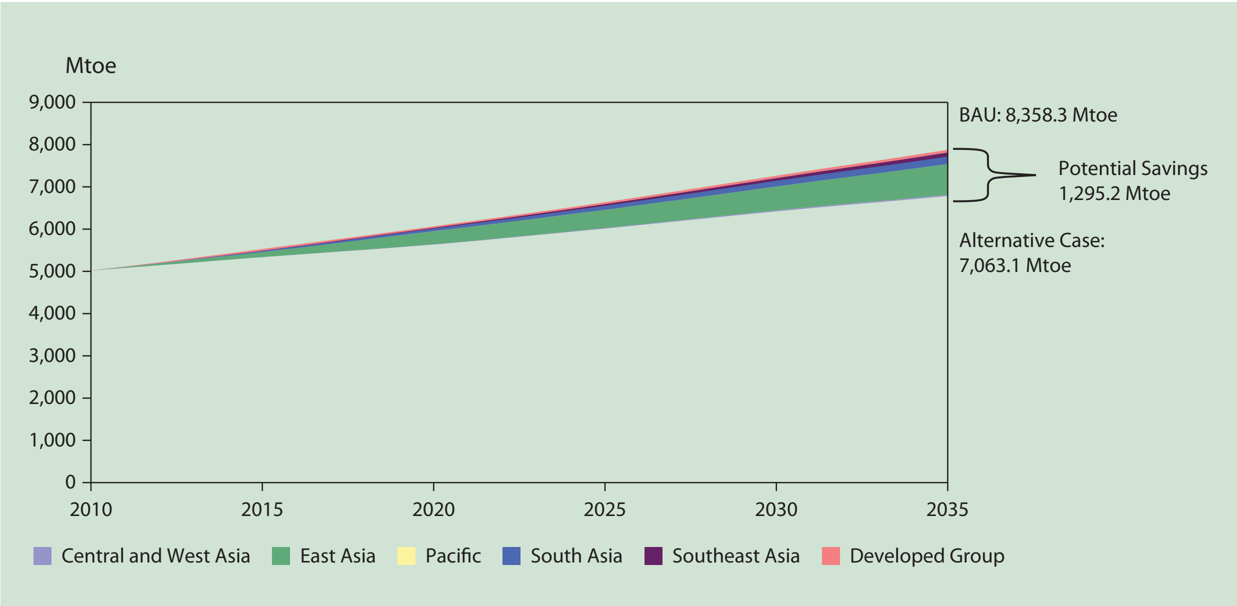
South Asia would have the second biggest primary energy savings potential, estimated at 214.7 Mtoe in 2035. India would account for 94.3% of the estimated energy savings in South Asia, estimated at 202.4 Mtoe in 2035. Meanwhile Southeast Asia's primary energy savings may reach 114.6 Mtoe in 2035, followed by the Developed Group at 73.9 Mtoe, Central and West Asia at 37.6 Mtoe, and the Pacific at 0.5 Mtoe in 2035.

The panels in Figure 4.5 compare primary energy demand of BAU and the alternative case for each region in Asia and the Pacific. The primary energy demand mix in the BAU case could substantially differ from that in the alternative case, as targets and plans on low-carbon-emitting sources are assumed to make inroads in the latter case.

4.3 Primary Energy Demand: Savings Potential by Sector

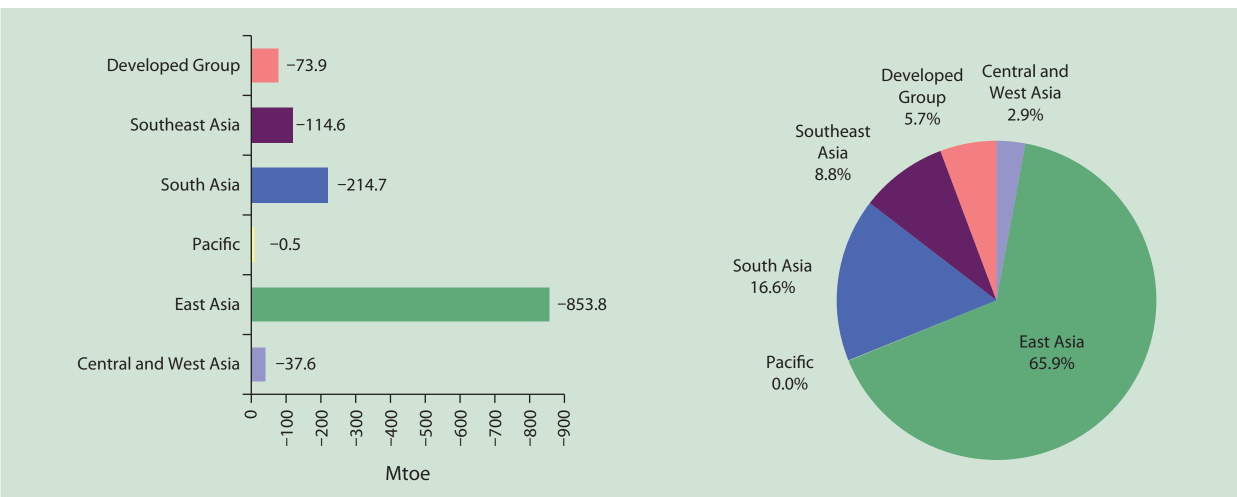
The primary energy demand of Asia and the Pacific in the BAU case is compared with that in the alternative case (Figure 4.6) to depict the sectoral contributions for energy savings. The transformation sector (including power generation and other transformations such as

Figure 4.3 Regional Contributions to Primary Energy Savings: Business-as-Usual and the Alternative Case



BAU = business-as-usual case, Mtoe = million tons of oil equivalent.

Figure 4.4 Regional Primary Energy Savings in 2035 (left) and Regional Share to Total Primary Energy Savings in 2035 (right)

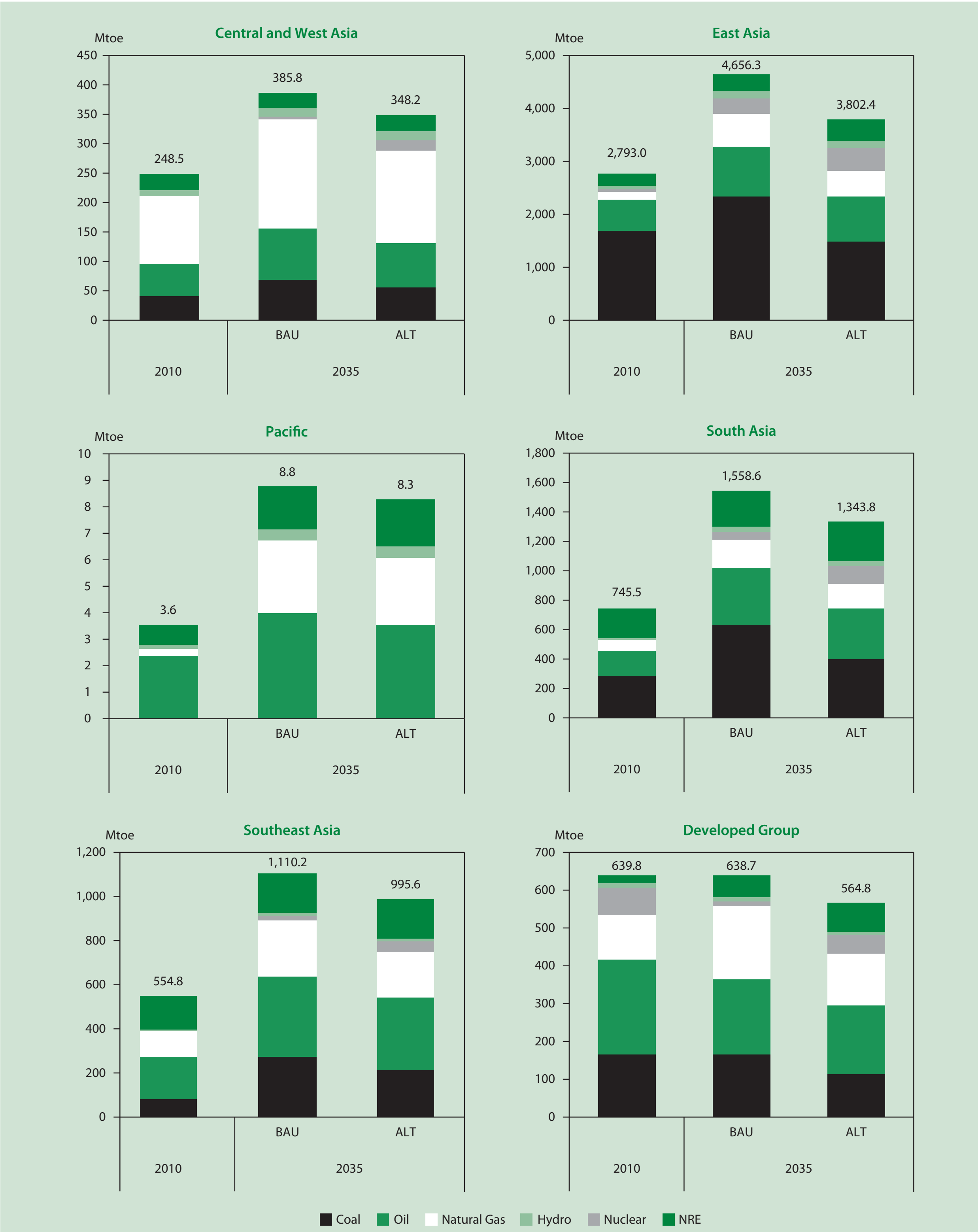


Mtoe = million tons of oil equivalent.

refinery and gas processing) would represent the biggest energy savings potential, estimated at 734.6 Mtoe in 2035. This would result from two factors: thermal efficiency improvement of coal-fired and natural gas-fired generation and demand savings mainly for electricity.

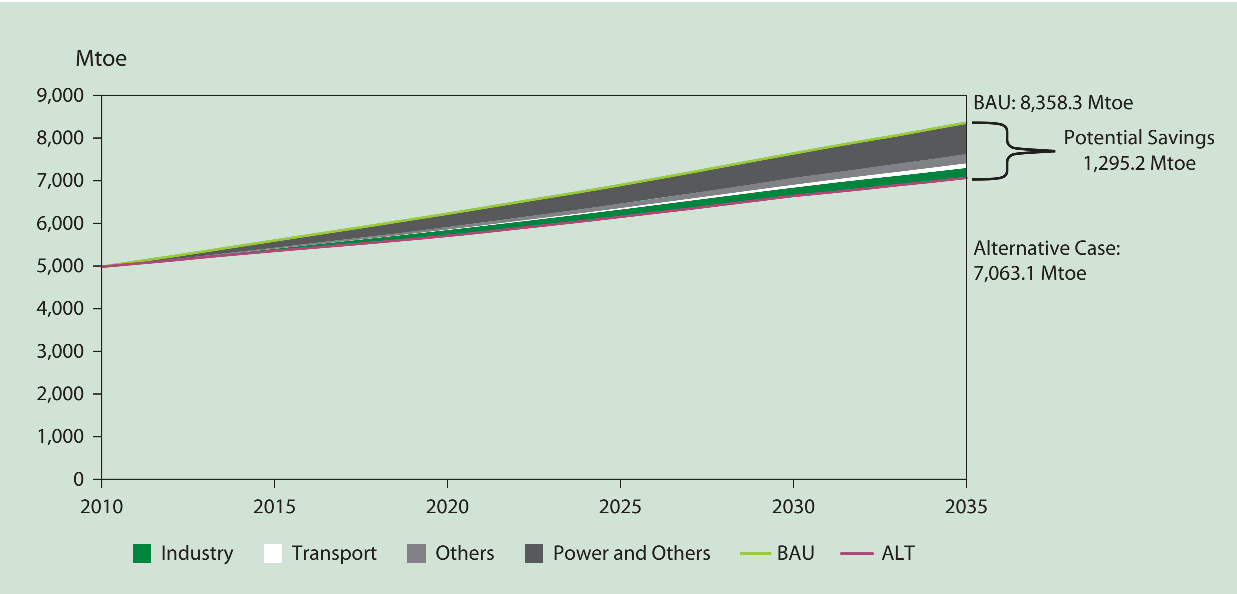
Among the end-use sectors, the industry sector would have a savings potential of 234.7 Mtoe in 2035 as a result of deployment of advanced technologies. The other sectors (including residential and commercial) have a savings potential of 216.4 Mtoe in 2035, reflecting the diffusion and deployment of efficient appliances as well as the improvement in space heating

Figure 4.5 Comparisons of Primary Energy Demand: Business-as-Usual and the Alternative Case by Region



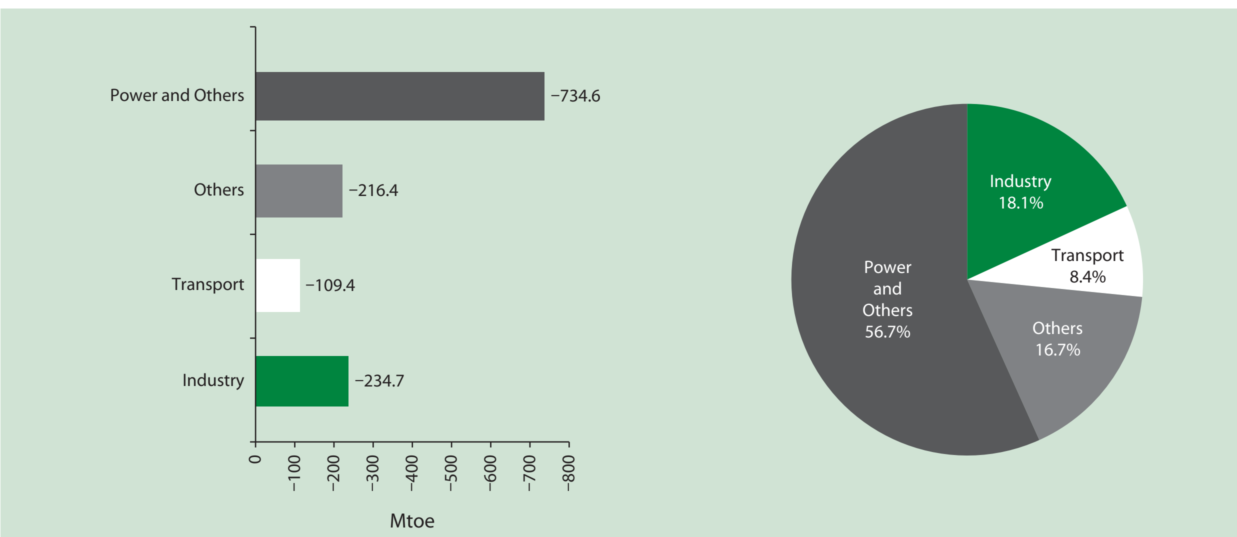
ALT = alternative case, BAU = business-as-usual case, Mtoe = million tons of oil equivalent, NRE = new and renewable energy.

Figure 4.6 Comparisons of Business-as-Usual and the Alternative Case: Sectoral Contributions



ALT = alternative case, BAU = business-as-usual case, Mtoe = million tons of oil equivalent.

Figure 4.7 Sectoral Primary Energy Savings (left), and Sectoral Share to Total Primary Energy Savings (right)



Mtoe = million tons of oil equivalent.

efficiency. The transport sector's energy savings would be 109.4 Mtoe in 2035 as a result of shifts toward fuel-efficient vehicles.

4.4 Industry Energy Savings Potential

In the alternative case, advanced existing energy-saving technologies and some innovative technologies are assumed to be applied by the industry sector within the ADB members in

Asia and the Pacific. With these assumptions, the industry sector's energy demand among the ADB members will be 1,536.7 Mtoe in 2035, which is 234.7 Mtoe (13.3%) lower compared with that in the BAU case.

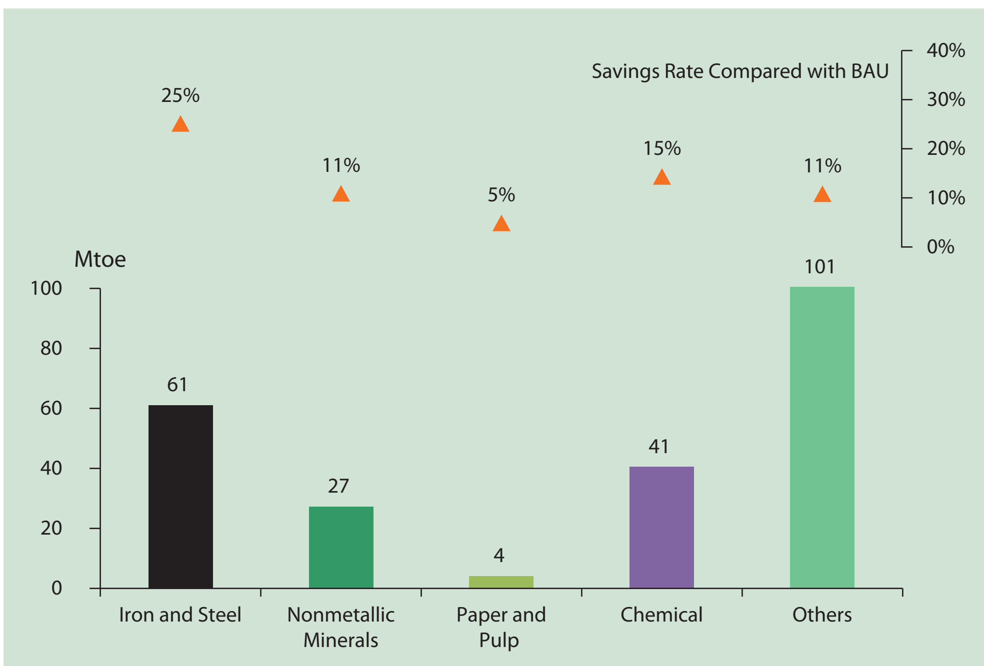
Of the energy savings potential of the industry sector in ADB members, 57.0% is contributed by the energy-intensive subsectors, which include the iron and steel, nonmetallic mineral, paper and pulp, and chemical industries.

The iron and steel subsector has the largest energy savings potential among industries in Asia and the Pacific. Most of the energy demand reduction in the steel production process will result from the progress in the recovery of by-product gases[6] and heat, and the greater utilization of mature technologies such as coke dry quenching, top gas recovery turbines, and pulverized coal injection. The introduction of innovative technologies, like carbon iron composite, will also contribute to the reduction in the energy demand of the iron and steel subsector.

The chemical industry has the second highest energy savings potential among the industry subsectors. Energy demand reduction will be achieved by various measures, including waste recycling, heat recovery, combined heat and power, more efficient equipment, process improvements, and more optimal operations.

The energy savings potential of the cement industry will be attributed to the recycling of wastes as fuel and material, increased use of new suspension pre-heater kilns (NSP), efficient mills and fuel burners, power generation with exhaust gas, more intensive production, etc. The paper and pulp industry could reduce its energy demand by raising

Figure 4.8 Industry Energy Savings Potential in 2035



BAU = business-as-usual case, Mtoe = million tons of oil equivalent.

[6] Such as coke oven gas, blast furnace gas, and the basic oxygen furnace gas.

the recycling rate of old paper, introducing more efficient boilers and cogeneration, using waste as fuel, and so on.

For all of the industries, more efficient motors and boilers and further progress in energy management will result in reduced energy demand in the alternative case.

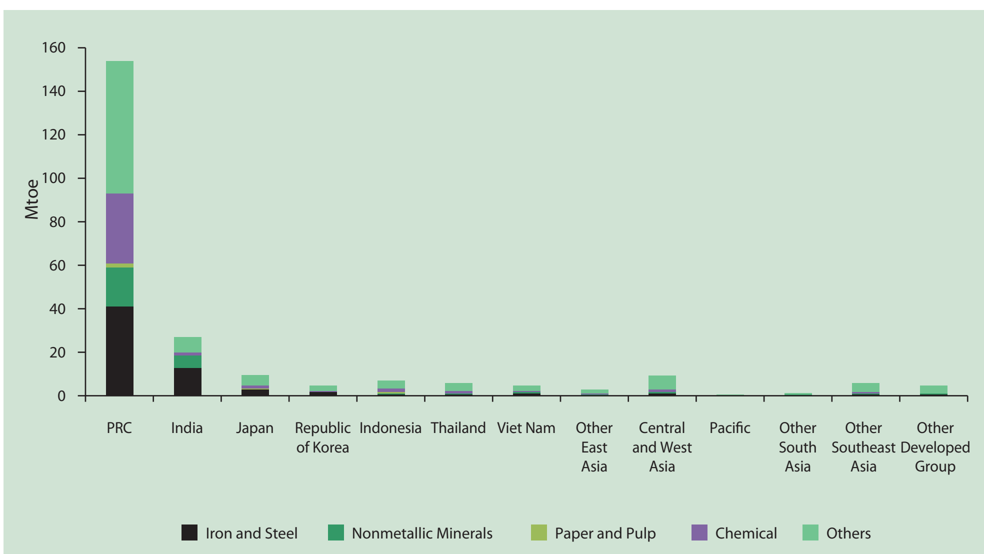
In 2010, the PRC accounted for 58.5% of the industry sector final energy demand of ADB members in Asia in the Pacific. The share of the PRC's energy-intensive industries (iron and steel, nonmetallic minerals, paper and pulp, and chemicals industries) in the country's total final energy demand is highest among the ADB members in Asia and the Pacific (Figure 4.9). In addition, 60.5% of the reduction in the PRC's industry sector final energy demand in 2035 will come from the country's energy-intensive industries.

The energy savings potential of the industry sector in India ranks second in magnitude among the ADB members. Around three-quarters of the energy savings potential would come from the materials industry. Although the share of the materials industry in the final energy demand of the industry sector in India is currently only 27.8%, it will increase rapidly with the rapid industrialization expected during 2011–2035.

Japan has the second-largest energy-intensive industry sector among the ADB members. Although the energy efficiency of the industry sector in Japan is the highest in the world, it is still possible to make further improvements through innovative technologies.

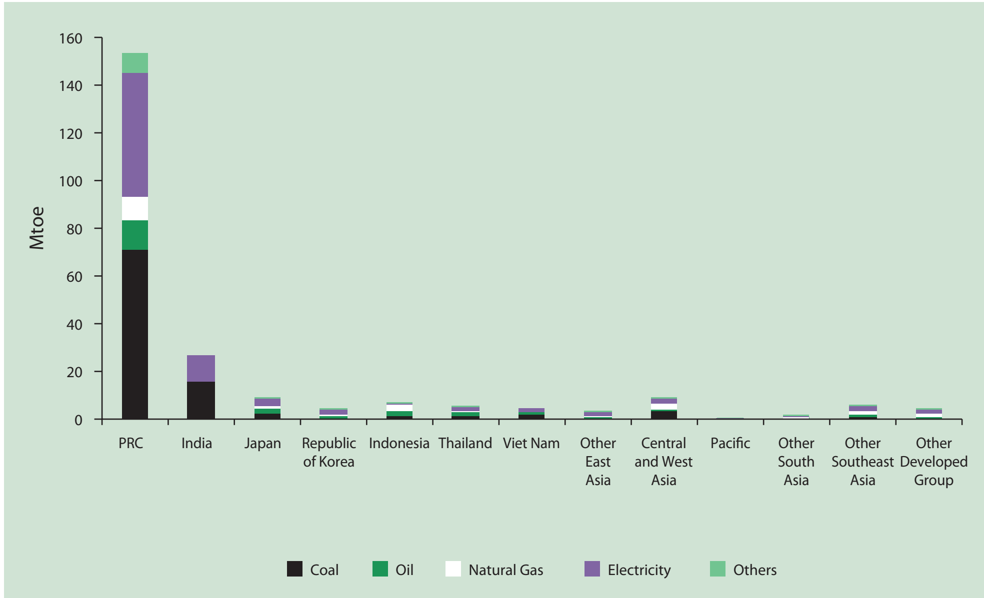
Of the total energy savings potential from the industry sector in Asia and the Pacific, 42.8% would come from the reduction in coal demand, mainly in the PRC and India, with efficiency improvements in the iron, steel, and cement industries and in industrial boilers. A reduction in electricity demand,

Figure 4.9 Industry Energy Savings Potential in 2035 by Subsector



Mtoe = million tons of oil equivalent, PRC = People's Republic of China.

Figure 4.10 Industry Energy Savings Potential in 2035 by Source



Mtoe = million tons of oil equivalent, PRC = People's Republic of China.

mainly due to more efficient motors, will contribute 33.6% to the energy savings potential. Oil and natural gas demand reductions would respectively bring about 9.6% and 9.0% in energy savings from the industry sector in Asia and the Pacific. Most of the remaining energy savings potential would be derived from the reduced demand for heat in the PRC (Figure 4.10).

4.5 Transport Energy Savings Potential

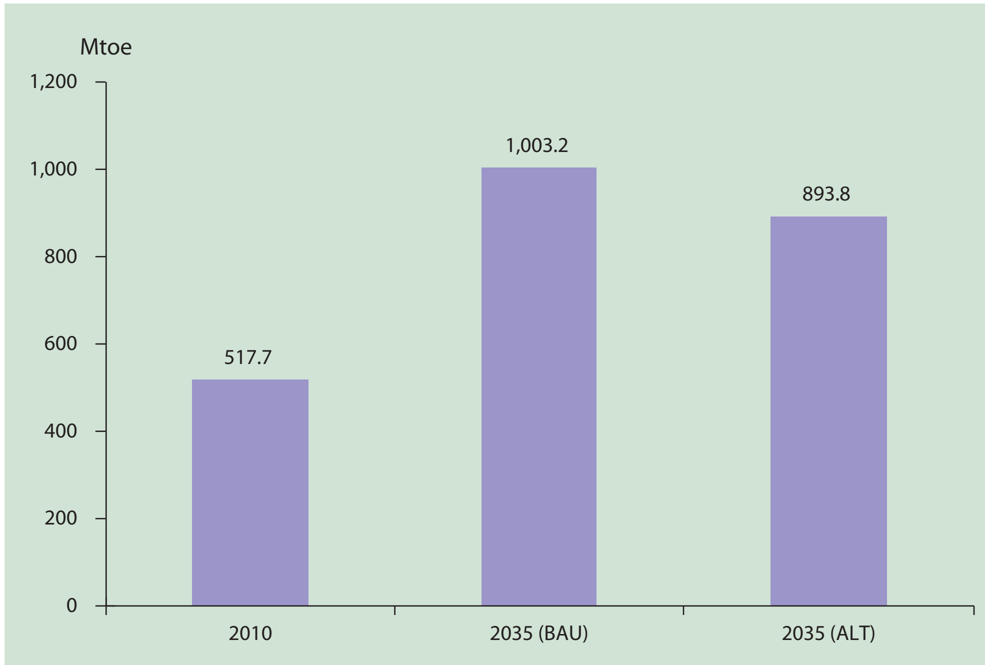
In the BAU case, the transport sector's energy demand is projected to increase at the fastest rate among the final energy-consuming sectors, with an annual rate of 2.7%. Along with economic development, people's aspirations toward mobility and the need for freight transport increase. These factors would translate into the relatively fast increases in transport energy demand compared with the industry, residential, and commercial sectors.

Meanwhile, the alternative case is developed to analyze how Asia and the Pacific can curb the growth in transport energy demand, and how much energy savings potential exists in the transport sector. The analysis focuses on the passenger road transport subsector as it is the driving force for the overall growth in transport energy demand in Asia and the Pacific.

Passenger vehicle stocks are maintained at the same level as in the BAU case analysis; meanwhile, the alternative case considers a rather aggressive deployment of vehicles that are more fuel efficient than conventional gasoline- or diesel-engine vehicles (such as hybrid, plug-in hybrid, electric, and compressed natural gas vehicles) on the assumption that consumers will give more weight to environmental conservation when deciding on vehicle ownership.[7]

[7] Because of data limitations, the submodel was developed only for the major transport energy-consuming members (Australia; the PRC; India; Indonesia; Hong Kong, China; Japan; the Republic of Korea; Malaysia; New Zealand; the Philippines; Singapore; Taipei,China; Thailand; and Viet Nam) whose transport energy demand accounted for 93.0% of total transport energy demand in Asia and the Pacific in 2010. The energy savings potential for the other members is estimated using the ratio to members with a similar level of economic development.

Figure 4.11 Comparison of Transport Energy Demand Outlook: Business-as-Usual and the Alternative Case (2010 and 2035)



ALT = alternative case, BAU = business-as-usual case, Mtoe = million tons of oil equivalent.

The consumer's vehicle purchasing decision is assumed to be determined by three factors: economy (in terms of cost of vehicle fleet), environmental performance, and convenience (for fuel charge).[8] Each factor is weighted differently. The BAU case does not consider environmental performance, while the alternative case places more emphasis on the environmental performance of vehicle technologies.

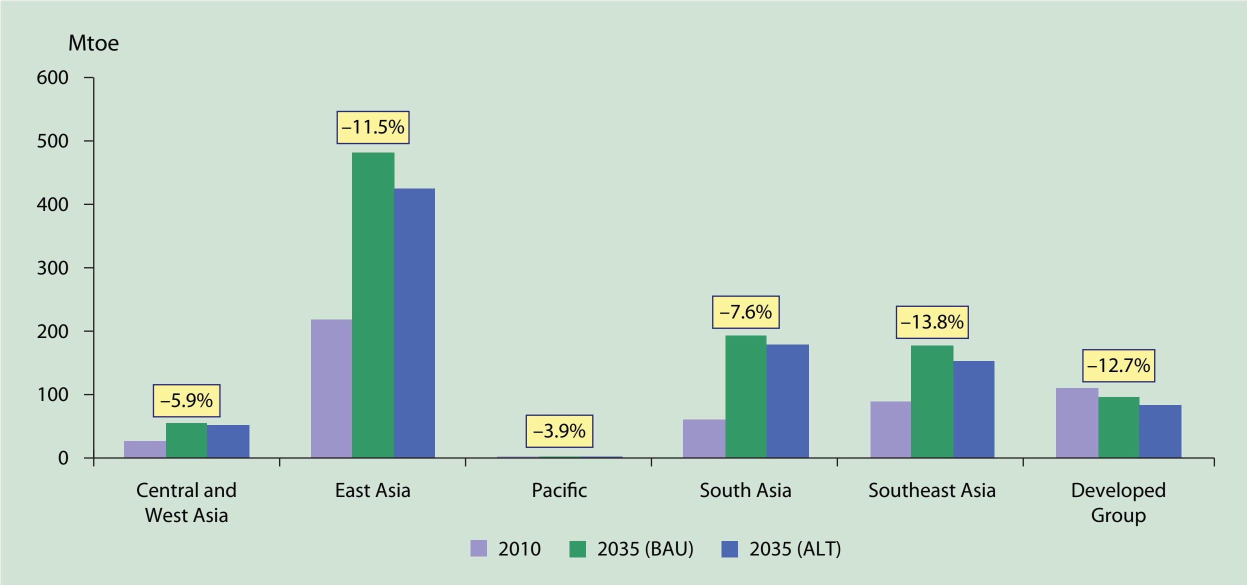
Figure 4.11 compares the transport energy demand in 2035 for the two cases. The transport energy demand in the alternative case would reach 893.8 Mtoe in 2035, up from 517.7 Mtoe in 2010, growing at an annual rate of 2.2%. This is lower than the growth rate of the transport sector energy demand in the BAU case, which is 2.7% per year over the same period. With the slow growth, the transport energy demand in the alternative case would be 109.4 Mtoe lower than that of the BAU case (equivalent to a 10.9% savings).

Figure 4.12 compares the transport energy demand of BAU and the alternative case by region. Double-digit savings could be expected in East Asia, Southeast Asia, and the Developed Group assuming that their relatively high vehicle ownership levels by 2035 could be shifted toward fuel-efficient vehicles. In contrast, the savings ratio for the Pacific, Central and West Asia, and South Asia will be lower—between 5.4% and 7.6%—under the assumption that the potential for the shifts toward fuel-efficient vehicles will be more limited in view of the regions' economic and infrastructure development levels.

By member, the PRC will achieve the largest transport energy savings at 50.1 Mtoe in 2035, which would account for 25.2% of the total transport sector energy savings of Asia and the

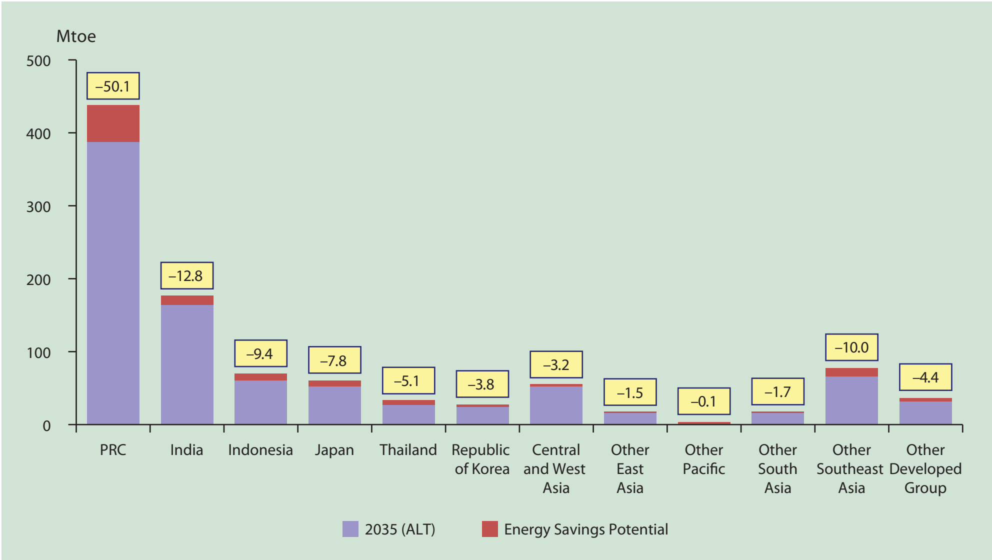
[8] See Shigeru et al. (2010).

Figure 4.12 Comparison of Transport Energy Demand Outlook by Region: Business-as-Usual and the Alternative Case



ALT = alternative case, BAU = business-as-usual case, Mtoe = million tons of oil equivalent.
Note: Numbers inside the boxes refer to reductions in the 2035 regional transport sector energy demand that could be achieved by shifting from the BAU case to the alternative case, expressed as percentages of the 2035 regional transport energy demand in the BAU case.

Figure 4.13 Transport Energy Savings Potential in 2035



ALT = alternative case, Mtoe = million tons of oil equivalent, PRC = People's Republic of China.
Note: Numbers inside the boxes refer to the reductions in the 2035 transport sector energy demand that could be achieved by shifting from the BAU case to the alternative case, in Mtoe.

Pacific (Figure 4.13). This will be followed by India (12.8 Mtoe), Indonesia (9.4 Mtoe), Japan (7.8 Mtoe), Thailand (5.1 Mtoe), and the Republic of Korea (3.8 Mtoe) in 2035.

Figure 4.14 compares passenger vehicle stocks for BAU and the alternative case in 2035 for the PRC, India, Indonesia, and Thailand. The comparison shows that given the same level of passenger vehicle stocks, vehicle types are more diversified toward fuel-efficient and

Figure 4.14 Passenger Vehicle Stocks by Type: People's Republic of China, India, Indonesia, and Thailand (2010, 2020, and 2035)

ALT = alternative case, BAU = business-as-usual case, CNG = compressed natural gas, LPG = liquefied petroleum gas.

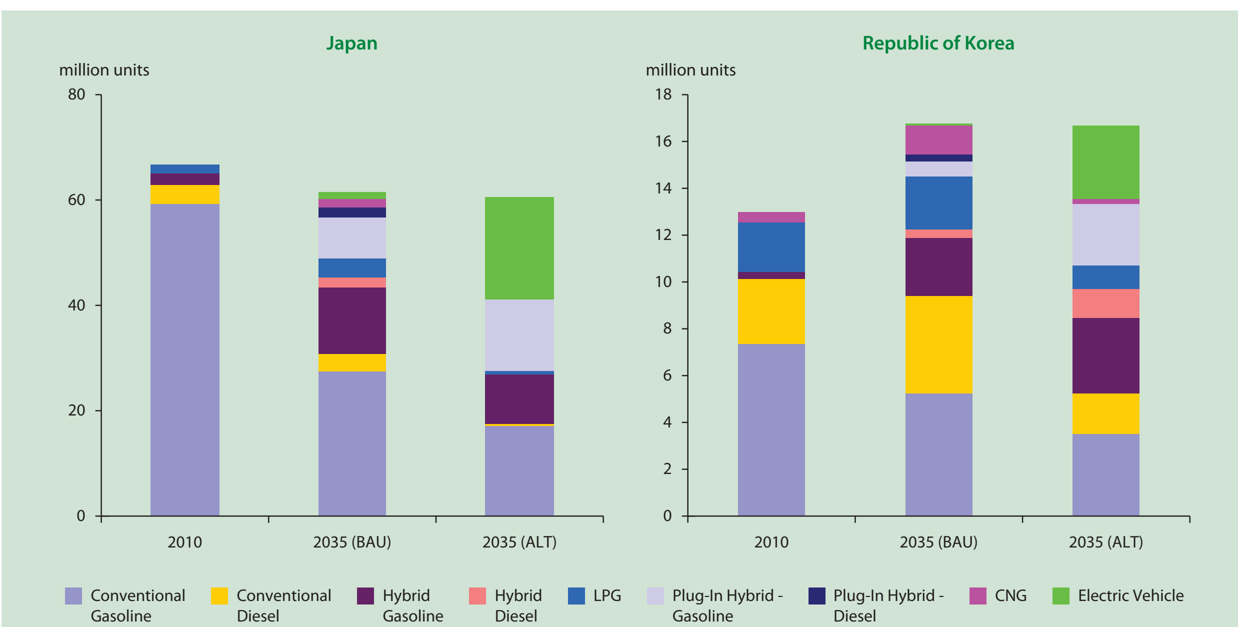
low-carbon-emitting ones in the alternative case. Major expansions for hybrid gasoline vehicles are expected in the four members mentioned in view of the rise in consumers' preference toward environmental conservation. Hybrid vehicles could be a cost-competitive option among the alternative vehicles. Following hybrid vehicles, electric vehicles are expected to make more inroads into the market for the PRC, Indonesia, and Thailand. Nevertheless, their share is much smaller compared with hybrid vehicles due to higher costs. The introduction of electric vehicles is assumed to be limited in India in view of infrastructure constraints (economic development level is lower relative to the other three members, and this results in much lower estimates for electric vehicles).

Figure 4.15 compares passenger vehicle stocks for BAU and the alternative case in 2035 for Japan and the Republic of Korea. The comparison shows that the share of conventional gasoline and diesel vehicles is much lower for both members in the alternative case, respectively at 28.9% and 31.6%. In the BAU case, the share of conventional gasoline and diesel vehicles for Japan and the Republic of Korea in 2035 would be higher at 50.3% and 56.0%, respectively. Consumers in Japan and the Republic of Korea are assumed to place more weight on the environmental aspects of vehicle ownership, thereby making the introduction of plug-in hybrids and electric vehicles substantial.

4.6 Residential and Commercial Energy Savings Potential

The alternative case was developed to estimate the energy savings potential that would result from the deployment of energy-efficient appliances in the residential and commercial sectors. Energy savings in the agriculture and fishery sectors were not calculated since the energy consumption in these subsectors is considerably small compared with that in the residential and the commercial sectors.

Figure 4.15 Passenger Vehicle Stocks by Type: Japan and the Republic of Korea (2010 and 2035)



ALT = alternative case, BAU = business-as-usual case, CNG = compressed natural gas, LPG = liquefied petroleum gas.

Two major factors influencing the total energy consumption in the residential and the commercial sectors are the diffusion/penetration rate[9] of appliances and the number of hours the appliances are operated. In a study by the Lawrence Berkeley National Laboratory (LBNL) in the United States (McNeil, Letschert, and de la Rue du Can 2008),[10] it was found that the diffusion of home appliances in a country is strongly correlated with the following three indicators that describe the country's economic development: household income (GDP per household), urbanization rate, and electrification rate. On the other hand, the penetration of appliances and equipment in the commercial sector is driven by overall economic activity that can be measured by GDP as a proxy.

The other factor, the number of hours an appliance is operated, varies from country to country, mainly depending on climate characteristics and income levels. Operational hours of appliances are usually affected by geographic economic factors as discussed in section 3.4.

The approach developed in the LBNL study for projecting the diffusion/penetration rate of appliances and equipment is applied in this exercise, along with other parameters from the same study, to assess the energy savings potential from the residential and the commercial sectors in Asia and the Pacific. In the residential sector, the energy savings potential of the following appliances was estimated: refrigerator, air conditioner, water heater, lighting, washing machines, television, standby power (power consumption by appliances while switched off or in standby mode), and space heating. In the commercial sector, the energy savings potential of the following energy end uses was estimated: cooling, office equipment, lighting, refrigeration, and ventilation. To simplify the calculation, the diffusion/penetration and operational hours of each end use appliance were assumed to be the same in both cases, with energy savings estimated by applying different energy efficiencies to the products under the two scenarios.

4.6.1 Overall Energy Savings Potential in The Residential and Commercial Sectors

In the alternative case, the final energy demand in the other sectors, which include the residential, commercial, agriculture, and fishery sectors, is projected to grow at an annual rate of 2.1% through 2035 reaching 1,980.0 Mtoe at the end of the projection period, representing an energy savings potential of 216.4 Mtoe in 2035 compared with that in the BAU case. Given their large populations, the PRC and India are expected to achieve the biggest energy savings in the residential and commercial sectors, with their energy savings potential estimated at 111.4 Mtoe and 32.9 Mtoe, respectively, in 2035 (Figure 4.16).

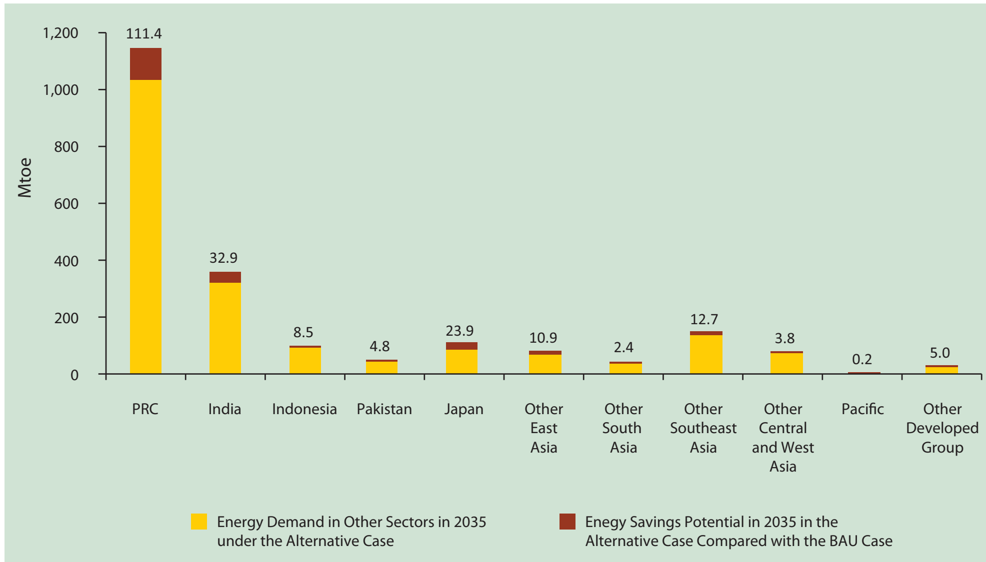
4.6.2 Energy Savings Potential by End Use

In terms of end use, heating and cooling account for the largest chunk of the energy savings potential in the residential and commercial subsectors (Figure 4.17). In countries with cold climates, the biggest proportion of household energy consumption is for heating. In 2010, about 54.5% of Japan's household energy demand was for space and water heating (EDMC 2012). Energy savings from nonelectric space heating and water heaters would account for 52.4% and 54.6% of the total household energy savings potential of Japan and the PRC, respectively, in 2035 (Figure 4.17). Air conditioners, which can be used for both heating and cooling, would contribute a large part of household energy savings in high-income areas such

[9] Average ownership of certain equipment per household in the residential sector; average equipment installation per unit floor space in the commercial sector.

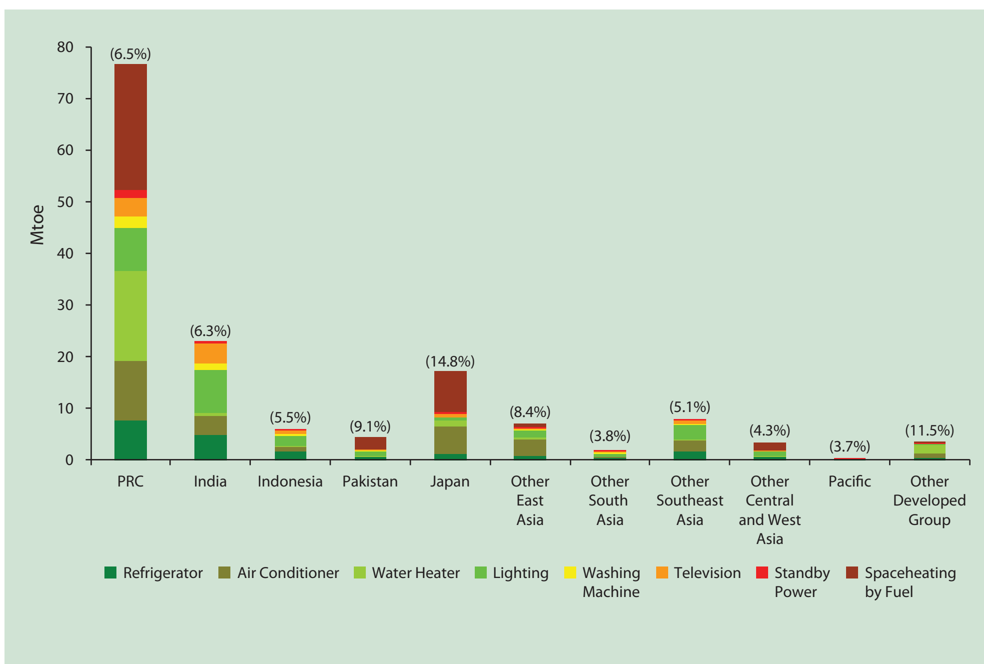
[10] The work was supported by the Ministry of Economy, Trade and Industry of Japan and the Institute of Energy Economics, Japan.

Figure 4.16 Energy Demand in the Other Sectors in the Alternative Case and Energy Savings Potential



BAU = business-as-usual case, Mtoe = million tons of oil equivalent, PRC = People's Republic of China.

Figure 4.17 Energy Savings Potential in the Residential Sector by End Use (2035)



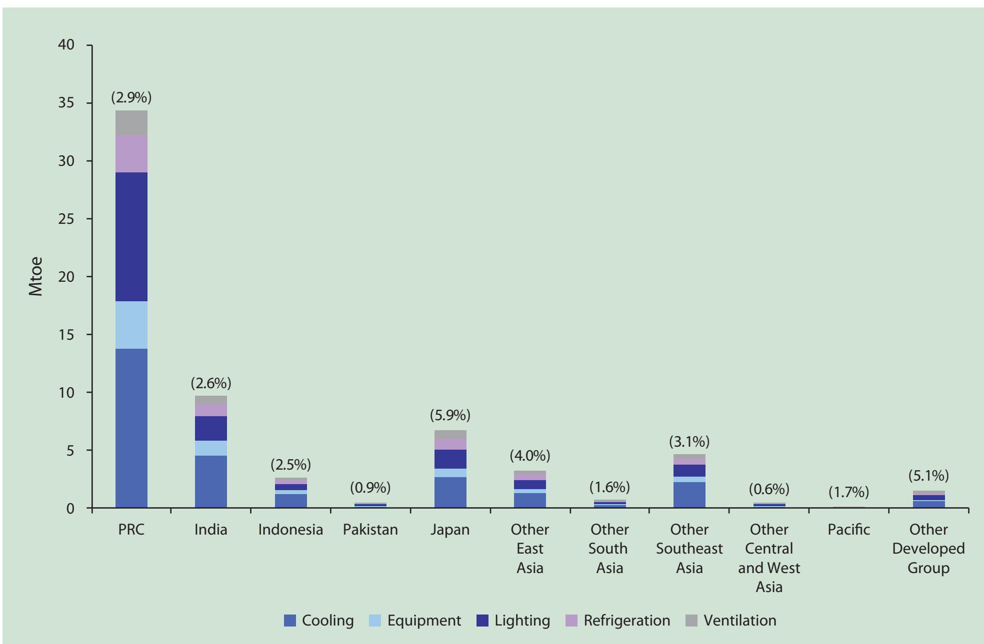
BAU = business-as-usual case, Mtoe = million tons of oil equivalent, PRC = People's Republic of China.
Note: Numbers inside the parentheses refer to the reductions in the 2035 residential sector energy demand that could be achieved by shifting from the BAU case to the alternative case, expressed as percentages of the 2035 energy demand of the other sectors in the BAU case.

as Australia; Singapore; and Hong Kong, China, but is less significant in developing countries because of their low diffusion rate. Air conditioning is still a luxury for average-income families in developing countries. The diffusion rate of air conditioners in India is projected to be 6.7% in 2035. In the commercial sector, the largest energy savings potential is expected to be from cooling. In the PRC and Japan, energy for cooling accounts for around 40.1% of the total estimated commercial energy savings potential in 2035. In warmer areas such as South Asia and Southeast Asia, the shares are higher, about 47.0% and 48.6%, respectively.

A promising technology for reducing residential and commercial energy consumption for heating and cooling is the heat pump. The air conditioner is a familiar example of a heat pump. A heat pump is a device that transfers heat from a heat source (outdoor air, water, or ground source) to a heat sink (indoor air, a heating network, or a domestic hot water tank) against a temperature gradient. A heat pump can be driven by electricity or by a heat source (burning of gas, solar thermal, or geothermal) and can be used for space heating, space cooling, and water heating.

The term coefficient of performance (COP) is often used to describe the efficiency of heat pumps. COP is the ratio of useful heat movement per work input. A COP larger than 1 indicates more output compared with input. A heat pump's COP ranges from 3 to 4 on a mild day, while the COP of an electrical resistance heater is no more than 1. However, the actual performance of a heat pump is dependent on its environment. Higher temperature differentials during periods of extreme cold or heat lead to declining efficiency (lower COP). The COP of an air source heat pump can approach 1 in extremely cold weather. Heat pumps using underground water or a ground source as its heating source always have higher COPs than air source heat pumps.

Figure 4.18 Energy Savings Potential in the Commercial Sector by End Use (2035)



BAU = business-as-usual case, Mtoe = million tons of oil equivalent, PRC = People's Republic of China.
Notes:
1. Due to data scarcity and diversity of methods for office heating, the energy savings potential from space heating in the commercial sector was not estimated for this exercise.
2. Numbers inside the parentheses refer to the reductions in the 2035 energy demand of the commercial sector that could be achieved by shifting from the BAU case to the alternative case, expressed as percentages of the 2035 energy demand of the other sectors in the BAU case.

The most widely installed heat pumps in Asia and the Pacific are air conditioners, an air-to-air reversible heat pump usually driven by electricity. Many of the ADB members in Asia and the Pacific have launched energy efficiency policies and subsidy programs to encourage the installation of high-efficiency air conditioners. The Government of Japan launched the Top Runner Programme in 1998 targeting 21 items[11] of major energy-consuming equipment in residential and commercial buildings as well as vehicles to improve their energy efficiencies. The basic principle of the Top Runner Programme is to set the future standard for energy efficiency of targeted end uses based on the technology of best performance currently available in the market (which is the "top runner") and keep updating the standard in the same fashion. Because of this program, the average cooling COP of air conditioners in Japan improved 67.8%, from 3.01 in 1997 to 5.05 in 2004.[12]

Lighting is also expected to play a significant role in energy savings in the residential and commercial sectors. In fact, in developing member countries with warmer climates, including South Asia, Southeast Asia, and the Pacific islands, the largest energy savings are expected to come from lighting since lighting appliances are generally the first to be deployed in households. Lighting is estimated to contribute 36.3% of India's residential energy savings potential in 2035. A considerable energy reduction can also be achieved in the commercial sector through efficiency improvements of lighting. It accounts for 36.2% in the PRC's total estimated commercial energy savings potential in 2035, and 22.1% in India's (Figure 4.18). The difference is in part attributed to the geographic factor that lighting is used for longer hours in high-latitude areas.

[11] This was expanded to 23 items as of April 2012.

[12] See Government of Japan, Ministry of Economy, Trade and Industry. http://www.enecho.meti.go.jp/policy/saveenergy/data/tr-kaizen.pdf (in Japanese).

Chapter 5

Electricity Outlook

Electricity Outlook

- *Electricity generation in Asia and the Pacific will grow annually at 3.2% on average, reaching 18,531.9 terawatt-hours (TWh) in 2035, which is slower than the historical trend of 6.0% from 1990 to 2010. Fossil fuel will continue to dominate the electricity generation mix in Asia and the Pacific, although its share in total power generation will decline from 77.4% in 2010 to 72.4% in 2035 as the increasing share of natural gas in the mix will be offset by a decline in the share of coal.*
- *New and renewable energy will increase its share in electricity generation to 7.1% in 2035, up from 1.9% in 2010.*
- *In the alternative case, electricity generation in Asia and the Pacific will be reduced by 3,103.3 TWh to 15,428.6 TWh in 2035 compared with the business-as-usual (BAU) case.*

This chapter presents the electricity outlook through 2035 in Asia and the Pacific. The projected trend of electricity demand and electricity generation in the BAU case is described in the first two sections, and a comparison of the electricity generation outlook between BAU and the alternative case follows.

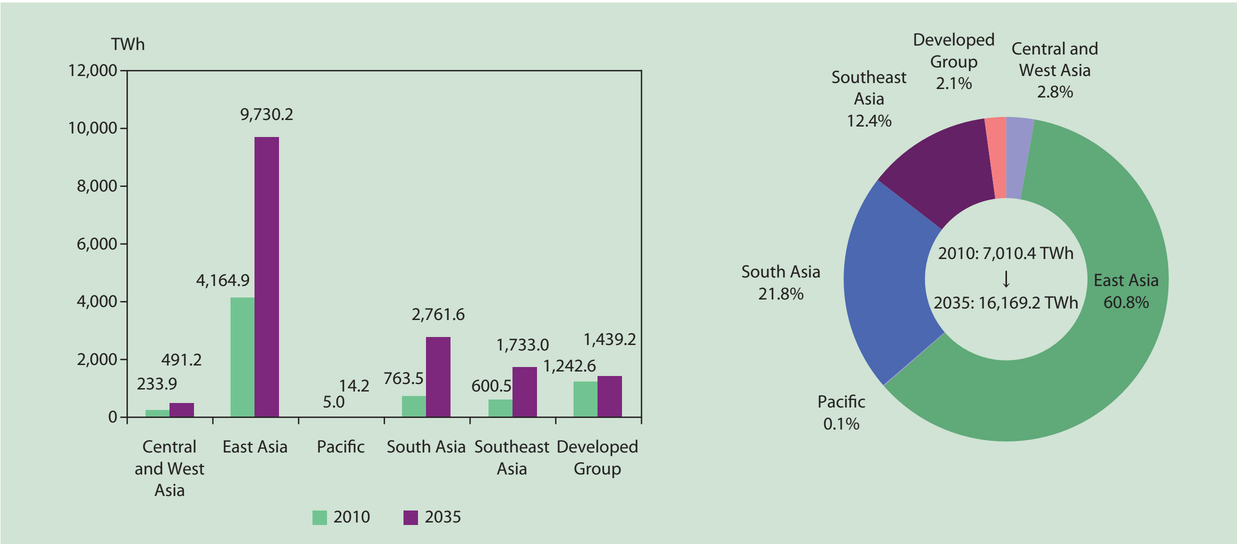
5.1 Electricity Demand

Electricity demand in Asia and the Pacific is projected to more than double between 2010 and 2035, increasing from 7,010.4 TWh in 2010 to 16,169.2 TWh in 2035. The annual growth rate will be 3.4% over the outlook period, which is slower than the historical trend of 6.0% between 1990 and 2010. The electricity demand of the developing members will grow slightly faster, at an annual rate of 3.8% on average through 2035, and increase their share in the total electricity demand of Asia and the Pacific from 82.3% in 2010 to 91.1% in 2035.

By region, East Asia will lead electricity demand in Asia and the Pacific over the outlook period. East Asia is projected to have the biggest electricity demand at 9,730.2 TWh in 2035, of which the People's Republic of China (PRC) will account for 90.1% (Figure 5.1, left). The PRC's dominance in East Asia's electricity demand will be maintained due to its scale and robust economic growth. East Asia will account for 60.8% of the incremental electricity demand growth between 2010 and 2035 (Figure 5.1, right).

Regardless of scale, however, electricity demand will grow substantially in the regions where economic development is likely to continue, and electricity supply infrastructure is expected to be facilitated and improved. South Asia will register the fastest growth rate among the regions at 5.3%, a more than threefold increase to 2,761.6 TWh in 2035. Both the Pacific and Southeast Asia will demonstrate a robust demand growth at 4.3%. As a result, South Asia will be the second-largest contributor to the incremental electricity demand growth during the outlook period at 21.8%, followed by Southeast Asia at 12.4%.

Figure 5.1 Electricity Demand by Region (left) and Regional Contributions to Incremental Electricity Demand Growth between 2010 and 2035 (right)

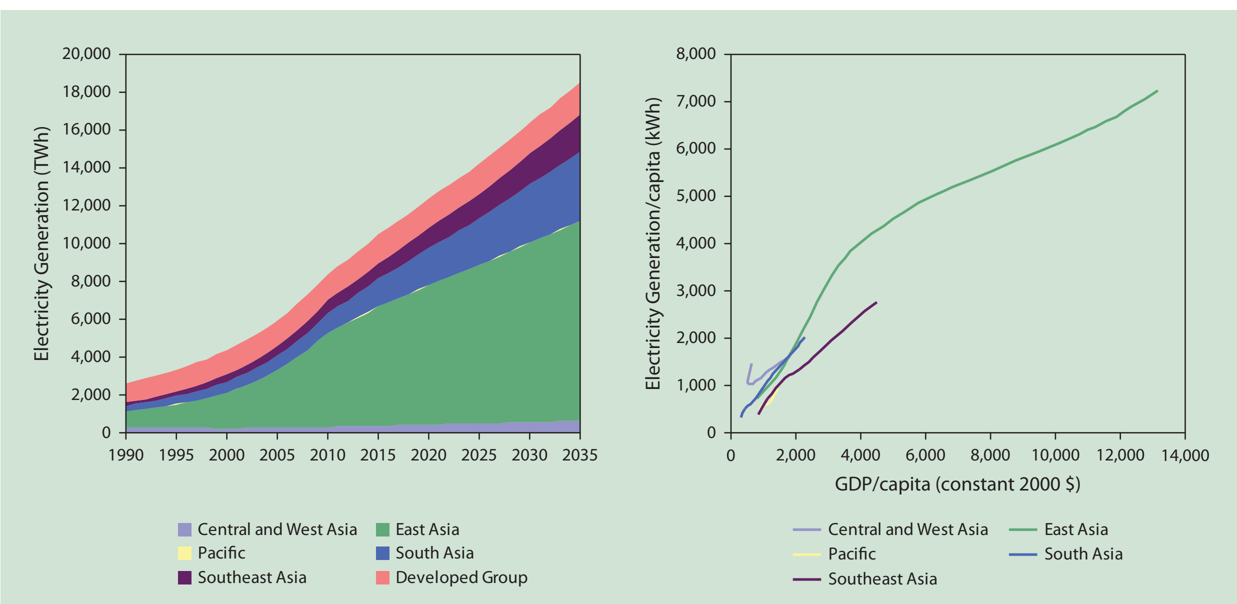


TWh = terawatt-hour.

5.2 Electricity Generation

Electricity generation in Asia and the Pacific will grow annually at 3.2% on average, increasing from 8,407.8 TWh in 2010 to 18,531.9 TWh in 2035 (Figure 5.2, left). The Developed Group's electricity generation is likely to grow moderately at an average annual rate of 0.7% through

Figure 5.2 Electricity Generation by Region (left) and Electricity Generation per Capita and GDP per Capita in Developing Member Countries: 1990–2035 (right)



GDP = gross domestic product, kWh = kilowatt-hour, TWh = terawatt-hour.

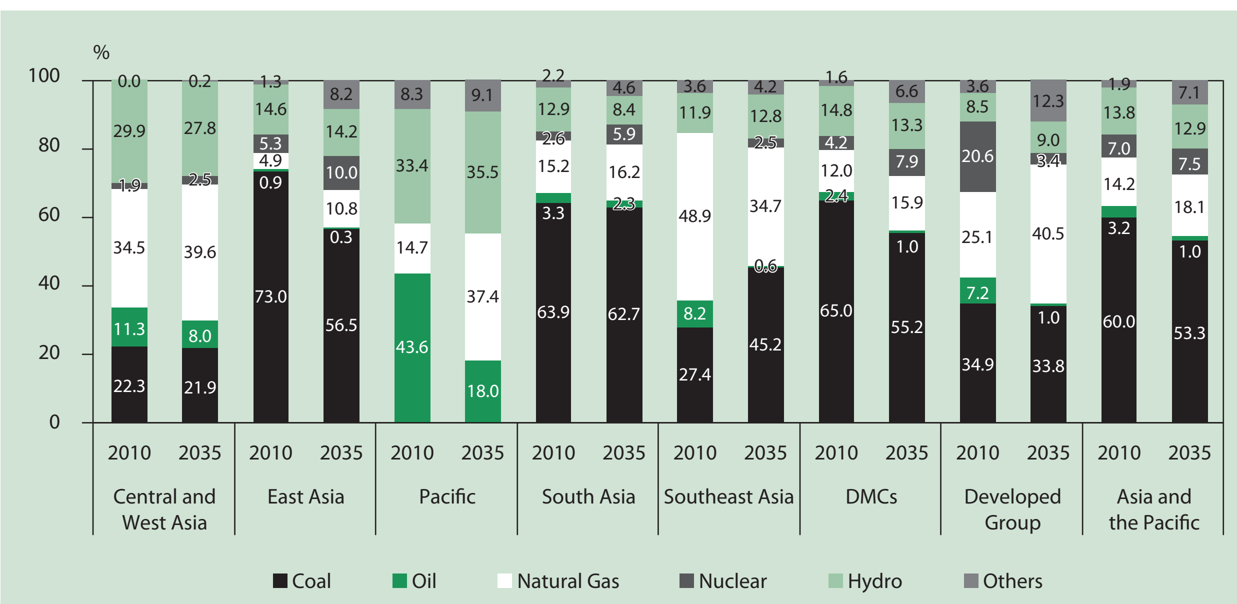
2035, mainly affected by the decline in Japan's electricity generation. Meanwhile, the electricity generation in the developing member countries will grow at an annual rate of 3.6% and reach 16,859.9 TWh in 2035, accounting for 91.0% of the total electricity generation in Asia and the Pacific. The PRC and India will lead the increase, representing 70.0% of the total electricity generation in 2035. The PRC is projected to register the largest amount of electricity generation in Asia and the Pacific at 9,542.4 TWh in 2035, followed by India at 3,437.3 TWh.

The developing member countries' electricity generation increase is expected to continue through 2035. Electricity generation would expand, corresponding to increased demand for electricity driven by economic and industrial development and improvement in living standards. This trend can be observed in Figure 5.2 (right), which traces the patterns between electricity generation per capita and gross domestic product (GDP) per capita between 1990 and 2035. Among the regions compared, East Asia has the highest per capita electricity generation since advanced industry and higher living standards translate into a high electricity requirement. Southeast Asia follows as its income and economic development level is projected to improve.

The electricity generation mix varies substantially in Figure 5.3, which shows regional comparisons for the period between 2010 and 2035. The use of coal in power generation is projected to be dominant over the outlook period although its share will decline moderately. Because of the dominance of coal in power generation in East Asia, South Asia, and Southeast Asia, coal will continue to occupy the largest share in the electricity generation mix. Coal's price competitiveness and abundance will also make it possible to be the major continuous source of electricity generation.

Natural gas is projected to make up the second-largest share in the electricity generation mix of Asia and the Pacific and to expand its share in the regions, except in Southeast Asia where coal will replace natural gas as a major fuel for power generation. Since Central and West Asia

Figure 5.3 Electricity Generation Mix in 2010 and 2035: Business-as-Usual



DMC = developing member country.

and the Pacific are endowed with vast natural gas resources, natural gas-fired generation will continue to dominate the electricity generation mix in these regions.

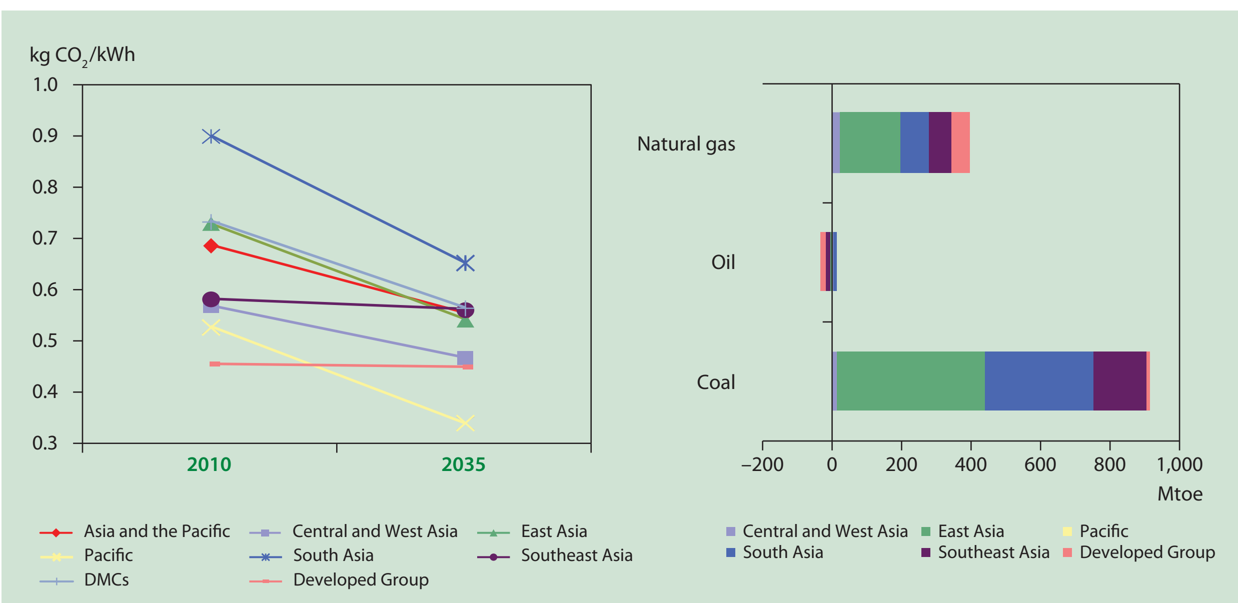
The share of new and renewable energy (NRE) will increase slightly in the electricity generation mix over the outlook period although it will remain low. NRE has drawn attention as it will help diversify energy sources and utilize domestic resources, consequently leading to energy security enhancement. In addition, NRE such as solar and wind will be useful for off-grid power generation in remote areas that have no access to electricity. Cost competitiveness and technology availability will affect the deployment level for NRE.

Although there are only a few ADB members in Asia and the Pacific adopting nuclear power, the share of nuclear power generation will increase marginally through 2035. Substantial reductions in nuclear power generation in Japan will offset the expected increase in some members such as the PRC and India.

The change in the electricity generation mix between 2010 and 2035 will be reflected in the ratio of carbon dioxide (CO_2) emissions and electricity generation between 2010 and 2035 (Figure 5.4, left). CO_2 emissions per unit of electricity generated would be reduced in Asia and the Pacific on the whole; substantial decreases will be observed in most members whereas the reduction in Southeast Asia and the Developed Group will be slight. This limited reduction will be affected by the expansion of coal-fired generation in Southeast Asia and the reduction of nuclear power generation in the Developed Group through 2035.

Thermal efficiency improvements are expected to curb fuel requirements for generation. In Asia and the Pacific, the requirements for coal and natural gas are projected to grow at an annual rate of 2.2% and 3.9% through 2035, respectively, while coal-fired generation will grow annually at 2.7% and natural gas-fired generation at 4.2%. Figure 5.4 (right) shows the regional contributions

Figure 5.4 Carbon Dioxide Emissions per Electricity Generation Unit between 2010 and 2035 by Region (left), and Incremental Fuel Input Growth between 2010 and 2035 by Region (right)



DMC = developing member country, kg CO_2 = kilogram of carbon dioxide, kWh = kilowatt-hour, Mtoe = million tons of oil equivalent.

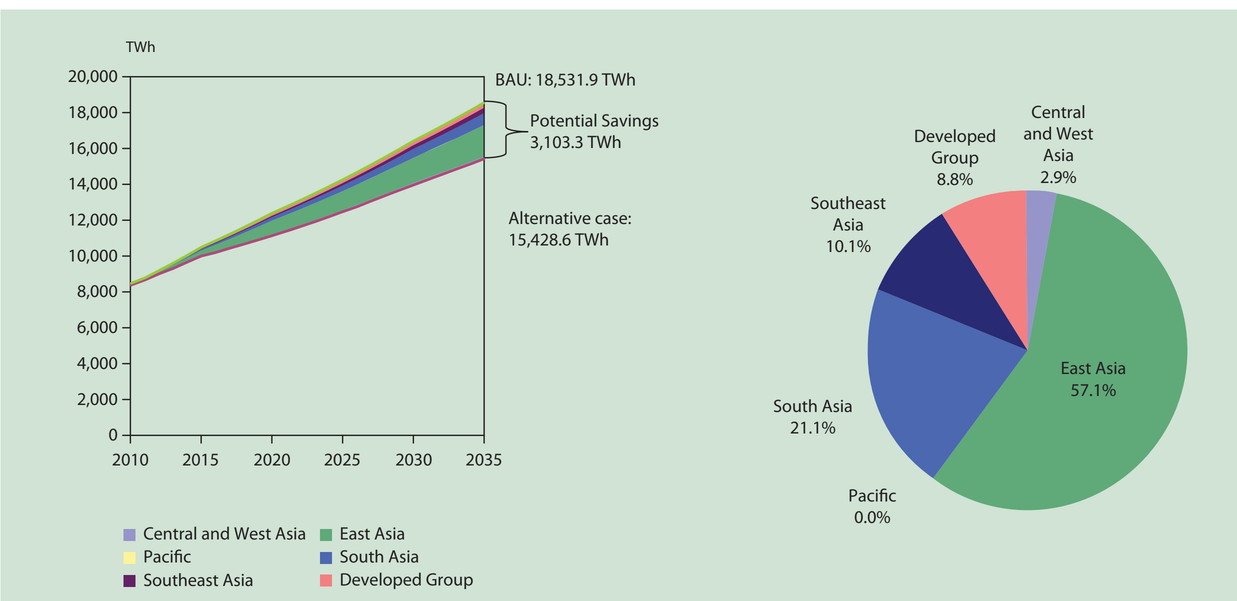
to the growth in incremental fossil fuel requirements between 2010 and 2035. Coal's incremental growth stands out, led by East Asia, South Asia, and Southeast Asia. The natural gas input will increase in all regions whereas the oil requirement will decline in most regions.

5.3 Comparison of the Business-as-Usual and Alternative Cases

In the alternative case, electricity generation will be reduced by 3,103.3 TWh compared with the BAU case, reaching 15,428.6 TWh in 2035 in Asia and the Pacific (Figure 5.5, left). The annual growth rate of electricity generation in the alternative case will be slower at 2.5% over the outlook period than in the BAU case at 3.2%. These potential savings could be the result of demand savings in the final energy demand sectors (mainly in the industry, residential, and commercial sectors). As Figure 5.5 (right) shows, East Asia would account for 57.1% of the estimated energy savings, followed by South Asia at 21.1% and Southeast Asia at 10.1%.

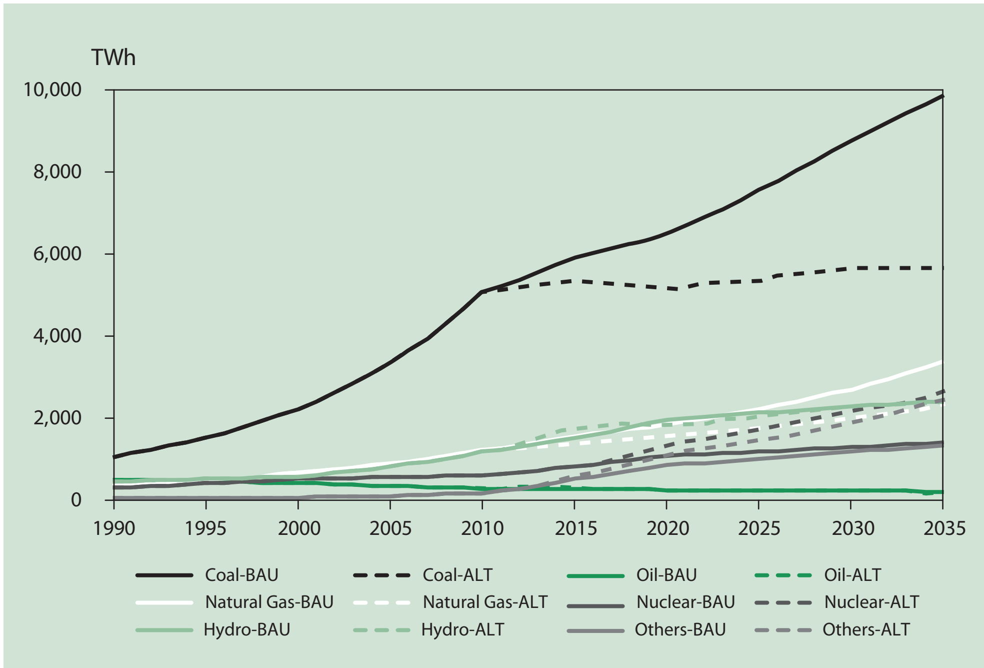
Figure 5.6 shows how much the electricity generation mix could differ between the two cases. The largest observable difference is the share of coal in the generation mixes of the two cases. The alternative case would achieve a 43.0% reduction in power generation from coal compared with the BAU case. The annual growth rate of electricity generation from coal in the alternative case is 0.4% between 2010 and 2035. Similarly, the average annual growth rate of natural gas-fired power generation would slow to 2.6% in the alternative case, compared with 4.2% in the BAU case over the outlook period. By contrast, electricity generation sourced from nuclear and the others, including NRE, is projected to show substantial increases in the alternative case: an increase of 81.1% for nuclear and 84.4% for the others. There is a slight difference in the power generation from hydro and oil between the two scenarios.

Figure 5.5 Comparisons of Electricity Generation (left), and Regional Contributions to the Electricity Generation Savings between Business-as-Usual and the Alternative Cases (right)



BAU = business-as-usual case, TWh = terawatt-hour.

Figure 5.6 Comparisons of Electricity Generation by Source between the Business-as-Usual and the Alternative Cases



ALT = alternative case, BAU = business-as-usual case, TWh = terawatt-hour.

The same trend can be seen in the regions (Figure 5.7). In the alternative case, coal and natural gas would reduce their shares in electricity generation through 2035 whereas nuclear and the others would expand more than in the BAU case. Electricity generation of most regions except the Pacific will decline significantly in the alternative case: 14.4% for Central and West Asia, 16.8% for East Asia, 18.0% for South Asia, 15.7% for Southeast Asia, and 16.3% for the Developed Group.

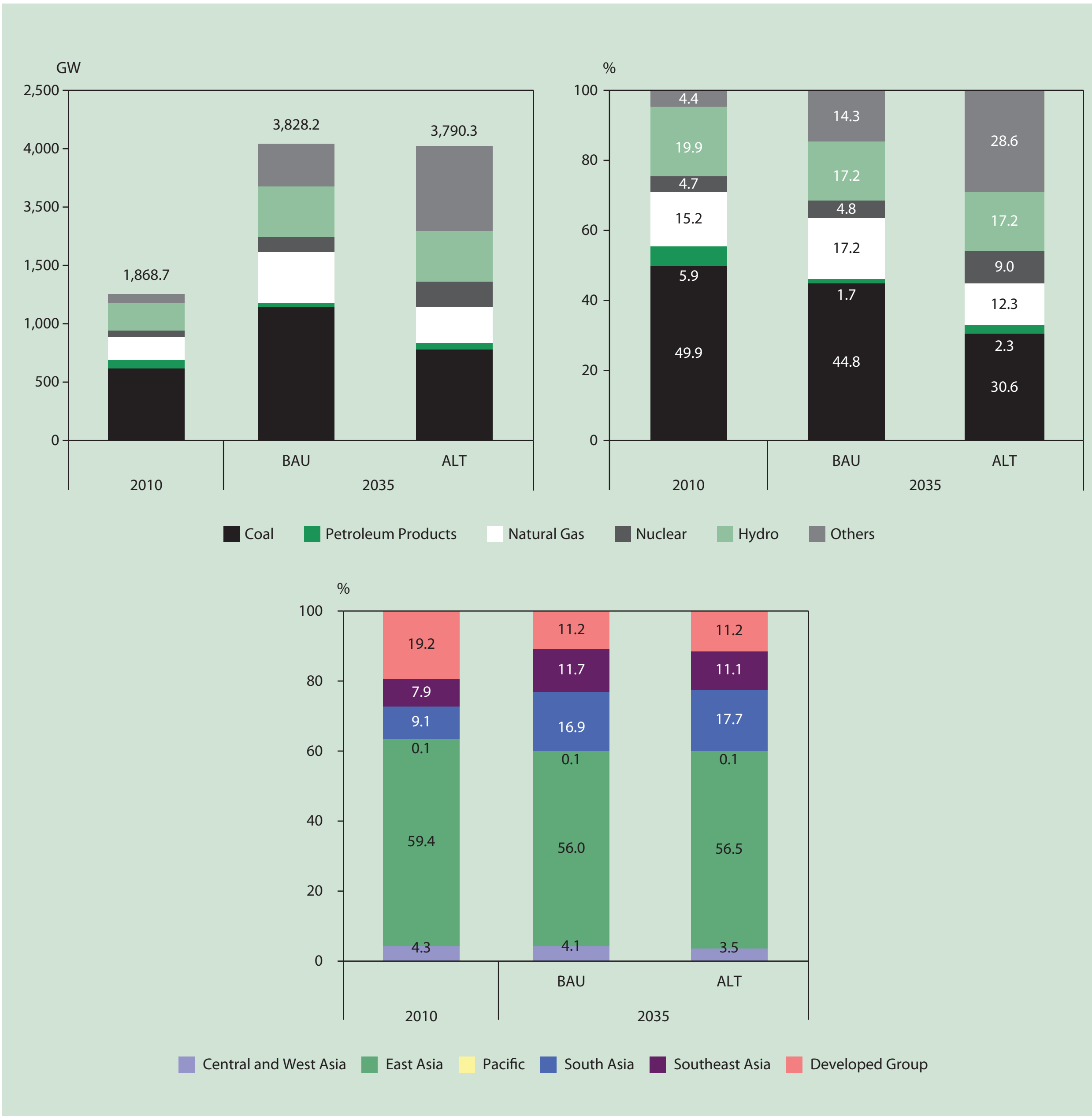
The total installed capacity in Asia and the Pacific may not differ considerably between the two cases. When considered by source, however, there are differences: in the alternative case, there is a significant addition of the others' installed capacity, a reduction in coal capacity in 2035 (Figure 5.8, left and Figure 5.8, middle), and an expanded nuclear installed capacity. Looking at the installed capacity by region, the two scenarios may follow a similar trend toward 2035 (Figure 5.8, right). Compared with the situation in 2010, in both cases, South Asia and Southeast Asia will expand their shares in the total installed capacity in 2035 whereas the Developed Group and East Asia will reduce their shares from the 2010 level.

NRE such as wind and solar power is expected to play a more important role in electricity generation through 2035 (Figure 5.9). In the alternative case, deployment of NRE is assumed to be facilitated for electricity generation as planned. For wind power generation, the installed capacity in the alternative case is projected to reach 634.3 gigawatts (GW) in 2035 from 48.6 GW in 2010, whereas it would be 392.4 GW in 2035 in the BAU case. The installed capacity for wind power will be concentrated in East Asia, South Asia, and the Developed Group. Although Central and West Asia and Southeast Asia would account for a marginal part of the wind power installed capacity, both regions would introduce more wind power capacity in relative terms in the alternative case compared to the BAU case.

Figure 5.7 Comparisons of Electricity Generation by Region

ALT = alternative case, BAU = business-as-usual case, TWh = terawatt-hour.

Figure 5.8 Comparisons of Installed Capacity by Source (left), Share (right), and Regional Share (bottom)

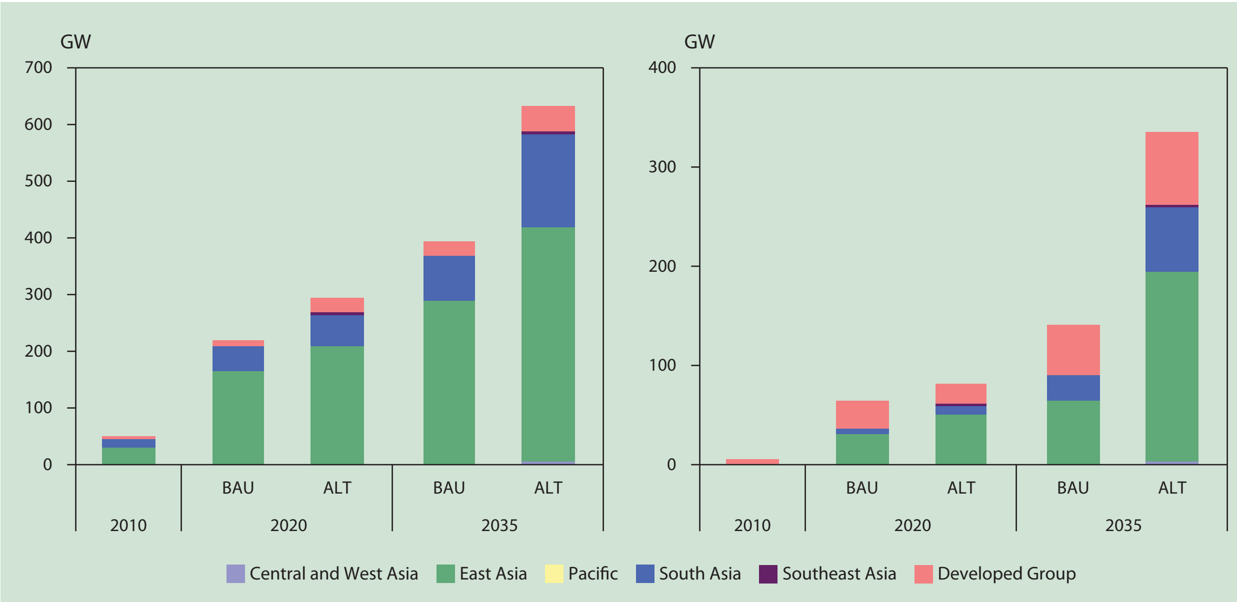


ALT = alternative case, BAU = business-as-usual case, GW = gigawatt.

Solar power installed capacity could be enhanced significantly in the alternative case, from a mere 5.6 GW in 2010 to 338.2 GW in 2035, which is 2.4 times larger than the capacity in the BAU case. Currently, solar power generation is more popular in Europe. However, this outlook suggests that Asia and the Pacific could become the global leader in terms of installed solar power generation capacity by 2035.

The thermal efficiencies of natural gas- and coal-fired power plants are expected to improve in the alternative case. The thermal efficiency of natural gas-fired power plants is the highest among the

Figure 5.9 Comparisons of Installed Capacity of Wind Power (left) and Solar Power (right)



ALT = alternative case, BAU = business-as-usual case, GW = gigawatt.

fossil fuel generation technologies since less energy-intensive technologies such as combined-cycle gas turbines have already been applied. While the thermal efficiency of coal-fired power plants will be enhanced over the outlook period in both cases, that in the alternative case will be higher than that the BAU case in 2035. Super- and ultra-supercritical pulverized coal combustion technologies offer better efficiencies than existing conventional coal power plants. Since oil-fired power plants are anticipated to be replaced by other power generation technologies, the efficiency of oil-fired power generation could decrease over the outlook period regardless.

Chapter 6

Carbon Dioxide Emissions Outlook

Carbon Dioxide Emissions Outlook

- *Carbon dioxide (CO_2) emissions in Asia and the Pacific as a whole will increase from 13,404.0 million tons of CO_2 (Mt CO_2) in 2010 to 22,112.6 Mt CO_2 in 2035 at a growth rate of 2.0% per year, a slightly slower rate than for primary energy demand at 2.1% per year.*
- *East Asia will contribute the most to the increase in CO_2 emissions in Asia and the Pacific, driven by strong economic growth, but its CO_2 intensity (CO_2 emissions per total primary energy demand) will decrease at 0.3% per year mainly due to the shift to less carbon-intensive energy sources such as nuclear, natural gas, and renewable energy. In contrast, South Asia's and Southeast Asia's CO_2 intensities are projected to increase as a result of the expected increase in coal demand, especially in the power generation sector.*
- *Per capita CO_2 emissions will vary among the regions due to diversity in fuel choice, level of electrification, economic development, industry structure, and living standards. The per capita CO_2 emissions of the developing members is expected to increase, while those of the Developed Group is expected to decrease.*
- *CO_2 emissions in Asia and the Pacific in the alternative case will be 27.6% lower than in the BAU case. Energy efficiency improvements and switching to low-carbon technologies will account for 52.6% and 47.4% of the total CO_2 reduction, respectively. This result implies that energy conservation and optimization of the fuel mix are essential factors for further CO_2 abatement in Asia and the Pacific.*

This chapter presents the carbon dioxide (CO_2) emissions outlook through 2035 in Asia and the Pacific. The projected trend of CO_2 emissions in the business-as-usual (BAU) case is described is the first three sections, and a comparison of the CO_2 emissions outlook between the BAU case and the alternative case follows.

6.1 Carbon Dioxide Emissions

In the BAU case, CO_2 emissions in Asia and the Pacific will rise from 13,404.0 million tons of CO_2 (Mt CO_2) in 2010 to 22,112.6 Mt CO_2 in 2035, with an annual rate of 2.0% (Table 6.1). The projected growth of CO_2 emissions is slightly slower than that of the projected primary energy demand, which is at 2.1%. This reflects the slight improvement in overall CO_2 intensity (or CO_2 emissions per unit of total primary energy demand [TPED]) in Asia and the Pacific. (The CO_2 intensity trend is described in section 6.2.)

Figure 6.1 shows the CO_2 emissions by region. Among the regions, East Asia will contribute the biggest share in the CO_2 emissions in Asia and the Pacific in 2035, amounting to 12,989.3 Mt CO_2, followed by South Asia with 3,961.4 Mt CO_2, Southeast Asia with 2,596.1 Mt CO_2, the Developed Group with 1,598.1 Mt CO_2, and Central and West Asia with 949.2 Mt CO_2. The Pacific region will contribute the lowest amount of emissions with 18.5 Mt CO_2.

Although East Asia is likely to contribute the largest share, its share in total CO_2 emissions will decrease slightly from 62.1% in 2010 to 58.7% in 2035 (Figure 6.2). This reflects the projected slow growth of CO_2 emissions of the region (an annual rate of 1.8% through 2035, compared with the

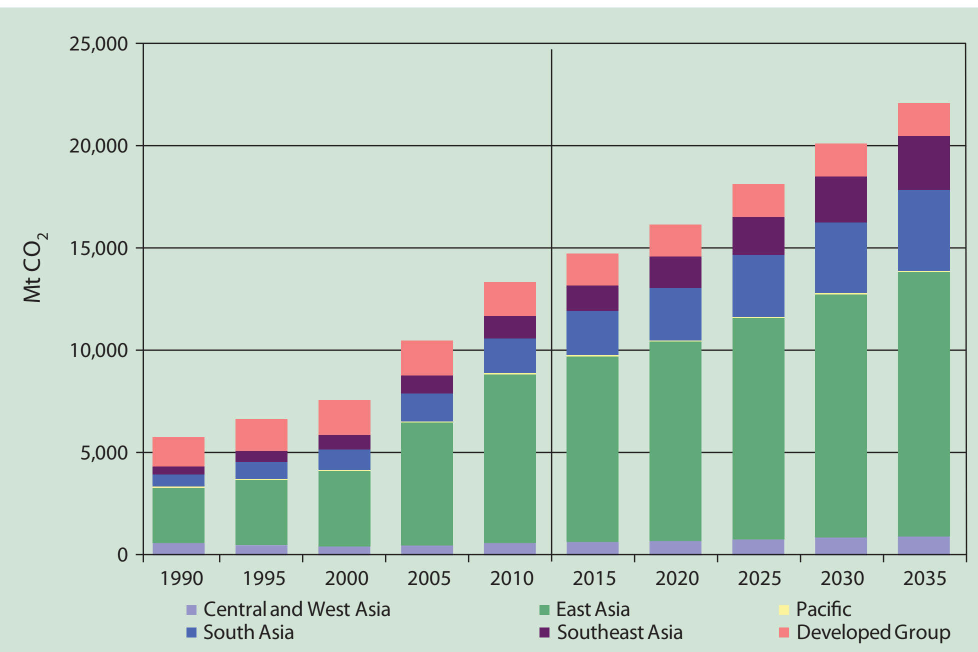
Table 6.1 Carbon Dioxide Emissions by Region (1990, 2010, 2020, and 2035)

	CO_2 Emissions (Mt CO_2)					Annual Growth Rates (%)	
	1990	2000	2010	2020	2035	1990–2020	2010–2035
DMCs	4,337.8	5,904.9	11,716.7	14,634.2	20,514.5	3.6	3.0
Central and West Asia	615.7	415.5	580.3	717.0	949.2	(0.3)	2.0
East Asia	2,721.8	3,748.8	8,330.0	9,799.9	12,989.3	5.8	1.8
Pacific	3.7	4.7	7.9	13.0	18.5	3.9	3.5
South Asia	608.1	994.7	1,727.8	2,600.1	3,961.4	5.4	3.4
Southeast Asia	388.5	741.2	1,070.8	1,504.3	2,596.1	5.2	3.6
Developed Group	1,455.9	1,678.0	1,687.3	1,550.5	1,598.1	0.7	(0.2)
ADB Total	5,793.7	7,583.0	13,404.0	16,184.8	22,112.6	4.3	2.0
World	…	…	31,305.0	35,209.6	43,219.8	…	1.3
OECD	…	…	12,860.8	13,252.0	14,323.0	…	0.4

( ) = negative number,… = no data or not applicable, ADB = Asian Development Bank, CO_2 = carbon dioxide, DMC = developing member country, Mt CO_2 = million tons of carbon dioxide, OECD = Organisation for Economic Co-operation and Development.
Sources: APERC estimates (for Asia and the Pacific); and United States Energy Information Administration. 2011. *International Energy Outlook*. Washington, D.C. (for the world and OECD).

average growth rate of developing member countries at 2.3%). The Developed Group's share in CO_2 emissions will largely decrease, from 12.6% in 2010 to 7.2% in 2035. In contrast, South Asia's and Southeast Asia's shares are expected to increase, from 12.9% in 2010 to 17.9% in 2035 and from 8.0% in 2010 to 11.7% in 2035, respectively. Central and West Asia's and the Pacific's shares are projected to stay the same throughout the outlook period, at 4.3% and 0.1%, respectively.

Figure 6.1 Carbon Dioxide Emissions by Region (1990–2035)



Mt CO_2 = million tons of carbon dioxide.

Figure 6.2 Carbon Dioxide Emissions Share by Region (2010 and 2035)

The CO_2 emissions of Asia and the Pacific accounted for about 42.8% of world CO_2 emissions in 2010. However, through 2035, CO_2 emissions in Asia and the Pacific will increase rapidly at an annual rate of 2.0%, compared with the world average growth rate of 1.3% per year through 2035 (EIA 2011). Thus, the share of Asia and the Pacific is projected to reach more than half of world CO_2 emissions in 2035.

6.2 Carbon Dioxide Intensity

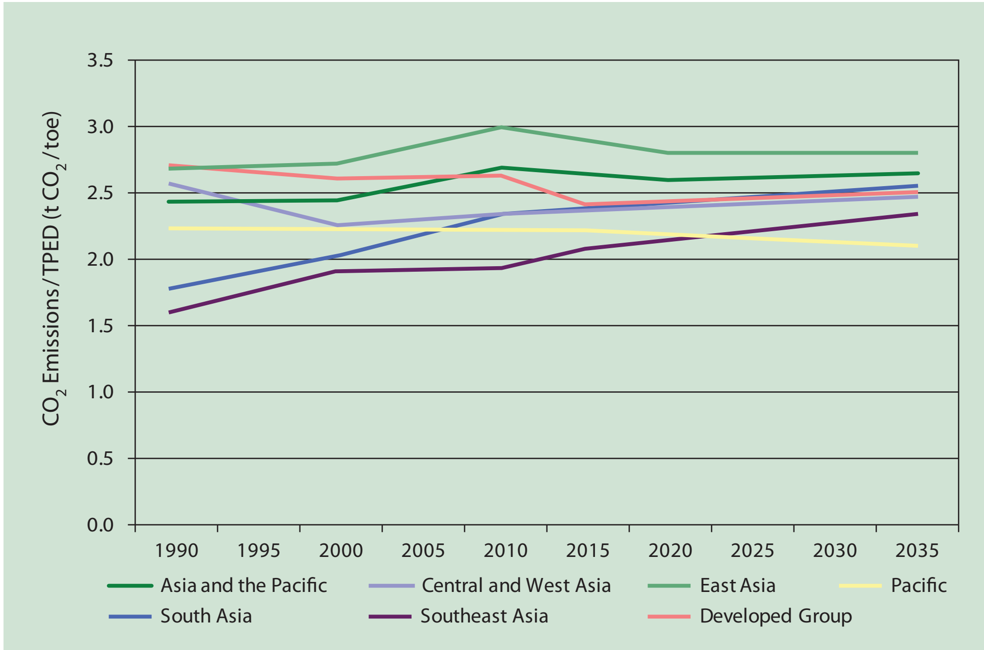
An indicator that could help understand the underlying factors that affect the change in total CO_2 emissions is CO_2 intensity, which is defined as the CO_2 emissions requirement per unit of TPED. A higher CO_2 intensity would mean higher CO_2 emissions per unit of energy demand.

The CO_2 intensities of South Asia and Southeast Asia—whose shares in total emissions are expected to increase—will increase at an annual rate of 0.4% and 0.8%, respectively, over the outlook period (Figure 6.3 and Table 6.2). The increases in CO_2 intensity are a result of the increased share of coal in the regions' total energy demand and a fuel shift from renewable energy to electricity (electrification) in the residential sector. In contrast, CO_2 intensities are expected to decline in East Asia (–0.3% per year) due to the shift to less carbon-intensive energy such as nuclear, natural gas, and renewable energy from higher carbon content fuels such as coal and oil. As a result, the CO_2 intensity of Asia and the Pacific as a whole will decline at 0.1% per year through 2035.

6.3 Carbon Dioxide Per Capita

There is a wide gap among the regions in terms of projected per capita CO_2 emissions. Due to the diversity in fuel choice, level of electrification, economic development, industry structure,

Figure 6.3 Carbon Dioxide Intensity (1990–2035)



CO_2 = carbon dioxide, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TPED = total primary energy demand.

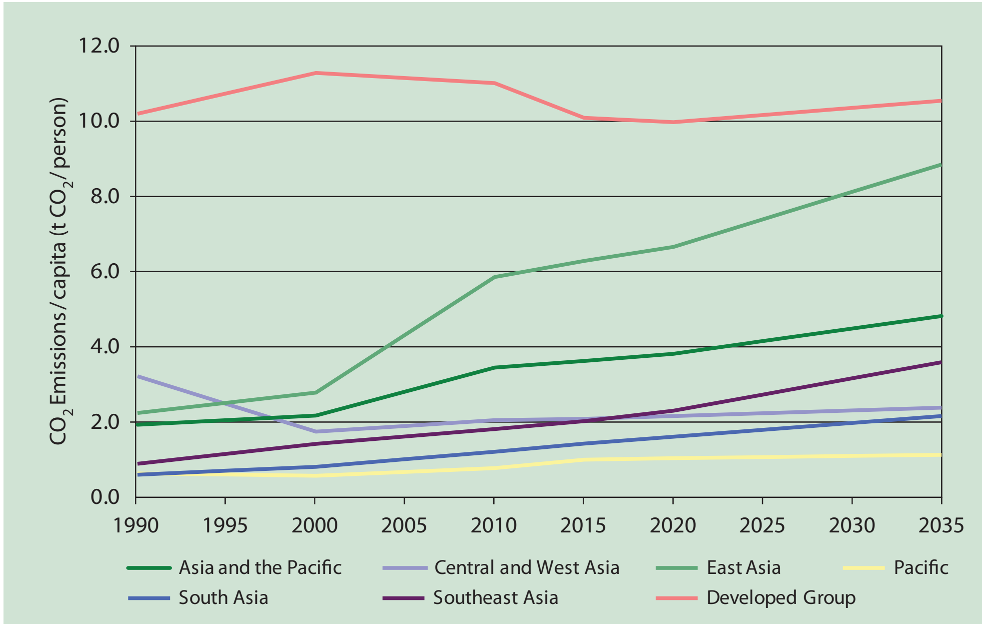
Table 6.2 Carbon Dioxide Intensity by Region (1990, 2010, 2020, and 2035)

	CO_2 Intensity (t CO_2/2000 $ billion)					Annual Growth Rates (%)	
	1990	2000	2010	2020	2035	1990–2020	2010–2035
DMCs	0.69	0.58	0.69	0.65	0.61	0.0	(0.5)
Central and West Asia	2.56	2.24	2.33	2.40	2.46	(0.5)	0.2
East Asia	2.68	2.71	2.98	2.79	2.79	0.5	(0.3)
Pacific	2.23	2.21	2.21	2.19	2.09	0.0	(0.2)
South Asia	1.78	2.02	2.32	2.42	2.54	1.3	0.4
Southeast Asia	1.60	1.89	1.93	2.14	2.34	1.0	0.8
Developed Group	2.70	2.61	2.64	2.42	2.50	(0.1)	(0.2)
World	…	…	2.38	2.26	2.23	…	(0.3)
OECD	…	…	2.14	2.02	1.97	…	(0.3)

( ) = negative number, … = no data or not applicable, CO_2 = carbon dioxide, DMC = developing member country, OECD = Organisation for Economic Co-operation and Development, t CO_2 = ton of carbon dioxide.
Sources: APERC estimates (for Asia and the Pacific); and United States Energy Information Administration. 2011. *International Energy Outlook*. Washington, DC (for the world and OECD).

and living standards, per capita CO_2 emissions in 2035 range from the Pacific region's 1.13 tons of CO_2 (t CO_2) per capita to the Developed Group's 10.55 t CO_2 per capita (Figure 6.4 and Table 6.3). East Asia's per capita CO_2 emissions at 8.85 t CO_2 per capita are expected to become the second largest behind the Developed Group, followed by Southeast Asia at 3.59 t CO_2 per capita, Central and West Asia at 2.38 t CO_2 per capita, South Asia at 2.16 t CO_2 per capita, and the Pacific at 1.13 t CO_2.

Figure 6.4 Per Capita Carbon Dioxide Emissions



CO_2 = carbon dioxide, t CO_2 = ton of carbon dioxide.

6.4 Comparison of the Business-as-Usual and Alternative Cases

In the alternative case, CO_2 emissions would be reduced by 6,104.3 Mt CO_2 compared to the BAU case, reaching 16,008.3 Mt CO_2 in 2035 in Asia and the Pacific (Figure 6.5). The annual growth rate of the alternative case would be slower at 0.7% over the outlook period than that of the BAU case at 2.0%.

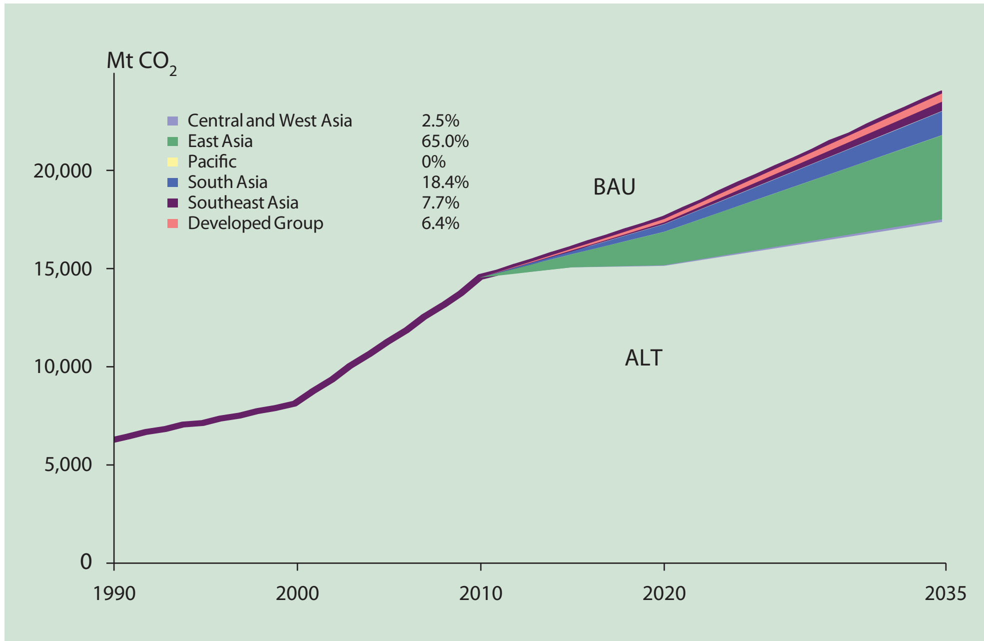
Table 6.3 Per Capita Carbon Dioxide Emissions by Region (1990, 2000, 2010, 2020, and 2035)

	Per Capita CO_2 Emissions (t CO_2/person)					Annual Growth Rates (%)	
	1990	2000	2010	2020	2035	1990–2020	2010–2035
DMCs	1.44	1.43	2.27	3.12	4.13	2.3	2.4
Central and West Asia	3.22	1.74	2.05	2.16	2.38	(2.2)	0.6
East Asia	2.24	2.78	5.86	6.66	8.85	4.9	1.7
Pacific	0.63	0.57	0.77	1.04	1.13	1.0	1.5
South Asia	0.60	0.81	1.21	1.61	2.16	3.6	2.3
Southeast Asia	0.89	1.42	1.82	2.30	3.59	3.6	2.8
Developed Group	10.20	11.28	11.02	9.98	10.55	0.4	(0.2)
World	…	…	4.55	4.63	5.11	…	0.5
OECD	…	…	10.51	10.29	10.54	…	0.0

( ) = negative number, … = no data or not applicable, CO_2 = carbon dioxide, DMC = developing member country, OECD = Organisation for Economic Co-operation and Development.

Sources: APERC estimates (for Asia and the Pacific); and United States Energy Information Administration. 2011. *International Energy Outlook*. Washington, D.C. (for the world and OECD).

Figure 6.5 Regional Contributions to the Carbon Dioxide Emissions Reductions between Business-as-Usual and the Alternative Cases



ALT = alternative case, BAU = business-as-usual case, Mt CO_2 = million tons of carbon dioxide.

The largest reduction amount is achieved in East Asia, which accounts for 65.0% of Asia and the Pacific's total reduction in the alternative case, followed by South Asia (18.4%), Southeast Asia (7.7%), the Developed Group (6.4%), and Central and West Asia (2.5%).

The major factor affecting CO_2 emissions, both historical and the future outlook, is expressed as the "Kaya Identity," which decomposes total CO_2 emissions as a product of the factors considered to be the underlying causes: (i) CO_2 emissions intensity over energy (CO_2/E), (ii) energy demand over economic growth (E/GDP), (iii) economic growth per population (GDP per capita), and (iv) and population growth. Total CO_2 emissions are derived by multiplying these factors:

$$CO_2 = \underbrace{(CO_2/E)}_{CO_2\text{ intensity}} \times \underbrace{(E/GDP)}_{\text{Energy intensity}} \times \underbrace{(GDP/POP)}_{\text{Economic growth}} \times \underbrace{POP}_{\text{Population}}$$

where

CO_2: CO_2 emissions expressed in million tons of CO_2

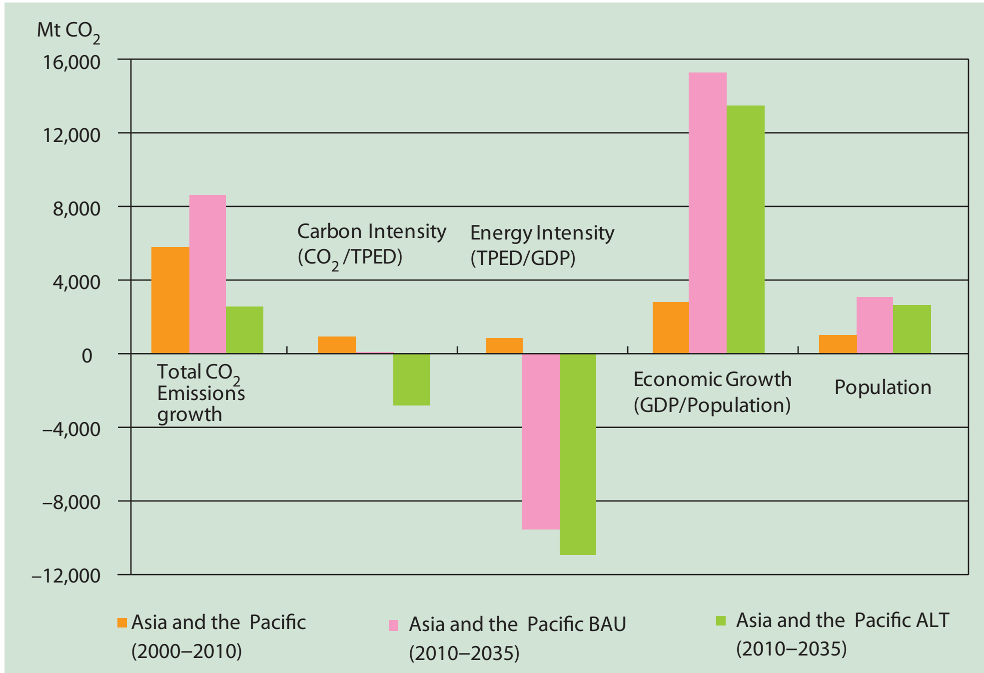
E: primary energy demand expressed in tons of oil equivalent

GDP: gross domestic product expressed in constant 2000 $

POP: population.

Figure 6.6 shows the decomposition analysis of the historical trend (2000–2010), the BAU case (2010–2035), and the alternative case (2010–2035) of CO_2 emissions. For the historical emissions, the total emissions increase was affected by growth of CO_2 intensity (1,002.2 Mt CO_2), energy intensity (873.2 Mt CO_2), GDP per capita (2,829.8 Mt CO_2), and population (1,073.3 Mt CO_2). All four factors contributed to growth in CO_2 emissions; thus, total emissions rose from

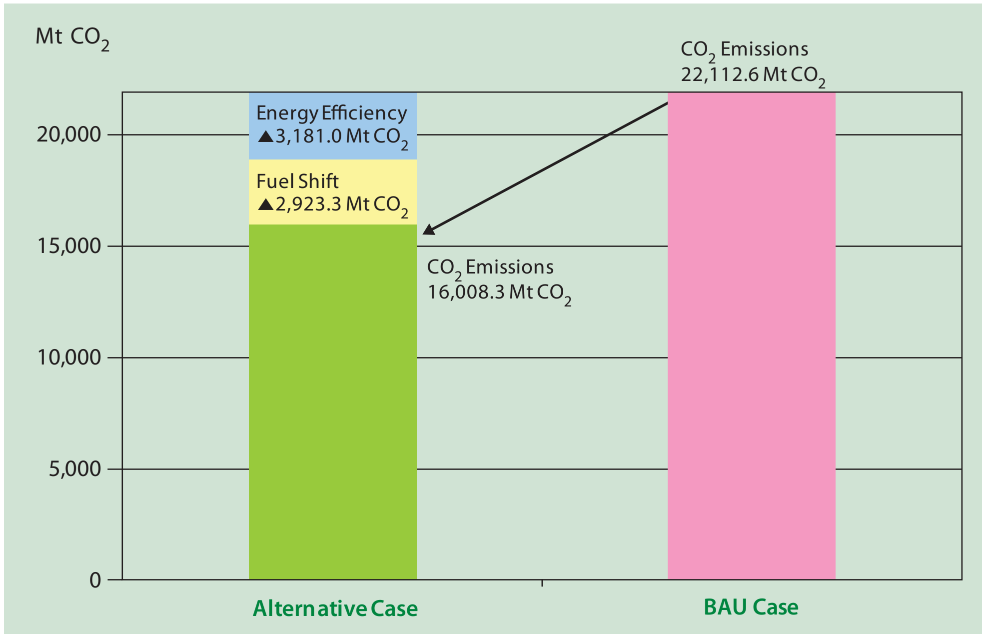
Figure 6.6 Decomposition Components of Carbon Dioxide Emissions Growth: Historical Trend (2000–2010), Business-as-Usual (2010–2035) and the Alternative Cases (2010–2035) in Asia and the Pacific



ALT = alternative case, BAU = business-as-usual case, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, TPED = total primary energy demand.

7,583.0 Mt CO_2 to 13,404.0 Mt CO_2 during 2000–2010. In the BAU case, total emissions will be affected mainly by economic growth (15,351.3 Mt CO_2) and population growth (3,114.4 Mt CO_2), while CO_2 intensity (–65.7 Mt CO_2) and energy intensity (–9,522.5 Mt CO_2) will contribute to the decrease in CO_2 emissions. Similarly in the alternative case, total emissions will be affected by economic growth (13,573.8 Mt CO_2) and population growth (2,706.0 Mt CO_2). Energy intensity will be the largest decreasing factor with –10,922.7 Mt CO_2, followed by CO_2 intensity with –2,752.8 Mt CO_2. It is notable that fuel switching from carbon-intensive to less carbon-intensive energy sources will be more heavily encouraged in the alternative case than in the BAU case. The share of non-fossil fuel energy, such as nuclear and new and renewable energy, in total primary energy demand will increase from 16.8% in the BAU case to 25.6% in the alternative case. A noticeable increase in non-fossil fuel energy is observed in the power generation sector, and the share of nuclear and new and renewable energy is expected to be grow to 47.8% in the alternative case from 27.6% in the BAU case.

Figure 6.7 Decomposition Components of Carbon Dioxide Emissions Reduction from Business-as-Usual (2035) to the Alternative Case (2035) in Asia and the Pacific



BAU = business-as-usual case, CO_2 = carbon dioxide, Mt CO_2 = million tons of carbon dioxide.

The factors affecting CO_2 reduction from the BAU case to the alternative case are also estimated by the decomposition analysis. Energy intensity will account for 52.6% and CO_2 intensity for 47.4% of the total reduction in CO_2 emissions from the BAU case to the alternative case (Figure 6.7). This result possibly implies that enhancement of energy conservation and a fuel shift to less carbon-intensive energy are essential for further reduction of CO_2 emissions in Asia and the Pacific.

Chapter 7

Energy Investment Outlook

Energy Investment Outlook

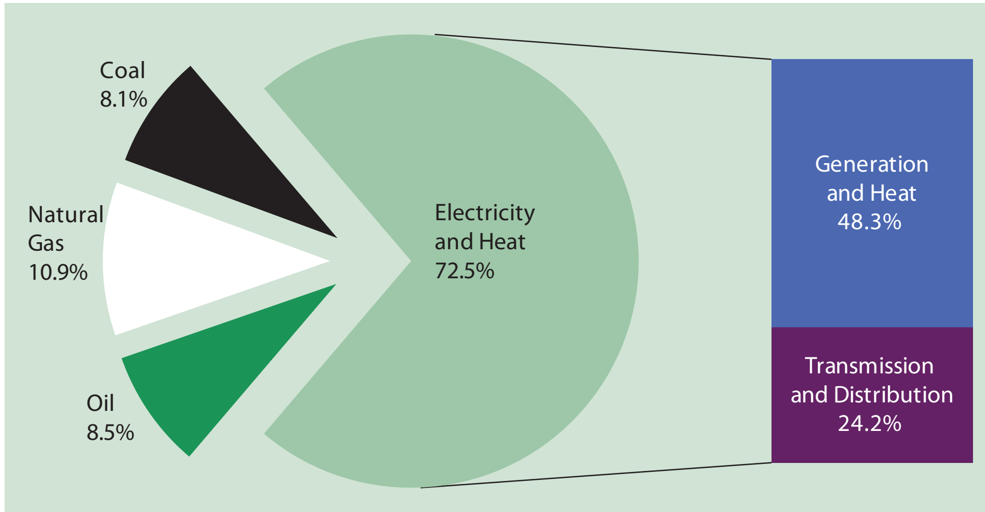
- *To meet the business-as-usual (BAU) energy demand, Asia and the Pacific will require a cumulative investment of about $11.7 trillion in the energy sector (2010–2035), from upstream energy extraction and production, to midstream energy transformation and transportation, to downstream energy distribution.*
- *By type of energy source, electricity and heat will account for the biggest share of total investment requirements in the BAU case at 72.3%, followed by natural gas (including its extraction, production, and export and import facilities) at 10.9%, oil at 8.5%, and coal at 8.1%.*
- *Meanwhile, in the alternative case, an investment of about $19.9 trillion for both the supply and demand sides will be required. Demand-side investments (additional to the BAU case) of $7.3 trillion will be required to deploy advanced energy-efficient technologies for the transport, residential, commercial, and industry sectors. Supply-side investments will amount to $12.6 trillion—higher than the BAU investment needs—due to additional investments necessary for deploying advanced coal-fired and natural gas-fired power generation technologies for thermal efficiency improvement as well as low-carbon-emitting power generation units (nuclear, wind, and photovoltaic).*

An investment analysis was conducted for both the BAU case and the alternative case. For the BAU case, an analysis was conducted of the investment requirements on the supply side (from energy extraction, transportation, transformation, and distribution) necessary to meet demand-side energy needs and each member country's energy exports and imports. For the alternative case, the analysis covered both the supply-side analysis and additional investment needs for the deployment of advanced technologies in the final energy demand sectors. For the purpose of considering the difference in investment requirements, an investment outlook was prepared by member and by sector. The sectors considered are coal (exploration, production and transport); oil and natural gas production (exploration, production, and refinery/processing); oil and natural gas trade (international tanker and pipeline transport); oil and natural gas domestic supply (domestic transport by pipeline, tanker, rail, and road); and electricity (generation, transmission, and distribution). The investment analysis results can also be classified by supply chain from extraction and production to transformation, energy transportation (pipeline/tanker transport and electricity transmission), and distribution. The investment requirements and gross domestic product (GDP) figures in this chapter are presented in US dollars in constant 2006 prices.

7.1 Energy Investment Outlook: Business-as-Usual Case

To meet the BAU energy demand, Asia and the Pacific as a whole will require an investment of about $11.7 trillion (constant 2006 prices) between 2010 and 2035 into the energy sector (upstream, midstream, and downstream). As Figure 7.1 shows, of the estimated investment requirements, electricity and heat will require the biggest investment at $8.5 trillion, representing 72.5% of the total investment requirements in Asia and the Pacific. This is divided into generation and heat (48.3%) and transmission and distribution (24.2%). Given Asia and the Pacific's resources endowment of some members in Central and West Asia (such as Azerbaijan, Kazakhstan, Uzbekistan, and Turkmenistan) and Australia in the Developed Group,

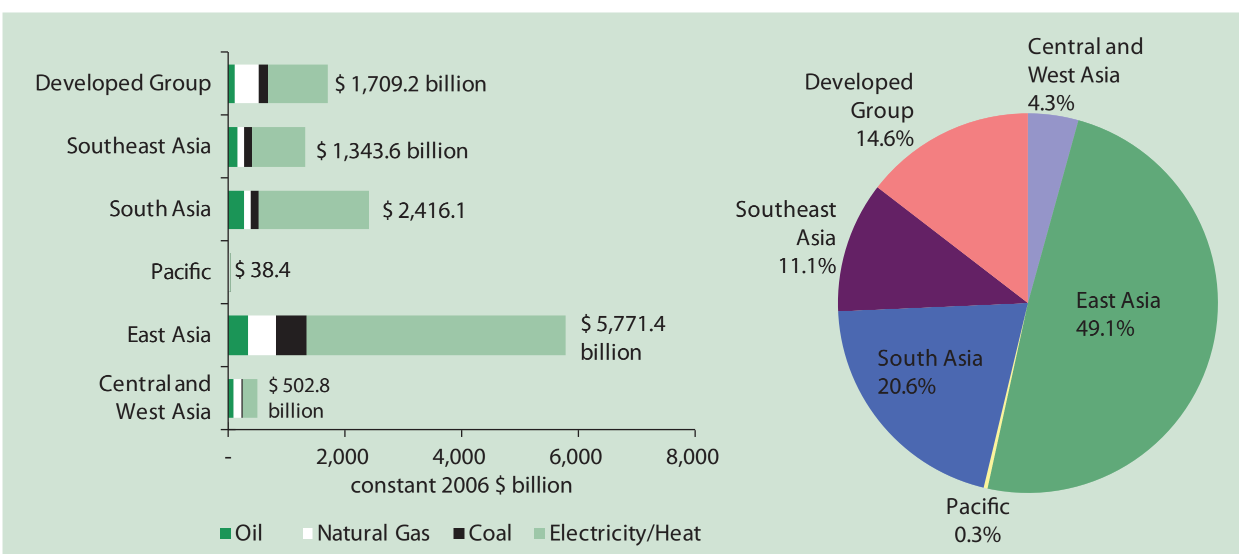
Figure 7.1 Sectoral Investment Share: Business-as-Usual



the investment for natural gas (from extraction to export and import facilities) accounts for the second-largest share at 10.9%, or $1.3 trillion, during the outlook period. Investments related to oil extraction, transportation, and distribution will reach a cumulative amount of about $1.0 trillion, followed by the investment for coal at $0.96 trillion.

Energy investment requirements differ by member depending on demand, energy choice, and energy imports and exports. Figure 7.2 (left) shows the regional investment outlook. As the figure shows, the biggest investment requirements over the outlook period are estimated for East Asia, at $5.8 trillion, mainly driven by electricity and heat needs. The region's energy investment needs account for 49.1% of total investments in Asia and the Pacific, with the

Figure 7.2 Cumulative Energy Investment by Region (2010–2035, left) and Regional Investment Share (right)



bulk of the requirements reflecting the large-scale energy investment needs in the People's Republic of China (PRC), estimated at $5.3 trillion.

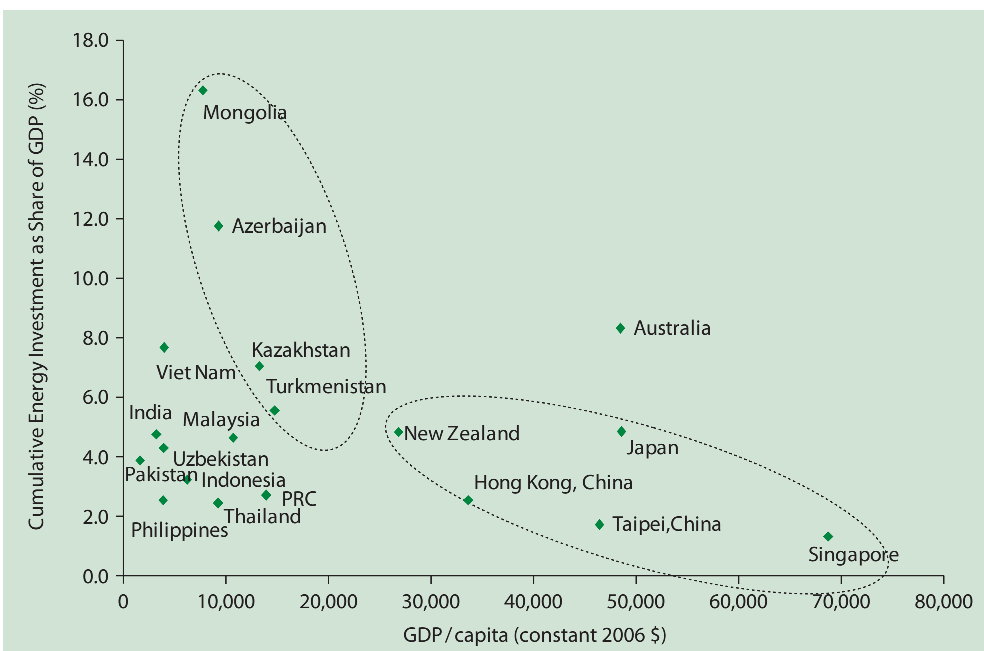
South Asia's investment needs are the second largest at $2.4 trillion (or 20.6% of total investment requirements in Asia and the Pacific). India will account for an estimated $2.3 trillion or 95.6% of energy investment requirements in South Asia.

The Developed Group's energy investment requirements are the third biggest in Asia and the Pacific at $1.7 trillion, which can be broken down into those for Japan ($883.7 billion), Australia ($781.1 billion), and New Zealand ($44.4 billion). Japan's relative large investment needs result from its deployment of large-scale new and renewable energy sources (wind at 9.2 gigawatts [GW] and photovoltaic at 45.3 GW in 2035) to cope with the assumed phaseout of nuclear power generation in the BAU case. Meanwhile, investment in upstream and export infrastructure to support LNG and coal exports make up 69.7% of Australia's total investment needs.

Figure 7.3 shows the ratio of cumulative investment requirements per cumulative GDP over the period 2010–2035 (on y-axis), which is compared with the respective member's per capita GDP in 2035. As the figure shows, the ratio of investment requirements per GDP differs by member depending on energy demand, energy choice, and energy imports and exports.

Resource-rich members (Australia, Azerbaijan, Mongolia, and Turkmenistan) have a relatively large ratio of investments per GDP, exceeding 5.0%. Aside from meeting domestic energy demand, these members require investments for upstream extraction and midstream transportation for exports.

Figure 7.3 Comparison of Energy Investments as Share of Gross Domestic Product and Gross Domestic Product per Capita for Selected Members



GDP = gross domestic product, PRC = People's Republic of China.

Table 7.1 Energy Investment for Asia and the Pacific (constant 2000 $ billion)

Developing Members	**10,037.3**
Central and West Asia	503.4
Azerbaijan	97.5
Kazakhstan	139.7
Pakistan	116.0
Turkmenistan	51.0
Uzbekistan	60.0
Other Central and West Asia	39.2
East Asia	5,771.4
People's Republic of China	5,261.2
Hong Kong, China	16.0
Korea, Republic of	298.3
Mongolia	48.2
Taipei,China	147.6
Pacific	38.4
Papua New Guinea	34.5
Other Pacific Islands	3.8
South Asia	2,415.9
India	2,310.7
Other South Asia	105.2
Southeast Asia	1,308.3
Brunei Darussalam	45.2
Indonesia	540.1
Lao People's Democratic Republic	12.9
Malaysia	164.6
Philippines	113.5
Singapore	43.7
Thailand	144.0
Viet Nam	141.8
Other Southeast Asia	102.5
Developed Group	**1,709.2**
Australia	781.1
Japan	883.7
New Zealand	44.4
Asia and the Pacific Total	**11,746.5**

High-income members (Singapore; Taipei,China; and Hong Kong, China) have a relatively low ratio of investments per GDP at around 2.0% as their infrastructure is already developed. In contrast, relative to their high income levels, the ratio for Japan and New Zealand is high due to the investment needs for the power sector, whose dependence on new and renewable sources and associated higher capital costs are projected to increase.

The emerging countries undergoing industrialization (the PRC, India, Indonesia, Malaysia, Pakistan, the Philippines, Thailand, and Viet Nam) show relatively high levels of energy investment per GDP at above 2.0%. As their economies industrialize, these countries require larger investments relative to the size of their GDP.

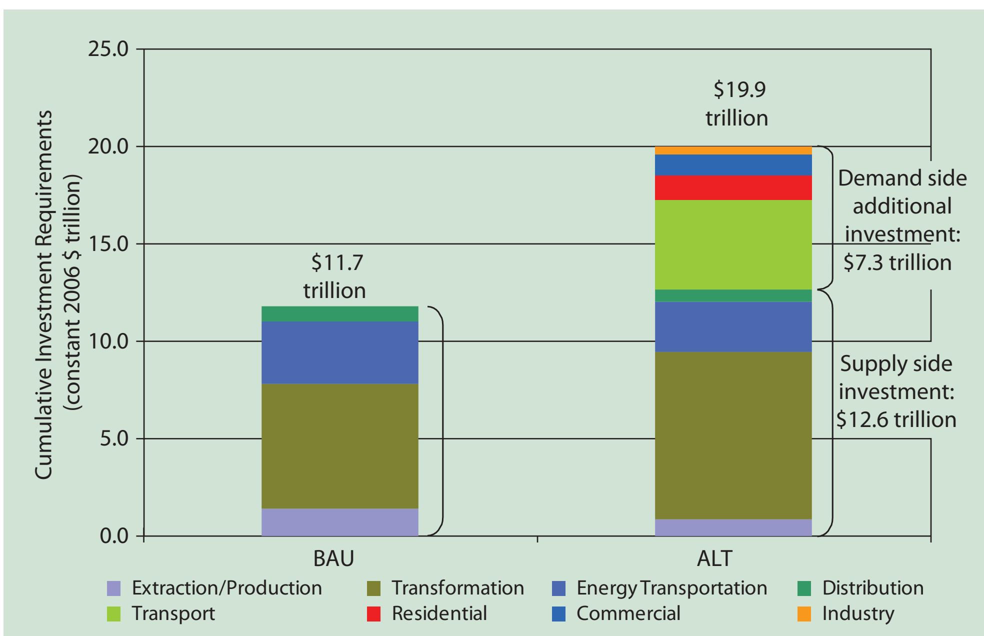
7.2 Energy Investment Outlook: Alternative Case

An analysis was conducted to consider the investment requirements for the alternative case. Aside from supply-side investments required for meeting the projected demand for upstream energy extraction and production, midstream energy transformation and energy transportation, and downstream energy distribution, the alternative case analyzed the "additional" investment requirements for energy savings in the transport, residential, commercial, and industry sectors.

Figure 7.4 shows the comparison of cumulative investments for the BAU case and the alternative case between 2010 and 2035. The alternative case investments include the supply-side investment needs along with the additional investments for energy savings in the final energy-consuming sectors. The alternative case investment requirements for Asia and the Pacific as a whole would amount to $19.9 trillion (constant 2006 prices). This represents a 69.2% increase compared with the BAU investment requirements.

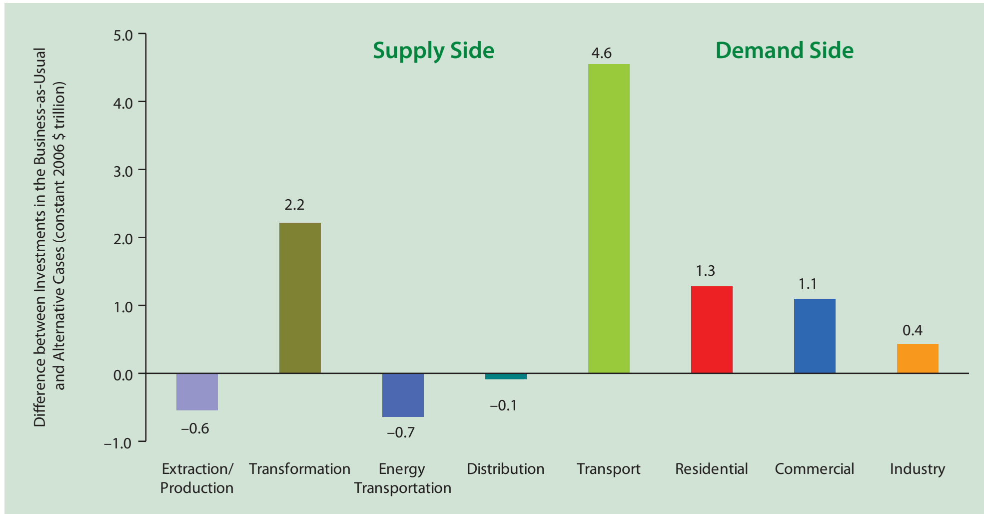
Meanwhile, energy savings can be generated in the alternative case. Primary energy demand for coal, oil, and natural gas could be reduced by as much as 1,704.2 Mtoe in 2035. Assuming international energy prices of coal ($120 per ton), oil ($135 per barrel), and natural gas ($13 per

Figure 7.4 Comparison of Investment Requirements in Asia and the Pacific for the Business-as-Usual and Alternative Cases (Cumulative, 2010–2035)



ALT = alternative case, BAU = business-as-usual case.

Figure 7.5 Difference between Investments in the Business-as-Usual and Alternative Case, by Sector



million British thermal units),[13] the benefits of fossil fuel savings for the outlook period could reach a cumulative amount of $6.2 trillion.[14] Despite the benefits, it is important to note that net additional investment for the alternative case will be higher than BAU by $1.9 trillion.

Figure 7.5 shows the differences between the BAU and alternative case investments between 2010 and 2035 by sector. On the supply side, investment into extraction and production will be lower by $0.6 trillion in the alternative case since it is assumed that some members will reduce upstream investment to cope with the lower potential exports of oil, coal, and natural gas. Transformation would require additional investments of $2.2 trillion in the alternative case because of the assumed deployment of higher thermal efficiency technologies (ultra-supercritical coal-fired generation and advanced combined-cycle technologies). Meanwhile, investments in energy transformation (such as oil/gas pipeline, tanker, and LNG facilities) as well as in distribution will be lower in the alternative case, respectively, by $0.7 trillion and $0.1 trillion, because of lower exports and imports due to energy savings.

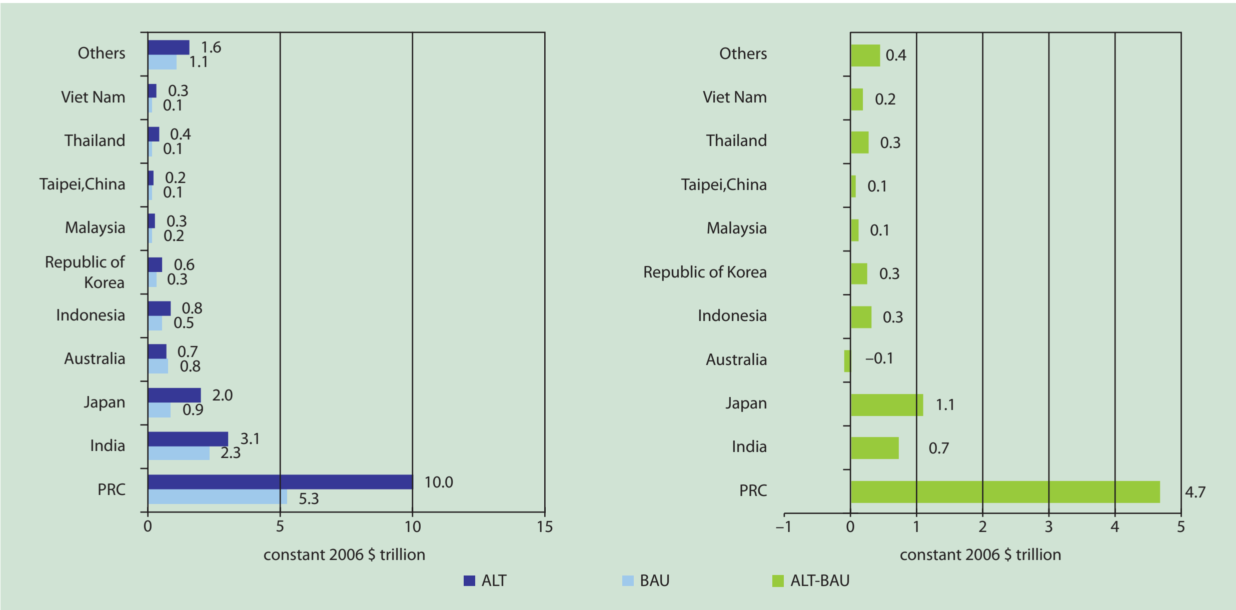
In contrast, substantial additional investments are required for the demand side, with transport (for fuel-efficient vehicles) requiring the biggest additional investment at $4.6 trillion, followed by residential (for efficient appliances and space heating) at $1.3 trillion, commercial (for efficient appliances) at $1.1 trillion, and industry (for deploying the best available technologies) at $0.4 trillion.

Figure 7.6 (left) shows the BAU and alternative investment requirements of the top 10 members, whose investment requirements represent 90.5%–92.1% of the requirements in Asia and the Pacific. It is important to note that the differences between the alternative case investments and those in the BAU case (Figure 7.6, right) have different magnitudes and directions, depending on the member's energy exports and imports needs, magnitude of

[13] Coal, oil, and natural gas prices are based on IEA (2010).

[14] Benefits of fossil fuel savings are estimated based on the assumption that revenue can be generated from sales of the saved amount in the international market.

Figure 7.6 Comparison of (left) and Difference between (right) Investments in the Business-as-Usual and Alternative Cases, by Member



ALT = alternative case, BAU = business-as-usual case, PRC = People's Republic of China.

shifts toward low-carbon-emitting power generation, and deployment/diffusion of energy efficient technologies for energy savings on both the supply and demand sides.

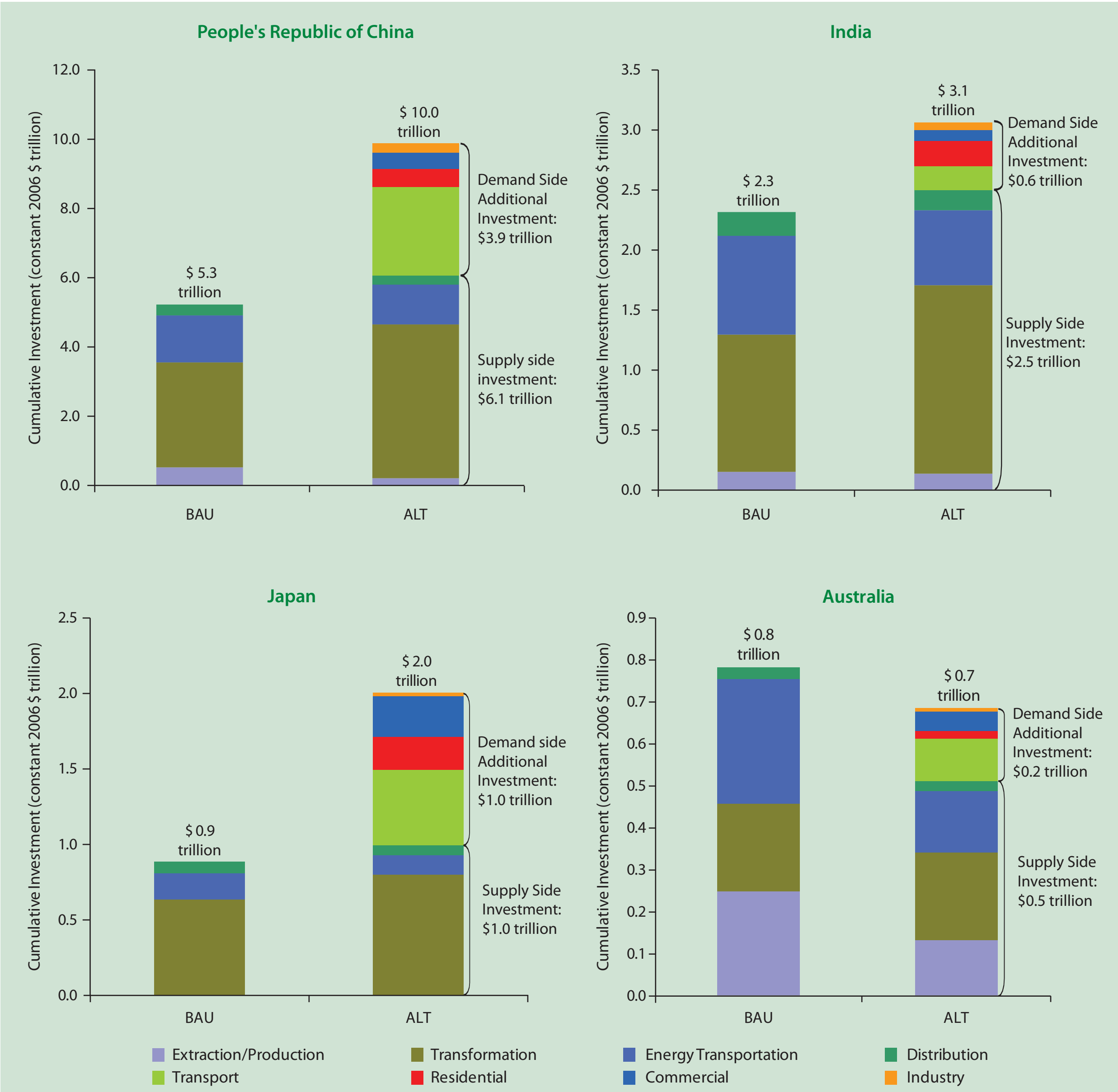
Taking the top four members (average between BAU and the alternative case), Figure 7.7 shows a comparison of the BAU case and the alternative case in terms of energy investment requirements. The figure shows the differences in sectoral investment requirements in the BAU case and the alternative case.

In the PRC, the required investment in extraction/production is lower in the alternative case due to reduced needs for coal production (by $0.3 trillion) due to energy shifts to low-carbon-emitting sources. However, substantial additional investment is required in transformation to meet the member's capacity expansion for nuclear, new and renewable energy, and thermal efficiency improvement from advanced coal-fired/natural gas-fired generation technologies (an increase of $1.4 trillion compared with BAU). The assumed deployment of fuel-efficient vehicles in the alternative case would translate into an additional investment of $2.6 trillion, followed by residential and commercial ($1.0 trillion) and industry ($0.3 trillion).

India's case shows that the projected differences in the alternative case investment relative to the BAU case are focused on additional investments in power generation resulting from shifts to low-carbon-emitting sources as well as deployment of advanced coal-fired and natural gas-fired generation units. The demand-side additional investments in the alternative case will amount to $0.6 trillion, broken down into residential ($0.2 trillion), transport ($0.2 trillion), commercial ($0.09 trillion), and industry ($0.06 trillion).

Japan's alternative case investments are divided into those for the demand side ($1.0 trillion) and the supply side ($1.0 trillion). On the supply side, transformation will require an additional

Figure 7.7 Comparison of Business-as-Usual and Alternative Case Investments for the People's Republic of China, India, Japan, and Australia



ALT = alternative case, BAU = business-as-usual case.

investment of $0.2 trillion in the alternative case, compared with the BAU case, for the deployment of advanced power generation technologies and low-carbon-emitting generation units. On the demand side, the deployment of advanced technologies will result in substantial investments in the transport ($0.5 trillion), residential ($0.2 trillion), and commercial ($0.3 trillion) sectors, while the additional investments in the industry sector will be smaller by $0.02 trillion compared with the other sectors' additional investments. In the case of Japan, the deployment of efficient technologies in the industry sector is assumed in the BAU case to conform with Japan's top runner standards.

Unlike other member countries, Australia's alternative case investments will be lower than those in the BAU case, even though additional investments for energy savings are expected. The lower investment requirements in the alternative case are due to reduced investments for energy exports, mainly natural gas and coal. LNG exports in the alternative case are assumed to be lower by 18.2% compared with BAU, and coal exports will be 34.9% lower in view of the reduced demand in the alternative case in Asia and the Pacific.

7.3 Financing Implications

Asia and the Pacific's energy demand and energy exports and imports require varying levels of investment. The estimated burden of energy investments as a share of GDP—in the BAU case—tends to be high for rapidly developing members. These countries would have to introduce new infrastructure and energy transformation facilities as well as upgrade existing ones. Nevertheless, governments of these rapidly developing member countries tend to be constrained by tight fiscal conditions and cannot allocate sufficient investments for energy infrastructure development and renovation. Market reform has been undertaken in many of the regional member countries to increase the tariff on energy supplies to cover the cost of investment, though such efforts sometimes face political challenges. Steady progress in this regard is necessary to cope with the projected future investment requirements in the developing member countries.

The alternative case analysis suggests that substantial additional investments are required to save energy in the industry, residential, commercial, transport, and power sectors. Meanwhile, the estimated additional investments somewhat outweigh the estimated benefits of saving fossil fuels. Therefore, members are encouraged to prioritize investing in options that can generate maximum energy savings at the least cost.

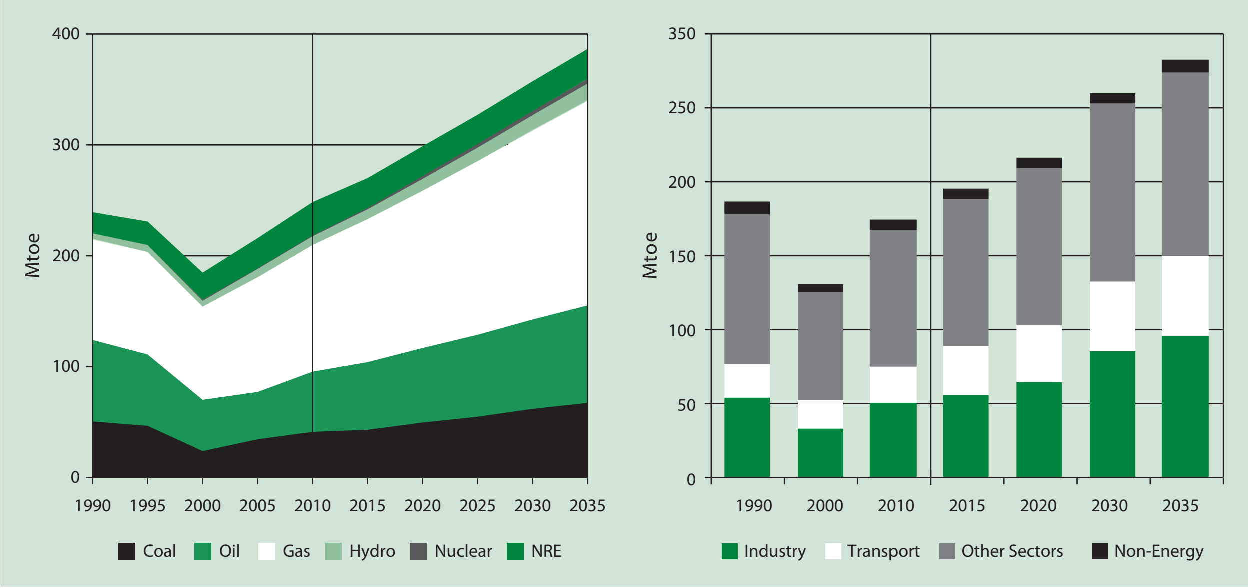
Chapter 8

Central and West Asia

Central and West Asia

- *In the business-as-usual (BAU) case, Central and West Asia's primary energy demand is projected to increase from 248.5 million tons of oil equivalent (Mtoe) in 2010 to 385.8 Mtoe in 2035 at an annual rate of 1.8% (Figure 8.1). Kazakhstan, Pakistan, and Uzbekistan will account for 80.4% of primary energy demand in Central and West Asia in 2035.*
- *In the alternative case,* the annual growth rate of primary energy demand would average 1.4% through 2035. Central and West Asia has the potential to save about 37.6 Mtoe in 2035 or a 9.8% reduction compared with the BAU case (Figure 8.2). Similarly, Central and West Asia's electricity generation will be reduced by 14.4% in the alternative case.*
- *Many of the members in Central and West Asia are faced with challenges in electricity supply due to facility deterioration and lack of rehabilitation and maintenance, which are caused by tight financial situations. To overcome this, the members in Central and West Asia are required continue making efforts in electricity sector reform, especially the tariff reform so that utilities can generate funds internally to install new facilities.*

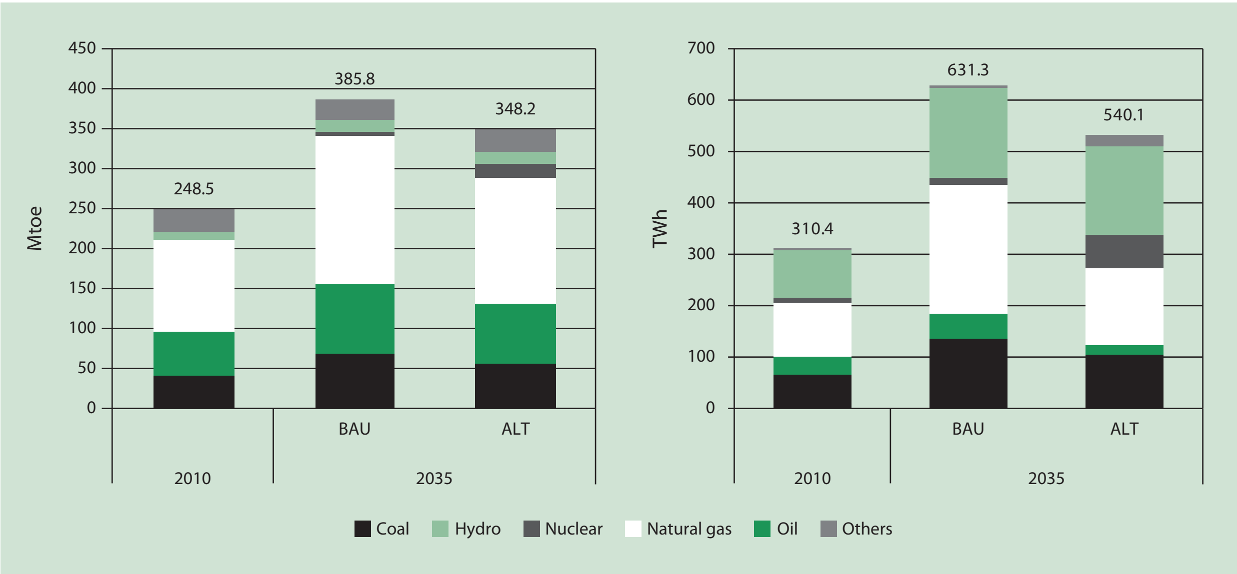
Figure 8.1 Primary Energy Demand (left) and Final Energy Demand (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

Figure 8.2 Business-as-Usual and the Alternative Case: Primary Energy Demand (left) and Electricity Generation (right)



ALT = alternative case, BAU = business-as-usual case, Mtoe = million tons of oil equivalent, TWh = terawatt-hour.

8.1 Afghanistan

- *In the BAU case, the primary energy demand of Afghanistan is projected to reach 4.3 million tons of oil equivalent (Mtoe) in 2035, growing at an annual rate of 6.5%. With this growth, Afghanistan's per capita energy demand will reach 0.07 tons of oil equivalent (toe) per person, almost double that in 2010.*
- *In the alternative case,* Afghanistan's primary energy demand will increase at an annual rate of 6.0% through 2035. With this growth, Afghanistan's primary energy demand will reach 3.8 Mtoe, which is 0.5 Mtoe (or about 11%) lower than in the BAU case in 2035.*

Recent Energy Trends and Energy Policy Issues

Since Afghanistan's economy was severely damaged by civil war and political instability in the early 1990s, total energy demand plunged to 0.8 Mtoe in 1992. The repercussions of internal strife hindered the country's economic development in the 1990s. With attempts at political reconstruction supported by the international community starting in late 2001, Afghanistan's economy started to recover substantially with a double-digit annual growth rate, from $2.7 billion of gross domestic product (GDP) in 2000 to $9.1 billion (constant 2000 $) in 2010. Total primary energy demand bottomed out in 2002 at 0.5 Mtoe, which is less than half the level in 1990, but it has increased to 0.9 Mtoe in 2010.

Afghanistan is endowed with abundant natural resources: recoverable coal reserves of 73 million tons and proven natural gas reserves of 5 trillion cubic feet. However, access to these energy sources has been limited because the country's infrastructure was destroyed or deteriorated as a consequence of the civil war. Hence, the country relies on imported petroleum products and electricity, and domestic hydropower from facilities that were mostly built several decades ago. Currently, the electrification rate in households is less than 30%.

To utilize the energy resources available domestically, the Government of Afghanistan has put priority on natural gas development by expanding the supply network and increasing production, which would lead to reduced dependence on oil. In addition, the government is aware of the importance of improving power supply capacity for the country's development, as it is addressed in its power sector strategy. Rehabilitation of power infrastructure damaged by the war and expansion of installed capacity and the distribution network are considered urgent needs.

In the national development strategy (2008–2013), increasing the access of residential households to electricity in both urban and rural areas and rebuilding the electricity tariff system are planned. Enhancing renewable energy such as micro-hydro and solar is also

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

included in the strategy. In addition, the National Energy Supply Program was launched in 2012 to accelerate existing electricity projects; encourage new cost-effective investments in electricity generation, transmission, and distribution; and increase capacity to manage electrical production and distribution efficiently.

Owing to its favorable location, several energy transportation routes are planned to pass Afghanistan. In 2010, an agreement to build the Turkmenistan–Afghanistan–Pakistan–India (TAPI) pipeline was signed.

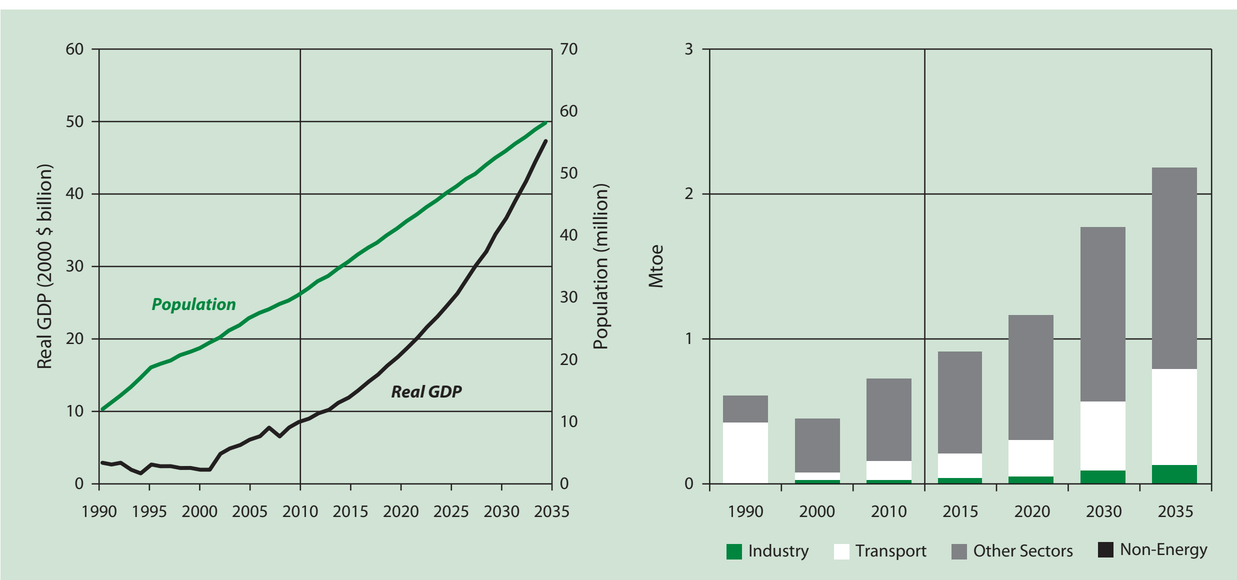
Business-as-Usual Case: Energy Demand Outlook through 2035

Over the outlook period, Afghanistan's real GDP is projected to increase at an annual rate of 6.8%. With this growth, GDP will be $47.7 billion (constant 2000 $), almost 5 times of that in 2010 (Figure 8.1.1). The population is projected to increase at a relatively fast pace of 2.6% per year through 2035, reaching 59.0 million in 2035 from 31.4 million in 2010. GDP per capita will rise from $290 in 2010 to $808 in 2035.

In the BAU case, Afghanistan's final energy demand is projected to increase at an annual rate of 4.5% to reach 2.2 Mtoe in 2035, almost triple the current level.

The energy demand of the other sectors (including residential, commercial, and agriculture) will moderately increase at 3.6% per year, but their share of Afghanistan's final energy demand will decrease to 63.9% in 2035 from 81.9% in 2010. Currently, nearly three-quarters of the other sectors' energy demand is for noncommercial biomass. Over the outlook period, biomass

Figure 8.1.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

demand will grow at a slow pace of 0.6% per year. Its share will drop to 36% in 2035. The electricity demand of the other sectors will increase at 7.5% per year through 2035, and its share will reach 63%.

In contrast, transport energy demand will increase at 6.8% per year over the outlook period, and its share will rise to 30.1% in 2035. Oil is the main energy source fueling the transport needs in Afghanistan, and its share will remain at nearly 100% over the outlook period.

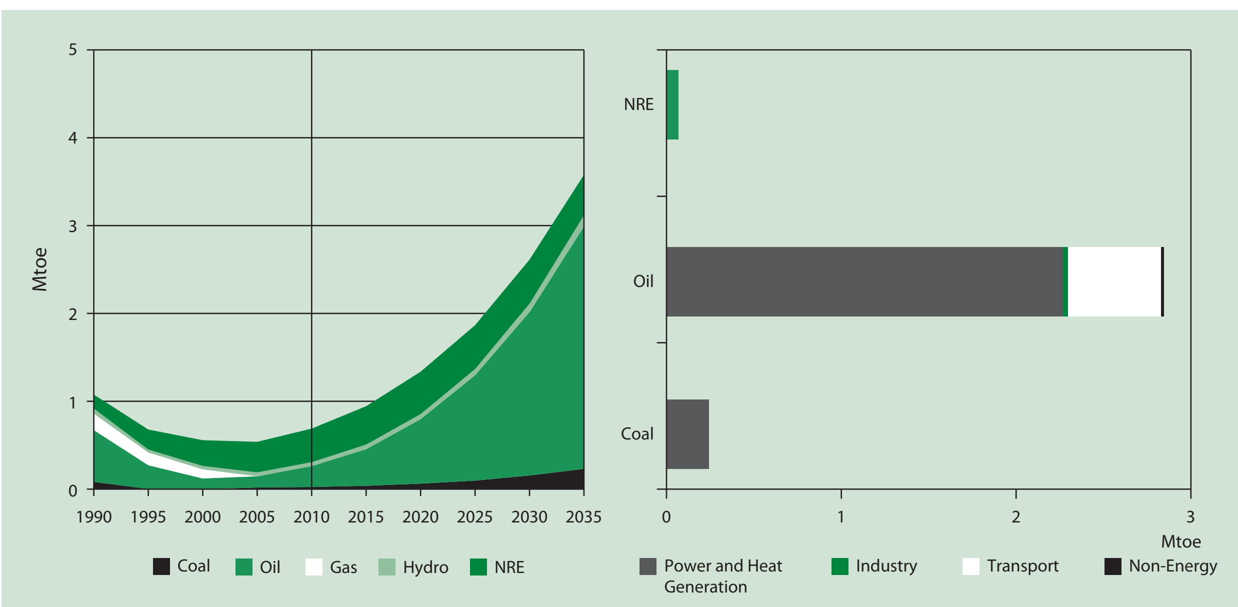
The energy demand of the industry sector will increase at 6.0% per year through 2035, but its share will still only be 6.0% in 2035. Within the industry sector's energy demand, oil demand will increase at 6.8% per year, and its share will rise to 29.3% in 2035, more than double that in 2010. Electricity demand will grow 5.0% per year, and its share will drop to 70.7% in 2035.

In the BAU case, the primary energy demand of Afghanistan is projected to reach 4.3 Mtoe in 2035, growing at an annual rate of 6.5%. With this growth, Afghanistan's per capita energy demand will rise to 0.07 toe per person, almost double that in 2010.

By energy type, oil demand will increase at a rapid pace of 10.3% per year over the outlook period, and its share will reach 73.3% in 2035, more than double the current level. Currently, biomass occupies more than half of the total primary energy demand; by 2035, its share will drop to 16.9%, and the average annual growth rate will be 1.2%.

The sectoral contributions to the incremental energy demand growth from 2010 to 2035 are shown in Figure 8.1.2. As is presented in the figure, oil will demonstrate the biggest incremental

Figure 8.1.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

growth at 2.9 Mtoe, mainly driven by the increased use in the power and transport sectors. The 0.2 Mtoe increase in coal demand will be led mostly the by power sector.

Alternative Case: Energy Savings Potential and Energy Source Diversification

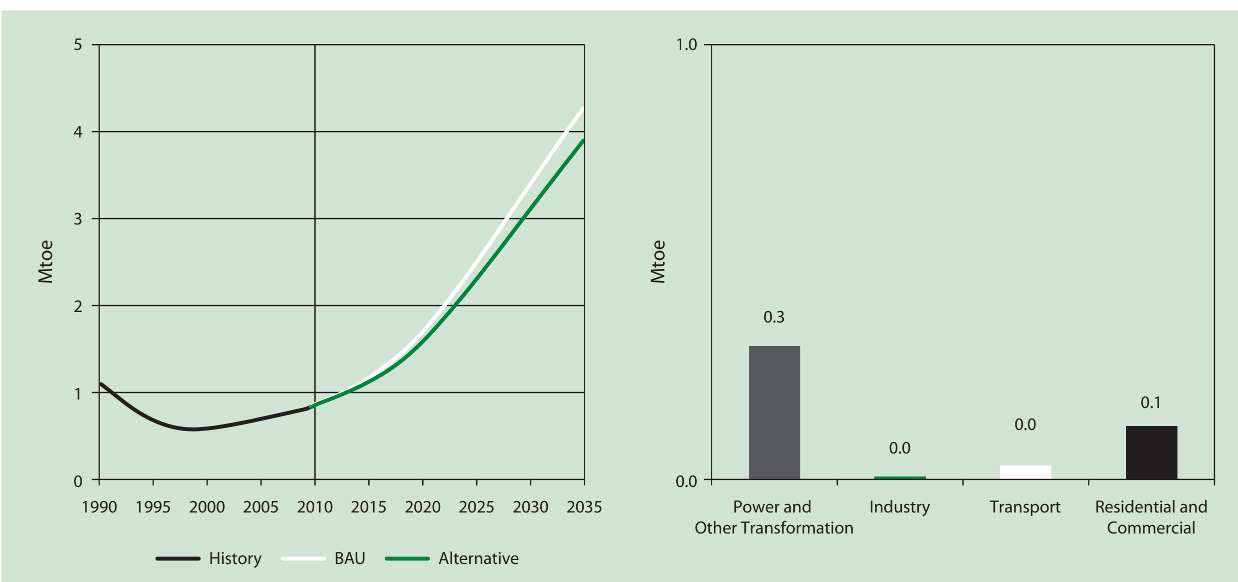
In the alternative case, Afghanistan's primary energy demand will increase at an annual rate of 6.0% through 2035. With this growth, Afghanistan's primary energy demand will reach 3.8 Mtoe, which is 0.5 Mtoe (or about 11%) lower than the BAU case in 2035 (Figure 8.1.3).

By sector, the power sector represents the biggest energy savings potential at 0.31 Mtoe in 2035, which is followed by residential and commercial at 0.12 Mtoe, transport at 0.03 Mtoe, and industry at 0.01 Mtoe.

The residential and commercial sectors' energy savings at 0.12 Mtoe in 2035 are mainly from electricity savings as a result of the deployment of efficient appliances. The major appliances that contribute to the electricity savings are lighting, refrigerators, and heaters.

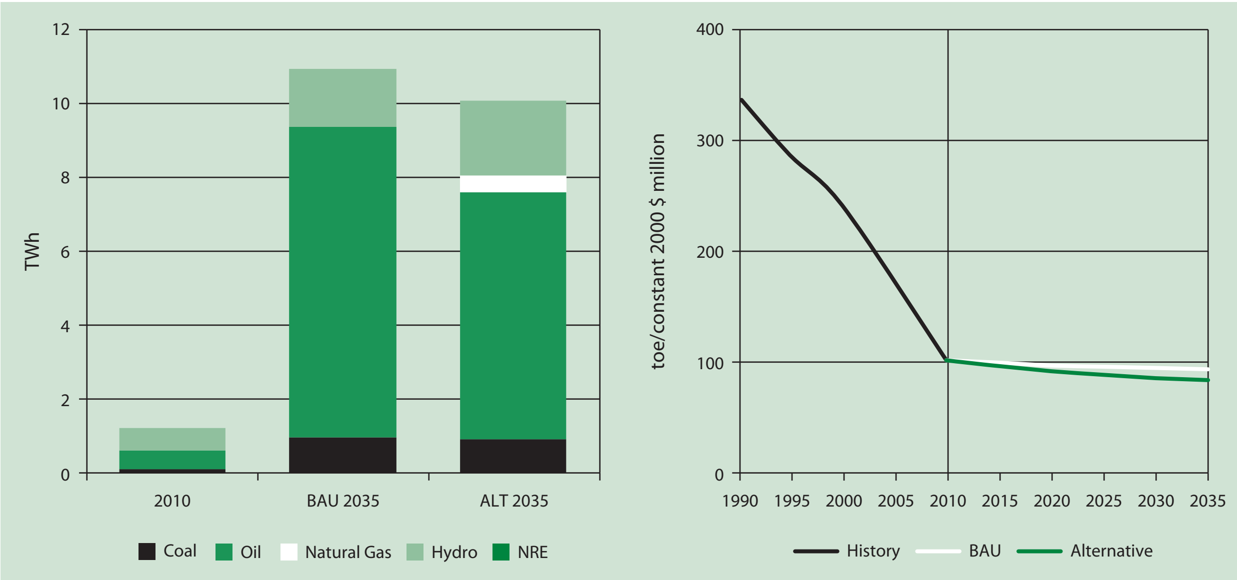
The power sector's energy savings mainly come from electricity demand savings and the increase of hydropower, which is assumed to have 100% conversion efficiency compared with that of oil-fired thermal plants at 30%. In the alternative case, Afghanistan's electricity generation in 2035 will be 10.1 terawatt-hours (TWh), 7.9% lower than in the BAU case at 11.0 TWh (Figure 8.1.4). Electricity generation from hydropower in the alternative case will reach 2.1 TWh in 2035, 27.1% higher than in the BAU case.

Figure 8.1.3 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Figure 8.1.4 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, toe = ton of oil equivalent, TWh = terawatt-hour.

Energy Policy Implications

Energy infrastructure is the key policy agenda item for economic development. Further expansion is necessary for economic development and improvement in living standards. Acknowledging the benefits of rebuilding infrastructure, the government plans to expand electricity capacity and the distribution network by using imported electricity and domestic resources like coal, natural gas, and hydropower.

However, Afghanistan's financial base is still too fragile to invest in such infrastructure development independently. Financial support from abroad, including from development banks and the private sector, is necessary for infrastructure rehabilitation and development. A strong government commitment—such as ensuring a stable political situation and developing an appropriate legal framework—is essential to improve the investment climate to facilitate infrastructure development.

Making full use of its advantageous location as a transit country linking energy-rich Central Asian countries with energy-deficient South Asian countries, Afghanistan can maximize the benefits from international energy transportation projects to help develop its domestic infrastructure and build capacity in the energy sector.

The major concern is the ongoing political instability in Afghanistan. Terrorist attacks often destroy the infrastructure supporting economic activities, such as electricity supply and roads. Such an unstable situation makes it difficult for investors to participate in the country's reconstruction. Ensuring political stability and security is as fundamental as developing the country's infrastructure.

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8.2 Armenia

- *In the BAU case, Armenia's primary energy demand is projected to increase from 2.4 Mtoe in 2010 to 7.2 Mtoe in 2035. In the alternative case,* with advanced technologies utilized for energy savings, it will reach 6.8 Mtoe in 2035 at a slightly lower growth rate of 4.2% compared with the BAU case. Armenia has a savings potential of 0.4 Mtoe, or a 5.7% reduction in primary energy demand.*
- To enhance energy security, it is essential for Armenia to reduce its heavy dependence on energy imports. Facilitating the use of indigenous sources such as new and renewable energy or small hydro may be effective in energy source diversification. While nuclear energy may also be a solution, there are security concerns surrounding its outdated facilities and location in earthquake-prone areas, and uncertainty regarding the financing for the construction of a new reactor, among others. Furthermore, rehabilitation of aging power infrastructure such as its transmission and distribution network, expansion of regional power trade, and enhancement of energy efficiency will help improve energy supply reliability.

Recent Energy Trends and Energy Policy Issues

With continuous double-digit gross GDP growth between 2002 and 2007, Armenia's primary energy demand increased 8.8% annually until the start of the global economic downturn in 2008. Repercussions were severe, mainly because Europe was the major export destination, and private investment plunged, which resulted in substantial losses in the construction sector, one of the major industries. The member's primary energy demand decreased by 13.2% in 2009 and 6.0% in 2010, although Armenia's economy was revived in 2010 after its GDP contracted by 14.1% in 2009.

Armenia relies heavily on energy imports due to limited indigenous energy resources. The country imports petroleum products and natural gas mainly from the Russian Federation via Georgia and Iran. Its geographical feature poses a latent threat to energy security. Surrounded by Azerbaijan, Georgia, Iran, and Turkey, the landlocked country shares borders only with Georgia and Iran on account of a blockade imposed by the other two countries that are embroiled in a political conflict with Armenia. In fact, Armenia suffered from energy supply interruptions on the Trans-Caucasus gas pipeline during the Georgia–Russian Federation dispute in 2008. Hence, it is critical for Armenia to enhance its energy security by diversifying energy sources. Armenia has strengthened its energy cooperation with Iran. In addition to launching natural gas imports from Iran in 2009, both countries plan to increase seasonal electricity swaps and construct a pipeline for petroleum products. In November 2012, Iran also agreed to transit gas from Turkmenistan to Armenia and Turkey. This could enhance Armenia's bargaining power vis-à-vis the Russian Federation regarding gas prices.

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

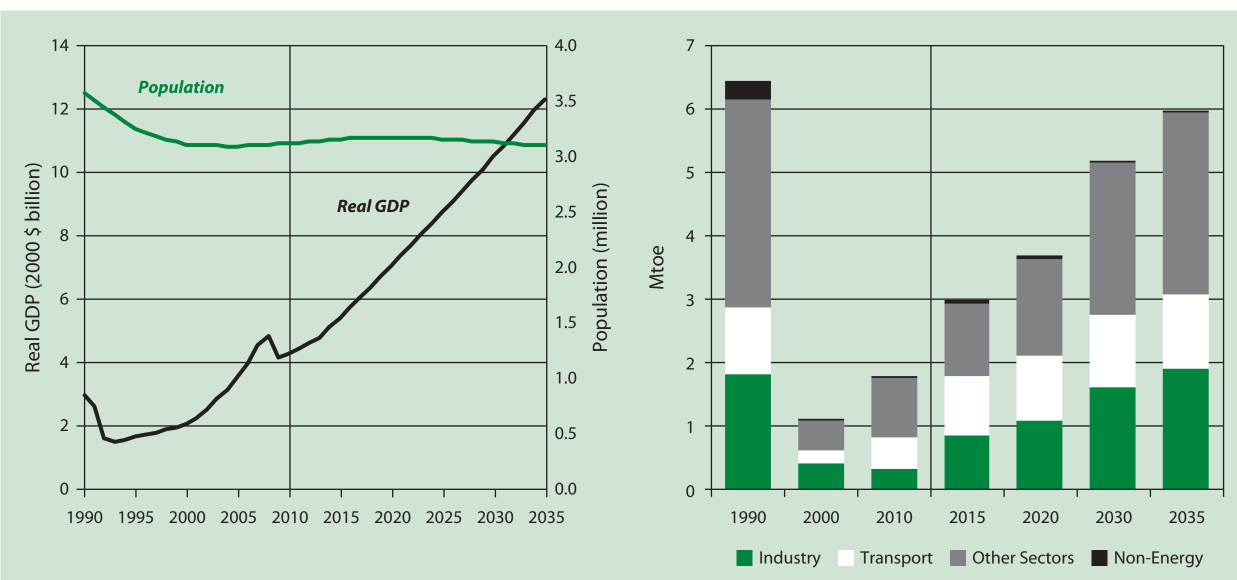
Nuclear energy is vital for Armenia's energy security but is associated with various uncertainties regarding the construction and financing of a new unit. Armenia has one operating reactor, Unit 2 of the Metsamor nuclear power plant, which was initially scheduled to close in 2016. Armenia has been under intensified pressure, especially from its neighboring countries, to shut down the unit swiftly due to its outdated facilities and location in a seismic zone. In October 2012, however, the Armenian government confirmed that the facility's operations would be extended to 2026, which will allow the member some time until a new unit is commissioned (World Nuclear Association website). Armenia plans to construct a new reactor (1,000 megawatts), originally by 2020, with support from the Russian Federation. Although the Russian Federation agreed to finance 50% of the cost of $5 billion, securing a finance source has been a challenge for Armenia, especially given the difficulty to raise end-user tariffs to cover the costs.

Business-as-Usual Case: Energy Demand Outlook through 2035

Armenia's GDP is projected to increase from $4.1 billion (constant 2000 $) to $12.1 billion in 2035 at an annual rate of 4.4% (Figure 8.2.1). Although the population will continue to increase at a slow pace of 0.2% per year until 2020, it will decrease gradually at almost same the speed after the peak. The population in 2035 will be slightly lower than the 2010 level. Consequently, Armenia's GDP per capita will almost triple to $3,953 in 2035 compared with the 2010 level of $1,327.

In the BAU case, Armenia's final energy demand is projected to increase robustly from 1.8 million tons of oil equivalent (Mtoe) in 2010 to 6.0 Mtoe in 2035 at an annual growth rate of 5.0% (Figure 8.2.1). By sector, the dominance of the other sectors (including residential, commercial, agriculture, and fishery) will remain over the outlook period, accounting for 48.1% in 2035. The industry sector will gradually expand its share and reach 31.8% in 2035, while the transport sector will account for 19.5%.

Figure 8.2.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

The energy demand from industry is projected to register the fastest rate of 7.5% per year, and natural gas will continue to occupy the majority of this sector. Armenia's major energy-intensive industries, such as mining and nonferrous minerals, will contribute to the gas demand increase.

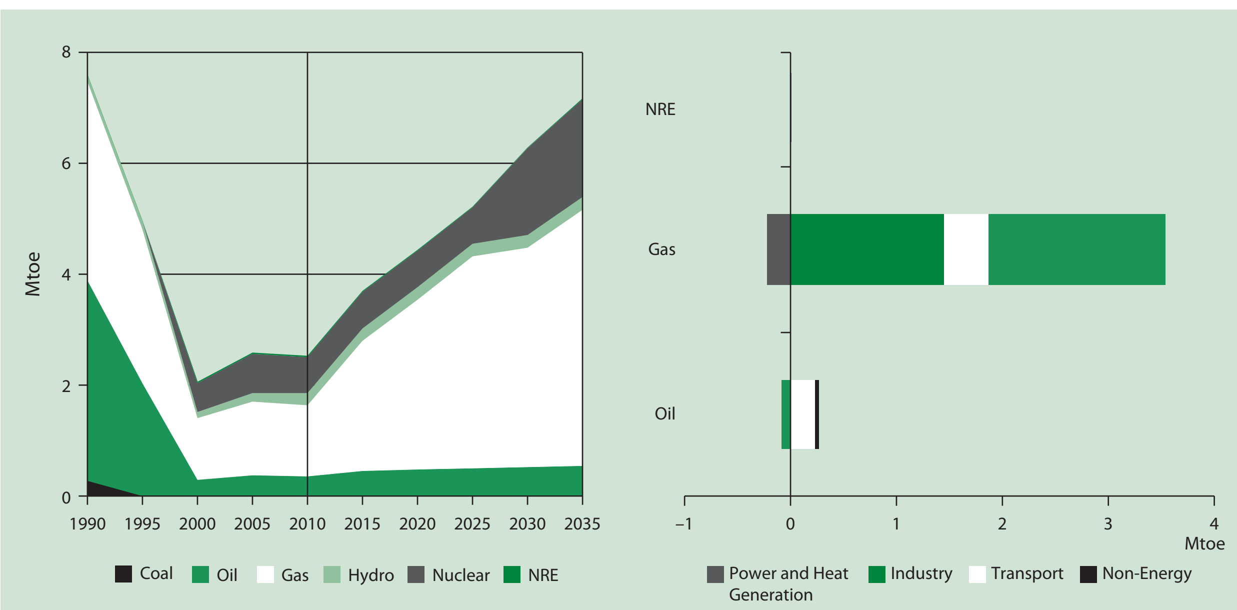
The energy demand of the other sectors will increase at a steady annual growth rate of 4.5% over the outlook period. Similar to the industry sector, natural gas, primarily used for space and water heating, will be the dominant fuel, accounting for 75.5% in 2035, followed by electricity at 21.9%.

The transport sector's growth rate will be the most moderate at 3.5% among the sectors between 2010 and 2035. For this sector, natural gas will remain as the leading fuel based on the assumption that use of natural gas vehicles will continuously expand.

With an average annual growth rate of 4.4%, total primary energy demand is projected to increase from 2.4 Mtoe in 2010 to 7.2 Mtoe in 2035 in the BAU case. Armenia's per capita energy demand will be 2.33 tons of oil equivalent (toe) in 2035, a substantial increase from 0.79 toe per person in 2010. A population decrease after 2020—in contrast to the energy demand increase—is likely to boost this rise.

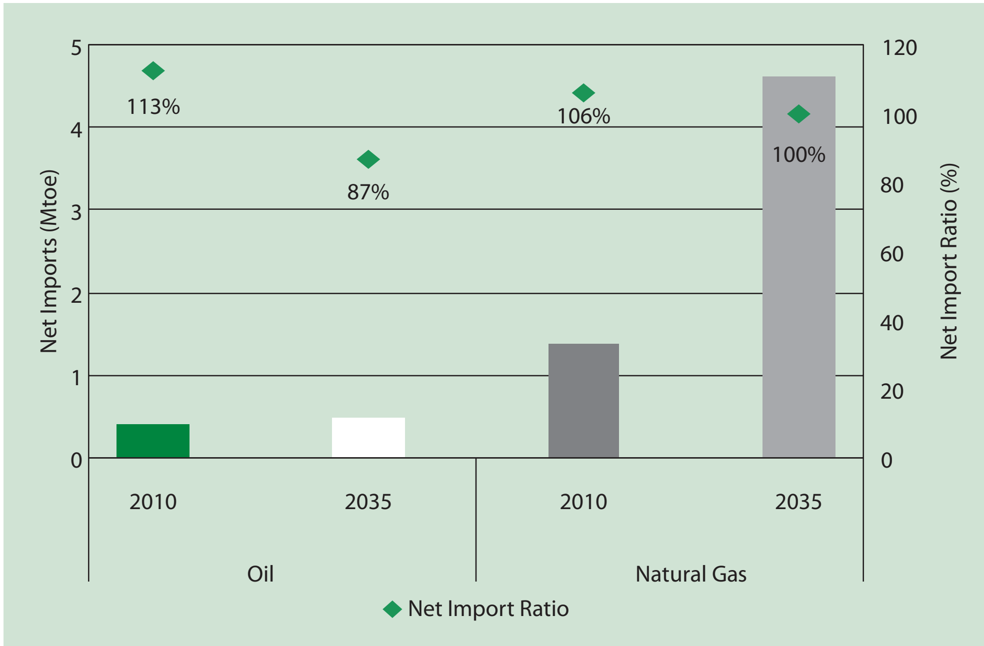
In Armenia's primary energy mix in 2035, natural gas will remain as the major energy source with a share of 64.5% through 2035, followed by nuclear at 24.6% and oil at 7.6%. While natural gas vehicles have become pervasive in the transport sector, the recent rapid gasification enabled households to use more gas for heating, which is less expensive than electricity-based heating. Still, there is room left for a gas network, especially in the rural areas where gas accessibility is lower than the country average of about 80% (Ersado 2012). It is assumed in this study that a new nuclear power plant will go online in 2026, which will increase the supply of electricity from nuclear energy.

Figure 8.2.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 8.2.3 Net Imports of Oil, and Natural Gas, and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

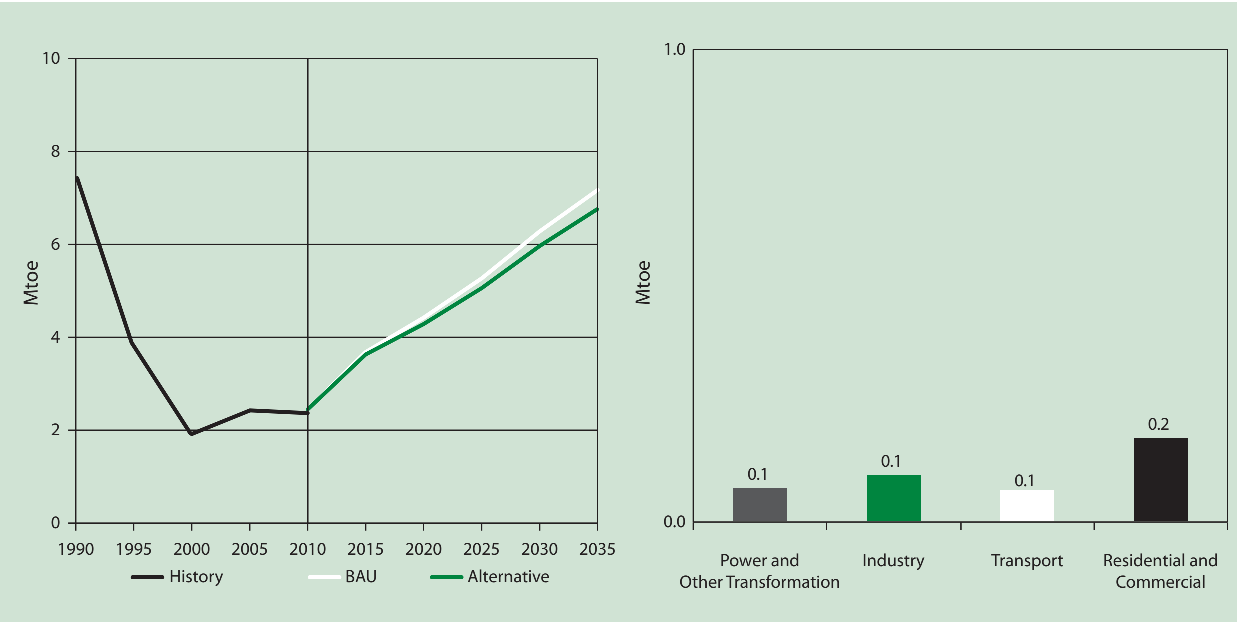
As Figure 8.2.2 on the sectoral contributions to the incremental energy demand growth from 2010 to 2035 shows, gas demand is projected to increase substantially by 3.3 Mtoe, with increased use in the industry, transport, and other sectors. By contrast, gas demand in power generation will decrease as a result of the commissioning of a new nuclear power plant. The transport sector is the main contributor to the incremental growth in oil demand.

With limited indigenous energy resources, Armenia's net import ratio is likely to stay high at around 100% through 2035 (Figure 8.2.3). While Armenia will import petroleum products and natural gas from Iran and the Russian Federation, it may gradually turn to Iran for energy imports. In exchange for electricity, Iran is expected to increase pipeline exports of natural gas to 224 million cubic feet per day (2,125 kilotons of oil equivalent [ktoe]) in 2020 (EIA website). In addition, the construction of a 365-kilometer oil pipeline linking Iran to Armenia is expected to be completed in 2014 and will carry 1.5 million liters of petroleum products per day (470 ktoe) for 25 years.

Alternative Case: Energy Savings Potential and Energy Source Diversification

In the alternative case, primary energy demand in Armenia will reach 6.8 Mtoe in 2035 at a slightly lower growth rate of 4.2% compared with the BAU case (Figure 8.2.4). Utilizing advanced technologies for energy savings, the estimated savings for Armenia will be 0.4 Mtoe or a 5.7% reduction in primary energy demand.

Figure 8.2.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Among the sectors, the other sectors (mainly residential and commercial) could have the biggest energy savings potential of 0.2 Mtoe in 2035. Approximately three-quarters of the estimated savings will be observed in home electric appliances such as lighting and refrigerators if advanced technologies are deployed to improve efficiency.[15]

The industry sector's energy savings potential will be the second largest at 0.1 Mtoe in 2035. The nonmetallic minerals industry will account for approximately 10.9% of the energy savings potential in 2035.

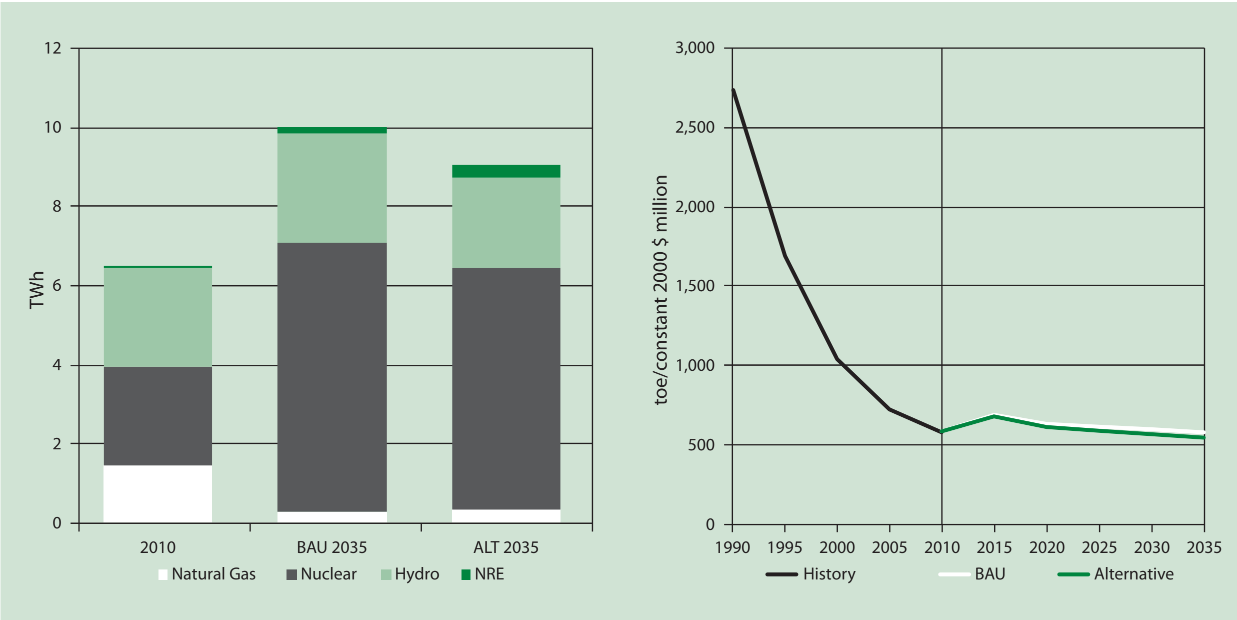
For the power sector, the lower electricity demand will result in reduced electricity generation. This indicates that deployment of upgraded technologies that improve energy efficiency for the final energy demand sectors may help the power sector reduce electricity generation, consequently yielding a bigger energy savings potential.

The transport sector's savings potential could be the smallest among the sectors, partially because compressed natural gas vehicles have already become popular in Armenia. Still, potential savings could be raised if electric and similar vehicles could make inroads into the car market.

Figure 8.2.5 shows the power generation by fuel in 2035 for BAU and the alternative case. Power generation in 2035 in the alternative case will be reduced by 9.6% compared with BAU, brought about by efficiency improvement in the industry and other sectors (mainly residential and commercial). For both scenarios, nuclear energy will dominate the generation mix in 2035 if a new reactor successfully replaces the existing one by 2026. Power generation sourced mainly from natural gas is expected to meet the increasing electricity demand until then.

[15] With regard to space heating, insulation is assumed to be the same for both the BAU case and the alternative case.

Figure 8.2.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hours.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

In the alternative case, new and renewable energy is likely to expand its share slightly toward 2035. Armenia has put weight on the utilization of new and renewable energy as a way to increase domestic energy resources. Among others, there is potential for wind power, demonstrated by the Lori-1 wind power plant, which was introduced in 2006 and has an installed capacity of 2.6 megawatts (MW), followed by Iran–Armenia Wind Farm with an installed capacity of 30 MW.

As for primary energy per GDP, there is no stark difference between BAU and the alternative case due to the relatively small impacts of energy efficiency improvements. Energy intensity in 2035 will return to almost the same level as 2010 in the BAU case and will decrease at an annual growth rate of merely 0.3% in the alternative case.

Energy Policy Implications

Given its geopolitical features and limited indigenous energy resources, energy security enhancement is the key for Armenia. It is essential to reduce the heavy dependence on energy imports since the country is exposed to energy supply disruptions and fuel price fluctuations. As one way to cope with this issue domestically, facilitating the use of indigenous sources such as new and renewable energy or small hydro may be effective in energy source diversification. Nuclear seems a viable option for energy independence; however, reliance on one energy source may not ensure energy security in view of the need for regular maintenance to ensure safety. In other words, the possibility of a power shortage has to be taken into consideration if the nuclear power plant is not commissioned as planned or its operation is brought to a halt due to technical difficulty.

In addition, the replacement or repair of obsolete energy infrastructure such as gas pipelines and the electricity transmission and distribution network will help improve the reliability of the energy supply because the new or rehabilitated infrastructure will enlarge the energy transport capacity. However, this implies that Armenia will face the other challenging task of securing finance sources for energy infrastructure improvements.

Last but not least, expansion of regional power trade with Georgia and Iran will strengthen Armenia's electricity exchange capacity. Currently, there are two projects to construct a transmission line connecting Armenia with the two neighbors; a 400-kilovolt single-circuit line with Georgia and a 300-kilometer Armenia–Iran 400-kilovolt double-circuit line. For instance, when construction of the Armenia–Iran transmission line is completed, the volume of power swapped will rise from 350 MW to 1,200 MW.

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8.3 Azerbaijan

- *The primary energy demand of Azerbaijan in the BAU case, is projected to increase from 11.8 Mtoe in 2010 to 20.8 Mtoe in 2035 at an annual rate of 2.3%, compared with the alternative case at 18.9 Mtoe in 2035.*
- *Azerbaijan will continue to be energy self-sufficient, backed by its vast oil and natural gas resources. The country could also benefit largely from realizing its energy savings potential estimated in the alternative case,* to further enhance its energy security. Enhancement of policies, measures, and programs for energy savings on both the demand and supply sides will ultimately benefit Azerbaijan's socioeconomic development.*

Recent Energy Trends and Energy Policy Issues

With the opening of the Baku–T'blisi–Ceyhan oil export pipeline and its rich oil and natural gas resources, Azerbaijan registered double-digit average GDP growth rates as high as 18% per year, starting from 2004 to 2010. This pipeline delivers oil resources to the Mediterranean Sea port in Turkey by way of Georgia from the Azeri–Chirag–Gunashli (ACG) field in the Caspian Sea. Oil production expanded to 1.03 million barrels per day mb/d in 2010 compared with the 1997 level of 0.183 mb/d when Azerbaijan's oil production hit bottom. Along with the increase in oil exports, there was an economic boom in the non-export sector, led by the construction, banking, and real estate sectors (Energy Charter Secretariat 2011). Meanwhile, in the recent past, Azerbaijan's GDP growth slowed to 9.3% for the period 2008–2009 and 5.0% for the period 2009–2010, for different reasons in the respective years: in 2009 due to slower growth in the construction sector, and in 2010 due to the fact that oil production was maintained at almost the same level as in 2009 in order to enhance safety on the oil drilling platform.

While the country's GDP registered double-digit growth from 2004 to 2010, the primary energy demand declined on average at an annual rate of 1.2%. In fact, this was a result of various factors as the investigation into the energy demand by sector shows a different trend. For example, the energy demand of the other sectors (including residential, commercial, agriculture, and fishery)—the main energy consumer in Azerbaijan—remained constant, whereas the increase in natural gas demand resulting from the country's gasification efforts was offset by the decrease in electricity demand caused by the tariff level increases.[16]

The energy demand of the industry sector maintained a decreasing trend and was eventually surpassed by the energy demand of the transport sector, due mainly to the growth in demand for road transport.

Azerbaijan adopted the State Programme for the Development of the Fuel and Energy Sector (2005–2015) to fully meet the country's electricity demand using domestic energy sources and

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions the same as in the BAU case. Please refer to Table 1.1 for more details.

16 Azerbaijan's electraicity tariff increase took place in 2007 for the first time since 1997, raising to $0.075 per kWh in 2007 from $0.024 per kWh in 1997.

satisfy the energy needs through continued development. In fact, the electricity sector faced a number of challenges in meeting demand, including deterioration of power facilities, and lack of rehabilitation and maintenance caused by the tight financial situation of the electricity industry (ADB n.d.). To eliminate these challenges, gradual improvements have been taking place, including efforts toward tariff reform (ultimately to reach full cost recovery level in the medium term), and replacement of obsolete combined heat and power units by efficient combined-cycle gas turbines.

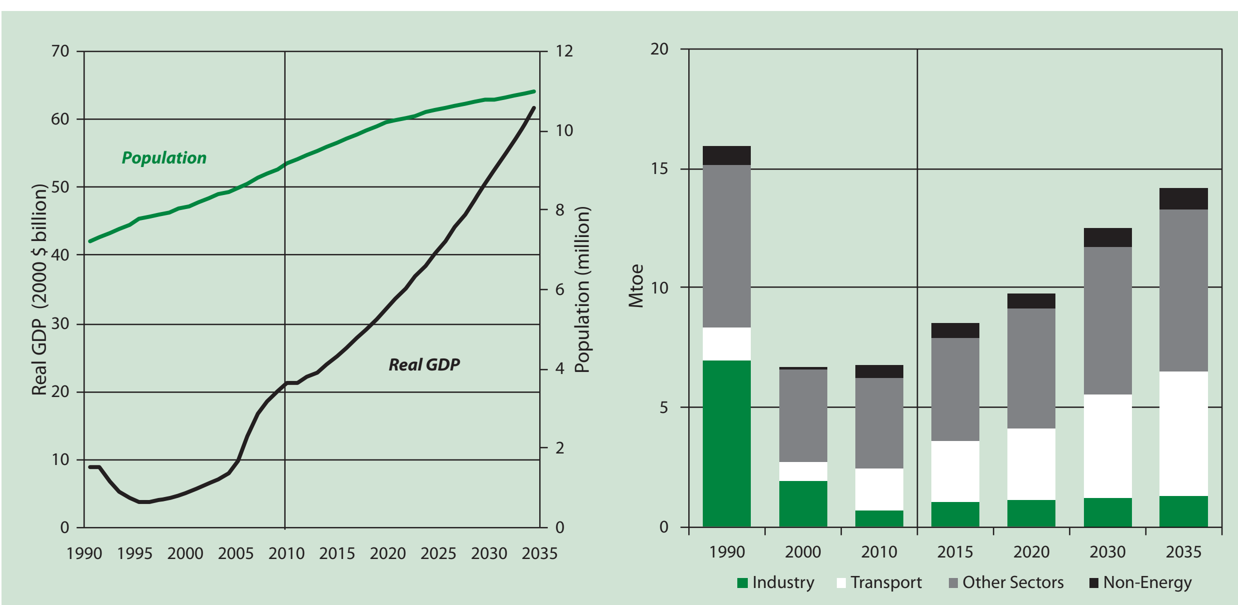
Business-as-Usual Case: Energy Demand Outlook through 2035

Over the outlook period, Azerbaijan's GDP is projected to increase from $21.2 billion (constant 2000 $) in 2010 to $61.9 billion in 2035 (Figure 8.3.1) at an annual rate of 4.4%. Azerbaijan's population will increase at a moderate pace of 0.7% through 2035, reaching 11.0 million from 9.2 million in 2010. As a result, Azerbaijan's per capita GDP will more than double from 2010 level at $2,311, reaching $5,605 in 2035.

In the BAU case, the final energy demand of Azerbaijan is projected to increase at 3.0% per year over the outlook period—a slower pace compared with the projected GDP growth rate of 4.4%. Sectoral energy demand offers a different growth pace with the transport sector representing the fastest pace at 4.0% through 2035, followed by industry (2.4%), other sectors (residential, commercial, agriculture, and fishery) at 2.3%, and the non-energy sector at 2.2%.

The overall energy demand of the other sectors will increase at an annual rate of 2.3%, though the growth trend varies by energy type. From 2007 to 2010, the other sectors' electricity demand has experienced a decline—due to tariff increases—but the trend is expected to rebound at an annual growth rate of 3.5% through 2035 as a result of income growth and deployment of more appliances. Gas demand growth will register a fast pace of 2.2% through 2035, with the

Figure 8.3.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

expansion in the infrastructure for city gas supply across the country. These energy sources will replace oil, which will decline by 0.7% between 2010 and 2035.

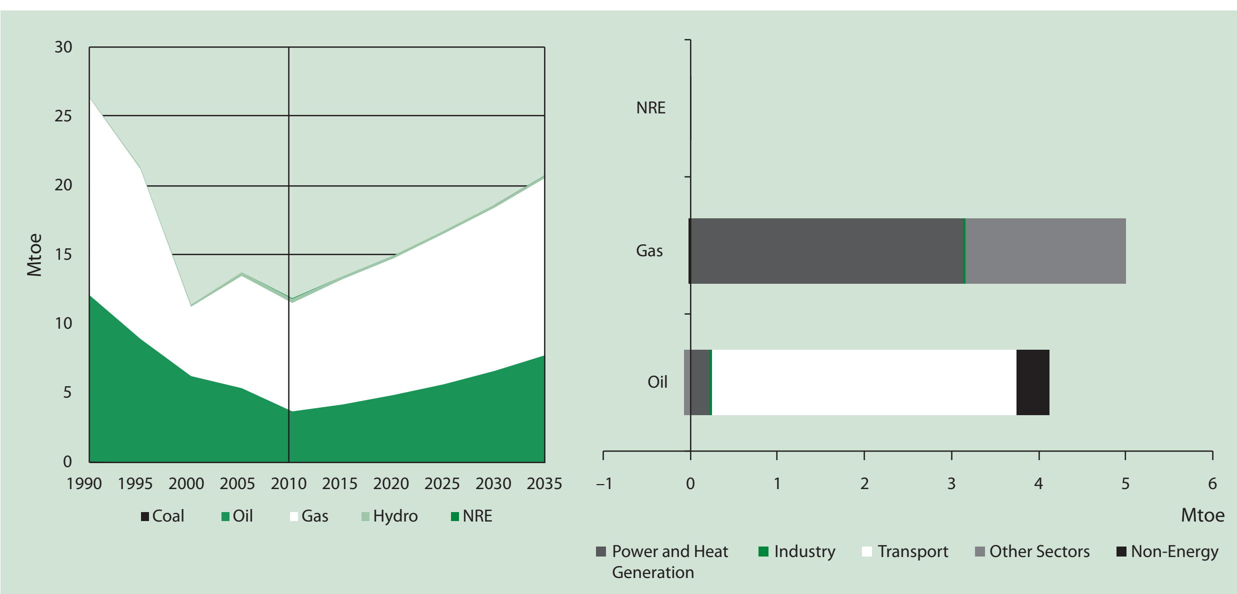
Starting from a low base, transport energy demand will register a fast growth rate of 4.5% through 2035. Near-term growth will be faster at 5.6% (2010–2020) than long-term growth at 3.7% (2020–2035). Motorization will drive the growth of Azerbaijan's transport energy demand. The country's vehicle stocks (including both passenger vehicles and freight trucks) are expected to reach 161.4 units per 1,000 population in 2035—more than double the 2010 level at 74.6 units per 1,000 population in 2010.

The industry sector's energy demand has been declining as a result of tariff increases, combined with a slowdown in chemical sector activity and contraction of investment, mainly in construction, while over the outlook period, industry energy demand will recover to increase at a relatively moderate growth of 2.3% per year.

In the BAU case, the primary energy demand of Azerbaijan is projected to increase from 11.8 Mtoe in 2010 to 20.8 Mtoe in 2035 (Figure 8.3.2) at an annual rate of 2.3%. In terms of the energy type, natural gas will maintain the largest share at above 60% through 2035, of which demand will be driven by the power and other sectors. The share of oil will increase to reach 37.4% in 2035 from 31.4% in 2010, driven by the increased oil demand from the transport sector.

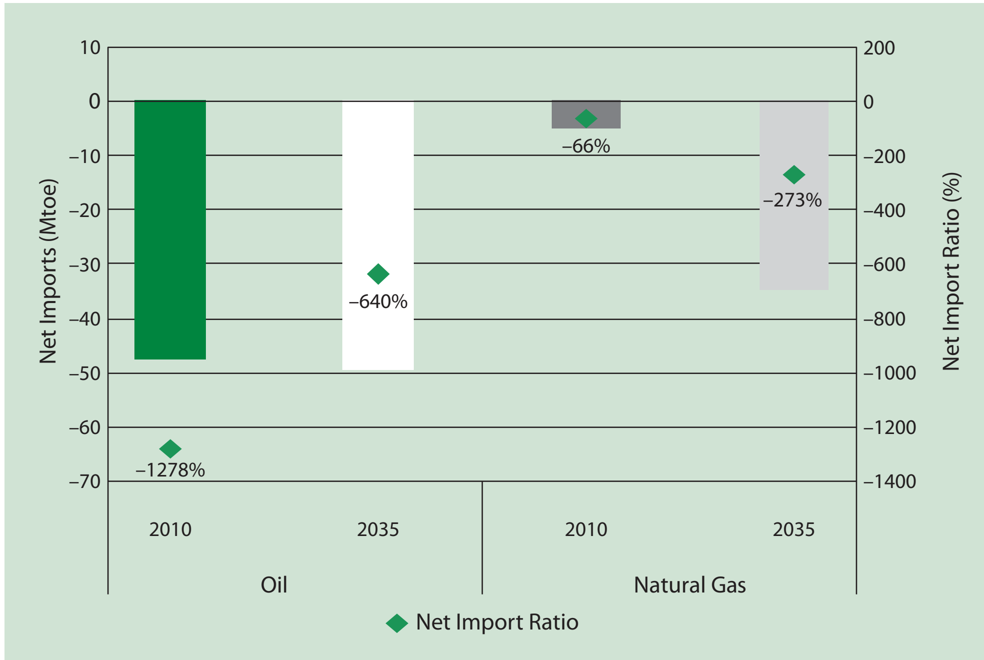
Azerbaijan will maintain its net export position in oil and natural gas over the outlook period, producing well above the country's domestic demand level (Figure 8.3.3). With the production increase in the ACG oil field, Azerbaijan's oil production will peak at 1.4 mb/d by 2015, while the production of the ACG oil field will decline from 2020 onward; therefore, overall oil production will decline to 1.26 mb/d in 2035. Natural gas production will expand from 15 billion cubic meters (bcm) in 2015 to 22 bcm in 2035 with the increased production from Shah Deniz field.

Figure 8.3.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 8.3.3 Net Energy Imports and Net Energy Imports Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

Alternative Case: Energy Savings Potential and Energy Source Diversification

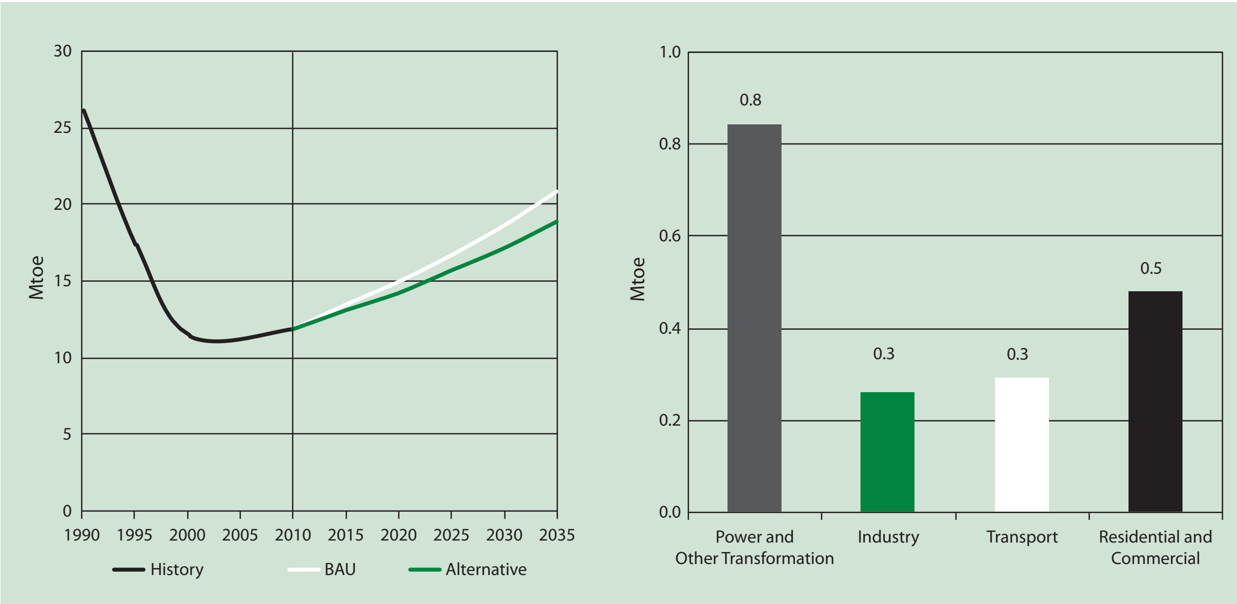
Deployment of advanced technologies will result in substantial energy savings for Azerbaijan. In the alternative case, primary energy demand is projected to increase at an annual rate of 1.9% through 2035, reaching 18.9 Mtoe in 2035 (Figure 8.3.4). This compares with the annual growth rate of primary energy demand of BAU at 2.3% during the same period. The slower energy demand growth in the alternative case will result in energy savings of about 1.9 Mtoe in 2035 (or 9.0% lower than BAU), which is comparable to the combined total of industry and non-energy demand at 2.2 Mtoe in 2035 in the BAU case.

By sector, the power sector is expected to represent the biggest energy savings at 0.8 Mtoe in 2035, followed by residential and commercial at 0.5 Mtoe, transport at 0.3 Mtoe, and industry at 0.3 Mtoe.

The power sector's energy savings are a result of the combination of two factors: electricity demand reduction and thermal efficiency improvement of generation units. The impacts of electricity savings will be much larger at 60% of the sector's savings in 2035. The remainder is from the thermal efficiency improvement. The deployment of advanced combined-cycle gas turbines, shifting away from the obsolete combined heat and power units, will elevate the average thermal efficiency of Azerbaijan from 34% in 2010 to 43% in 2035 in the alternative case.

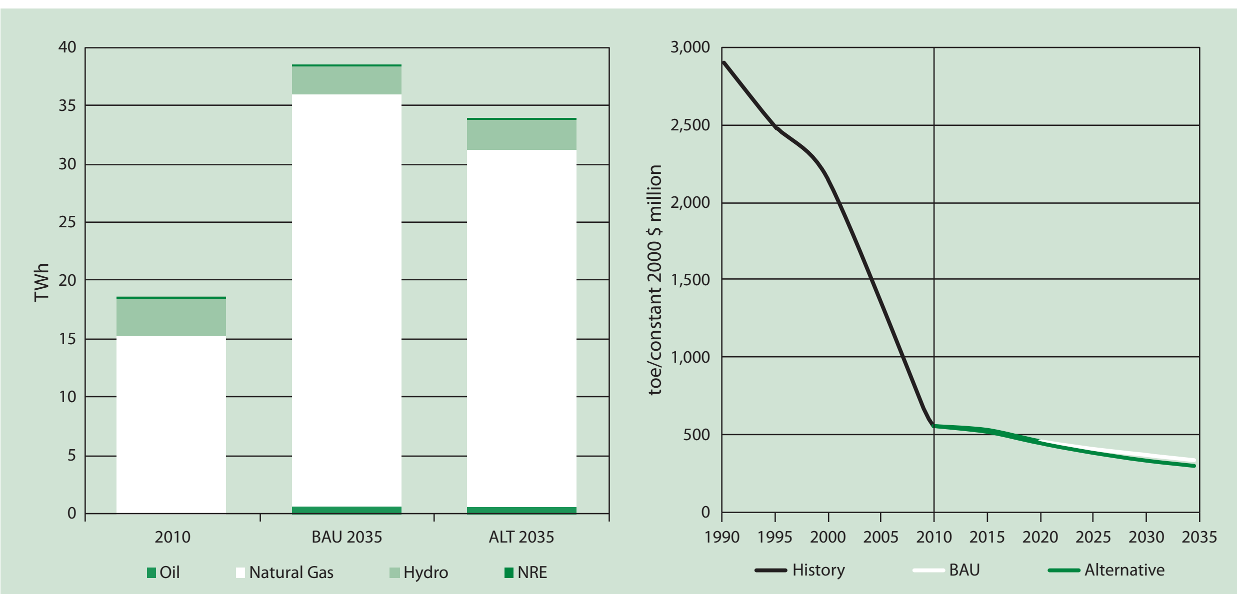
The residential and commercial sectors will represent the second-largest energy savings at 0.5 Mtoe in 2035. The introduction of efficient lighting in the residential sector is the major contributor to its energy savings, followed by the efficiency improvement of refrigerators and water heaters.

Figure 8.3.4 Comparison of Primary Energy Demand (left), and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Figure 8.3.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hours.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

In the alternative case, Azerbaijan's electricity generation in 2035 will be about 12% lower at 33.9 TWh in 2035, compared with that of BAU at 38.5 TWh (Figure 8.3.5). The savings will mainly result from electricity demand savings in the industry, residential, and commercial sectors. Despite the lower electricity generation requirements, electricity generation in 2035 will be nearly 80% higher than in 2010 in the alternative case.

By energy type, electricity generation in the alternative case is almost identical to that of BAU in 2035, with a slight contraction of the natural gas share in 2035 at 90.5% compared with BAU at 91.8%, and a minor increase in the share of new and renewable energy in the alternative case at 0.6% in 2035, in contrast to BAU at 0.1% in the same year. The State Program on Use of Alternative and Renewable Energy Resources in the Azerbaijan Republic was approved by presidential decree in 2004, focusing on hydropower and wind projects. However, the projects are currently curtailed by limited financial availability. Because of the country's cost competitiveness in hydrocarbon resources, prospects for introducing more new and renewable energy sources are low, even in the alternative case. The installed capacity for wind energy may stay at 106 MW (reflecting the ongoing projects in Sitalcaj and Baku, and planned projects in Shrabad and Gobustan) in 2035.

Energy Policy Implications

The recent tariff reform has had some impacts on energy demand savings. Nevertheless, in the long run, economic growth and subsequent improvement in living standards will continue to drive the energy demand growth of Azerbaijan. Although the country will maintain its net export position in oil, natural gas, and electricity through 2035, in recognition of its importance as the main driving force of the economy, it is important for Azerbaijan to recognize the impacts from energy savings to effectively allocate them for export purposes. According to the analysis, Azerbaijan could save about 1.9 Mtoe of primary energy by 2035, half of it coming from power sector savings. Aside from the energy savings from the shifts to combined-cycle gas turbine technologies from combined heat and power and rehabilitation of aging transmission and distribution networks on the supply side, the magnitude of impacts coming from demand-side electricity savings needs to be well noted. Enhancement of policies, measures, and programs will ultimately benefit Azerbaijan's socioeconomic development.

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8.4 Georgia

- *As Georgia's industry sector will shift to less energy-intensive industries like the services industry, Georgia's primary energy demand will grow slowly in the BAU case, at an annual growth rate of 1.5%, reaching 4.5 Mtoe in 2035.*
- *In the alternative case,* with advanced technologies for energy savings, primary energy demand will increase to 4.2 Mtoe with an annual growth rate of 1.2% through 2035. Compared with the BAU case, Georgia has the potential to save about 0.3 Mtoe in 2035, or an 8% reduction in primary energy demand.*

Recent Energy Trends and Energy Policy Issues

During the Soviet era, the economy of Georgia was composed of production of ferro-alloys, ferrous scrap, ores, and agricultural goods such as tea, wine, and fruit for export to neighboring countries. However, Georgia was forcefully faced with an economic downturn due to the several political disruptions after the Soviet breakup (Ministry of Foreign Affairs of Japan 2010).

Georgia experienced positive economic growth in recent years averaging at 5.2% (2005–2010), but the global economic slowdown affected the country's economy, resulting in a negative GDP growth rate of –3.8% for 2008–2009. The start-up of the Baku–Tbilisi–Ceyhan pipeline in 2006—the second largest oil pipeline in the world, transporting offshore crude oil from the Caspian Sea to the coast of the Mediterranean via Georgia—boosted the economy as it has attracted foreign direct investment for infrastructure development as well as brought in transit earnings. Moreover, the South Caucasus natural gas pipeline, transporting Azerbaijan's natural gas from Shah Deniz field, transits Georgia en route toward the European market. One estimate suggests that the pipeline transit fee could reach $62.5 million annually (Papava 2005). Georgia is expected to play an important role as the pipeline transit country as well as trade hub, building on its location at the crossroads of Europe and Asia.

Contrary to the economic growth, the primary energy demand of Georgia grew slowly from 2.8 Mtoe in 2005 to 3.1 Mtoe in 2010, growing at an annual rate of 1.9%. Meanwhile, final energy demand registered an annual growth of 3.3% during the same period. Efficiency improvement in the transformation sector (mainly in power generation) offset the growth in sectoral energy demand.

Energy intensity (primary energy demand per GDP) declined to 553 tons of oil equivalent (toe) per million constant 2000 dollars in 2010 compared with 1,514 toe per million constant 2000 dollars in 1990, reflecting the decline in the production of Georgia's heavy industries due to the collapse of the Soviet Union and the shift toward the services industry.

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* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

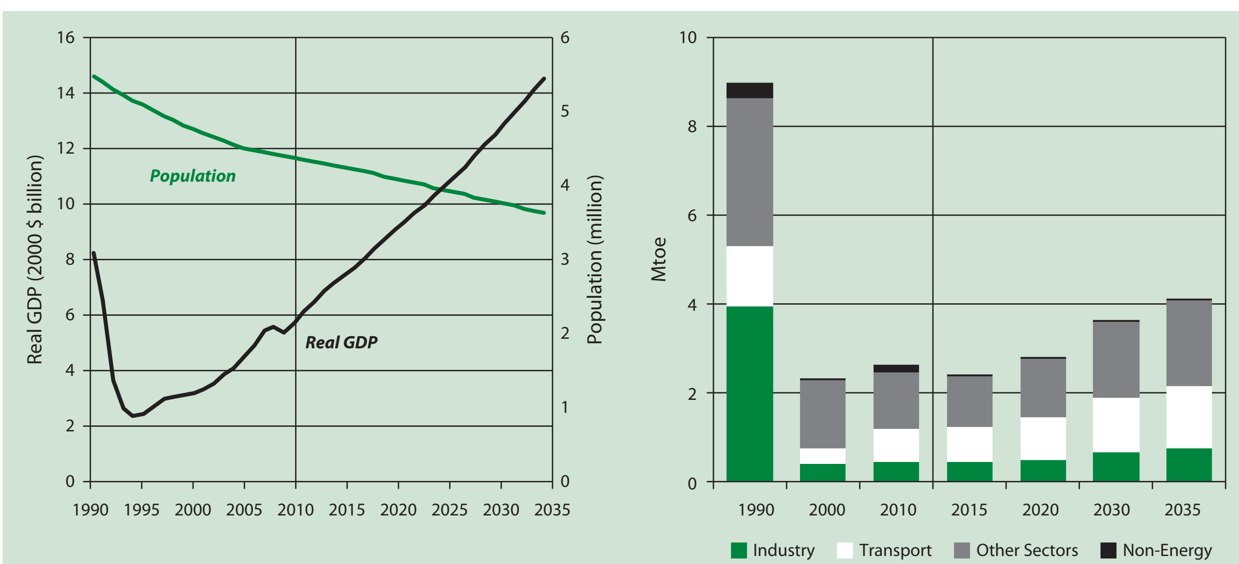
Business-as-Usual Case: Energy Demand Outlook through 2035

Georgia's GDP is projected to increase steadily from $5.6 billion (constant 2000 dollars) in 2010 to $14.6 billion in 2035 (Figure 8.4.1) with an average annual growth rate of 3.9%. Meanwhile, the population will decrease moderately over the outlook period from 4.4 million in 2010 to 3.6 million in 2035. Accordingly, Georgia's GDP per capita will reach $4,071 in 2035, which is about 3.1 times higher than the 2010 level at $1,295, and Georgia will become one of the middle-income economies in the world.

In the BAU case, Georgia's final energy demand is projected to grow at 1.5% per year between 2010 and 2035. In terms of share of the energy demand by sector, the "other sectors" (including residential, commercial, and agriculture) have the largest share at 48.8%, followed by transport at 28.9%, and industry at 16.6% in 2010. The ranking order for the share of each sector will stay the same over the outlook period with the other sectors at 47.2%, followed by transport at 35.0% and industry at 18.1%.

Transport sector demand, which is expected to register the largest growth during the outlook period, will be driven by the rising demand for private vehicles in line with increasing affluence in the country. Meanwhile, the industry sector will have the smallest share next to the non-energy sector. Regarding the industry sector's activities, although the export of mining products and energy-intensive products were previously the country's fundamental revenue streams, Georgia has been shifting its key industry to the other sectors, including earnings from the transport, materials, tourism, agriculture, and finance sectors. Thus, the combined total value added from the industry sector is less than one-third the level observed during the Soviet era, which affects the energy demand structure in Georgia.

Figure 8.4.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

Primary energy demand is projected to grow at 1.2% per year, from 3.1 Mtoe in 2010 to 3.1 Mtoe in 2035 in the BAU case. With structural change from energy-intensive to less energy-intensive industries, Georgia's energy intensity (energy demand per million constant 2000 $ GDP) will decrease from 553 toe per GDP in 2010 to 310 toe per GDP in 2035. On the other hand, per capita energy demand will increase from 0.72 toe per person in 2010 to 1.26 toe per person in 2035 due to people seeking material affluence and due to population decline.

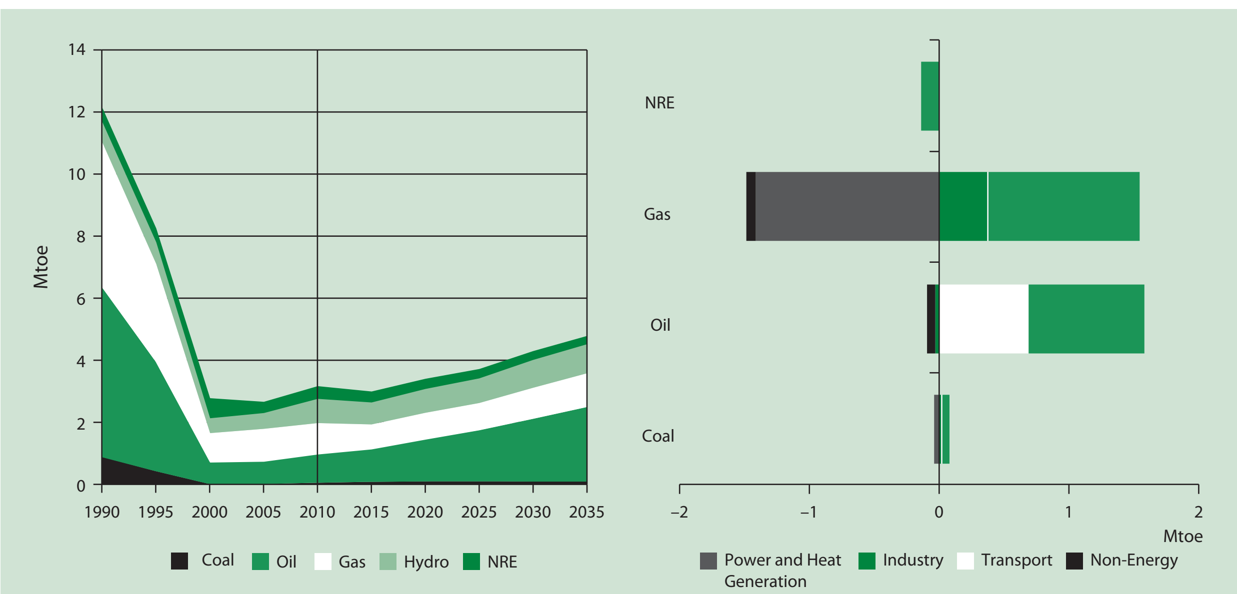
As for the breakdown of primary energy demand by energy source, the share of natural gas is currently the largest at 32.5%, followed by oil (30.5%) and hydro (25.8%). Over the outlook period, oil demand will grow 3.8% per year—a faster rate than the projected growth rate of total primary energy demand at 1.5%—and will account for more than half of Georgia's primary energy mix in 2035.

In terms of the incremental energy demand growth from 2010 to 2035 (Figure 8.4.2), oil will demonstrate the biggest increase at 1.5 Mtoe, to which the transport and other sectors will contribute.

Natural gas in power and heat generation will decrease substantially because of thermal efficiency improvement in power generation, while natural gas in the other sectors will increase because of rising demand for heat supply.

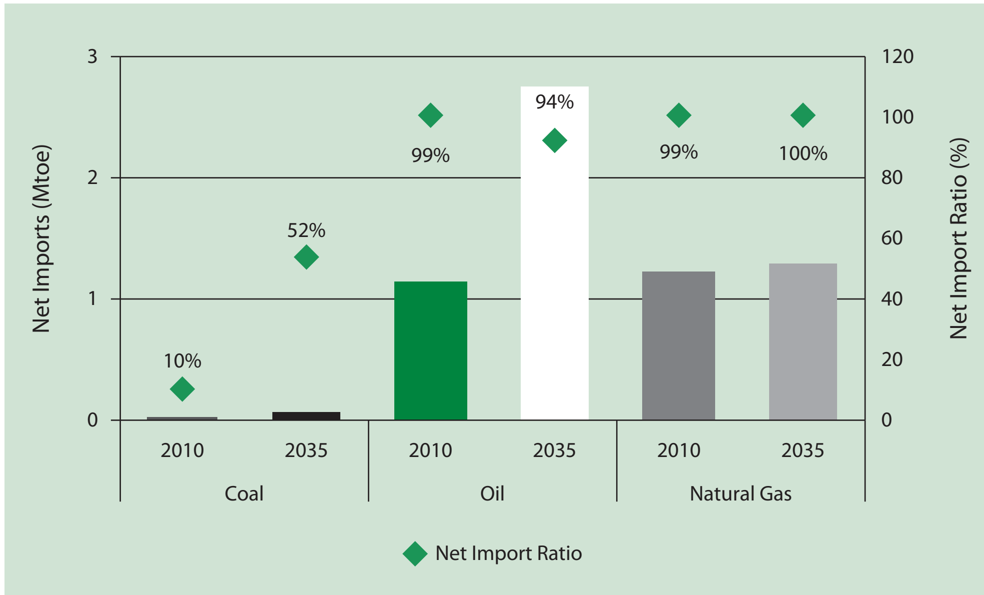
Georgia is endowed with a small amount of fossil fuel resources, and demand will need to be met by imports over the outlook period (Figure 8.4.3).

Figure 8.4.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 8.4.3 Net Imports of Coal, Oil, and Natural Gas, and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

Alternative Case: Energy Savings Potential and Energy Source Diversification

In the alternative case, primary energy demand in Georgia will reach 4.2 Mtoe in 2035 (Figure 8.4.4), growing at a slower annual growth rate of 1.2% (against 1.5% per year in the BAU case). Compared with the primary energy demand of the BAU case, the primary energy demand of Georgia in the alternative case is 0.3 Mtoe (or 7.7%) lower in 2035.

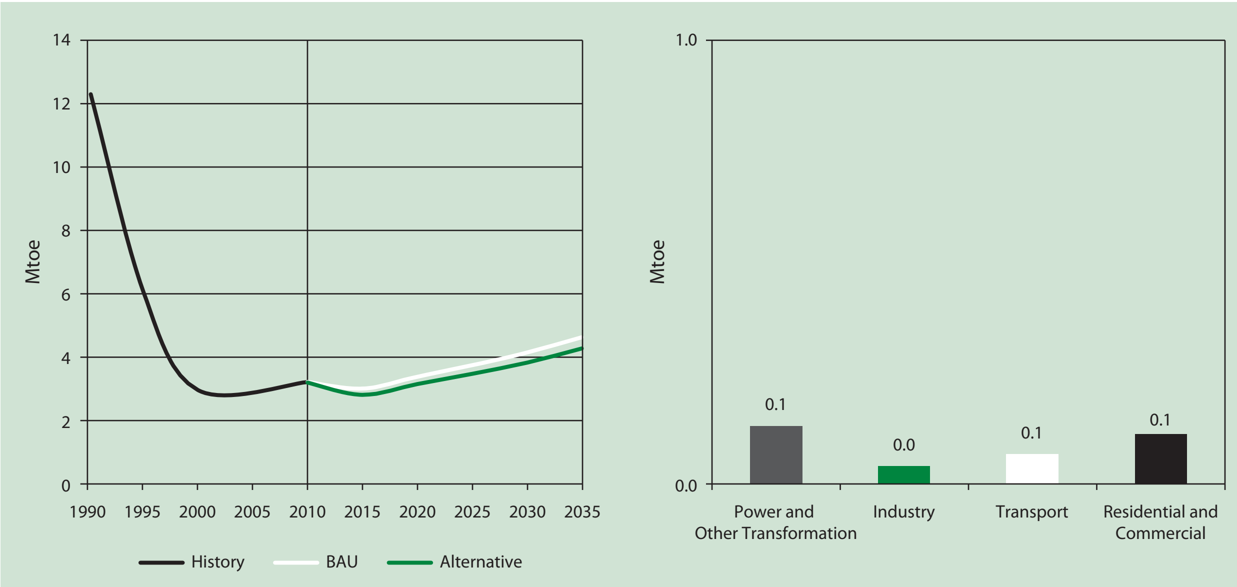
By sector, the power and other sectors indicate the biggest energy savings potential at 0.13 Mtoe. Most of the energy savings can be explained by the reduced power generation requirements while the amount from thermal efficiency improvement is relatively small.

The residential and commercial sectors indicate the second-biggest energy savings potential at 0.11 Mtoe. Utilization of more efficient appliances such as lighting and refrigerators mainly leads to the estimated potential savings. The transport sector follows with a savings potential of 0.07 Mtoe.

Electricity generation by energy type is compared between BAU and the alternative case in Figure 8.4.5. The total electricity generation in 2035 in the alternative case is approximately 4% lower than that of BAU, mainly because of efficiency improvements in the industry and other sectors.

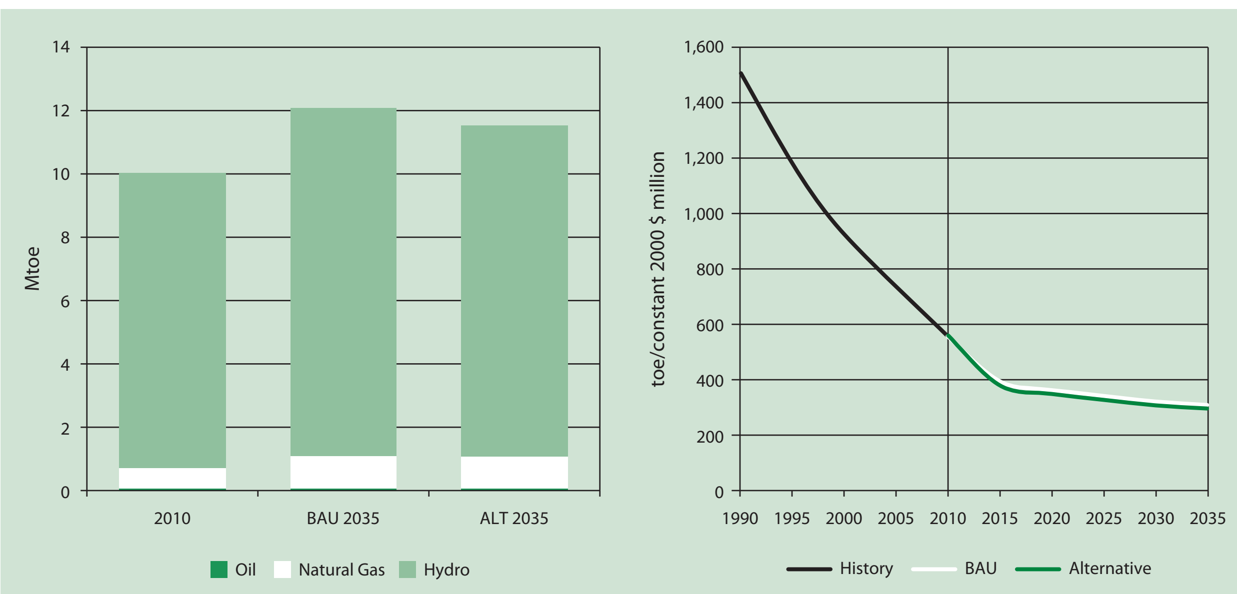
Hydro will remain dominant in the electricity generation mix through 2035 in both cases. Georgia is blessed with water resources and is highly dependent on hydropower generation, but there are seasonal power supply fluctuations. To overcome this issue, untapped hydro resources have to be continuously developed and small hydro in particular seems the most feasible option in terms of finance and technology.

Figure 8.4.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Figure 8.4.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hours.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Primary energy demand per GDP (i.e., energy intensity) will continuously decrease at a moderate pace. Energy intensity will improve at an annual rate of 2.3% in the BAU case and 2.6% in the alternative case. This slight difference is from the small scale of the energy savings potentials in the alternative case.

Energy Policy Implications

Georgia is endowed with limited fossil fuels and will continue to rely on energy imports from neighboring countries. To reduce energy import dependency and enhance the country's energy security, it is important for Georgia to strengthen its energy conservation measures, especially for energy transportation and distribution where losses are greatest. Additionally, improvement of the residential and commercial buildings' energy efficiency is essential, since they consumed the largest amount of natural gas for space heating in 2010. Setting energy efficiency standards for appliances, equipment, and buildings could enhance further energy conservation in Georgia over the outlook period.

With respect to international energy policy, Georgia is enhancing its international presence as a gateway for the Caspian Sea with a pipeline for the transport of crude oil and natural gas to European countries. Georgia is one of the transit countries of the Baku–T'blisi–Ceyhan and South Caucasus pipelines, which enable European countries to import Caspian oil and gas products without going through the Russian Federation. In addition, Georgia's national policy aims to enhance electricity exchange with neighboring countries for export of excess electricity and, in case of necessity, for its import. Georgia should also take advantage of its geopolitical location and is expected to provide energy transport infrastructure connecting Europe and Asia.

As a transit country, through cooperation with neighboring countries, it is important to ensure a stable energy supply as it can benefit Georgia's economy as well as that of its neighbors.

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8.5 Kazakhstan

- *In the BAU case, Kazakhstan's primary energy demand is projected to reach 108.0 Mtoe in 2035, increasing from 75.0 Mtoe in 2010. As a result, per capita primary energy demand will reach 5.97 toe in 2035—almost 6 times the average for Central and West Asia at 0.97 toe in the same year. In contrast, in the alternative case,* Kazakhstan's primary energy demand will reach 96.1 Mtoe in 2035. This represents a savings potential of about 11%.*
- *Additional routes and markets need to be secured to realize Kazakhstan's full potential in oil and natural gas production growth.*
- *As the Law on Energy Savings and Efficiency has been passed, sectorwide policy measures are required to achieve energy intensity reduction targets. These measures not only incentivize new technology deployment, but also shift people's attitudes toward energy conservation.*

Recent Energy Trends and Energy Policy Issues

Rich in energy resources of oil, coal, and natural gas, Kazakhstan's economy has been driven by its exports. Oil and other minerals accounted for 23% of GDP and 63% of exports in 2010. Although the global economic slowdown in 2009 had a negative impact on Kazakhstan, GDP growth rebounded to 7.3% for 2009–2010 and achieved an average growth of 6.2% per year between 2005 and 2010. The strong economic performance translated into a fast increase in primary energy demand at 8.1% per year during the same period. With this fast growth, Kazakhstan's primary energy demand recovered to 75.0 Mtoe in 2010—slightly higher than in 1990 at 73.4 Mtoe.

Kazakhstan's energy intensity (primary energy demand per GDP) reached almost 1,852 toe per dollar—three times as high as the Organisation for Economic Co-operation and Development (OECD) average in 2010. This is due to the dominance of energy-intensive resource extraction industries and obsolete energy supply infrastructure for power generation, industrial factories, and buildings.[17]

With continued economic growth and the resulting energy demand growth, Kazakhstan faces enormous challenges in upgrading its energy infrastructure and improving sectorwide energy efficiency. This is critical for sustainable use of domestic resources and increased export earnings.

To cope with the challenges, Kazakhstan passed the Law on Energy Savings and Energy Efficiency in January 2012. This sets targets of energy intensity reduction by 10% during 2008–2015 and 25% during 2008–2020. Meeting these targets would require concerted efforts across the sector to create conditions conducive to investments in advanced technologies, and to create policies to improve the operational aspects of energy consumption.

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* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions the same as in the BAU case. Please refer to Table 1.1 for more details.

[17] In fact, 45% of electricity assets in Kazakhstan are older than 30 years and are in need of replacement or upgrade.

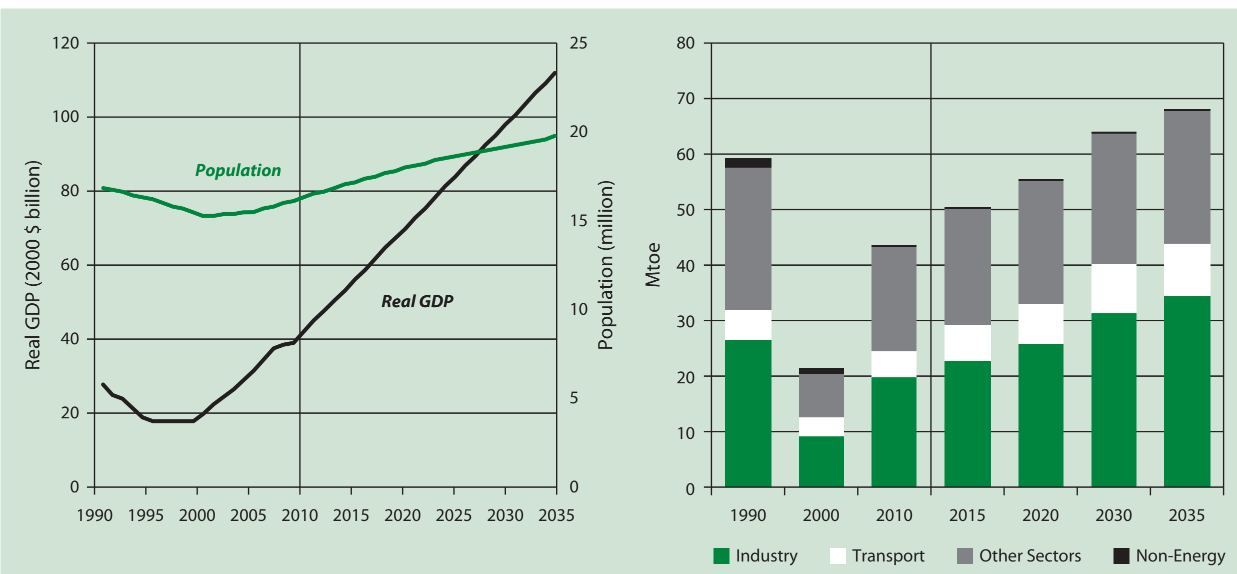
Business-as-Usual Case: Energy Demand Outlook through 2035

Driven mainly by the exports of mineral resources, Kazakhstan's GDP is projected to reach \$110.7 billion (constant 2000 \$) in 2035, increasing from \$40.5 billion in 2010 (Figure 8.5.1) at an annual rate of 4.1%. The population will increase moderately at 0.4% per year through 2035, reaching 18.1 million in 2035 from 16.3 million in 2010. As a result, Kazakhstan's GDP per capita will reach \$6,126, more than double the 2010 level of \$2,483.

In the BAU case, the final energy demand of Kazakhstan is projected to increase 2.1% annually—a moderate growth rate compared with 7.3% growth registered from 2000 to 2010. By sector, the industry sector will continue to dominate energy demand, accounting for 47.7% of the total final energy demand in 2035, followed by the other sectors (including residential, commercial, agriculture, and fishery) at 38.6%, transport at 13.2%, and non-energy at 0.5%.

The transport sector's energy demand is projected to grow the fastest, at 2.9%, to cope with the rising passenger and freight transport requirements neededto integrate the economic activities within the vast land area and to facilitate the transboundary transport of goods and services. By contrast, the other sectors' energy demand will grow moderately at 1.6% through 2035. Meanwhile, the other sectors' electricity demand will grow relatively fast at 3.6% through 2035 as a result of the improvement in living standards. The industry sector's energy demand is projected to increase at a moderate pace of 2.2%, but growth trends differ by energy type. Electricity and natural gas use will increase fast at 3.5% and 2.9%, respectively, as shifts from coal occur with the growth in manufacturing near natural gas deposits in the western region, and with the development of electricity transmission lines to integrate the resource-rich north with the south.

Figure 8.5.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

In the BAU case, the primary energy demand of Kazakhstan is projected to increase from 75.0 Mtoe in 2010 to 108.0 Mtoe in 2035 at an annual rate of 1.5%. With such steady growth, Kazakhstan's per capita energy demand will increase from 4.60 toe per person in 2010 to 5.97 toe per person in 2035, which is comparable to the Central and West Asia average at 1.05 toe per person in 2035.

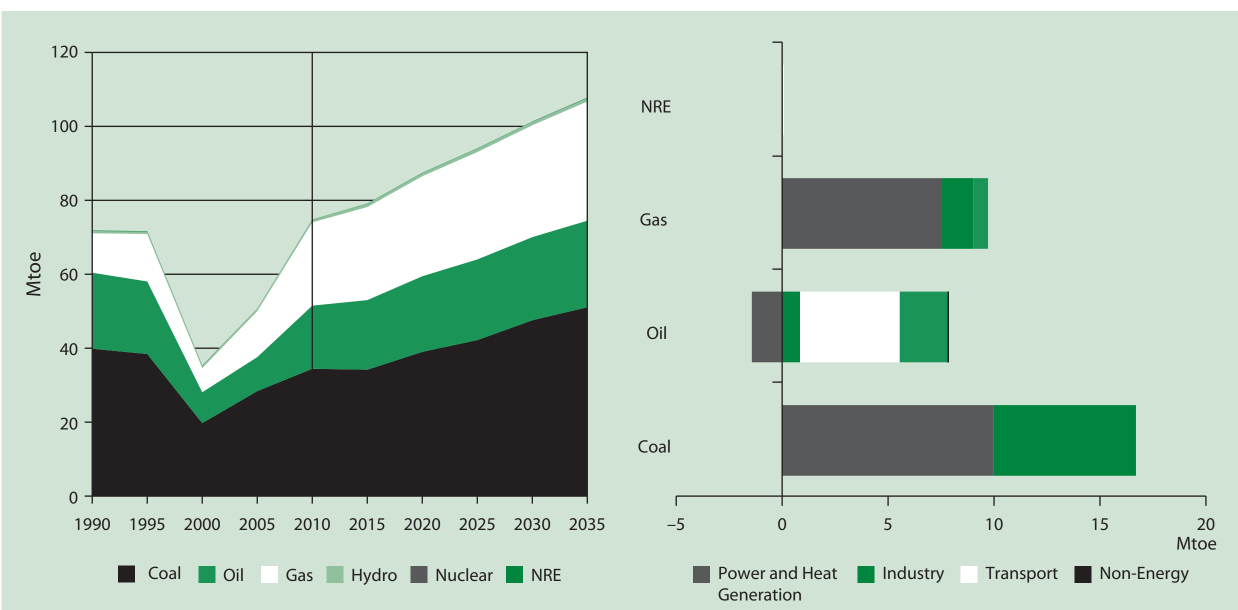
By energy type, currently Kazakhstan's primary energy mix is dominated by coal (at 46%), followed by natural gas (30%) and oil (23%) in 2010. The mix of energy will not change substantially by 2035 as dominance of coal will continue (47%), followed by natural gas at 30%, and oil at 22% in 2035.

The incremental energy demand growth from 2010 to 2035 by sector is shown in Figure 8.5.2. As the figure shows, the demand for coal is projected to increase substantially by 18.8 Mtoe, with the increased use in both the power and industry sectors. The increase in oil demand will be driven mainly by the transport sector, and gas demand will be led mainly by the growth in the power sector, followed by industry and others.

A substantial production increase in coal and oil production is expected to improve the net export situation of Kazakhstan (Figure 8.5.3).

Over the outlook period, oil production is projected to increase from 1.6 million barrels per day (mb/d) in 2010 to 3.4 mb/d in 2035. This reflects the assumed production increases from the five major fields (Aktobe, Karachaganak, Kashgan, Tengiz, and Uzen). Out of these fields, Karachaganak, Kashagan, and Tengiz are expected to drive the growth in oil production as

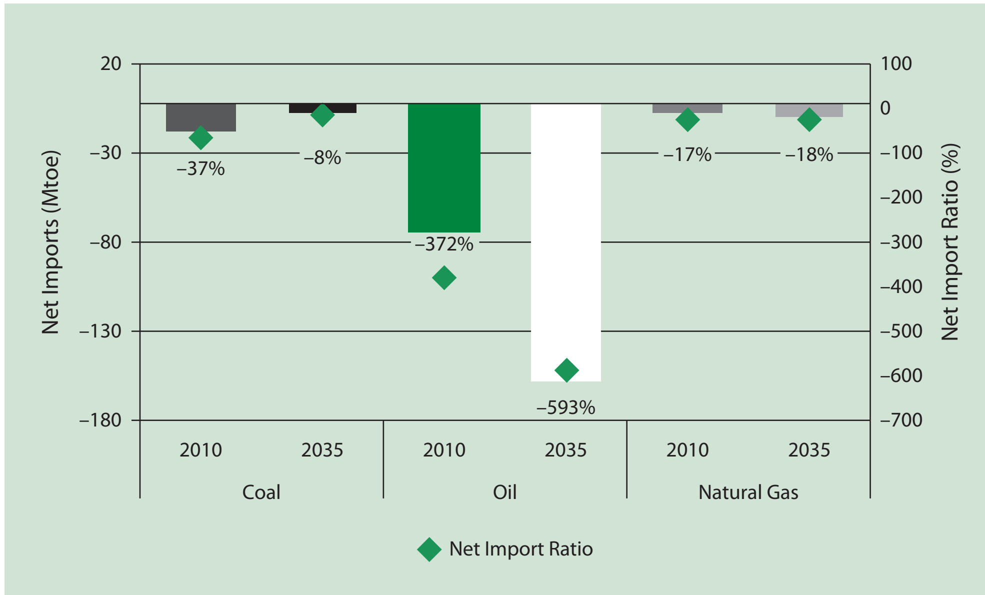
Figure 8.5.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.

Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 8.5.3 Net Imports of Coal, Oil, and Natural Gas, and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

they will account for about 80% of Kazakhstan's entire growth in oil production through 2035. About 90% of total oil production will be dedicated to export in 2035.[18]

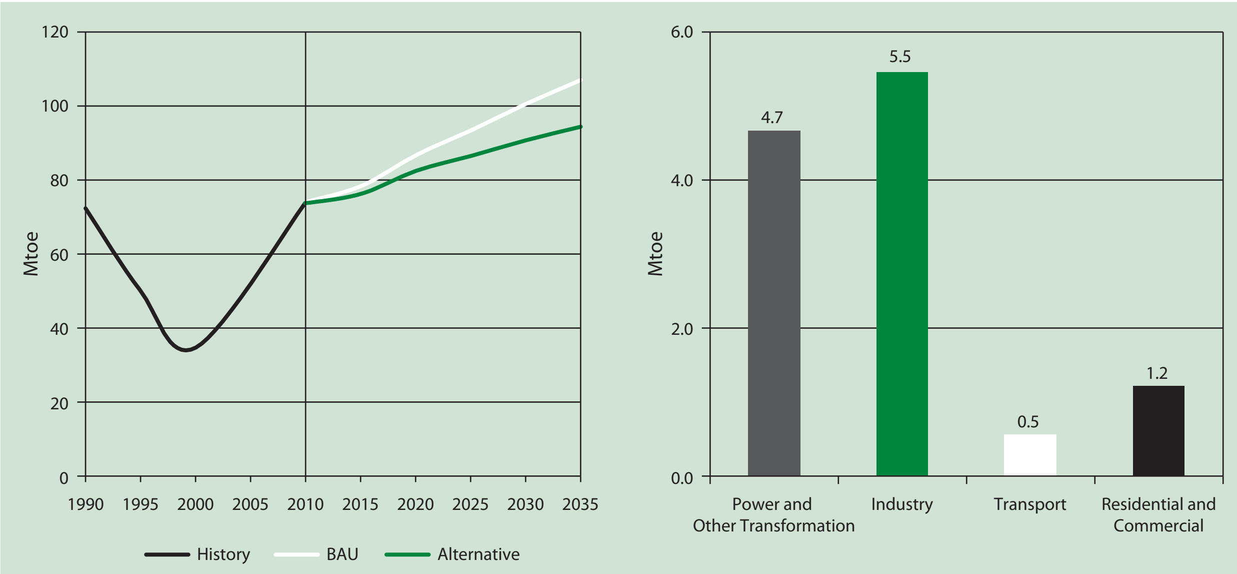
Natural gas production will increase from 17.6 billion cubic meters (bcm) in 2010 to 48 bcm in 2035. The production increase will come mainly from the western deposits, the Karachaganak field whose proven reserves account for more than 70% of all natural gas reserves in Kazakhstan. Production from Amangeldy will meet demand in the southern region, which currently relies on imports from Uzbekistan. Out of the total natural gas production, Kazakhstan will be able to export about 12 bcm in 2035.

Alternative Case: Energy Savings Potential and Energy Source Diversification

As a result of deployment of advanced technologies for energy savings, Kazakhstan's primary energy demand in the alternative case will increase moderately at 1.0% through 2035, reaching 96.1 Mtoe in 2035. This means that Kazakhstan has the potential to save about 11.8 Mtoe (or 11%) in 2035 compared with the primary energy demand in the BAU case in 2035 (Figure 8.5.4).

[18] Major developments have been made in diversifying oil export routes. In 2001, construction of the oil pipeline linking Tengiz field (the largest oil and natural gas field in Kazakhstan) with the Black Sea port of Novorossiisk in the Russian Federation was commissioned by the Caspian Pipeline Consortium. Then in 2005, Azerbaijan and Kazakhstan reached an agreement that allows Kazakh oil to be re-exported through the Baku–T'blisi–Ceyhan pipeline from Baku in Azerbaijan to Ceyhan, a sea port in Turkey. More recently, the construction of the Kazakhstan–People's Republic of China oil pipeline was completed in 2009, whose maximum capacity could expand to 400,000 mb/d from the initial capacity of 200,000 mb/d.

Figure 8.5.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

The industry sector has the biggest energy savings potential at 5.5 Mtoe, a quarter of which comes from the iron and steel industry. The power sector has the second-largest energy savings potential at 4.7 Mtoe in 2035.

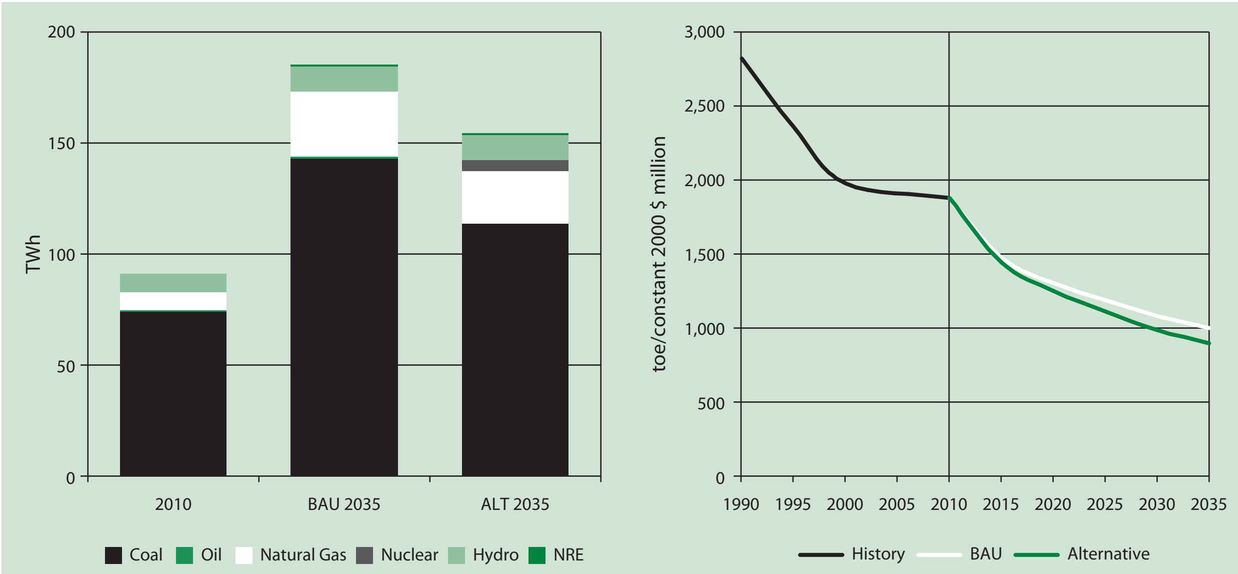
Improvements in thermal efficiencies may explain about a quarter of the total savings in the power sector, while the rest mainly reflects the reduced generation requirements due to lower demand. (However, the increased nuclear power generation may mean higher fuel input requirements per unit of electricity generation with nuclear power plants' assumed 33% thermal efficiency, compared with the assumed average fossil fuel thermal efficiency of 39%.) This highlights the importance of demand-side energy savings mainly in the industry, residential, and commercial sectors.

The potential energy savings of the other sectors (residential, commercial, agriculture, and others) will be 1.2 Mtoe in 2035. Of this, the deployment of higher-efficiency appliances (lighting, refrigerators, and water heaters) in the residential sector is the main contributor (at 0.7 Mtoe in 2035). The remaining savings would come from energy efficiency improvements in space heating.

The potential energy savings from the transport sector may account for the smallest share by sector at 0.5 Mtoe in 2035. Only modest shifts toward efficient vehicles such as hybrids, and to electricity from conventional internal combustion engines, may take place as the relatively low prices of gasoline and diesel are maintained.

The power generation by energy type for the BAU case and the alternative case are compared in Figure 8.5.5 (left). In the alternative case, total electricity generation in 2035 will be about 17% lower than that of BAU as a result of efficiency improvements mainly in the industry, residential, and commercial sectors. The alternative case assumes a slightly diversified electricity generation mix with the introduction of wind (0.6% of total generation

Figure 8.5.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hours.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

in 2035) and nuclear (3% in 2035), in contrast to the BAU case, which assumes almost no introduction of these sources.

Kazakhstan's law on the use of renewable energy sources obliges all electricity transmission companies to allow the integration of renewables to the grid, and the legislation states that 5% of Kazakhstan's total energy balance must be renewable by 2024. Meanwhile, lack of policy support may hinder the competitiveness of renewables to meet this target.

The assumed introduction of nuclear power (600 MW) in the alternative case reflects Kazakhstan's agreement with the Russian Federation (reached on 29 March 2011) for the peaceful use of nuclear energy. The agreement includes plans to install a small-scale reactor (300 MW per unit) in the district of Aktau town of Mangistausk Region (ROSATM n.d.).

Energy Policy Implications

Kazakhstan is endowed with vast energy reserves of coal, oil, and natural gas, and these have great potential to serve as important sources of export earnings. Meanwhile, with Kazakhstan being landlocked, export expansion greatly depends on the development of export routes. Additional routes and markets need to be secured to realize Kazakhstan's full potential in oil and natural gas production growth. Furthermore, earnings from oil exports will have to be distributed to the public in Kazakhstan to avoid the concentration of wealth within certain industries, and to improve the economic basis for harmonized development across the country.

To cope with the rising electricity and heating demands, new facilities (generation, transmission, and distribution) need to be developed and obsolete facilities modernized or replaced. However, there are many obstacles to this. Nonpayment problems continue to strangle distribution companies. In addition, generators have few incentives to build and modernize facilities as the regulated electricity tariffs are too low to cover the cost. To link the resource-rich northern region to the central and southern demand centers, the second North–South transmission lines have been developed, and there are plans to enhance the grid system to reduce electricity imports of the sometimes unreliable supply from neighboring countries. A clear future direction, as well as supporting legislation, toward building and modernizing infrastructure need to be developed to promote investment in the electricity sector. Additionally, the electricity tariffs should be set high enough for the utilities to generate income internally and reinvest in the construction of new electricity infrastructure and capacity.

Kazakhstan has great potential for energy savings, particularly in the industry and power sectors. Replacing existing electricity generation units and transmission facilities poses great challenges. Additional investments for energy efficiency interventions need to be secured, on top of investments for new infrastructure to satisfy energy demand. The domestic tariff levels are low, and regulatory reforms are necessary to increase the tariff levels to incentivize private investors to finance power sector projects. With the Law on Energy Savings and Efficiency having been passed, sectorwide policy measures are required to realize energy intensity reduction targets. These measures are needed not only to incentivize new technology deployment, but also to shift people's attitudes toward energy conservation.

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8.6 Kyrgyz Republic

- *In the BAU case, the Kyrgyz Republic's primary energy demand is projected to reach 5.9 Mtoe in 2035, increasing from 2.9 Mtoe in 2010. As a result, per capita primary energy demand will increase from 0.55 toe in 2010 to 0.85 toe in 2035.*
- *In the alternative case,* the Kyrgyz Republic's primary energy demand will increase moderately at 2.4% through 2035, reaching 5.3 Mtoe in 2035. This means that the Kyrgyz Republic has the potential to save about 0.6 Mtoe (or 9.9%) in 2035 compared with the primary energy demand in the BAU case.*
- *Upgrading and replacement of existing obsolete energy supply infrastructure, particularly the hydro-based electricity supply system, will be important to enhance the energy supply security of the Kyrgyz Republic.*

Recent Energy Trends and Energy Policy Issues

The Kyrgyz Republic's GDP has seen a fluctuating trend in recent years. The member's first revolution—the "tulip revolution" against President Askar Akayev in 2005—made its economy contract by 0.2% in 2005. It has rebounded to register positive growth from 2006 to 2009, averaging 4.9% per year, as the economy was sustained by the growth in industry (such as textile and chemicals) and services sectors. Nevertheless, the second Kyrgyz Revolution against President Kurmanbek Bakiyev in 2010 has led the economy to contract by 1.4% in 2010. As a result of these political incidents, a constitutional referendum was held to reduce presidential powers and strengthen democracy (CACI 2010). The economy of the Kyrgyz Republic is expected to recover to a steady growth path in the future, while higher civil service wages, social spending, and reconstruction in the south has been weighing on the fiscal balance (ADB 2012).

From 2005 to 2010, the Kyrgyz Republic's final energy demand grew at 4.4%, though its growth trends differ by sector. The transport sector grew at a fast rate of 16.7% per year, driven mainly by increased freight transport as the economy recovers. Industry demand grew at a pace of 3.8% per year in line with GDP growth (averaging 4.2% per year). The other sectors' energy demand registered a negative growth rate of –2.8% per year as the politically unstable situation contracted residential and agriculture energy demand. The Kyrgyz Republic is endowed with negligible resources of oil, coal, and natural gas, and blessed with plentiful water resources as the third-largest hydropower producer among the Commonwealth of Independent States. Therefore, its electricity generation relies heavily on hydropower, accounting for 91.0% in 2010. Hydro generation, however, is largely affected by weather conditions. Particularly during the winter season, the Kyrgyz Republic has to rely on imports of electricity from neighbors such as the People's Republic of China, Kazakhstan, the Russian Federation, and Uzbekistan, and exports its excess generation to these countries in summer.

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* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

Meanwhile, the output of hydropower has been constrained by depletion of assets over the past 15 years. The current utilization of hydropower stands at less than 10% of its 26,000 megawatts megawatt (MW) potential (ADB 2007). Replacing the existing plants and rehabilitating network assets are critically important, in addition to securing supplies during the winter season.

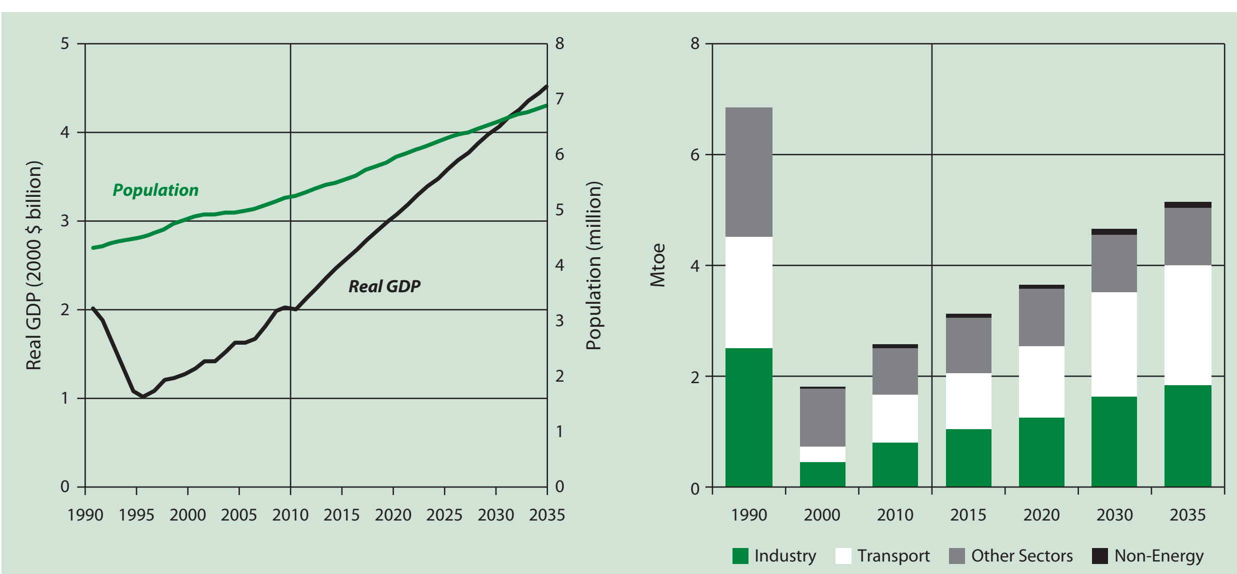
Business-as-Usual Case: Energy Demand Outlook through 2035

Driven mainly by the exports of mining materials such as gold, the Kyrgyz Republic's GDP is projected to increase from $2.0 billion (constant 2000 dollars) in 2010 to $4.5 billion in 2035, growing at an annual rate of 3.3%. In contrast, the population will increase moderately at 1.1% per year through 2035, reaching 6.9 million in 2035, up from 5.3 million in 2010 (Figure 8.6.1). As a result, the Kyrgyz Republic's GDP per capita will reach $647, from its 2010 level of $375.

In the BAU case, the final energy demand of the Kyrgyz Republic is projected to increase at an annual rate of 2.9%. Despite the increase, final energy demand in 2035 will be lower than in 1990. By sector, transport will continue to dominate energy demand, accounting for 41.6% of the total final energy demand in 2035, followed by industry at 36.1%, others (including residential, commercial, agriculture, and fishery) at 20.6%, and non-energy at 1.7%.

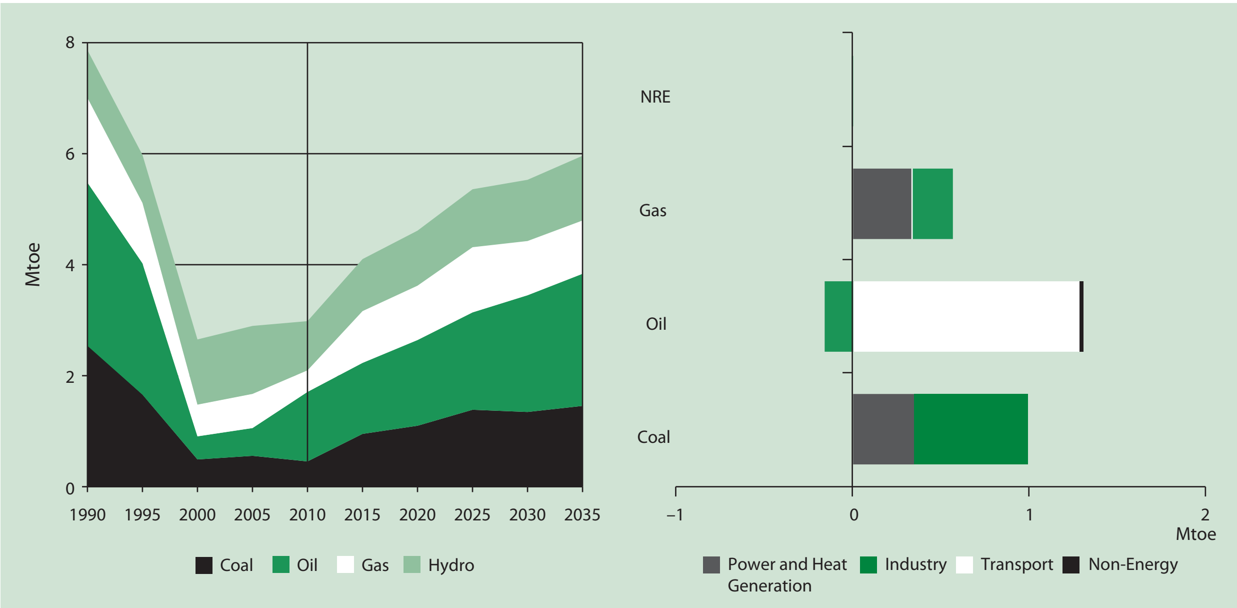
In terms of the growth rate, the transport sector is projected to grow the fastest at 3.7% to cope with the rising transport needs for both passengers and freight, and oil will continue to be the dominant fuel for this sector. Industry energy demand is also growing at a relatively fast pace of 3.4% as the mining and manufacturing industry is expected to grow over the outlook period. In contrast, the other sectors' energy demand is expected to grow moderately at 0.9% through 2035, while the other sectors' electricity demand will grow relatively strong as a result of the diffusion of appliances and improvement in living standards.

Figure 8.6.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

Figure 8.6.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

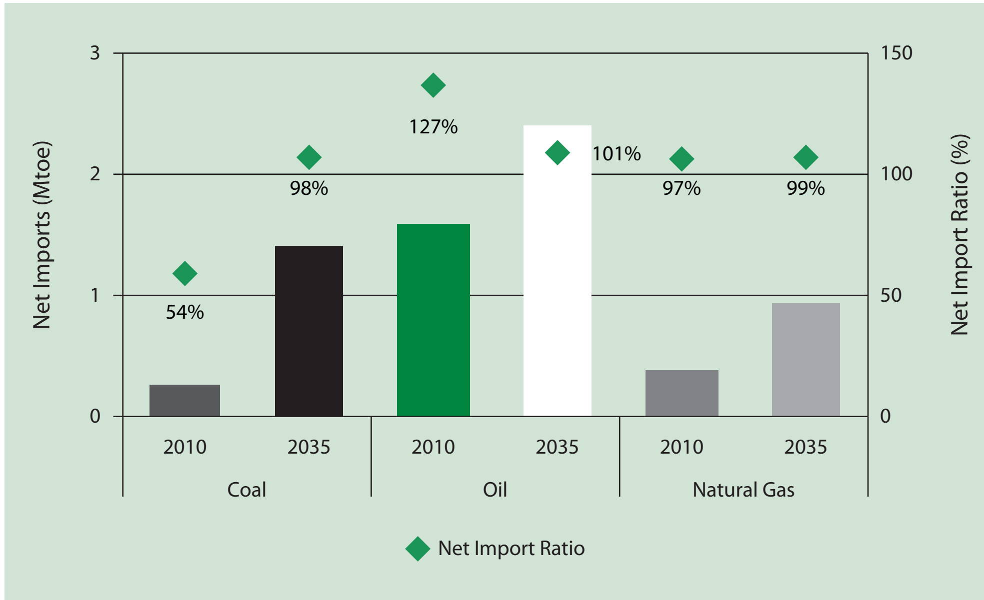
In the BAU case, the primary energy demand of the Kyrgyz Republic is projected to increase from 2.9 Mtoe in 2010 to 5.9 Mtoe in 2035, growing at an annual rate of 2.9%. The Kyrgyz Republic's per capita energy demand is relatively small at 0.85 toe per person in 2035, which compares with that of Central and West Asia at 0.97 toe per person in 2035.

By energy type, the Kyrgyz Republic's primary energy mix was dominated by oil (at 43%), followed by hydro (30%) and coal (16%) in 2010. In 2035, oil will continue to be a dominant source (40%), followed by coal at 24% and hydro at 20%.

The sectoral contributions to the incremental energy demand growth from 2010 to 2035 are shown in Figure 8.6.2. As the figure shows, demand for oil is projected to increase substantially with increased need from the transport sector, followed by coal in the industry sector. Natural gas demand is expected to increase driven by the power and other sectors' demand. To cope with electricity shortages in the winter, the Kyrgyz Republic plans to install natural gas-fired generation, for which input fuel will be imported from Uzbekistan, which is the largest exporter of natural gas to the Kyrgyz Republic (REEEP Policy Database n.d.).

Endowed with few fossil fuel resources, the Kyrgyz Republic's demand for oil, coal, and natural gas will have to be met by imports from neighboring countries: natural gas from Uzbekistan; crude oil from Kazakhstan, the Russian Federation, and Uzbekistan; and coal from Kazakhstan (CACI n.d.; Energy in Asia n.d.).

Figure 8.6.3 Net Imports of Coal, Oil, and Natural Gas, and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

Alternative Case: Energy Savings Potential and Energy Source Diversification

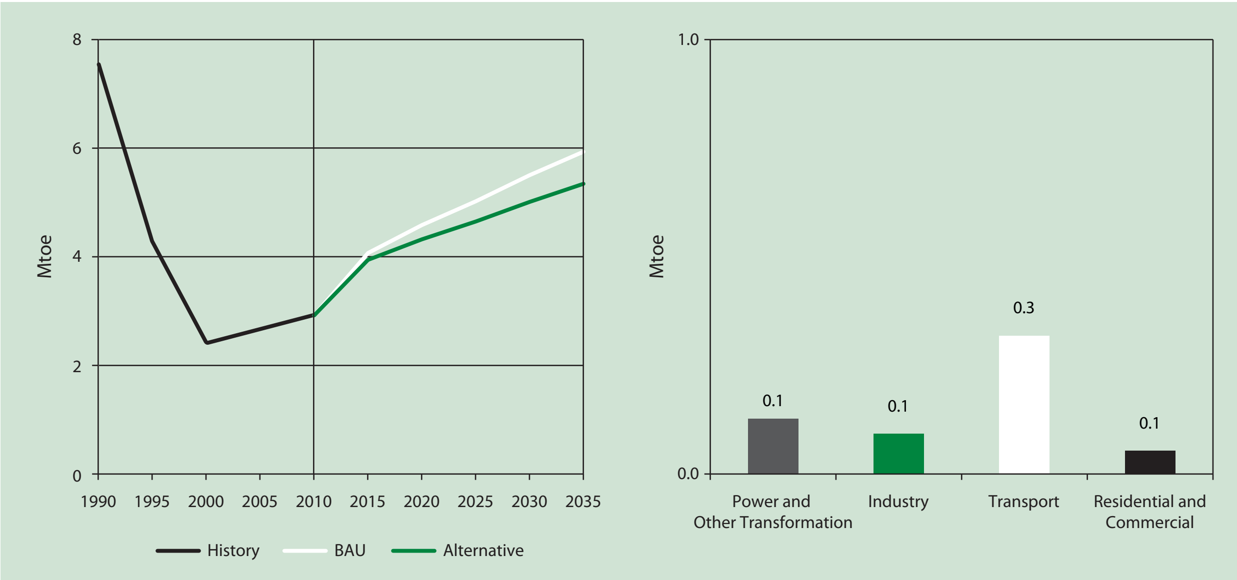
As a result of the deployment of advanced technologies for energy savings, the Kyrgyz Republic's primary energy demand in the alternative case will increase moderately at 2.4% through 2035, reaching 5.3 Mtoe in 2035 (Figure 8.6.4). This means that the Kyrgyz Republic has the potential to save about 0.6 Mtoe (or 9.9%) in 2035, compared with the primary energy demand in the BAU case.

By sector, the transport sector has the biggest energy savings potential at 0.3 Mtoe. Within the sector, oil demand will decrease while electricity demand will increase because of the assumed deployment of fuel-efficient vehicles (such as hybrids) and marginal shifts to electric vehicles from conventional gasoline-engine vehicles.

The power sector would represent the second-largest energy savings potential at 0.1 Mtoe in 2035. The savings in the power sector predominantly derive from the deployment of higher-efficiency appliances in the residential and commercial sectors, combined with higher-efficiency technology deployment (together explaining 78% of total power sector energy savings), while the rest reflects improvement of thermal efficiency (responsible for 22%).

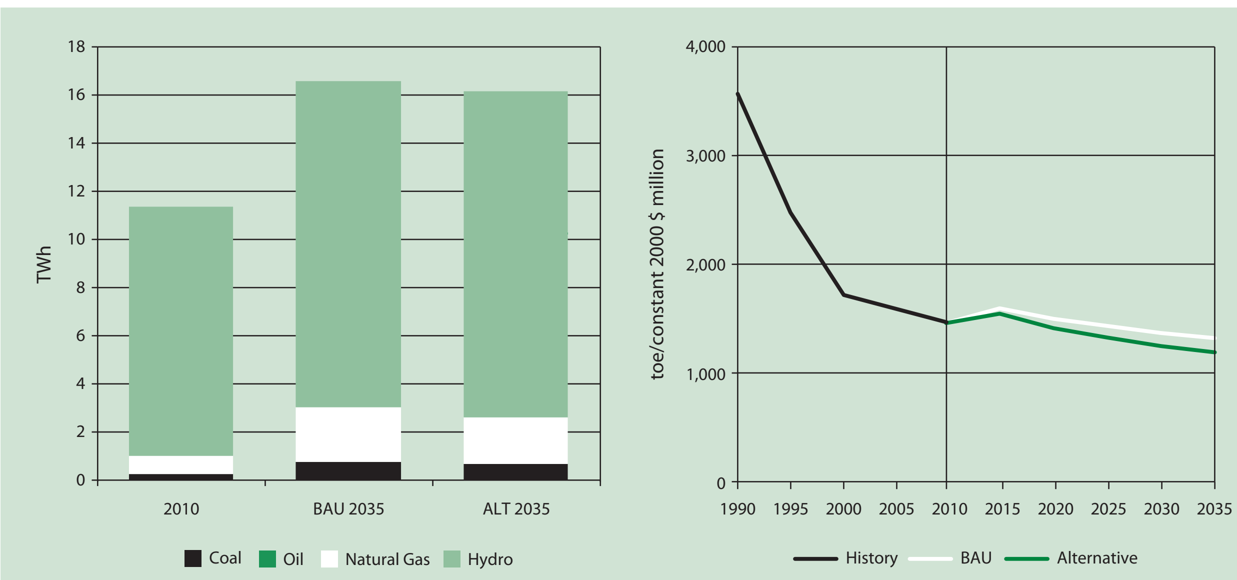
In the alternative case, the Kyrgyz Republic's electricity generation in 2035 will be about 3% lower at 16.1 terawatt-hours (TWh), compared with BAU at 16.6 TWh (Figure 8.6.5). Substantial savings in total generation in 2035 result from the electricity demand savings in the industry, residential, and commercial sectors. In both cases, hydro will retain the dominant share with more than 80% in power generation output over the outlook period.

Figure 8.6.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Figure 8.6.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Energy Policy Implications

As other Central Asian developing countries, the Kyrgyz Republic is struggling with low electricity tariffs, which leaves inadequate funds for the maintenance of old facilities, power supply shortages in dry winters, power theft, and unrecorded exports.

Among the issues, the supply shortage in the power sector is of significance. Even though the Kyrgyz Republic has abundant water resources, it still has to import electricity from neighboring countries in the winter. Thus, the construction of hydropower facilities and upgrade of the electricity grid will be essential to overcome the electricity supply shortage. Furthermore, further exploration and development of its fossil fuel resources will strengthen the country's energy supply system.

In addition, reform of governance and management in the energy sector is necessary. In particular, to cope with low tariffs, power theft, and unrecorded exports, the government has recently taken steps forward to establish special escrow accounts at power generating and transmission companies for all export receipts. These kinds of governance reforms should be enhanced over the outlook period to improve energy efficiency in the country. The government has to focus on expanding domestic energy resources, enhancing effective demand management and loss reduction measures, reforming tariff policy, improving the financial performance of sector entities, attracting private sector development, and expanding regional power exports (IMF 2012).

The development of energy transport infrastructure and cooperation with neighboring countries are necessary for securing the country's energy supply. Over the outlook period, the projected increases in energy imports (oil, coal, and natural gas) will have to be accompanied by infrastructure development for pipelines and roads. Moreover, cooperation with the neighboring countries (such as the People's Republic of China, Kazakhstan, the Russian Federation, and Uzbekistan) will be important to secure energy sources. As well, financial support from developed countries and international organizations and institutions will be important to facilitate such infrastructure development.

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8.7 Pakistan

- *In the BAU case, the primary energy demand of Pakistan is projected to increase from 84.6 Mtoe in 2010 to 145.8 Mtoe in 2035, growing at an annual rate of 2.2%. With this growth, Pakistan's per capita energy demand will reach 0.59 toe per person, compared with that in 2010 of 0.49 toe. Meanwhile, with the deployment of advanced technologies, about 10.3% of primary energy demand (or 15.0 Mtoe) could be saved by 2035 in the alternative case,**
- *Diversification of the energy supply source away from natural gas and imported fuel oil, in addition to securing necessary financial sources and an enabling environment for building energy supply infrastructure, will be the important elements for energy security of Pakistan. Pakistan has proceeded with demand-side energy efficiency improvements, and consistently implements policy and measures for energy efficiency improvement across the sectors.*

Recent Energy Trends and Energy Policy Issues

Pakistan's economy has recovered from the impacts of the 2009 global economic slowdown and registered an annual growth of 3.8% in 2010. Severe floods at the start of 2011 impacted the economic activity in the first half of the year, while the economy maintained an annual average growth of 2.4% supported by exports of textiles and flood relief-related service activity (ADB 2012).

Despite the rebound in the economy, energy shortages have been constraining economic growth. Pakistan is faced with domestic energy supply shortages of coal, oil, and natural gas, as well as a shortage of hydro generation capacities. These fuel constraints have severely affected the power sector, resulting in a significant decline in power production—some generators were unable to operate at their installed capacity. At its peak, the gap between electricity demand and supply was as high as 40% (i.e., 40% of the demand could not be met).

In fact, the curtailment of domestic natural gas and the lack of hydro capacity resulting from the lack of dams to store water made it necessary for the generators to shift to expensive fuel oil. Nevertheless, Pakistan's power sector has been suffering from the so-called "circular-debt crisis": Pakistan's Central Power Purchasing Agency suffers from revenue shortfalls and thus cannot pay the power supply companies fully. The circular-debt crisis involves many layers of issues: for instance, some private power producers had to cease operations as the state-owned power company did not pay them. This is a problem that was caused by nonpayment by the biggest consumers—the provincial and federal governments. Moreover, even if the electricity tariff were to be paid, it is not high enough to cover the cost of generation, as it is regulated to maintain an affordable level for the public (*The Economist* 2012). Above all, one important issue revolving around the power sector remains unsolved: technical and nontechnical transmission and distribution losses.

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* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

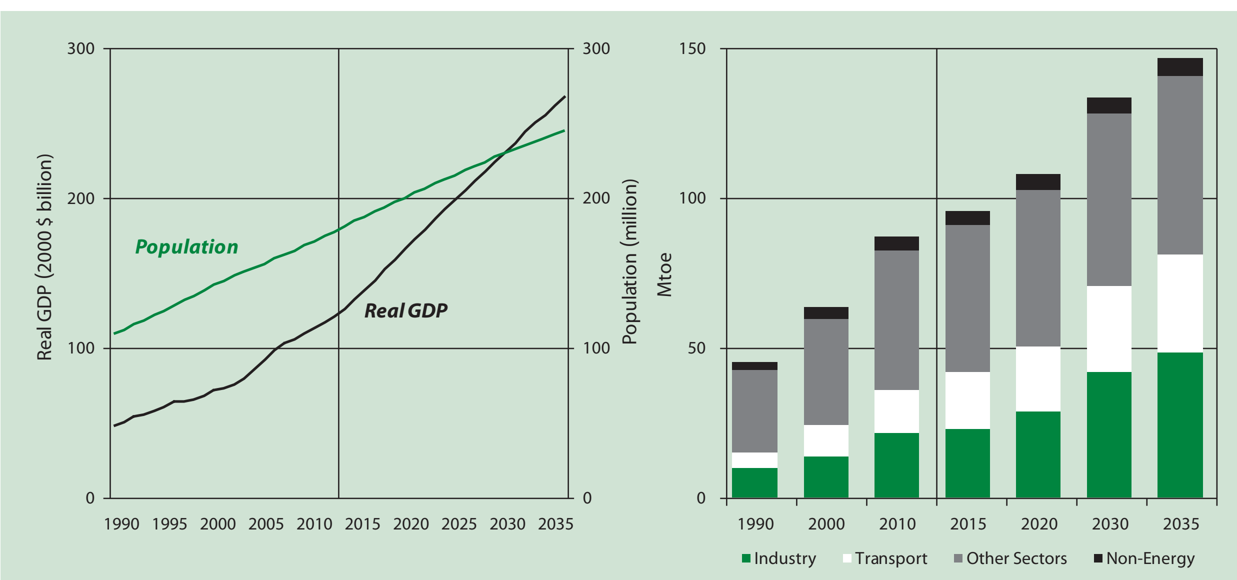
Ensuring electricity supply in a manner that meets demand is fundamental to the economic growth and improvement of the living standards in Pakistan. In coping with the situation, Pakistan is faced with a number of challenges: (i) developing domestic energy sources to diversify away from a heavy dependence on imported fuel oil; (ii) securing affordable and reliable energy import sources; (iii) restructuring the electricity sector to improve its financial basis and management, including electricity tariff rationalization; (iv) developing infrastructure necessary to deliver electricity and gas, since 30% of the population has no access to electricity and 80% has no access to pipeline gas (Friends of Democratic Pakistan 2010); (v) investing in electricity supply infrastructure that can meet the demand growth while assuring reliability; and (vi) improving sectoral energy efficiency to manage demand growth. Since achieving all this takes time, Pakistan will therefore be required to consider options in the short, medium, and long term.

Business-as-Usual Case: Energy Demand Outlook through 2035

Over the outlook period, Pakistan's GDP is projected to increase at an annual rate of 3.4%. With this growth, GDP will more than double from $116 billion (constant 2000 dollars) in 2013 to $269.6 billion in 2035 (Figure 8.7.1). The population is projected to increase at a relatively fast pace of 1.4% through 2035, reaching 245.9 million in 2035 from 173.4 million in 2010.

In the BAU case, the final energy demand of Pakistan is projected to increase at an annual rate of 2.1% through 2035, slower than the projected GDP growth rate of 3.4% during the same period. With this growth rate, the final energy demand will reach 117.6 Mtoe in 2035, up from 69.8 Mtoe in 2010. By sector, the other sectors (including residential, commercial, agriculture, and fishery), whose share was the largest in 2010 at 51.4%, will increase moderately at 1.0% as a whole to decrease its share in final energy demand to 40.5% in 2035. In contrast, transport and industry energy demand will increase at respective rates of 3.4% and 3.2% per year over the outlook period.

Figure 8.7.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

While the other sectors' energy demand as a whole will grow moderately, growth trends vary by energy type. Shifting from noncommercial biomass for cooking and heating, the other sectors' demand for natural gas and electricity will grow at a relatively fast rate of 2.4% and 2.9%, respectively, through 2035. Demand for noncommercial biomass will remain almost constant at around 25 Mtoe, and its share will decline from 68.5% in 2010 to 54.1% in 2035.

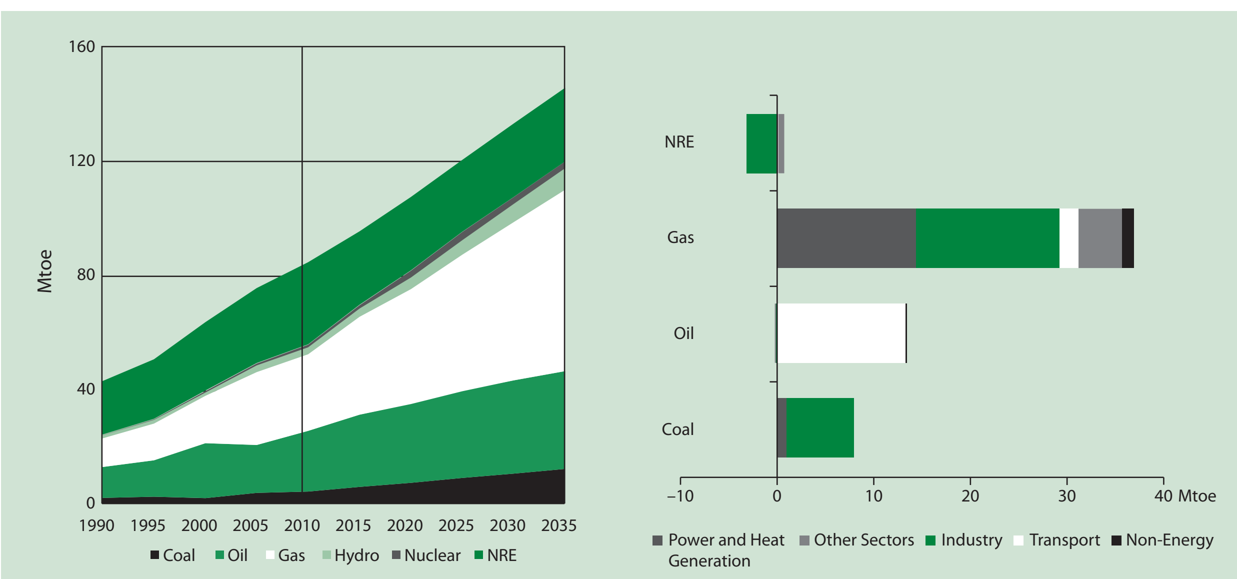
The industry sector's energy demand will grow at 3.8% through 2035. Near-term growth is much faster at 4.2% (2010–2020) than long-term growth at 3.5% (2020–2035). In terms of energy source, natural gas will grow the fastest at 4.0% through 2035, followed by electricity at 3.7% during the same period.

In the transport sector, oil and natural gas are the main energy sources satisfying the transport needs in Pakistan. Meanwhile, oil demand will grow faster at 3.5% through 2035, compared with natural gas demand at 2.6% through 2035. As a result, the share of oil is expected to increase to 83% in 2035 from 80% in 2010, in contrast to the declining share of natural gas to 17% in 2035 from 20% in 2010.

In the BAU case, Pakistan's primary energy demand is projected to increase from 84.6 Mtoe in 2010 to 145.8 Mtoe in 2035, growing at an annual rate of 2.2%. With this growth, Pakistan's per capita energy demand will reach 0.59 toe per person in 2035, compared with 0.49 toe in 2010.

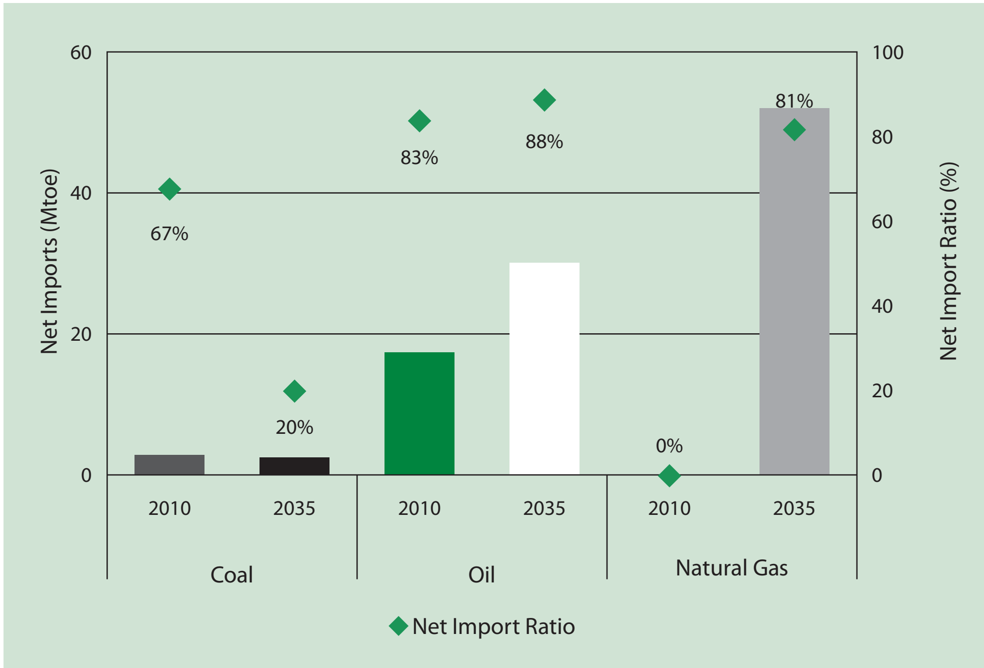
By energy type, natural gas will maintain the largest share, reaching 43.8% in 2035, followed by oil at 23% and others (including noncommercial biomass and new and renewable energy) at 18%. Use of coal will increase as a result of the start-up of the Thar coalfield to feed the needs for both the power and industry sectors. The share of hydro is projected to increase slightly to 5.2% in 2035, with the capacity increasing to 25.1 gigawatts (GW) from 6.5 GW in 2010, and nuclear will account for 2% in 2035, with the capacity reaching 1.3 GW in 2035, up from 0.5 GW in 2010. The

Figure 8.7.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 8.7.3 Net Imports of Coal, Oil, and Natural Gas, and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

sectoral contributions to the incremental energy demand growth from 2010 to 2035 are shown in Figure 8.7.2 (right). As the figure presents, natural gas demand will represent the biggest incremental growth at 32 Mtoe, driven by the increased use in the industry, power, and other sectors. Oil demand will be led mostly by the transport sector, shifting from the use of natural gas. Domestic coal production will be focused on the Thar coalfield and prospects for imported coal are kept low, thereby making it likely that the increase is much smaller than for the other sources at 7.8 Mtoe over the outlook period, with growth being driven by the power and industry sectors.

Securing energy supply sources of natural gas, oil, hydro, and coal will be critical for Pakistan's economic growth. Currently, Pakistan is self-sufficient in natural gas—the main energy source to meet its primary energy demand—while domestic production will decline from the current 38.4 billion cubic meters (bcm) to 13 bcm in 2035 (Malik and Sheikh 2010), and Pakistan will have to start importing natural gas sometime after 2015.[19]

Some projects are now being planned, such as for liquefied natural gas (LNG) imports from Qatar and pipeline imports from Iran or from Turkmenistan via Afghanistan. What is more, oil import dependency may rise to nearly 90% by 2035 (Figure 8.7.3) if domestic oil production is maintained at a constant level. In contrast, coal import dependency will decline to 20% in 2035 from 67% in 2010. Coal production is projected to increase from the current 1.4 Mtoe to

[19] According to EIA (2011), Pakistan has a technically recoverable shale gas potential of 1.43 trillion cubic meters in contrast to the proven natural gas reserves at 0.78 trillion cubic meters that are economically recoverable. In this analysis, proven natural gas reserves have been considered to estimate the economic potential of natural gas production through 2035 under the assumption that a number of hurdles need to be overcome to realize the technical potential of shale gas, such as securing funds, laying the necessary infrastructure for transporting natural gas, and finding enough water resources required for hydraulic fracturing. Nevertheless, it is important to note that Pakistan has made enough progress in shale gas development to invite bids for pilot projects, which might lead to expansion of domestic natural gas production if appropriate conditions are provided.

9.7 Mtoe by 2035, with the expanded production from the Thar coalfield. Additionally, Pakistan is endowed with potential new and renewable sources such as wind, solar, and biomass, and their contributions will be important as well to diversify energy sources. Nevertheless, the prospects of their making inroads into the energy market in Pakistan are small in the BAU case because the policies and measures are not in place to incentivize the private sector.

Alternative Case: Energy Savings Potential and Energy Source Diversification

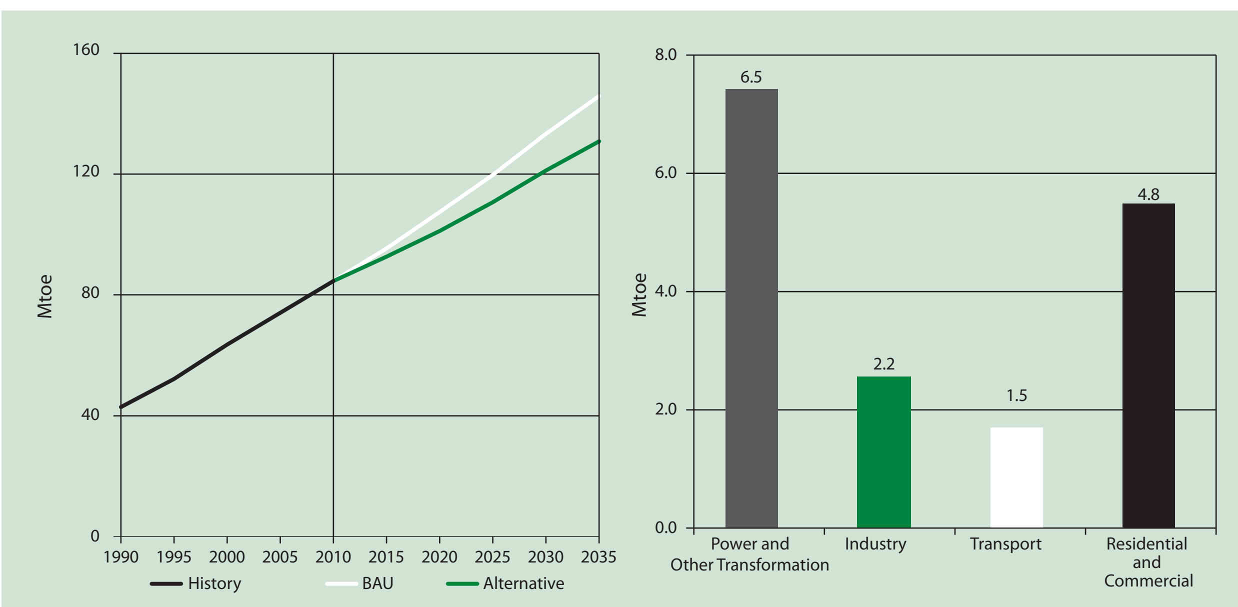
Pakistan has substantial energy savings potential with the deployment of advanced technologies for energy savings. In the alternative case, Pakistan's primary energy demand will increase at an annual rate of 1.8% through 2035. With this growth, Pakistan's primary energy demand will reach 130.9 Mtoe in 2035, 15.0 Mtoe (or 10.3%) lower than the BAU case (Figure 8.7.4).

By sector, the power sector represents the biggest energy savings potential at 6.5 Mtoe in 2035, followed by residential and commercial at 4.8 Mtoe, industry at 2.2 Mtoe, and transport at 1.5 Mtoe.

The power sector's energy savings will result mainly from electricity demand savings and resulting lower input fuel requirements. Thermal efficiency improvement in power generation will account for about 15% of total savings.

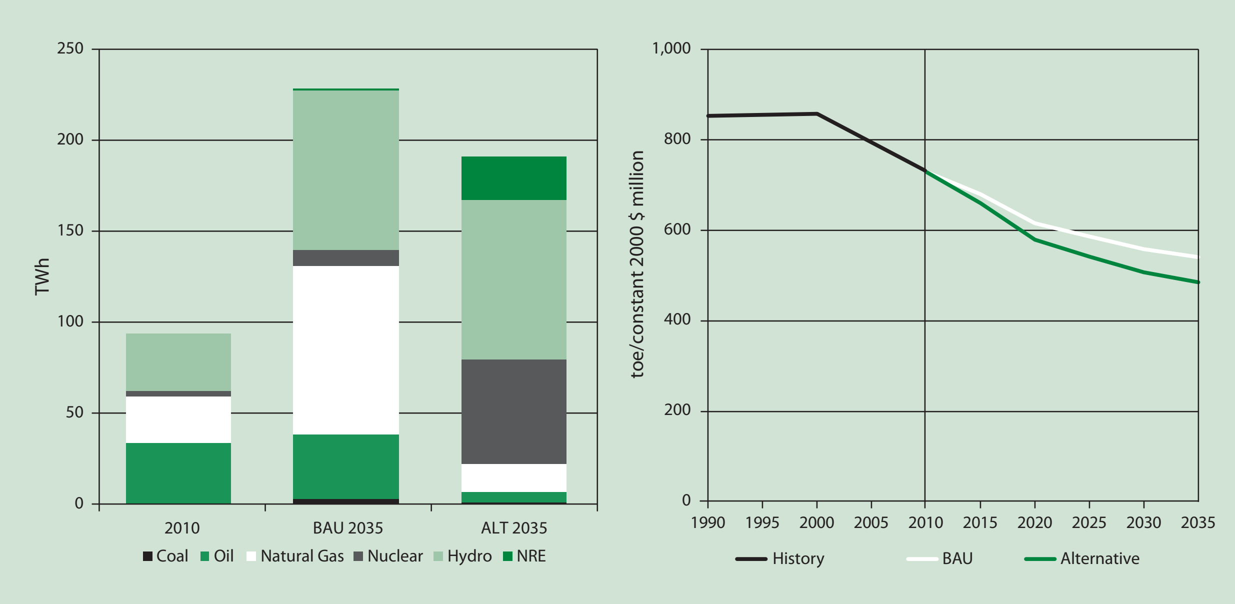
Meanwhile, the residential and commercial sectors' energy savings at 4.8 Mtoe in 2035 will come from electricity savings as a result of deployment of efficient appliances (2.5 Mtoe), and lower fuel requirements for space heating (2.3 Mtoe) in 2035. The major appliances that contribute to the electricity savings are lighting and refrigerators.

Figure 8.7.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Figure 8.7.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hours.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

The industry sector's energy savings at 2.2 Mtoe in 2035 are from the deployment of advanced technologies in the various industry subsectors, including cement, refineries, paper and pulp, and others.

The transport sector's energy savings will amount to 1.5 Mtoe in 2035. They will come from a combination toward efficient vehicles (mainly hybrid and electric vehicles) from internal combustion engine vehicles and compressed natural gas (CNG).

In the alternative case, Pakistan's electricity generation in 2035 will be about 16% lower at 192 terrawatt-hour (TWh) in 2035, compared with that of the BAU case at 230 TWh. Substantial savings in total generation in 2035 will result from electricity demand savings in the industry, residential, and commercial sectors. Despite the lower electricity generation requirements, it will be almost twice the 2010 level.

By energy type, electricity generation in the alternative case is more diversified than in the BAU case. In 2035, at the expense of natural gas and oil for power generation, the share of nuclear will expand to 30%, with the installation of 8.9 GW of nuclear power, compared with 1.3 GW in the BAU case. The share of new and renewable energy (wind, solar, and biomass generation) will also increase to 13% in 2035 in the alternative case, compared with 0.5% in the BAU case.

Energy Policy Implications

With continued energy demand growth in Pakistan, it will be increasingly difficult to meet demand with domestic sources. Pakistan is faced with constraints in domestic energy supply as well as the need for upgrades and replacement of obsolete energy supply infrastructure, including power plants and transmission and distribution systems.

In terms of domestic energy supply, Pakistan will have to increasingly rely on imported energy sources. Some initiatives and plans are underway to import natural gas from Iran, Qatar, and Turkmenistan. Cooperation with the neighboring countries will be important in this regard to lay the necessary infrastructure for import. Progress has been made in programs to develop domestic coal resources from the Thar coalfield. Nevertheless, the cost of development would be high as its deposits are spread over 9,000 kilometers, and the resources are located between 1.2 kilometers and 4.8 kilometers below the ground. Securing sufficient investment will pose a challenge.

Steady progress will have to be made in diversifying of energy sources away from natural gas as well as in energy savings, particularly on the demand side, to cope with the challenges surrounding supply constraints. Nuclear and new and renewable energy sources are being considered for expansion. These generation sources will greatly reduce import needs, while the safety of nuclear usage, as well as the enhancement of grid stability through the expanded new and renewable energy sources, will have to be secured. The achievement of energy source diversification, particularly in the power sector, may require fundamental structural reform to ensure that electricity tariffs reflect the true cost and to assure long-term purchases from the private generators.

It is important to note that demand-side efficiency improvements, mainly to reduce electricity demand, will greatly affect Pakistan's overall energy requirements. It is therefore desirable for Pakistan to consider energy efficiency as a priority item in its energy policy agenda.

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8.8 Tajikistan

- *In the BAU case, Tajikistan's primary energy demand is projected to reach 4.8 Mtoe in 2035, increasing from 2.3 Mtoe in 2010. In contrast, primary energy demand in the alternative case,* will increase to 4.4 Mtoe in 2035, or a 7.0% reduction compared with the BAU case.*
- *To reduce energy use, it is necessary to rehabilitate and/or phase out aging, unreliable, and low-efficiency electric power infrastructure. It will also be necessary to raise energy tariffs to levels that will allow the recovery of costs.*
- *Facilitating a regional energy network will also help Tajikistan enhance its energy security.*

Recent Energy Trends and Energy Policy Issues

Tajikistan's economy is significantly influenced by external factors. Aluminum and cotton, the country's major exports, are vulnerable to world price fluctuations while remittances as a major contributor to GDP hinge on economic performance of the Russian Federation.[20] Still, the country achieved steady economic growth at 6.6% per year between 2005 and 2010.

Nevertheless, total primary energy demand has been on a declining trend since after 2007 with an annual growth rate of –0.3% between 2005 and 2010. Accounting for more than half of the primary energy demand, demand for hydropower, which fell by 1.4% annually during the same period due to an inefficient power supply system and seasonal fluctuations in generation, could explain the dip.

Tajikistan's electricity supply has become unreliable since late 2009 when it withdrew from the Central Asian Electrical Power System (CAPS).[21] Without electricity trade with neighboring members through CAPS, Tajikistan is forced to spill water during summer as reservoir capacity is not adequate to store for winter when river flows are low, that is, power generation is reduced. This explains the substantial amounts of the unserved (unmet) energy demand.[22] The winter power deficit from which Tajikistan has suffered is an obstacle for economic development as industries face difficulties in maintaining continuous operations throughout the season.

In addition, natural gas imports dropped significantly since the purchase price of natural gas imported from Uzbekistan more than quadrupled from 2006 to 2010 (Melikyan and

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* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

[20] Aluminum and cotton accounted for approximately 80% of export revenues in the 2000s. Influenced by the economic situation of the Russian Federation, remittances totaled $2.4 billion in 2010, which is equivalent to 40% of GDP.

[21] CAPS is currently composed of South Kazakhstan, the Kyrgyz Republic, and Uzbekistan. Tajikistan and Turkmenistan operate electricity systems in isolated mode. In 2010, construction of a north–south 500 kilovolt line connecting the previously separated northern and southern regions of Tajikistan rendered power flow through Uzbekistan unnecessary.

[22] ADB (2012b) reports that the unserved demand estimation varies from 1,000 GWh to 3,780 GWh. The World Bank (2012), on the other hand, reports that the estimated unserved energy demand is 2,700 GWh on the consumer level.

Ghuskassayan 2011). Most of Tajikistan's natural gas imports comes from Uzbekistan. Hence, the decreasing demand for natural gas also puts energy demand on a downward trend.

Tajikistan's energy intensity (primary energy demand per GDP) at 1,202 toe per million constant 2000 $ is considered rather high relative to the country's development level and is higher than the average energy intensity of Central and West Asia in 2010. Dilapidated power infrastructure and extremely low tariffs are the primary causes of the high intensity. Of the installed capacity, 74% is over 30 years old and most of the transmission network was built during the 1960s and 1970s (ADB 2012b). Although the electricity tariff has been substantially increased, especially since the late 2000s, it is still below the cost recovery level, thereby making the investment environment unattractive (Melikyan and Ghuskassayan 2011). Progress in modernizing and rehabilitating the power infrastructure has been so slow that inefficient energy use and chronic power shortages in winter remain insurmountable obstacles for Tajikistan.

The Government of Tajikistan is actively pursuing two projects in the energy area (ADB 2010). First, with support from the World Bank, the Central Asia South Asia Regional Electricity and Trade project, referred to as "CASA-1000," plans to enable trade of 1,300 megawatts (MW) of summer surplus electricity between the Kyrgyz Republic and Tajikistan in Central Asia and Afghanistan and Pakistan in South Asia (World Bank n.d.). Regardless of the potential risks involved in this project, it is expected to bring in benefits, such as utilization of surplus hydropower, enhancement of regional trade and cooperation, and promotion of private sector participation. Second, the Rogun hydropower station (3,600 MW) is also included in the national strategy. The power station project, however, has been riddled with financial issues as well as opposition from Uzbekistan. The project has been viewed as controversial both domestically and internationally due to the station size, since a station with a multiyear storage facility could alter the water flow in the Vakhsh and Amu Darya[23] rivers, which could have environmental and economic costs for downstream members (Melikyan and Ghuskassayan 2011).

Business-as-Usual Case: Energy Demand Outlook through 2035

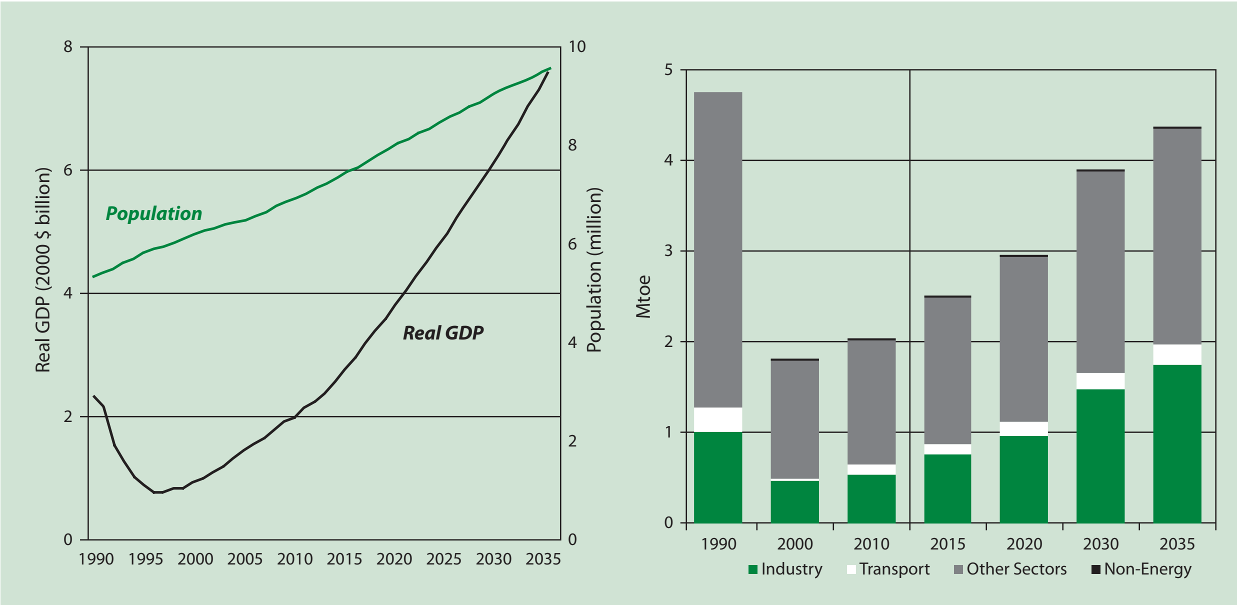
Tajikistan's GDP is projected to increase steadily from $1.9 billion (constant 2000 $) in 2010 to $7.4 billion in 2035 with an average annual growth rate of 5.6% (Figure 8.8.1). The population will show a rather moderate annual growth rate of 1.3% over the outlook period; it will increase by 2.6 million from 2010 to 9.5 million in 2035. Accordingly, Tajikistan's GDP per capita will reach $783 in 2035, which is about 2.8 times higher than the 2010 level at $279.

In the BAU case, the final energy demand of Tajikistan is projected to grow at 3.1% per year between 2010 and 2035 and its annual growth rate is likely to slow down gradually toward 2035. By sector, the other sectors (including residential, commercial, agriculture, and fishery) will account for 55.1% of the final energy demand in 2035, whereas the industry sector will follow but expand its share from 26.9% in 2010 to 40.1% in 2035. The transport sector will account for the rest (4.8%).

Among the sectors, the energy demand of the industry sector, where electricity is the only energy source utilized, is projected to register the fastest growth rate of 4.5% per year. This will be primarily influenced by Tajik Aluminium Company (TALCO), which is the single largest electricity consumer and accounts for 35% of total electricity demand.

[23] The Amu Darya flows into Uzbekistan and Turkmenistan.

Figure 8.8.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

By contrast, the growth rate of the other sectors' energy demand will be the most moderate at 2.3% annually. Within the other sectors, however, oil is projected to increase at a faster pace of 4.6% through 2035, partially because diesel generators can be used to arrange for emergency power capacity in case of an energy shortage (Melikyan and Ghuskassayan 2011).

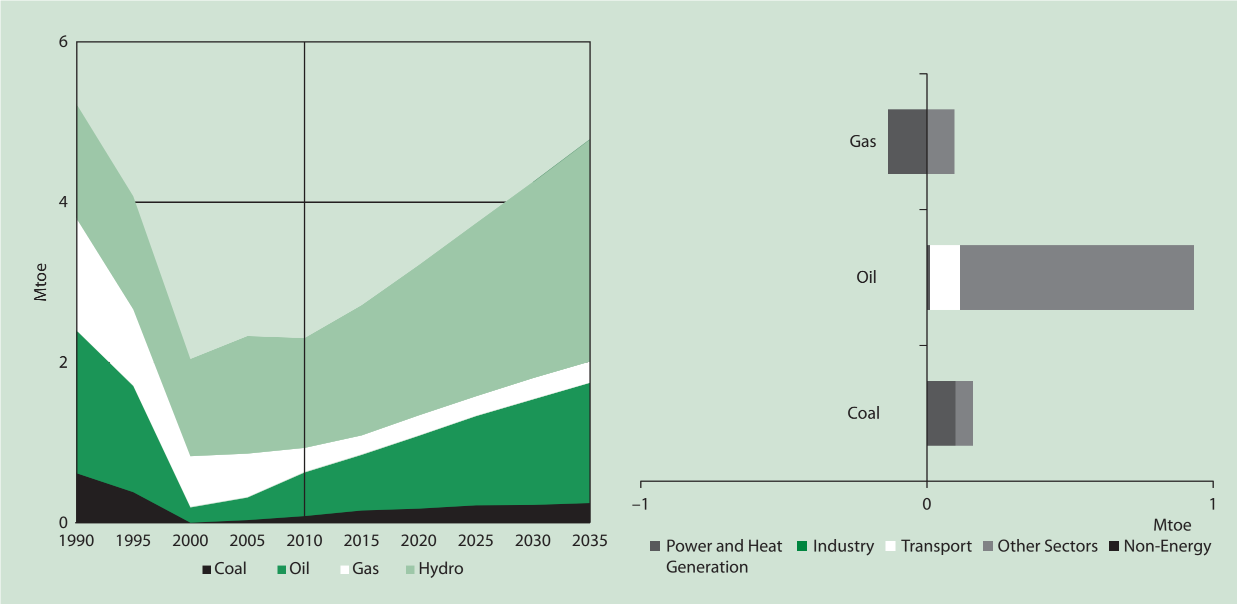
The energy demand of the transport sector will remain small and grow relatively slowly at an annual growth rate of 2.8% since Tajikistan is not likely to enter the motorization phase by 2035 unless the income level increases substantially.

Primary energy demand is projected to grow at 2.9% per year, from 2.3 million tons of oil equivalent (Mtoe) in 2010 to 4.8 Mtoe in 2035 in the BAU case. With steady economic development and population growth, Tajikistan's per capita energy demand will increase from 0.34 toe per person in 2010 to 0.50 toe per person in 2035.

In 2010, hydro accounted for more than half of Tajikistan's primary energy mix at 59.0%, followed by oil (23.4%) and natural gas (12.9%). Hydro will continue to occupy the biggest share in the energy mix over the outlook period. Oil's share in primary energy demand is projected to increase gradually through 2035, whereas that of natural gas will decrease. Coal demand is likely to increase after 2013 when a coal-fired combined heat and power plant with an installed capacity of 250 megawatts (MW) is planned to start operation in Dushanbe.

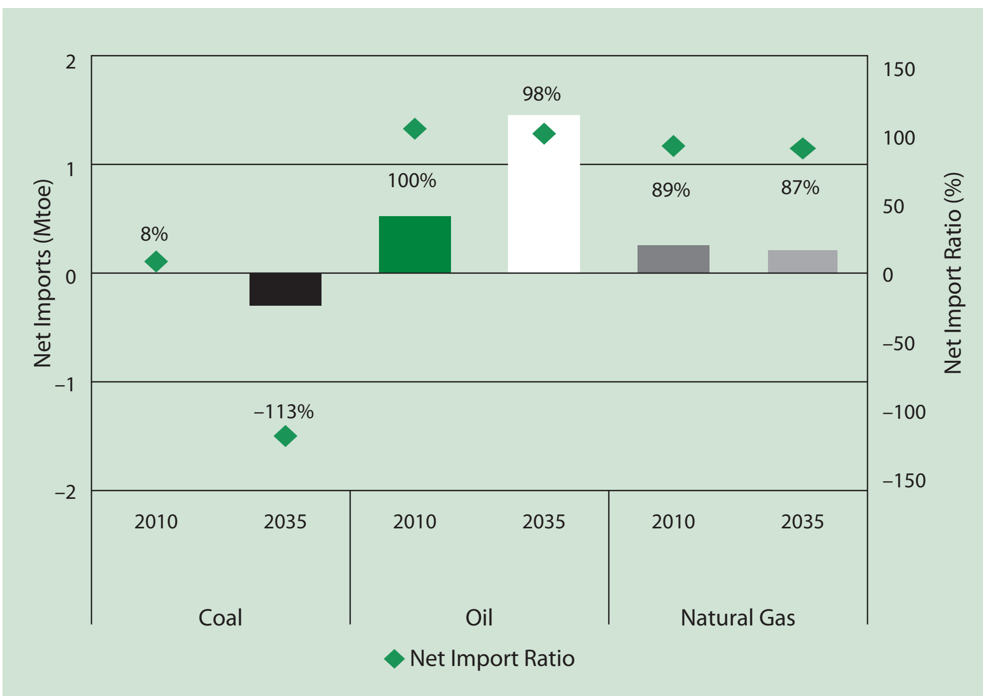
As to the sectoral contributions to the incremental energy demand growth from 2010 to 2035 shown in Figure 8.8.2, oil demand will demonstrate the biggest increase of 0.9 Mtoe, to which the transport and other sectors will contribute. While power and heat generation will account for more than half of coal demand increases, it will pull the gas demand downward.

Figure 8.8.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.

Figure 8.8.3 Net Imports of Coal, Oil, and Natural Gas, and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

Tajikistan is projected to remain a net importer of oil and natural gas. On the other hand, the country is expected to become a net exporter of coal after 2015 if the government's development program for the coal sector, which aims to produce 815,000 tons by 2015—a significant increase from the 2009 level of 176,000 tons—is carried out as planned (Melikyan and Ghuskassayan 2011).

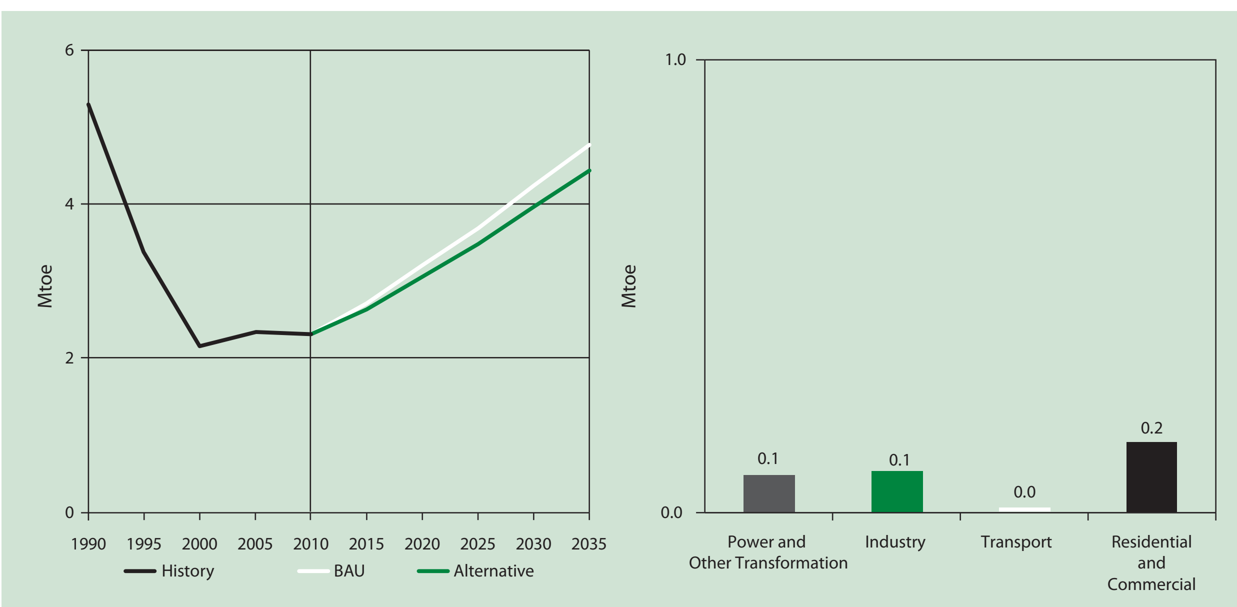
Alternative Case: Energy Savings Potential and Energy Source Diversification

In the alternative case, primary energy demand in Tajikistan will reach 4.4 Mtoe in 2035 at an annual growth rate of 2.6% due to the deployment of advanced technologies for energy savings (Figure 8.8.4). Compared with the primary energy demand in the BAU case in 2035, Tajikistan has the potential to save about 0.3 Mtoe in 2035 (or a 7.0% reduction).

By sector, the other sectors indicate the biggest energy savings potential at 0.2 Mtoe. Utilization of higher-efficiency appliances such as lighting and refrigerators mainly reflects the estimated potential savings. The industry sector will follow with a savings potential of 0.1 Mtoe. To what extent TALCO can apply advanced technologies to reduce demand for electricity is a key to improving energy efficiency of the industry sector on the whole. For the power sector and others, most of the energy savings are explained by the reduced power generation requirements based on the lower electricity demand.

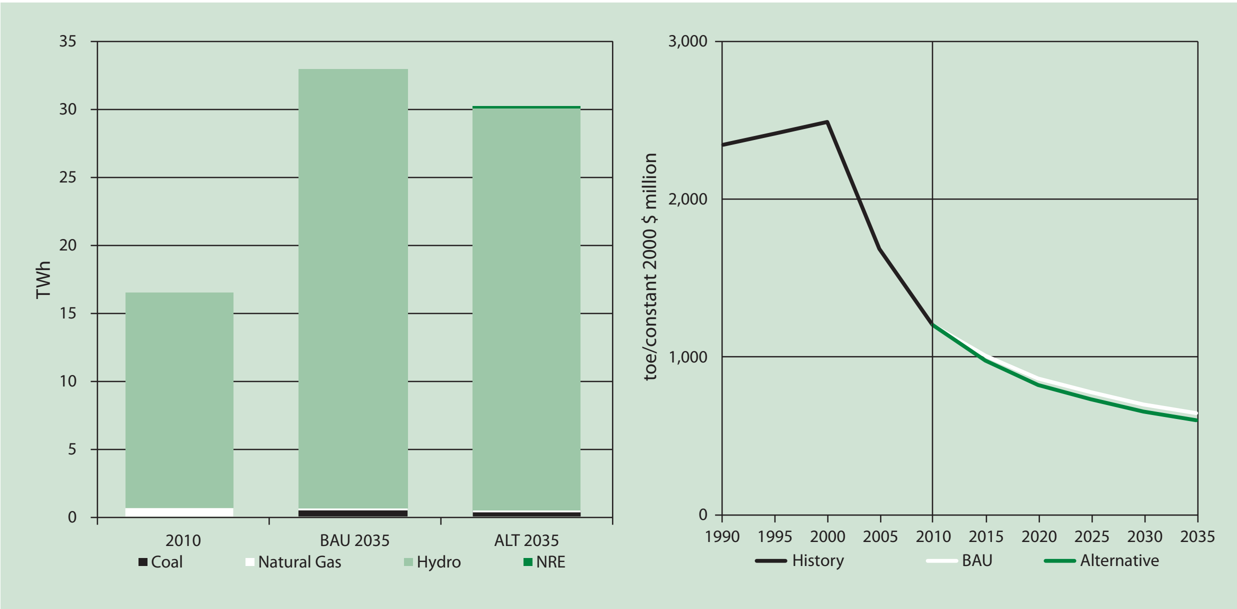
Electricity generation by energy type is compared between BAU and the alternative case in Figure 8.8.5. The total electricity generation in 2035 in the alternative case is approximately 8.0% lower than in the BAU case, mainly because electricity use efficiency is assumed to have improved in the industry and other sectors.

Figure 8.8.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Figure 8.8.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hours.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Hydro will remain dominant in the electricity generation mix through 2035 in both cases. Seasonable power supply fluctuations caused by exclusive reliance on hydropower is likely to continuously suppress electricity demand, unless reliability of supply and accessibility to electricity is improved. New and renewable energy for power generation is not expected to increase noticeably in the alternative case. Although potential for wind power has been identified, small hydro seems the most feasible option in terms of finance and technology, and it is included under hydropower.

Primary energy demand per GDP (i.e., energy intensity) will continuously decrease at a moderate pace. The energy intensity will decrease at an annual rate of 2.5% in the BAU case and 2.8% in the alternative case. The small energy savings potential in Tajikistan and the limited utilization of new and renewable energy in the alternative case are the reasons why there is a small difference between the rates of decrease in energy intensities of the BAU and alternative cases.

Energy Policy Implications

Unreliable power supply is a major culprit that hinders Tajikistan's economic development. Given that most energy infrastructure is obsolete, the energy sector requires huge investments for upgrades and replacement of the existing facilities. To this end, creating an appropriate and attractive business climate for private and foreign investors is indispensable. A fundamental requirement is to establish a legal framework that ensures transparency and accountability and that would protect the property rights of investors. Regulatory arrangements will also help create a sound financial management system that is designed to fix the arrears problem and raise tariffs to a cost recovery level. Additionally, facilitating a regional energy network will be beneficial for Tajikistan to implement economy of scale as well as enhance the energy security of the region.

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8.9 Turkmenistan

- *In the BAU case, the primary energy demand of Turkmenistan is projected to increase from 21.3 Mtoe in 2010 to 28.2 Mtoe in 2035, growing at an annual rate of 1.1%. In contrast, with the deployment of advanced technologies, the primary energy demand of Turkmenistan in the alternative case,* is projected to increase at a slower pace of 0.8% during the same period, and primary energy demand in 2035 will be 26.0 Mtoe (7.6% lower than BAU).*

Recent Energy Trends and Energy Policy Issues

Similar to the other economies in Central and West Asia, Turkmenistan's GDP declined sharply after the collapse of the former Soviet Union in 1990 until it hit bottom in 1995. The economy started rebounding from 1996 to 2003; however, its growth potential, building on its vast natural gas reserves (ranked fourth largest in the world), was constrained by the lack of export infrastructure in the landlocked country. With the operational start-up of the natural gas pipeline to the People's Republic of China (PRC) and Iran—on top of the already built pipeline to the Russian Federation—Turkmenistan was able to export larger volumes of natural gas, which greatly increased export earnings. Although natural gas exports temporary declined in 2008 from the previous year (as a result of reduced exports to the Russian Federation), Turkmenistan's GDP registered rapid growth, averaging 8.2% from 2004 to 2010, assisted by the high international natural gas prices and natural gas exports to the PRC and Iran.

In contrast to GDP growth at 8.2% per year from 2004 to 2010, the primary energy demand of Turkmenistan on average grew at a relatively slow rate of 3.5% per year during the same period. The decoupling of energy demand growth from GDP was mainly due to the combination of two factors. First, the government's policy to heavily subsidize the supply of electricity, gas, and water caused the sharp increase in energy demand by the other sectors (which include the residential and commercial sectors).[24]

Second, demand growth was offset by the decline in the energy requirements for natural gas production (categorized as own use sector), in line with the country's temporary decline in natural gas production from 2008 to 2010.

Turkmenistan's energy mix is primarily reliant on natural gas, accounting for 81% of primary energy demand in 2010. With its abundant natural gas reserves, Turkmenistan has not implemented a policy to promote energy efficiency or diversify energy sources away from a heavy dependence

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

[24] The public receives gas free of charge up to set limits, with the excess charged at TKM2 (approximately $0.70) per 1,000 cubic meters. The tariff for industrial customers is also subsidized, with Turkmenenergo receiving gas at $1.30 per 1,000 cubic meters. Gasoline up to 120 liters per month is provided free to private vehicle owners, with excess charged at $0.19 per liter. Industrial and commercial users also enjoy heavily subsidized tariffs. Residential consumers receive the first 35 kWh of electricity per person per month free with excess charged at TKM9.2 per 1,000 kWh ($0.003/kWh). Industrial users also enjoy subsidized tariffs. The average domestic utility tariff is $0.005 per kWh.

on natural gas. In addition, significant energy losses are observed from the use of obsolete energy supply infrastructure for production, processing, and delivery. In recognition of the importance of natural gas as the main contributor to export earnings, the country should establish policies and measures to promote the efficient utilization of available natural resources.

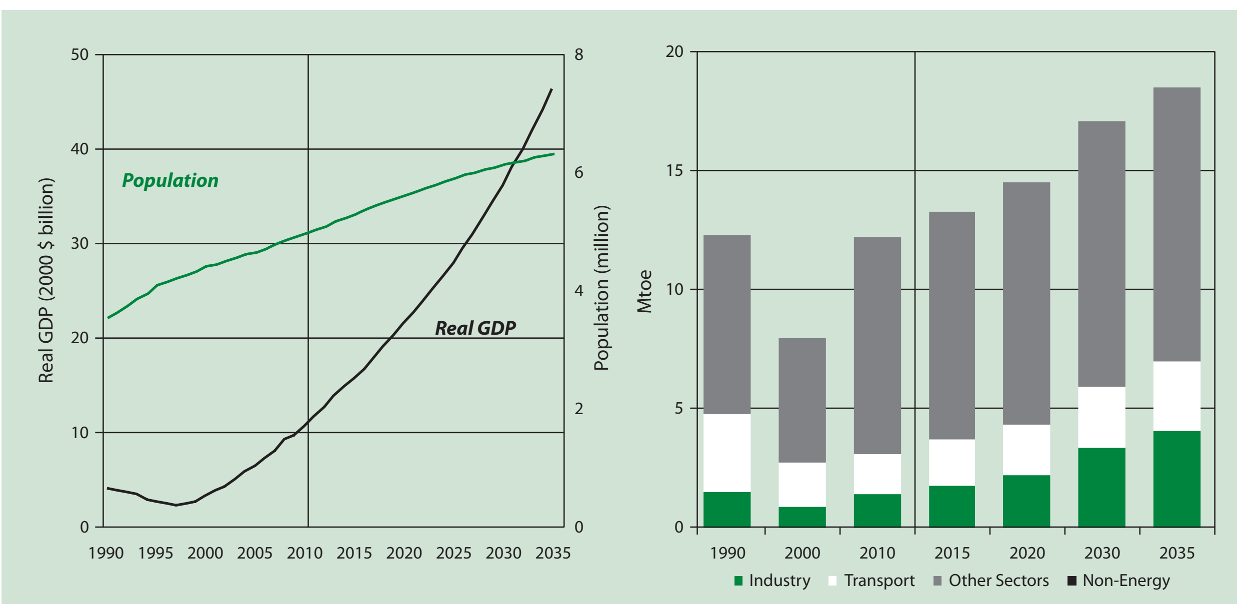
Business-as-Usual Case: Energy Demand Outlook through 2035

Over the outlook period, Turkmenistan's GDP is projected to increase at an annual rate of 6.2%. With this growth, the country's GDP will reach $46.4 billion (constant 2000 $) in 2035, increasing from $10.4 billion in 2010. The population is projected to increase from 5 million in 2010 to 6.3 million in 2035. As a result, per capita GDP will more than triple to $7,326 in 2035, compared with $2,062 in 2010.

In the BAU case, the final energy demand of Turkmenistan is projected to increase from 12.2 Mtoe in 2010 to 18.5 Mtoe in 2035 at an annual rate of 1.7%. This compares with the fast annual growth rate of GDP at 6.2% through 2035. Compared with GDP growth, the growth trend of final energy demand is moderate, as it is largely influenced by the relative slow growth trend (0.9% per year) of the other sectors (residential, commercial, agriculture, and fishery), accounting for 62.3% of final energy demand in 2035.

The other sectors' energy demand will maintain the most dominant share, while their growth rate will be the slowest at 0.9% per year. Meanwhile, the growth trend varies by energy type. Natural gas, the main energy type in the other sectors for cooking and heating, will continue to dominate at above 75% through 2035, and grow moderately at 1.0% per year over the outlook period. With the improvement in living standards, electricity demand will increase at a relative fast pace of 2.4% per

Figure 8.9.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

year through 2035, increasing its share from 5.3% in 2010 to 7.6% in 2035. In contrast, oil demand will decline at an annual rate of 0.2%, being increasingly replaced by natural gas and electricity.

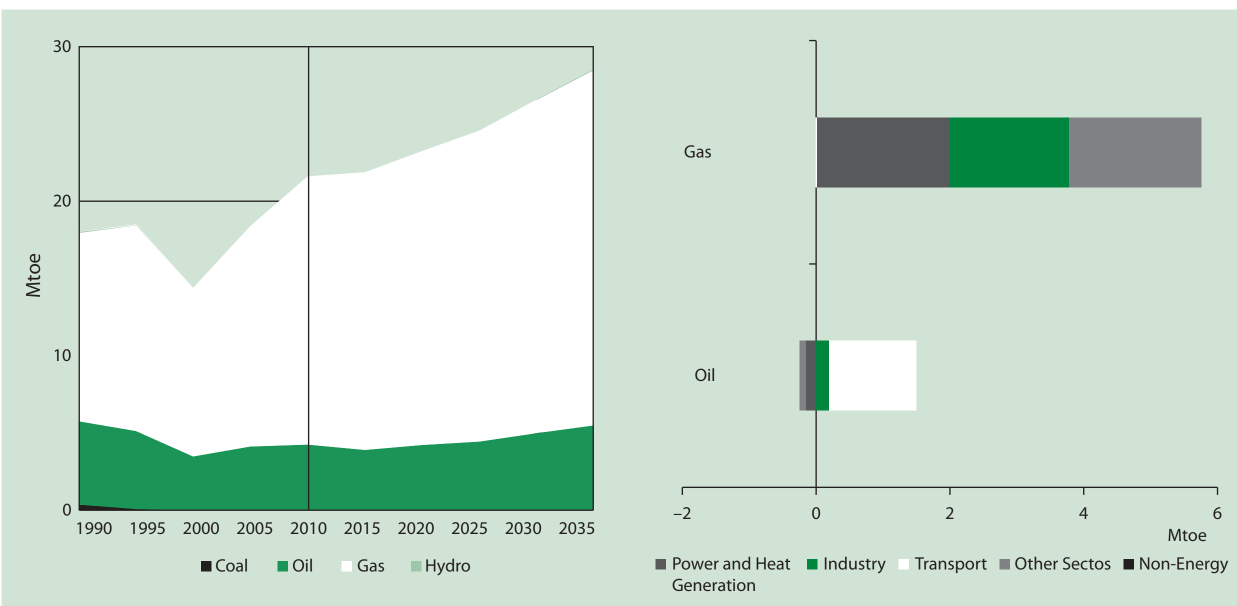
Starting at a low level, the industry sector's energy demand is projected to increase at a relatively fast rate of 4.2%. Aside from the oil and natural gas industry, the food processing, fabricated metal, and manufacturing industries are expected to grow. The free trade zone established in the nearby Caspian Sea area will host a significant amount of foreign investment and assist Turkmenistan's efforts toward industry diversification. By energy type, natural gas and electricity will boost the industry's activities, growing at an annual rate of 5.4% and 4.9%, respectively, by 2035.

The transport sector's energy demand is projected to increase at an annual rate of 2.3% through 2035. Along with a quadrupling of the income level, vehicle ownership will increase, and result in increases in oil demand. Compared with international standards, vehicle ownership per 1,000 population in Turkmenistan will be low at 80.1 units in 2035, increasing from 22.8 units per 1,000 population in 2010.

In the BAU case, the primary energy demand of Turkmenistan is projected to increase from 21.3 Mtoe in 2010 to 28.2 Mtoe in 2035 (Figure 8.9.2), growing at an annual rate of 1.1%. With this growth, Turkmenistan's per capita energy demand will reach 4.48 toe per person in 2035, compared with 4.23 toe in 2010.

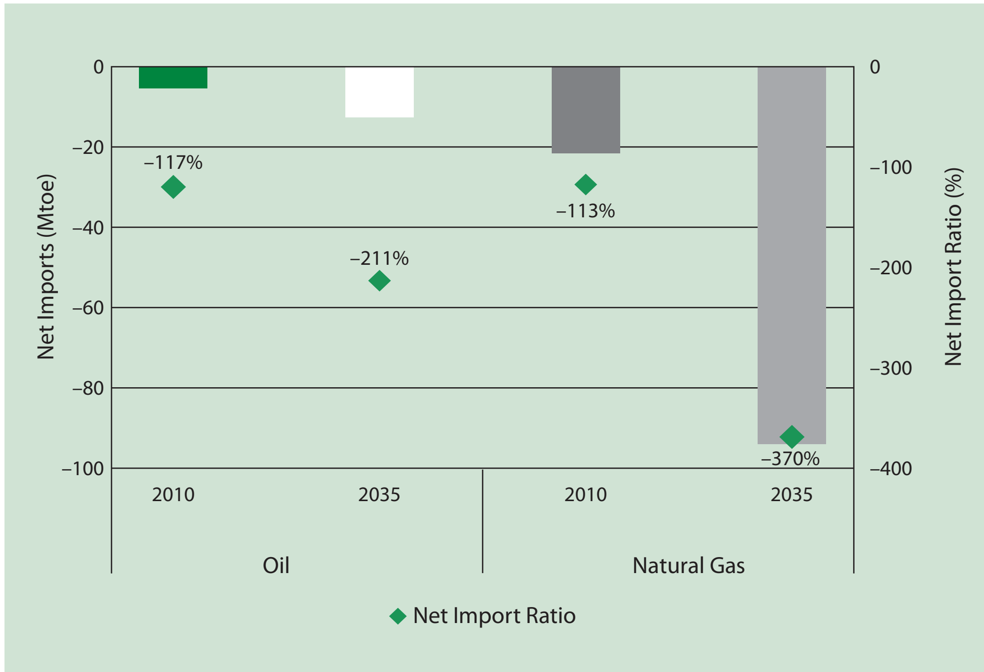
In terms of the incremental growth between 2010 and 2035, natural gas will represent the largest share at 5.4 Mtoe (Figure 8.9.2). Sectoral contributions are almost evenly spread across the power, industry, and other sectors. Growth in oil demand will account for 1.4 Mtoe from 2010 to 2035, driven mainly by the increase in the transport sector.

Figure 8.9.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 8.9.3 Net Imports of Oil, and Natural Gas, and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

Backed by substantial reserves, Turkmenistan's natural gas production will increase from the current 36.4 billion cubic meters (bcm) to 120 bcm in 2035. The projected natural gas production is smaller than in the government's plan at 250 bcm by 2030, in consideration of the constraints in the export pipeline capacity. About 80% of the total natural gas production in 2035 will be allocated to export. With the rise in exports, Turkmenistan's net export ratio of natural gas will reach 370% in 2035 from 113% in 2010 (Figure 8.9.3).

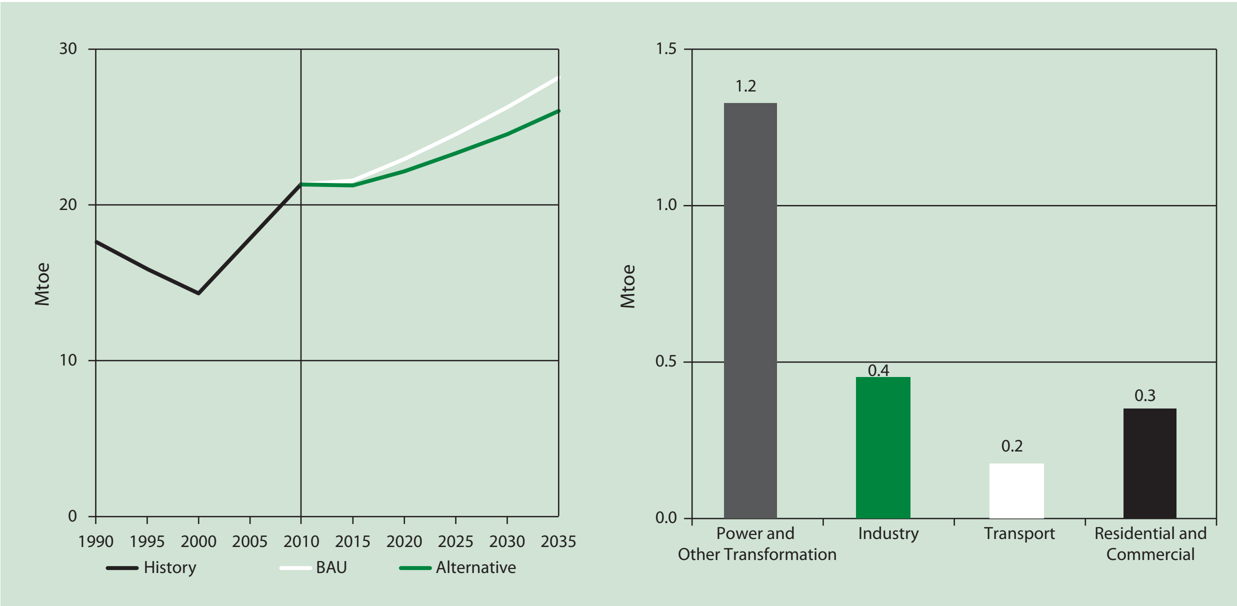
Oil production is projected to increase from 216,000 barrels per day in 2010 to 355,000 barrels per day in 2035. About 30% of the total production will be allocated to the domestic market, while the remainder will be exported by tanker to neighboring countries, including Azerbaijan and Iran.

Alternative Case: Energy Savings Potential and Energy Source Diversification

Turkmenistan has good energy savings potential. With the deployment of advanced technologies, Turkmenistan's primary energy demand in the alternative case will increase at a slower pace of 0.8% between 2010 and 2035, compared with that of BAU at 1.1% during the same period. With this growth, primary energy demand in the alternative case will reach 26.0 Mtoe in 2035 (Figure 8.9.4), or about 7.6% lower than in the BAU case.

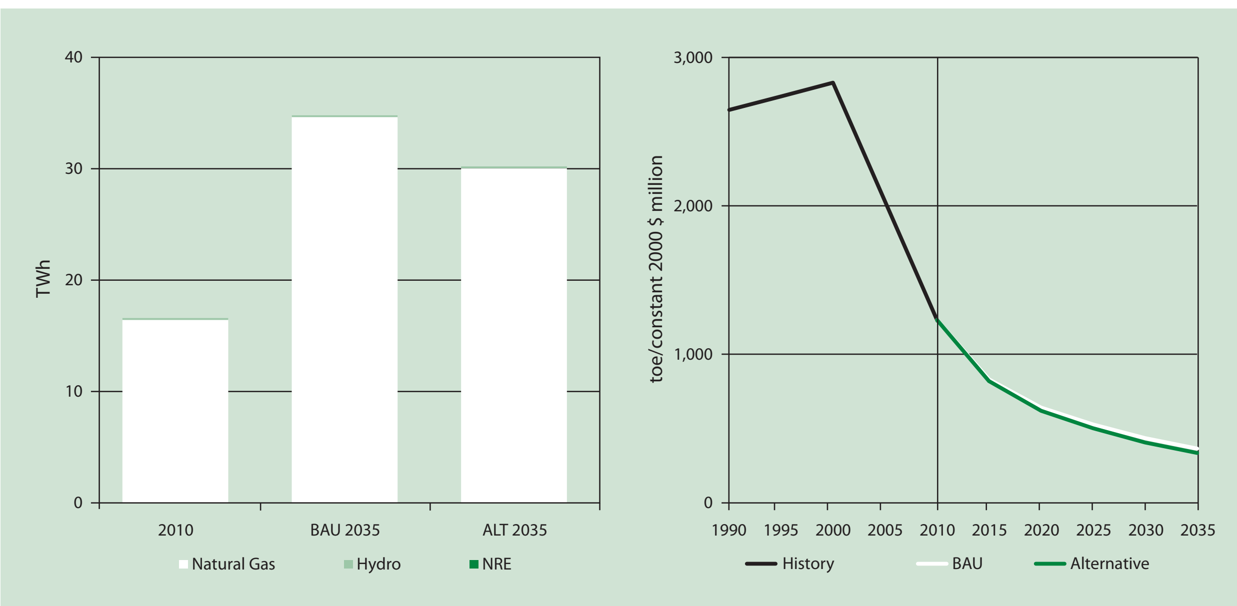
By sector, the power sector has the biggest energy savings potential at 1.2 Mtoe in 2035, followed by industry at 0.4 Mtoe, residential and commercial at 0.3 Mtoe, and transport at 0.2 Mtoe.

Figure 8.9.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Figure 8.9.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hours.

The power sector's energy savings will result from both supply-side thermal efficiency improvements and demand-side savings. About one-third of the entire savings would come from demand-side electricity savings.

In the alternative case, Turkmenistan's electricity generation in 2035 will be about 14% lower at 30.2 TWh in 2035, compared with that of BAU at 34.9 TWh (Figure 8.9.5). Electricity demand savings in the industry, residential, and commercial sectors will lead to this result. In terms of energy choice, excluding the small off-grid solar system, almost all of the generation will be met by natural gas backed by the vast domestic reserves, even in the alternative case.

Energy Policy Implications

The primary energy demand of Turkmenistan is projected to increase at a moderate rate of 1.1% over the outlook period. It is a much slower pace compared with the projected GDP growth rate of 6.2% during the same period. Despite moderate growth, Turkmenistan is required to upgrade and replace its obsolete energy supply infrastructure and build new facilities to meet the demand growth. Meanwhile, Turkmenistan's electricity and gas are supplied for free to residential and commercial customers, and industry customers enjoy low tariffs. Along with the demand increases, tariff reform may be required to ease the utilities' balance sheets and to allocate necessary financial resources to the upgrades, replacement, and new construction of infrastructure.

Deployment of advanced technologies can result in substantial energy savings in Turkmenistan. Despite the potential, a law on energy efficiency has not yet been promulgated. Because of the economic benefits from the energy savings, Turkmenistan could start formulating the necessary policies toward energy efficiency.

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8.10 Uzbekistan

- *In the BAU case, Uzbekistan's primary energy demand is projected to increase moderately at 1.0% over the outlook period, reaching 56.4 Mtoe in 2035. In contrast, with the deployment of advanced technologies, primary energy demand in 2035 will reach 51.8 Mtoe in 2035 in the alternative case,* about 8.2% lower than BAU.*
- *To realize the estimated energy savings potential, various policies and measures need to be implemented. A realistic option would be to take a prioritized approach, starting from the most cost-effective option that can achieve the largest energy savings. For example, judging by the magnitude of its potential energy savings, the power sector could be one priority area where energy savings efforts must be approached from both the demand and supply sides.*

Recent Energy Trends and Energy Policy Issues

Uzbekistan made a relatively fast recovery from the economic repercussions caused by the collapse of the former Soviet Union in 1990. GDP declined from 1990 to 1995 at 4.1% per year, and rebounded from 1996 onward with a positive annual growth of 6.2% through 2010. Specifically, Uzbekistan's GDP increased rapidly from the mid-2000s, mainly driven by exports of commodities, including copper, gold, natural gas, and cotton (World Bank 2012). These commodity price increases in the international market have helped boost the country's GDP growth as well (CIA 2012). In 2009 and 2010, Uzbekistan's GDP increased at an annual rate of 8.1% and 8.5%, respectively.

In contrast to the booming growth of the economy, the primary energy demand of Uzbekistan declined by 11.1% in 2009 and 2.5% in 2010. This decline was a result of the increased domestic sales prices of electricity, natural gas, and gasoline. Although the prices remain low compared with international standards, in 2010, for example, the electricity price increased by 17.7% and the natural gas price rose by 9% (Central Asia Newswire 2011). Previously, Uzbekistan had implemented a policy to maintain low price levels to allow energy to be affordable for the public; nevertheless, its policy has been gradually reoriented toward balancing three—often conflicting—factors: (i) energy efficiency improvement, (ii) social stability enhancement, and (iii) competitiveness of domestic enterprises (Mukhamedkhanova 2012).

In fact, the country's energy policy has been shifting toward an emphasis on improvement of energy efficiency and deployment of renewable energy sources for the sustainable utilization of natural gas, which is Uzbekistan's main export commodity. With the historical policy to ensure affordability of energy sources, in addition to the obsolete energy supply infrastructure resulting in energy supply losses, Uzbekistan's energy intensity (in terms of primary energy demand per GDP) in 2010 stood at 1,639 toe per GDP (million constant 2000 $), or 57% higher than the average level in Central and West Asia. The Law on Rational Energy Utilization was established in 1997 and an amendment was made in 2003. The law stipulates the scope, state responsibility, and economic mechanisms for energy efficiency improvement and renewable energy usage; however, it will be

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

important to ensure that management mechanisms are put in place—which they are currently not—to enforce the measures specified in the law (EBRD n.d.).

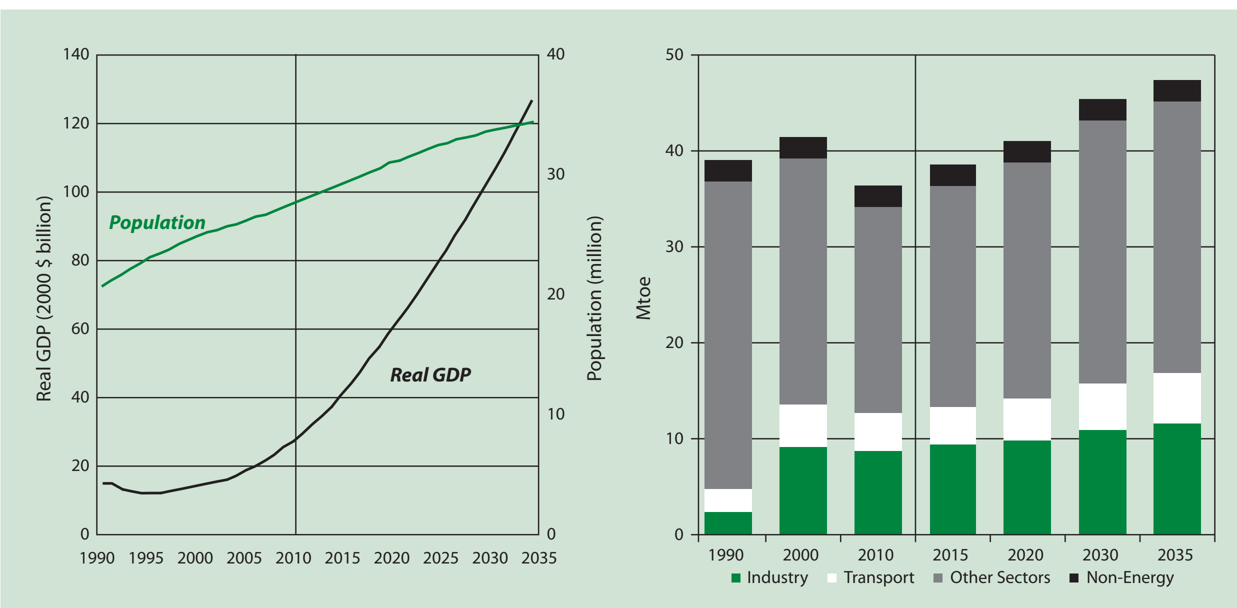
Business-as-Usual Case: Energy Demand Outlook through 2035

Uzbekistan's GDP is projected to increase at 6.4% per year from 2010 to 2035. The near-term growth is projected to be much faster at 8.0% (2010–2020), driven mainly by the increased export of natural gas, in contrast to the long-term projected growth at 5.3% (2020–2035). Uzbekistan's population will reach 34.2 million in 2035 from 27.4 million in 2010 (Figure 8.10.1).

Final energy demand is projected to increase at an annual rate of 1.1% per year from 2010 to 2035. With this growth rate, Uzbekistan's final energy demand will increase by 30% from the 2010 level, reaching 42.5 million tons of oil equivalent (Mtoe) in 2035. Growth trends show a somewhat similar speed across the sectors, with industry at 1.1% per year, transport at 1.1%, and others (residential, commercial, agriculture, and fishery) at 1.1%.

The other sectors' energy demand dominates the final energy demand, accounting for over 60% throughout the projection period. While the overall growth trend remains moderate at 1.1% through 2035, growth trends differ by energy type. Natural gas, used mainly for heating and cooking, will grow at the fastest rate of 1.7% per year through 2035. In Uzbekistan, more than 80% of the entire population has access to the city gas infrastructure, and further improvement in access will assist the growth. Meanwhile, electricity demand is projected to increase moderately at 0.8% per year by 2035. Almost the entire population has access to electricity in Uzbekistan and not much of an additional increase is expected. In terms of shares, natural gas and electricity will represent about 95% of the entire energy demand of the sector in 2035. In contrast, the demand for heat will decline at an annual rate of 5.6% through 2035, as it will be increasingly replaced by natural gas as the gas supply infrastructure is developed.

Figure 8.10.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

The industry sector's energy demand will grow at 1.2% through 2035. Currently, natural gas dominates the industry sector's energy demand, accounting for 77% in 2010, while it will grow moderately at 0.7% per year by 2035, reaching a 68% share in 2035. In contrast, with the development of the manufacturing industry (such as automobiles and agricultural machinery), demand for electricity will grow at a faster pace of 2.8% per year through 2035. With this growth rate, the share of electricity in the industry sector will reach 27% in 2035, increasing from 18% in 2010.

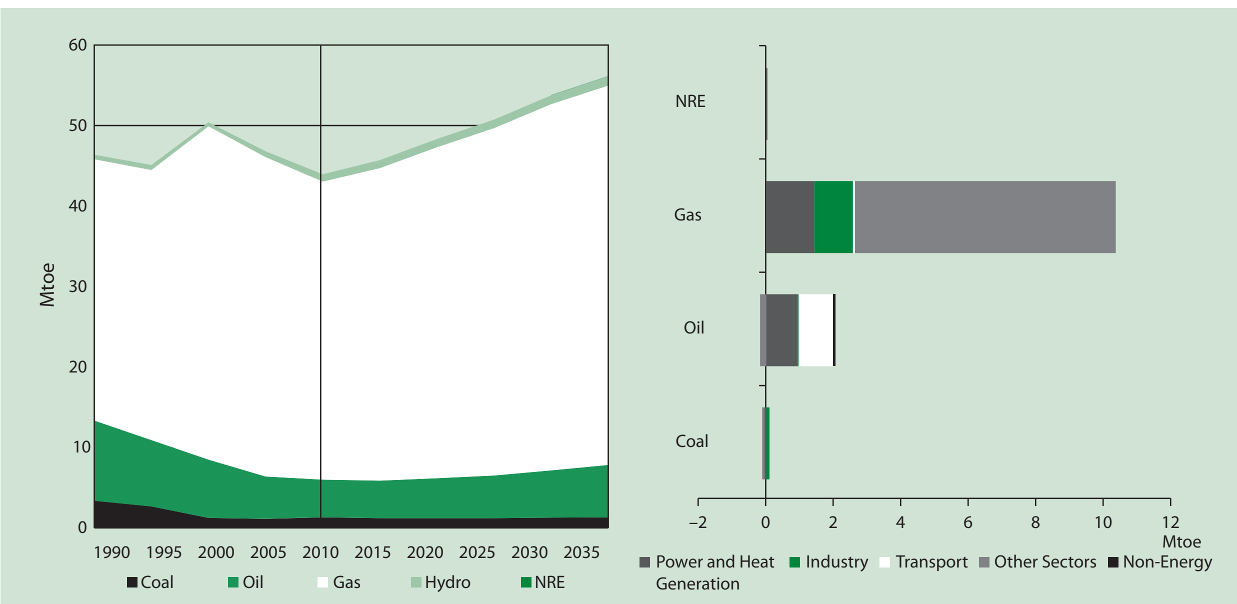
In the transport sector, the overall energy demand is projected to increase at 1.1% per year through 2035. Oil, the main energy source fueling the needs of mobility and freight transport, will grow at a faster annual rate of 1.6% per year. In 2010, the vehicle stock (including passenger vehicles and trucks) of Uzbekistan was 66.2 per 1,000 population, which will increase to 137.3 per 1,000 population by 2035.

In the BAU case, Uzbekistan's primary energy demand is projected to increase from 44.1 Mtoe in 2010 to 56.4 Mtoe in 2035, growing at an annual rate of 1.0%. As its population will grow at an annual rate of 0.9% during the same time, Uzbekistan's per capita energy demand will remain almost unchanged to reach 1.60 toe in 2035, compared with 1.57 toe in 2010.

Primary energy demand growth will be led mostly by natural gas, as Figure 8.10.2 shows. In terms of the sectoral contributions to natural gas demand growth, the other sectors will account for the largest share (more than 74.6 % of the total incremental growth of natural gas).

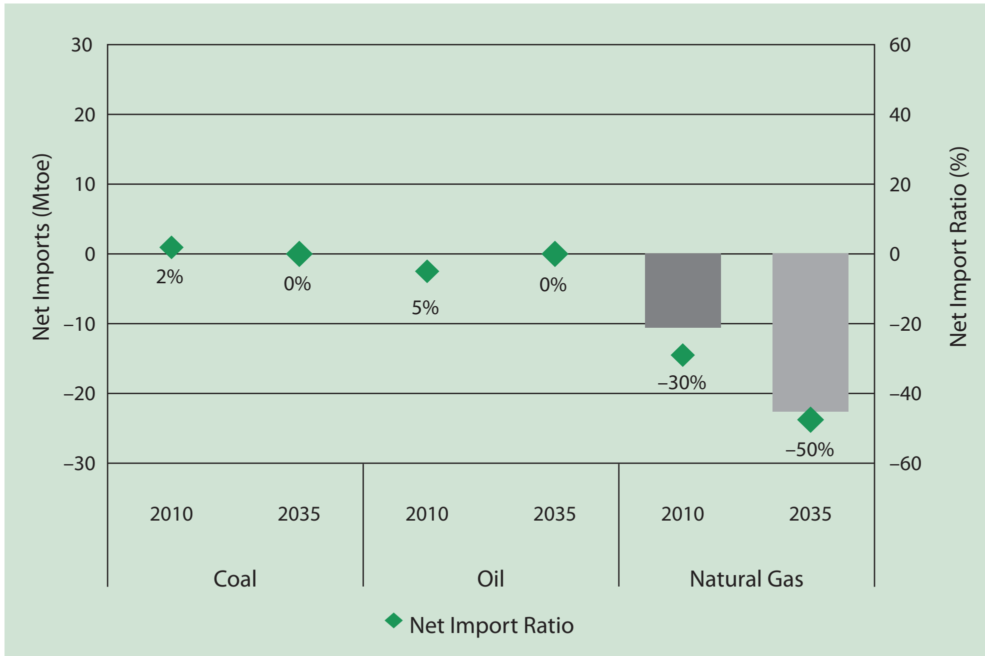
Although the production of Uzbekistan's existing natural gas fields such as Kokdumalak and Shurtan has plateaued, the intensified exploration and production efforts in the southwestern Gazli region will lead to increases in natural gas production from 60 bcm in 2010 to 71 bcm in 2015 and 80 bcm in 2035 (EIA 2012). Uzbekistan's oil reserves are limited to 594 million barrels, and production will moderately increase to 141,000 barrels per day in 2035, from 107,000 barrels

Figure 8.10.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 8.10.3 Net Imports of Coal, Oil, and Natural Gas, and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

per day in 2010. As domestic oil demand will increase faster than production, Uzbekistan will become marginally able to meet domestic demand through 2035 (Figure 8.10.3).

Alternative Case: Energy Savings Potential and Energy Source Diversification

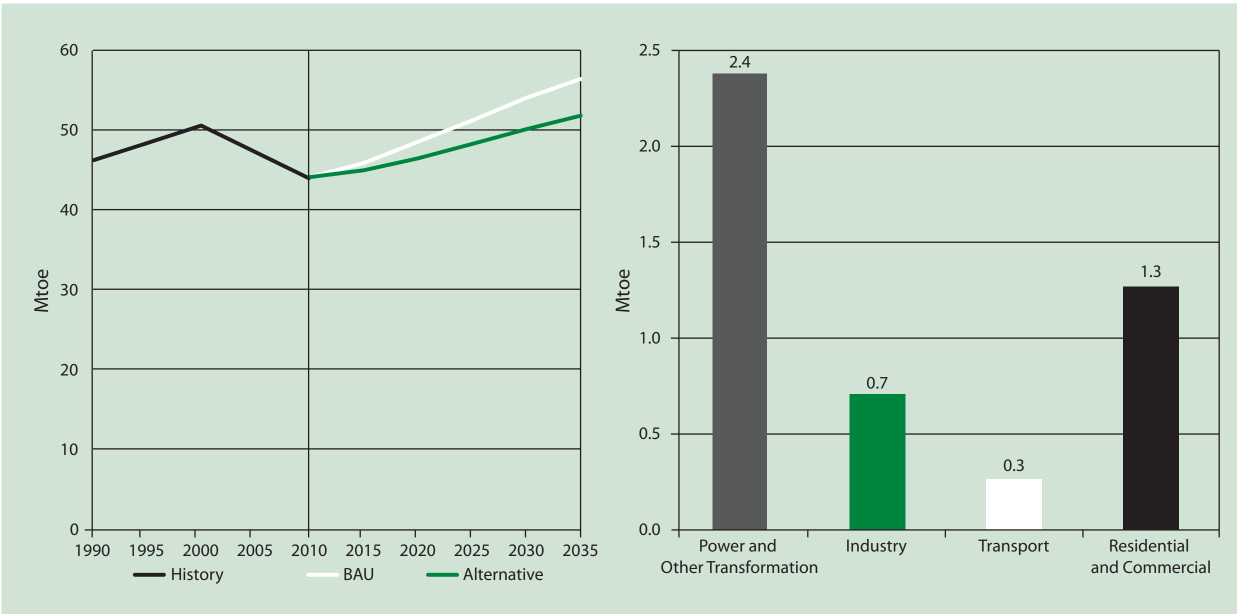
The deployment of advanced technologies for energy savings will result in some energy savings in Uzbekistan. In the alternative case, Uzbekistan's primary energy demand will increase at a slower pace of 0.6% per year by 2035. With this growth, Uzbekistan's primary energy demand will reach 51.8 Mtoe in 2035 (Figure 8.10.4), or 8.2% lower than BAU.

By sector, the power sector represents the biggest energy savings in the alternative case—compared with BAU—at 2.4 Mtoe in 2035, followed by residential and commercial at 1.3 Mtoe, industry at 0.7 Mtoe, and transport at 0.3 Mtoe.

The power sector's energy savings are a combination of two factors: lower input fuel requirements caused by electricity demand savings, and thermal efficiency improvement of power generation units. Of the power sector's total energy savings, thermal efficiency improvement accounts for about 28% in 2035.

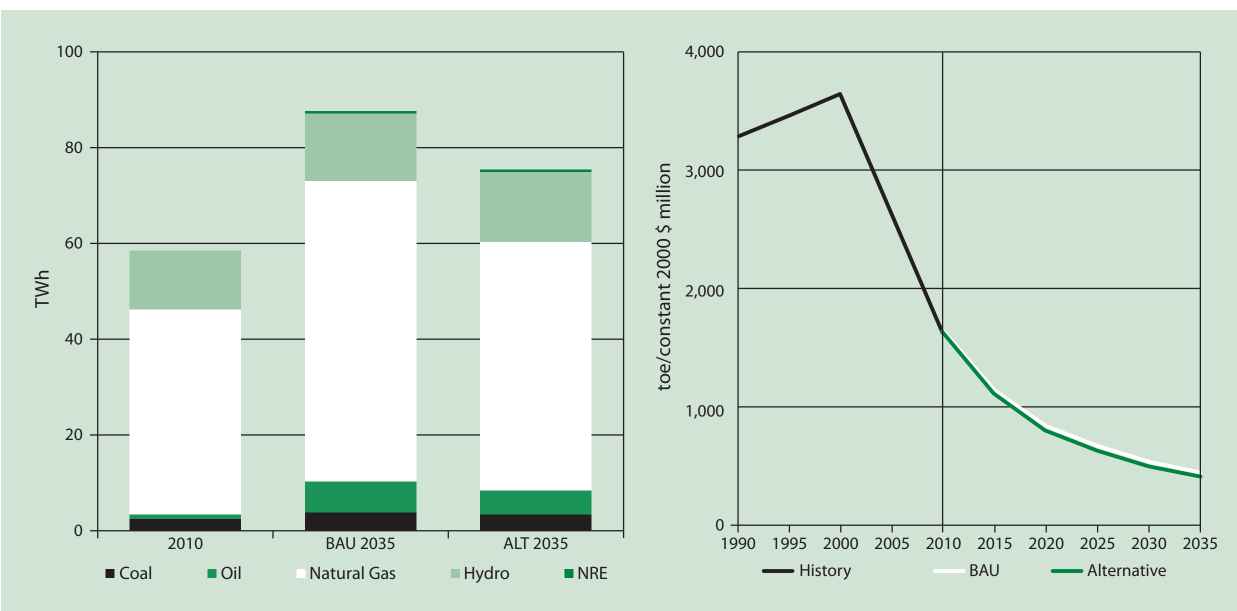
The residential and commercial sectors' energy savings at 1.3 Mtoe in 2035 come from electricity savings as a result of efficient appliances deployment (0.7 Mtoe) and lower fuel requirements for space heating (0.6 Mtoe). The major appliances that contribute to the electricity savings are lighting and refrigerators.

Figure 8.10.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Figure 8.10.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hours.

The industry sector's energy savings at 0.7 Mtoe in 2035 are a result of the deployment of advanced technologies in the various industry subsectors, including cement, refineries, paper and pulp, and others.

The transport sector's energy savings will be 0.3 Mtoe in 2035, or about 6% lower than in the BAU case. This is a result of shifts toward higher fuel economy vehicles (mainly hybrid and electric vehicles).

In the alternative case, Uzbekistan's electricity generation in 2035 will reach 67.6 terawatt-hours (TWh), or about 14% lower than BAU at 78.7 TWh in the same year (Figure 8.10.5). This will come from demand-side savings of the industry, residential, and commercial sectors.

By energy type, the generation mix is not much different from that of BAU, excluding some additions of new and renewable energy sources (for wind power and solar).

Energy Policy Implications

As the country's energy policy shifts highlight, Uzbekistan is in a process toward improving energy efficiency. A sizable impact can already be observed from the pricing reforms in recent years. With further economic development in the future, Uzbekistan has some potential to save energy. According to the analysis, the country's energy savings potential is about 8.2% by 2035. To achieve the estimated energy savings, various policies and measures need to be implemented. A realistic approach would be to prioritize the implementation of the most cost-effective options. For example, looking at the magnitude of potential energy savings, the power sector could be one priority area in which energy savings efforts can be approached from both the demand and supply sides.

Uzbekistan has a plan to promote alternative energy sources, including small hydro and solar. Meanwhile, its potential is restricted by a lack of supporting tangible policies and measures. Aside from the introduction of policies and measures, financial mechanisms are essential to ensure the economic competitiveness of new and renewable sources against conventional electricity generation reliant on natural gas.

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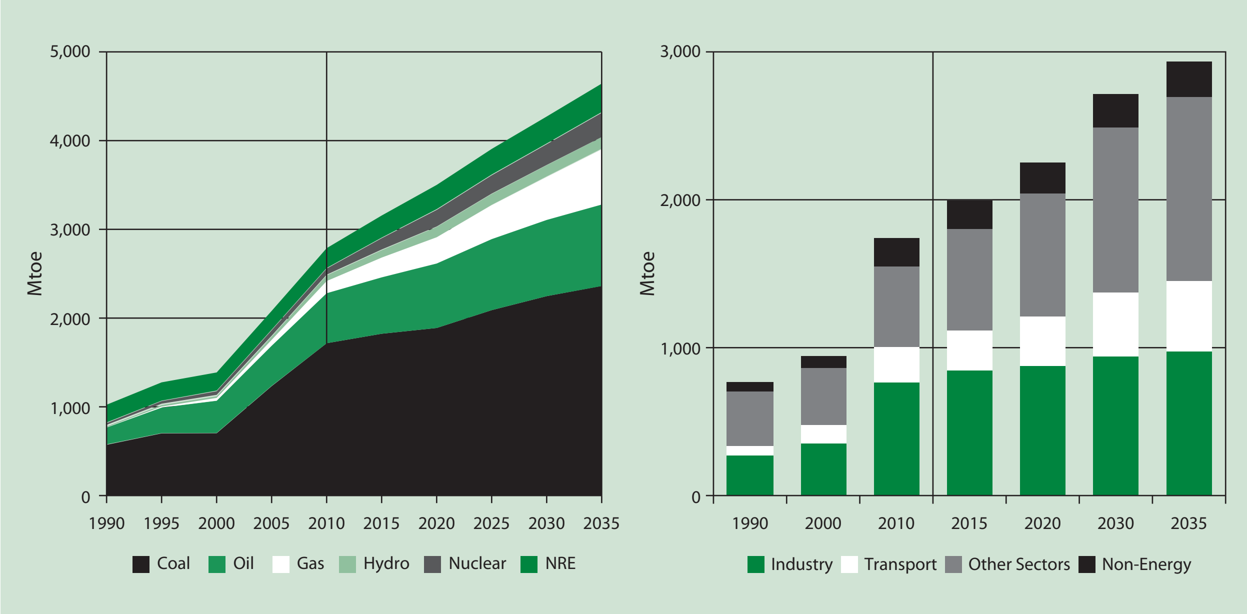
Chapter 9

East Asia

East Asia

- *In the business-as-usual (BAU) case, East Asia's primary energy demand is projected to increase from 2,793.0 million tons of oil equivalent (Mtoe) in 2010 to 4,656.3 Mtoe in 2035 at an annual rate of 2.1% (Figure 9.1). Of the total primary energy demand of East Asia, the People's Republic of China will account for 90.6% in 2035.*
- *In the alternative case,* the primary energy demand of East Asia will reach 3,842.3 Mtoe by 2035, reflecting an average annual growth rate of 1.2% for the period 2010–2035 (Figure 9.2). East Asia has the potential to save about 814.0 Mtoe in 2035, a 17.5% reduction compared with the BAU case. Similarly, East Asia's electricity generation will be reduced by 16.8% in the alternative case.*
- *Energy security enhancement, particularly in oil and natural gas, will continue to be important on the policy agenda for East Asia due to lack of domestic resources. Aside from the continued efforts for energy efficiency improvement and energy source diversification—particularly away from oil—the region as a whole could make concerted efforts in overseas upstream investment as well as in infrastructure development to further strengthen the supply security in a flexible manner..*

Figure 9.1 Primary Energy Demand (left) and Final Energy Demand (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

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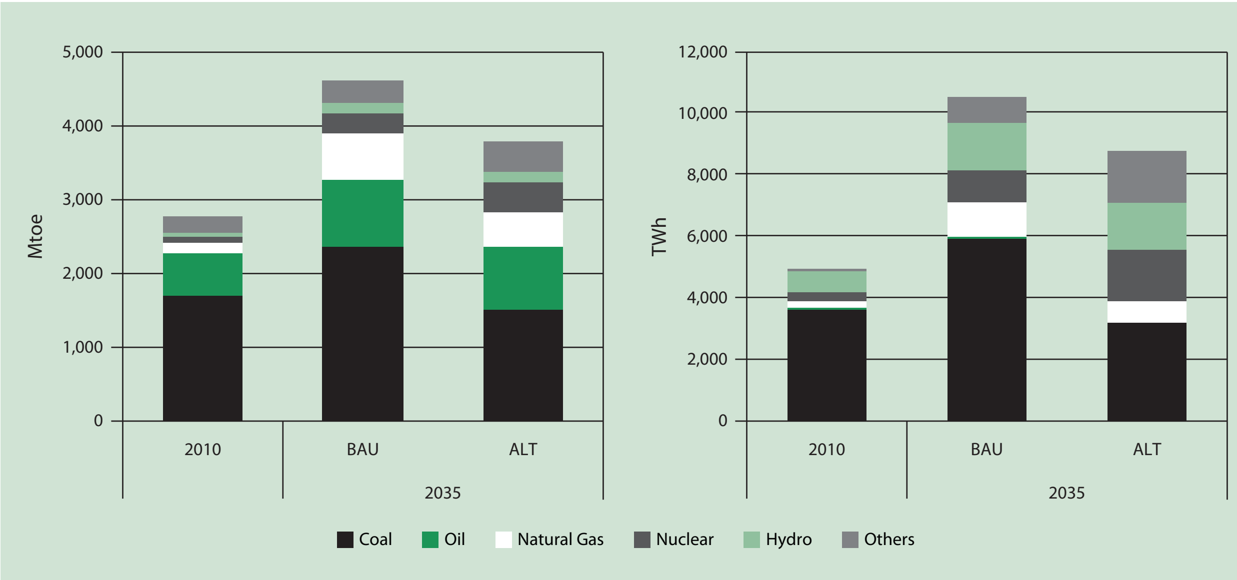
* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

Figure 9.2 Business-as-Usual and the Alternative Case: Primary Energy Demand (left) and Electricity Generation (right)



ALT = alternative case, BAU = business-as-usual case, Mtoe = million tons of oil equivalent, TWh = terawatt-hour.

9.1 People's Republic of China

- *In the BAU case, the primary energy demand of the People's Republic of China (PRC) is projected to increase from 2,417.1 Mtoe in 2010 to 3,098.0 Mtoe in 2020 and 4,218.1 Mtoe in 2035, growing at an annual rate of 2.3%. Primary energy demand per capita will reach 2.23 toe per person in 2020 and 3.05 toe per person in 2035, from 1.80 toe per person in 2010.*
- *In contrast, there is a substantial energy savings potential with the deployment of advanced technologies. In the alternative case,* about 799.4 Mtoe of primary energy demand savings can be achieved in 2035 compared with BAU. The power and industry sectors in the PRC will contribute around 80% of the energy savings.*
- *Energy efficiency improvement on both the demand and supply sides will continue to be policy agenda priorities as the country's energy demand is expected to grow faster than the pace of domestic production of oil and natural gas.*

Recent Energy Trends and Energy Policy Issues

The energy demand of the PRC increased drastically in the early half of the new millennium's first decade. The annual growth rate of the energy demand was above 10% in several years, and the energy elasticity of the gross domestic product (GDP)[25] was bigger than 1. In the 11th Five-Year Plan period (2006–2010), energy demand growth slowed down, attributed to the strong comprehensive policies to promote energy efficiency. Regardless, the average annual growth rate during 2000–2010 was high at 8.2%. Rapid urbanization and the resulting need for vast infrastructure development has contributed the ballooning energy demand growth. In 2010, the PRC became the world's biggest market of automobiles. Presently, the PRC is the largest energy producer and consumer—and carbon dioxide (CO_2) emitter—in the world. However, energy demand per capita of the PRC in 2010 was 1.8 tons of oil equivalent (toe) per person, almost the same level as the global average, but less than half of that in developed members of the Asian Development Bank (ADB).

With abundant resources, the PRC is the world's largest coal producer and consumer. In 2010, coal consumption in the PRC was 1,595.1 Mtoe, accounting for 69.3% of the total coal demand of ADB members. In 2010, 66.0% of primary energy and 79.7% of electricity in the PRC were provided by coal. The PRC is also attempting to build more plants to convert solid coal to oil or gas at low cost. More than 90% of coal demand is satisfied by domestic production. However, due to the high price in the domestic coal market, coal imports rose substantially from 2009, and reached more than 160 million tons in 2010. Although the import may continue to increase, domestic production will remain the major source to meet the domestic demand.

The PRC is the world's second largest consumer and fourth largest producer of oil. The country's growing oil demand is increasing its reliance on imports. According to BP statistics, the PRC

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

[25] The energy elasticity of GDP refers to the ratio of the percentage change in GDP to the percentage change in primary energy demand.

imported 294.5 million tons of crude oil and oil products in 2010, accounting for 11.2% of global oil imports. The oil import dependency was 60% in 2010. The PRC is striving to enhance the diversity of foreign suppliers and transportation routes of oil. Operations on the oil pipeline from Kazakhstan began in 2006 and the pipeline from East Siberia was completed in 2010. A 771-kilometer pipeline that will transport Middle East oil via the Indian Ocean is under construction at the time of writing. To strengthen the country's energy security, the stockpiling of oil has been promoted.

The demand for natural gas in the PRC increased rapidly, and the average annual growth rate during 2000–2010 was more than 15%. To satisfy the burgeoning demand, the PRC expanded domestic production and boosted the import of pipeline gas and liquefied natural gas (LNG). Since 2009, gas has been imported from Central Asia and a number of LNG terminals have been built in the coastal areas, with more planned. In July 2013, China National Petroleum Corporation switched on the 793-kilometer pipeline that connects the Bay of Bengal with Yunnan Province, which is expected to transfer 12 billion cubic meters of gas to the PRC annually. The PRC is also trying to develop nonconventional gas, which is estimated to be abundant in the inland regions.

The PRC has also set ambitious targets for nuclear power. Following the Fukushima nuclear accident in Japan, the PRC has suspended the permission to build new nuclear power stations, strengthened nuclear power safety plans, and moderated expansion. According to the medium- and long-term nuclear development plan (2011–2020) decided in October 2012, the new target for nuclear power is 40 gigawatts (GW) by 2015 and 58 GW by 2020.

The PRC also has huge resources of renewable energy and hydro and wind power have achieved rapid growth. Presently, the PRC has the world's largest installed capacity of hydro and wind power. The 12th Five-Year Plan (2011–2015) included the target for hydropower at 290 GW (including 30 GW pumped-storage power) by 2015 and 420 GW (including 70 GW pumped-storage power) by 2020, and for wind power at 100 GW by 2015 and 200 GW by 2020. The target for solar power is 21 GW by 2015 and 50 GW by 2020.

Within the PRC, the eastern coastal areas are the main energy consumer and the western inland areas are the main energy producer. To transport the fossil fuel and electricity, a number of railways, pipelines, and ultra high voltage transmission lines have been built.

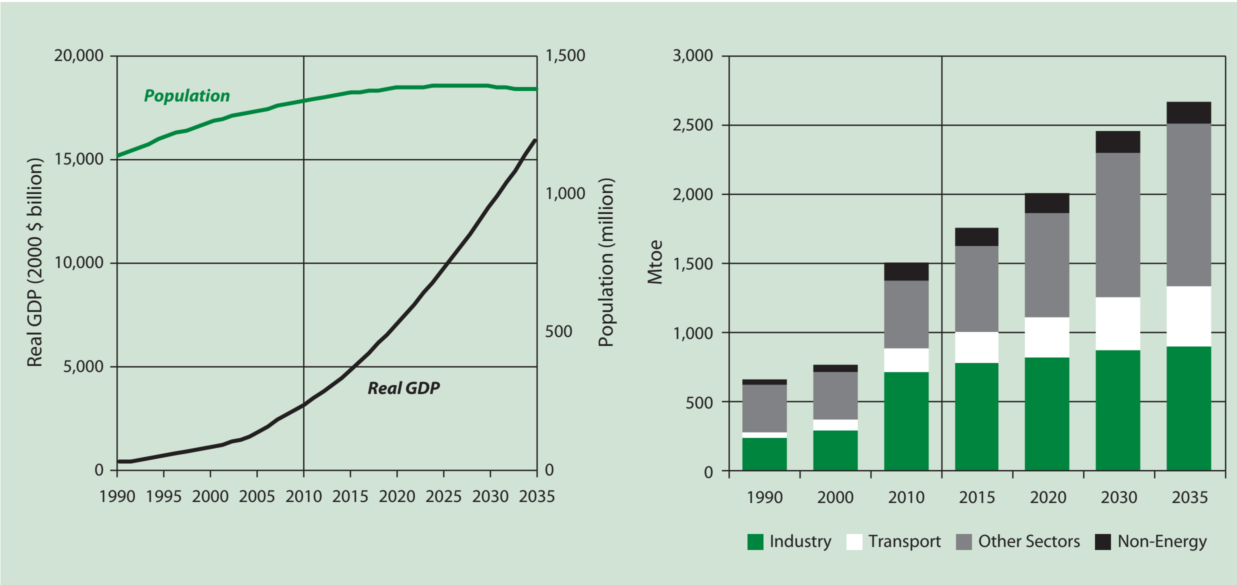
Since the 11th Five-Year Plan, the PRC has strongly promoted energy savings. A large number of inefficient plants and equipment were discarded, and the goal of improving energy intensity of GDP by 20% during 2006–2010 was almost achieved. The new goal announced in the 12th Five-Year Plan is to reduce energy intensity of GDP by 16% of its 2010 value by 2015, and to bring down total primary energy demand to under 2,800 Mtoe by 2015.

In the new five-year plan, the government also commits to a 17% improvement in CO_2 intensity of GDP by 2015 compared with 2010 and in the long term to reduce the GDP CO_2 intensity in 2020 to 40%–45% below the 2005 level.

Business-as-Usual Case: Energy Demand Outlook through 2035

Over the outlook period, the PRC's GDP is projected to increase at an annual rate of 6.6%. With this growth, GDP will be $15,872 billion (constant 2000 $) in 2035, almost five times that in 2010 (Figure 9.1.1). The population is projected to increase at a moderate pace of 0.3% during the

Figure 9.1.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

2010s and peak at around 1,390 million in the 2020s, dropping to 1,380 million in 2035. GDP per capita will rise from $2,420 in 2010 to about $11,500 in 2035.

In the BAU case, the PRC's final energy demand is projected to increase at an annual rate of 2.3% through 2035—a slower rate compared with the projected GDP growth rate of 6.6% during the same period. The total amount will rise to 2,684.5 Mtoe in 2035 from 1,512.2 Mtoe in 2010.

By sector, the other sectors (including residential, commercial, agriculture, and fishery), whose share was the second largest in 2010 at 32.2%, will increase demand rapidly at 3.6% per year to 1,176.6 Mtoe in 2035. Their share will be the largest at 43.8% in 2035. In contrast, industry energy demand, which accounted for the largest share in 2010 at 47.1%, will moderately increase at 1.0% per year over the outlook period, and reach 902.8 Mtoe in 2035 with a drop in its share to 33.6% in 2035. Transport energy demand will increase at 3.6% per year through 2035, reaching 436.7 Mtoe in 2035, 2.4 times the 2010 level. Its share will rise from 12.1% in 2010 to 16.3% in 2035.

In the other sectors, a large amount of noncommercial biomass is being consumed by rural households (accounting for about 40% of the other sectors' energy demand). With progress in urbanization and improvement of living standards, the utilization of electricity and natural gas will increase rapidly. The share of electricity and natural gas will rise respectively from 19% and 6% in 2010 to 37% and 18% in 2035. The share of biomass will drop to 19% during the same period. Coal's share will decrease from 16% in 2010 to 6% in 2035, and oil will maintain its share around 10%.

Within the industry sector's energy demand, coal will reduce its share from 57% in 2010 to 46% in 2035, due to the reduced production of the main coal consumer—the basic material industries such as steel and iron, and cement. In contrast, the industry sector's share in the electricity demand will increase from 28% in 2010 to 34% in 2035. Natural gas demand will achieve the fastest growth during the outlook period, and its share will rise to 6.4% in 2035 from 2.4% in 2010. The share of oil will increase slightly from 6.9% in 2010 to 8.2% in 2035.

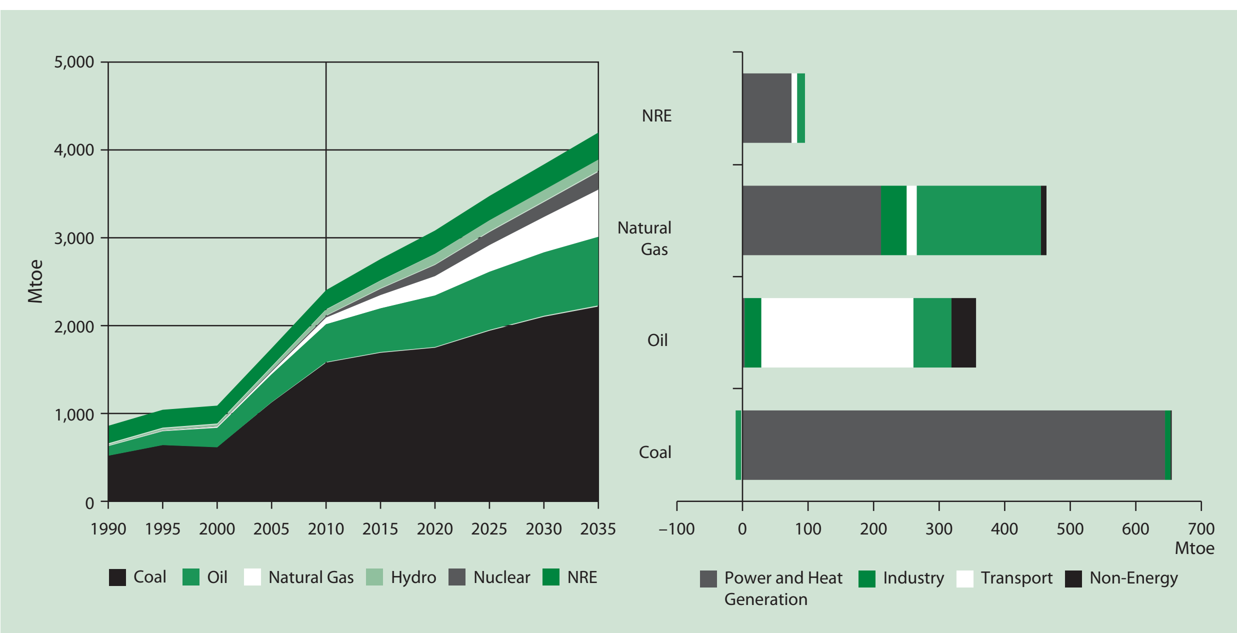
In the transport sector, oil is the main energy source fueling the increasing transport needs of progressive motorization in the PRC. However, because of the dissemination of new energy-type vehicles, the demand for gas and electricity will achieve more rapid growth. During the outlook period, the share of oil will decrease to 91% in 2035 from 96% in 2010 and the share of gas and electricity will respectively rise from 0.3% and 1.7% in 2010 to 3.6% and 2.7% in 2035. The share of biofuels will increase from 0.8% in 2010 to 2.2% in 2035.

In the BAU case, the primary energy demand of the PRC is projected to increase from 2,417.1 Mtoe in 2010 to 4,218.1 Mtoe in 2035, growing at an annual rate of 2.3%. With this growth, the PRC's per capita energy demand will reach 3.05 toe per person, compared with 1.8 toe per person in 2010.

By energy type, coal will continue to occupy the largest share. However, its share will drop from 66.0% in 2010 to 53.1% in 2035. In contrast, shale gas will increase its share in demand from 3.7% in 2010 to 13.1% in 2035. During the outlook period, nuclear will increase rapidly at nearly 10% per year and raise its share from 0.8% in 2010 to 4.8% in 2035. The share of oil and hydro will respectively increase to 18.7% and 3.0% in 2035, up slightly from their shares in 2010. The share of new and renewable energy will drop from 9.1% in 2010 to 7.3% in 2035.

The sectoral contributions to the incremental energy demand growth from 2010 to 2035 are shown in Figure 9.1.2. As the figure presents, coal will represent the biggest incremental growth at 644.3 Mtoe, mainly driven by the increased use in the power sector. Due to the expanding demand from the power sector and the other sectors (residential and commercial), gas demand will increase at 463.2 Mtoe. Oil demand will be led mostly by the transport sector,

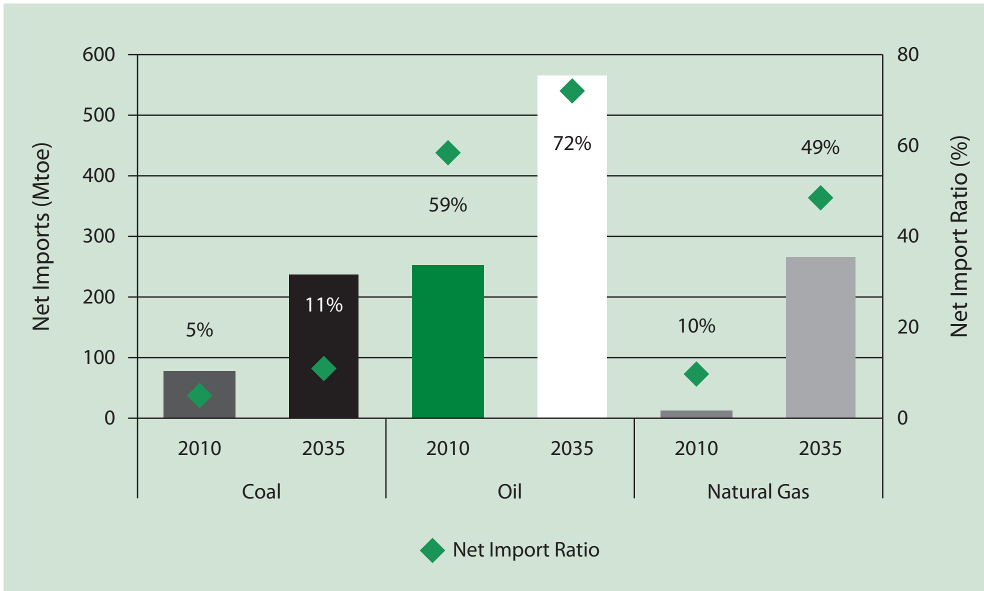
Figure 9.1.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.

Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 9.1.3 Net Imports of Coal, Oil, and Natural Gas and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

increasing at 355.7 Mtoe during the outlook period. New and renewable energy will increase to 90.3 Mtoe, mainly due to the growth of wind and solar power.

Domestic coal production will continue to fill most of the demand in the next decades. However, due to the large demand, coal imports of the PRC will reach more than 200 Mtoe in 2035 (Figure 9.1.3).

In contrast to the continuous rapidly rising oil demand, domestic oil production in the PRC will remain at around 200 Mtoe. Net import of oil will exceed 500 Mtoe by 2035 and the net import ratio will be higher than 70%. Within the domestic production of fossil fuels, natural gas will grow at the fastest pace of 7.6% per year, reaching 280 Mtoe in 2035. However, the demand for gas will grow even faster at 4.8% per year. As a result, the net import ratio of gas will rise from 10% in 2010 to nearly 50% in 2035.

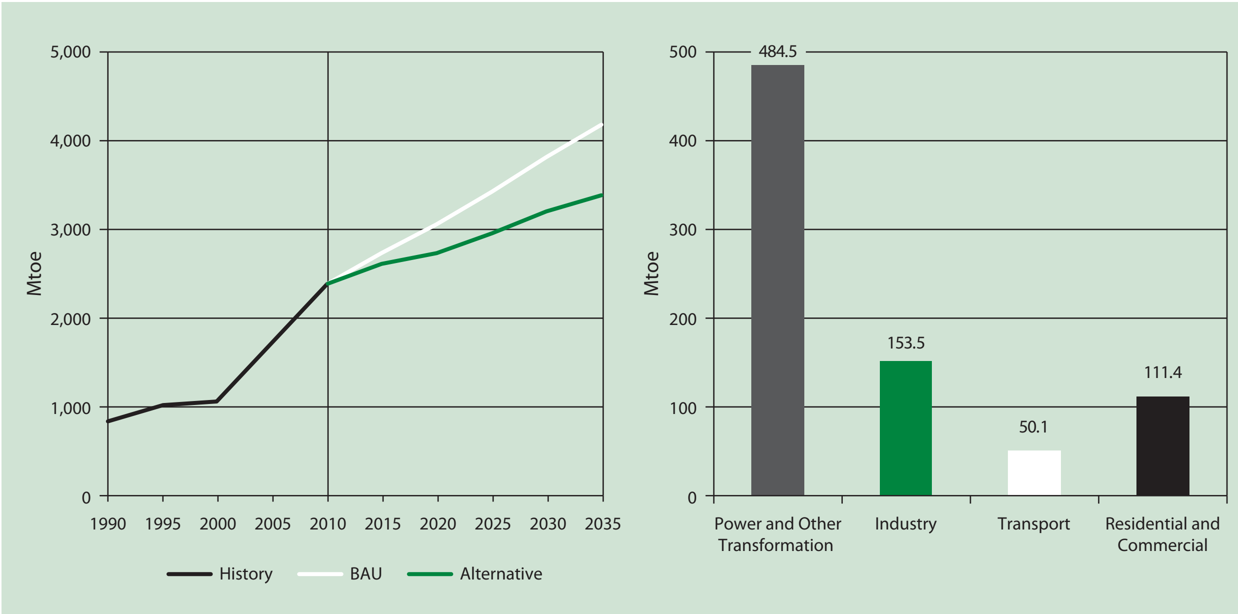
Alternative Case: Energy Savings Potential and Energy Source Diversification

The PRC has a substantial energy savings potential with the deployment of advanced technologies for energy savings. In the alternative case, the PRC's primary energy demand will increase at an annual rate of 1.4% through 2035. With this growth, the PRC's primary energy demand will reach 3,418.7 Mtoe, 799.4 Mtoe (or about 19%) lower than that of BAU in 2035 (Figure 9.1.4).

By sector, the power sector has the biggest energy savings potential at 484.5 Mtoe in 2035, followed by industry at 153.5 Mtoe, residential and commercial at 111.4 Mtoe, and transport at 50.0 Mtoe.

The power sector's energy savings mainly come from the electricity demand savings and resulting lower input requirements. Thermal efficiency improvement in power generation will account for more than half of the input savings.

Figure 9.1.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Meanwhile, the industry sector's energy savings at 153.5 Mtoe in 2035 are a result of the deployment of advanced technologies in the various industry subsectors, including iron and steel, cement, refineries, paper and pulp, and others.

The residential and commercial sectors' energy savings at 111.4 Mtoe in 2035 are mainly from electricity savings as a result of efficient appliances deployment. The major appliances that contribute to the electricity savings are water heating, air conditioners, and lighting.

The transport sector's energy savings will be 50.0 Mtoe in 2035. This is due to shifts toward efficient vehicles (mainly hybrid and electric vehicles) from internal combustion engine vehicles.

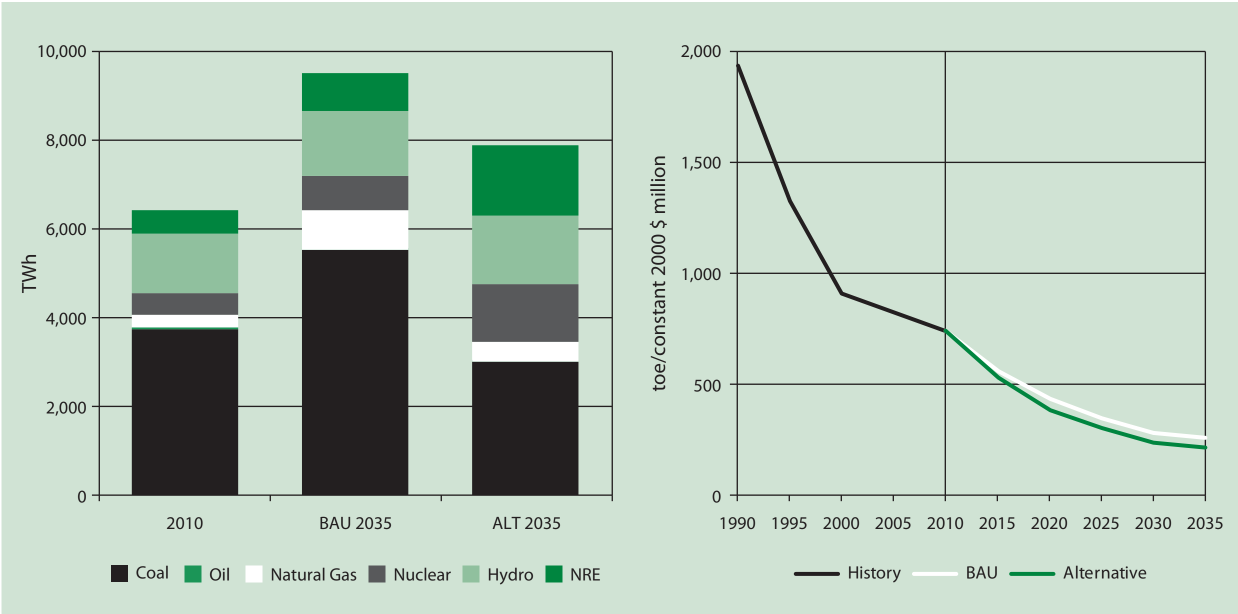
In the alternative case, the PRC's electricity generation in 2035 will be about 16.9% lower at 7,925.1 TWh in 2035, compared to 9,542.4 TWh in the BAU case (Figure 9.1.5). Substantial savings in total generation in 2035 result from the electricity demand savings in the industry, residential, and commercial sectors.

By energy type, electricity generation in the alternative case is more diversified than in the BAU case. In 2035, the share of nuclear energy will expand to 16.3%. Furthermore, the share of new and renewable energy (wind, solar and biomass generation) will increase to 20.0% in 2035 in the alternative case, compared with 8.8% in the BAU case. Due to the lower electricity conversion ratio, the share of fossil fuels will be much lower than in the BAU case. Although coal will continue to have the largest share, it will drop to 37.8%, compared with 58.1% in the BAU case.

Energy Policy Implications

Throughout the outlook period, coal will continue to hold the largest share in the energy demand in the PRC, and the power sector and industry will remain the main consumers. To

Figure 9.1.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

obtain the same amount of heat, the combustion of coal will release more CO_2, oxides of sulfur (SO_X), and oxides of nitrogen (NO_X) into the atmosphere than when burning oil or gas. Enhancing efficiency, especially in the coal-fired power plants, and improving the clean use of coal have high priority.

Gas will greatly increase its presence in the PRC's energy supply and demand. The potential for the domestic production of conventional natural gas is relatively limited. Therefore, development of nonconventional gas, increase in gas imports by pipeline, and importing LNG are expected to occur. To close the gap between the demand and domestic supply of oil, the PRC will depend heavily on overseas resources. Thus, the issue of energy security will grow in importance. To ensure oil and gas imports at reasonable prices, strengthening international cooperation in East Asia on market price formulation and supply networks will be necessary.

The PRC consumes the largest amount of fossil fuels in the world. The regional environmental pollution and global warming issues will be exacerbated by the combustion of fossil fuels. To mitigate the impacts, the development of nonfossil energy and improvement of energy conservation are key.

Nuclear energy is considered a stable and economically efficient nonfossil energy source. In the PRC, a number of nuclear power stations are under construction or planned. Following the Fukushima nuclear accident in Japan, however, the safe use of nuclear power has been given more attention. Ensuring the safety of operations, waste disposal, and cyclical use of nuclear fuel will remain a serious challenge.

Hydropower is also an important low-carbon energy source for the PRC. It is necessary to give more consideration to ecosystem conservation and the resettlement of populations that will be displaced by hydro projects. As some of the rivers with large potential are international rivers, cooperation with the downstream countries will be essential to develop these resources.

To support the PRC's ambitious targets for wind, solar, and other renewable energy, it is important to encourage efforts in technology development and cost reduction. Also, making the transmission and distribution grids more flexible—for example, by adopting smart grids and incorporating more auxiliary plants—will be needed to deal with the intermittent nature of most renewable energy systems and enhance utilization efficiencies.

Energy conservation is the most effective means to reduce CO_2 emissions and enhance energy security. In recent years, with the strict administration of the PRC government, the industry sector has made substantial progress in energy savings, mainly by the closure of inefficient plants. In the future, the transport sector and the residential and commercial sector will significantly raise their presence in energy demand. To increase the productivity of the industry sector, induce more fuel-efficient and new energy car, diffuse more energy saving type appliance, using market mechanisms, such as emissions trading, will be more effective.

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9.2 Hong Kong, China

- *In the BAU case, primary energy demand of Hong Kong, China is projected to increase from 13.4 Mtoe in 2010 to 17.6 Mtoe in 2035, growing at an annual rate of 0.7%. Over the same period, Hong Kong, China's per capita energy demand will reach 2.01 toe per person, compared with that of 2010 at 1.89 toe.*
- *In the alternative case,* Hong Kong, China's primary energy demand will decrease at an annual rate of –0.7% over the projection period and at the end of the period the demand will reach 11.3 Mtoe, 35.8% lower than that in the BAU case.*
- *Without indigenous energy resources, Hong Kong, China depends on imports for its energy supply. Singapore is its primary supplier of oil products. Most coal is imported from Indonesia. All the natural gas is supplied from mainland PRC through undersea pipelines.*

Recent Energy Trends and Energy Policy Issues

With no indigenous energy resources, ensuring a stable and affordable energy supply is critical to Hong Kong, China's economic development. Tackling the environmental issues caused by burning of fossil fuels has also emerged as an important factor in Hong Kong, China's energy policy making. The government has been promoting the development of a low-carbon economy.

On the supply side, Hong Kong, China will keep shifting away from coal toward increased use of gas for power generation. On 28 August 2008, the Government of the Hong Kong Special Administrative Region of the People's Republic of China and the National Energy Administration of the PRC signed a memorandum of understanding, among other things, on the enhanced supply of natural gas to Hong Kong, China in the coming 2 decades (Government of the Hong Kong Special Administrative Region of the People's Republic of China 2011).

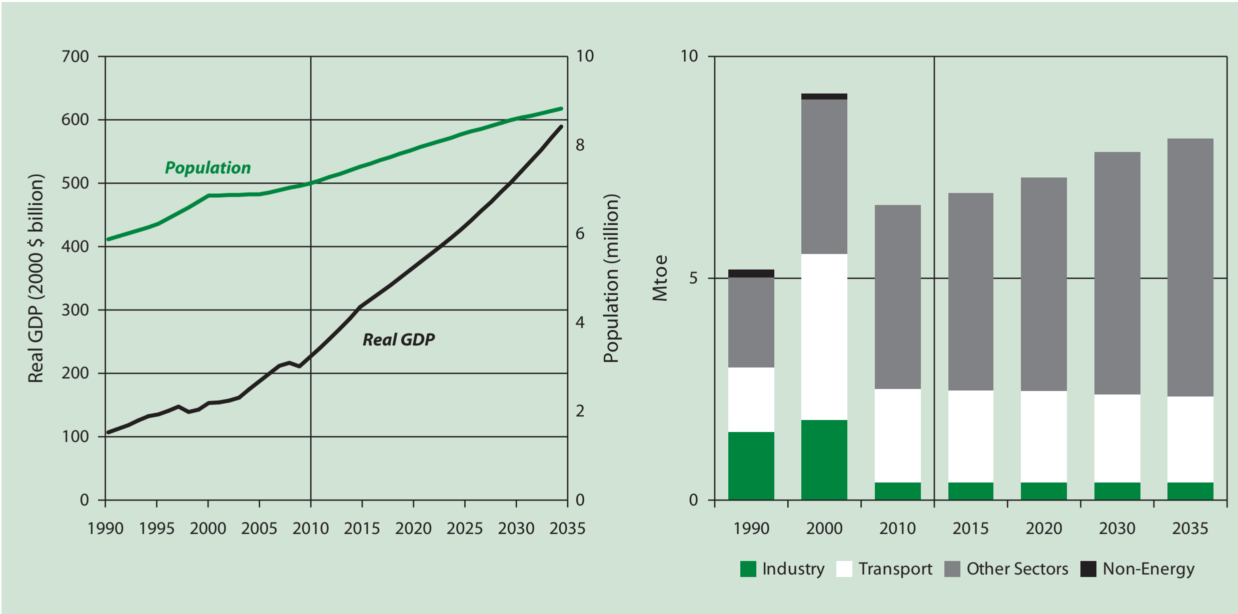
On the demand side, as an economy based on service industries, energy conservation plays a significant role. Based on the Voluntary Energy Efficiency Labelling Scheme, the government introduced the mandatory Energy Efficiency Labelling Scheme through the Energy Efficiency (Labelling of Product) Ordinance published on 9 May 2008. To improve building energy efficiency, the government formulated the Building Energy Efficiency Ordinance, which came into full operation on 21 September 2012.

Business-as-Usual Case: Energy Demand Outlook through 2035

Over the outlook period, Hong Kong, China's GDP is projected to grow at an annual rate of 4.0%. With this growth, GDP will reach $667.4 billion (constant 2000 $), more than 2.6 times

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

Figure 9.2.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

the 2010 level of $251.2 billion (Figure 9.2.1). Hong Kong, China's population is projected to increase 0.9% per year through 2035, reaching 8.7 million in 2035 from 7.1 million in 2010.

In the BAU case, the final energy demand of Hong Kong, China is projected to increase at an annual rate of 0.8% through 2035. By sector, the other sectors (including residential, commercial, agriculture, and fishery) will continue to have the largest demand, with its share reaching 64.1% in 2035, up from 53.8% in 2010. On the other hand, the energy demand from domestic transport will decrease over the projection period and its share is projected to decrease to 23.9% in 2035 from 32.0% in 2010. Energy demand in industry, which is the smallest, is projected to increase slightly, but its share will decrease from 5.7% in 2010 to 4.9% in 2035.

As an economy based on service industries, the majority of Hong Kong, China's energy demand comes from the other sectors. Energy demand from these sectors is expected to continue to increase through 2035 at an annual rate of 1.4%. Electricity, which is the dominant fuel in these sectors, will see the fastest demand growth at a rate of 1.7% per year and its share will climb to 84.5% in 2035 from 82.5% in 2010. Gas demand will also increase, though slower than that for electricity, at an annual rate of 1.1%. Demand for oil and biomass will remain small, both lower than 1% in 2035.

Due to a decline in vehicle numbers and the growing use of mass transport systems (both rail and bus), energy demand in the domestic transport sector will decrease at a rate of –0.4% over the projection period. Most of the demand will be met by oil.

Starting from the late 1970s, most of Hong Kong, China's labor-intensive manufacturing was relocated to the mainland of the PRC. However, as a result of efforts by Hong Kong, China's government to develop knowledge-based, high-technology, higher-value-added industries such as the information industry and biotech industry, energy demand in the industry sector is expected to continue growing, at an annual rate of 0.2% over the projection period.

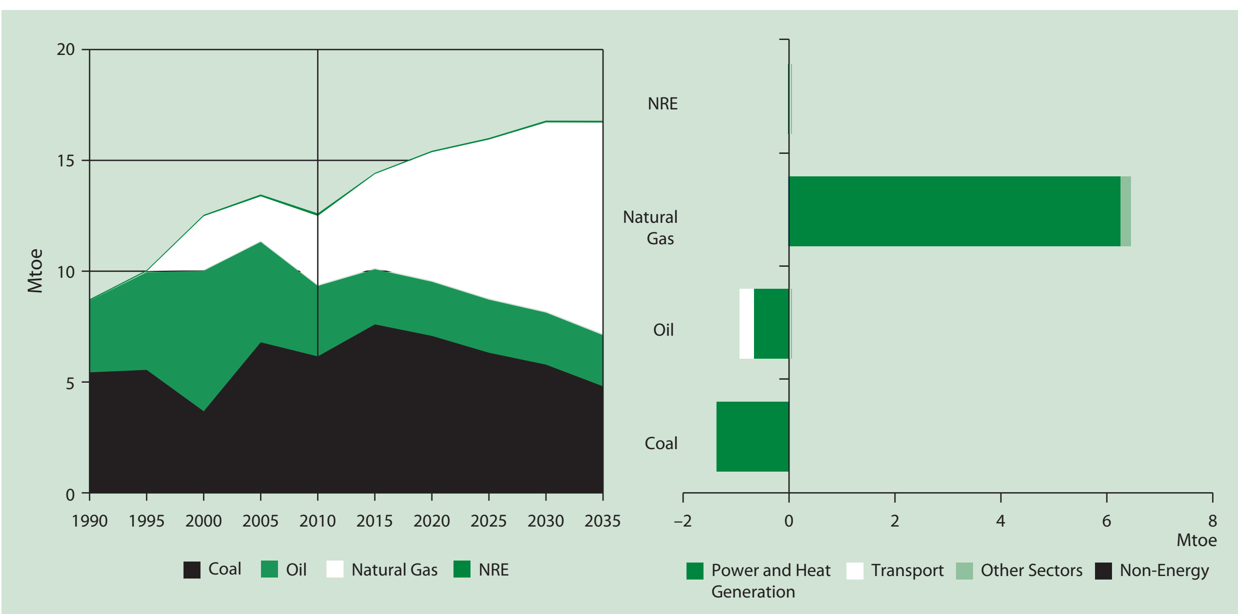
In the BAU case, the primary energy demand of Hong Kong, China is projected to increase from 13.4 Mtoe in 2010 to 17.6 Mtoe in 2035, growing at an annual rate of 0.7% (Figure 9.2.2). With this growth, Hong Kong, China's per capita energy demand will reach 2.01 toe per person at the end of the projection period, compared with 1.89 toe in 2010.

By energy type, natural gas will surpass coal as the largest energy source, with its share increasing from 23.5% in 2010 to 54.6% in 2035. Almost all of the incremental growth, estimated at 4.6 Mtoe, is driven by demand from the power sector following the government's policy of cleaning its power generation mix (which means shifting from coal to gas for power generation). As a result, the share of coal in the total primary energy supply will decrease to 27.7% from 46.6% over the same period. Declining demand from the domestic transport sector will lead oil's share to decrease to 13.2% in 2035 from 24.0% in 2010.

There are no indigenous energy resources in Hong Kong, China except renewable energy resources. Singapore has always been the largest supplier of certain oil products imported into Hong Kong, China. In 2011, Singapore accounted for 72.5% of imports of fuel oil and 58.8% of unleaded motor gasoline (Census and Statistics Department 2012). Apart from domestic consumption and re-export, more than two-thirds of the imported oil products were consumed by international marine bunkers and international aviation bunkers in the 5 years from 2006 to 2010.

Indonesia has been the main supplier of steam coal and other coal imported into Hong Kong, China (Census and Statistics Department 2012). With the declining demand for coal after 2015, import is also expected to decrease accordingly.

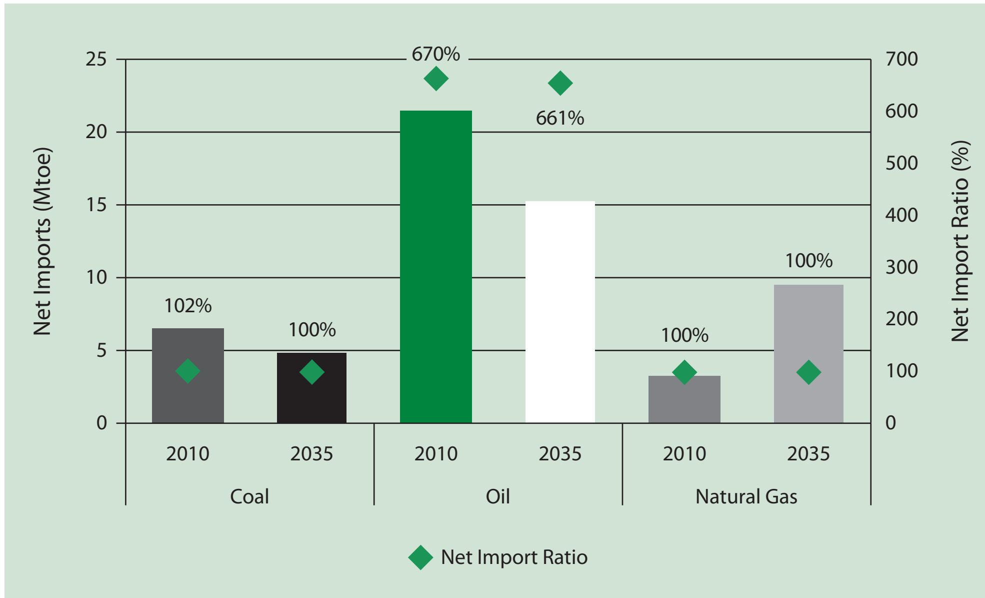
Figure 9.2.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.

Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 9.2.3 Net Imports of Coal, Oil, and Natural Gas and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

On the other hand, gas demand—and thus import—will increase, driven by demand for power generation. Gas imports will increase from 3.1 Mtoe in 2010 to 9.5 Mtoe in 2035 (Figure 9.2.3).

Alternative Case: Energy Savings Potential and Energy Source Diversification

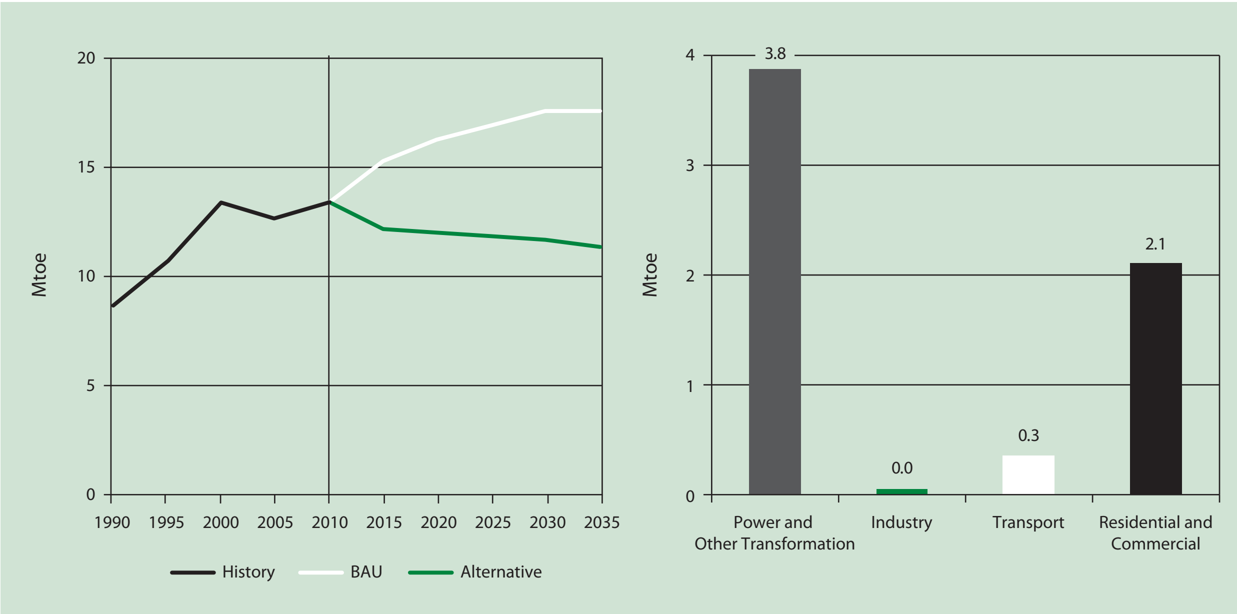
In the alternative case, Hong Kong, China's primary energy demand will decrease at an annual rate of –0.7% through 2035, in contrast to the energy demand growth in the BAU case of 0.7%. As a result of substantial energy savings, Hong Kong, China's primary energy demand will reach 11.3 Mtoe, which is 6.3 Mtoe or 35.8% lower than in the BAU case in 2035.

By sector, the power sector has the biggest energy savings potential, estimated at 3.8 Mtoe in 2035. Reduction of final electricity demand is expected to contribute more than 80% of the reduction of primary energy need for power generation. The remaining 20% of energy savings potential comes from the deployment of power generation technologies with higher thermal efficiency.

In the final energy demand sectors, not surprisingly, the largest energy savings potential is expected from the residential and commercial sectors, estimated at 2.1 Mtoe in 2035. Air conditioning, which consumes the most energy, will contribute the most (about 56.8%) for energy savings in these sectors, followed by lighting (about 29.1%).

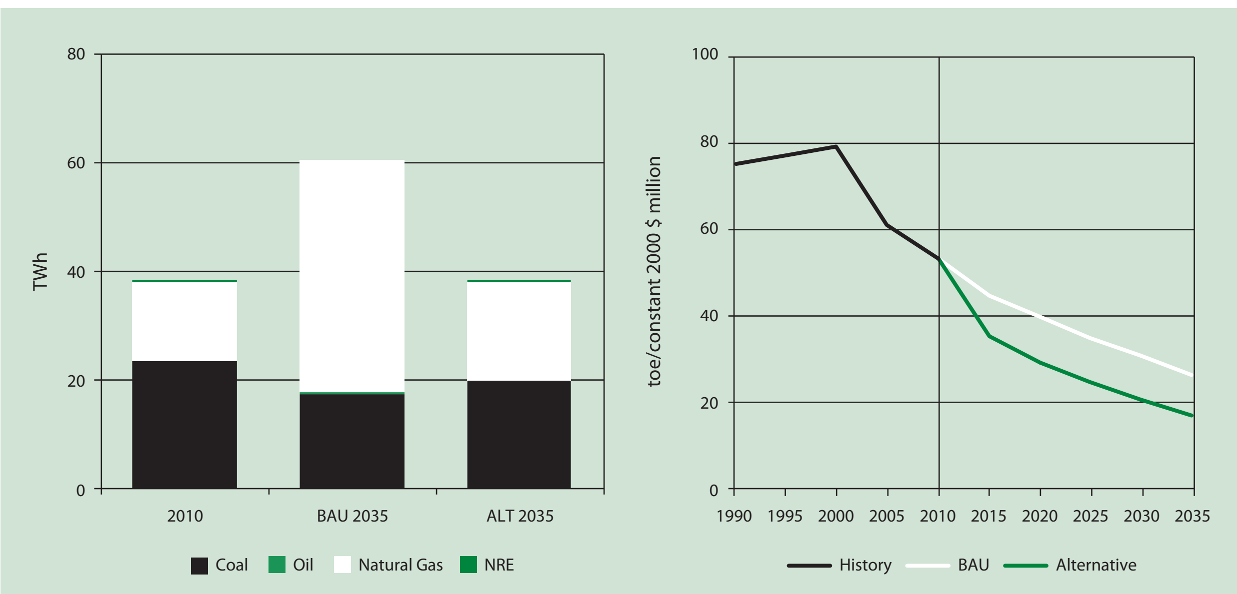
Hong Kong, China has developed a highly efficient public transport system. In 2008, the daily patronage of all means of public transport exceeded 11 million passenger trips, representing about 90% of the daily total number of commuters (Transport Department 2012). Given the situation, the transport sector is expected to contribute little to energy savings, estimated at 0.3 Mtoe in 2035.

Figure 9.2.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Figure 9.2.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

The energy savings potential of the industry sector is also very small, estimated at 0.04 Mtoe (Figure 9.2.4). This is because most of Hong Kong, China's energy-intensive and labor-intensive industries have been relocated to the mainland of the PRC.

In the alternative case, Hong Kong, China's electricity generation in 2035 will be about 36.6% lower at 38.3 TWh in 2035, compared with 60.4 TWh in the BAU case. In the alternative case, electricity generation will be around the same as the 2010 level. Given resource and space constraints, even in the alternative case, renewable energies (solar, wind, biomass) will play a small role in the power generation portfolio. In 2035, the share of renewable power is expected to reach 0.3% of total power generation, compared with 0% in the BAU case.

Energy Policy Implications

With its lack of capacity to refine oil or to build many new power plants, the economy is heavily dependent on imported oil, gas, and electricity, especially to supply the large energy demands from both international aviation and its residential and commercial sectors. It is critical that Hong Kong, China improve its energy security, in particular to protect itself from fluctuations in the energy market. While the lack of indigenous resources means little can be done to improve the security of the supply of fossil fuels, electricity security could be greatly improved by ensuring the continuation of the contract with Guangdong Daya Bay Nuclear Power Station. Although Hong Kong, China is almost entirely dependent on imported energy, the fact that much of this energy is imported from the PRC mainland, with which it has close political and economic ties, should help to reduce the risk to supply.

In terms of reducing its greenhouse gas emissions, the shift away from coal to gas for power generation will make a significant difference. Stricter building energy efficiency standards and diffusion of high-efficiency electric appliances will help reduce electricity consumption in the residential and commercial sectors, which are the largest electricity consumers. Electricity savings from the final sector will translate into less fuel being burnt for power generation.

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9.3 Republic of Korea

- *In the BAU case, the primary energy demand of the Republic of Korea is projected to increase at a moderate pace of 0.5% per year, from 250.0 Mtoe in 2010 to 284.0 Mtoe in 2035. With this growth, per capita primary energy demand will reach 5.67 toe per person in 2035, compared with East Asia's average at 3.17 toe. In contrast, with the deployment of advanced technologies, the Republic of Korea's primary energy demand in the alternative case,* will be lowered from the 2010 level, reaching 250.8 Mtoe.*
- *The Republic of Korea's decision on nuclear power expansion will be one of the most important policy agenda items as the fossil fuel requirements will ultimately depend on the size of the nuclear power installation. Aside from ensuring safety of operations, it will be important to reinforce the government's inspection mechanism to assure quality control of nuclear power technologies.*

Recent Energy Trends and Energy Policy Issues

The global economic slowdown contracted the economy of the Republic of Korea in 2009 to register an annual growth rate of 0.3%, while it rebounded at an annual growth rate of 6.2% in 2011. Economic growth slowed again in 2011 to 3.6% because of sluggish domestic demand, particularly investment (ADB 2012). From the supply side, in 2011, the manufacturing and services sectors' output increased respectively by 7.1% and 2.6%, while construction contracted by 5.6% (ADB 2012). The Republic of Korea's strength in the manufacturing sector relates to their exports, driven by automobiles, iron and steel, shipbuilding, and semiconductors. On average, the Republic of Korea's GDP registered 3.9% growth from 2005 to 2011.

From 2005 to 2010, the Republic of Korea's primary energy demand grew at 3.4% per year, reaching 257.5 Mtoe, up from 210.2 Mtoe in 2005, though growth trends differ by energy type. Oil, the dominant energy source accounting for 36% of total primary energy demand in 2011, remained flat between 2005 and 2011 at around 92.0 Mtoe, due to an almost constant level of refineries and petrochemical operations. In addition, nuclear energy registered a slow growth of 0.6% per year with no capacity additions made during this time. By contrast, natural gas and coal grew at relatively fast paces, registering an annual growth rate of 8.3% and 19.8%, respectively, to meet substantial growth in power generation requirements.

Endowed with few indigenous energy resources, the Republic of Korea needs to rely on imports to meet its fossil fuel demand. In 2010, out of the total primary energy demand, excluding nuclear, hydro, and some renewable energy sources, 82.9% was met by imported energy sources. Given the importance of energy in sustaining its economic development, the Republic of Korea has included the 3Es (energy security, economic growth, and environmental sustainability) in its energy policy, while aiming to enhance supply security with energy sources that have low environmental burdens. In 2008, faced with the global economic slowdown, the Republic of Korea introduced the "Green Growth" energy strategy, which promotes the

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

deployment of low-carbon-emitting sources and the use of low-carbon technologies, including nuclear power, new and renewable energy, and advanced fossil fuel generation technologies, to strengthen the domestic manufacturing sector. In addition, the strategy sets targets for energy intensity improvement from 0.341 toe per GDP in 2006 to 0.185 toe per GDP in 2030. The change from the 2006 base year represents a 46% improvement by 2030 and is equivalent to an average annual improvement of 2% (APERC 2011). The new administration, which took office on 25 February 2013, will continue to strive to achieve the 3Es with a strong emphasis on low-carbon-emitting technologies.

Business-as-Usual Case: Energy Demand Outlook through 2035

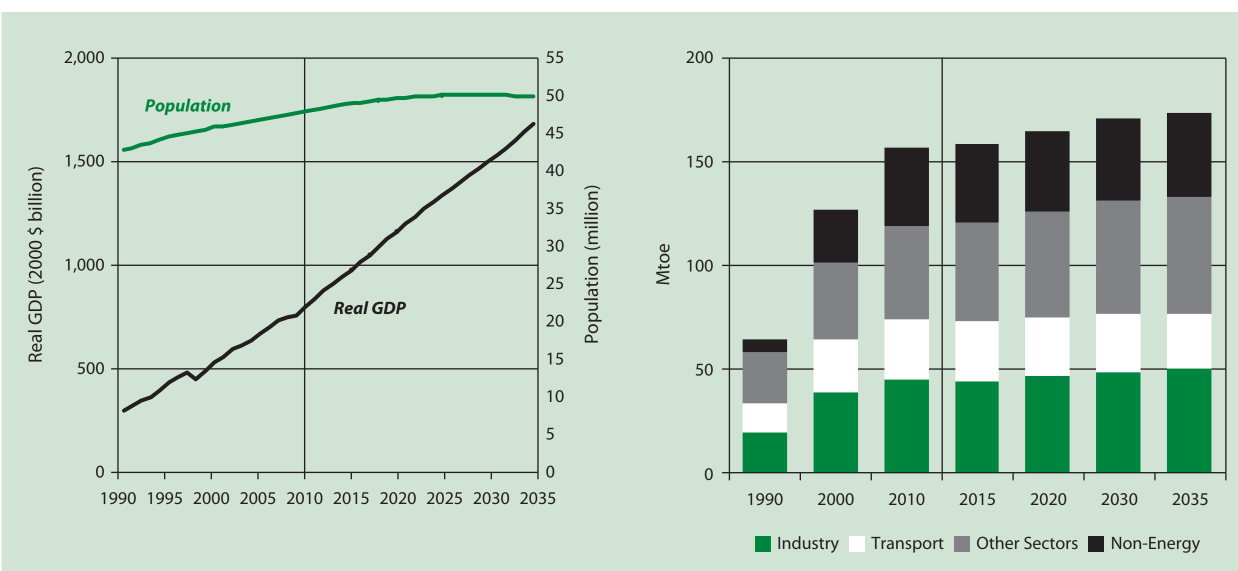
The Republic of Korea's GDP is projected to reach $1,684.1 billion (constant 2000 $) in 2035, up from $800.2 billion in 2010, at an annual growth rate of 3.0% (Figure 9.3.1). The doubling of the growth in economy will be led by the manufacturing industry (electronics, semiconductors, and automobiles), most of which are for export.

The population is projected to reach its peak in 2030 at 50.3 million and decline thereafter to 50.0 million in 2030, compared with the 2010 level at 48.2 million. As a result of continued economic growth and overall slow population growth, the Republic of Korea's per capita GDP will reach a high of $33,649, doubling the 2010 level of $16,607.

In the BAU case, the final energy demand of the Republic of Korea is projected to increase from 157.4 Mtoe in 2010 to 174.0 Mtoe in 2035, growing relatively slowly at 0.4% per year from 2010, although growth trends differ by sector.

The other sectors' (including residential, commercial, agriculture, and fishery) energy demand will register the fastest growth at 1.0% and account for the biggest share in final energy demand at

Figure 9.3.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

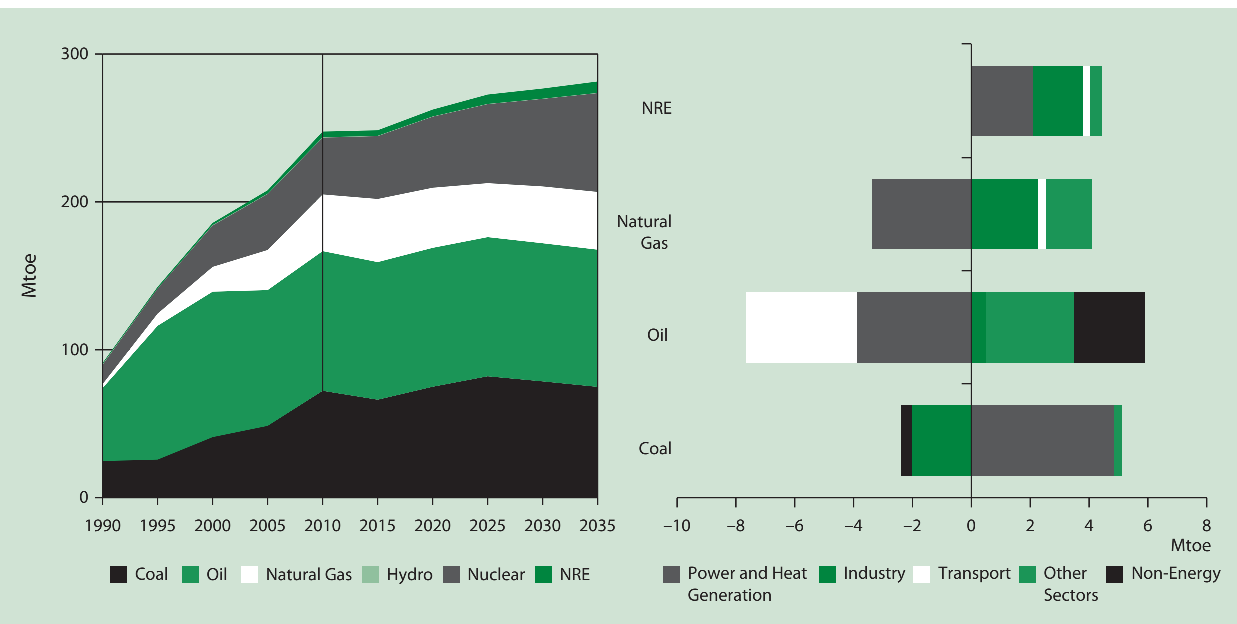
32.5% in 2035. The increased energy demand is based on growth in high-value-added commerce in the commercial sector. In terms of energy type, demand for electricity will grow the fastest at 1.6% per year, driven by the diffusion of air conditioning and electric appliances. Natural gas, used for space heating and cooking, will grow relatively slowly at 0.7%, as the natural gas supply network has been nearly completed, and marginal increases are expected in the future.

The industry sector's energy demand, representing the second-largest share in final energy demand, will grow relatively slowly at 0.4% per year, reaching 50.0 Mtoe in 2035. The relatively slow growth is due to the expected relocation of energy-intensive industries to areas outside of the Republic of Korea, and energy efficiency improvements in the domestic manufacturing industries, which are focused on energy-intensive industries. By energy type, electricity will dominate the industry's energy demand at 22.7 Mtoe in 2035, followed by natural gas at 9.1 Mtoe, oil at 6.4 Mtoe, and coal at 6.3 Mtoe.

Transport energy demand will decline at an annual rate of –0.4% through 2035, from 29.9 Mtoe in 2010 to 27.0 Mtoe in 2035. This is mainly because the country's vehicle stock is expected to plateau with slower economic growth and the decline in population during the outlook period. Well-developed public transport networks (including subways and buses), mainly in Seoul, will also help to slow the growth in domestic transport energy demand.

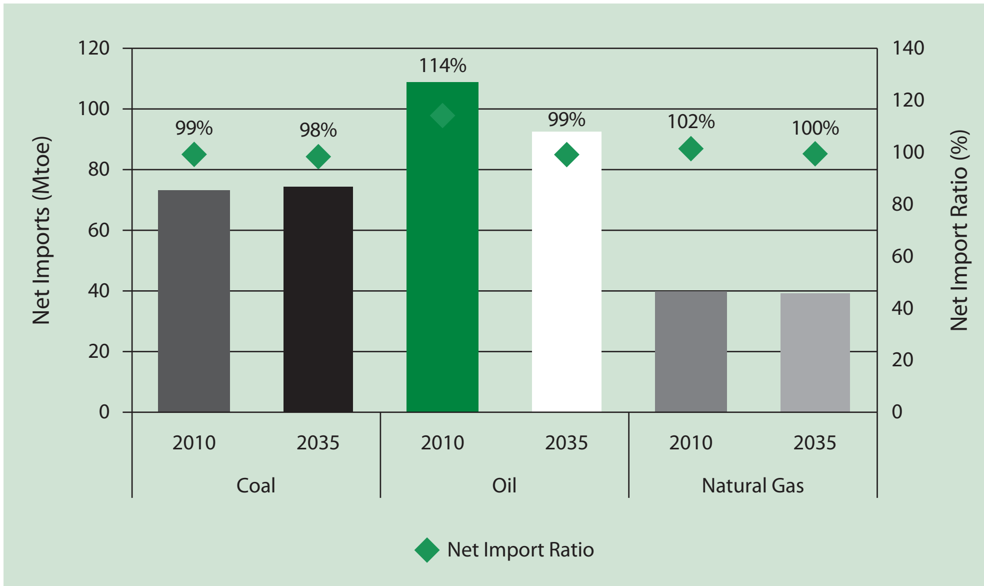
The Republic of Korea's primary energy demand is projected to increase at 0.5% per year through 2035, increasing from 250.0 Mtoe in 2010 to 284.0 Mtoe in 2035 (Figure 9.3.2). The projected growth rate is much slower compared with the historical trend of 5.1% (1990–2010), when the energy demand growth was led by the build-up of energy-intensive industries such as iron and steel, automobiles, and shipbuilding.

Figure 9.3.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 9.3.3 Net Imports of Coal, Oil, and Natural Gas and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

Oil will continue to dominate the Republic of Korea's total primary energy demand, representing 32.9% in 2035, although its demand will decline at –0.1% per year through 2035. The decline in oil demand is a result of the transport sector's contraction and the power sector's shifts to other energy sources (natural gas, coal, and nuclear). Coal will remain the second most dominant energy type in the country's primary energy demand, with its share estimated to reach 26.8% in 2035, growing by 0.1% per year (2010–2035), followed by natural gas (13.9%) and nuclear energy (23.7%)

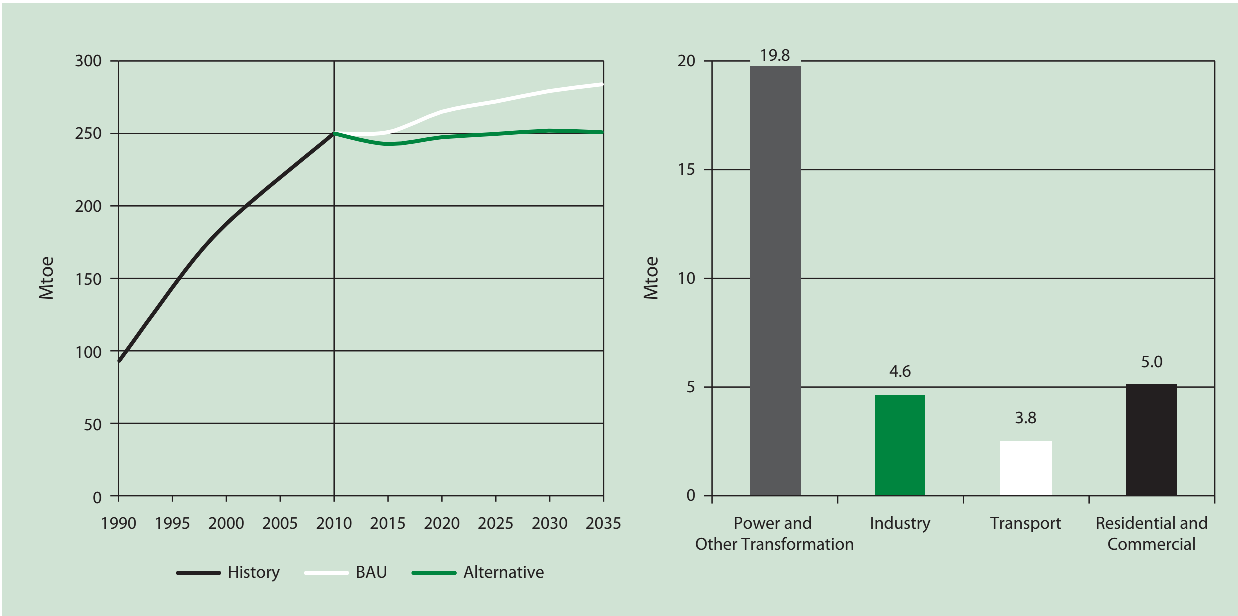
The BAU case projects that the Republic of Korea's total nuclear installed capacity will reach 34.0 gigawatts (GW) in 2035, up from 18.7 GW in 2010. Despite more than 80% capacity increases, the projected 2035 capacity is lower than the government's plan of 40 GW, taking into account the issues relating to the recent suspension of nuclear operations at some sites (for technical reasons) and the public opposition against the development of new nuclear energy facilities.

Endowed with few indigenous energy resources, the Republic of Korea will continue to rely on imports to meet its domestic fossil fuel demand. Meanwhile, because of the projected expansion of nuclear power capacity and some additions of new and renewable energy sources (photovoltaic, wind, and biomass), energy import dependency will decline to 73.6% in 2035, in contrast to 82.9% in 2010. Accordingly, import requirements for coal and natural gas are expected to remain similar to 2010 levels, respectively at 76.4 Mtoe and 39.4 Mtoe in 2035, while oil imports will slightly decline to 93.4 Mtoe in 2035 as a result of transport energy demand contraction (Figure 9.3.3).

Alternative Case: Energy Savings Potential and Energy Source Diversification

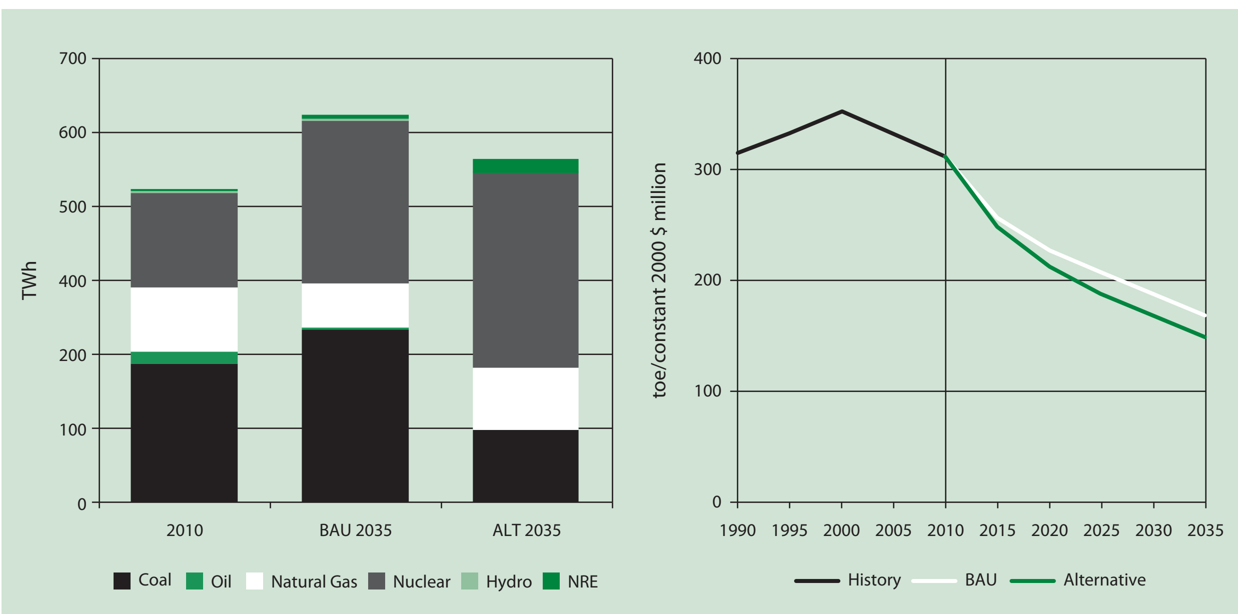
The Republic of Korea has some energy savings potential with the deployment of advanced technologies. In the alternative case, primary energy demand can maintain a constant level

Figure 9.3.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Figure 9.3.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

through 2035, reaching 251.9 Mtoe compared with 250.0 Mtoe in 2010 (Figure 9.3.4). Compared with BAU, primary energy demand in the alternative case is 32.1 Mtoe lower in 2035 (or energy savings of 11.3%). The biggest savings will come from the power sector (18.7 Mtoe), followed by residential and commercial (5.0 Mtoe), industry (4.6 Mtoe), and transport (3.8 Mtoe).

In the alternative case, the Republic of Korea's electricity generation in 2035 will be about 11.4% lower at 545.8 TWh in 2035, up from 496.6 TWh in 2010 (Figure 9.3.5). The estimated savings will amount to 69.9 TWh compared with BAU generation of 615.7 TWh in 2035. Substantial savings in total generation in 2035 will come from electricity demand savings in the industry, residential, and commercial sectors.

In terms of the generation mix, nuclear will account for the largest share (56.4%) with 40 GW of installed capacity in 2035 in the alternative case. The share of coal will be the second largest (20.8%), which contrasts greatly with the coal share in the BAU case at 44.7% in the same year. Generation based on natural gas will total 98.5 TWh in 2035, in contrast to 71.6 TWh in the BAU case. New and renewables will account for 4.0% in total generation, reflecting the deployment of wind (7.3 GW) and photovoltaic (3.5 GW) in 2035 in line with the target in the green growth plan.

Energy Policy Implications

Finding ways to secure stable and affordable energy supplies will continue to be critical for the economic growth of the Republic of Korea as energy is an important input fueling the country's economic growth. In light of slow but continued energy demand growth, particularly driven by the residential and commercial sectors' electricity demand growth, the decision on nuclear power expansion will be highest on the policy agenda for the Republic of Korea as the fossil fuel requirements will ultimately depend on the installed nuclear capacity. Recent incidents surrounding the suspension of six nuclear power units—due to technical reasons—overshadow the future prospects of nuclear power in the country. Aside from ensuring safety of the operations, it will be important to reinforce the government's inspection mechanism to assure quality control of nuclear power technologies.

The outlook results suggest that even in the BAU case, the Republic of Korea's primary energy intensity per GDP will improve by about 46% between 2010 and 2035. In addition to implementation of related policies and measures, this improvement will result from the shifts in economic structure (which affects industry demand), and slower economic growth and population decline (which impacts transport demand). Meanwhile, there is great technological potential in electricity demand savings in the residential and commercial sectors and the industry sector. These advanced technologies will offer cost-effective options to avoid imports of expensive fossil fuels from the international market, and the government hopes to encourage implementation of policies and measures that can create conditions to facilitate the uptake of advanced technologies.

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9.4 Mongolia

- *In the BAU case, the primary energy demand of Mongolia is projected to increase from 3.3 Mtoe in 2010 to 12.1 Mtoe in 2035, growing at an annual rate of 5.4%. Over the same period, Mongolia's per capita energy demand will reach 3.35 toe per person, compared with 1.19 toe in 2010.*
- *In the alternative case,* Mongolia's primary energy demand will increase at an annual rate of 4.5% over the projection period and demand will reach 9.8 Mtoe at the end of the period, 19.3% lower than in the BAU case.*
- *Mongolia has great potential to grow as a major coal exporter.*

Recent Energy Trends and Energy Policy Issues

Mongolia has large proven reserves of coal, gold, copper, and other minerals. The country's economy has benefited from increasing global prices for some mineral commodities and from growing overseas demand. From 2005 to 2010, the country's GDP expanded at over 6% per year, except in 2009 when the effects of the recession caused by global economic crisis were felt. Increasing incomes and expansion of mining activities will drive the country's demand for a stable and accessible energy supply system.

However, Mongolia's competitiveness suffers from aging and insufficient infrastructure. The main heating and power system in Ulaanbaatar is well beyond its economic life and is vulnerable to failure (ADB 2012). Oyu Tolgoi mine in the middle of the Gobi Desert of Mongolia, which holds the world's largest undeveloped copper deposits, will import electricity from the PRC to power its production. The country's need for a new combined heat and power (CHP) plant is urgent.

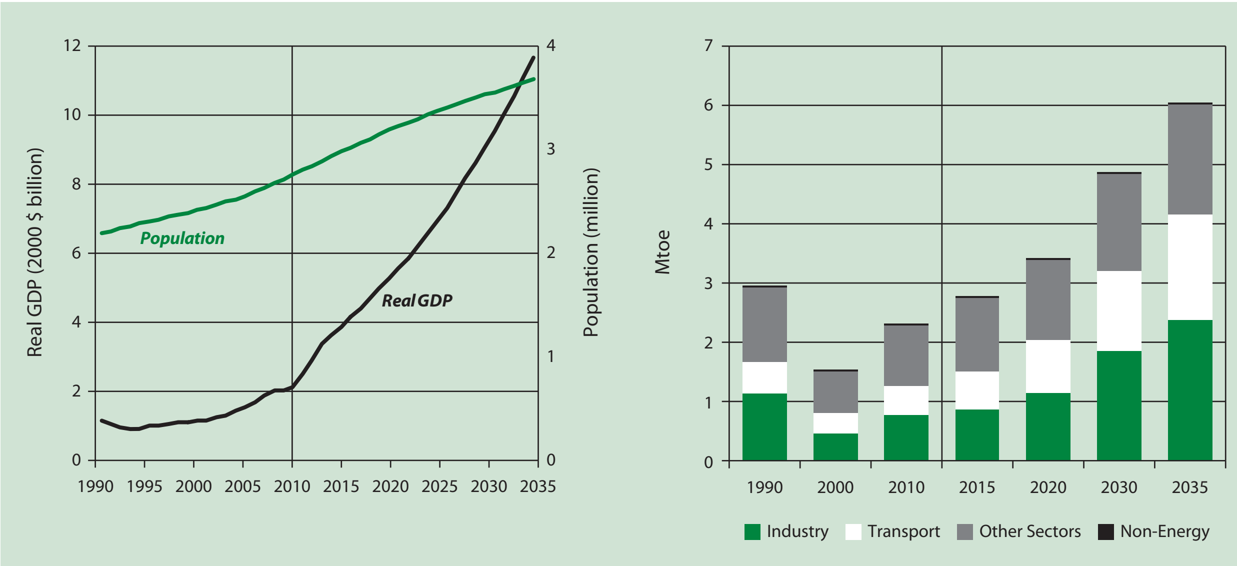
The economy will continue to be driven by its mining sector. However, infrastructure development is needed to facilitate the mining sector's further growth as well as to create jobs and related industry services. For the power infrastructure, a large portion of Mongolia's new capacity will have to come from coal-fired thermal power plants, given the country's large deposits of coal. The country's proven coal reserves and inferred coal reserves amount to 9.8 billion tons, and 162.3 billion tons, respectively (Wasaster 2012). Thus, mitigating the environmental impact from coal-fired generation by introducing high-efficiency power (and heat) plants is important to the country's sustainable growth.

Business-as-Usual Case: Energy Demand Outlook through 2035

Over the outlook period, Mongolia's GDP is projected to maintain strong growth at an annual rate of 7.3%. With this growth, GDP will reach $12.7 billion (constant 2000 $), more than five

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

Figure 9.4.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

times the 2010 level of $2.2 billion (Figure 9.4.1). The country's population is projected to increase 1.1% per year through 2035, reaching 3.6 million in 2035 from 2.7 million in 2010.

In the business-as-usual (BAU) case, the final energy demand of Mongolia is projected to increase at an annual rate of 4.0% through 2035. By sector, the transport sector will experience the fastest demand growth, at an annual rate of 5.5%, starting from a relatively small base. The industry sector will follow closely with its energy demand increasing 4.6% per year, and it will become the largest energy consumer with its share in final energy demand climbing from 34.1% in 2010 to 39.6% in 2035. The other sectors (including residential, commercial, agriculture, and fishery) will grow at the slowest pace of 2.4% per year, resulting in its share going down from 45.0% to 30.7% over the projection period.

While the other sectors' energy demand as a whole will grow moderately, growth trends vary by energy type. There will be a fuel shift from fossil fuels and noncommercial biomass to electricity over the projection period. As a result, the electricity demand in the other sectors will grow rapidly at an annual rate of 6.9%. This will be at the expense of other fuels: though at different paces, demand for coal, oil, and noncommercial biomass will all decline over the projection period (coal: –0.1%, oil: –1.7%, noncommercial biomass: –0.6%). With the increase in the population, heat demand will also grow steadily at a rate of 1.3% per year.

Driven by mineral projects and related infrastructure construction, coupled with fuel switching from coal to electricity, strong oil[26] and electricity demand in the industry sector is expected. Demand for oil will grow at a rate of 6.6% per year over the projection period, while demand for electricity will increase even faster at 7.3% per year. At the same time, coal demand will decline at an annual rate of –7.8% over the same period.

Starting from a small base, energy demand in the transport sector will increase the fastest. The demand is mainly driven by two factors. One is the increasing motorization caused by rapidly

[26] From 2005 to 2010, diesel demand in the mining subsector experienced an average annual growth rate of 13.2%.

rising income. Mongolia's GDP per capita is projected to reach $3,511 in 2035, more than four times the 2010 level of $796. The other driver is the expansion of the country's mineral activities, which will lead to growing demand for transport of mineral commodities. As a result, energy (mainly oil) demand in the transport sector will grow at a high rate of 5.4% per year.

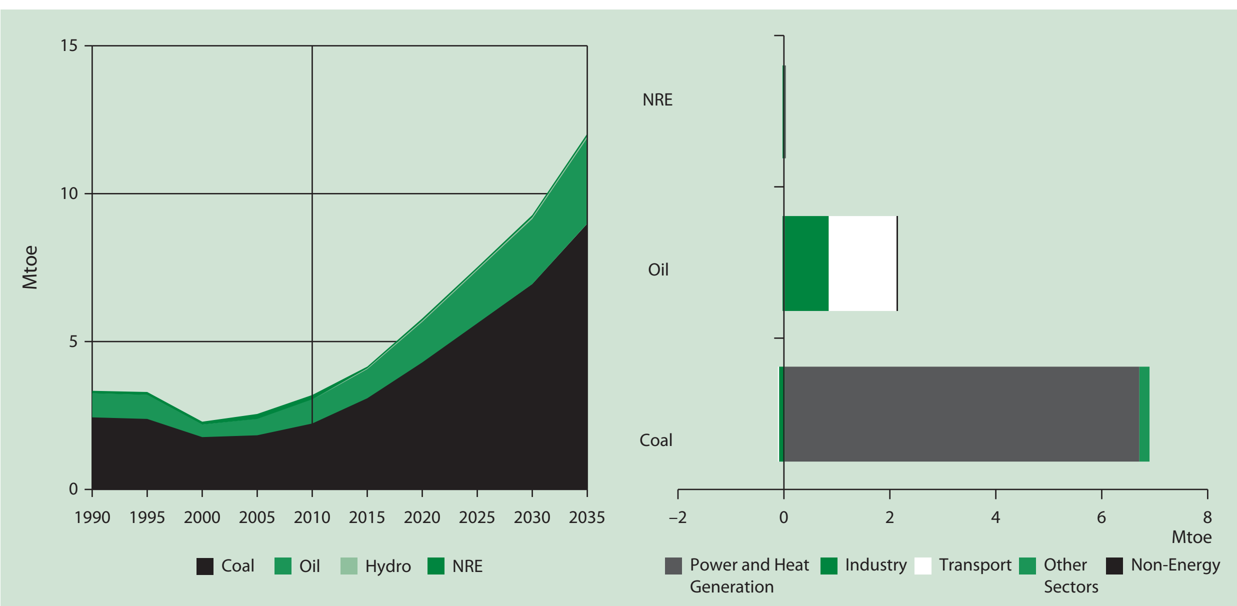
In the BAU case, the primary energy demand of Mongolia is projected to increase from 3.3 Mtoe in 2010 to 12.1 Mtoe in 2035, growing at an annual rate of 5.4% (Figure 9.4.2). With this growth, Mongolia's per capita energy demand will reach 3.35 toe per person, compared with 1.19 toe in 2010.

By energy type, coal will continue to be the single largest energy source, with its share reaching 74.9% in 2035, up from 69.6% in 2010. All the incremental growth, estimated at 6.8 Mtoe, is driven by demand for power generation. Mongolia has abundant resources of coal. Though the country might also have large reserves of oil and production of crude oil has already started, there are no refinery facilities in Mongolia, meaning that all the oil products are imported, mostly from the Russian Federation. Given that there is also no gas production in the country, coal becomes the natural choice for power and heat generation. This situation is expected to persist over the projection period until 2035 in the BAU case.

Oil is the second-largest energy source in Mongolia's primary energy supply. While the absolute amount of oil supply will grow fast at an annual rate of 5.1% through 2035, its share in total primary energy supply will decline slightly from 25.3% in 2010 down to 24.0% in 2035. Oil demand will be driven by growing consumption in the transport sector and in the industry sector. The transport sector accounts for 59.0% of the incremental growth of oil while industry accounts for 41.0%.

In 2011, the majority of Mongolian coal was exported to the PRC, the southern neighbor of the landlocked country. To diversify its exports, there is a plan to build a 1,100-kilometer

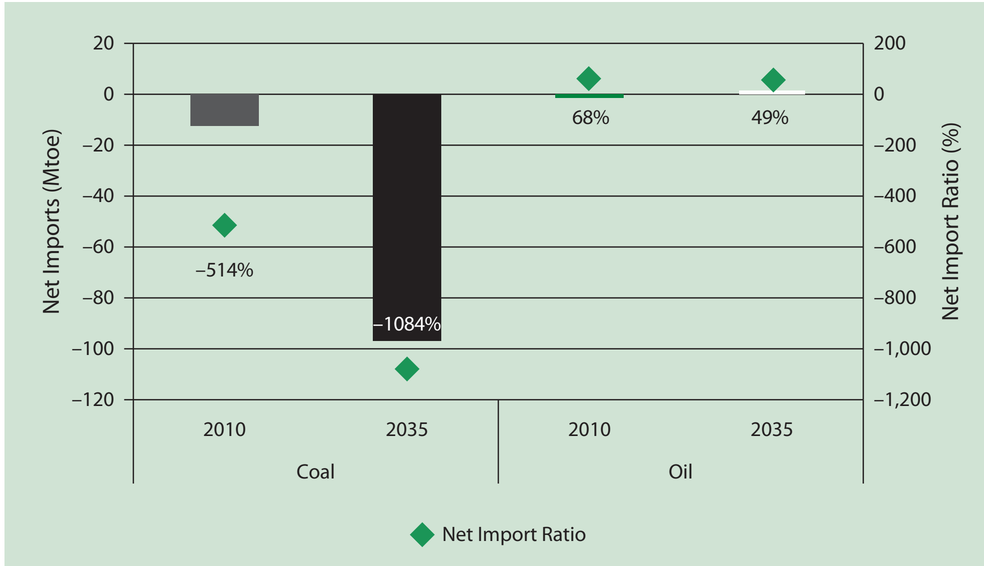
Figure 9.4.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.

Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 9.4.3 Net Imports of Coal, and Oil, and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

railway from the Tavan Tolgoi deposit in the southern Gobi desert to the Siberian coast to access the markets in Japan and the Republic of Korea. Tavan Tolgoi is one of the world's largest untapped coking and thermal coal deposits with a reported 6.5 billion metric tons (Gt) of coking coal. With increasing foreign investment and a push from the Mongolian government, the export of coal is expected to continue to grow in the future. Although the country currently imports electricity from the PRC to support its mining activities at Oyu Tolgoi mine, Mongolia has the potential to export electricity to the PRC. The Government of Mongolia proposed a 4,800-megawatt (MW) coal-fired power station, Shivee Ovoo power station, with 4,000 MW slated for export to the PRC. Net coal exports in 2035 are estimated at 98.3 Mtoe (Figure 9.4.3)

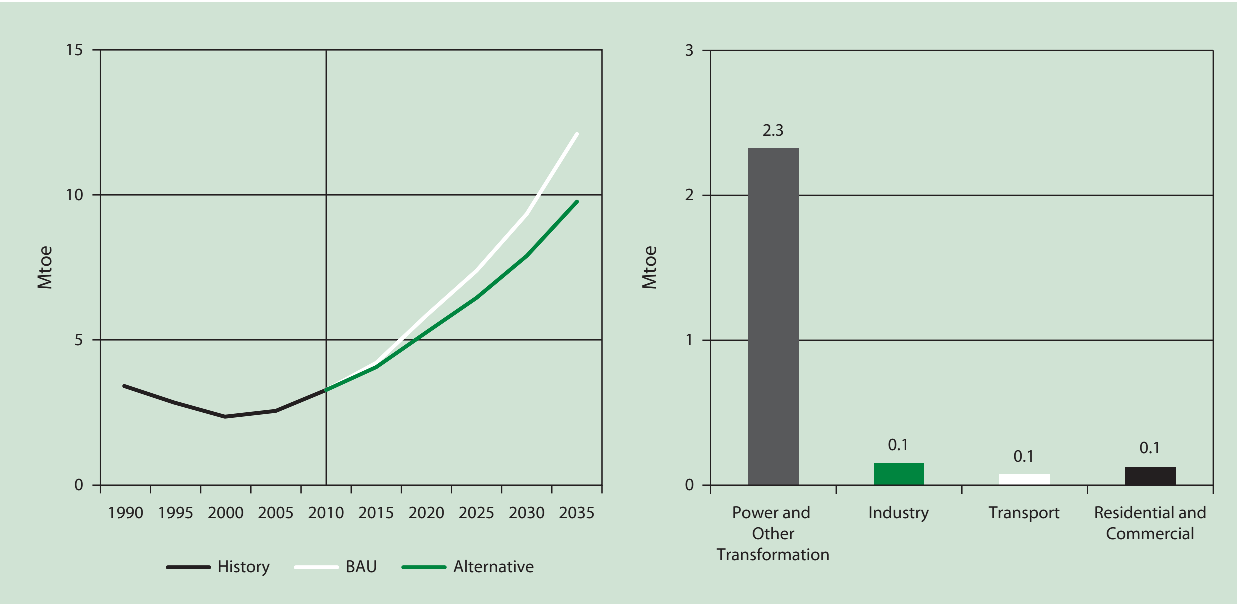
Due to scarcity of exploration data, Mongolia's petroleum potential remains unknown, although there is already production of crude oil and a high probability of finding substantial petroleum reserves. However, there is no refinery capacity in Mongolia and almost all of the demand for petroleum products is met through imports from the Russian Federation. At present, Mongolia is a net importer of oil.

Alternative Case: Energy Savings Potential and Energy Source Diversification

In the alternative case, Mongolia's primary energy demand will increase at an annual rate of 4.5% through 2035, slower than that of 5.4% in the BAU case (Figure 9.4.4). With this growth, Mongolia's primary energy demand will reach 9.8 Mtoe in 2035, 2.3 Mtoe (or 19.3%) lower than in the BAU case.

By sector, the power sector has the biggest energy savings potential at 2.3 Mtoe in 2035, which is much larger than that of the residential and commercial sectors (0.11 Mtoe), industry sector (0.15 Mtoe), and transport sector (0.05 Mtoe).

Figure 9.4.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

The power sector's energy savings potential comes from a reduction of final electricity demand and deployment of power generation technologies with higher thermal efficiency. Thermal efficiency improvement in power generation will account for about 44% of the total savings potential of the power sector.

The energy savings potential in the residential and commercial sectors comprise electricity savings and fuel savings. The electricity savings potential, estimated at 0.083 Mtoe, comes from diffusion of high efficiency electric appliances, while the fuel savings potential comes from efficiency improvement, estimated at 0.034 Mtoe.

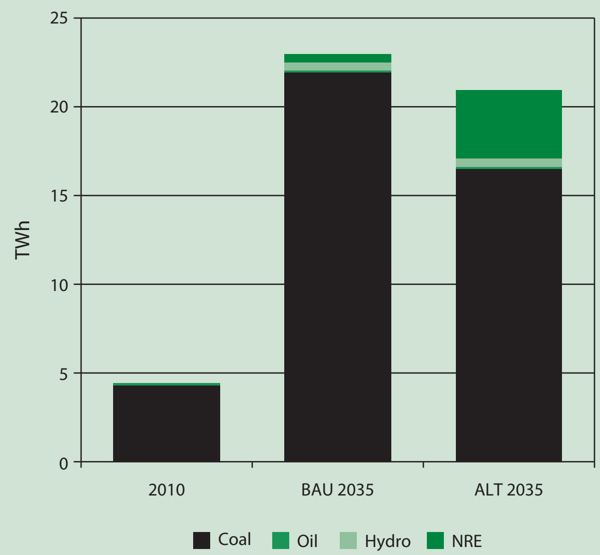
By sector, industry has the largest potential for reducing final energy demand. Industrial energy savings, at 0.15 Mtoe in 2035, derive from the deployment of advanced technologies in the various industry subsectors.

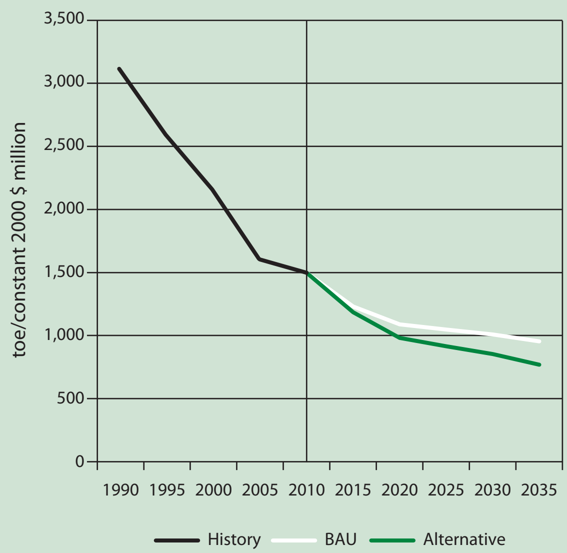
The energy savings potential of the transport sector is estimated at 0.05 Mtoe in 2035, representing a reduction of about 3% compared with the BAU energy demand in the sector. The savings potential mainly comes from deployment of new cars with higher fuel efficiency.

In the alternative case, Mongolia's electricity generation in 2035 will be about 8.9% lower at 21.0 TWh in 2035, compared with 23.1 TWh in the BAU case (Figure 9.4.5). Driven by the country's strong economic growth and increasing income, electricity generation even in the alternative case will be more than 4.5 times the 2010 level.

In the alternative case, renewable energies (solar, wind, biomass) will play a larger role in the power generation portfolio. In 2035, the share of renewable power is expected to reach 18.1% in total power generation, compared with 1.8% in the BAU case. While more than half of the power generation in 2035 will still come from coal-fired thermal power plants even in the alternative case, the share will be reduced to 79.0% compared with 95.6% in the BAU case.

Figure 9.4.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)





ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Energy Policy Implications

Given its large domestic reserves, not surprisingly, coal accounts for about 70% in Mongolia's primary energy and more than 90% in power and heat generation. From the standpoint of energy security and economic viability, inevitably coal will be chosen to meet the country's increasing electricity demand. However, this comes with environmental concerns since compared with other fossil fuels, coal has the highest carbon emissions rate and air pollutants such as oxides of sulfur (SO_X) and oxides of nitrogen (NO_X).

An option to reduce reliance on coal for power generation is to deploy more renewable power technologies such as hydro, biomass, solar, and wind. The cost of renewable technologies such as solar photovoltaic and wind has decreased dramatically in recent years, and the declining trend is expected to continue. Besides higher cost, another issue with the scaling up of renewable power generation is how to accommodate technologies with intermittent output, such as solar photovoltaic and wind. In a country like Mongolia where most of its base load is supplied by coal-fired power plants, whose start/stop operations can usually be quickly adjusted according load changes in the system, this obstacle is more challenging. Furthermore, coal-fired power plants—usually combined heat and power plants—not only supply electricity but also heat. If the country is to replace coal-fired power plants with renewable energies on a large scale, it is not only the power system but also the heat system that has to be adjusted accordingly. This might require increased deployment of electricity heat pumps or stand-alone boilers to reduce demand for district heating.

Given the country's large reserves of coal, coal-to-gas technology could help the country use coal more efficiently. However, to scale up the utilization of gas, investments are required not only for coal-to-gas plants but also for gas delivery networks.

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9.5 Taipei,China

- *In the BAU case, the primary energy demand of Taipei,China is projected to increase from 109.3 Mtoe in 2010 to 124.5 Mtoe in 2035, growing at an annual rate of 0.5%. Over the same period, Taipei,China's per capita energy demand will reach 5.30 toe per person, compared with 4.73 toe in 2010.*
- *In the alternative case,* Taipei,China's primary energy demand will increase at an annual rate of 0.1% over the projection period and at the end of the period the demand will reach 111.9 Mtoe, 10.1% lower than in the BAU case.*
- *Taipei,China has extremely limited energy reserves. More than 95% of its energy demand must be met by imported fuels.*

Recent Energy Trends and Energy Policy Issues

Taipei,China is highly dependent on import fuels to meet its energy demand. According to statistics of the Bureau of Energy, the economy's energy import dependency was 97.9% in 2011. Facing the challenges of energy security and environmental concerns, the government announced its framework for a sustainable energy policy in 2008. Within the framework, energy efficiency was given a significant role. A goal of annually improving energy efficiency by 2% was set, and, compared with the 2005 level, energy intensity is expected to decrease 20% by 2015 and 50% by 2025 (Bureau of Energy 2008).

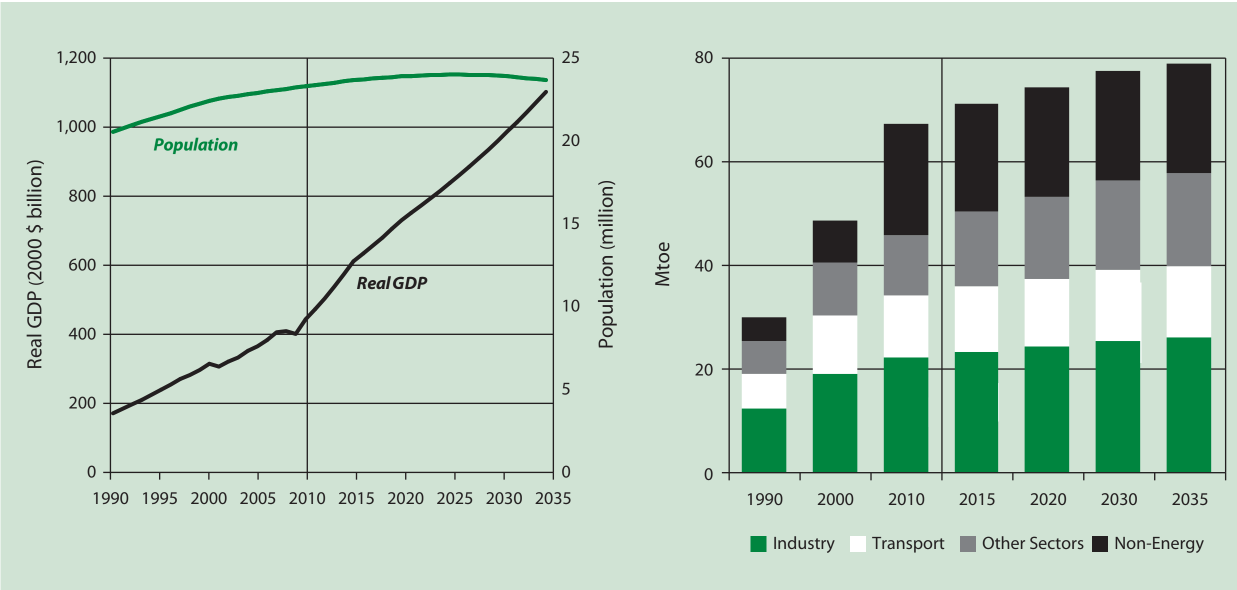
After the Fukushima accident in Japan, the government reviewed Taipei,China's energy situation and formulated the New Energy Policy under which the economy's nuclear energy dependence will be reduced. In the policy, it is stated that "If the two reactor units of the 4th Nuclear Power Plant has steadily operated before 2016, the First Nuclear Power Plant will also stop operations in advance" (Bureau of Energy 2011). With the phasing out of nuclear power, the economy is expected to need more LNG for power generation. At the same time, renewable power generation is also expected to be given more attention.

Business-as-Usual Case: Energy Demand Outlook through 2035

Over the outlook period, Taipei,China's GDP is projected to maintain relatively strong growth at an annual rate of 3.8%. GDP will reach $1,092.1 billion (constant 2000 $), more than 2.5 times the 2010 level of $434.3 billion. The economy's population is projected to increase in the near term (2010–2020) and decline in the long term (2020–2035). Over the whole projection period, the population is projected to increase slightly from 23.1 million in 2010 to 23.5 million in 2035 at an average rate of 0.1% per year (Figure 9.51.).

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

Figure 9.5.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

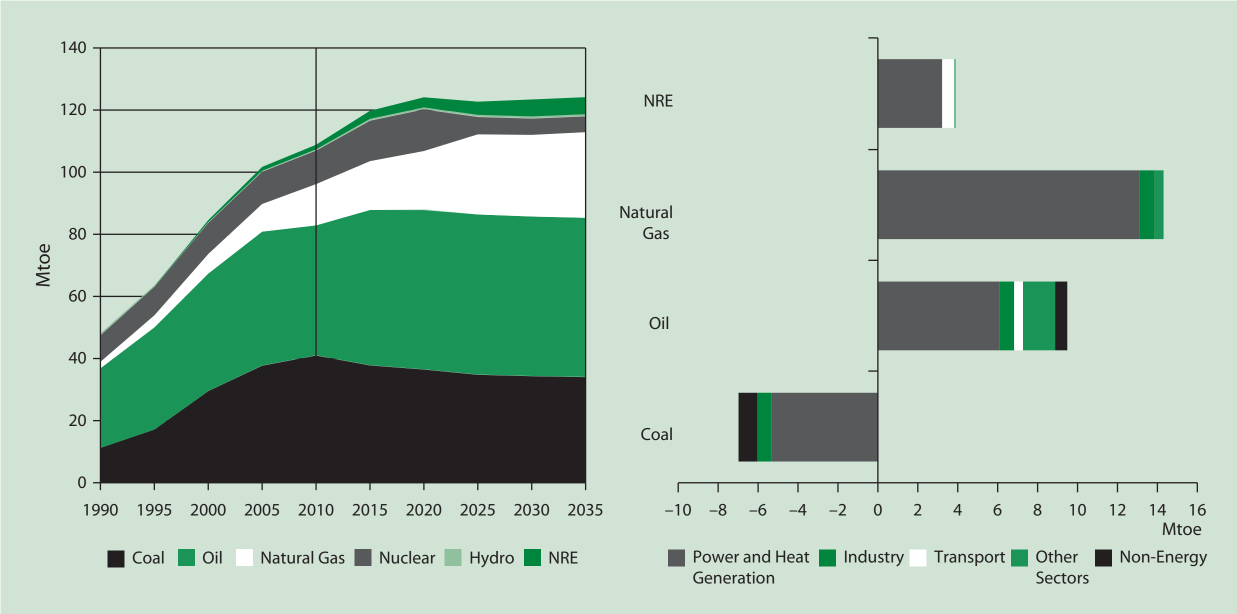
In the BAU case, the final energy demand of Taipei,China is projected to increase at an annual rate of 0.6% through 2035. By sector, the other sectors (including residential, commercial, agriculture, and fishery) will experience the fastest growth at an annual rate of 1.8%, surpassing the transport sector to become the second-largest energy consumer. The industry sector will remain the largest energy consumer with its share increasing slightly from 32.9% in 2010 to 33.2% in 2035, while energy demand in the transport sector will grow the slowest at an annual rate of 0.4% and its share is projected to decrease to 17.0% in 2035 from 18.0% in 2010.

In the other sectors, by fuel type, electricity will grow the fastest at an annual rate of 1.9% over the projection period and continue to be the primary fuel in the sector, supplying 68.3% of the sector's energy demand in 2035, up from 66.7% in 2010. This is the result of fuel switching from oil products to electricity. The share of oil products will decline from 23.7% in 2010 to 22.2% in 2035. Over the same period, the share of gas will stay nearly unchanged at 8.7% and renewables (biomass) will remain at less than 1%.

Given Taipei,China's slow population growth and substantial development in mass transportation, energy demand in the transport sector is expected to grow at a low rate of 0.4% per year over the projection period. In addition, the diffusion of hybrid and electric cars will help reduce dependency on oil. The share of oil products is expected to decrease to 92.4% in 2035 from 96.4% in 2010. On the other hand, the share of other fuels, including electricity, biofuels, and a small amount of hydrogen, will increase from 3.6% in 2010 to 7.6% in 2035.

Taipei,China's industry is experiencing structural change from a high-energy-intensity industry to a high-value-added electronic or information and communication technology (ICT)-based industry. This trend will result in a slowdown of energy demand in the industry sector, with the demand growing at 0.9% per year in the near term (2010–2020) and 0.5% per year in the long term (2020–2035). By fuel type, demand for gas and electricity will grow the fastest with a rate of 2.6% and 1.0%, respectively.

Figure 9.5.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.

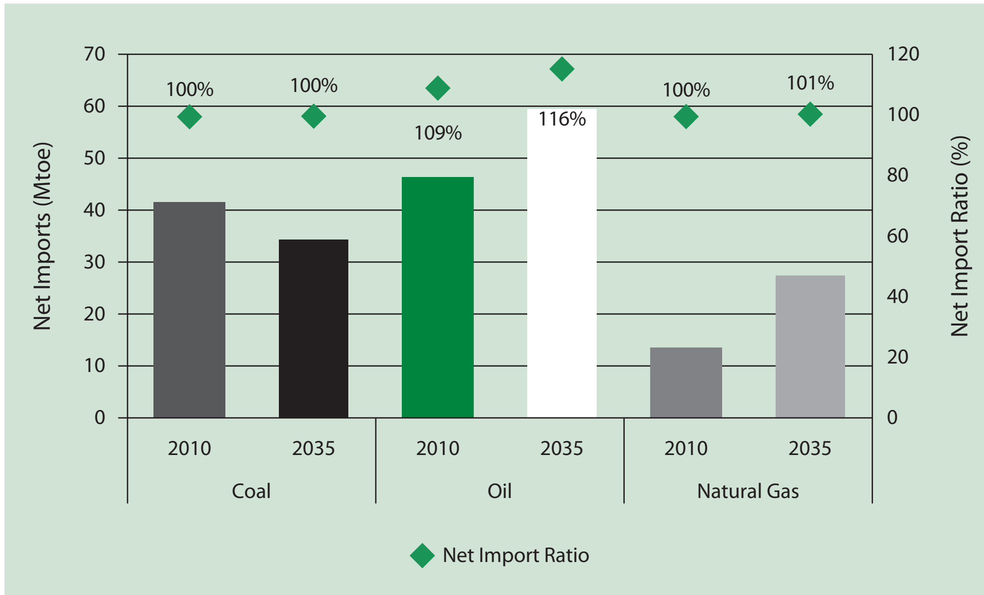
In the BAU case, the primary energy demand of Taipei,China is projected to increase from 109.3 million tons of oil equivalent (Mtoe) in 2010 to 124.5 Mtoe in 2035, growing at an annual rate of 0.5% (Figure 9.5.2). With this growth, the economy's per capita energy demand will reach 5.30 toe per person, compared with 4.73 toe in 2010.

By energy type, oil will remain the dominant energy source, with its share reaching 41.5% in 2035, up slightly from 38.6% in 2010. The incremental growth, estimated at 6.7 Mtoe, is driven by demand from all sectors, with non-energy use (which means oil chemistry) being the biggest. Demand for gas will grow the fastest among the fossil fuels at a rate of 3% per year. This is mainly driven by demand for power generation to meet additional increases in electricity demand and to replace nuclear and coal-fired power. On the other hand, coal demand will decline at an annual rate of –0.7% over the projection period as result of substantial phasing out of coal-fired power plants.

In terms of nonfossil fuels, due to the government's policy of reducing dependency on nuclear power after the Fukushima accident, its share is expected to be much lower than the current level, although in the short to medium term there is an increase. The share of nuclear in total primary energy supply will go down to 4.1% in 2035 compared with 10.8% in 2010, while the shares of hydro and other renewable energy sources will increase substantially, respectively reaching 0.5% and 4.4% in 2035 from 0.3% and 1.4% in 2010.

Although Taipei,China meets almost all of its crude oil demand with imports, it has a robust petrochemical industry and is a net exporter of oil products. The state-owned Chinese Petroleum Corporation (CPC) is the sole player in oil exploration and production. The company is also active in overseas oil exploration and production. As of the end of 2011, CPC engaged in cooperative exploration in 21 fields in 7 countries, including Australia, Chad, Ecuador, Indonesia, Libya, the United States, and Venezuela. However, the company is facing competition from private companies, with more than 40% of the economy's total refinery capacity owned by Formosa Petrochemical.

Figure 9.5.3 Net Imports of Coal, Oil, and Natural Gas and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

Taipei,China has very limited coal reserves and domestic production of coal stopped in 2001. Australia, Indonesia, and the PRC are the main suppliers of its coal imports. Taipei,China's power generation portfolio is expected to keep shifting from coal to clean sources such as natural gas and renewable energy, and this trend will result in a substantial decline of coal demand—and thus coal imports—over the projection period. From 41.3 Mtoe in 2010, net coal imports are estimated to decrease to 34.4 Mtoe in 2035 (Figure 9.5.3).

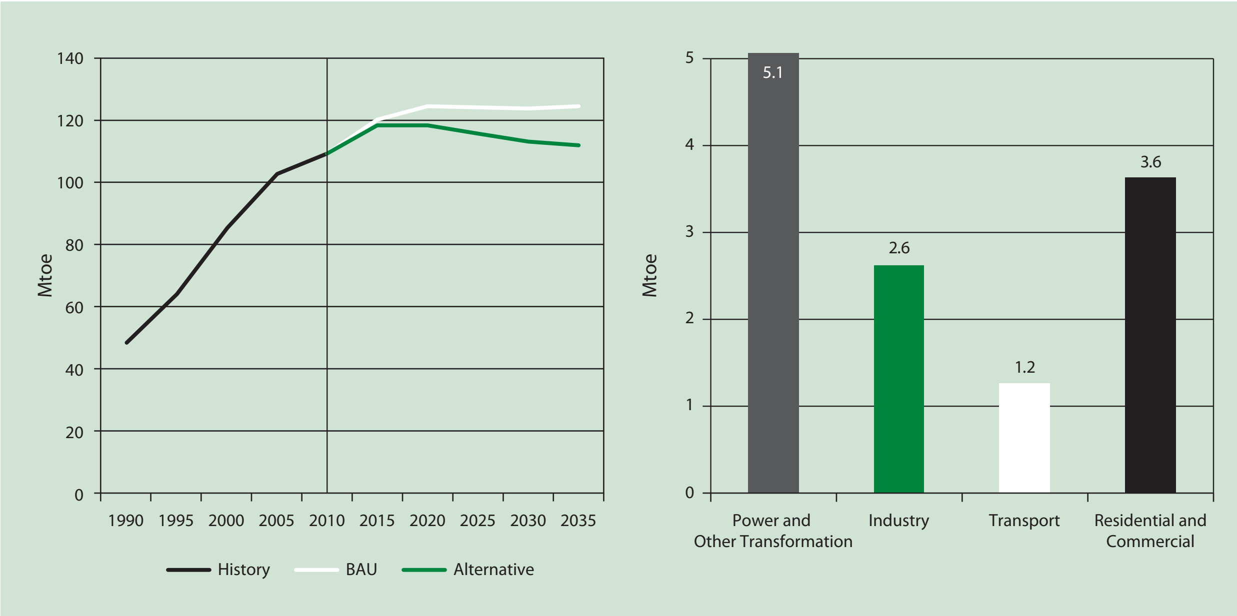
Almost all of the natural gas requirements of Taipei,China is imported in the form of LNG from Indonesia and Malaysia, and supply from Qatar is increasing. CPC is the sole importer of LNG in Taipei,China. Two LNG receiving terminals were under operation as of the time of writing and the location for the third LNG receiving terminal is due to be finalized. CPC is reportedly working with the state-owned People's Republic of China National Offshore Oil Corporation to draw up a pact to jointly explore for natural gas.

Alternative Case: Energy Savings Potential and Energy Source Diversification

In the alternative case, Taipei,China's primary energy demand will increase at an annual rate of 0.1% through 2035, slower than in the BAU case at 0.5%. Especially in the long term (2020–2035), primary energy demand is expected to decline (at an annual rate of –0.4%) due to substantial energy saving efforts. With this growth, Taipei,China's primary energy demand will reach 111.9 Mtoe, 12.6 Mtoe or 10.1% lower than in the BAU case in 2035.

By sector, the power sector has the biggest energy savings potential at 5.1 Mtoe in 2035, representing more than half of the total energy savings potential. Electricity demand reductions are expected to contribute largely to the primary fuel savings for power generation.

Figure 9.5.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Around 96.7% of the power sector's energy savings potential in 2035 is estimated to come from a reduction in final electricity demand, with the remainder from the deployment of high-efficiency power generation technologies.

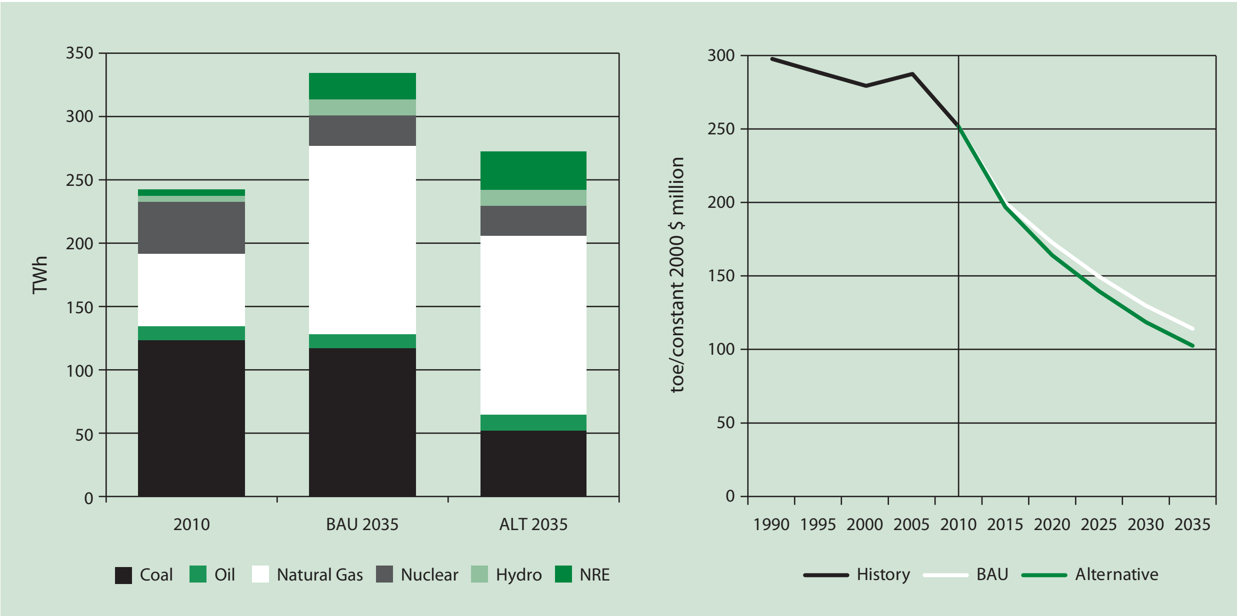
Among the final energy-consuming sectors, the "other sectors" (which includes the residential and commercial sectors) is expected to have the largest potential energy savings, estimated at 3.6 Mtoe in 2035, a 19.8% decrease from the BAU level. The energy savings potential comes from diffusion of high-efficiency electric appliances. Air conditioning and lighting are the two subsectors with the largest energy savings potential.

The industry sector will see an energy savings potential estimated at 2.6 Mtoe in 2035, resulting from further structural change to electronic and ICT-based industries and the deployment of advanced technologies in the various industry subsectors.

The energy savings potential of the transport sector is estimated at 1.2 Mtoe in 2035, representing a reduction of about 9.2% compared with the BAU energy demand in this sector. The savings potential mainly comes from the deployment of new cars with higher fuel efficiency and diffusion of hybrid and electrical vehicles.

In the alternative case, Taipei,China's electricity generation in 2035 will be about 18.1% lower at 275.0 TWh in 2035, compared with 339.5 TWh in the BAU case. In the alternative case, renewable energy (solar, wind, biomass) will play a larger role in the power generation portfolio. In 2035, the share of non-hydro renewable power is expected to reach 11.4% of total power generation, compared with 6.2% in the BAU case. Coal-fired power plants are expected to be further phased out in the alternative case, with their share down to 19.5% in 2035 compared with 35.1% in the BAU case in the same year.

Figure 9.5.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product. NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.

Energy Policy Implications

With limited domestic energy resources, the security of Taipei,China's energy supply is central to its energy policy goals of meeting growing energy demands. Together with the need to tackle the increasing climate change concerns, the economy will have to look to alternative energy sources, in particular replacing coal with natural gas and renewable energy. Taipei,China has already moved to promote renewable energy with the 2009 introduction of the Renewable Energy Development Act, which uses a fixed feed-in tariff mechanism and grid-connecting obligations to encourage new and renewable energy-based generation.

To decouple energy consumption and GDP growth, the services sector needs to be further promoted and expanded, and the industry sector needs to move to a less energy-intensive structure. For example, promoting knowledge-based industries such as the Green Silicon Island, as well as high-value-added and low-energy-intensive scientific industry parks, could be one way to foster a less energy-intensive economy.

The establishment of international stockpiling through regional cooperation could be an important way of stabilizing domestic energy supply, as could the acquisition of equity in international energy resource developments by CPC, which is already active in such deals.

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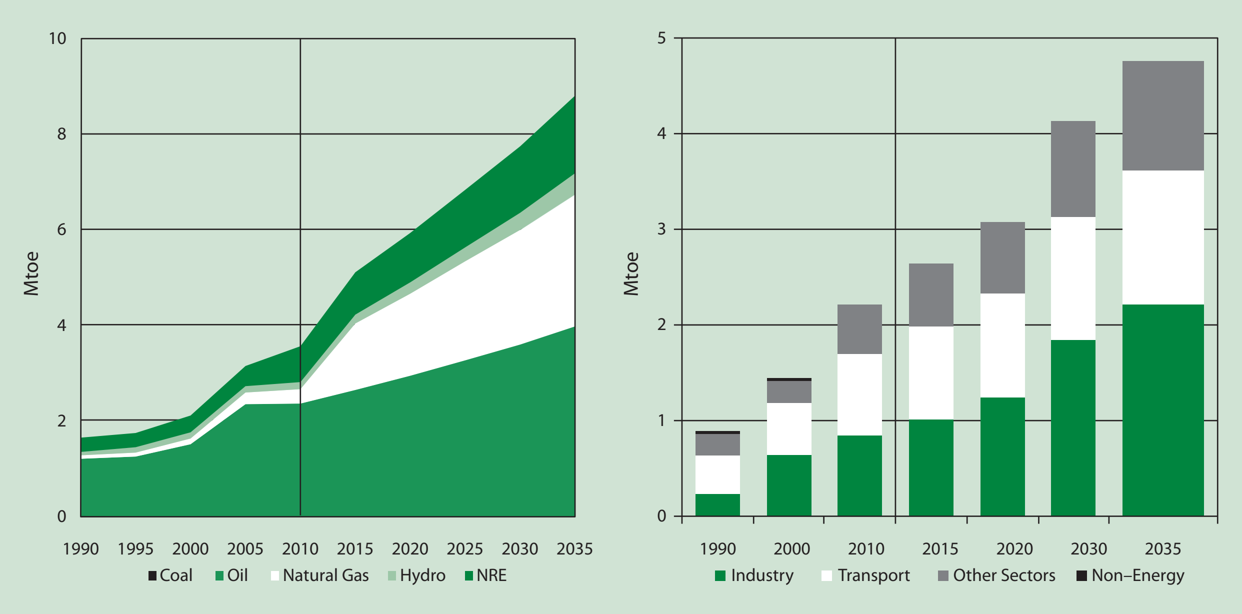
Chapter 10

The Pacific

The Pacific

- *In the business-as-usual (BAU) case, the Pacific's primary energy demand is projected to increase from 3.6 million tons of oil equivalent (Mtoe) in 2010 to 8.8 Mtoe in 2035 at an annual rate of 3.7% (Figure 10.1). Papua New Guinea will account for 75.8% of total primary energy demand in the Pacific in 2035, up from 62.0% in 2010.*
- *Diversity in the economic development among the members in the Pacific will result in different levels of per capita energy demand in the Pacific, ranging from Fiji's 0.91 tons of oil equivalent (toe) per person in 2035 to Timor-Leste's 0.12 toe per person in 2035 in the BAU case.*
- *In the alternative case,* the primary energy demand of the Pacific will reach 8.3 Mtoe by 2035 (Figure 10.2). The annual growth rate of primary energy demand will average 3.3% for the period 2010–2035. The Pacific has the potential to save about 0.5 Mtoe in 2035, or a 5.4% reduction compared with the BAU case. Similarly, the Pacific's electricity generation will be reduced by 8.1% in the alternative case. Policy needs to be formulated to realize this potential through advanced technology deployment.*

Figure 10.1 Primary Energy Demand (left) and Final Energy Demand (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

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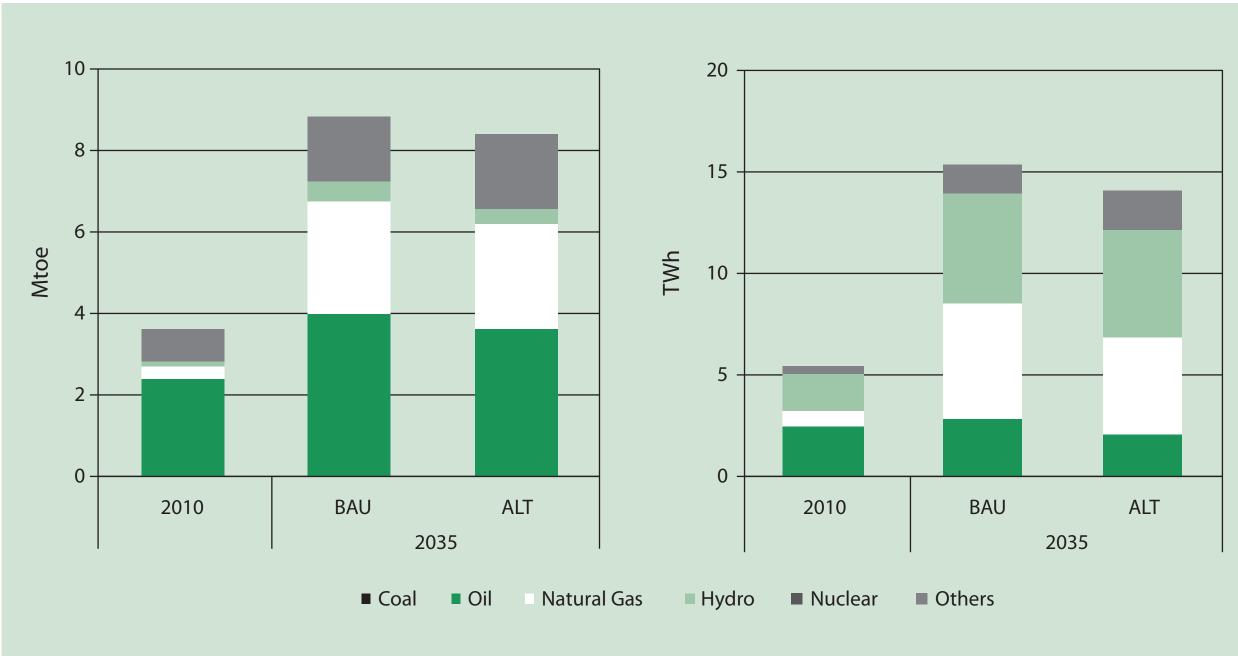
* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

Figure 10.2 Business-as-Usual and the Alternative Case: Primary Energy Demand (left) and Electricity Generation (right)



ALT = alternative case, BAU = business-as-usual case, Mtoe = million tons of oil equivalent, TWh = terawatt-hour.

10.1 Fiji

- *In the BAU case, the primary energy demand of Fiji is projected to increase from 0.6 million tons of oil equivalent (Mtoe) in 2010 to 0.9 Mtoe in 2035, growing at an annual rate of 1.3%. With this growth, Fiji's per capita energy demand will reach 0.91 toe per person, compared with 0.75 toe in 2010.*
- *In the alternative case,* Fiji's primary energy demand will increase at an average annual rate of 1.2% over the projection period. At the end of the period, Fiji's primary energy demand will reach 0.87 Mtoe, 1.3% lower than in the BAU case.*
- *With no domestic production, all the country's petroleum needs will rely on import. Given Fiji's high reliance on oil for its energy needs, the country is highly vulnerable to international oil price fluctuations.*

Recent Energy Trends and Energy Policy Issues

Fiji is endowed with rich natural resources such as forests and minerals, but it has few fossil fuel resources. The country relies heavily on imported fuels for its energy supply. At present, roughly 55% of the country's electricity demand is supplied by hydro and other renewable resources, and diesel generators meet the remaining balance of 45%. Of household expenditure on utilities, nearly 40% is for petroleum products. The high reliance on imported petroleum fuels makes the country vulnerable to international oil price fluctuations.

Urbanization and electrification, together with fuel shifting to electricity, will substantially drive the country's electricity demand. Furthermore, in the short term, mineral projects on the main islands will require a great deal of power compared with the country's current generation capacity. How to meet the country's growing demand for power while reducing its dependence on oil is an important issue in the country's energy policy.

Hydropower as well as power from other renewable energy sources, such as biomass and wind, are expected to be an option for increasing Fiji's electricity supply. Currently, Fiji's hydropower capacity is over 80 megawatts (MW),[27] with another 40 MW under construction by Fiji Electricity Authority (FEA). There are also plans for several biomass projects to be developed by several independent power producers (IPPs).

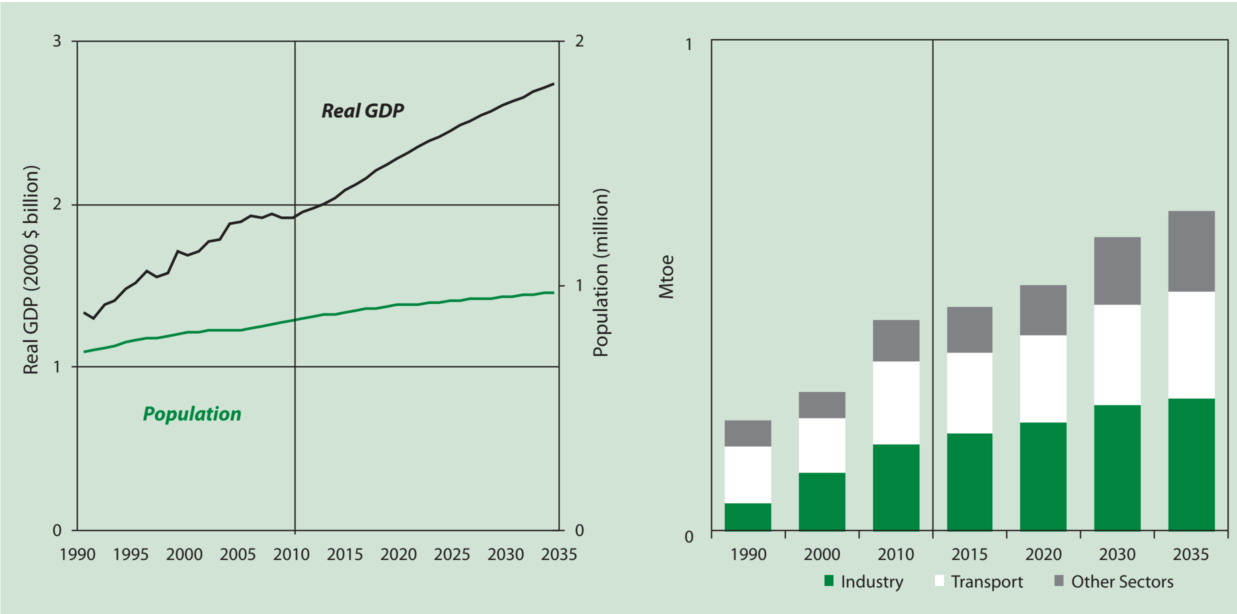
Business-as-Usual Case: Energy Demand Outlook through 2035

Over the outlook period, Fiji's gross domestic product (GDP) is projected to increase moderately at an annual rate of 1.4%. Its GDP will reach $2.8 billion (constant 2000 $) in 2035 from $1.9 billion

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

[27] The country's peak load is estimated at around 140 MW.

Figure 10.1.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

in 2010 (Figure 10.1.1). The population is projected to increase at a pace of 0.5% through 2035, reaching 1 million in 2035 from 0.9 million in 2010.

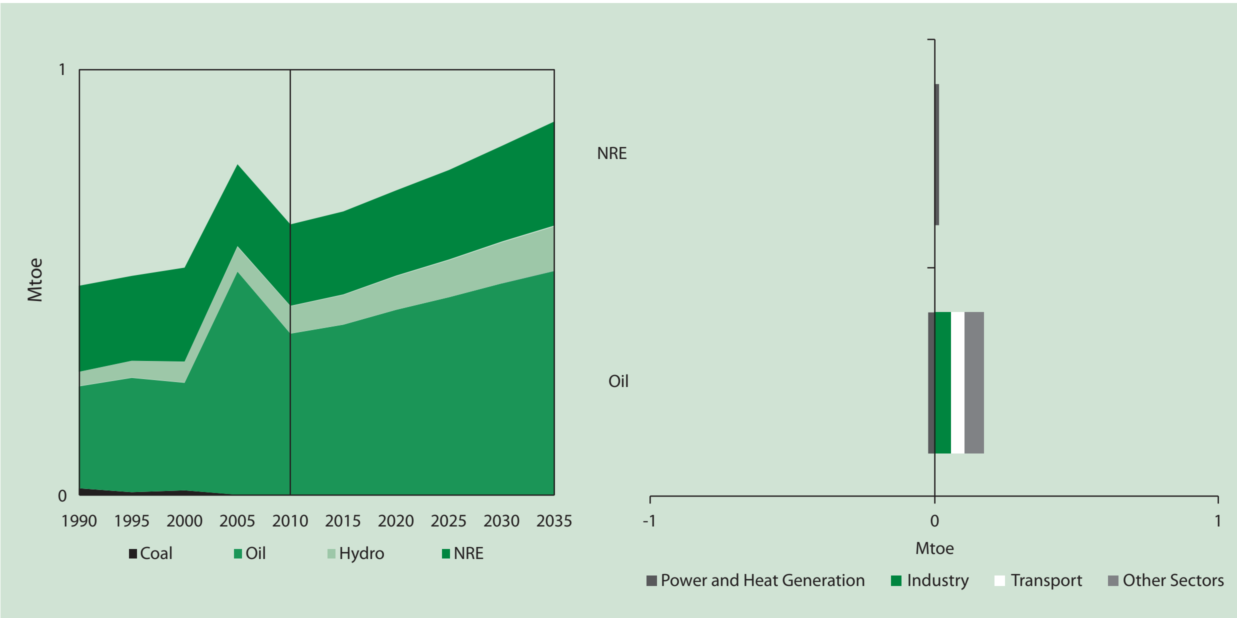
In the BAU case, the final energy demand of Fiji is projected to increase at an annual rate of 1.7% through 2035. By sector, the other sectors (including residential, commercial, agriculture, and fishery) are expected to grow the fastest. Their share in total final energy demand will reach 25.1% in 2035, rising from 19.9% in 2010. Industry will continue to be the largest energy consumer, accounting for 41.8% of the total final energy demand in 2035. Though the energy demand in the transport sector will increase slowly, its share is projected to decline from 39.1% in 2010 to 33.1% in 2035.

Energy demand in the other sectors will grow at an annual rate of 2.6%. The demand increase will be covered by oil and electricity. Oil will remain the dominant fuel in this sector with its share rising to 75.7% in 2035 from 64.6% in 2010. Demand for oil for cooking and lighting is expected to increase at an annual rate of 3.3%. Electricity demand will grow at a moderate rate of 1.4% per year. Demand for noncommercial biomass will remain almost constant at around 0.008 Mtoe and its share will decline from 9.2% in 2010 to 4.8% in 2035.

The industry sector's energy demand will grow at 1.7% through 2035. Energy demand in this sector is met mainly by oil and electricity, and a small amount of coal. Over the projection period, electricity demand is expected to grow the fastest, at an annual rate of 2.5%, with its share reaching 31.3% in 2035. Though demand for oil will increase at a slower rate of 1.4%, its share will remain the largest at 68.5% in 2035. Coal consumption in this sector will remain almost unchanged at around 0.001 Mtoe.

Oil is the only fuel consumed in the transport sector. Demand for oil for transport will increase at a moderate rate of 1.0% per year over the projection period.

Figure 10.1.2 Primary Energy Demand (left) and Incremental Growth by Energy and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

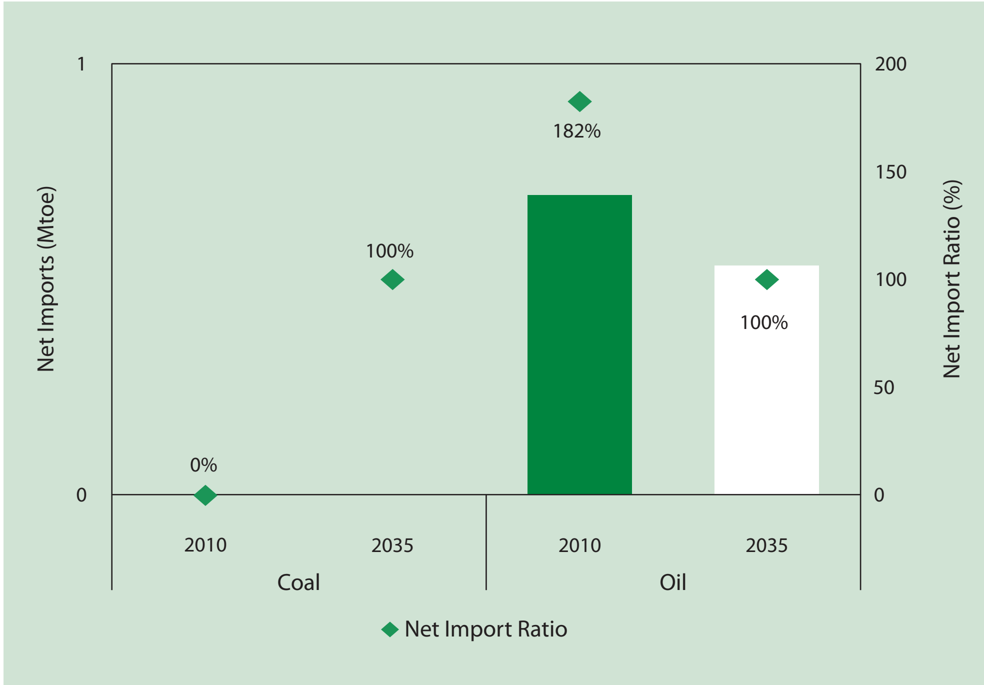
In the BAU case, the primary energy demand of Fiji is projected to increase from 0.6 Mtoe in 2010 to 0.9 Mtoe in 2035, growing at an annual rate of 1.3%. Fiji's per capita energy demand will reach 0.91 toe per person, compared with 0.75 toe in 2010.

By energy type, oil will maintain the largest share, reaching 60.1% in 2035, declining slightly from 59.8% in 2010. Driven by the government's policy to reduce reliance on imported oil for power generation, hydropower is expected to increase substantially over the projection period, at an annual rate of 2.0%. Others, including noncommercial biomass and new and renewable energy, will increase moderately with their share declining to 27.8% in 2035 from 30.1% in 2010.

The sectoral contributions to the incremental energy demand growth from 2010 to 2035 are shown in Figure 10.1.2. As the figure shows, oil demand for power generation will decrease due to a shift in fuel to hydro and other renewable energy sources. However, resulting from a demand increase in the industry, transport, and other sectors over the projection period, oil demand will see a net incremental growth of 0.1 Mtoe. Over the same period, there will be a 0.02 Mtoe increase in renewable energy driven by renewable power generation demand.

Fiji produces no oil and relies on imports to fulfill all its petroleum needs (Figure 10.1.3). The country imports petroleum fuels from Australia, New Zealand, and Singapore, with Australia and New Zealand being the major suppliers.

Figure 10.1.3 Net Imports of Coal, and Oil, and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

Alternative Case: Energy Savings Potential and Energy Source Diversification

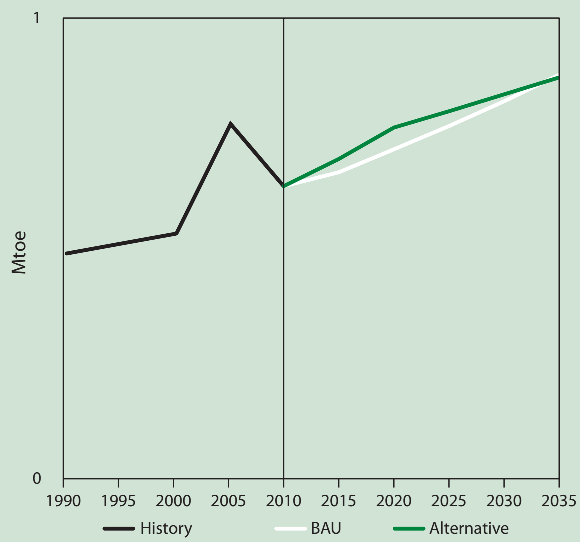
In the alternative case, Fiji's primary energy demand will increase at an annual rate of 1.2% through 2035. With this growth, Fiji's primary energy demand will reach 0.87 Mtoe in 2035, 1.3% lower than in the BAU case. However, due to a reduction in electricity generation from oil-fired power plants, coupled with an increase in electricity generation from biomass power plants, the primary energy demand in the alternative case will be higher than that of BAU in the near term. With improvements in the thermal efficiency of biomass power plants and reductions in final energy demand because of the use of advanced technologies, the difference between the primary energy demand in the BAU and alternative cases is expected to narrow in the long run.

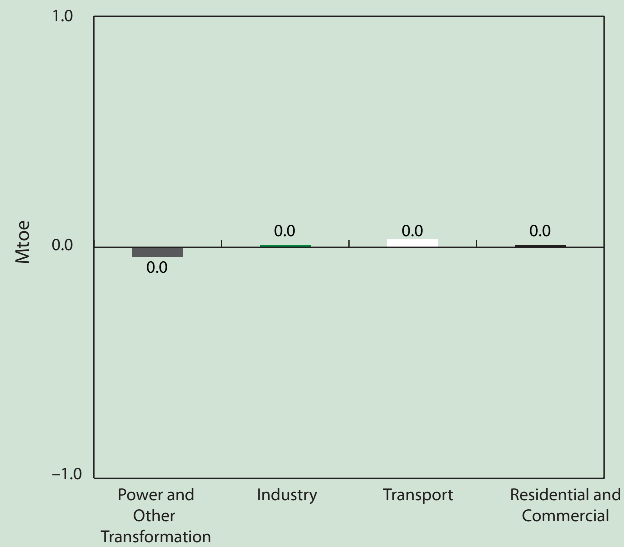
Among the final energy consumption sectors, the transport sector has the biggest energy savings potential at 0.03 Mtoe in 2035, followed by industry at 0.01 Mtoe and residential and commercial at 0.01 Mtoe (Figure 10.1.4).

By energy type, the primary demand for oil is expected to have the biggest reduction of 0.04 Mtoe in 2035. As a result of the increased introduction of non-hydro renewable power, coupled with electricity savings, the demand for hydropower will see a 0.02 Mtoe reduction in the alternative case compared with the BAU case, while the demand for non-hydro renewables will increase by 0.03 Mtoe in 2035.

In the alternative case, Fiji's electricity generation in 2035 will be about 5.3% lower at 1.4 terrawatt-hours (TWh) in 2035, compared with 1.5 TWh in the BAU case (Figure 10.1.5).

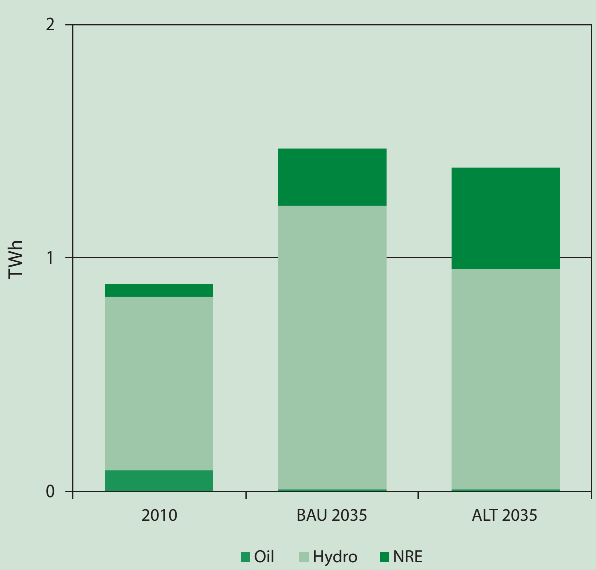
Figure 10.1.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)

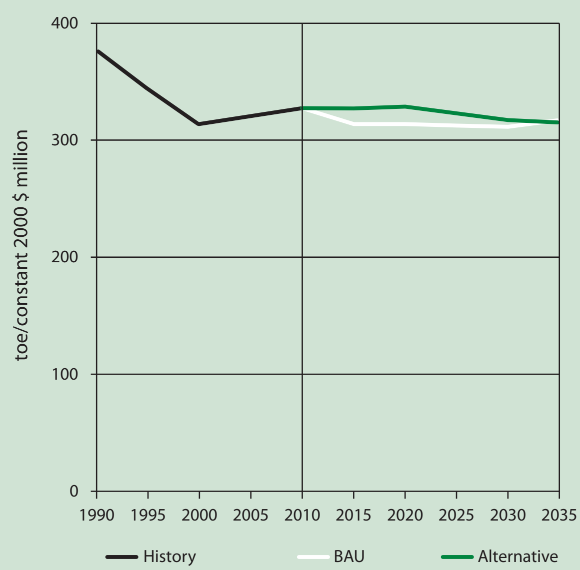




BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Figure 10.1.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)





ALT = alternative case, BAU = business-as-usual case, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Substantial savings in total generation in 2035 will result from electricity demand savings in the industry, residential, and commercial sectors. In both cases, oil's share in power generation will be largely reduced.

Energy Policy Implications

Without domestic fossil fuel resources, Fiji is heavily dependent on imported oil for its energy supply. This makes the country highly vulnerable to international oil price fluctuations. Oil products are used in all sectors in the country, including for power generation, fuel for cars, and cooking and lighting in the household. Reducing the reliance on imported oil is important to the country's energy security.

With further development of hydropower and other non-hydro renewable resources such as biomass, solar, and wind for power generation, consumption of oil for power generation could be largely lowered. However, with no backup or energy storage system, which will require additional investment, it is difficult for the country's small power system to accommodate renewable technologies with intermittent output, such as solar photovoltaic, on a large scale. In this regard, small or micro hydropower and biomass/biogas power generation are better options for the country to reduce its dependency on oil for power generation.

Although a large development of the country's mining sector[28] could greatly transform the country's future energy demand, the energy requirement to support such mining activities was not considered in the projection at this stage. However, the development of the country's mining activities should be followed closely and the energy demand projection updated accordingly.

With fuel switching to electricity, oil consumption in the other sectors could also be reduced. In the transport sector, the main consumer of oil, fuel economy improvement is expected to be the most effective way to reduce oil demand.

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[28] Mining is a major economic activity in Fiji, and gold is one of the country's largest exports. The Namosi Joint Venture (NJV), a consortium of an Australian and two Japanese companies, holds a license to explore areas in the Namosi and Naitasiri provinces in Fiji for mineral deposits. NJV's Waisoi Project, if developed, will produce copper and gold for export, and is estimated to have a mine life of 20 to 25 years.

10.2 Papua New Guinea

- *In the BAU case, the primary energy demand of Papua New Guinea (PNG) is projected to grow at 4.5% per year, increasing from 2.2 Mtoe in 2010 to 6.7 Mtoe in 2035. In the alternative case,* the projected growth rate of primary energy demand is slightly moderate at 4.2% per year through 2035, reaching 6.6 Mtoe in 2035. This suggests that PNG's potential energy savings (the difference between the primary energy demand in the BAU and alternative cases) will be small at about 0.1 Mtoe in 2035, or a reduction equivalent to 2.0% of the primary energy demand in the BAU case in 2035.*
- *With the possibility of becoming a net oil importer sometime after 2020, it is important for PNG to develop underutilized indigenous energy sources such as hydro and natural gas.*

Recent Energy Trends and Energy Policy Issues

PNG demonstrated a strong economic performance, achieving a 6.0% annual growth rate between 2005 and 2010. Endowed with substantial mineral resources, including gold, copper, and natural gas, PNG relies heavily on exports of minerals and crude oil for its government revenues. Agricultural commodities also contribute to economic growth. The start of construction on a liquefied natural gas (LNG) plant and the recovery in global commodity prices primarily accelerated PNG's economic growth in 2010.

The currently planned LNG export projects in PNG are expected to benefit its economy. The ExxonMobil-led PNG LNG project is anticipated to start up in 2014 with a capacity of 6.9 million tons per year. In November 2012, the PNG government also approved InterOil's Gulf LNG development project to be supplied by the Elk-Antelope gas fields. This LNG project is planned to produce 3.8 million tons per year initially and then increase to 12 million tons per year in three phases: 4 million tons per year each from the first tranche in 2016, the second in 2018, and the third in 2020 (Visaggio 2012). However, there is some uncertainty involved in the construction timetable as observed in the PNG LNG project, which encountered some delays in 2010 since land access and compensation issues were raised by the local population.

A challenge for PNG's economic and social development is to improve access to electricity. PNG's electrification rate in 2010 was merely 16.7%, especially low in rural areas where around 87.6% of the population lives (SPC website). Even where power is available in urban areas, the power supply is not always reliable, resulting in the use of inefficient and expensive generators fueled by diesel. Electrification may be slow in PNG due to difficult geographical features, high up-front costs for power generation capacity development, and low technical and operational capability. Nevertheless, expanding electricity access and enhancing reliability of power supply will facilitate economic activity and consequently help reduce poverty while making investment conditions better. The Electricity Industry Policy took effect in 2011 and is designed to address issues of low access to electricity services, unreliable electricity supply, and affordability for consumers by improving the performance of the electricity industry. Effective implementation of this policy may

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

bring about a structural change and participation of the private sector to the electricity industry, which is expected to accelerate electricity infrastructure development.

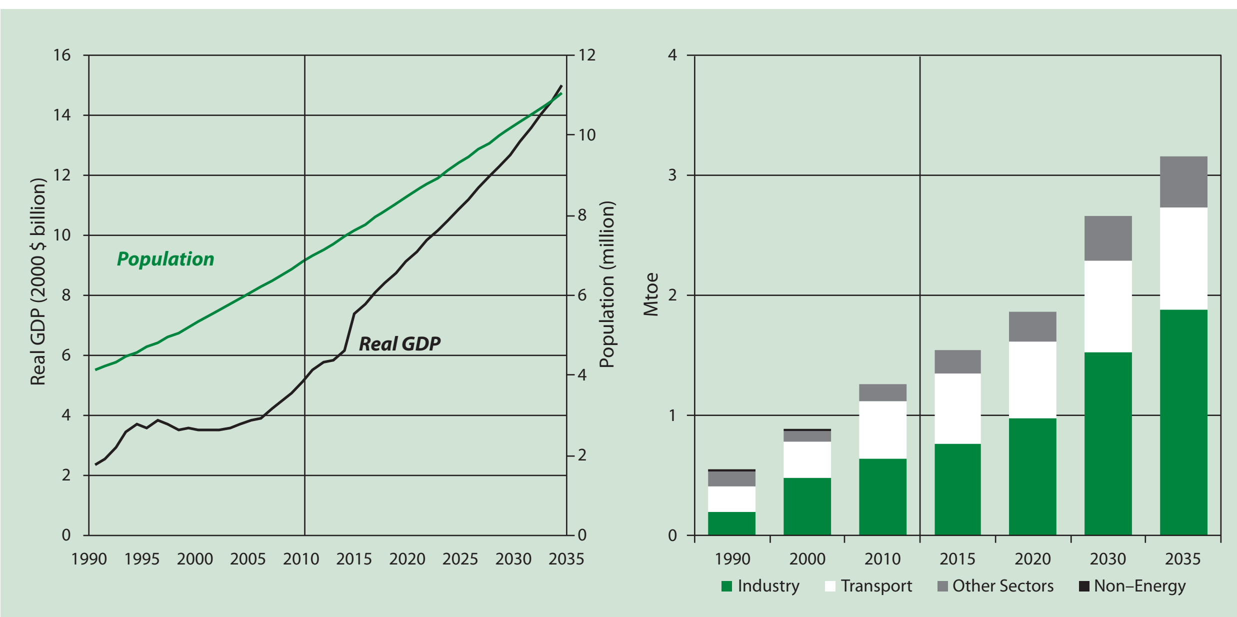
Business-as-Usual Case: Energy Demand Outlook through 2035

PNG's GDP is projected to more than triple from \$5.1 billion (constant 2000 \$) in 2010 to \$16.2 billion in 2035 with an average annual growth rate of 4.7% (Figure 10.2.1). Compared with the historical trend, population growth will be slower at an annual growth rate of 1.9%. The population will increase by 4.2 million to 11.1 million in 2035. GDP per capita will almost double from \$744 in 2010 to \$1,466 in 2035.

In the BAU case, PNG's final energy demand is projected to increase from 1.2 Mtoe in 2010 to 3.2 Mtoe in 2035 with an annual growth rate of 3.8% over the outlook period. In terms of sectoral share, the industry sector will remain dominant at 59.7% in 2035, followed by the transport sector, which will gradually reduce its share to 26.7% in 2035. The other sectors (including residential, commercial, agriculture, and fishery) will account for the rest, showing a slight increase in share from 10.8% in 2010 to 13.7% in 2035.

By sector, the energy demand of the other sectors is projected to register the fastest growth rate of 4.8% through 2035. In the other sectors, commercial energy demand will be primarily for electricity, kerosene, and liquefied petroleum gas (LPG). There are currently no plans for construction of a gas distribution network for residential and commercial customers. The projection for the other sectors includes only final demand for commercial energy, due to inadequate information about noncommercial energy use in PNG, although the member's demand for noncommercial biomass is assumed to remain significant over the outlook period.

Figure 10.2.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

Final industrial energy demand is projected to increase at an average annual rate of 4.4%, from 0.6 Mtoe in 2010 to 1.9 Mtoe in 2035. This outlook supposes that PNG's industry sector will retain its current structure, which consists mainly of mining, light manufacturing, and agricultural processing. Meanwhile, the scale of production of these industries is expected to grow.

By contrast, final energy demand in the transport sector will grow relatively slowly at an annual growth rate of 2.3%. This demand will be met almost entirely by oil-derived fuels.

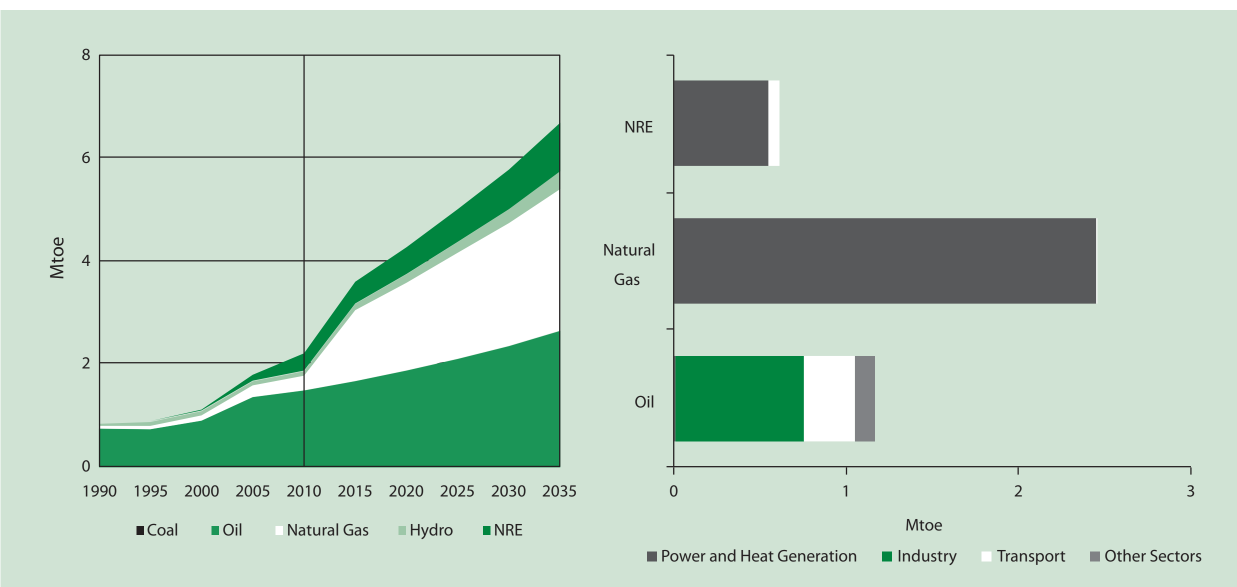
In the BAU case, primary energy demand is projected to grow at 4.5% per year, from 2.2 Mtoe in 2010 to 6.7 Mtoe in 2035. PNG's energy demand per capita will increase from 0.32 tons of oil equivalent (toe) per person in 2010 to 0.61 toe per person in 2035.

Oil will be increasingly supplemented with natural gas and hydro, although it was the predominant form of energy before 2010. Natural gas will demonstrate a substantial growth at 9.3% over the outlook period, accounting for 41.1% in 2035. Oil will follow at 39.7%, others at 14.1%, and hydro at 5.1%.

As to the sectoral contributions to the incremental energy demand growth from 2010 to 2035 shown in Figure 10.2.2, the power sector will explain most of the increases in demand for natural gas and for new and renewable energy. More than half of oil demand is expected to increase in the industry sector, owing to diesel and heavy oil generators used for self-generation or backup purposes.

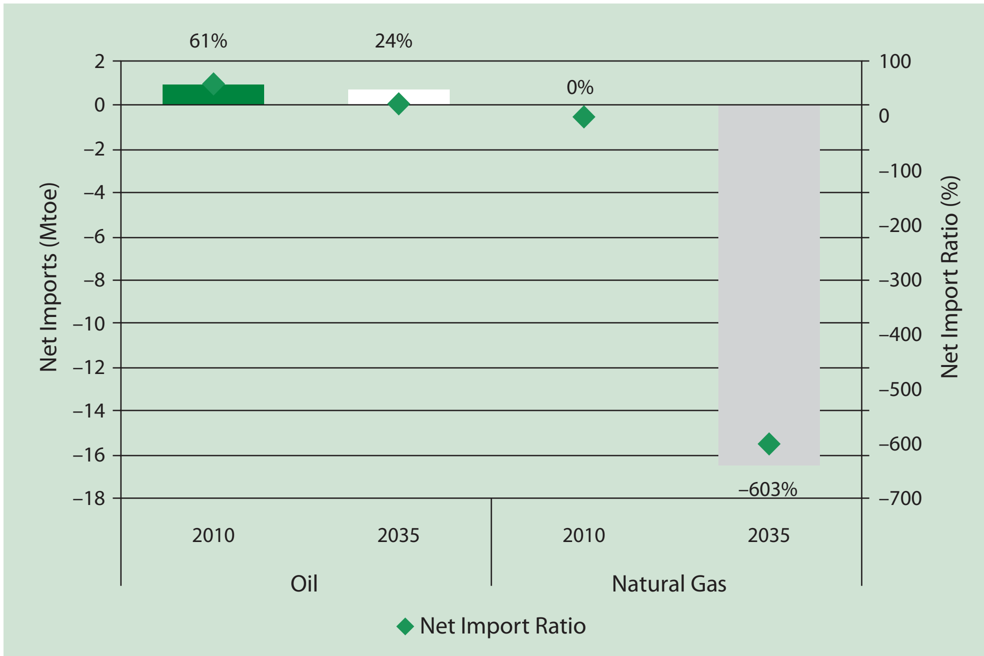
Historically, PNG has been a modest oil exporter, but it could become a net oil importer sometime after 2020 unless new reserves of oil are found. On the other hand, PNG will become

Figure 10.2.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others)

Figure 10.2.3 Net Imports of Oil and Natural Gas and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

a net natural gas exporter with the start-up of LNG export projects after 2014. Net exports of natural gas in 2035 are estimated to amount to 16.6 Mtoe (Figure 10.2.3)

Alternative Case: Energy Savings Potential and Energy Source Diversification

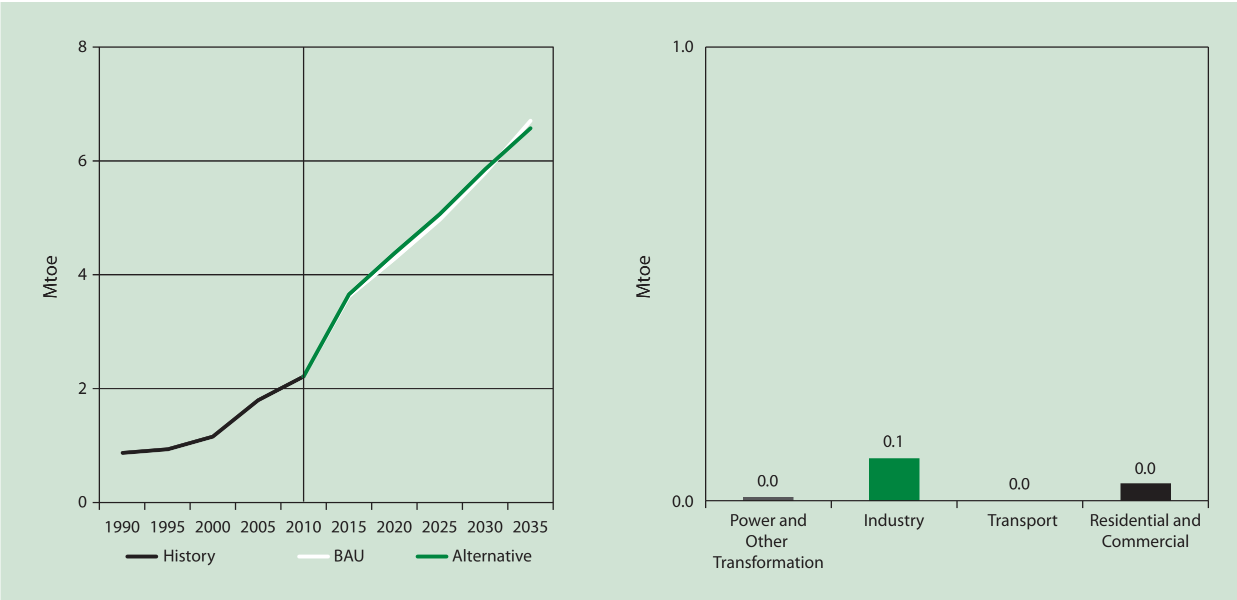
In the alternative case, PNG's primary energy demand is projected to grow at 4.2% per year, reaching 6.6 Mtoe in 2035 if advanced technologies are utilized for energy savings (Figure 10.2.4). Compared with the primary energy demand in 2035 in the BAU case, PNG has the potential to save about 0.14 Mtoe in 2035 (or a 2% reduction).

Among the sectors, the industry sector indicates the biggest energy savings potential at 0.09 Mtoe, an approximately 14.6% reduction from the BAU case. The savings potential may hinge on energy-saving technology adopted by the mining industry. The residential and commercial sectors would follow with a savings potential of 0.03 Mtoe, to which deployment of higher-efficiency appliances such as lighting and refrigerators would contribute.

Electricity generation by energy type is compared between BAU and the alternative case in Figure 10.2.5. The total electricity generation in 2035 in the alternative case is approximately 7% lower than in the BAU case, mainly because of the estimated electricity savings on the demand side.

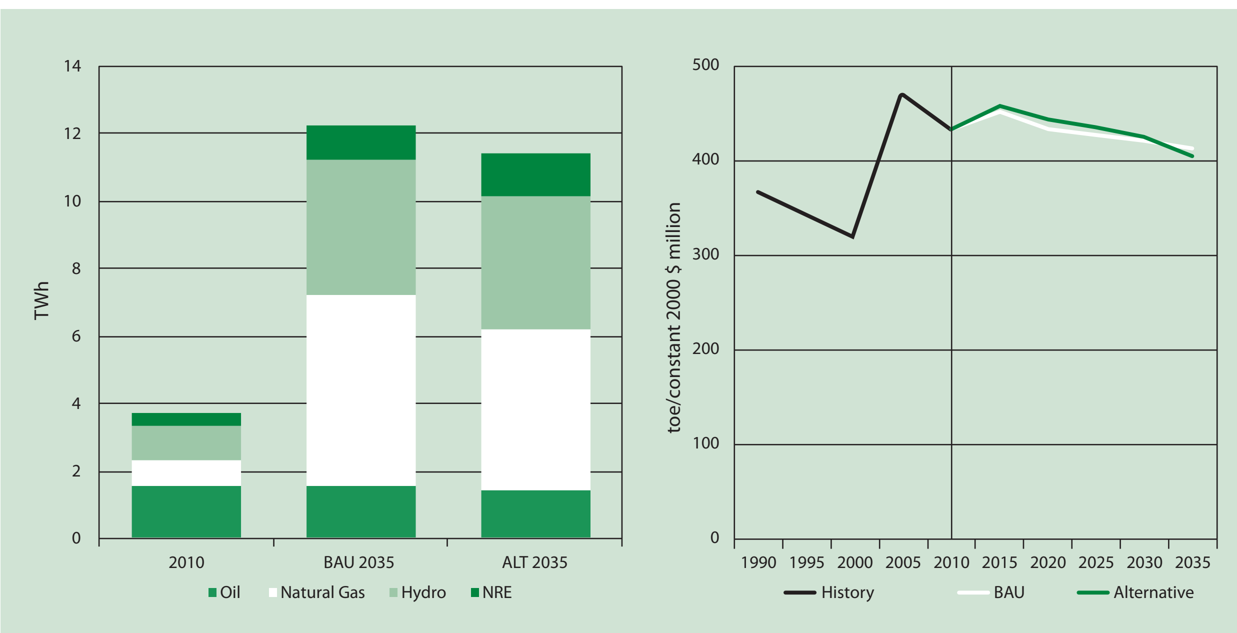
In electricity generation for both cases, natural gas is projected to increase significantly as a result of natural gas supply becoming available in the Port Moresby area. Similarly, hydropower

Figure 10.2.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Figure 10.2.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

is expected to be developed further through 2035. According to the PNG government's plan, approximately 800 MW of hydropower generating capacity are planned to be put into operation by 2030 (Government of PNG 2010).

Primary energy demand per GDP (i.e., energy intensity) will decrease at a slow pace after 2015 for both cases at an annual rate of 0.2% in the BAU case and 0.3% in the alternative case. Without any regulations to facilitate efficient energy use, the energy demand increase in the industry sector (especially the mining subsector) may be an obstacle to improving the energy intensity. Implementation of energy efficiency policy could be a fundamental step to encourage energy intensity improvement.

Energy Policy Implications

With the possibility to become a net oil importer over the medium to long term, there may be a considerable change in the energy mix in PNG. Since PNG has significant underutilized indigenous energy sources such as hydro, natural gas, geothermal, and solar-based systems, development of these resources would heighten PNG's potential to sustain economic growth and to enhance the electrification rate. For instance, development of the LNG export projects will help not only to reduce dependence on oil in energy supply but also to compensate for revenue reductions from oil export. In electricity generation, utilization of hydro (mini hydro) and solar power may be an appropriate choice in off-grid and rural areas without access to electricity.

It is urgently necessary for PNG to implement fundamental energy policies. The National Energy Policy and the Rural Electrification Policy have been under review since 2006. Although the supply side policy (i.e., the 2011 Electricity Industry Policy) is in effect, energy efficiency policy on the demand side is still missing as it has received limited attention from the government. Such a policy framework is critical for PNG to move toward the rational utilization of domestically available energy sources. In addition, PNG's investment environment could be improved by laying out regulatory and administrative groundwork that would enhance accountability and transparency of the investment process. Since high up-front investment costs are required to tap the underdeveloped resources, creating better investment conditions will be essential to draw in investors. Establishment of the essential energy policy will be the key for PNG's future energy structure.

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10.3 Timor-Leste

- *In the BAU case, Timor-Leste's primary energy demand is projected to reach 0.27 Mtoe in 2035, increasing from 0.09 Mtoe in 2010 at an average annual rate of 4.6%.*
- *In the alternative case,* Timor-Leste's primary energy demand will increase at a lower rate of 1.9% through 2035, reaching 0.14 Mtoe. This means that Timor-Leste has the potential to halve its BAU consumption in 2035 with the deployment of more efficient demand technologies and new and renewable energy.*

Recent Energy Trends and Energy Policy Issues

A new country recognized internationally only in 2002, Timor-Leste is relatively small in terms of land area and population. It has a total land area of 14,870 square kilometers and its population was 1.1 million in 2010. The country's GDP during the same year amounted to $446.3 million (constant 2000 prices) with per capita GDP of $396 (World Development Indicators)—one of the lowest among the developing member countries (DMCs) of the Asian Development Bank (ADB).

However, Timor-Leste is one of the only two countries among ADB's DMCs in the Pacific that possesses energy reserves, with 554 million barrels of proven oil reserves and 200 billion cubic meters of proven natural gas reserves (CIA 2012).

Timor-Leste produced 7.2 million tons of crude oil in 2002, and this increased at an annual rate of 0.3% until 2008. Almost all of the crude oil production is exported—with a small amount used for electricity generation—while the country imports its petroleum product requirements in the absence of oil-refining facilities.

The economy of Timor-Leste grew at an average annual rate of 6.5% per year from 2002 to 2010 with a faster average rate of 12.1% experienced from 2006 to 2010 per year (World Development Indicators). Its total primary energy supply and total final energy consumption grew at annual average rates of 2.4% and 5.4%, respectively (UNSD 2011).

Timor-Leste's energy policies are embodied in the newly released Program of the Fifth Constitutional Government 2012–2017 Legislature that was promulgated on 26 August 2012. These policies include the policy on electricity supply. The country aims to provide the entire population with access to reliable electricity 24 hours a day. It also endeavors to utilize renewable energy (solar, wind, and hydro) and complete rural electrification in the next 5 years. The program considers the petroleum sector as the key pillar in the country's future development. It therefore aims to develop the petroleum industry such that it involves the "maximum participation of Timorese businesses and citizens" (Presidency of the Council of

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

Ministers 2012). Timor-Leste aims to transform itself from a largely subsistence agricultural economy to a modern and well-diversified one with high-quality infrastructure (Office of the Prime Minister 2010).

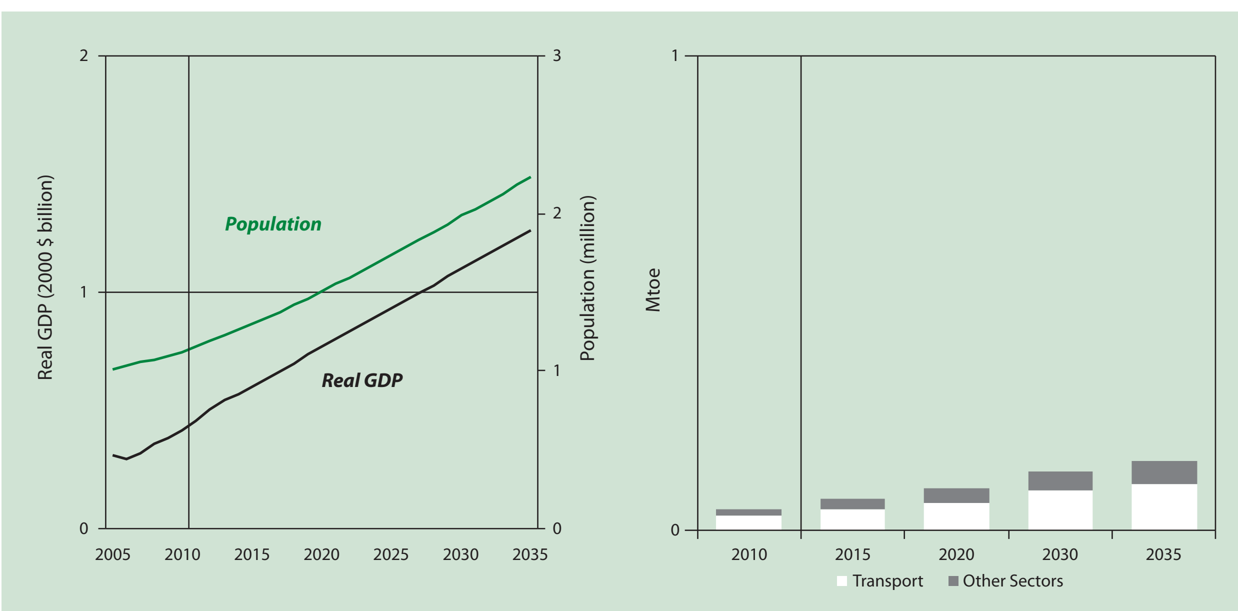
Business-as-Usual Case: Energy Demand Outlook through 2035

Timor-Leste's economy is projected to continue to improve with GDP growth assumed at 6.4% per year from 2010 to 2020. The growth rate is projected to be slower from 2020 to 2035, but the average growth rate from 2010 will stand at 4.6% to 2035.

With such economic growth assumptions from 2010 to 2035, final energy demand is projected to grow at an annual rate of 4.7% from 0.05 Mtoe in 2010 to 0.14 Mtoe in 2035 (Figure 10.3.1). Oil consumption will grow at 4.6% per year, while electricity consumption will grow at 4.9% per year.

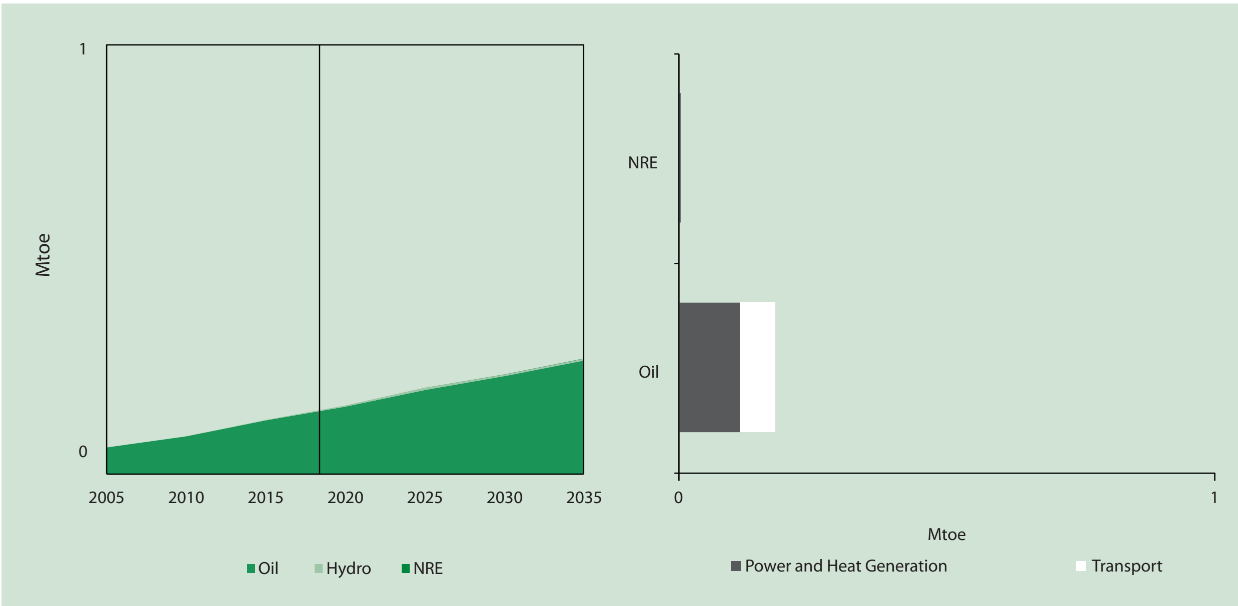
Timor-Leste's energy data do not include the consumption of biomass, which has a high probability of being used in the country. Therefore, only the consumption of oil and electricity has been forecasted. The projection of final energy demand would have been more accurate if biomass consumption data were available. Furthermore, final energy consumption data are only available for transport and other sectors (residential and commercial). There is no accounting of industrial energy consumption data. In view of this lack of information, only the consumption of the transport and other sectors are projected. The transport sector's consumption will grow at the same rate of oil consumption

Figure 10.3.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

Figure 10.3.2 Primary Energy Demand (left) and Incremental Growth by Energy and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

(4.6% per year), while electricity consumption will grow at the same rate as the other sectors' consumption (4.9% per year).

In the BAU case, the primary energy demand of Timor-Leste is projected to increase from 0.09 Mtoe in 2010 to 0.27 Mtoe in 2035, growing at an annual rate of 4.6%. With the steady growth, Timor-Leste's per capita energy demand will increase from 0.08 tons of oil equivalent (toe) per person in 2010 to 0.12 toe per person in 2035, still very low compared with the average consumption per capita in the Pacific region of 0.2 toe per person in 2008.

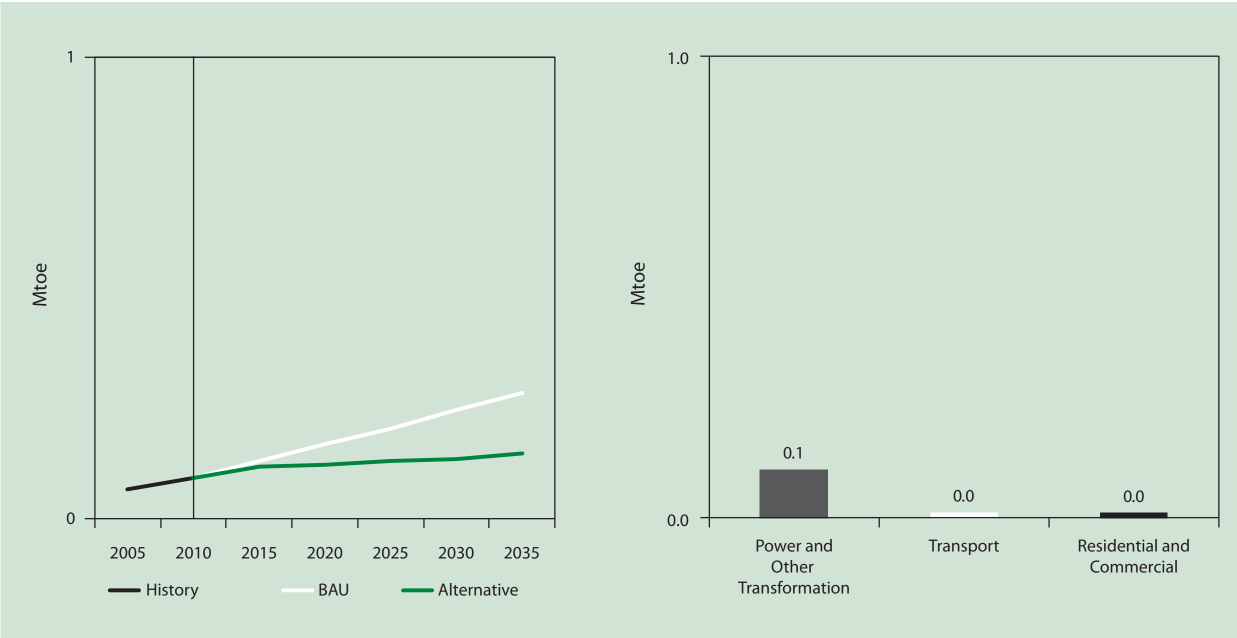
By energy type, Timor-Leste's primary energy mix in 2010 was dominated by oil (at 99.8%) with hydropower taking the balance of 0.02%. The mix of energy will not change substantially by 2035 as dominance of oil will continue (98.1%), followed by hydro at 1.7% and other new and renewable energy at 0.2% in 2035.

The sectoral contributions to incremental energy demand growth from 2010 to 2035 are shown in Figure 10.3.2. As the figure shows, demand for oil is projected to increase substantially by 0.18 Mtoe, with increased use for both the power and the transport sectors.

Alternative Case: Energy Savings Potential and Energy Source Diversification

As a result of the deployment of advanced technologies, Timor-Leste's primary energy demand in the alternative case will increase modestly at 1.9% through 2035, reaching 0.14 Mtoe

Figure 10.3.3 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

(Figure 10.3.3). This translates to 0.13 Mtoe potential savings as compared with the primary energy demand in the BAU case in 2035 (or a 48.2% reduction).

By sector, the power sector has the biggest energy savings potential at 0.11 Mtoe with the transport sector and other sectors' savings potential estimated at 0.01 Mtoe each.

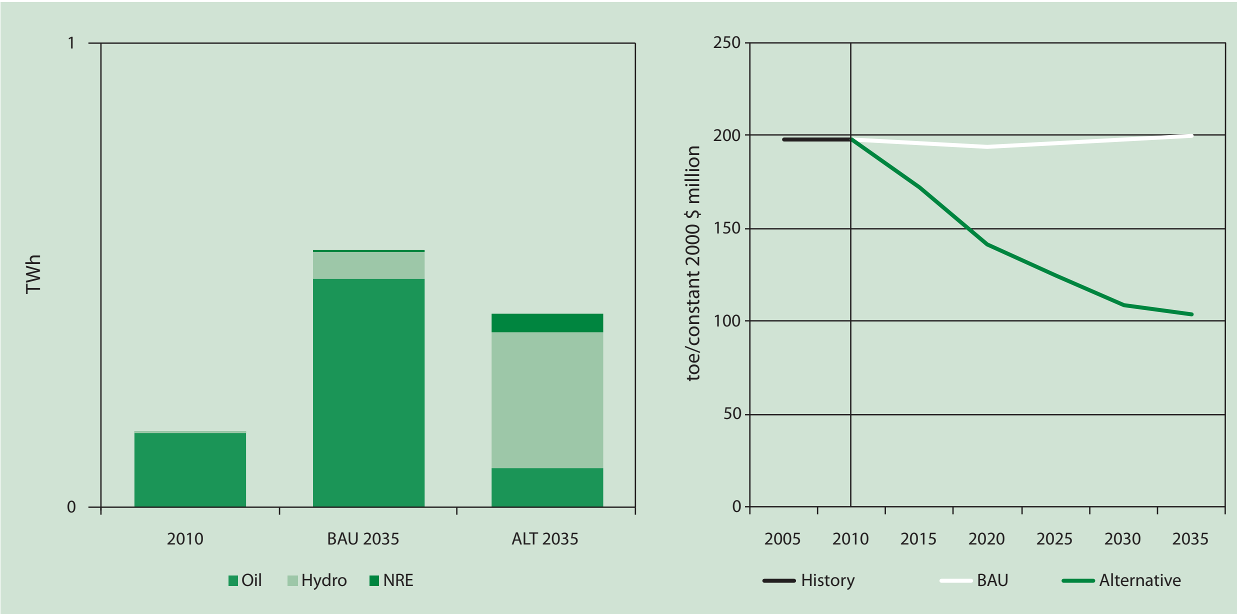
The total savings in the power sector is a combined effect of reduced final electricity demand, improved thermal efficiency, and the displacement of oil by new and renewable energy (hydro and other new and renewable energy), which are assumed to be 100% efficient.

The other sectors (residential and commercial) will have potential energy savings of 0.01 Mtoe in 2035. These estimated savings will be the result of the deployment of more efficient appliances (lighting, refrigeration, and other appliances).

The potential energy savings from the transport sector of 0.01 Mtoe in 2035 may come from a shift toward more efficient vehicles, such as hybrid and electric vehicles, from the conventional internal combustion engines.

The power generation by energy type for BAU and the alternative case is compared in Figure 10.3.4. In the alternative case, total electricity generation in 2035 will be 24.5% lower than in the BAU case as a result of end-use efficiency improvement. In terms of electricity generation sources, they are expected to be significantly diversified in the alternative case compared with the BAU case, with an increase in the share of hydro (70% in 2035) and the introduction of solar energy (accounting for 5% of total generation in 2035). The BAU case assumes a more conservative estimate with 10% hydro and 1% solar, with oil taking 89%.

Figure 10.3.4 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

As a result of the improved energy efficiency and the switch from conventional fuels to new and renewable energy, the energy intensity in the BAU and alternative cases will be significantly different. In the BAU case, energy intensity in 2035 will be almost the same as the 2010 level, while in the alternative case, a significant decrease of 2.6% per year is projected.

Energy Policy Implications

A more accurate analysis of Timor-Leste's energy sector is hampered by incomplete data. A study on the country's energy situation should therefore be carried out, especially on the amounts of energy production and consumption.

On the policy side, Timor-Leste's energy policies embodied in its Program of the Fifth Constitutional Government 2012–2017 is appropriate and timely. The country understands what it has, what it needs, and what it is supposed to do to maximize the use of what it has to achieve its strategic vision of a country transformed from an agricultural economy to a modern one with highly developed infrastructure.

The country therefore should not waver on its vision and efforts to reach its goals. It should find partners that will share its aspiration of a more affluent Timor-Leste and provide it with all the support it needs. These kinds of partners need not provide assistance in terms of dole outs but merely share the benefits of Timor-Leste's oil and gas resources justly.

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10.4 Other Pacific Islands

- *Other Pacific Islands (OPI) consist of the Cook Islands, Kiribati, the Marshall Islands, the Federated States of Micronesia, Nauru, Palau, Samoa, Solomon Islands, Tonga, and Vanuatu. Tuvalu is not included due to absence of energy data.*
- *In the BAU case, OPI's primary energy demand is projected to reach 0.98 Mtoe in 2035, increasing from 0.63 Mtoe in 2010 at an average annual growth rate of 1.8%.*
- *In the alternative case, OPI's primary energy demand will increase at a slower annual rate of 0.8%, reaching 0.78 Mtoe in 2035. This means that OPI have the potential to save about 0.2 Mtoe in 2035 compared with the primary energy demand in the BAU case (or a 21% reduction).*

Recent Energy Trends and Energy Policy Issues

OPI consist of the Cook Islands, Kiribati, the Marshall Islands, the Federated States of Micronesia, Nauru, Palau, Samoa, Solomon Islands, Tonga, and Vanuatu. Tuvalu is not included due to the unavailability of energy data. All of these islands do not posses proven reserves of coal, oil, and gas. The OPI's oil supply is 100% imported.

Some countries among the OPI have hydro resources that could be tapped for electricity generation. In fact, the power generation mix of Palau and Samoa in 2008 comprise 11.8% and 45.0% of hydropower, respectively (UNSD 2011). Solomon Islands, which possesses the biggest land area among the OPI, could have the largest potential for hydro.

Wind energy is another resource that could be tapped in the OPI depending on the competitiveness of this resource with other options. Construction of a 3 MW wind power plant in Vanuatu has been completed and it has been connected to the Port Villa grid. The resource assessment for a second wind farm is being conducted (Renewable Energy and Energy Efficiency Partnership website). Solar power is also widely used in the OPI, with grid-connected solar power plants in Micronesia (52.5 kilowatt-peak [kWp]), Palau (100 kWp), and Samoa (400 kWp). Solar home systems are also used in all the OPI countries, particularly in islands far from the capital cities (Renewable Energy and Energy Efficiency Partnership website). Solar home systems were touted to offer the most cost-effective solution due to distances between islands, sparse population, and good solar conditions (GENI website).

The OPI's land area spans over 47,000 square kilometers scattered throughout the Pacific Ocean. The total population of the OPI was more than 1.4 million in 2010. The collective GDP of these eight island countries totaled $2.14 billion (constant 2000 $) in 2010, with per capita GDP of $1,550.

As regards energy policies, the countries in the OPI focus on their electricity sector in terms of capacity expansion, improvement of grid service, and use of new and renewable energy (NRE). These countries aim to increase the use of solar, wind, and liquid biofuels to reduce the dependence on imported oil for electricity generation.

To illustrate, the following are the renewable energy policy goals and targets of the countries in the OPI as compiled by the International Renewable Energy Agency (IRENA 2012):

- Cook Islands—increase renewable energy share in electricity generation to 50% by 2015, to increase 100% by 2020 (Renewable Energy Development Division 2011)
- Kiribati—10% of electricity generation from renewable energy
- Marshall Islands—renewable energy will provide 20% of electrical energy generated by the end of 2020 (Ministry of Resources and Development 2009)
- Federated States of Micronesia—10% of electricity generation in urban areas and 50% in rural areas should come from renewable energy by 2020 (Renewable Energy and Energy Efficiency Partnership website)
- Nauru—50% of energy demand should be met by alternative energy sources, which includes renewable energy by 2015
- Palau—20% of primary energy should come from renewable energy by 2020
- Samoa—20% of primary energy should come from renewable energy by 2030
- Solomon Islands—50% of electricity generation should come from renewable energy by 2015
- Tonga—50% of electricity generation should come from renewable energy by 2012
- Vanuatu—the Vanuatu Energy Roadmap was launched in October 2011 with the following vision: "To energise Vanuatu's growth and development through the provision of secure, affordable, widely accessible, high quality, clean energy services for an Educated, Healthy, and Wealthy nation" but no measurable targets on renewable energy were mentioned in the road map (Renewable Energy and Energy Efficiency Partnership website).

These policies are likely to be driven largely by the dependence of the OPI on imports for their entire oil requirements.

Business-as-Usual Case: Energy Demand Outlook through 2035

The GDP of the OPI collectively grew at an average annual rate of 2.6% from 1990 to 2010. From 2010 to 2020, GDP is projected to grow at 2.9% and growth will taper off to 1.8% per year from 2020 to 2035.

With this economic growth rate coupled with 1.6% annual growth of the population from 2010 to 2035, the OPI's final energy demand is projected to grow at an annual rate of 2.0% from 0.49 million tons of oil equivalent (Mtoe) in 2010 to 0.81 Mtoe in 2035 (Figure 10.4.1).

The other sectors (composed of the residential and commercial sectors) are projected to experience the fastest growth rate in final energy demand among the sectors at 2.2% per year from 2010 to 2035. The transport sector will have the second-fastest growth of 1.9%, while the industry sector will have a lower growth rate of 1.8% per year during the same period.

In the BAU case, the primary energy demand of the OPI is projected to increase from 0.63 Mtoe in 2010 to 0.98 Mtoe in 2035, growing at an annual rate of 1.8%. Among energy types, renewable and solar energy will grow the fastest at an average annual rate of 2.7% per year during the same period. Hydro will grow at the same rate at 2.7% per year and oil demand will grow at a slower rate of 1.1% per year.

The sectoral contributions to the incremental energy demand growth from 2010 to 2035 are shown in Figure 10.4.2. As the figure shows, demand for new and renewable energy is projected to increase substantially by 0.21 Mtoe, with the increased use for both the power and other sectors. The increase in oil demand will be driven mainly by the transport sector and secondly by the power sector.

Alternative Case: Energy Savings Potential and Energy Source Diversification

As a result of the deployment of advanced technologies, the OPI's primary energy demand in the alternative case will increase at a slower rate of 0.8% per year through 2035, reaching 0.78 Mtoe (Figure 10.4.3). This means that the OPI have the potential to save about 0.2 Mtoe in 2035 compared with the primary energy demand in the BAU case during the same year (or a 21% reduction).

By sector, the other sectors have the biggest energy savings potential at 0.12 Mtoe, followed by the power sector at 0.04 Mtoe. The transport sector will have potential savings of a little less than 0.04 Mtoe.

The savings in the power sector is a combined effect of improved energy efficiency of electrical appliances reducing electricity demand; the improved thermal efficiency of power generation facilities; and the displacement of oil with new and renewable energy technologies, which are assumed to have efficiencies of 100%.

The power generation by energy type for BAU and the alternative case is compared in Figure 10.4.4. In the alternative case, total electricity generation in 2035 will be about 22% lower than in the BAU case as a result of efficiency improvements, mainly in the industry, residential, and commercial sectors. In terms of electricity generation sources, the alternative case will have the same generation mix, although the total amount of generation will be lower than in the BAU case.

The energy intensity of the OPI in the BAU case is projected to decline at an average rate of 0.4% per year from 296 toe per million constant 2000 $ in 2010 to 264 toe per million constant 2000 $ in 2035. In the alternative case, the rate of decline is faster at 1.4% per year, bringing the energy intensity to 210 toe per million constant 2000 dollars in 2035.

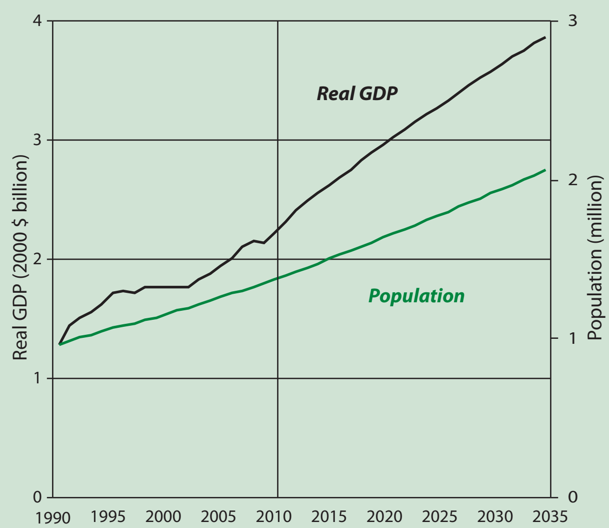
Energy Policy Implications

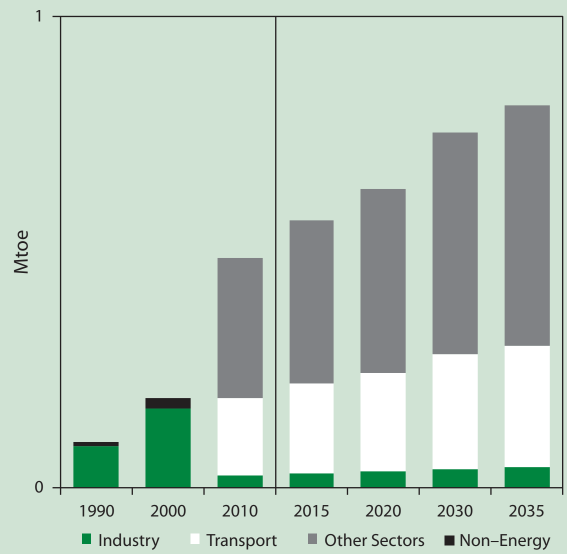
Several countries in the OPI have made aggressive targets for the use of new and renewable energy for electricity generation, although a few have somewhat low targets. Some analysts find these targets to be unattainable, likely in consideration of the current state of new and renewable energy developments in these countries (Dornan 2012).

It could be argued, however, that the current level of oil prices makes new and renewable energy a viable option in the Pacific. This could be further driven by the decreasing cost of renewable energy technologies that could further fall with large-scale production, making new and renewable energy increasingly more competitive than oil-based generation. The fact that new and renewable energy is carbon-neutral further supports its development and utilization.

While new and renewable energy targets in the OPI may be too high for some countries and too low for others, it cannot be discounted that new and renewable energy will play a huge

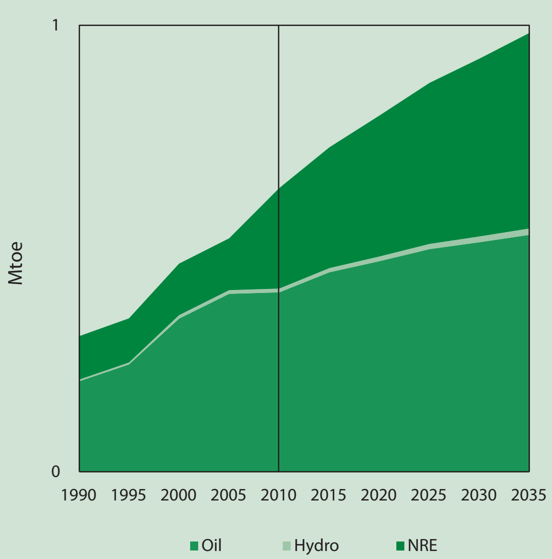
Figure 10.4.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual

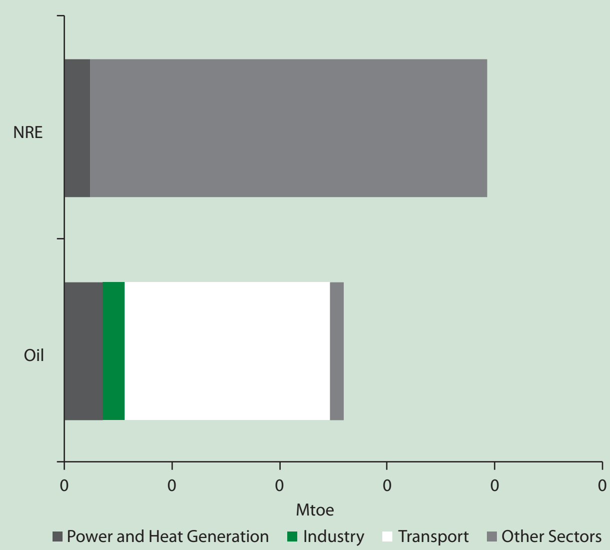




GDP = gross domestic product, Mtoe = million tons of oil equivalent.

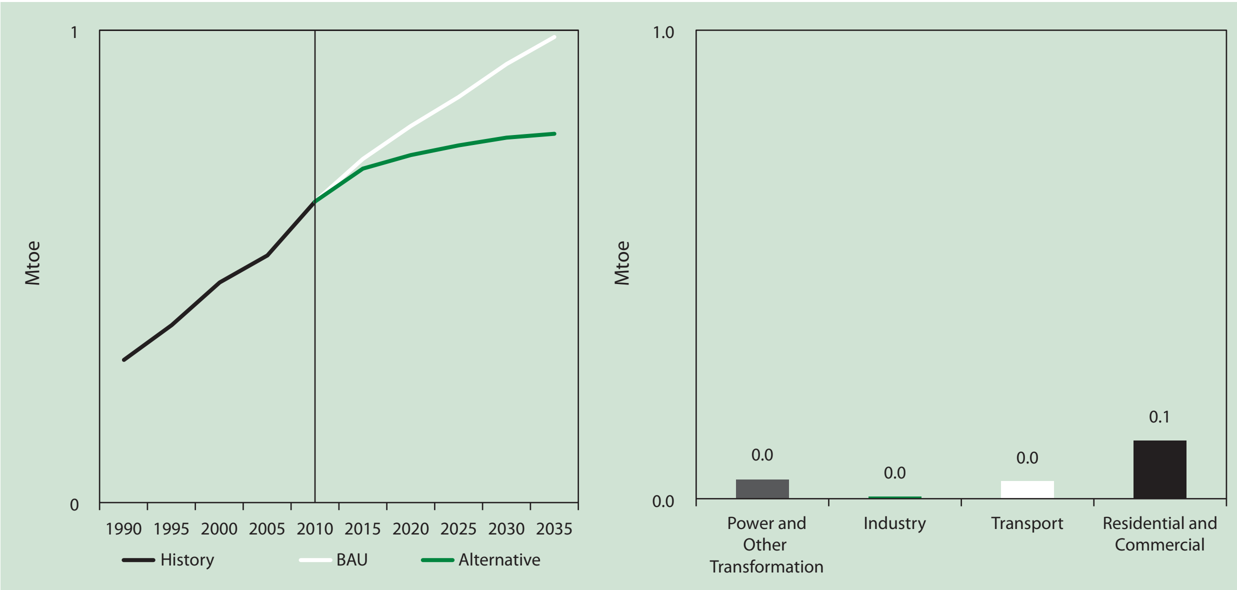
Figure 10.4.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual





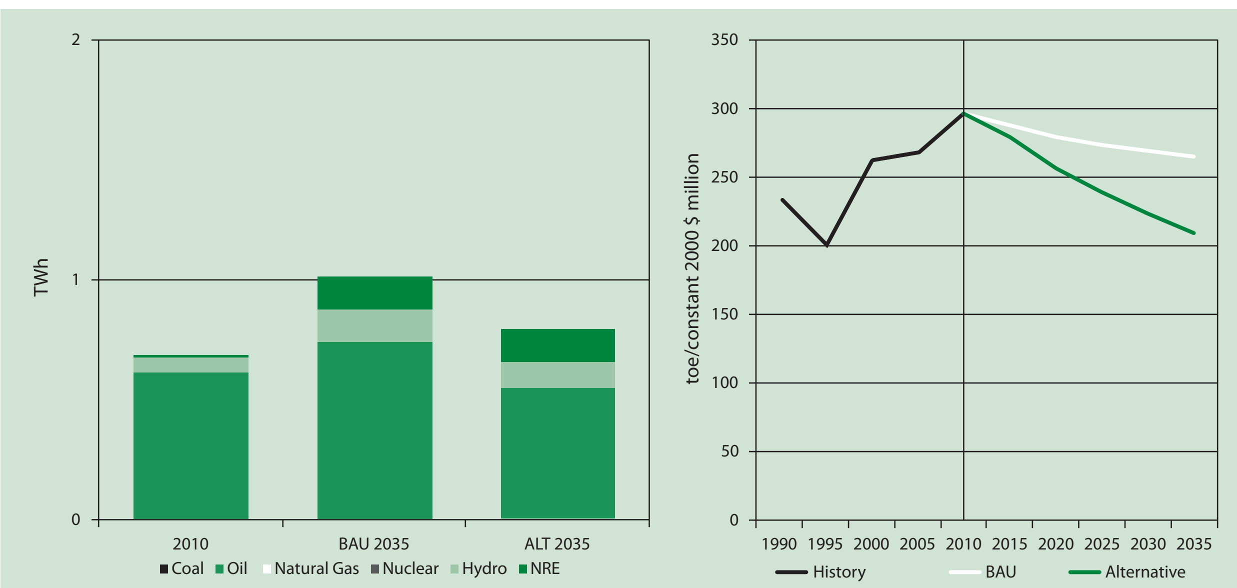
Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 10.4.3 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Figure 10.4.4 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

role in the OPI's future energy mix. The following course of action is therefore recommended for OPI countries:

- review the current new and renewable energy targets taking into account the resource availability, applicability, and costs;

- use available international mechanisms similar to the Clean Development Mechanism that would further improve the competitiveness of new and renewable energy against conventional fuels;
- study demand management options so that the intermittency of new and renewable energy is taken into account in planning power system improvement and/or expansion; and
- develop expertise in new and renewable energy in anticipation of employment opportunities in the new and renewable energy sector.

In addition, the quality and availability of data in the OPI need to be improved for a more robust analysis of the region's future energy outlook. Capacity building on energy statistics should be carried out and a complete accounting of energy production and consumption will be necessary.

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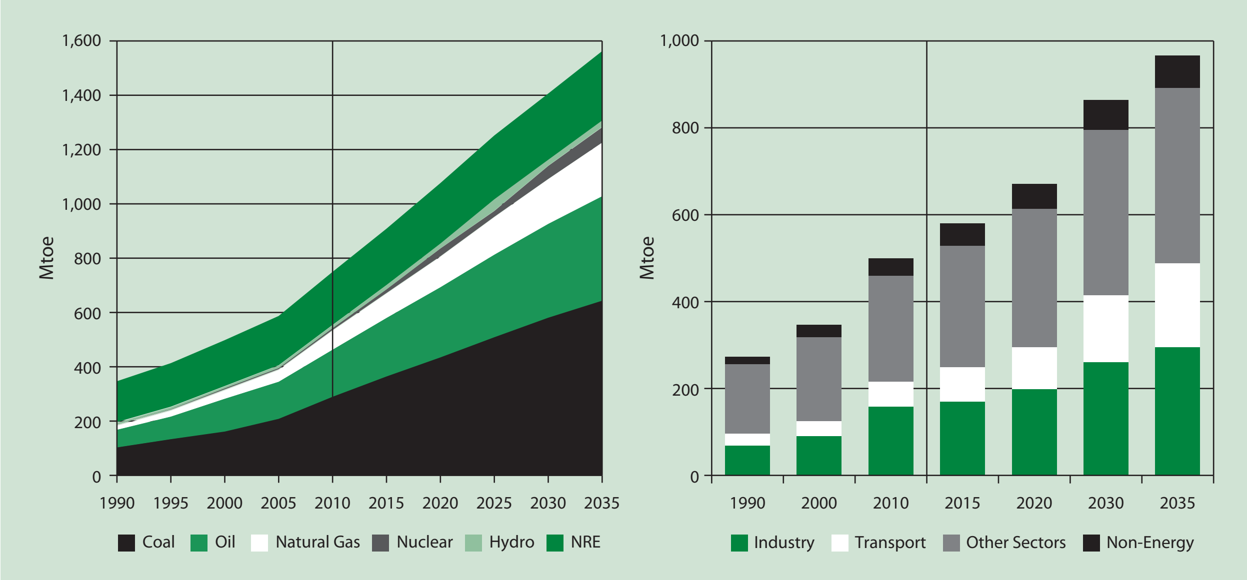
Chapter 11

South Asia

South Asia

- *In the business-as-usual (BAU) case, South Asia's primary energy demand is projected to increase from 745.5 million tons of oil equivalent (Mtoe) in 2010 to 1,558.6 million tons of oil equivalent Mtoe in 2035 at an annual rate of 3.0% (Figure 11.1). Coal will remain dominant through 2035, driven by the power sector. India will continue to account for the bulk of the energy share in South Asia at 92.5% in 2035. The final energy demand will reach 974.0 Mtoe in 2035 with an annual growth rate of 2.7%. Despite its relatively small share, the transport sector's energy demand is likely to register the fastest growth rate of 4.7% over the outlook period.*
- *In the alternative case,* primary energy demand will reach 1,343.8 Mtoe in 2035, growing at an average annual rate of 2.4% from 2010 to 2035 (Figure 11.2). South Asia has the potential to save about 214.7 Mtoe in 2035, or a 13.8% reduction compared with the BAU case. The primary energy mix in the alternative case will be more diversified by reducing coal dependence as well as increasing the use of nuclear and new and renewable energy. As for electricity generation, an 18.0% reduction may be possible in 2035 in the alternative case.*
- *Energy security is an important issue for South Asia due to its heavy dependence on imports of fossil fuels. To improve the situation, it will be essential to explore and utilize indigenous energy sources and to apply advanced technologies for energy savings.*

Figure 11.1 Primary Energy Demand (left) and Final Energy Demand (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

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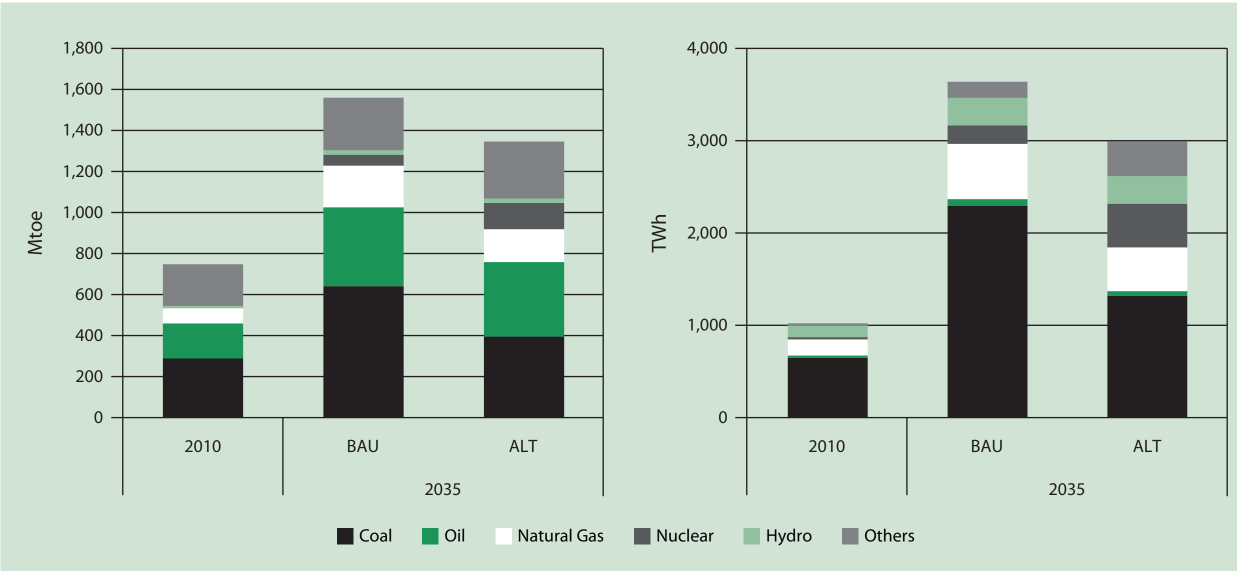
* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

Figure 11.2 Business-as-Usual and the Alternative Case: Primary Energy Demand (left) and Electricity Generation (right)



ALT = alternative case, BAU = business-as-usual case, Mtoe = million tons of oil equivalent, TWh = terawatt-hour.

11.1 Bangladesh

- *In the BAU case, Bangladesh's primary energy demand is projected to increase from 31.1 Mtoe in 2010 to 77.6 Mtoe in 2035, growing at an annual rate of 3.7%. In the alternative case,* with advanced technologies deployed, primary energy demand will be reduced to 68.8 Mtoe in 2035 and grow at a slower pace of 3.2%. This shows that the potential of energy savings will be 8.8 Mtoe in 2035 compared with the BAU case (or a 11.3% reduction).*
- *Securing energy supply without delay will be fundamental to sustaining the economic growth of Bangladesh. Faced with a fast-paced energy demand growth, it is important for Bangladesh to strengthen its power generation capacity, upgrade the transmission and distribution network, and diversify energy sources away from natural gas.*

Recent Energy Trends and Energy Policy Issues

Bangladesh has demonstrated robust economic growth, maintaining a gross domestic product (GDP) growth rate of above 6% since 2004 except in 2009 when it was 5.7%. Along with industrialization, the industry sector's contribution to GDP has expanded, driven mainly by manufacturing of products such as garments and textiles. Economic performance could have been better, however, if energy had been adequately supplied.

Chronic power shortages and frequent blackouts have caused substantial economic losses. The unreliable power supply is partially a result of insufficient gas supply. Bangladesh is heavily dependent on natural gas in power generation, whereas the existing gas reserves will not provide sufficient supply to sustain economic activity beyond 2016 if the current gas consumption level is unchanged (Ministry of Finance 2011). Hence, the government is seeking to diversify energy sources for power generation. For instance, a target of 500 megawatts (MW) of power from renewable energy by 2015 has been set with emphasis on solar photovoltaic, wind, and biogas. In addition to domestic coal development, coal-fired power generation using imported coal is also expected to expand. Import of liquefied natural gas (LNG), which is expected to start in 2015, will also help energy source diversification.[29] In the long term, a nuclear power plant is planned to begin operation in 2018.

Power shortage is affected by poor infrastructure development and maintenance in transmission and distribution as well as lack of generation capacity. Taking this matter seriously, the Bangladesh government envisions ensuring a reliable and quality supply of electricity and aims to add 20,000 MW of generation capacity by 2020 (Board of Investment n.d.). Infrastructure development to enhance energy supply necessitates substantial investment, which the government expects especially from the private sector's participation in the form of a public–private partnership and pure private investment, given financing difficulties by the public sector. Electricity tariffs that are artificially lower than supply costs have kept the

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

[29] The startup date was originally planned for 2013.

energy industry in deficit and discouraged private companies' involvement. In fact, Bangladesh is required to launch a fuel price reform as a part of its loan commitment with the International Monetary Fund so that the fund is not used for fuel subsidies.

Business-as-Usual Case: Energy Demand Outlook through 2035

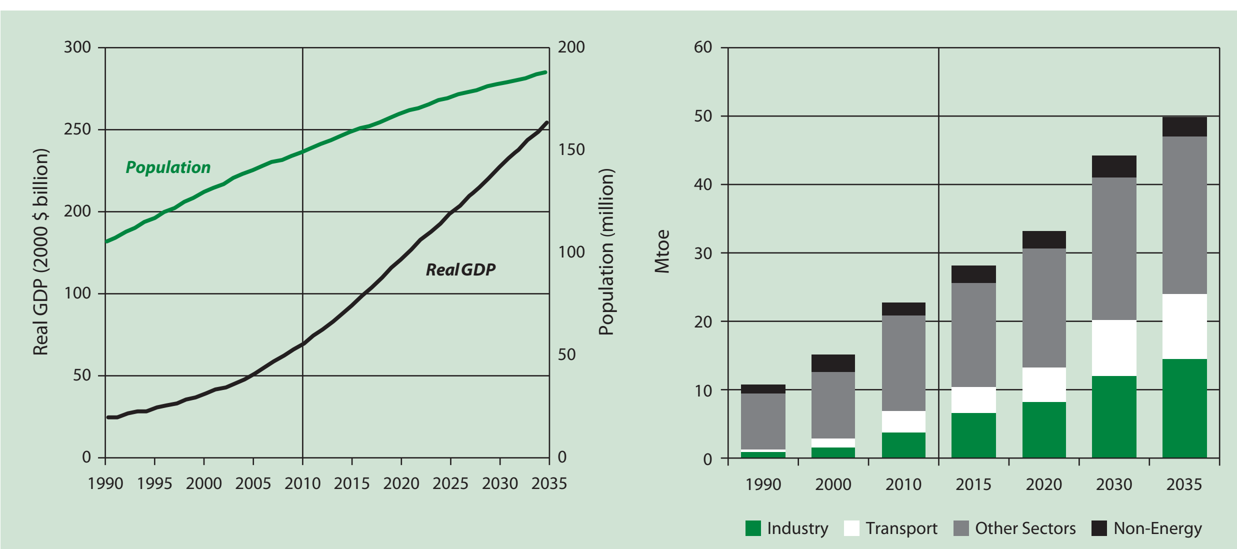
Bangladesh's GDP is projected to almost triple from $83.0 billion (constant 2000 $) in 2010 to $243.0 billion in 2035 at an annual growth rate of 4.4% (Figure 11.1.1). Population growth will be moderate at 0.9% over the outlook period, reaching 187.1 million in 2035 from 148.7 million in 2010. Accordingly, GDP per capita will increase from $558 in 2010 to $1,299 in 2035.

Final energy demand in the BAU case is projected to increase from 22.9 Mtoe in 2010 to 50.3 Mtoe in 2035 at an annual growth rate of 3.2%. By sector, although the other sectors (which includes the residential, commercial, and agriculture sectors) will remain dominant through 2035, the share will decline from 61.3% in 2010 to 45.6% in 2035. In contrast, the industry and transport sectors will gradually increase their shares from 17.8% to 29.1% and from 13.0% to 19.3%, respectively, over the outlook period.

The industry sector's energy demand will register the fastest annual growth rate at 5.2%, increasing from 4.1 Mtoe in 2010 to 14.6 Mtoe in 2035. Natural gas will account for the largest share at 61.4% in 2035. Production of fertilizers needed in agriculture, the country's major industry, will continue to boost natural gas demand.

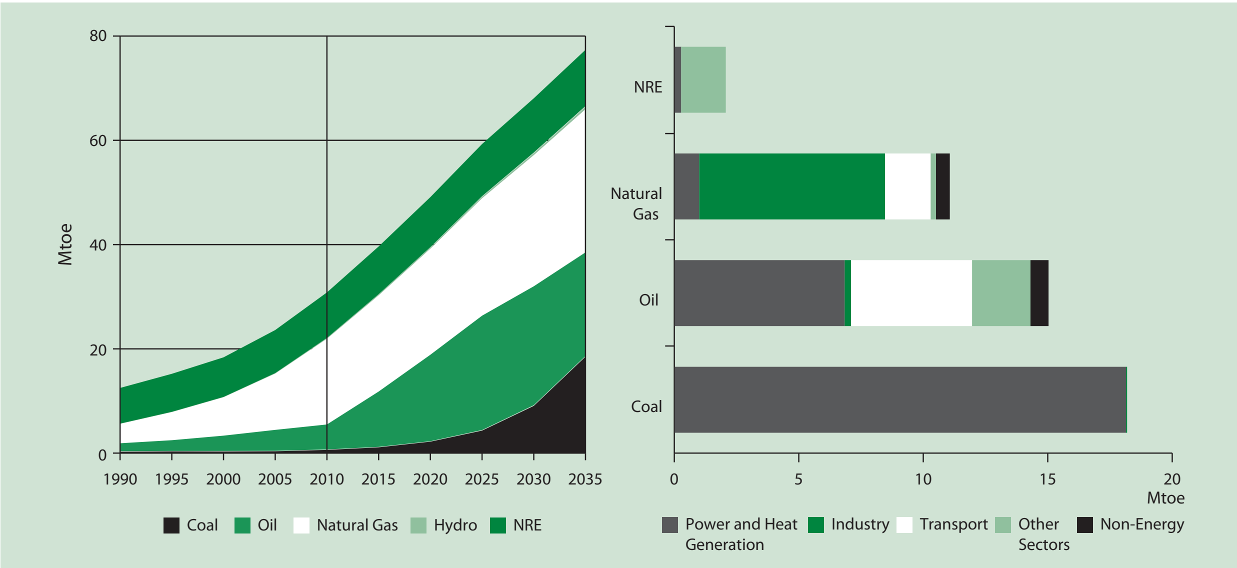
The energy demand of the transport sector will also grow robustly at 4.8% per year between 2010 and 2035. Oil will maintain its dominant share in transport energy demand at approximately 70% through 2035. Meanwhile, natural gas will account for the rest with a robust growth rate of

Figure 11.1.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

Figure 11.1.2 Primary Energy Demand (left) and Incremental Growth by Energy and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

5.2%, since compressed natural gas vehicles are assumed to be used continuously for energy security and air quality improvement.

The final energy demand of the others sectors makes up the biggest share of the total final energy demand, although the growth rate is the slowest among the end-use sectors, averaging only 2.0% per year during the outlook period. A fuel switch from biomass (mainly for residential cooking) to commercial energy sources is likely to take place in Bangladesh. While the demand for electricity and oil is projected to increase at an annual growth rate of 5.9% and 4.0%, respectively, biomass will grow at merely 0.7%. The government target of providing electricity to all by 2020 is assumed to improve access to electricity, resulting in electricity demand increases.

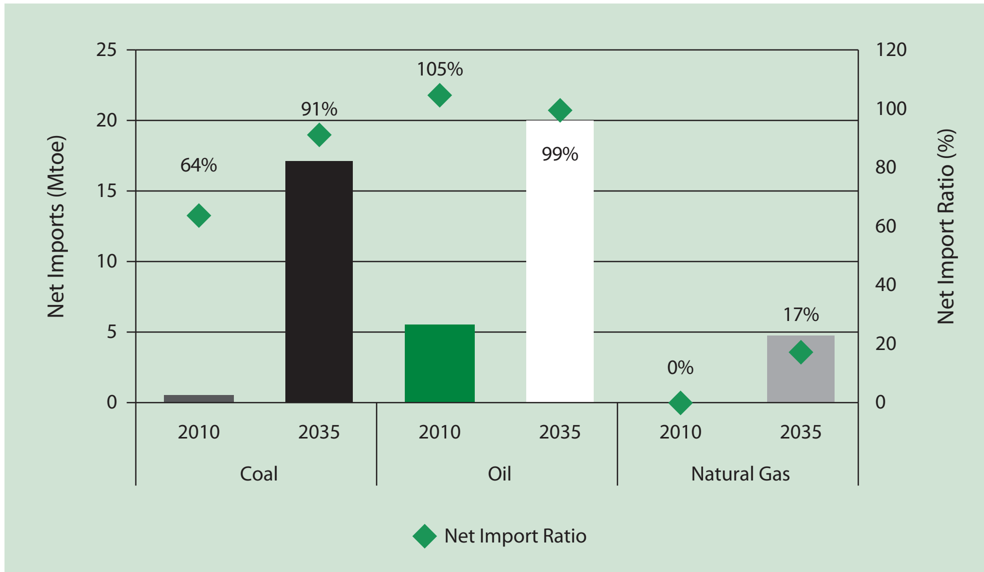
In the BAU case, Bangladesh's primary energy demand is projected to increase from 31.1 Mtoe in 2010 to 77.6 Mtoe in 2035, growing at an annual rate of 3.7%. Primary energy demand per capita will increase from 0.21 tons of oil equivalent (toe) per person in 2010 to 0.41 toe per person in 2035, which is comparably low.

Bangladesh's primary energy mix will change significantly in 2035 in that the share of coal will expand substantially to 24.2% from 2.0% in 2010, and natural gas and new and renewable energy will reduce their shares gradually.[30] Still, natural gas will be the dominant fuel at 35.5% in 2035, followed by oil at 25.9%.

In Figure 11.1.2 showing the incremental energy demand growth by sector over the outlook period, coal demand is projected to increase by 18.1 Mtoe, which will be used mostly in the power sector and marginally in the industry sector. An increase in oil and natural gas demand will be observed across the sectors. The power sector, rather than the transport sector, will contribute most to the increase in oil demand. Demand for new and renewable energy will increase mainly in the other sectors.

[30] New and renewable energy includes biomass (such as wood and animal waste), geothermal, wind, solar, and others.

Figure 11.1.3 Net Imports of Coal, Oil, and Natural Gas and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

Oil net import is projected to steadily increase between 2010 and 2035, with the net import ratio remaining around 100%, due to very limited oil production and oil refinery capacity.[31] The net import ratio of coal is projected to increase continuously as coal-fired power plants are assumed to expand in power generation so that reliance on natural gas can be eased (Figure 11.1.3). To make up for the shortage in domestic natural gas supply, Bangladesh plans to import LNG at the country's first floating LNG import facility, which is targeted to be set up in 2015. A potential natural gas supplier is Qatar, with whom Bangladesh signed a memorandum of understanding in 2011 for 4 million tons of LNG per year. Through regional cooperation, Bangladesh will import 500 MW of electricity each from India and Myanmar, which is expected to help Bangladesh's electricity supply in the medium to long term (Ministry of Finance 2011).

Alternative Case: Energy Savings Potential and Energy Source Diversification

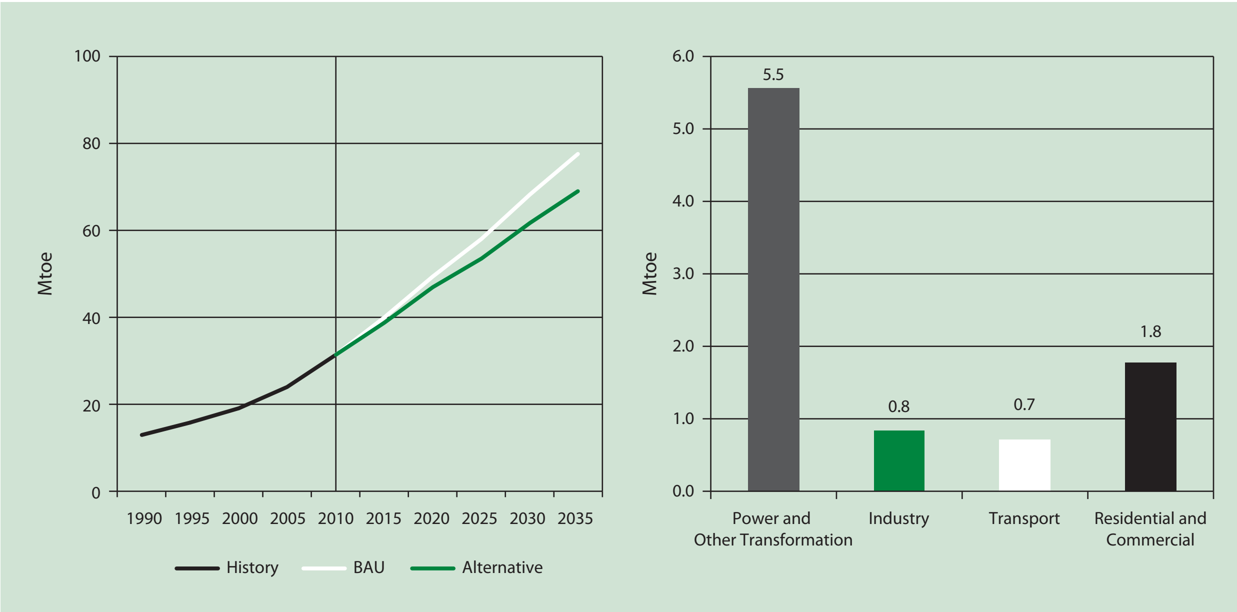
With the use of advanced technologies for energy savings, Bangladesh's primary energy demand in the alternative case could be reduced to 68.8 Mtoe in 2035 and grow at a slower pace of 3.2% compared with the BAU case (Figure 11.1.4). Potential energy savings will amount to 8.8 Mtoe in 2035, or a 11.3% reduction in primary energy demand from the BAU case.

The power sector could demonstrate the largest energy savings potential at 5.5 Mtoe. Approximately 86.0% of total savings may be explained by fewer electricity generation inputs as a result of electricity demand reductions, while thermal efficiency improvement will account for the rest.

The next biggest savings potential comes from the other sectors, with energy savings of 1.8 Mtoe. Application of increasingly energy-efficient appliances including lighting,

[31] In Bangladesh, only one refinery with a capacity of 30,000 barrels per day is in operation, which covers about 30% of demand for petroleum products.

Figure 11.1.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

refrigerators, televisions, and air conditioners will facilitate the energy demand reduction of the other sectors. In particular, lighting will account for more than one-third of the savings potential.

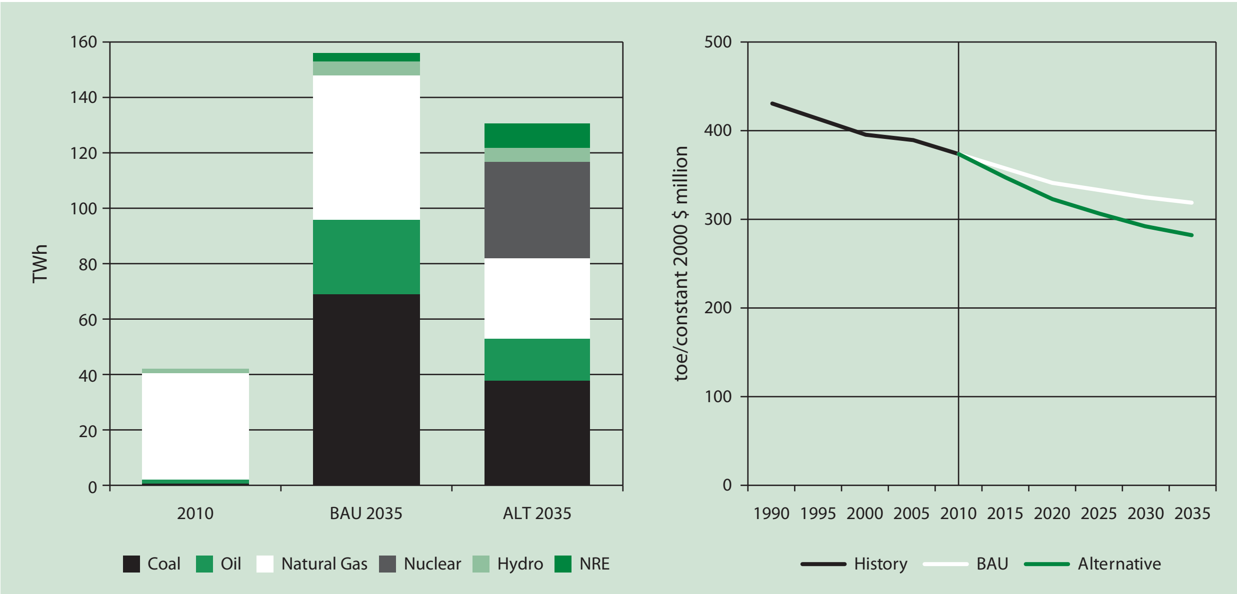
The potential energy savings from the industry sector will be 0.8 Mtoe. Energy efficiency improvement in the energy-intensive sectors, which cover the nonmetallic minerals, paper and pulp, and petrochemical subsectors, will make up about 17% of the estimated savings.

The transport sector may contribute the least to the energy savings potential. The estimated savings of 0.7 Mtoe will come mainly from fuel efficiency improvement of gasoline and diesel vehicles. An increase in electric vehicle use will also help reduce the sector's fossil fuel energy demand, although its contribution will be marginal.

In the alternative case, total electricity generation will be reduced by 16.5%, reaching 131.1 terawatt-hours (TWh) in 2035, compared with 157.0 TWh in the BAU case (Figure 11.1.5). The majority of the savings will come from reduced electricity demand in the industry and other sectors (mainly residential and commercial). Looking at the power generation mix, it will be diversified in the alternative case, shifting away from sole dependence on natural gas, toward coal, nuclear, and new and renewable energy.

It is assumed that development of nuclear power plants will be carried out as planned in the alternative case. Bangladesh signed an agreement with the Russian Federation's Rosatom in February 2011 for two 1,000 MW-class reactors to be built in Rooppur by 2017. In June 2012, the Bangladesh Parliament passed the Bangladesh Atomic Energy Control Bill 2012, which is expected to facilitate the Rooppur nuclear power project and aims to set up the Bangladesh Atomic Energy Regulatory Agency. Construction of the first unit is planned to start in 2013 and operation in 2018. The alternative case also reflects the government vision of 5,000 MW of nuclear capacity to be added by 2030 (World Nuclear Association website).

Figure 11.1.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Primary energy demand per GDP (i.e., energy intensity) will moderately decline for both BAU and the alternative case through 2035. In the alternative case, energy intensity will reach 283 toe per million constant 2000 $ in 2035, an 11.3% reduction compared with the BAU case.

Energy Policy Implications

Securing energy supply without delay will be fundamental in sustaining the economic growth of Bangladesh. In particular, given the country's energy demand—projected in the BAU case to increase at a relatively fast pace of 3.7% through 2035—it is important to strengthen power generation capacity, upgrade the transmission and distribution network, and diversify energy sources away from natural gas in view of the decline in proven and probable gas reserves. To achieve this, it is crucial for Bangladesh to establish an attractive investment environment for the private sector. Implementing the planned energy projects will be difficult without the appropriate investment conditions necessary to yield profits and ensure viability. Energy price reform and the establishment of an institutional framework are fundamental factors to improve the business climate in Bangladesh. The country's inadequately low electricity tariff has been an obstacle to facilitating investments in the power sector. Similarly, the regulated wholesale gas price has limited profits for the suppliers. Therefore, reforms in the pricing of energy that reflect supply costs will be a positive development that may attract energy investments.

Institutional arrangements will also help make the investment environment reliable. While the government has planned to diversify energy sources by expanding new and renewable energy use and introducing nuclear power plants, the feasibility of these plans involves some uncertainty. Some support from the government in the form of regulations or financial assistance will help address uncertainties and risks involved in energy projects; for instance, a financial scheme that assists projects, such as feed-in tariffs that provide long-term guaranteed prices for electricity generated from new and renewable energy. A thorough regulatory framework is a must to ensure safety in nuclear power plant construction and operation, in addition to human resources development and financial management. Such a foundation will be a critical factor for the investors to make an investment decision.

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11.2 Bhutan

- *In the BAU case, Bhutan's primary energy demand is projected to reach 1.70 Mtoe in 2035, increasing from 1.41 Mtoe in 2010 or at an average annual growth rate of 0.8%. This is significantly lower than the 5.6% GDP growth assumption during the same period.*
- *In the alternative case,* Bhutan's primary energy demand will increase at a slower rate of 0.2%, reaching 1.46 Mtoe in 2035. This means that in 2035, Bhutan has the potential to reduce its primary energy demand by 14% compared with the BAU case.*

Recent Energy Trends and Energy Policy Issues

In a relatively small land area of just over 38,000 square kilometers, Bhutan's population was about 700,000 in 2010. The country's total primary energy consumption stood at 1.41 Mtoe, having increased at an annual rate of 2.3% from 0.90 Mtoe in 1990. Per capita energy consumption was 1.94 tons of oil equivalent (toe) in 2010, which is relatively high compared with the average in South Asia. However, 76.7% of Bhutan's TPEC comprises noncommercial biomass (mostly fuelwood) that is consumed to a large extent in the residential sector.

Bhutan has no proven oil or natural gas reserves. Accordingly, petroleum products such as kerosene and diesel oil are all imported. The country relies significantly on hydropower and fuelwood as energy sources. Coal is also produced and consumed in the country.

Bhutan is suitable for hydropower generation since the mountainous terrain and perennial flow of water in the rivers and streams provide an abundant energy source. Its hydropower resource potential is estimated at 30,000 megawatts (MW), only about 5% of which has been developed for electricity generation (Department of Energy 2009).

Since hydropower export is one of the major contributors to the country's revenues, hydropower development is one of the priorities in the country's energy policy. The Government of Bhutan's Tenth Five-Year Plan (2008–2013) addresses development plans of several mega-hydropower projects, while cognizant of giving importance to the environment and cost effectiveness. Despite such abundant electricity generation, however, the electrification rate in Bhutan is considerably low, 36.0% in 2005. The government set a target of providing electricity to all by 2013 (ADC 2011). The country, through Bhutan Power Corporation Limited, is working doubly hard to achieve this target with the deployment of solar home systems, in addition to the extension of the grid system with funding assistance from the Japan International Cooperation Agency (JICA) and the Asian Development Bank (ADB). As of the end of 2011, the electrification rate was over 80% and the government is still pursuing its target of energy for all by 2013 (BPC 2012).

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

Business-as-Usual Case: Energy Demand Outlook through 2035

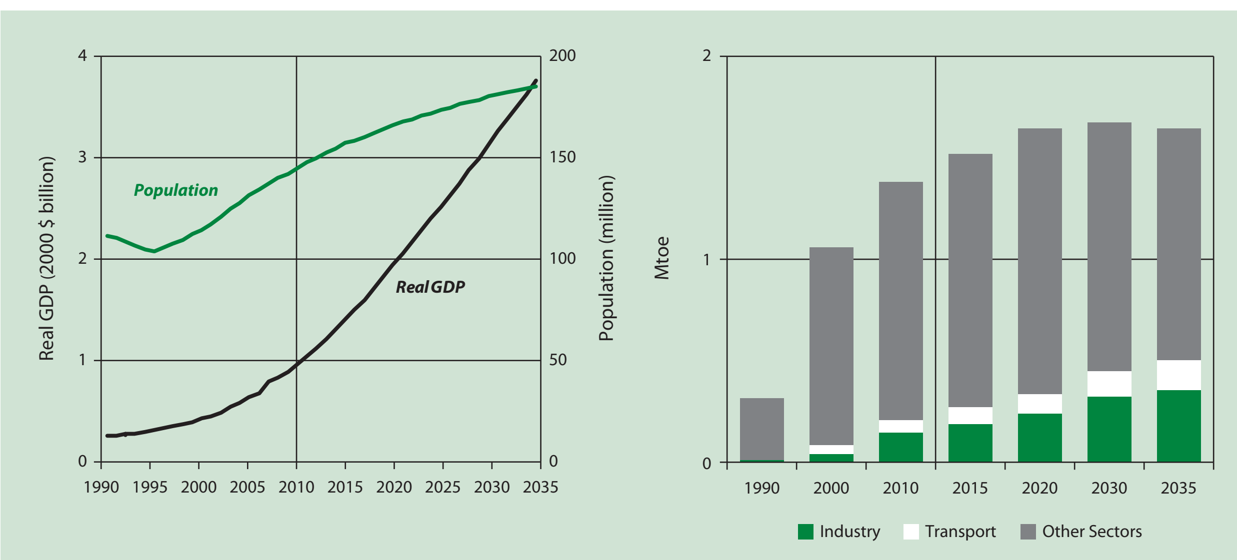
Bhutan's GDP has shown remarkable growth, averaging 8.6% per year during 2000–2010 (ADB 2012). The industry sector was the fastest-growing sector during the same period with an expansion rate of 11.3% per year, notably in the electricity, gas, water, and manufacturing sectors.

During the 10 years to 2020, GDP is projected to grow at a slower rate of 7.3% per year. From 2020 to 2035, much slower growth at 4.5% per year is projected. It is assumed that these growth rates will still be driven by the manufacturing and electricity generation sectors, while the services sector is also expected to expand faster than in the past. The population is projected to grow at a slower 1.0% per year from 2010 to 2035 compared with the actual growth rate of 1.3% per year from 1990 to 2010. By 2035, Bhutan's population is estimated to reach 0.9 million (Figure 11.2.1)

In the GDP and population growth assumptions, Bhutan's final energy demand is projected to grow at 0.7% per year. Although coal, oil, and electricity demand is projected to grow at annual rates of 1.7%, 2.7%, and 5.0%, respectively, biomass, which dominated Bhutan's final energy consumption mix with its 77.6% share of the total in 2012, will have a negative growth rate of –0.5% per year. This is due to the projected shift of household consumption from biomass to oil-based fuels like kerosene and liquefied petroleum gas (LPG) as the urban population and disposable incomes grow.

As mentioned, consumption of biomass in the residential sector will decrease in the future due to shift to commercial fuels. In this regard, the final energy consumption of the other sectors, which include the residential sector, will decrease at an annual rate of –0.1% from 2010 to 2035. Electricity and oil consumption of these sectors will, however, grow at annual rates of 6.2% and 0.3%, respectively.

Figure 11.2.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

Table 11.2.1 Primary Energy Mix in Bhutan in 2010 and 2035

Energy	2010		2035	
	ktoe	% share	ktoe	% share
Coal	132.28	9.4	169.05	11.6
Oil	80.64	5.7	144.82	9.9
Hydro	616.44	43.8	616.44	42.2
Biomass	1,078.4	76.7	802.64	55.0
Electricity	(501.53)	(35.7)	(727.7)	(18.7)
Other renewable energy	0.03	0.0	0.03	0.0
Total	**1,406.26**	**100.0**	**1460.28**	**100.0**

( ) = negative number, ktoe = kilotons of oil equivalent.
Note: The negative values in the primary energy mix indicate net exports.

With the industry sector expected to drive the economic growth of Bhutan, its energy consumption is also projected to grow at 3.7% per year. Electricity and coal, the fuels utilized in this sector, will grow at an annual rate of 4.7% and 1.6%, respectively.

The final energy demand of Bhutan's transport sector, which is currently in an underdeveloped stage due to lack of infrastructure and the country's mountainous terrain, will grow at an annual rate of 3.0% in line with the country's development of its manufacturing and services sector.

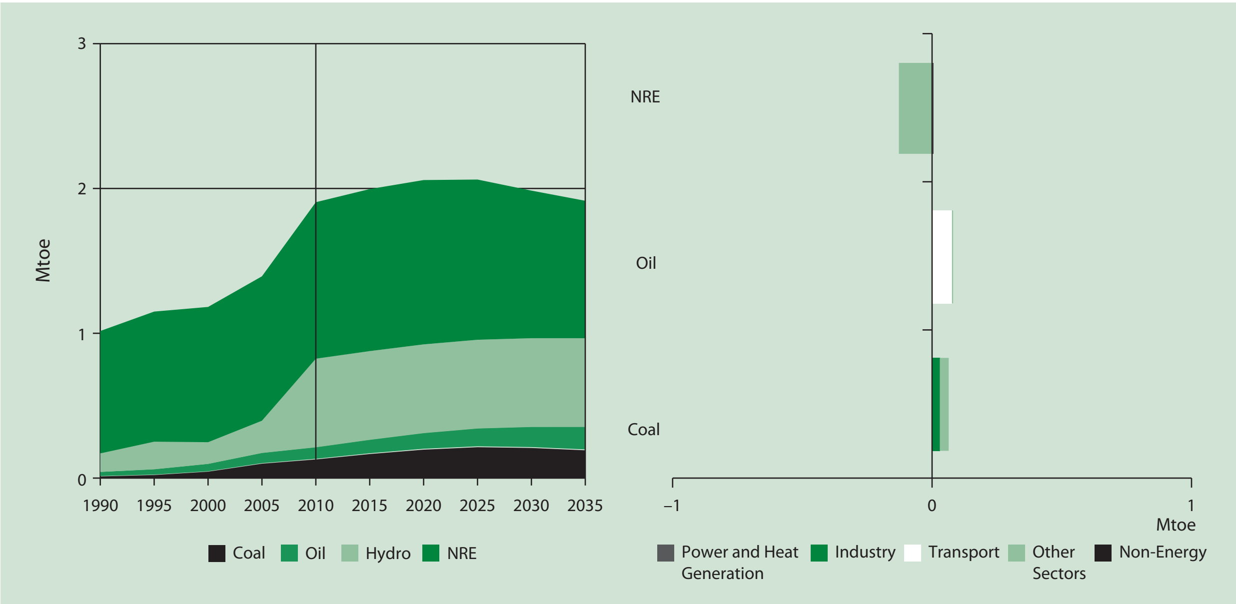
In the BAU case, the primary energy demand of Bhutan is projected to increase from 1.41 Mtoe in 2010 to 1.70 Mtoe in 2035, growing at an annual rate of 0.8%. In view of this low annual growth rate, Bhutan's per capita energy demand will decrease from 1.94 toe per person in 2010 to 1.84 toe per person in 2035. This per capita demand, despite the projected decrease, will still be the highest in South Asia, where average per capita consumption is projected to increase to just 0.85 toe per person in 2025.

By energy type, Bhutan's primary energy mix is dominated by biomass (mostly firewood at 76.7%), followed by coal (9.4%) and hydropower[32] (43.8%) in 2010 (Table 11.2.1). The energy mix is expected to change substantially by 2035 as the dominance of biomass and hydropower will decline to 55.0% and 42.2%, respectively. The shares of oil and coal, on the other hand, will increase, respectively, to 9.9% and 11.6% in 2035 from the 2010 levels of 5.7% and 9.4%.

The sectoral contributions to the incremental energy demand growth from 2010 to 2035 are shown in Figure 11.2.2. As the figure shows, demand for oil is projected to increase by 0.08 Mtoe, with the increased use in the transport sector. The increase in coal demand will be driven mainly by the industry and other sectors. The decrease in new and renewable energy consumption (mainly biomass) will be in the other sectors, which includes the residential sector.

[32] Hydropower production is actually 44% of the total primary energy consumption in Bhutan in 2010. However, since 81% of the electricity generated from hydropower was exported, the actual share of electricity from hydropower consumed in Bhutan was only 8% of the total primary energy mix.

Figure 11.2.2 Primary Energy Demand (left) and Incremental Growth by Energy and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Alternative Case: Energy Savings Potential and Energy Source Diversification

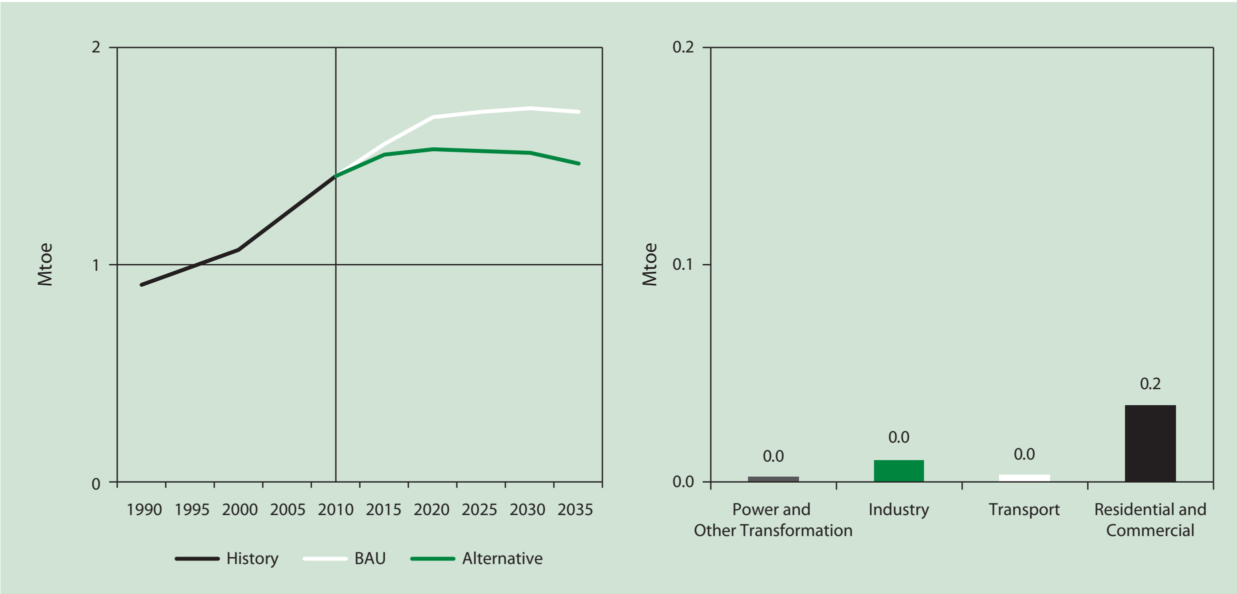
As a result of the deployment of advanced technologies, Bhutan's primary energy demand in the alternative case will increase at 0.2% through 2035, reaching 1.46 Mtoe during the year. This means that Bhutan has the potential to save about 0.24 Mtoe in 2035 compared with the primary energy demand in the BAU case (or a 14% reduction).

By sector, the other sectors (mainly the residential and commercial sectors), which will consume 69% of the country's final energy demand in 2035 in the BAU case, have the biggest energy savings potential at 0.17 Mtoe. Savings will derive from the deployment of more efficient electric appliances and biomass cook stoves. The industry sector will have the second-largest savings of 0.05 Mtoe, while the transport and power sectors will have 0.01 Mtoe savings each (Figure 11.2.3). The power sector's savings are due to decreased electricity generation as electricity demand decreases with more efficient use, and not due to more efficient power generation technologies as the country's electricity supply is envisioned to come mostly from hydropower until 2035.

The power generation by energy type for BAU and the alternative case is compared in Figure 11.2.4. There is no difference in the two scenarios as Bhutan is projected to continue to export excess electricity generated from its hydroelectric power plants until 2035. The excess power generated in Bhutan is exported to neighboring India.

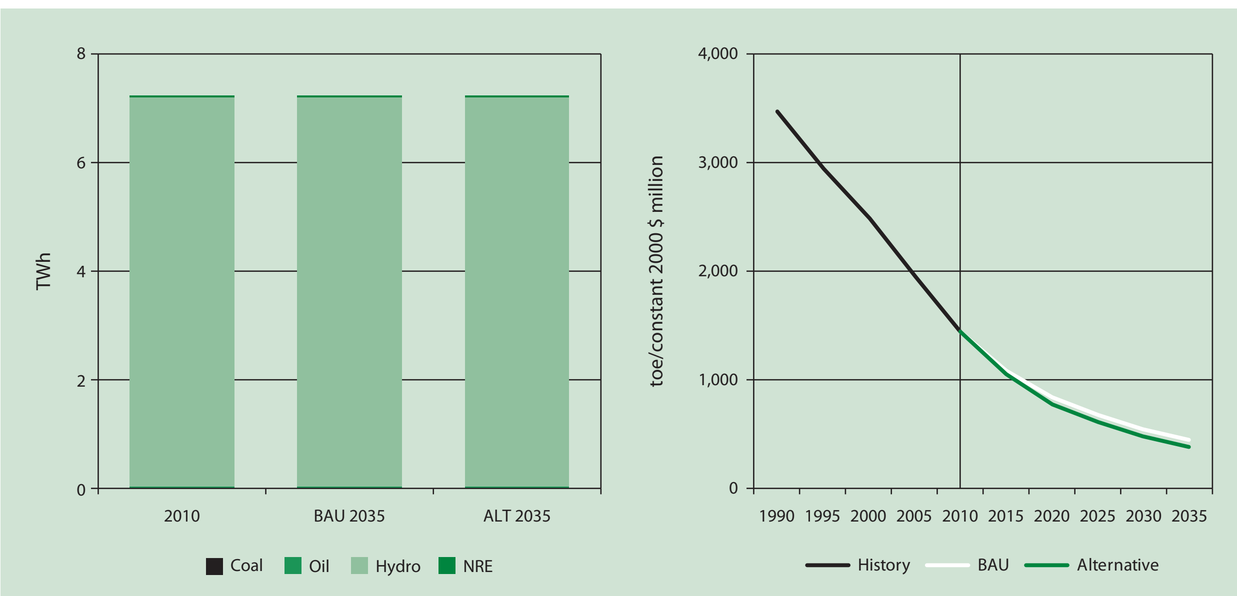
Although Bhutan intends to increase its export of electricity to India, there is no corresponding import target from India. This explains why the electricity generation in Bhutan in the two scenarios is assumed to be the same.

Figure 11.2.3 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Figure 11.2.4 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Bhutan's energy intensity has been declining during the past 2 decades due largely to the slow growth in the consumption of biomass, which formed 86% of the country's total energy consumption in 1990. Biomass remained the dominant fuel in the country and was still 77% of the total in 2010. The decreasing trend in energy intensity is projected to continue in the future but at a lower rate than in the past. The increased use of fossil fuels and electricity in the country to support its drive for economic growth will be the main reason for this projected trend. These conventional forms of energy will increase to 44% of total primary energy demand in 2035 from 23% in 2010.

Energy Policy Implications

Bhutan pursuit of gross national happiness (Ura et al. 2012), which covers nine domains, three of which are directly affected by energy development and use—health, ecological diversity and resilience, and living standards—is expected to be the ultimate objective under consideration in the formulation of Bhutan's energy policies.

In the health domain, energy development should ensure that there are no harmful effects to the population by enacting regulations to control the emission of pollutants that endanger people's health. While this will be relatively easy for the electricity generation sector in view of the high possibility that future power plants will be hydroelectric, this could prove to be a challenge in the transport sector. In this regard, the government should ensure through strict fuel quality control that transport fuels should not contain harmful pollutants.

Ecological diversity and resilience could pose a challenge for hydropower development. The state should therefore ensure that due diligence is carried out in the planning and implementation of hydropower projects.

As for the third domain, the energy sector is one sector to bring about improvement in living standards. However, in the context of gross national happiness, improved living standards are brought about not only by access to energy services but also by ensuring the health of the people and that of the environment. There may therefore be a need to formulate clearer policies that address both energy supply availability and impacts on people's lives and the environment.

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11.3 India

- *In the BAU case, the primary energy demand of India is projected to increase from 692.7 Mtoe in 2010 to 1,441.6 Mtoe in 2035, growing at an annual rate of 3.0%. In contrast, India has substantial energy savings potential with the deployment of advanced technologies. In the alternative case,* about 237.2 Mtoe of primary energy demand savings can be achieved in 2035 compared with BAU.*
- *As the country's energy demand is expected to grow faster than the pace of domestic production of oil and natural gas, energy efficiency improvement will be an important measure to enhance energy security.*

Recent Energy Trends and Energy Policy Issues

Due to the increase in population and economic growth, India's demand for energy has increased at a rapid pace. At the same time, dependence on imported fossil fuels, especially oil, is growing. In 2010, the net import ratio of oil exceeded 75% in India.

Representing the country's large domestic resources, India is currently the world's third-largest coal producer. However, the domestic coal production could not fully keep up with the rapidly growing demand, and coal imports increased in the first decade of the 21st century. In 2010, 16.4% of the primary coal demand in India was supplied by import. India also heavily relies on the import of oil. In 2010, the dependency on imported oil reached 76.0%. The Indian government has introduced policies aimed at increasing domestic exploration and production activities, and Indian national oil companies have increasingly acquired equity stakes in exploration and production projects overseas. In 2004, India also launched imports of LNG. Ensuring a reliable supply of energy at affordable prices will continue to be a critical item on India's energy policy agenda.

With the progress of industrialization and improvements in living standards, electricity demand has continued to increase fast, with the average growth rate during 2000–2010 reaching 6.8%. India's power supply, however, relies on its domestic coal power plants (68% of power generation was by coal in 2010), whose efficiency levels are low, and technical and nontechnical reasons have augmented the high transmission and distribution losses. In addition, the low electricity tariff has become a disincentive for investment in power supply. All of these factors have led to the lack of power supply. On 31 July 2012, a power outage—which affected more than 600 million people in over 20 states in north, east, and northeastern India, and was the largest blackout in global history in terms of number of people affected—occurred.

India is leading the introduction of nuclear power in the world after the People's Republic of China. In the aftermath of the Fukushima nuclear accident in Japan, the nuclear policy did

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* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

not substantially change. The Department of Atomic Energy plans to put up a total installed nuclear power capacity of 20,000 MW by 2020. In 2012, seven nuclear reactors (5.3 GW) were under construction.

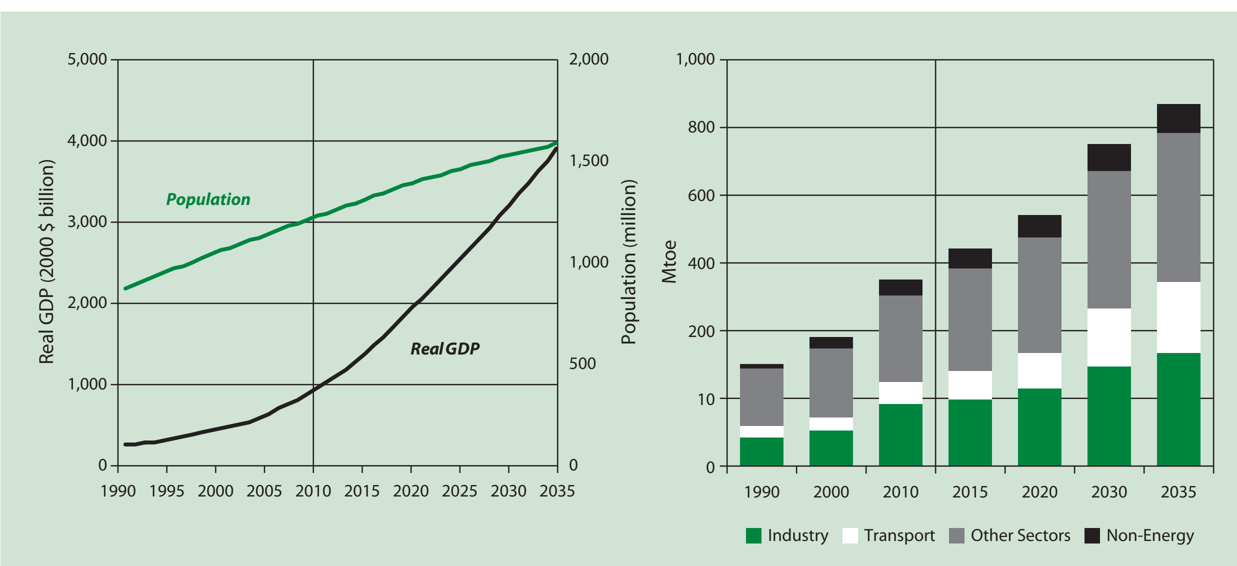
In 2010, around 14% of the total electricity generation in India was from renewable energy. Most of the renewable energy in India consists of hydro and wind, and there is a rising expectation for solar. In 2009, the Government of India published the Jawaharlal Nehru National Solar Mission with the goal of 20 GW of solar power by 2022.

Business-as-Usual Case: Energy Demand Outlook through 2035

Over the outlook period, India's GDP is projected to increase at an annual rate of 5.7%. With this growth, GDP in 2035 will be $3,877.0 billion (constant 2000 $), almost four times the 2010 level (Figure 11.3.1). The population is projected to increase at a relatively fast pace of 1.0% through 2035, and India will become the most populous country in the world during the 2020s, reaching 1.5798 billion in 2035 from 1.2246 billion in 2010. GDP per capita will rise from $787 in 2010 to $2,454 in 2035.

In the business-as-usual (BAU) case, the final energy demand of India is projected to increase at an annual rate of 2.7% from 2010 to 2035, a slower rate compared with the projected GDP growth rate of 5.7% during the same period. By sector, the share of the other sectors (including residential, commercial, agriculture, and fishery), which was the largest accounting for 46.3% in 2010, will moderately increase at 2.2% as a whole to decrease to 41.1% of final energy demand in 2035. In contrast, transport energy demand will increase at 4.7% per year over the outlook period. Industry energy demand will increase at 2.4% per year through 2035, and its share will remain around 30%.

Figure 11.3.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

In the other sectors' energy demand, the shift from noncommercial biomass to fossil fuels and electricity will accelerate. Demand for noncommercial biomass will start to decrease around 2020. Its share will decline from 65.8% in 2010 to 43.2% in 2035. The share of fossil fuels will increase from 18.8% in 2010 to 25.8% in 2035. Electricity will grow at a relatively fast rate of 5.2% through 2035, and its share will reach 31.0% in 2035, almost double that in 2010.

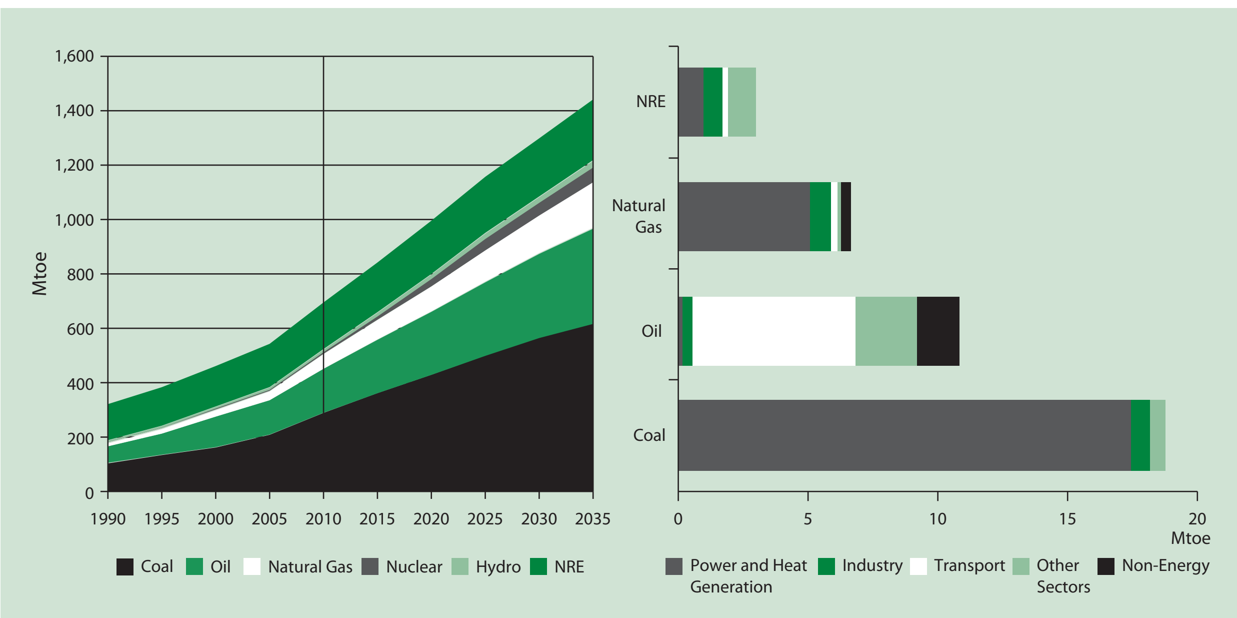
Within the industry sector's energy demand, coal will increase only at 0.7% per year, and its share will drop from 40.8% in 2010 to 26.9% in 2035. During the same period, electricity's share will rise from 18.2% to 38.4%, with an average growth rate of 5.5%. The growth rate of natural gas will be 4.4% per year, and its share will increase from 4.9% in 2010 to 7.8% in 2035.

In the transport sector, oil and natural gas are the main energy sources fueling the transport needs in India. During the outlook period, the share of oil and gas will remain almost constant at around 93% and 4%, respectively.

In the BAU case, the primary energy demand of India is projected to increase from 692.7 Mtoe in 2010 to 1,441.6 Mtoe in 2035, growing at an annual rate of 3.0%. With this growth, India's per capita energy demand will reach 0.91 toe per person, compared with 0.57 toe in 2010.

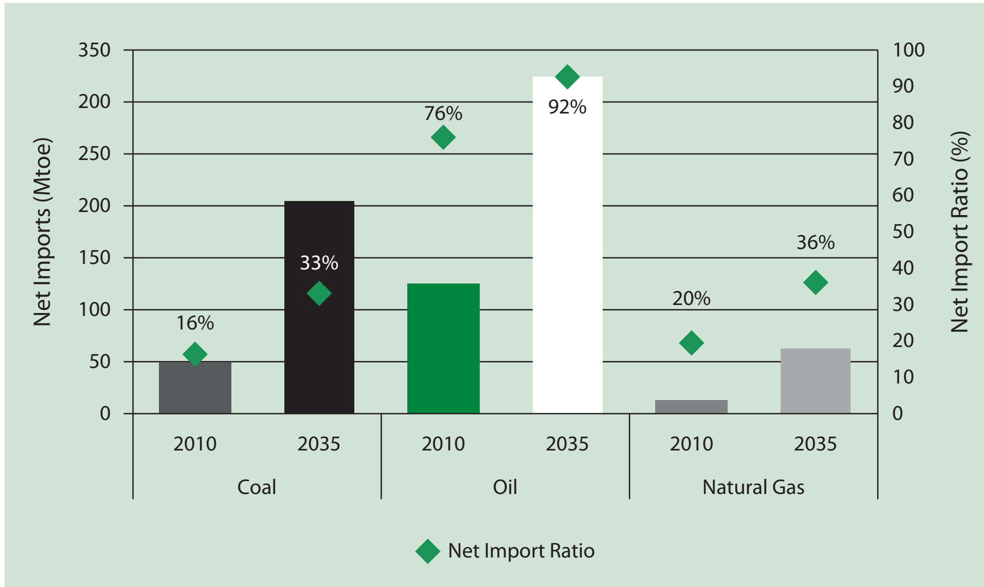
By energy type, coal will maintain the largest share, reaching 42.8% in 2035, which will be followed by oil at 24.4% and others (including noncommercial biomass and new and renewable energy) at 15.6%. Within fossil fuels, natural gas will increase most rapidly with a growth rate of 4.8% per year, its share reaching 11.7% in 2035. The share of hydro is projected to increase slightly to 1.6% in 2035, and nuclear will account for 3.9% in 2035.

Figure 11.3.2 Primary Energy Demand (left) and Incremental Growth by Energy and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 11.3.3 Net Imports of Coal, Oil, and Natural Gas and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

The sectoral contributions to the incremental energy demand growth from 2010 to 2035 are shown in Figure 11.3.2. As the figure presents, coal demand will represent the biggest incremental growth at 328.5 Mtoe, mainly driven by its increased use in the power sector. Oil demand will be led mostly by the transport sector and increase 189.4 Mtoe. Gas demand will rise by 116.4 Mtoe, mainly due to the expanding use in the power and industry sectors.

In the BAU case, power generation in India will reach 1,855.3 TWh in 2020 and 3,437.3 TWh in 2035, from 959.9 TWh in 2010. The average growth rate during 2010–2020[33] and 2020–2035 will be 6.8% and 4.2 per year, respectively.

Domestic coal production will reach 412.3 Mtoe in 2035. The increase of demand driven by the power sector will surpass the growth of production, however, and the net import ratio will double its level in 2010 and reach 33.2% in 2035. In contrast to the continuously rapidly rising oil demand, oil production in India will start to decrease before 2015. As the country's net import of oil will exceed 300 Mtoe by 2035, the net import ratio will be over 90% (Figure 11.3.3). Among the domestic production of fossil fuel, gas will grow at the fastest pace of 3.8% per year, reaching 108.0 Mtoe in 2035. However, the demand for gas will grow even faster at 4.8% per year. As a result, the net import ratio of gas will rise from 19.5% in 2010 to 36.1% in 2035.

[33] In the draft national electricity plan for the 12th Five-Year Plan, the average growth rate of electricity demand is 7.1%–9.0% from 2012 to 2022, based on the assumption of a GDP growth rate during the same period at 9%, which is much higher than the GDP assumption of this outlook, at 7.3% per year during 2010–2020.

Alternative Case: Energy Savings Potential and Energy Source Diversification

India has substantial energy savings potential with the deployment of advanced technologies for energy savings. In the alternative case, India's primary energy demand will increase at an annual rate of 2.4% through 2035. With this growth, India's primary energy demand will reach 1,239.2 Mtoe, which is 190.8 Mtoe (or 13.3%) lower than in the BAU case in 2035 (Figure 11.3.4).

By sector, the power sector has the biggest energy savings potential at 130.1 Mtoe in 2035, followed by residential and commercial at 32.9 Mtoe, industry at 26.6 Mtoe, and transport at 12.8 Mtoe.

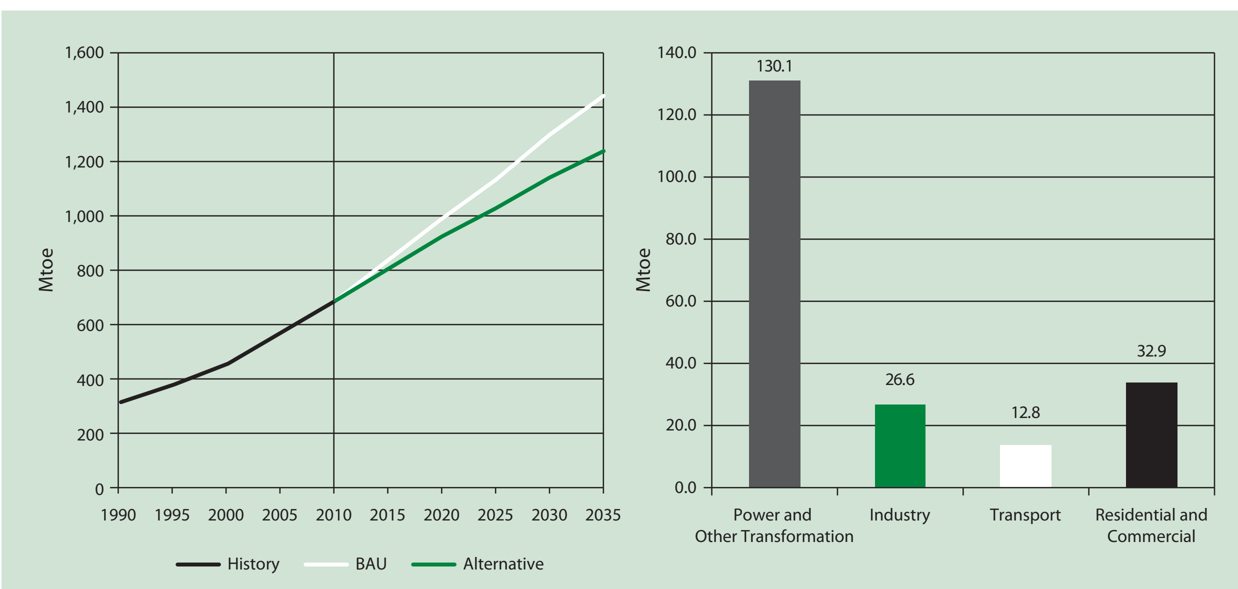
The power sector's energy savings are mainly from electricity demand savings and resulting lower input fuel requirements. The thermal efficiency improvement in power generation will account for about a quarter of total savings.

Meanwhile, the residential and commercial sectors' energy savings at 32.9 Mtoe in 2035 are mainly a result of electricity savings from the deployment of efficient appliances. The major appliances contributing to the electricity savings are lighting, refrigerators, and televisions.

The industry sector's energy savings at 26.6 Mtoe in 2035 will come from the deployment of advanced technologies in the various industry subsectors, including cement, refineries, paper and pulp, and others.

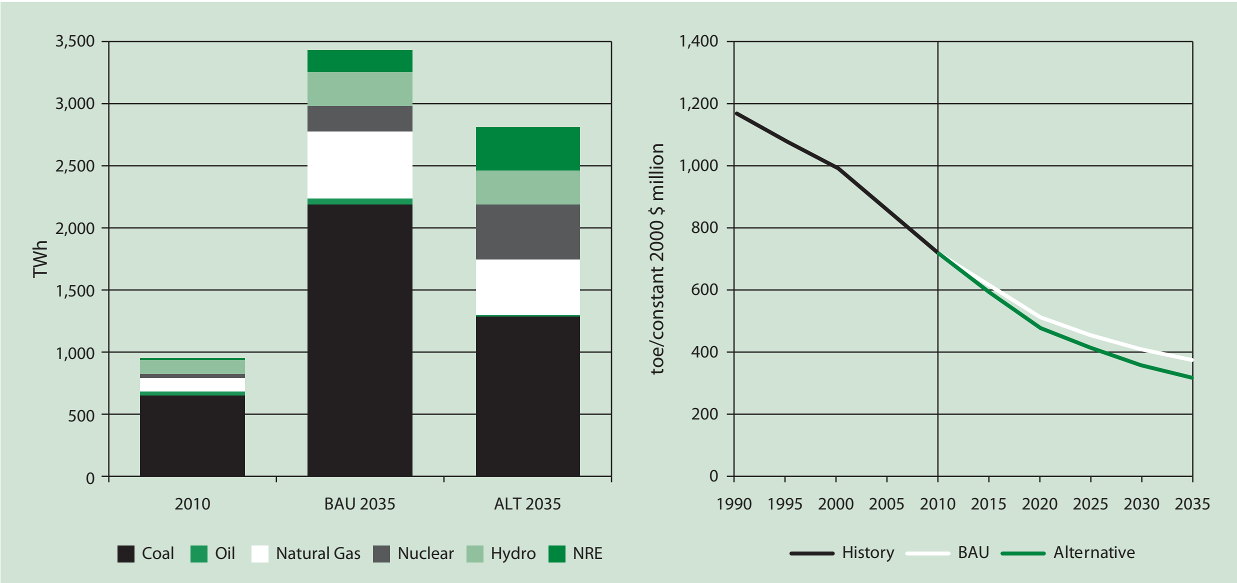
The transport sector's energy savings will be 12.8 Mtoe in 2035, owing to shifts toward efficient vehicles (mainly hybrid and electric vehicles) from internal combustion engine vehicles.

Figure 11.3.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Figure 11.3.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

In the alternative case, India's electricity generation in 2035 will be about 18% lower at 2,816.6 TWh in 2035, compared with 3,437.3 TWh in the BAU case (Figure 11.3.5). Substantial savings in total generation in 2035 will result from the electricity demand savings in the industry, residential, and commercial sectors. Despite the lower electricity generation requirements, it will almost triple its 2010 level.

By energy type, electricity generation in the alternative case is more diversified than in the BAU case. In 2035, the share of nuclear will expand to 15.8% at the expense of natural gas and oil for power generation. Furthermore, the share of new and renewable energy (wind, solar, and biomass) in generation will increase to 12.2% in 2035 in the alternative case, compared with 4.7% in the BAU case in the same year.

Energy Policy Implications

As energy demand is expected to grow much faster than domestic energy production, the economic impacts of importing of fossil fuel, oil, gas, and coal are rising, and energy security has become a policy priority for India. Energy efficiency improvement on both the demand and supply sides has been identified as an important measure for enhancing the security of supply.

A core problem in India is energy pricing. Oil prices are government-controlled and do not fully reflect the procurement prices. Kerosene and diesel, in particular, and even liquefied petroleum gas are priced far lower. In addition, electricity tariffs are also at low levels. Electricity for agricultural use, which is supported through a complex subsidy mechanism, is almost free in certain areas. The low energy prices serve as disincentives for energy efficiency efforts.

On the demand side, although India has been achieving rapid economic growth, it still has a large number people living in poverty. The electrification rate is only 75% and about 300 million people have no access to electricity. Promoting energy management and diffusion of low-cost, high-efficiency technology should have high priority.

At the same time, the low oil price has oil marketing companies registering losses, as well as accentuating the fiscal deficit of the national and state governments. Electricity price controls have also curtailed the motivation to invest in new power plants, further hurting electricity supply. On the supply side, building a more reasonable energy price system, enhancing the efficiency of existing energy-using equipment, and diversifying the energy source will be important.

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11.4 Maldives

- *In the BAU case, the Maldives' primary energy demand is projected to reach 0.64 Mtoe in 2035, increasing from 0.26 Mtoe in 2010 or at an average annual growth rate of 3.6%. This growth rate is slower that the assumed GDP growth rate of 4.5% per year during the same period.*
- *In the alternative case,* the Maldives' primary energy demand will increase at 2.9% through 2035, reaching 0.55 Mtoe. This means that the Maldives has an energy savings potential of 0.09 Mtoe in 2035, or a 14.3% reduction from the BAU level..*

Recent Energy Trends and Energy Policy Issues

The Republic of the Maldives is one of the smallest countries in the world, with a total land area of around 300 square kilometers with 1,192 islands spread over roughly 90,000 square kilometers of the Indian Ocean. Its population in 2010 was around 300,000 with a per capita income of above $2,000 at constant 2000 $. The Maldives is also the lowest country in the world, with its average elevation at 1.5 meters above sea level and the highest point at only 2.3 meters, making the country susceptible to the feared sea level rise as a consequence of global warming (REEGLE n.d.).

Available energy data show that the Maldives' primary energy consumption stood at 0.26 Mtoe in 2010, all of which is oil. From 1990 to 2010, total primary energy consumption grew at an average annual rate of 9.3%. Although there are reports of biomass consumption in the islands outside the nation's capital, there is no existing estimate on its amount. Likewise, solar energy is also being used for water heating and electricity generation in some resort establishments, but as in the biomass case, there is no estimate on the amount either.

The country's 100% dependence on imports for its oil requirements rendered the country vulnerable to high oil price. According to REEGLE, an information gateway for renewable energy and energy efficiency, the Maldives' electricity costs are the highest in South Asia at $0.30 per kilowatt-hour.

In view of its adverse topography and 100% dependence on oil imports, the Government of the Maldives has pledged to be carbon-neutral by 2020, while enhancing energy security and at the same time reaping economic, social, and environmental benefits. The government also aims to provide all citizens with access to reliable and sustainable energy services at the lowest possible cost, promote energy conservation and energy efficiency, and increase national energy security (REEGLE n.d.).

The following are the government's national energy policy objectives (Ministry of Environment and Energy 2012):

- provide all citizens with access to affordable and reliable supply of electricity,

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* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

- achieve carbon neutrality by year 2020,
- promote energy conservation and energy efficiency to reduce costs, and
- promote renewable energy technologies.

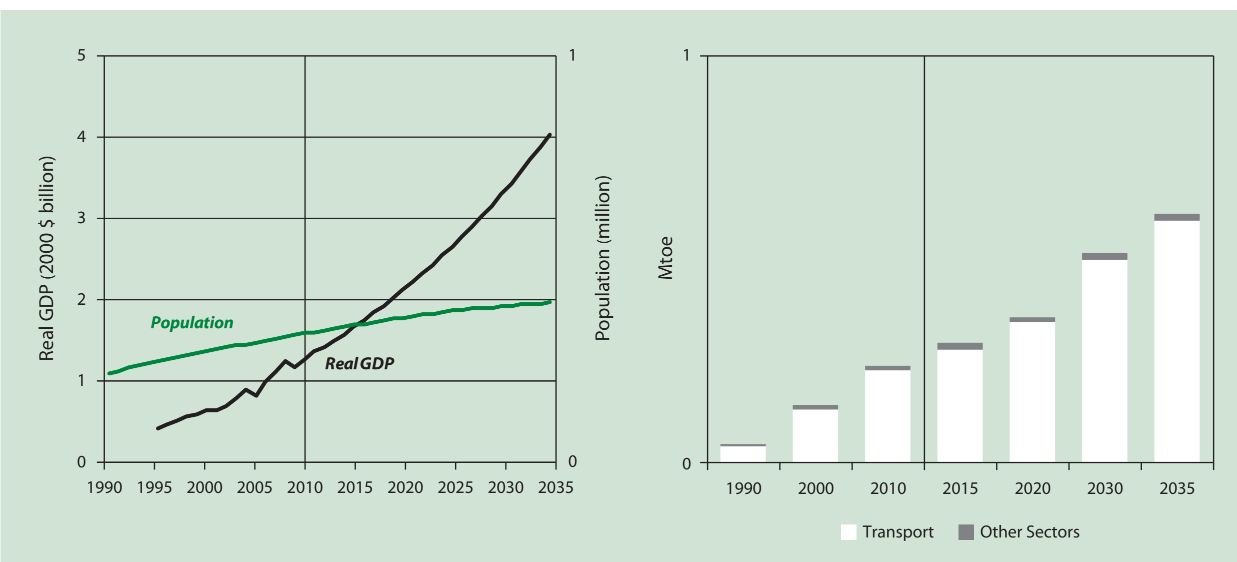
The economy of the Maldives has experienced a rapid growth rate in the last 15 years with GDP growing at an average rate of 7.5% per year. The services sector is the biggest contributor to the economy with its more than 80% share of GDP. It is expected to continue to be the country's main economic sector in the future with GDP projected to grow at an annual rate of 4.5% from 2010 to 2035. The population will grow at an average of 0.8% per year in the same projection period.

Business-as-Usual Case: Energy Demand Outlook through 2035

The country's fast GDP growth at 4.5% per year and sustained population growth at 0.8% per year through 2035 will result in the growth of the country's final energy demand by an average of 3.7% per year from 0.24 Mtoe in 2010 to 0.61 Mtoe 2035 (Figure 11.4.1). Most of this growth is from transport sector demand, which is projected to grow by 3.8% per year. Demand from the other sectors (services and households) will grow at a slower rate of 1.7% per year.

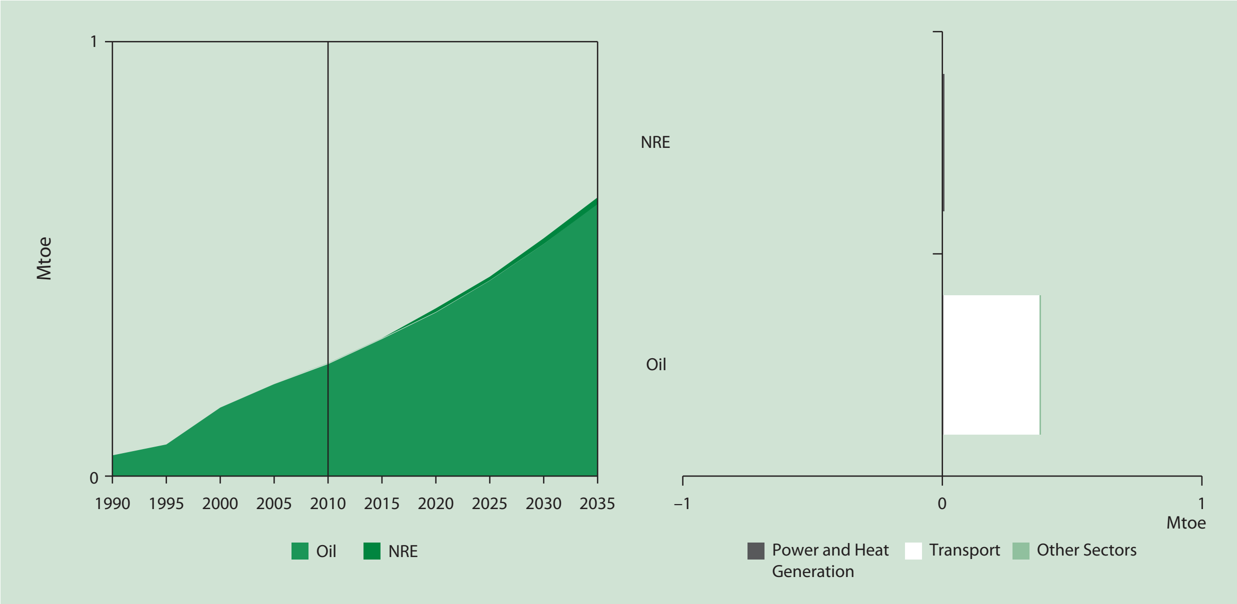
The transport sector's energy consumption is projected to increase at a fast rate of 3.8% to provide mobility to the country's huge tourism industry, which relies heavily on air and water transport over the country's 90,000 square kilometers of territorial seas. The services sector, that is largely hotels and restaurants, will also experience a rapid growth in electricity demand as the sector's growth is the prime mover of the islands' economy. The growth rate of the household sector will be lower, being driven largely by population growth.

Figure 11.4.1 Population and GDP (left), and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

Figure 11.4.2 Primary Energy Demand (left) and Incremental Growth by Energy and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

In the BAU case, the primary energy demand of the Maldives is projected to increase from 0.26 Mtoe in 2010 to 0.64 Mtoe in 2035, growing at an annual rate of 3.6%. With the steady growth, the Maldives' per capita energy demand will increase from 0.82 toe per person in 2010 to 1.64 toe per person in 2035, and this does not even include the unaccounted noncommercial biomass consumption.

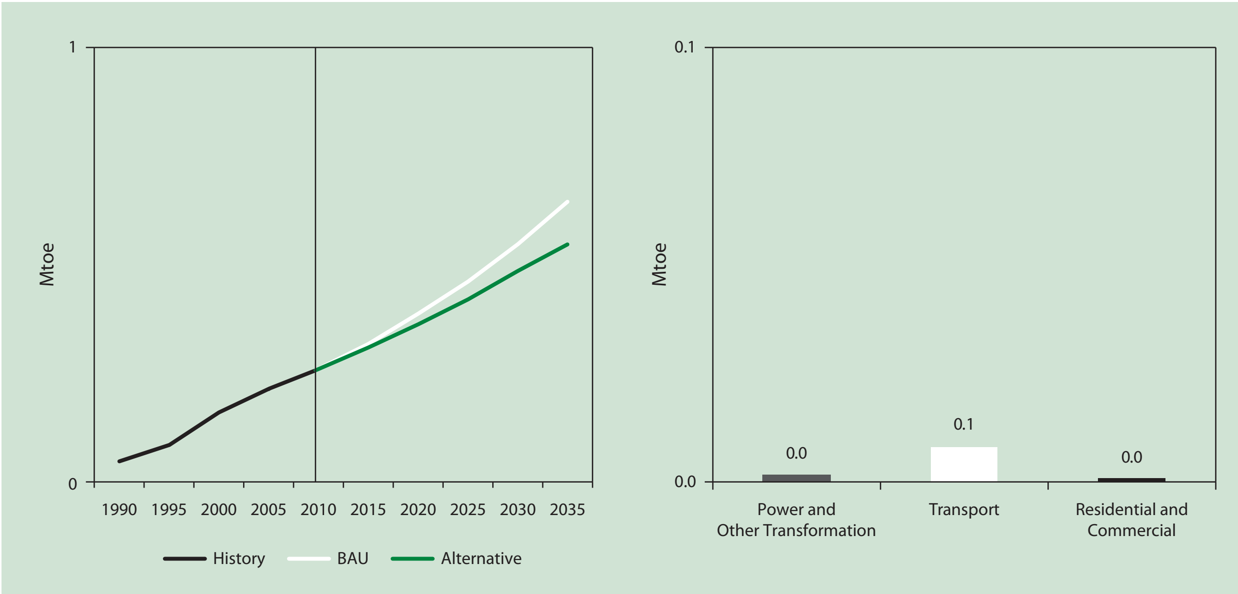
The Maldives' primary energy mix was dominated by oil (at 100%) in 2010. The mix will not change substantially by 2035 as dominance of oil will continue (97.6%) with solar energy, wind, and municipal waste collectively making a small dent of 2.4% in the total in 2035.

The sectoral contributions to the incremental energy demand growth from 2010 to 2035 are shown in Figure 11.4.2. As the figure shows, demand for oil is projected to increase substantially by 0.37 Mtoe with the increased use in the transport sector. New and renewable energy (solar energy, wind, and municipal waste) will enter the energy mix through the power sector, displacing 39.2% of oil-based electricity generation by 2035.

Alternative Case: Energy Savings Potential and Energy Source Diversification

As a result of the deployment of advanced technologies, the Maldives' primary energy demand in the alternative case will increase moderately at 2.9% through 2035, reaching 0.55 Mtoe (Figure 11.4.3). This translates into a potential energy savings of about 0.09 Mtoe in 2035 compared with the primary energy demand in the BAU case (a 14.9% reduction).

Figure 11.4.3 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



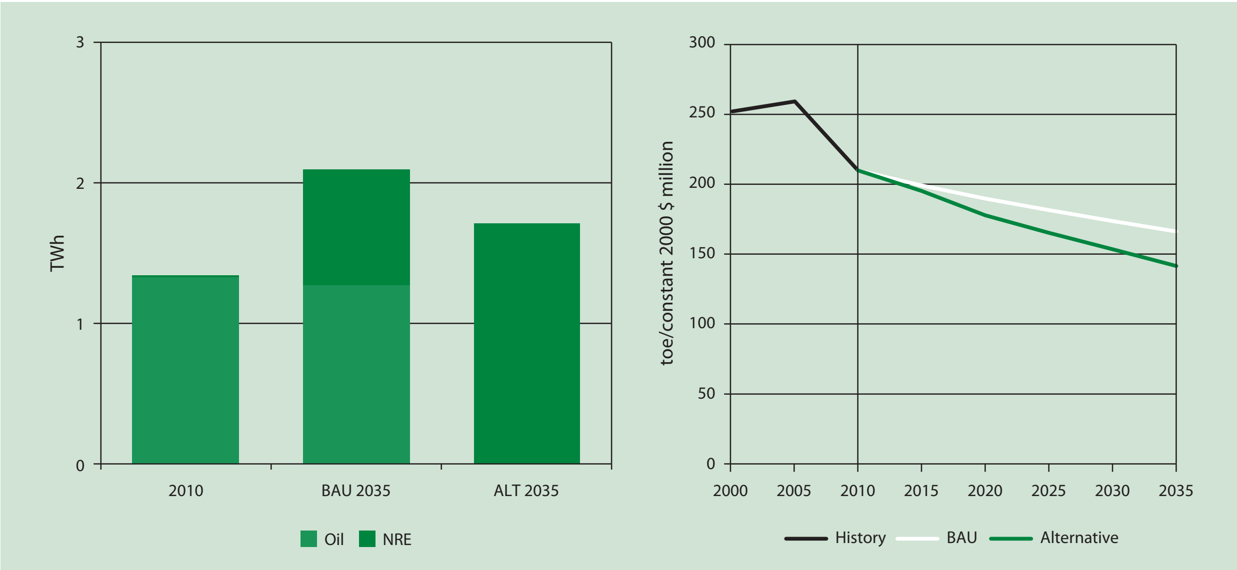
BAU = business-as-usual, Mtoe = million tons of oil equivalent.

By sector, the transport sector has the biggest energy savings potential at 0.08 Mtoe, almost 100% of the total. The power sector will represent the second-largest energy savings potential at 0.01 Mtoe in 2035 mainly due to the reduction in electricity demand brought about by improved energy efficiency in the other sectors (commercial and residential).

Power generation by energy type for BAU and the alternative case is compared in Figure 11.4.4. In the alternative case, total electricity generation in 2035 will be about 18.4% lower than that in the BAU case as a result of efficiency improvements in the residential and commercial sectors. In terms of electricity generation by source, the alternative case assumes a switch to new and renewable energy compared with the BAU case, with the introduction of solar energy, municipal waste, and wind energy for electricity generation as well as solar energy for water heating and distributed electricity generation systems (accounting for 100% of total generation in 2035) in contrast to the BAU case, which assumes a 39.2% share for new and renewable energy. While these assumed shares appear very substantial, especially from the point of view of large electricity systems, it is envisaged that the ever-increasing price of oil and the decreasing cost of solar electricity generation technology will allow new and renewable energy to achieve the assumed penetration rates in both cases.

The energy intensity of the Maldives from 2000 to 2010 decreased at an average annual rate of –1.8% from 253 toe per million constant 2000 \$ to 210 toe per million constant 2000 \$. In the BAU case, energy intensity will decline at a slower rate of –0.9% per year to 166 toe per million constant 2000 \$ in 2035. In the alternative case, the decline in energy intensity will be faster at –1.5% per year to 142 toe per million constant 2000 \$ in the same year. The larger decline in the alternative case is the combined effect of reduced final energy demand brought about by the deployment of more efficient demand technologies and the utilization of new and renewable energy for electricity generation, which has a higher efficiency than conventional oil-fired technologies.

Figure 11.4.4 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Energy Policy Implications

The national energy policies and objectives of the Maldives provide a clear direction on how energy supply and utilization should be managed in the country. However, bringing these policy objectives into fruition has proven to be challenging for the country.

It is possible that the policy objective of increasing the share of new and renewable energy in electricity could be attained through the combined effects of the high oil price and decreasing cost of distributed solar electricity generation systems, while the objective of achieving carbon neutrality by 2020 will be difficult to achieve. Currently, there are few alternatives to oil in the transport sector, and, based on the geography of the Maldives, the best alternative is liquid biofuels.

Liquid biofuels are now produced, at a competitive cost to oil, from agricultural crops such as sugar cane, potatoes, corn, palm oil, and coconut oil. These crops are suitable for cultivation in the tropical climate of the Maldives and could provide a different source of livelihood for the citizens. It should be noted, however, that cultivation of crops for energy purposes may compete with cultivation of food products. A study on how to produce biofuels and food products without the two competing with each other will need to be conducted before embarking on a new liquid biofuels policy. The Maldives also has a high potential for production of liquid biofuels from algae, although the current technology is still not at a commercial stage. The Maldives may consider cooperating with countries with technological know-how to research this topic.

Attaining 100% reliance on renewable energy for electricity generation will be a very challenging task. The available resources identified in its Scaling Up Renewable Energy Investment Plan (SREIP) are a maximum of 20 MW from municipal waste, 10–20 MW from wind energy, and an unlimited amount from solar energy. While the SREIP has already presented some strategies to potentially tap such resources, the relevant environment to encourage investors to venture in such business has yet to be set up. Investors will certainly look for supporting laws to protect their investments, while consumers will also look for provisions to protect them as well. The country has to find win–win solutions and promulgate the necessary legal and political tools to set up an environment that is friendly to investors and consumers alike.

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11.5 Nepal

- *In the BAU case, the primary energy demand of Nepal is projected to increase from 10.2 Mtoe in 2010 to 16.6 Mtoe in 2035, growing at an annual rate of 2.0%. With this growth, Nepal's per capita energy demand will reach 0.40 toe per person, compared with 0.34 toe in 2010.*
- *In the alternative case,* Nepal's primary energy demand will increase at an annual rate of 1.9% through 2035. With this growth, Nepal's primary energy demand will reach 16.3 Mtoe, which is 0.37 Mtoe (or 2.2%) lower than in the BAU case in 2035..*

Recent Energy Trends and Energy Policy Issues

Nepal's final energy demand at 10.1 Mtoe in 2010 represented one of the lowest levels among the regional members of the Asian Development Bank (ADB). Out of this total final energy demand, about 90% was consumed by the residential sector, which relies heavily on traditional energy sources such as biomass. Since the country's industry and road infrastructure stand at an early stage of development, energy demand by the industry and transport sectors represent smaller shares in the final energy demand, at 3.6% and 6.2%, respectively, in 2010. Despite their small shares, the energy demand of these sectors is growing relatively fast, with annual growth rates of 9.0% and 6.4%, respectively, from 1990 to 2010.

Most of the fossil fuel supply in Nepal depends on imports. Though it has abundant hydropower resources and significant potential to export electricity, because of low investments and geographical difficulties, Nepal is currently a net importer of electricity from India. Since most of the electricity generation in Nepal is from the run-of-the-river type of hydropower, significant electricity outages occur during the dry winter. The government is promoting hydropower for its electricity supply and formulating the strategies to build more reservoir-type hydropower.[34]

In Nepal, approximately one-third of the population has no access to electricity. Energy supply in its rural areas relies heavily on traditional biomass. The government introduced a new rural energy policy in 2006, aiming to provide access to clean commercial energy. Furthermore, to reduce the threats to the health of rural populations by the direct combustion of traditional fuels, the use of biogas has been promoted with the help of the United Nations Development Programme.

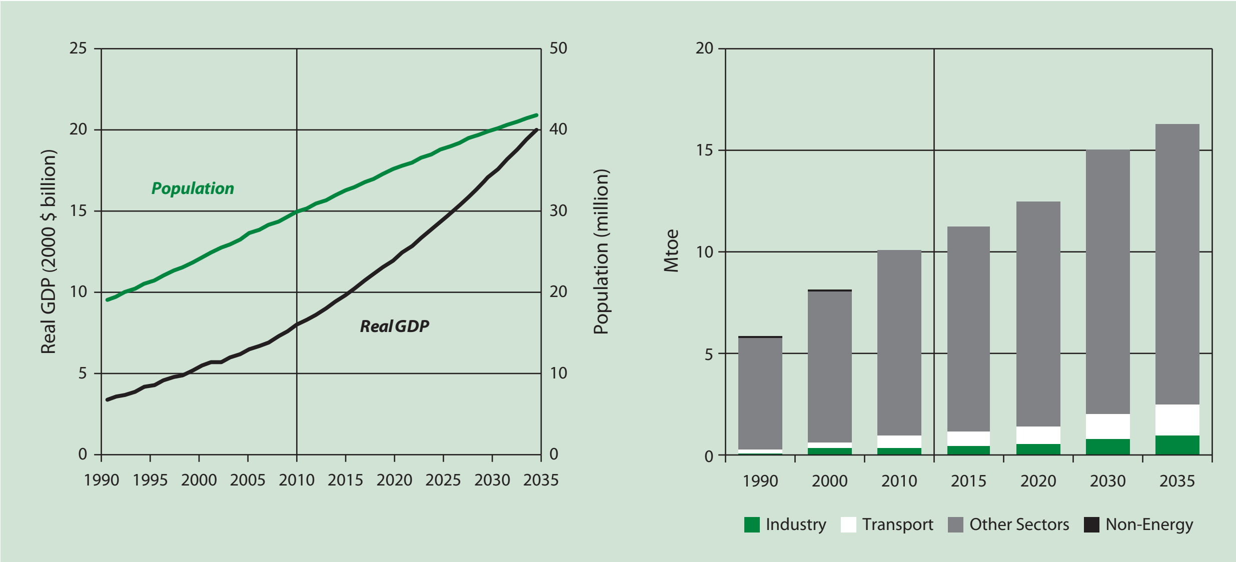
Business-as-Usual Case: Energy Demand Outlook through 2035

Over the outlook period, Nepal's GDP is projected to increase at an annual rate of 3.7%. As such, GDP will rise from $8 billion (constant 2000 $) in 2010 to $20 billion in 2035. The population is

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

[34] The Nationwide Master Plan Study on storage-type hydroelectric power development in Nepal is being conducted with support from the Japan International Cooperation Agency (JICA).

Figure 11.5.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

projected to increase at 1.4% per year through 2035, reaching 42 million in 2035 from 30 million in 2010 (Figure 11.5.1).

In the business-as-usual (BAU) case, the final energy demand of Nepal is projected to increase at an annual rate of 1.9% through 2035, slower compared with the projected GDP growth rate of 3.7% during the same period. By sector, the other sectors (including residential, commercial, agriculture, and fishery), which accounted for the largest share of final energy demand in 2010 at 90.2%, will grow moderately at 1.7% as a whole to decrease their share in final energy demand to 84.9% in 2035. In contrast, the industry and transport sectors' energy demand will increase at 4.0% per year and 3.5% per year, respectively, over the outlook period, and their respective shares will rise to 6.0% and 9.1% in 2035.

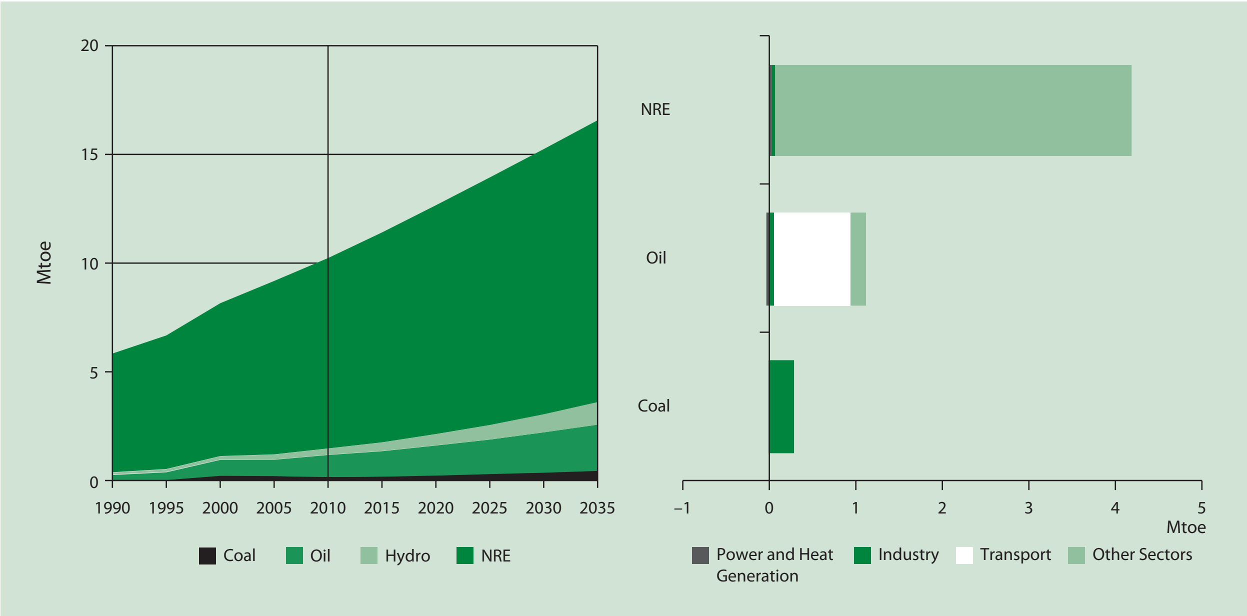
In Nepal, most of the other sectors' energy demand is for noncommercial biomass. Over the outlook period, though the share of biomass will show a slight decrease, it will remain at over 90% of the other sectors' energy demand. Electricity demand will grow at a relatively high rate of 5.3% per year through 2035, but even in 2035, it will account for only 4% of the other sectors' energy demand. The share of oil in the other sectors' energy demand will be 4% in 2035.

Within the industry sector's energy demand, electricity will increase at 5.4% per year through 2035 and its share will rise from 25% in 2010 to 35% in 2035. The average growth rate of oil and coal will be respectively 4.3% and 3.7% through 2035. The share of coal will stay at around half of the total and continue to be the largest. Noncommercial biomass will increase moderately at 2.2% per year, and its share will drop from 15% in 2010 to 9% in 2035.

In Nepal, oil will fuel most of the energy needs of the transport sector, maintaining a nearly 100% share over the outlook period.

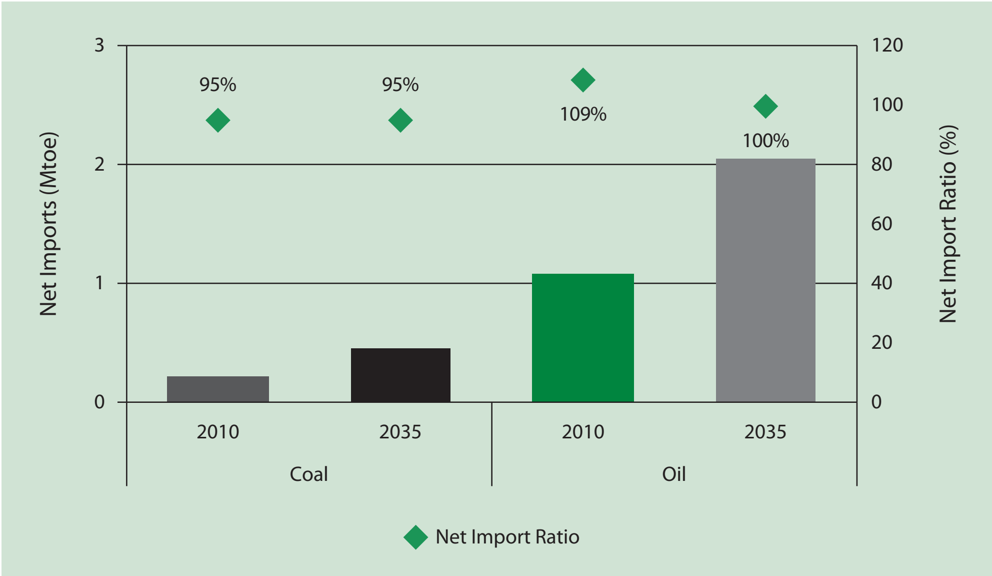
In the BAU case, the primary energy demand of Nepal is projected to increase from 10.2 Mtoe in 2010 to 16.6 Mtoe in 2035, growing at an annual rate of 2.0%. With this growth, Nepal's per capita energy demand will be 0.40 toe per person, compared with 0.34 toe in 2010.

Figure 11.5.2 Primary Energy Demand (left) and Incremental Growth by Energy and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 11.5.3 Net Imports of Coal, and Oil, and Net Import Ratio: Business-as-Usual



By energy type, noncommercial biomass will maintain the largest share, though its share will decrease from 85.7% in 2010 to 78.5% in 2035. Oil, which comprises the second-largest share of primary energy in Nepal, will rise from 9.6% in 2010 to 12.4% in 2035, increasing at 3.0% per year during the outlook period. Hydro, which displays the most rapid increase, will grow at 5.4% per year over the outlook period. The share of hydro is expected to increase to 6.2% in 2035 from 2.7% in 2010.

The sectoral contributions to the incremental energy demand growth from 2010 to 2035 are shown in Figure 11.5.2. As the figure presents, noncommercial biomass demand will show the biggest incremental growth at 4.3 Mtoe, mainly driven by the increased use in the residential sector. Oil and coal demand will respectively be led by the transport and industry sectors.

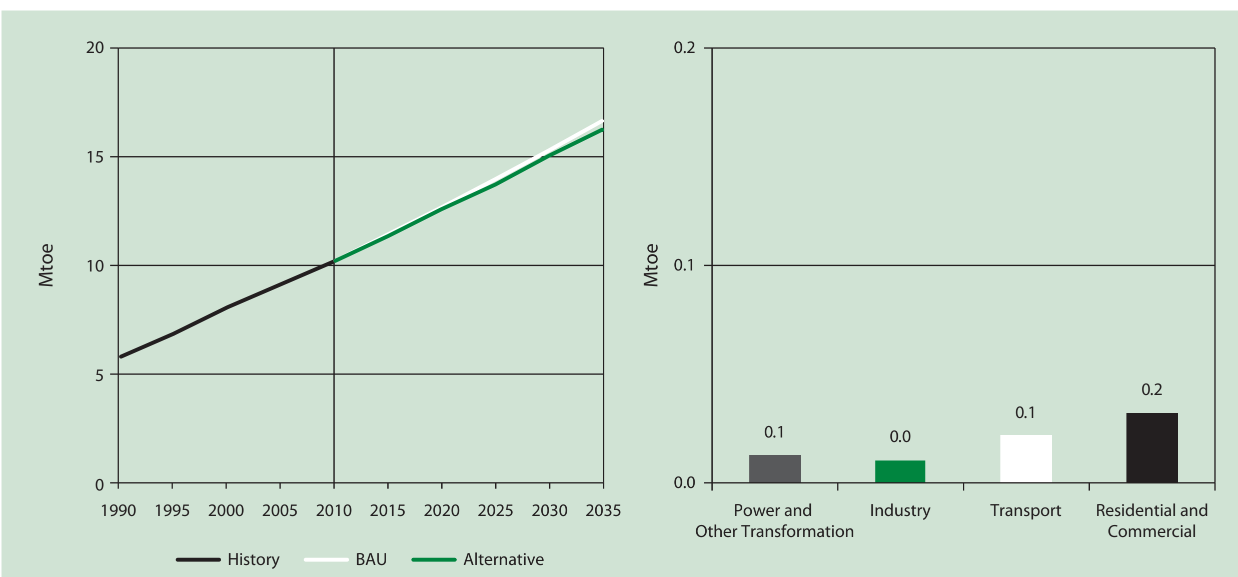
Nepal relies on imports to meet its need for fossil fuels. With the rise in demand, net import of coal will rise to 0.45 Mtoe in 2035 from 0.19 Mtoe in 2010 (Figure 11.5.3). On the other hand, oil imports will reach 2.06 Mtoe in 2035, almost doubling the 2010 level.

Alternative Case: Energy Savings Potential and Energy Source Diversification

In the alternative case, Nepal's primary energy demand will increase at an annual rate of 1.9% through 2035. With this growth, Nepal's primary energy demand will reach 16.3 Mtoe by 2035 (Figure 11.5.4). This is 0.37 Mtoe (or about 2.2%) lower than in the BAU case in 2035.

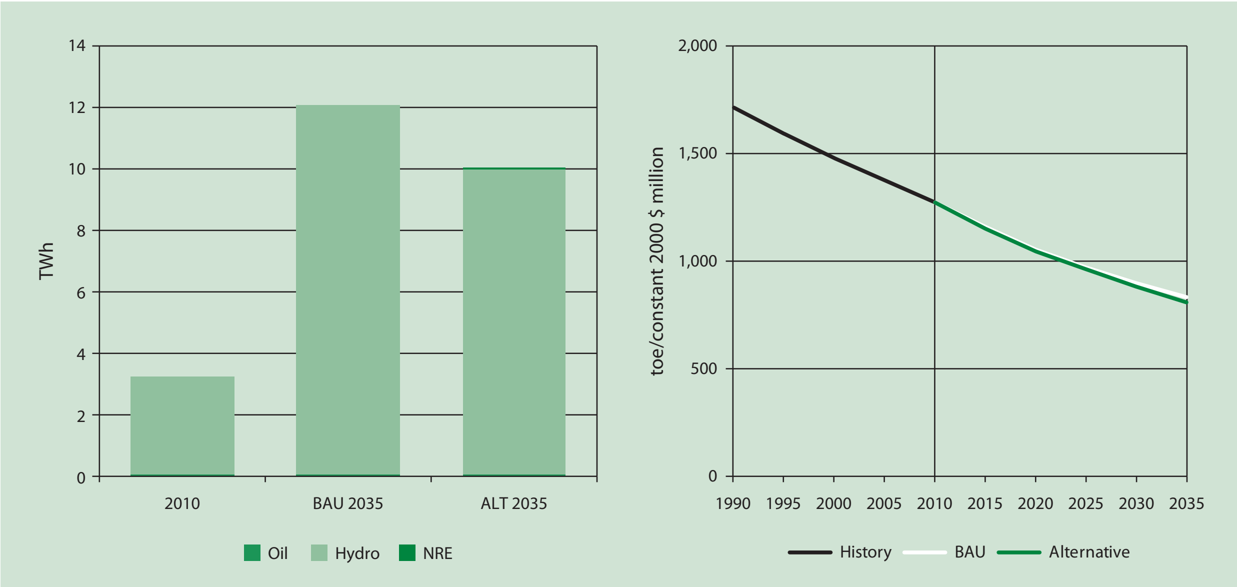
By sector, the residential and commercial sectors represent the biggest energy savings potential at 0.16 Mtoe in 2035, mainly resulting from electricity savings caused by efficient appliances deployment. However, because of the dominant share of biomass, the energy savings rate compared with the BAU case is only 1.1%.

Figure 11.5.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Figure 11.5.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

The energy savings rate of the transport and the industry sectors will be 7% and 5%, respectively, and their respective energy savings amount in 2035 will be 0.10 Mtoe and 0.05 Mtoe.

The power sector's energy savings potential is 0.06 Mtoe, mainly from electricity demand savings. In the alternative case, electricity generation in 2035 will reach 10.1 TWh (Figure 11.5.5).

Energy Policy Implications

Electricity shortages have been a critical issue for Nepal for years, affecting its economic activities and household quality of life. As Nepal produces virtually no fossil fuels, expansion of hydropower generation was selected as a priority in the country's energy policy. To counter the unreliable hydropower supply, it would be desirable to have more reservoir-type hydropower. Moreover, an effective way to deal with the difficulty of putting up transmission facilities in the mountainous areas is to increase micro-hydropower as well as renewable energy such as solar and wind.

As nearly 70% of the population will still live in rural areas in the 2030s, Nepal's energy is expected to rely on traditional forms, such as wood, crop residues, and animal manure, over the outlook period. Therefore, the efficient use of traditional energy will continue to be an important policy issue. At the same time, as Nepal's economy develops, demand for modern energy types, such as fossil fuels and electricity, is expected to increase faster than the overall growth in energy demand. The development of infrastructure to meet this demand growth may pose challenges due to lack of capital and technology.

Because of the lack of both financial and technical resources, support from neighboring countries, such as India and the People's Republic of China, and from developed countries and international organizations and institutions will be of great help for Nepal's development.

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11.6 Sri Lanka

- *In the BAU case, the primary energy demand of Sri Lanka is projected to increase from 9.9 Mtoe in 2010 to 20.3 Mtoe in 2035, growing at an annual rate of 2.9%. With this growth, Sri Lanka's per capita energy demand will reach 0.88 toe per person, compared with 0.47 toe in 2010.*
- *In the alternative case,* Sri Lanka's primary energy demand will increase at an annual rate of 2.3% through 2035, reaching 17.5 Mtoe in 2035, about 14% lower than in the BAU case.*
- *Without domestic production, all the country's fossil fuel demand relies on import. Sri Lanka's high reliance on oil for power generation makes the country vulnerable to international oil fluctuations..*

Recent Energy Trends and Energy Policy Issues

The end of civil war in 2009 and a well-educated workforce are expected to facilitate Sri Lanka's economic growth in the coming years. The economy's growth will drive up energy demand, particularly electricity demand. The country has no domestic production of coal, crude oil, or natural gas, and as a result all the fossil fuel demand is met through imports.

Sri Lanka's power supply is heavily reliant on oil. The share of oil-fired power increased from 7.3% in 1995 to 54.2% in 2000 and has since stayed around 50%. The high reliance on oil-fired power, together with the growing international oil price, pushed the cost of electricity generation up. Thus, the diversification of sources of electric power generation—in particular, building more baseload power plants—is an urgent issue for Sri Lanka's power sector.

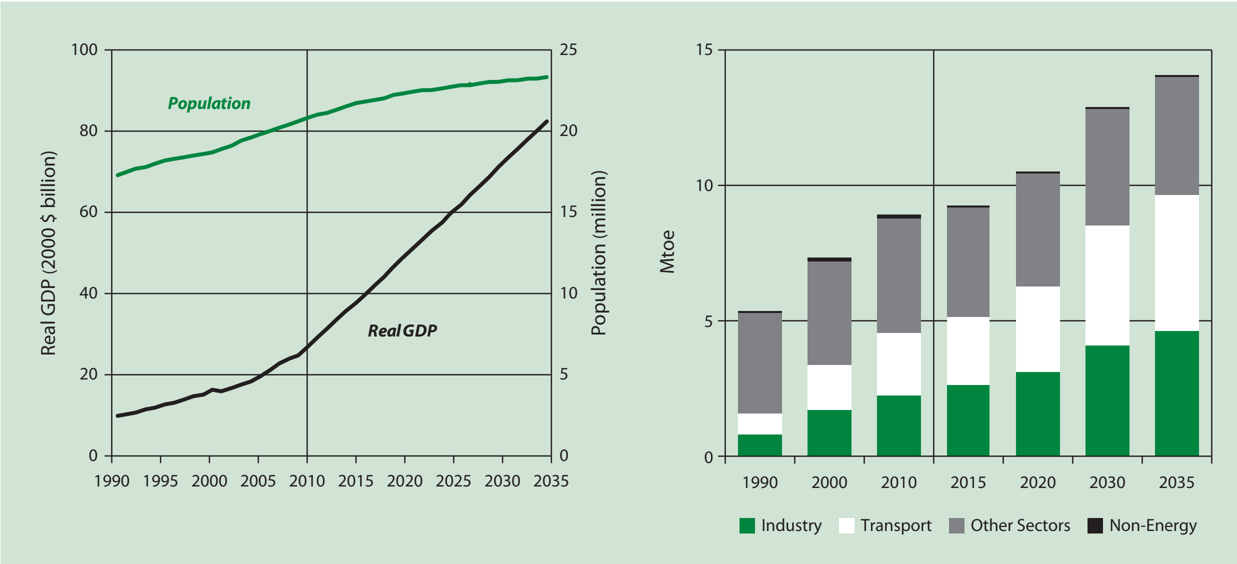
Facing rising power generation costs, the Government of Sri Lanka has approved the construction and operation of two coal-fired power stations with a total capacity of 1,400 MW, of which 300 MW in the first phase of the Norochcholai coal-fired power plant were already commissioned in 2011. An additional 600 MW of capacity is under consideration. However, obtaining permission for the construction of additional coal-fired power plants is expected to be difficult due to increasing public resistance brought about by concerns of the environmental impacts associated with coal-fired power generation.

Business-as-Usual Case: Energy Demand Outlook through 2035

Over the outlook period, Sri Lanka's GDP is projected to increase at an annual rate of 4.5%. With this growth, GDP will more than triple from $26.5 billion (constant 2000 $) in 2010 to

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

Figure 11.6.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

$79.6 billion in 2035 (Figure 11.6.1). The population is projected to increase at a moderate pace of 0.4% over the same period, reaching 23.1 million in 2035 from 20.8 million in 2010.

In the BAU case, the final energy demand of Sri Lanka is projected to increase at an annual rate of 1.9% through 2035. By sector, the other sectors (including residential, commercial, agriculture, and fishery), which accounted for 48.2% of Sri Lanka's total final energy demand in 2010, will increase slowly at 0.6% per year, while their share is projected to decrease to 30.9% in 2035. In contrast, the transport and industry energy demand will increase at an annual rate of 3.2% and 3.0%, respectively, over the outlook period.

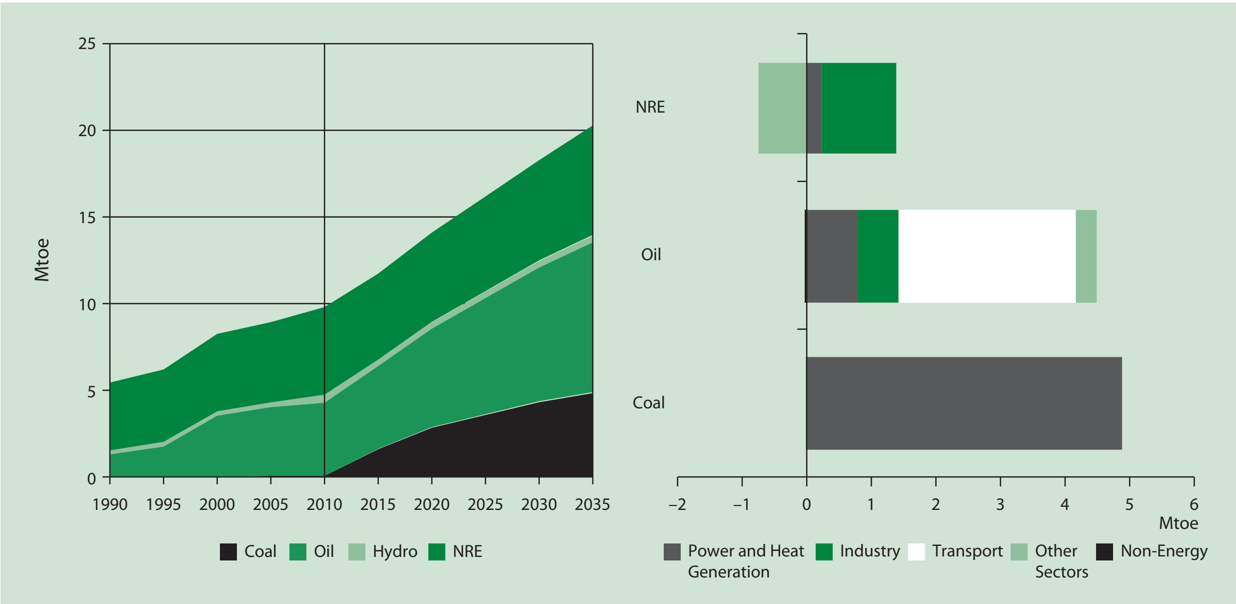
While the other sectors' energy demand as a whole will grow slowly, growth trends vary by energy type. Fuel shifting from noncommercial biomass to commercial fuels such as oil products and electricity will continue to take place throughout the outlook period. As a result, demand for noncommercial biomass will decline at an annual rate of –0.7% with its share decreasing from 80.2% in 2010 to 61.2% in 2035. Over the same period, electricity demand will grow at the fastest rate of 3.3% per year, followed by oil products at 2.9%.

Energy demand in the industry sector will grow at 3.0% through 2035. Electricity demand will see the fastest increase at an annual rate of 5.5% per year, followed by oil at 3.9%. Biomass, while its share will drop from 71.5% to 60.5% over the outlook period, will grow moderately at a rate of 2.3%. Demand for coal in the industry sector remains small and will decline slowly at a rate of –0.1% over the same period.

Oil is the only fuel consumed in the transport sector. The demand will grow 3.8% per year over the whole outlook period, with a faster near-term growth pace of 4.9% per year (2010–2020) compared with 3.1% per year over the long term (2020–2035).

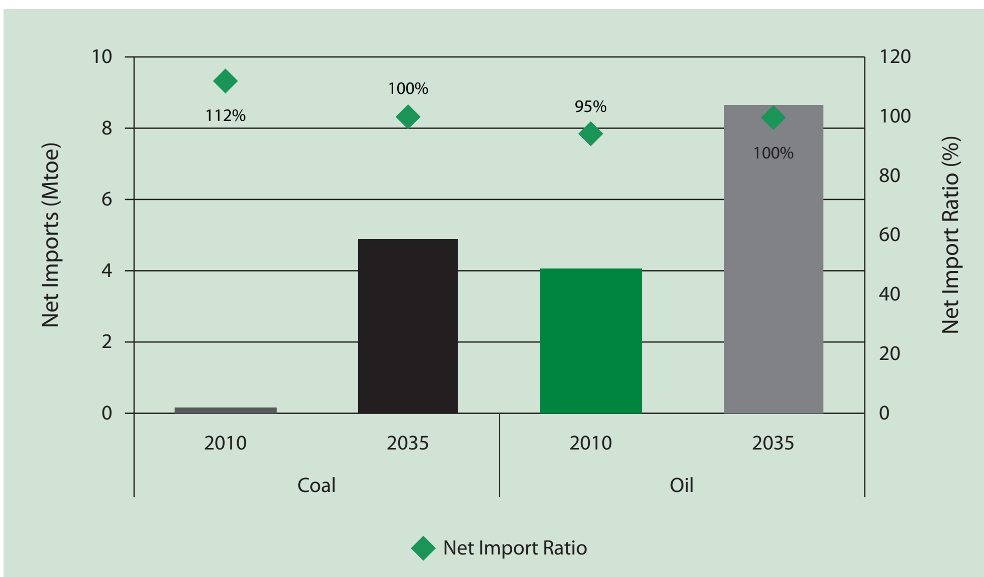
In the BAU case, the primary energy demand of Sri Lanka is projected to increase from 9.9 Mtoe in 2010 to 20.3 Mtoe in 2035, growing at an annual rate of 2.9%. With this growth, the country's energy demand per capita will reach 0.88 toe per person, compared with 0.47 toe in 2010.

Figure 11.6.2 Primary Energy Demand (left) and Incremental Growth by Energy and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 11.6.3 Net Imports of Coal, and Oil, and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

By energy type, driven by demand from the transport sector, the share of oil will surpass that of noncommercial biomass, accounting for 42.9%, the largest share, of Sri Lanka's primary energy demand in 2035. Coal is expected to experience the fastest growth, at a rate of 18.7%. This is driven by the commissioning of several coal-fired power plants that are under construction.

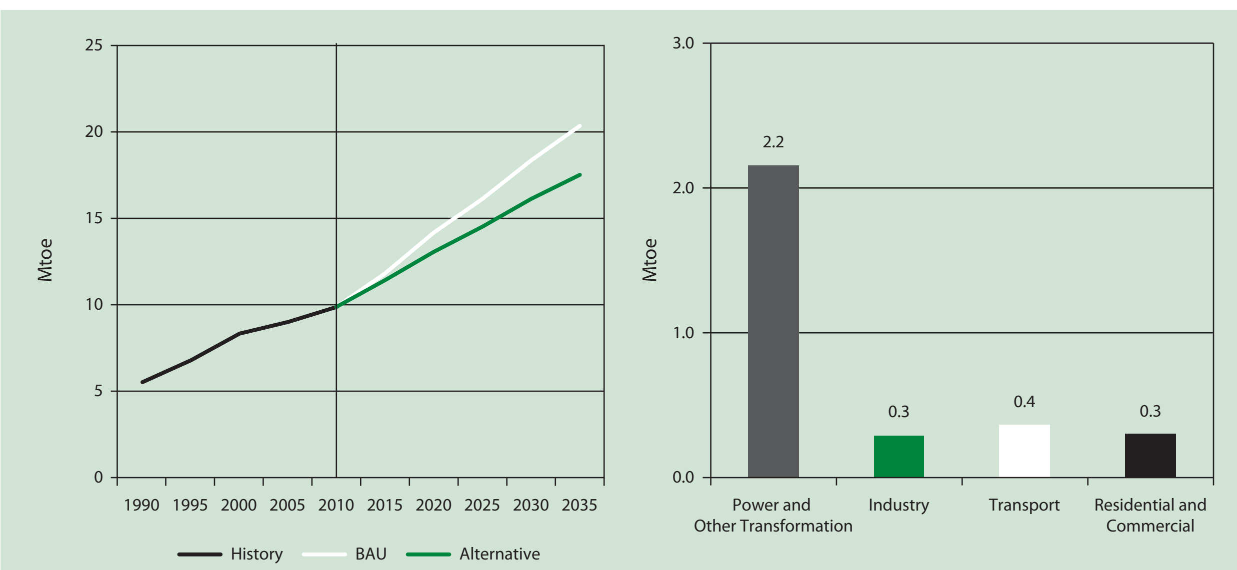
The sectoral contributions to incremental energy demand growth from 2010 to 2035 are shown in Figure 11.6.2. Coal demand will show the biggest incremental growth at 4.9 Mtoe, driven entirely by the need for power generation. Oil demand will be led mostly by the transport sector, due to the shift from natural gas in the sector.

Sri Lanka produces no oil and relies on imports for all of its oil demand. Since the end of the civil war, the government has been pushing for the exploration of hydrocarbon resources in its waters. In 2011, natural gas was found by Cairn Lanka, a private company, in the Mannar Basin, the sea area west of the island. It is assumed that the same basin, as well as the Cauvery Basin further north, also has petroleum reserves. With the commissioning of coal-fired power plants, the country's coal imports will increase. Coal import is handled by Lanka Coal Company, which was established in 2008. Australia and Indonesia are expected to be the two major suppliers for Sri Lanka's thermal coal need.

Alternative Case: Energy Savings Potential and Energy Source Diversification

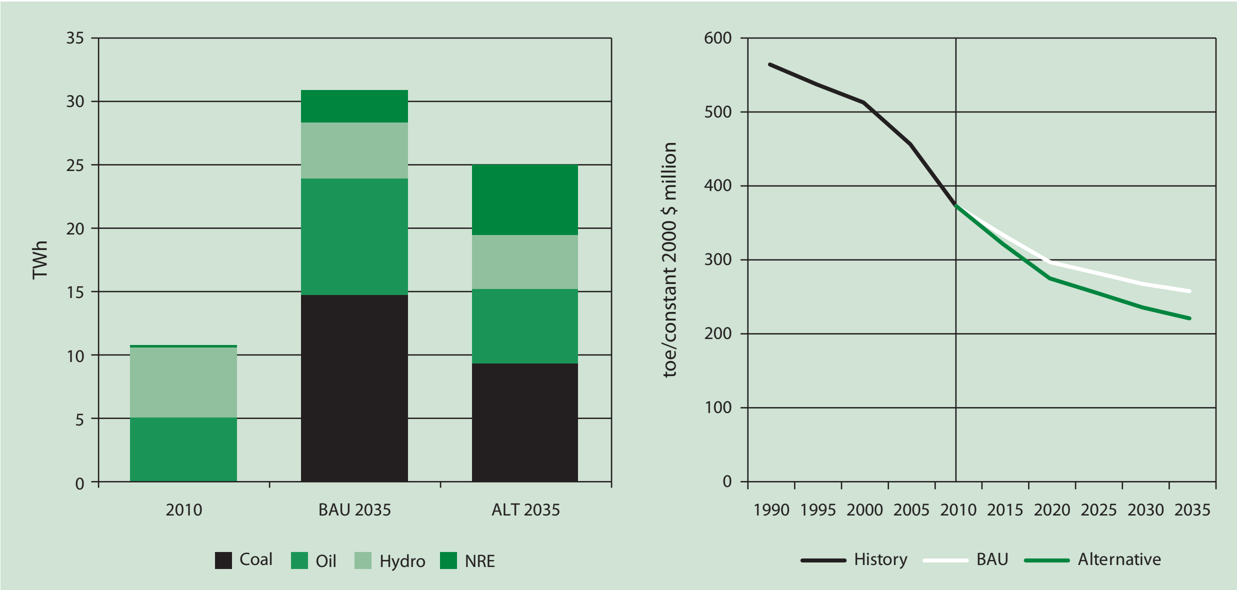
Sri Lanka has substantial energy savings potential with the deployment of advanced technologies. In the alternative case, Sri Lanka's primary energy demand will increase at an annual rate of 2.3%. Its primary energy demand will reach 17.5 Mtoe in 2035, 14.0% lower than in the BAU case (Figure 11.6.4).

Figure 11.6.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Figure 11.6.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

By sector, the power sector has the biggest energy savings potential at 2.2 Mtoe in 2035, followed by transport at 0.4 Mtoe, industry at 0.3 Mtoe, and residential and commercial also at 0.3 Mtoe.

Primary energy savings from power generation are a result of electricity demand reductions in the industry sector and the residential and commercial sectors.

The residential and commercial sectors' energy savings potential is estimated at 0.3 Mtoe in 2035 as a result of electricity savings through the diffusion of more efficient appliances. The biggest savings are expected to come from lighting.

Due to Sri Lanka's small heavy industry sector, the industrial energy savings potential, estimated at 0.3 Mtoe, is relatively small compared with other sectors.

The transport sector's energy savings potential of 0.4 Mtoe is the largest. The savings potential is mainly from the fuel economy improvement of new cars.

In the alternative case, Sri Lanka's electricity generation in 2035 will reach 25.1 TWh, about 19.4% lower compared with 31.2 TWh in the BAU case (Figure 11.6.5). Despite the savings efforts, electricity generation output will be more than double the 2010 level.

In the alternative case, new and renewable energy will have a larger share in the power generation portfolio. Renewable energy sources[35] (solar, wind, and biomass) will account for 21.8% of the total power generation in 2035 compared with 8.6% in the BAU case. As a result, at the end of the projection period, the share of thermal power will be reduced from 77.3% in the BAU case to 60.7% in the alternative case.

[35] Micro and small hydro are counted as hydro rather than renewable in this report.

Energy Policy Implications

Without any domestic production, all of Sri Lanka relies on imports for its fossil fuel demand. Although hydro supplies half of the country's power demand, the other half is met almost entirely by oil. This makes the country vulnerable to international oil price fluctuations and pushes up the country's power generation costs. Current construction and commissioning of coal-fired power plants are expected to add some low-cost baseload supply. However, given environmental concerns, it may be difficult to obtain further permission to operate conventional coal-fired power plants.

Driven by its strong economic growth and increasing incomes, the country's electricity demand is projected to grow 3.6% per year. Most of the country's hydropower resources have already been developed. From the standpoint of both energy security and environmental concerns, it is important to increase the role of non-hydro renewable energy in the country's power portfolio.

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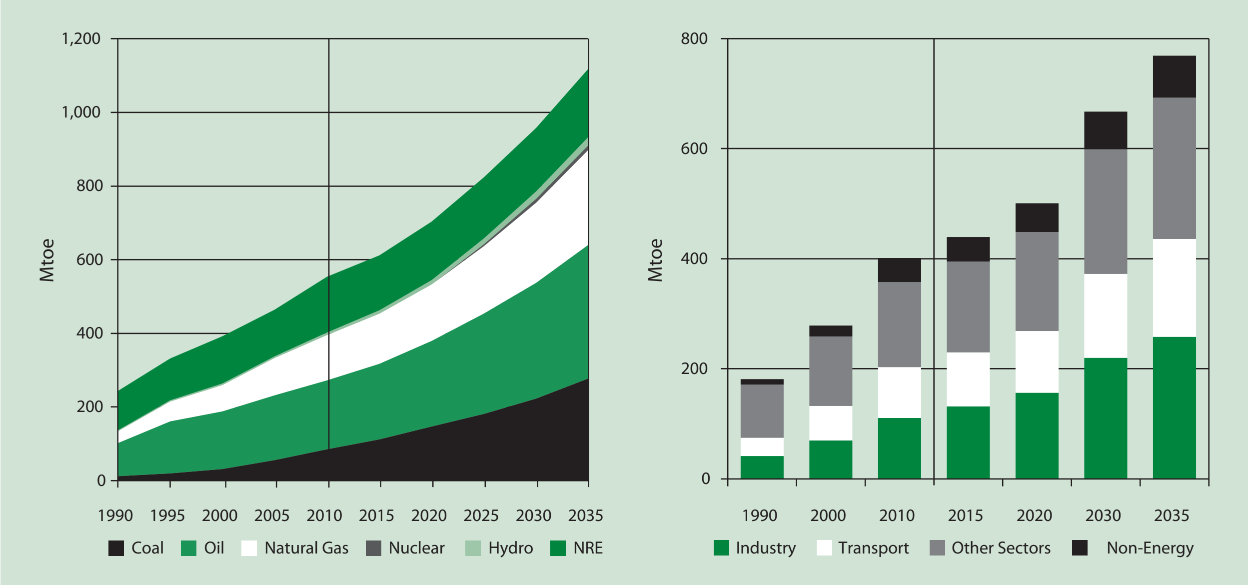
Chapter 12

Southeast Asia

Southeast Asia

- *In the business-as-usual (BAU) case, Southeast Asia's primary energy demand is projected to increase from 554.8 million tons of oil equivalent (Mtoe) in 2010 to 1,110.2 Mtoe in 2035 at an annual rate of 2.8% (Figure 12.1). While oil will be the dominant fuel through 2035, coal will register the fastest annual growth rate at 4.8%. The final energy demand will reach 768.9 Mtoe in 2035 with an annual growth rate of 2.6%, primarily driven by the industry sector, which will grow at 3.4% annually.*
- *In the alternative case,* the annual growth rate of primary energy demand will average 2.3% through 2035. This indicates that Southeast Asia has the potential to save about 126.3 Mtoe in 2035, or a 11.4% reduction compared with the BAU case (Figure 12.2). Similarly, Southeast Asia's electricity generation will be reduced by 15.7% in the alternative case. Compared with the BAU case, the shares of nuclear and new and renewable energy will expand in the generation mix, whereas those of coal and natural gas will contract.*
- *Energy trade, especially electricity trade, through regional cooperation will be critical to meet the domestic energy demand driven by robust demand growth. Energy security enhancement will continue to be important on the policy agenda as some members' domestic production is projected to decline. To cope with the situation, energy source diversification—away from natural gas in the power sector (for Indonesia, Malaysia, and Thailand)—and energy savings, particularly in the transport sector in Southeast Asia as a whole, will take priority in energy policy making.*

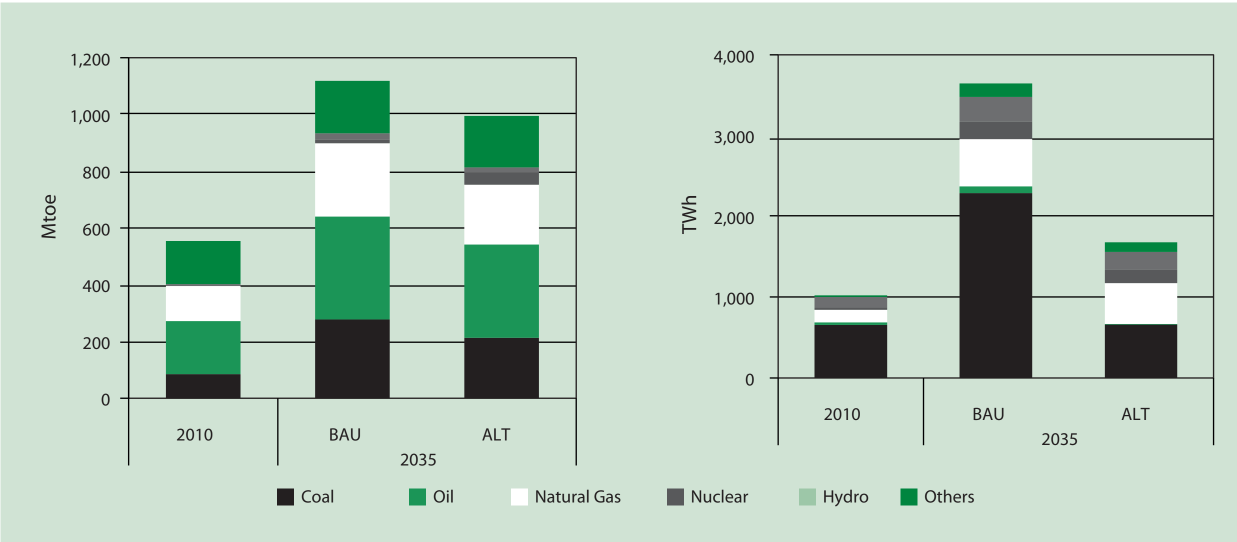
Figure 12.1 Primary Energy Demand (left) and Final Energy Demand (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

Figure 12.2 Business-as-Usual and the Alternative Case: Primary Energy Demand (left) and Electricity Generation (right)



ALT = alternative case, BAU = business-as-usual case, Mtoe = million tons of oil equivalent, TWh = terawatt-hour.

12.1 Brunei Darussalam

- *In the BAU case, the primary energy demand of Brunei Darussalam is projected to decrease slightly from 3.16 Mtoe in 2010 to 3.08 Mtoe in 2035, and the annual growth rate will be –0.1%. In 2035, Brunei Darussalam's per capita energy demand will drop to 5.64 toe per person, compared with 7.92 toe in 2010.*
- *In the alternative case,* Brunei Darussalam's primary energy demand will decrease at an annual rate of –0.6% through 2035. Brunei Darussalam's primary energy demand will be 2.74 Mtoe in 2035, 0.34 Mtoe (or about 11.0%) lower than in the BAU case.*

Recent Energy Trends and Energy Policy Issues

Endowed with oil and gas resources and a main exporter of crude oil and liquefied natural gas, Brunei Darussalam is one of the wealthiest countries in Southeast Asia. In 2010, the gross domestic product (GDP) per capita of Brunei Darussalam was $17,225 (constant 2000 $), much higher than the Southeast Asia average of $1,679. On the other hand, the economy relies heavily on oil and gas export. Due to the sluggish production of oil and gas because of the maturity of its main fields, the average annual GDP growth rate during 2000–2010 was only 1.4%, and GDP per capita in 2010 was even 6% lower than in 2000 at $18,350.

During 2000–2010, total primary energy demand in Brunei Darussalam increased at 7.6% per year, reaching 1.20 Mtoe in 2010 from 0.57 Mtoe in 2000. The per capita primary energy demand of Brunei Darussalam (7.92 tons of oil equivalent [toe] per person in 2010) is the highest among the members of the Asian Development Bank.

The final demand for non-energy use and of the industry sector led the growth in final energy demand, respectively expanding at 27% and 13% per year. Their shares rose from 16.1% in 2000 to 39.6% in 2010. The transport sector grew at 4.3% per year and continued having the largest share of the final energy demand, 34.6% in 2010. The final energy demand of the residential and commercial sectors increased at 4.0% per year, while their share decreased from 36.3% in 2000 to 25.8% in 2010.

Natural gas is the major fuel in Brunei Darussalam's primary energy demand. In 2010, primary gas demand reached 2.40 Mtoe, up by 30.0% from its value in 2000, and accounted for 76.1% of the total primary energy demand in 2010. Most of the natural gas is used by the power sector. In 2010, the methanol plant of Brunei Methanol Company, which has a capacity to produce 850 kilotons of methanol per year with natural gas, started operations.

Primary oil demand reached 0.76 Mtoe and a 23.9% share in 2010. Petroleum products produced by oil refineries in the country are primarily for domestic consumption by the transport sector. However, due to the limited domestic capacity for refining oil, Brunei Darussalam still needs

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

to import petroleum products. A project to build an oil refinery and aromatics cracker is being planned by a People's Republic of China (PRC) company, and the first phase of this plan, with a refining capacity of 135 kilobarrels per day, was approved by the government in 2011. This plant is expected to start operation by 2015.

Electricity generation reached 3.60 terawatt-hours (TWh) in 2010, up 41.6% from 2000. Per capita electricity generation was about 9,000 kilowatt-hours (kWh) per year, almost eight times the Southeast Asia group's average of 1,153 kWh per person. In Brunei Darussalam, electricity production is essentially all gas-fired. However, as these simple gas turbine plants have low operating ratios, the average generation efficiency was only 25.4% in 2010. There are efforts under way to upgrade plant efficiency by introducing more advanced combined-cycle generation technologies. The first gas-fired combined-cycle power plant of 110 megawatts (MW) was completed in 2007, and the second to fourth phases, each with a capacity of 200 MW, are also being planned.

Brunei Darussalam has abundant offshore and onshore liquid and gas hydrocarbon energy resources. Proven gas reserves are estimated at 10.2 trillion cubic feet and proven oil reserves at 1.1 billion barrels (BP 2012). In 2010, the production of gas and oil were respectively 10.3 Mtoe and 8.3 Mtoe. As a major energy exporter in Southeast Asia, 7.6 Mtoe of gas and 7.9 Mtoe of oil were exported in the same year. At the same time, many of the oil and gas fields are considered to be maturing and the production of both gas and oil have shown a decline since 2008.

The basic policy for the upstream energy sector of Brunei Darussalam has been to stabilize the production of oil and gas in the long term. Implementing enhanced oil recovery techniques in mature fields and expanding the exploration of new reserves are encouraged. Upon resolving its outstanding maritime boundary issue with Malaysia, it is expected that exploring the deepwater fields will significantly increase the potential for new reserves. For the downstream, Brunei Darussalam stresses the broadening of oil and gas utilization to produce methanol, fertilizer, and other chemical goods.

The 2007–2012 Ninth National Development Plan, which was developed alongside the country's long-term strategic framework Brunei's Vision 2035 (Wawasan Brunei 2035), outlines measures to strengthen the oil and gas industry, diversify the economy more broadly, and optimize the economic use of natural resources.

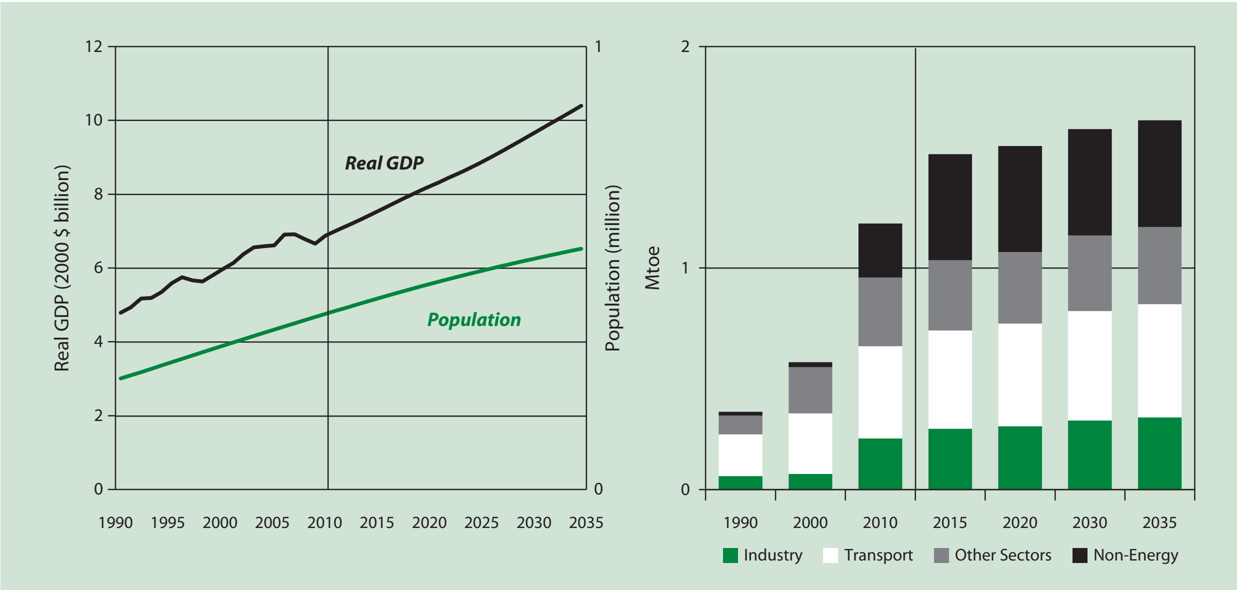
To improve energy conservation, a target to reduce the energy intensity to 285 toe per million dollars of GDP in 2010 to 210 toe per million dollars of GDP by 2035 has been announced. Measures toward achieving this goal, including reforms of the domestic energy price system, efficiency improvement of the power sector, promotion of demand-side management across sectors, and introduction of energy-efficient appliances and vehicles, are being planned.

Business-as-Usual Case: Energy Demand Outlook through 2035

Over the outlook period, Brunei Darussalam's GDP is projected to increase at an annual rate of 1.7%. With this growth, GDP will be $10.45 billion (constant 2000 $) in 2035, up 52.1% from 2010 (Figure 12.1.1). The population is projected to increase at 1.3% through 2035 and reach 0.55 million in 2035 from 0.40 million in 2010. GDP per capita will rise from $17,225 in 2010 to $19,125 in 2035.

In the BAU case, the final energy demand of Brunei Darussalam is projected to increase at an annual rate of 1.3% through 2035.

Figure 12.1.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

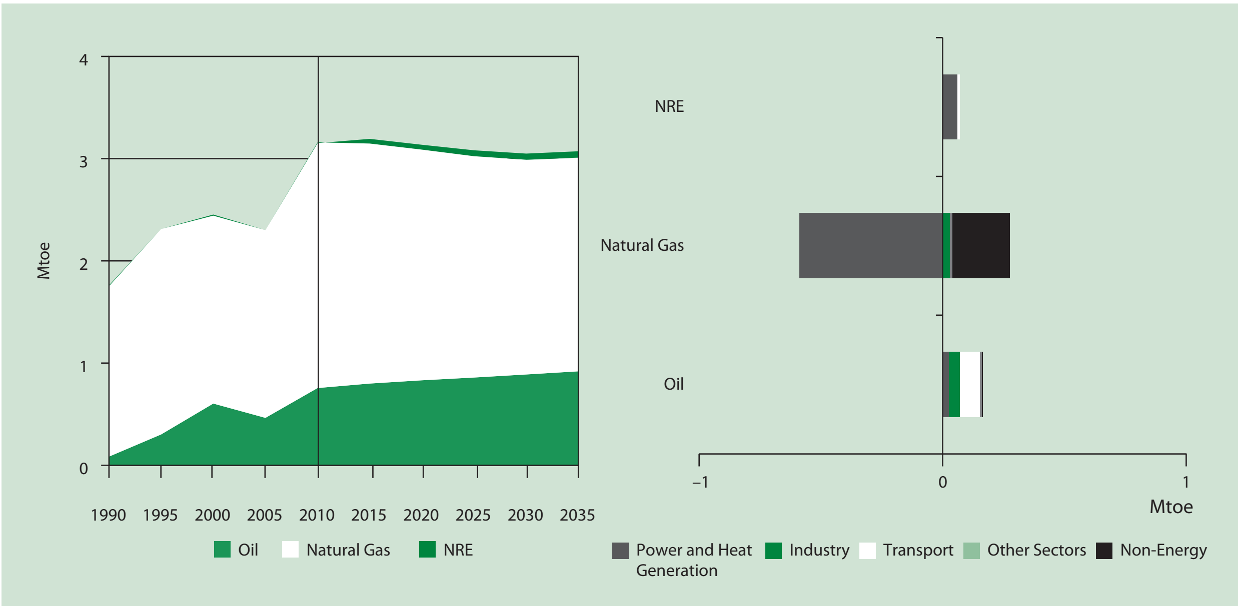
By sector, the transport sector accounted for the largest share in 2010 at 34.6%. The car ownership rate of Brunei Darussalam is one of the highest in the world. In the future, transport energy demand will increase moderately at 0.8% per year and its share will decrease to 30.7% in 2035. With an annual growth of 0.5%, the share of the other sectors (including residential, commercial, agriculture, and fishery) will decrease from 25.8% in 2010 to 20.9% in 2035. In contrast, with the development of the chemical industry, final energy demand for non-energy use will increase relatively fast at 2.7% per year, and its share will rise from 20.4% in 2010 to 28.9% in 2035. The final energy demand in the industry sector will increase 1.4% per year, and its share will grow slightly from 19.2% in 2010 to 19.5% in 2015.

By energy type, oil, gas, and electricity are the major types in the final energy demand of Brunei Darussalam. Almost all of the energy demand in the transport sector is for oil. Electricity is the major type in the other sectors' energy demand, accounting for more than two-thirds of the total in 2010, with the remainder being oil and gas. The main energy types in the industry sector are oil and electricity. For non-energy use, gas is the dominant resource. Over the outlook period, the pattern of final energy demand in each sector will be maintained. However, due to the structural changes, especially the relatively rapid growth of non-energy use demand for gas, the share of gas will increase from 24.9% in 2010 to 34.5% in 2035. The share of oil, moreover, will decrease from 52.2% in 2010 to 45.9% in 2035. Electricity's share will drop to 19.0% by 2035 from 22.8% in 2010.

With the improvement in efficiency of power generation, the primary energy demand of Brunei Darussalam is projected to decrease from 3.16 Mtoe in 2010 to 3.08 Mtoe in 2035, at an annual rate of –0.1%. The country's per capita energy demand will drop to 5.64 toe per person, compared with 7.92 toe in 2010.

By energy type, gas and oil occupied most of the primary energy of Brunei Darussalam. The shares of gas and oil were respectively 76.1% and 23.9% in 2010. Over the outlook period, although renewable energy, such as solar power, will increase at a relatively rapid pace, the

Figure 12.1.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

share will remain small, only 2.3% by 2035. Gas and oil will maintain their dominant share, respectively, at 67.9 % and 29.8% in 2035.

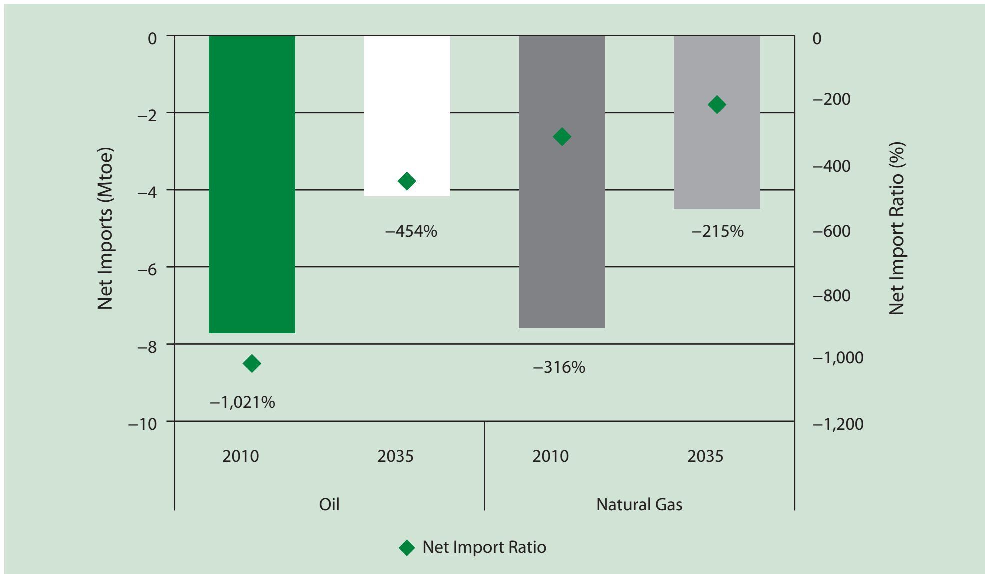
The sectoral contributions to the incremental energy demand change from 2010 to 2035 are shown in Figure 12.1.2. As the figure presents, oil demand will experience the biggest incremental growth at 0.16 Mtoe, mainly driven by the increased transport energy demand. Gas demand for non-energy use will rise, although the energy savings in the power sector will reduce gas demand dramatically. In the total, primary gas demand in Brunei Darussalam will decrease by 0.31 Mtoe by 2035 compared with 2010.

Currently, Brunei Darussalam is a major exporter of crude oil and liquefied natural gas (LNG) in the Southeast Asia group. However, due to the maturity of its main fields, the production and export of oil and LNG are expected to continue decreasing over the outlook period. The net export of oil will drop from 7.7 Mtoe in 2010 to 4.2 Mtoe in 2035, and the net export of natural gas from 7.6 Mtoe in 2010 to 4.5 Mtoe by 2035 (Figure 12.1.3).

Alternative Case: Energy Savings Potential and Energy Source Diversification

With the deployment of advanced technologies for energy savings, Brunei Darussalam could achieve less energy-intensive growth in the future. In the alternative case, Brunei Darussalam's primary energy demand will decrease at an annual rate of –0.6% and drop to 2.74 Mtoe by 2035, 0.34 Mtoe (or about 11%) lower than in the BAU case in 2035 (Figure 12.1.4).

Figure 12.1.3 Net Imports of Oil, and Natural Gas and Net Import Ratio: Business-as-Usual

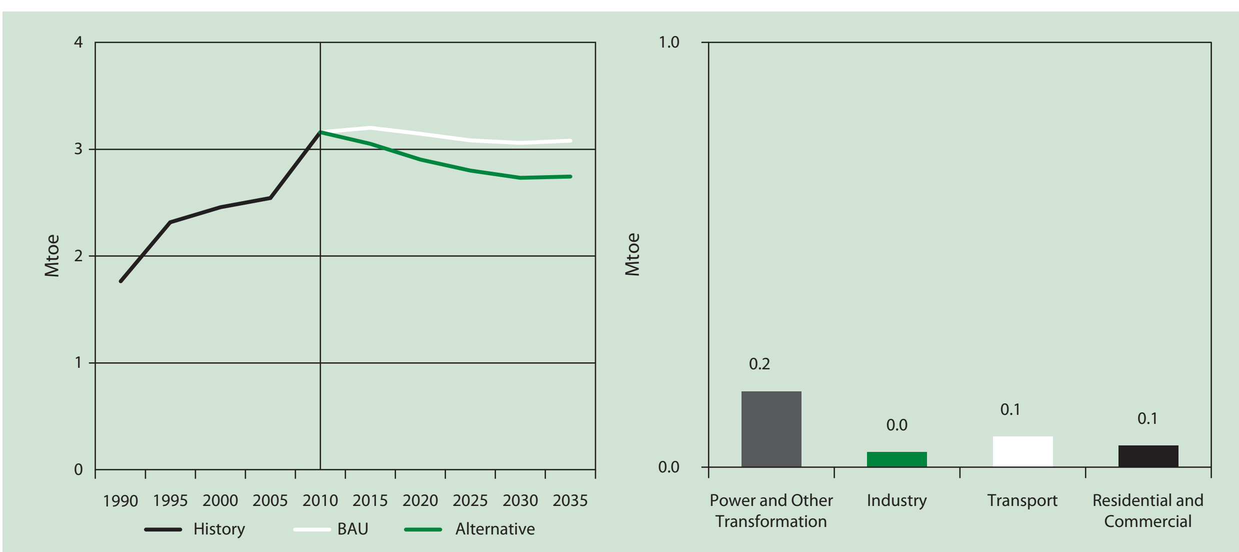


Mtoe = million tons of oil equivalent.

By sector, the power sector represents the biggest energy savings potential at 0.18 Mtoe in 2035, followed by transport at 0.07 Mtoe, residential and commercial at 0.05 Mtoe, and industry at 0.04 Mtoe.

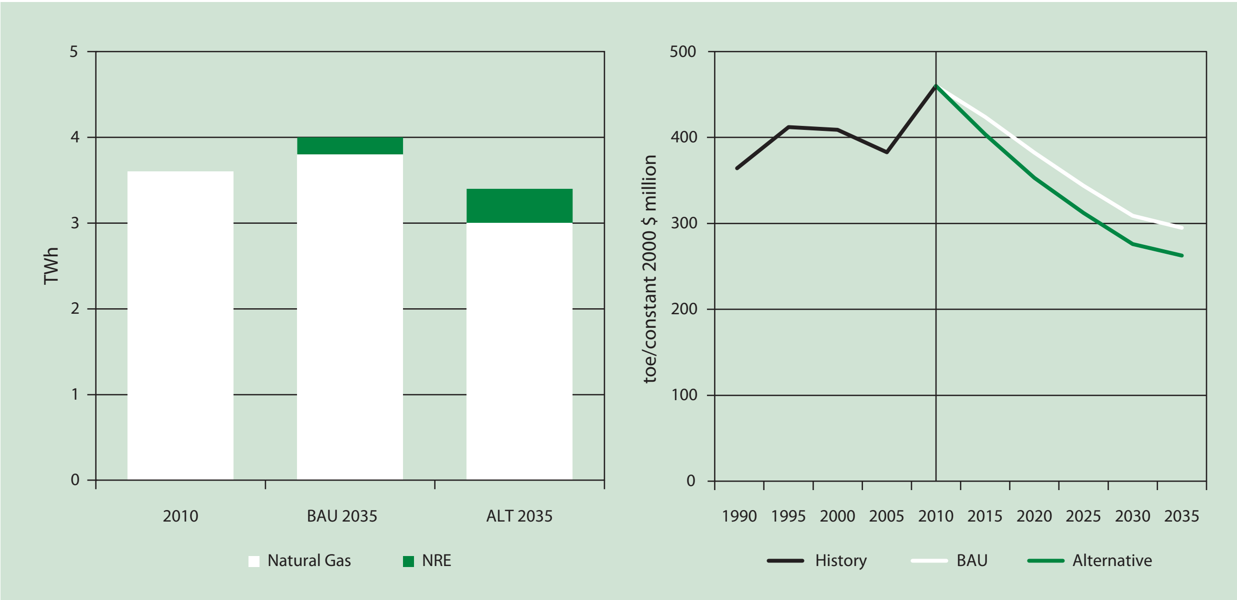
The transport sector's energy savings are produced by shifts toward more efficient internal combustion engine hybrid vehicles and even electric vehicles.

Figure 12.1.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Figure 12.1.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

The residential and commercial sectors' energy savings are mainly a result of electricity savings from the deployment of efficient appliances. The major appliances that contribute to the electricity savings are air conditioners and lighting in the residential sector, and cooling in the commercial sector.

The industry sector's energy savings will be achieved by deployment of advanced technologies in the various industry subsectors, especially the efficiency improvement in the oil refining and chemical industry.

Progress in energy conservation in the industry, residential, and commercial sectors will reduce electricity demand, and thus the needed fuel input for the power plants. In the alternative case, Brunei Darussalam's electricity generation in 2035 will be 3.40 TWh, 15.0% lower than in the BAU case. The efficiency improvement achieved through the development of gas-fired combined-cycle power plants will also contribute to the energy savings in the power sector.

In the alternative case, electricity generation using new and renewable energy, such as solar power and biomass, will achieve faster growth, reaching 0.16 Mtoe by 2035, more than double the BAU amount (Figure 12.1.5). In 2035, the share of new and renewable energy in primary energy demand will be 5.7%.

Energy Policy Implications

Over the outlook period, energy exports—specifically oil and gas—will continue to support the economic development of Brunei Darussalam. A heavy dependence on energy exports means that the country's economic development is vulnerable to fluctuations in the global market. Declining production is also impairing Brunei Darussalam's capacity to deal with the risks.

Japan and the Republic of Korea are currently the major LNG export markets for Brunei Darussalam. Of the 8.4 Mtoe of exported LNG in 2011, 89% went to Japan and 11% to the Republic of Korea. Most of the LNG trade is based on long-term contracts. A 20-year contract for exporting 6.0 million tons of LNG per year to Japan expired in March 2013. In the new contract between Brunei LNG and the Japanese companies, which was signed in 2012, the amount was reduced to 3.4 million tons per year and the contract term shortened to 10 years. At the same time, new LNG export projects in Australia and growing shale gas production in the United States are increasing the supply of LNG in the Pacific area. In contrast, gas demand in the PRC is growing rapidly and several LNG import terminals are being built in Southeast Asia. The changes in the energy market in the Pacific are exacerbating the uncertainty of LNG exports—and thus the economy of Brunei Darussalam.

To deal with these challenges, the long-term development plan of Brunei Darussalam includes indispensable policies to diversify the economy and develop the chemical industry using domestic hydrocarbon resources.

However, the development of the industry sector, especially the chemical manufacturing subsector, will likely raise Brunei Darussalam's overall energy intensity, greenhouse gas emissions, and domestic energy demand due to significant own-use of energy in these industrial processes.

Reducing domestic energy demand will contribute to the sustainability of the energy export potential. To improve energy efficiency across sectors, it will be essential to raise the energy price in the domestic market. Furthermore, it will be of benefit to introduce renewable energy, such as solar power, to decrease greenhouse gas emissions.

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12.2 Cambodia

- *In the BAU case, Cambodia's primary energy demand is projected to reach 8.9 Mtoe in 2035, increasing from 5.0 Mtoe in 2010, with an average annual growth rate of 2.3%. In contrast, in the alternative case,* primary energy demand will grow at 1.7% per year, reaching 7.7 Mtoe through 2035 incorporating the deployment of advanced technologies for energy savings. The projected lower primary energy demand in the alternative case suggests that Cambodia has a savings potential of about 1.2 Mtoe in 2035, or a 13.0% reduction compared with the BAU case.*
- *Cambodia faces a number of challenges to laying the infrastructure to meet the expected energy demand growth. In particular, finding ways to cope with rising electricity demand—projected to increase at an annual rate of 8.8% through 2035 in the BAU case—at lower tariff levels than currently will require concerted efforts among the various stakeholders in Cambodia to facilitate investment in infrastructure, from generation to transmission and distribution.*

Recent Energy Trends and Energy Policy Issues

After accession to the World Trade Organization in 2004, Cambodia's economy experienced remarkable growth. From 2004 to 2007, the economy grew at double-digit rates, averaging 11.4% per year, driven by the agriculture, garment and footwear, and tourism industries. The recent global economic recession hit Cambodia, and annual growth was 6.7% in 2008 and 0.1% in 2009. However, Cambodia's economy has been on a recovery track since 2010, when growth registered 6.0%. Despite the recent fast growth, Cambodia's per capita GDP in 2010 was one of the lowest among the Southeast Asian members at $559.0 (constant 2000 $) compared with the average of Southeast Asia at $1,678.6 in the same year.

Cambodia's primary energy demand in 2010 reached 5.0 Mtoe, up from 3.4 Mtoe in 2000. The per capita primary energy demand of Cambodia in 2010 was one of the lowest levels in Southeast Asia at 0.36 toe per person, compared with the region's average of 0.94 toe per person.

Of the total primary energy demand, noncommercial biomass (such as wood, rice husk, and animal waste) accounted for the largest share at 72.0% in 2010, followed by oil at 25.4%, imported electricity at 2.3%, and coal at 0.2%. Dominance of noncommercial biomass in the energy mix is reminiscent of Cambodia's long-lasted civil war during the 1970s and 1980s, which hindered domestic infrastructure development and resources exploration. At present, only 22.5% of households have electricity access (54% of urban households and 13% of rural households) (Ritouch 2011). The country's hydropower potential is estimated at about 10 gigawatts; nevertheless, only 1% of this capacity is presently utilized (Ritouch 2011). The power generation in Cambodia relies on imported electricity (57.9%), oil-fired generation (39.1%), hydro (1.1%), and biomass (0.8%), thereby making the country's electricity costs the

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

highest in Southeast Asia. In fact, Phnom Penh residents pay an electricity tariff rate of $0.18 per kilowatt-hour (Poch and Tuy 2012).

In view of the situation, the Government of Cambodia formulated an energy sector development policy in October 1994 and seeks to achieve the following energy policy objectives (UN 2004):

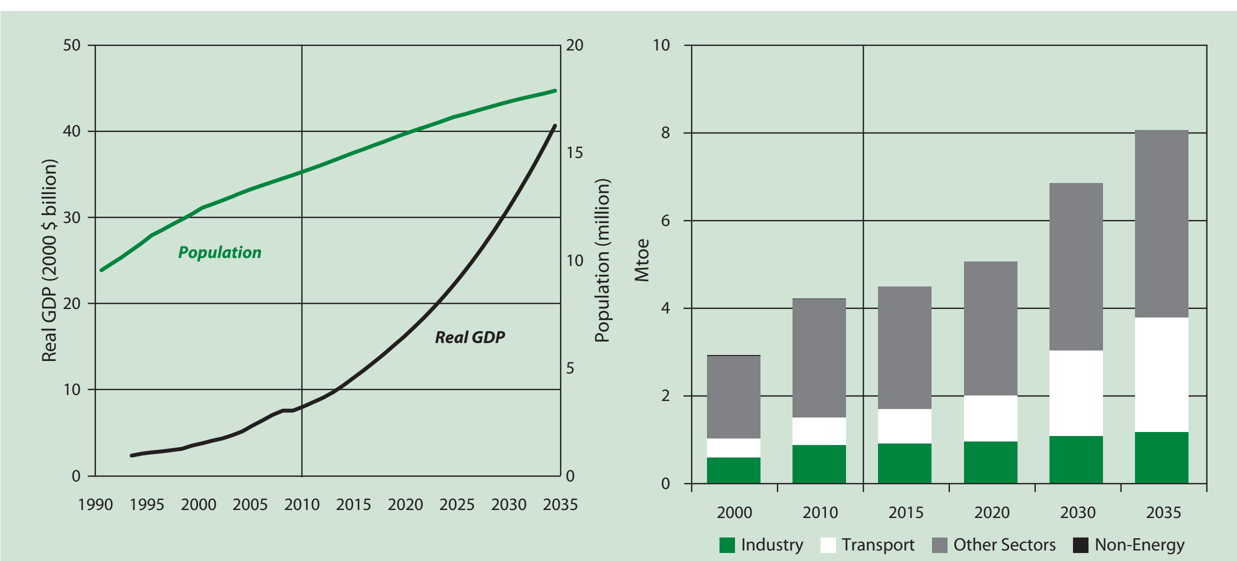
(1) to provide an adequate supply of energy throughout Cambodia at a reasonable and affordable price;
(2) to ensure a reliable, secure electricity supply at prices that facilitate investment in Cambodia and development of the national economy;
(3) to encourage exploration and environmentally and socially acceptable development of energy resources needed for supply to all sectors of the Cambodian economy; and
(4) to encourage the efficient use of energy and to minimize the detrimental environmental effects resulting from energy supply and use.

Business-as-Usual Case: Energy Demand Outlook through 2035

Over the outlook period, Cambodia's GDP is projected to increase from $7.9 billion (constant 2000 $) in 2010 to $40.8 billion in 2035 with an average annual growth rate of 6.8% (Figure 12.2.1). The population will grow at a slow annual rate of 0.9%, increasing from 14.1 million in 2010 to 17.8 million in 2035. Cambodia's GDP per capita will reach $2,296 in 2035, which is an almost fourfold increase from the 2010 level of $559.

In the BAU case, Cambodia's final energy demand is projected to increase from 5.0 Mtoe in 2010 to 8.9 Mtoe in 2035 with an average annual growth rate of 2.3%.

Figure 12.2.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.
Note: The historical data are available after 1998.

In terms of sectoral share, the other sectors (including residential, commercial, agriculture, and fishery) will account for 53.0% of the final energy demand in 2035, followed by transport at 32.4% and industry at 14.6%. Cambodia largely relies on its agriculture sector, which accounted for about one-third of its GDP in 2011 (Ministry of Foreign Affairs of Japan website) and is projected to continue to depend on the sector over the outlook period. In addition, the services sector, such as the tourism industry, is also expected to become a major contributor to the country's economy over the outlook period. Thus, the other sectors' energy demand will stay the largest.

In terms of growth rate, the transport sector is expected to grow at the fastest pace, 5.9% per year, which is mainly due to the increasing amount of freight transport and the people's increased personal mobility needs as the economy grows.

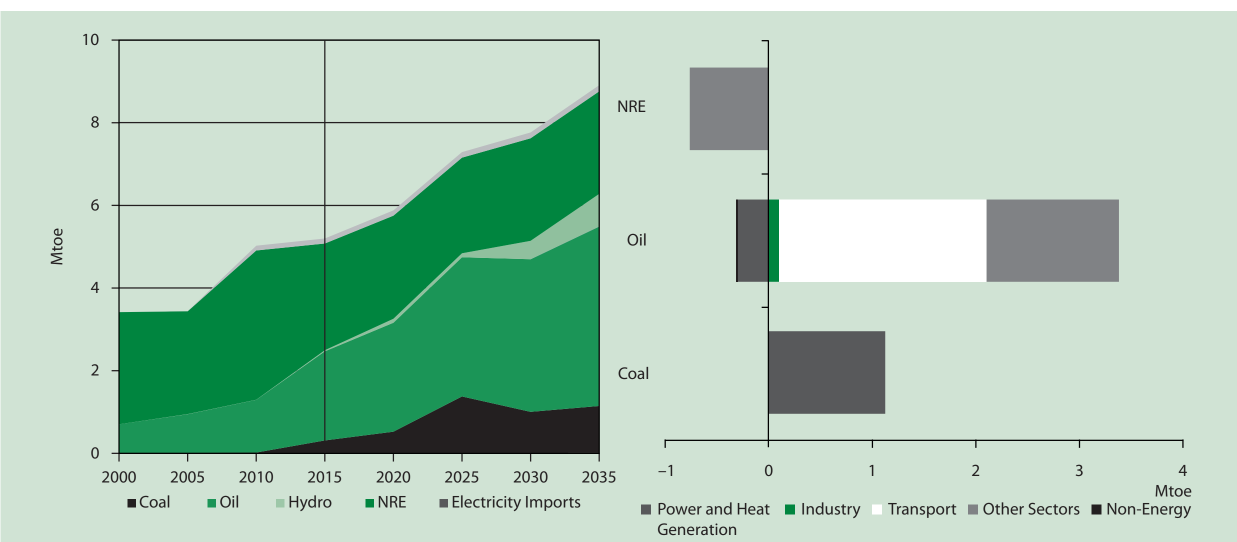
Only 26% of households in Cambodia have access to electricity. The rest depend on noncommercial biomass. To overcome this energy issue, the Government of Cambodia set a target for 70% of households to be electrified by 2030. As a result, electricity demand is expected to increase at the fastest rate of 8.8% per year over the outlook period, and noncommercial energy will decline at 1.1% per year.

Cambodia's primary energy demand is projected to grow at 2.3% per year between 2010 and 2035, increasing from 5.0 Mtoe in 2010 to 8.9 Mtoe in 2035 (Figure 12.2.2).

Cambodia's per capita energy demand will increase from 0.36 toe per person in 2010 to 0.50 toe per person in 2035 at an annual rate of 1.5%; however, it will stay at the lowest level in Southeast Asia.

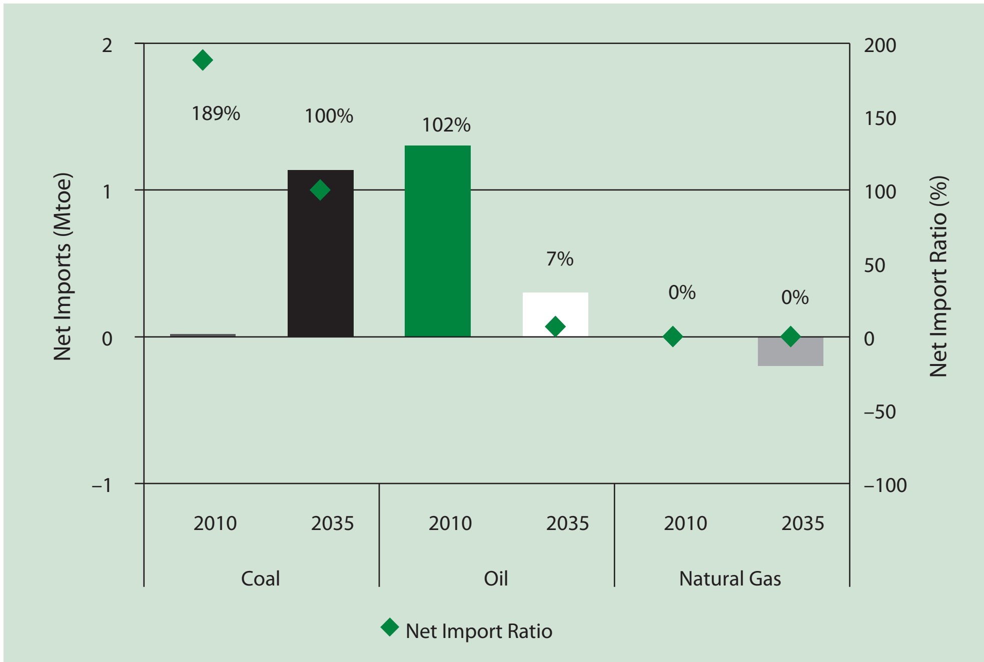
Oil will become the major fuel by 2035, with its share of the primary energy demand increasing to 48.8%, followed by new and renewable energy at 29.6%, coal at 12.8%, and hydro at 8.9%. The demand for oil by the transport and other sectors will increase. The demand for oil by the

Figure 12.2.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 12.2.3 Net Imports of Coal, Oil, and Natural Gas and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

power sector will decline, but the sector's demand for coal and hydropower will increase. By contrast, noncommercial biomass will register an annual decline of –1.4% per year. It is mainly due to the energy shift from noncommercial biomass to other commercial energy such as electricity and oil.

Figure 12.2.2 shows the contributions of the different sectors to the incremental growth in primary energy demand from 2010 to 2035. Oil demand will register the largest expected increases in the transport and other sectors. The second-largest increase will come from the demand for coal in the power sector. In contrast, new and renewable energy in the other sectors and oil in the power sector will decline in demand over the outlook period.

Despite being endowed with resources, Cambodia does not produce oil and natural gas. Cambodia has 8 sedimentary basins, divided into 19 blocks onshore and 6 blocks offshore. The Government of Cambodia has been actively seeking to promote its recent petroleum and natural gas resources exploration. "Block A," which is the most advanced development block among the above basins, is estimated to have 400 million to 500 million barrels for its reserve and is being explored by Chevron and Moeco (JPEC 2012). It is projected that Cambodia will be able to export about 0.2 Mtoe of natural gas by 2035 (Figure 12.2.3)

Electricity imports will be maintained at above 1,200.0 gigawatts (GWh) by around 2020 to cope with the domestic electricity demand increases. At the same time, electricity imports will gradually decline to 760.0 GWh through 2035 as domestic power generation capacities are assumed to start operation.

Alternative Case: Energy Savings Potential and Energy Source Diversification

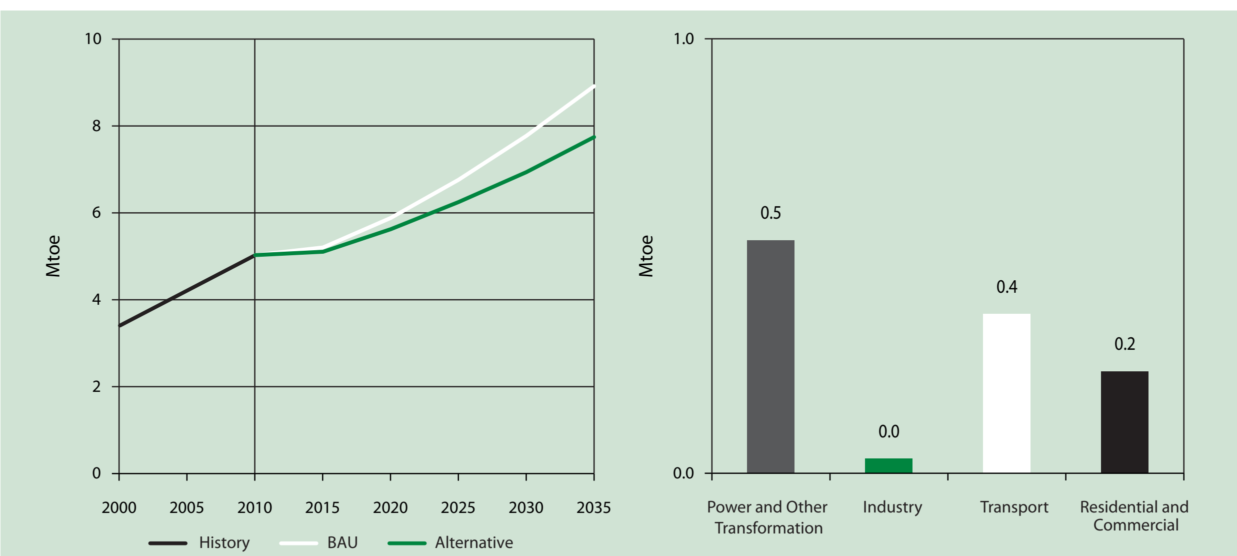
In the alternative case, Cambodia's primary energy demand is projected to reach 7.7 Mtoe in 2035, growing at an average annual growth rate of 1.7% (Figure 12.2.4). Compared with the BAU case in 2035, Cambodia has the potential to save about 1.2 Mtoe in 2035 (or a 13.2% reduction).

Among the sectors, the transport sector is expected to present the biggest energy savings potential at 0.37 Mtoe. Shifts toward more energy-efficient vehicles are expected over the outlook period. The residential and commercial sectors will follow with a savings potential of 0.23 Mtoe, mainly due to deployment of higher-efficiency appliances such as air conditioning and lighting. Energy savings in the industry sector's demand are expected to amount to only 0.03 Mtoe.

Figure 12.2.5 compares electricity generation by energy type between the BAU case and the alternative case. The total electricity generation in 2035 in the alternative case is approximately 16.1% lower than in the BAU case as a result of electricity demand decreases, mainly in the residential and commercial sectors due to the diffusion of more efficient home appliances. Thus, reduced power generation requirements resulting from decreased electricity demand explain most of the estimated savings, while thermal efficiency improvement will also contribute marginally.

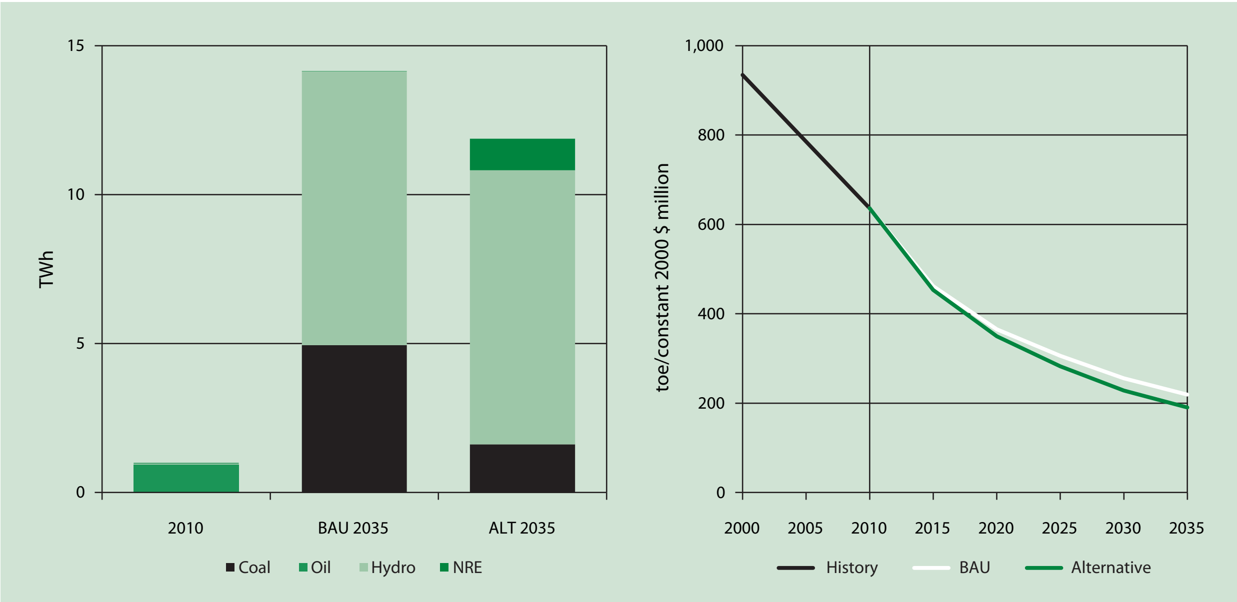
In the electricity generation mix, hydro will account for the largest share through 2035. Its share will increase to 77.4% in the alternative case compared with 65.0% in the BAU case. In the alternative case, about 120 MW of photovoltaic are expected to be deployed by 2035 to reflect the government's strategy to expand solar home systems in the residential sector (ADB 2011).

Figure 12.2.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.
Note: The historical data are available after 1998.

Figure 12.2.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: The historical data are available after 1998.

The energy intensity (primary energy demand per GDP) in the alternative case is projected to reach 190 toe per million constant 2000 $, which is 29.0 toe per million constant 2000 $ lower than in the BAU case. The application of advanced technologies to enable energy-efficient use across the sectors may explain the primary difference.

Energy Policy Implications

With the prospect for continued economic development and resulting energy demand growth, Cambodia is faced with a number of challenges to laying the infrastructure to meet the expected energy demand growth. In particular, finding ways to cope with the rising electricity demand—projected to increase at an annual rate of 8.8% through 2035 in the BAU case—at lower tariff levels than currently will require concerted efforts among the various stakeholders in Cambodia to facilitate investment in infrastructure—from generation to transmission to distribution—as well as to advance energy resources exploration and production. The projected shifts toward hydro and coal in the power generation mix, away from expensive diesel-based generation, imply difficult challenges that are specific to each energy source.

Cambodia is endowed with abundant hydro resources, which can provide a relatively low-cost generation option. However, the negative impacts of hydropower development, including the displacement of families at potential hydropower sites, will have to be addressed. Consideration must also be given to the seasonality of hydro energy production—alternative sources of electricity must be secured during times of drought.

Coal resources are likewise plentiful in Cambodia and the negative impacts from the use of coal-fired generation both on the local and global environment will have to be mitigated. Use of clean coal technologies—from exploration to production to generation—is encouraged;

still, the deployment of such technologies will involve higher capital investments. In this regard, cooperation with the developed members and lending institutions in terms of technology and financial support will have to be explored.

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12.3 Indonesia

- *In the BAU case, the primary energy demand of Indonesia is projected to reach 445.4 Mtoe in 2035, up from 207.8 Mtoe in 2010. With the deployment of advanced technologies, primary energy demand in the alternative case,* will be 62.5 Mtoe (or 14%) lower than BAU in 2035, reaching 382.9 Mtoe.*
- *Indonesia will continue to be a net exporter of coal, while its dependence on oil imports will continue to increase. Meanwhile, the economy is projected to be transformed into a net importer of natural gas sometime after 2030 unless new fields start production. Energy efficiency improvements must be prioritized to handle the growth in oil demand and resulting need for import. Energy source diversification efforts will make it necessary for Indonesia to increase coal use. Deployment of advanced coal technologies—particularly in the power sector—need to be made to reduce environmental burdens of coal use.*

Recent Energy Trends and Energy Policy Issues

Between 2005 and 2010, Indonesia's GDP grew at an average rate of 5.7% per year. Although the global economic crisis slowed GDP growth to 4.6% in 2009, it rebounded to 6.1% in 2010 and 6.5% in 2011. The recovery was led by private consumption, investment, and increases in net exports (ADB 2012). On the supply side, the strong growth in 2010 and 2011, was assisted by the manufacturing sector, including food processing, textiles and footwear, cement and nonmetallic minerals, iron and basic steel, and transport equipment. The export of hydrocarbons rebounded in 2010 after experiencing a decline in 2009. In fact, the decline in oil exports was more than offset by rapid expansion in gas exports (ADB 2012).

Indonesia's primary energy demand increased from 180.5 Mtoe in 2005 to 207.8 Mtoe in 2010 at a rate of 2.9% per year—a moderate growth compared with GDP growth during the same period. The relatively slow growth is explained by two factors: (i) the replacement of oil—the most dominant fossil fuel energy source—by coal and natural gas in power generation, and (ii) the relatively slow growth in demand for noncommercial biomass—another dominant energy source in the primary energy mix—at 2.5% per year.

To cope with the expected rise in commercial energy demand and dwindling domestic production of oil, Indonesia formulated the National Energy Policy (KEN) in 2006 in Presidential Decree No. 5 to achieve five key objectives: diversification, rational energy pricing, energy conservation, energy sector reform, and rural electrification. In the policy, targets for the optimal energy mix in 2035 have been set. One is to reduce oil's share, which currently accounts for a dominant share in primary energy demand, and to increase shares for coal and renewable energy. Another aims to reduce the energy elasticity to GDP to less than 1.

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* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

The new Electricity Law (Law No. 30/2009), enacted in September 2009, fully deregulates the power market by allowing independent power producers to generate and sell electricity to end users.

To meet the country's increasing energy needs, the Government of Indonesia initiated a two-phase "fast-track" generating program. In the first phase, the Perusahaan Listrik Negara (PLN), a state-owned general electricity company mandated to provide electricity to the Indonesian public, was authorized to build a total of 9,551 MW of new coal-fired generation capacity to become operational in 2010 and 2012.[36] In the second phase of the program, 11,144 MW of new capacity will be built, with coal-fired power plants taking the biggest share (68%), followed by geothermal power plants (19%), combined-cycle gas-powered plants (10%), and hydropower plants (3%).[37]

Subsidies for the energy sector impose a great burden on Indonesia, and subsidized energy prices—lower than the true cost—negate Indonesia's efforts in energy efficiency improvement. According to estimates by the Organisation for Economic Co-operation and Development (OECD), increasing international oil prices and a recovery in consumption led to a peak in 2008 when energy subsidies accounted for 4.5% of GDP. The same estimates suggest that energy subsidies declined to 1.7% of GDP in 2009 and to 2.3% of GDP in 2010 (OECD 2010). In the recent past, the Government of Indonesia removed subsidies on input fuels for power generation and industry and on high-octane gasoline for transport. Nevertheless, subsidies are maintained for lower-octane gasoline and diesel oil, kerosene, and certain classes of electricity use in households. Due to the political and social implications arising from the subsidy removal, Indonesia developed a package of programs in 2012 to deal with the rise in energy demand. This includes a ban on the purchase of high-octane gasoline by the high-income population, conversion of gasoline engine vehicles to natural gas engines, and electricity savings efforts in the public sector. A comprehensive strategy is necessary to phase out energy subsidies and encourage the rational use of energy across the sectors.

Business-as-Usual Case: Energy Demand Outlook through 2035

Indonesia's GDP is projected to increase from $274.4 billion (constant 2000 $) in 2010 to $1,045.2 billion in 2035 at an annual rate of 5.5% (Figure 12.3.1). With this growth, Indonesia's GDP will continue to be the highest in Southeast Asia. The growth will be led by the manufacturing industry, aside from the exports of natural gas and coal. Foreign direct investment will support the development of the manufacturing industry in Indonesia to reap the sales potential within the domestic market, and the possible exports to the neighboring Southeast Asian economies.

The population of Indonesia is projected to increase from 239.9 million in 2010 to 285.8 million in 2035, at an annual rate of 0.7%. The population of Indonesia will continue to be the biggest in Southeast Asia.

In the BAU case, the final energy demand of Indonesia is projected to increase from 156.4 Mtoe to 305.2 Mtoe at an annual rate of 2.7%. Industry is projected to have the fastest growth rate at 3.6%, and its demand will overtake that of the other sectors (residential, commercial, agriculture,

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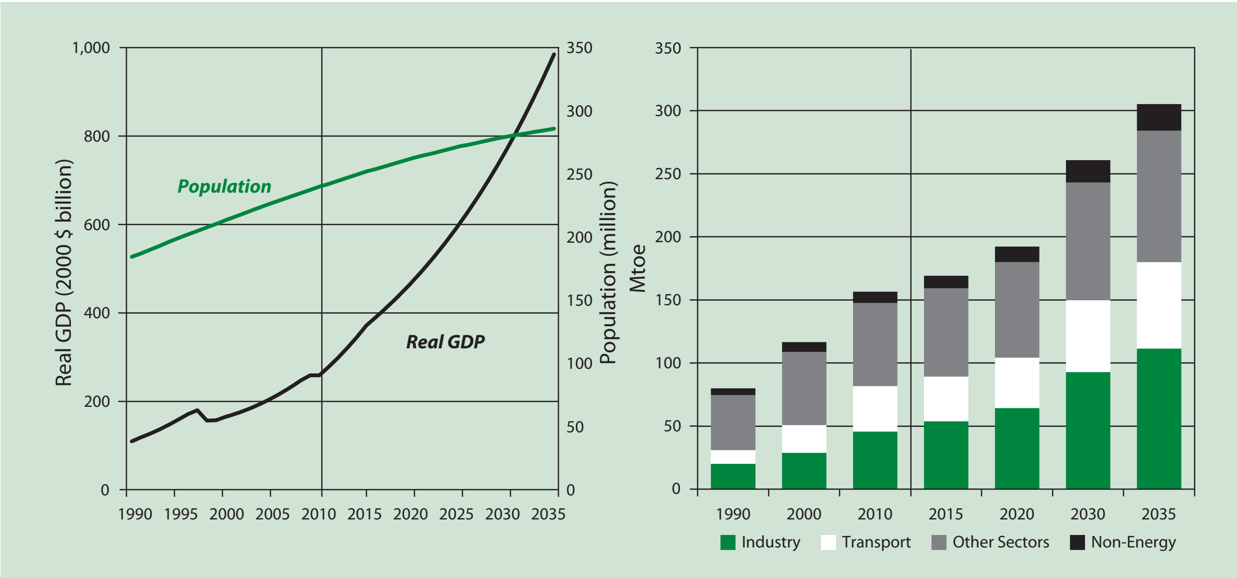
36 As of the end of 2012, construction has been completed for almost half of the planned capacity additions. The remainder of the planned capacity additions under the first phase of the "fast-track" program is expected to come on line in 2014.

37 Independent power producers will build more than 4,000 MW of the planned additional capacity in the second phase of the "fast-track" program, while the remaining capacity will be built by PLN.

Figure 12.3.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

and fishery) sometime after 2030 to represent the biggest demand among the final energy sectors. The transport sector will represent the second-fastest pace at 2.6%, followed by the other sectors at 1.9% through 2035.

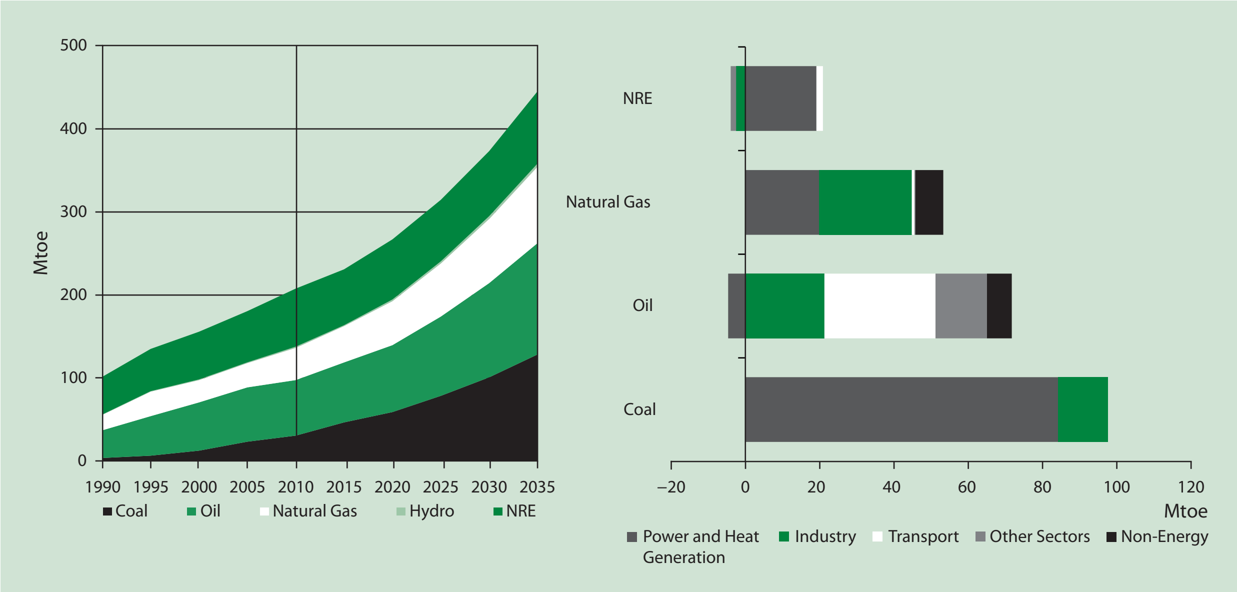
Industry energy demand is projected to more than double from 2010 to 2035, reaching 111.4 Mtoe. The growth will be in line with the current trend of capacity expansions, mainly for the manufacturing sector. By energy type, excluding biomass, which will register negative growth, all types of energy will grow steadily, with electricity, oil, and gas showing growth rates above 4.5% through 2035.

In line with its continued economic development, Indonesia's transport energy demand will grow, nearly doubling the 2010 level to reach 68.6 Mtoe in 2035. Vehicle ownership will increase as it has not yet reached saturation level. Much of the transport energy needs will be fueled by oil, which will account for 96% of the transport energy demand in 2035.

The other sectors (including residential, commercial, agriculture, and fishery) are expected to increase at 1.9% per year through 2035, reaching 104.2 Mtoe in 2035 from 65.8 Mtoe in 2010, though growth trends vary by energy type. Demand for noncommercial biomass, which accounts for about 70% of the other sectors' energy demand in 2010, will continue to maintain a constant level at around 45.0 Mtoe to fuel the needs in the rural areas. Demand for electricity will increase at a rapid pace of 6.2% per year (2010–2035), increasing from 7.6 Mtoe in 2010 to 34.1 Mtoe in 2035. Demand for gas will grow at a fast pace of 5.1% per year, starting from a low base of 0.1 Mtoe to reach 0.4 Mtoe in 2035.

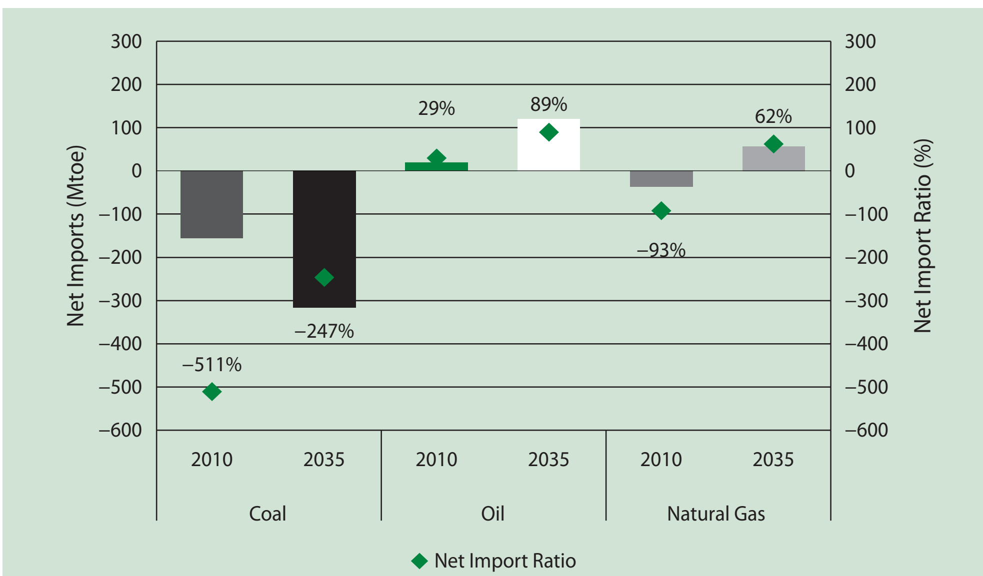
The primary energy demand of Indonesia is projected to increase from 207.8 Mtoe in 2010 to 445.4 Mtoe in 2035, at an annual rate of 3.1% (Figure 12.3.2). The energy mix will be dominated by oil, accounting for 30.1% of primary energy demand in 2035, followed by coal (28.8%); natural gas (20.7%); others including biomass, geothermal, and new energy sources (19.5%); and hydro (0.8%).

Figure 12.3.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 12.3.3 Net Energy Imports and Net Energy Imports Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

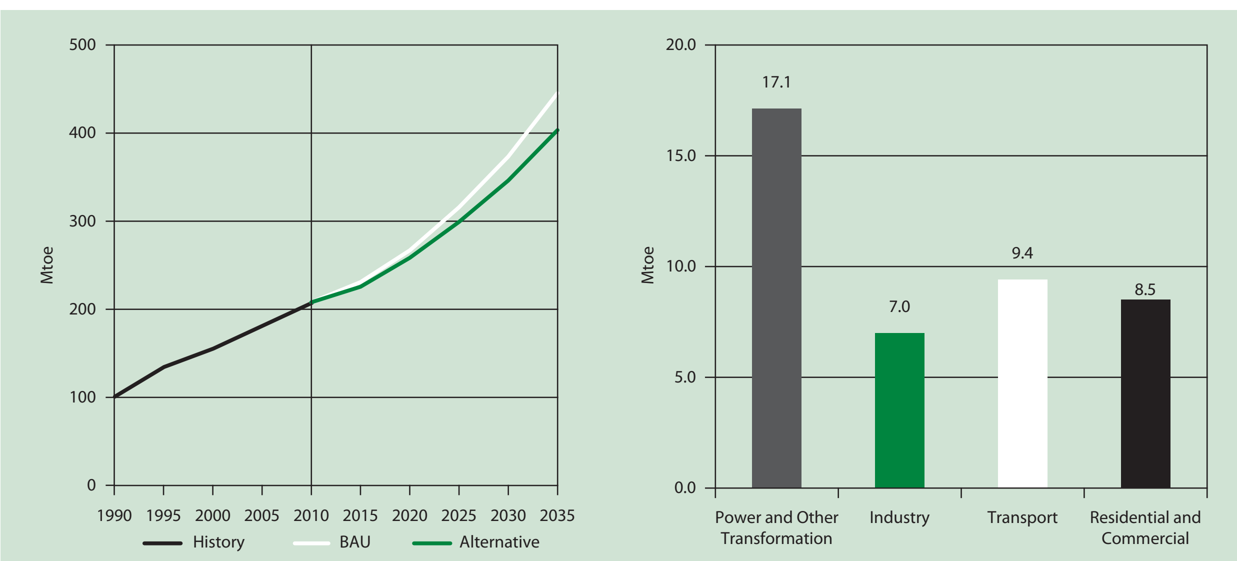
Among the energy types, the incremental growth in coal demand[38] will be the largest, driven mostly by the increases in the power sector's use. Indonesia is endowed with coal reserves, and the underutilized reserves will be developed for use in the power sector. The increase in oil demand will follow that of coal in terms of quantity. The use of oil will increase across the final demand sectors. Natural gas demand will be driven by increased usage in the industry, non-energy, and power sectors. Substantial increases in the demand for new and renewable energy sources will mainly come from geothermal (8.2 GW in 2035) and biomass sources for electricity generation (0.9 GW in 2035).

Indonesia will continue to produce coal, oil, and natural gas, although oil and natural gas production will dwindle. Indonesia will start importing natural gas sometime after 2020, unless new deposits are developed. Meanwhile, substantial increases in coal export are expected through 2035 (Figure 12.3.3).

Alternative Case: Energy Savings Potential and Energy Source Diversification

Indonesia has substantial energy savings potential with the deployment of advanced technologies. In the alternative case, primary energy demand is projected to increase at a slower annual rate of 2.5%, reaching 382.9 Mtoe in 2035 (Figure 12.3.4). This represents savings of about 62.5 Mtoe in 2035 (or 14.0% lower than the BAU primary energy demand at 445.4 Mtoe in 2035). The biggest savings will come from the power sector (37.5 Mtoe), followed by the transport sector (9.4 Mtoe), the residential and commercial sectors (8.5 Mtoe), and the industry sector (7.0 Mtoe).

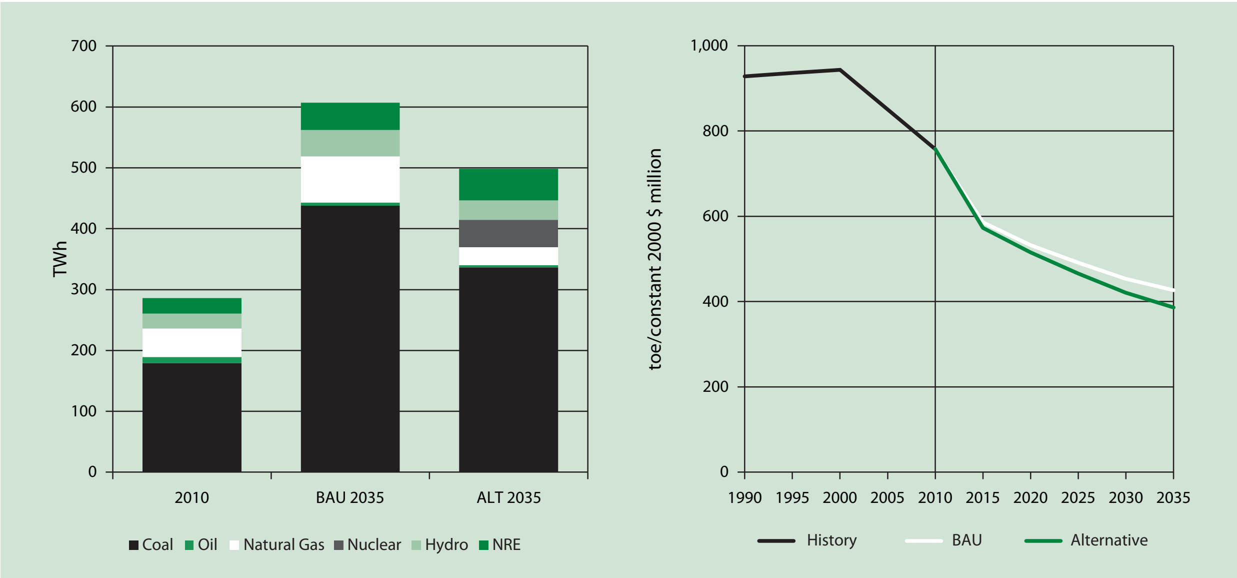
Figure 12.3.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

[38] Incremental growth in this report refers to the difference between the primary demand for an energy type in 2010 and 2035, reported in Mtoe.

Figure 12.3.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

The power sector's energy savings are a result of two factors: (i) electricity demand savings, and (ii) thermal efficiency improvement of fossil fuel generation. The industry sector's energy savings at 7.0 Mtoe in 2035 are due to the deployment of advanced technologies in the various industry subsectors, including cement, refineries, paper and pulp, and others. The transport sector's energy savings will reach 9.4 Mtoe in 2035 as a result of the shift toward fuel-efficient vehicles, including hybrid and electric vehicles, from internal combustion engine vehicles. The residential and commercial energy savings of 8.5 Mtoe result from electricity savings from the replacement of inefficient appliances by efficient ones, including lighting, refrigerators, and air conditioners.

In the alternative case, Indonesia's electricity generation in 2035 will be about 17.9% lower at 498.5 TWh in 2035, compared with 607.1 TWh in the BAU case (Figure 12.3.5). Substantial savings in total generation in 2035 will come from electricity demand savings in the industry, residential, and commercial sectors.

Compared with the BAU case, electricity generation in the alternative case has higher shares from low-carbon-emitting sources. The alternative case assumes the deployment of 5.2 GW of nuclear power plant capacity in 2035, and nuclear energy will account for 9% of total electricity generation in 2035. The BAU case and the alternative case assume the same capacity of geothermal at 8.2 GW in 2035, while a great expansion of new and renewable energy sources is assumed. In the alternative case, the capacity of wind is expected to reach 210 MW, solar 807 MW, and biomass 2GW in 2035.

Energy Policy Implications

Along with economic development, the energy demand of Indonesia is projected to increase steadily. In meeting the domestic demand for fossil fuels—excluding coal—Indonesia will have to increasingly rely on imported sources. Specifically, a rise in oil imports is inevitable as domestic oil and gas production is expected to dwindle in the future. Indonesia may need to start importing natural gas sometime around 2035. In view of the economic impacts from the rise in oil imports, the Government of Indonesia has been formulating measures to curb the growth in oil demand, especially in the transport sector—a main consumer of oil. A fundamental factor contributing to the growth in energy demand is the subsidized low retail price of energy. Brave steps need to be made toward the removal of energy subsidies, despite the fact that it faces strong public opposition and political difficulties. In addition, reduced oil dependence may be achieved by the implementation of a comprehensive package of measures that targets the transport sector, including curbing growth in vehicle ownership.

Energy source diversification away from oil to coal is projected to make progress. Meanwhile, the implications of such diversification on both the local and global environment should be well noted. The deployment of advanced coal-fired generation (such as ultra-supercritical technologies) is encouraged to efficiently utilize the domestically available coal resource to lower environmental burdens. Nevertheless, the higher initial capital investment requirement is a barrier to its deployment. Methods should be in place to facilitate financial assistance from developed members to allow the deployment of such technology. Among others, bilateral carbon offset mechanisms with developed members could be encouraged in this regard.

The outlook assumes the deployment of new and renewable energy sources, including geothermal and wind, particularly in the alternative case, to reflect domestic resource availability. Meanwhile, the introduction of such technologies will have to be supported by policies and measures. New and renewable energy will require measures to cope with the rise in electricity tariffs and to resolve local residents' resettlement issues near the sites. Concerted efforts are necessary across the relevant ministries as well as the local governments to make progress on the deployment of such energy sources in recognition of the long-term benefits for the Indonesian economy to achieve green growth and to utilize domestic fossil fuels efficiently.

In addition, the alternative case assumes the deployment of advanced technologies for energy savings on both the demand and supply sides. Energy efficiency improvements will likewise require relevant policies and measures, and Indonesia could start with the most cost-effective options to generate maximum energy savings at the lowest costs.

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12.4 Lao People's Democratic Republic

- *In the BAU case, primary energy demand in the Lao People's Democratic Republic (Lao PDR) is projected to increase from 2.8 Mtoe in 2010 to 7.9 Mtoe in 2035, with an annual growth rate of 4.3%. In the alternative case,* with deployment of advanced technologies, it will increase at a slightly slower pace of 4.0% through 2035, reaching 7.4 Mtoe in 2035. This indicates that the Lao PDR could have an energy savings potential of 0.5 Mtoe or a 6.4% reduction compared with the BAU case.*
- *From the viewpoint of energy security, since the Lao PDR is landlocked and a net oil importer, it is vital to establish good relationships with the neighboring countries so that energy trade will be maintained without disruption.*

Recent Energy Trends and Energy Policy Issues

Driven by exports of electricity and metals as well as tourism, the Lao PDR achieved robust economic growth at 7.5% in 2010.[39] With little impact felt of the global recession, the country maintained GDP growth of 8.1% annually on average between 2005 and 2010, which was underpinned by substantial investment in mining and hydropower. This upward economic trend rendered increases in primary energy demand with an annual growth rate of 7.3% during the same period, resulting in an energy elasticity at 0.9. This energy elasticity does not necessarily translate into energy-efficient consumption in the Lao PDR, but rather indicates that slow growth in noncommercial energy use offset fast growth in commercial energy consumption.

Power development is fundamental for economic and social development of the country. Endowed with substantial hydro potential, the government plans to effectively utilize hydropower both as a means of export and to meet domestic demand. On the one hand, it has promoted addition of hydropower capacity intended for export since electricity export to neighboring countries is a major economic activity. Two hydropower plants, Nam Theun 2 (1,070 MW) and Nam Ngum 2 (615 MW), started running at full capacity in 2010 and 2011, respectively, and consequently boosted hydropower output significantly (ADB 2012).[40] On the other hand, the Lao PDR puts priority on providing all households with access to electricity. The electrification rate needs to be improved in a situation where noncommercial energy such as firewood and charcoal still accounts for the majority of primary energy demand (62.4% in 2010). The country's target is to increase the percentage of households with access to electricity from approximately 67% in 2010 to 80% in 2015 and 90% in 2020 (ADB 2011). Of particular importance is the facilitation of rural electrification.

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* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

[39] The Lao PDR is endowed with a variety of mineral resources. According to the United States Geological Survey (2012), in 2010, production of tin, copper concentrate, silver, and gold increased by 46%, 26%, 7.2%, and 0.6%, respectively.

[40] Electricity generated at Nam Ngum 2 is exported to Thailand. Hydropower output increased by 18.5% in 2011.

The Lao PDR aims to diversify energy resources other than hydropower. The first coal-fired power plant in Hongsa district is under construction and scheduled for completion in 2015. This will bring a major change to the country's energy mix. In addition, the potential of new and renewable energy sources such as solar and biofuels is being pursued for use for off-grid power generation in remote areas.

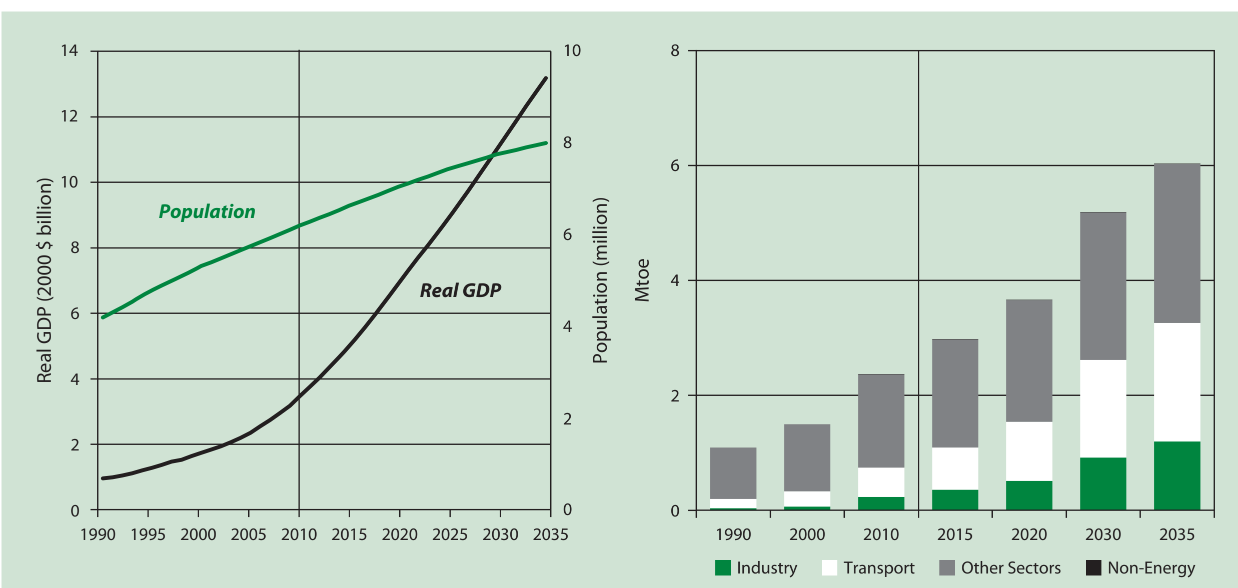
Business-as-Usual Case: Energy Demand Outlook through 2035

The Lao PDR's GDP is projected to increase robustly from $3.5 billion (constant 2000 $) in 2010 to $13.2 billion in 2035 at an annual growth rate of 5.5% (Figure 12.4.1), as it will be buttressed by exports based on hydropower and mining. Population growth will be moderate at 1.0% per year between 2010 and 2035, an increase from 6.2 million in 2010 to 8.0 million in 2035. Accordingly, the Lao PDR's GDP per capita will almost triple to $1,647 in 2035 compared with $560 in 2010.

In the BAU case, the final energy demand of the Lao PDR is projected to increase from 2.4 Mtoe in 2010 to 6.0 Mtoe in 2035 with an annual growth rate of 3.8%. Although decreasing during the scenario period, the share of the other sectors (which includes the residential, commercial, agriculture, and fishery sectors) in the total final energy demand will remain the biggest among the end-use sectors. On the other hand, the final energy demand shares of the industry and transport sectors will increase gradually through 2035. In 2035, the other sectors will account for 45.9% of the total final energy demand, while the transport and industry sectors' shares will be 34.2% and 19.9%, respectively.

The energy demand of the industry sector will register the fastest growth at 6.8% between 2010 and 2035, owing mainly to the mining industry. The share of noncommercial energy will be gradually reduced over the outlook period, whereas coal will increase its share and account for 52.7% in 2035.

Figure 12.4.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

Similarly, the transport sector's energy demand will show robust growth at an annual growth rate of 5.7%. Oil demand is projected to increase substantially based on the assumption that the energy demand from the road subsector will be enhanced in line with the rising income level.

By contrast, the energy demand of the other sectors will present a moderate annual growth rate of 2.2% through 2035. This will be caused by a slowdown in demand for combustible renewable energy, the leading fuel of the other sectors, since a gradual shift from noncommercial (mainly fuelwood) to commercial fuels will foster the trend through 2035.

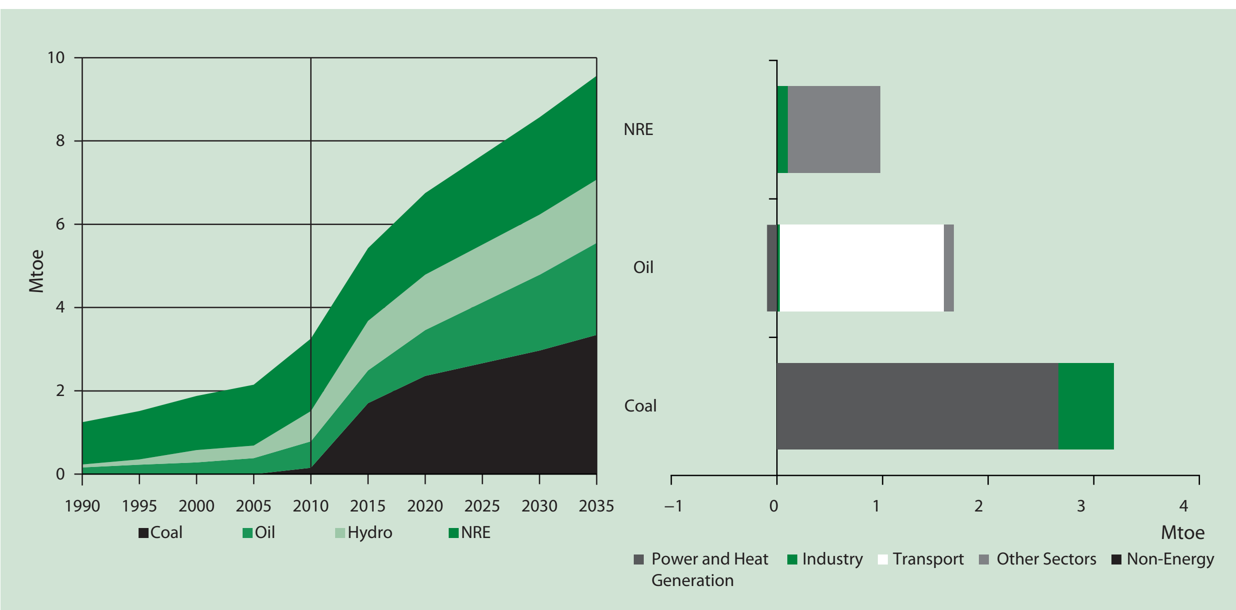
In the BAU case, the primary energy demand of the Lao PDR is projected to increase from 2.8 Mtoe in 2010 to 7.9 Mtoe in 2035, with an annual growth rate of 4.3%. Energy demand per capita will increase from 0.45 toe per person in 2010 to 0.99 toe per person in 2035, which is still relatively low.

Renewable energy sources such as biomass (fuelwood) have been dominant in the primary energy mix. However, the share will be exceeded by coal in 2015 when the Hongsa coal-fired power plant (1,800 MW) starts operations, and coal will occupy the biggest share of primary energy demand, accounting for 42.1% in 2035. Oil's share is projected to expand gradually and reach 27.8% in 2035, followed by hydro at 19.1%.

One cautionary note for the Lao PDR is that electricity export to neighboring countries will increase, resulting in substantial expansion of hydro-generating capacities. The Lao PDR secured export markets by signing memorandums of understanding with Thailand in 2007 and with Viet Nam in 2008 to supply 7,000 MW and 3,000–5,000 MW by 2020, respectively.

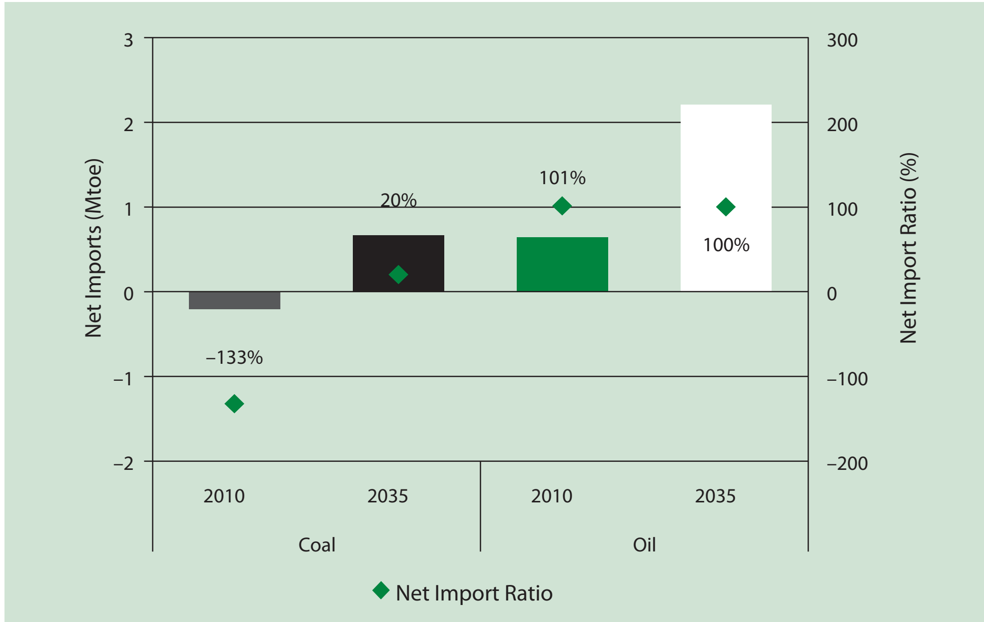
As to the sectoral contributions to the incremental energy demand growth from 2010 to 2035 shown in Figure 12.4.2, the incremental growth of coal demand stands out. As mentioned

Figure 12.4.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 12.4.3 Net Imports of Coal, and Oil, and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

earlier, coal demand is expected to increase substantially as a result of the Hongsa coal-fired power plant becoming operational in 2015. The transport sector will be the major contributor to the oil demand increase, which is driven by robust economic development. Incremental growth of new and renewable energy will be explained mostly by the other sectors.

While the Lao PDR will remain a net oil importer through 2035, the country will become a net coal importer after 2015 (Figure 12.4.3). The country's position in the coal import/export balance will change after commissioning of the Hongsa coal-fired power plant, which will require more coal.

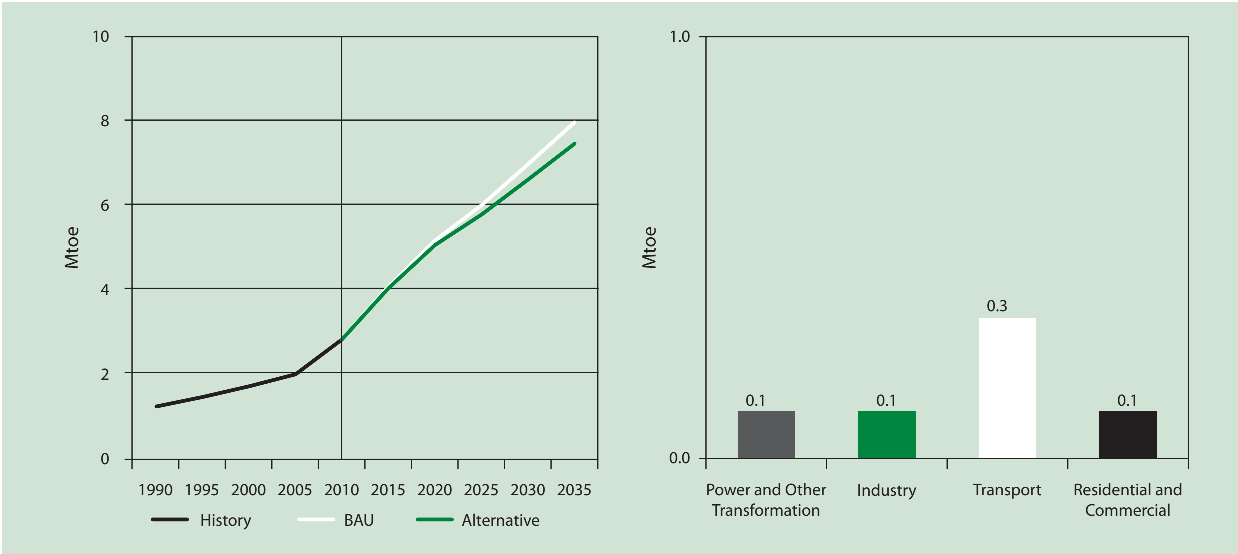
Alternative Case: Energy Savings Potential and Energy Source Diversification

In the alternative case, the Lao PDR's primary energy demand will amount to 7.4 Mtoe in 2035, growing at 4.0% per year, a slower pace compared with the BAU case (Figure 12.4.4). The estimated savings potential observed in the alternative case will be 0.5 Mtoe (or a 6.4% reduction) in 2035 compared with the BAU case.

The energy savings potential from the transport sector may account for the largest share among the sectors at 0.3 Mtoe in 2035. Fully relying on oil product imports, the Lao PDR is exposed to international oil price fluctuations. Thus, it is critical for the country to reduce its oil import dependency. In addition to fuel efficiency improvement, another possible strategy is the introduction of electric vehicles. This could be enabled by reserving some of the electricity generated for export for use domestically for electric vehicles.

The second-largest saving potential comes from the power sector at 0.1 Mtoe in 2035. Approximately 71.2% of the estimated savings will result from lower electricity generation

Figure 12.4.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)

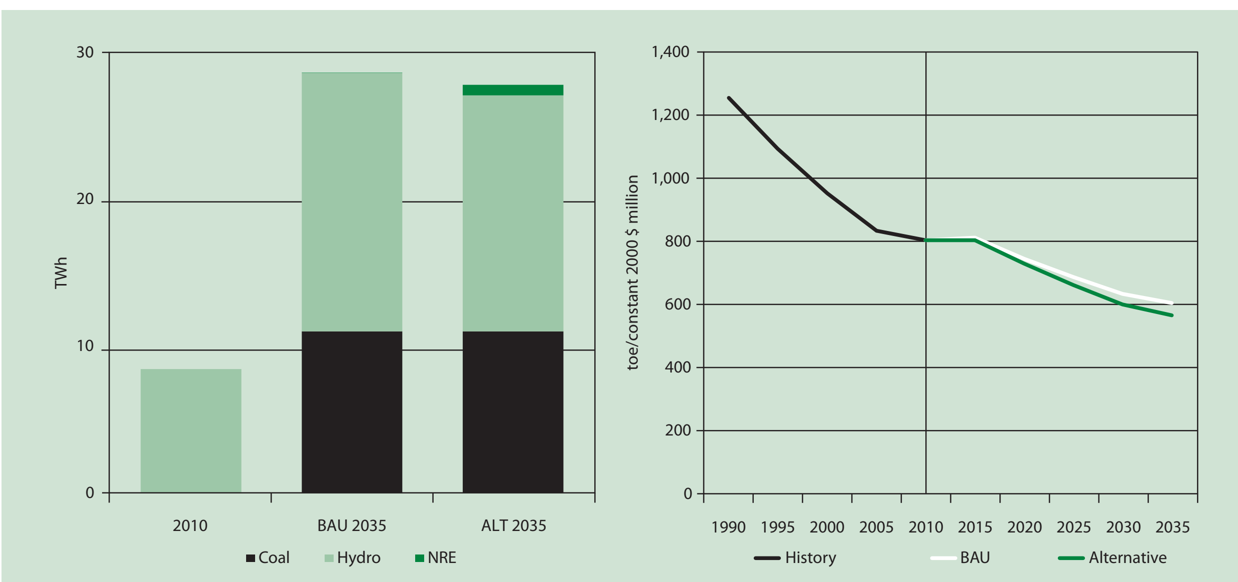


BAU = business-as-usual, Mtoe = million tons of oil equivalent.

requirements due to a decrease in electricity demand. This shows that the demand side holds the key to curbing electricity generation.

The industry sector has an estimated energy savings potential of 0.1 Mtoe in 2035. The nonmetallic mineral subsector will explain approximately one-quarter of the potential.

Figure 12.4.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

The other sectors' energy savings potential (mainly from the residential and commercial sectors) is the smallest at 0.1 Mtoe in 2035. Electricity savings could be brought about by deployment of more energy-efficient appliances such as air conditioners and lighting in the residential and commercial sectors.

In the alternative case, the Lao PDR's electricity generation in 2035 will amount to 27.9 TWh, which is 0.8 TWh or 2.8% lower than the BAU case (28.7 TWh). Energy savings are expected to be achieved in the industry, residential, and commercial sectors (Figure 12.4.5).

The Lao PDR will not be fully dependent on hydropower for power generation after 2015 as coal will also be used for to generate electricity. In the alternative case, new and renewable energy will be added to the electricity generation mix toward 2035. This reflects the Lao PDR's renewable energy policy, which aims to increase the share of renewable energy to 30% of the energy demand by 2025.

Primary energy demand per GDP in the alternative case will amount to 564 toe per million constant 2000 $ in 2035, which is 6.4% lower than that in the BAU case (604 toe per million constant 2000 $).

Energy Policy Implications

Although most of the energy savings potential will come from the lower energy demand, which would be facilitated by energy efficiency improvement on the demand side, the Lao PDR currently lacks a national energy efficiency plan and program. The estimated energy savings will not materialize if an appropriate institutional or regulatory framework is not established. Hence, setting up an administrative structure will be fundamental to laying out a national energy efficiency plan and programs and coordinating energy efficiency projects among the related parties.

Tapping hydropower and coal may need deliberate planning and prudent project management. Since hydropower development will continue mainly along the Mekong River, concerns over possible damage to the environment have been raised. In using coal for power generation, the impacts on both the global and local environments require the deployment of appropriate technologies. Hence, balancing and harmonizing economic development with environmental concerns may be an important policy agenda issue for the country to tackle.

As a landlocked country, the Lao PDR will benefit from engaging in regional cooperation and developing linkages with its neighboring countries. Regional cooperation will help the country to continue exporting power, which will sustain economic growth. In addition, the regional connectivity and stability will create a favorable climate to attract foreign investors.

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12.5 Malaysia

- *In the BAU case, Malaysia's primary energy demand is projected to increase from 72.6 Mtoe in 2010 to 109.5 Mtoe in 2035 with an annual growth rate of 1.7%. In the alternative case,* it will grow at a slower rate of 1.0% per year, reaching 93.5 Mtoe in 2035. This means that Malaysia has the potential to save about 16.0 Mtoe in 2035 or a 14.6% reduction compared with the BAU case.*
- *To ensure energy supply in the long term, Malaysia will need to intensify its oil and gas exploration and production, but at the same time increase import of liquefied natural gas to meet the demand of the industry and power sectors. Greater emphasis should be placed on efficient use of energy and promoting energy sources diversification through development of sustainable hydropower (in Sarawak) and new and renewable energy sources such as biomass, solar, and wind.*

Recent Energy Trends and Energy Policy Issues

Having recovered from an economic slump in 2009 due to the global recession, Malaysia demonstrated a vigorous GDP growth of 7.2% in 2010, which was driven by strong domestic demand and a recovery in merchandise exports. Malaysia presented a steady growth at 4.5% per year between 2005 and 2010, but primary energy demand increased at a slower annual average growth rate of 3.0% over the same period, although growth trends vary by energy type.

While manufacturing, including electrical and electronics, chemical products, and petroleum products, is the most energy-intensive sector in Malaysia, mining is also an important economic activity, as the country is endowed with various natural resources including oil, natural gas, and coal. Faced with a rise in domestic energy demand and maturing hydrocarbon reserves, however, Malaysia has attempted to safeguard depleting reserves by restricting the production of oil and gas, rejuvenating mature fields, and intensifying exploration activities.

To ensure its energy supply, Malaysia has pursued energy diversification and energy efficiency improvement. The principal policy implemented for energy diversification was the 1981 Four-Fuel Policy, which aimed to reduce dependence on oil and to optimize a fuel mix of oil, gas, hydro, and coal for use in electricity generation. It is now called the Five-Fuel Policy after incorporating renewable energy in 2001.

The utilization of renewable energy is underpinned by policy implementation. In the 2010 National Renewable Energy Policy and Action Plan, the Renewable Energy Act 2011 and the Sustainable Energy Development Authority Act 2011 were introduced to set up the framework for a new feed-in tariff mechanism. For the transport sector, the 2006 National Biofuel Policy promotes the production and consumption of biofuel, and ensures biodiesel quality by establishing an industry standard.

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* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

Malaysia has also attempted to establish a policy framework for energy efficiency improvement. For instance, the country put in place initiatives such as the Malaysia Green Labelling Program and Green Building Index to encourage the efficient use of energy. The Govenment of Malaysia is in the process of finalizing the National Energy Efficiency Master Plan to coordinate and implement energy efficiency and energy conservation in a systematic and holistic manner (APERC 2012b).

Business-as-Usual Case: Energy Demand Outlook through 2035

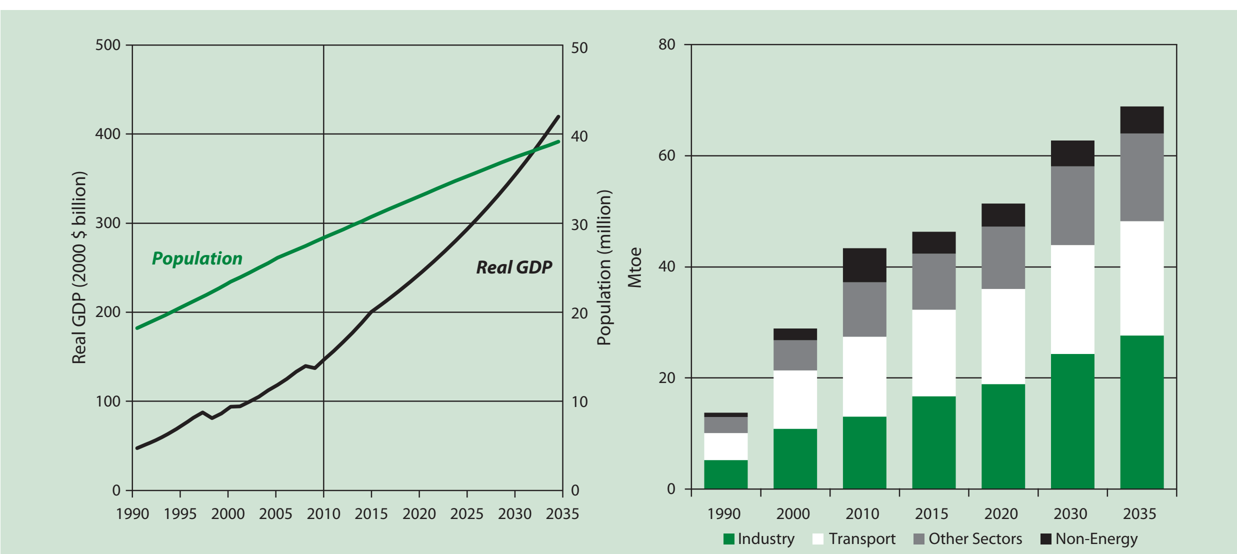
Malaysia's GDP is projected to increase from $147.3 billion (constant 2000 $) in 2010 to $419.8 billion in 2035 with an average annual growth rate of 4.3%. Population growth is likely to be moderate at 1.3%, reaching 39.2 million in 2035 (Figure 12.5.1). Accordingly, Malaysia's GDP per capita will reach $10,721 in 2035, which is more than double compared with the 2010 level of $5,185.

In the BAU case, Malaysia's final energy demand is projected to increase from 43.3 Mtoe in 2010 to 68.9 Mtoe in 2035 with an annual growth rate of 1.9%, a slowdown compared with the historical trend of 5.9% between 1990 and 2010. In terms of sector share, the industry sector will surpass the transport sector over the short to medium term and become dominant at 40.1% in 2035, followed by transport at 29.9% and the other sectors (including residential, commercial, agriculture, and fishery) at 22.9%.

Final energy demand of the industry sector is projected to more than double through 2035, growing faster than any other sector at 3.0% per year and reaching 27.6 Mtoe in 2035. Natural gas will account for the largest share of final industry demand at 33.4%, followed by electricity at 28.2% and oil at 28.1%.

By contrast, transport sector energy demand will show a modest annual growth rate of 1.4% over the outlook period, reaching 20.6 Mtoe in 2035. Petroleum products are expected to remain

Figure 12.5.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

the dominant transport energy source, but other energy resources, especially natural gas and biofuels, are expected to contribute an increasing share through 2035, together accounting for about 3% of the total transport final energy demand in 2035. This would be in line with existing government incentives to encourage utilization of natural gas and biofuel in light vehicles.

Final energy demand of the other sectors is projected to grow at an average annual rate of 2.0%, reaching 15.8 Mtoe in 2035. Electricity constitutes the largest portion, with a share of about 62.2% (9.8 Mtoe) in 2035. This will be heavily driven by the need for space cooling.

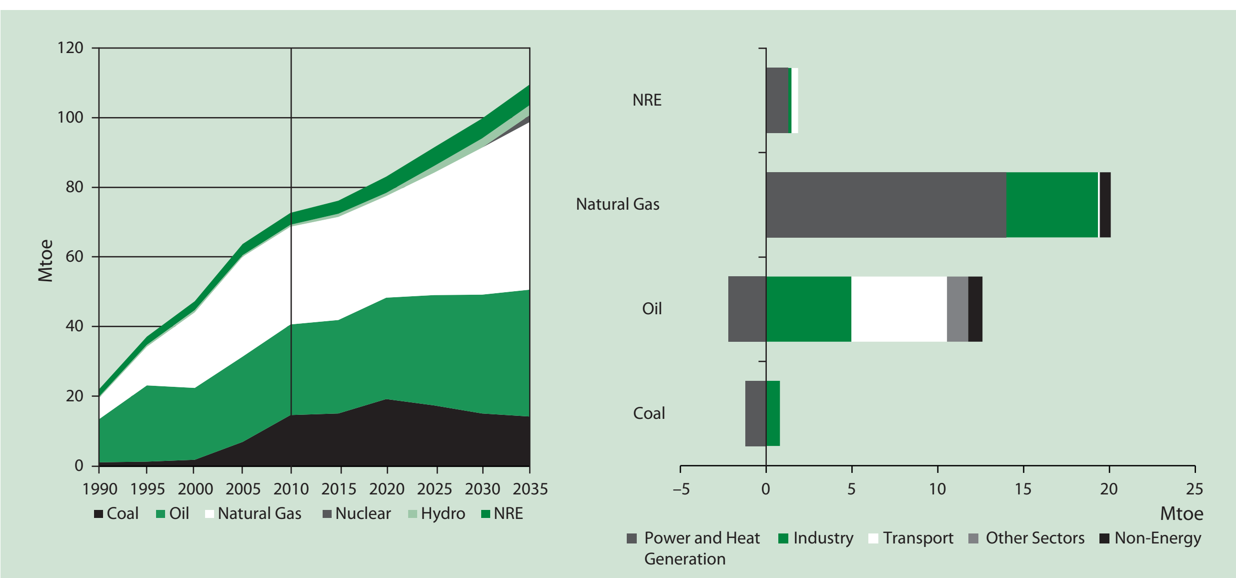
The primary energy demand of Malaysia is projected to grow at 1.7% per year, from 72.6 Mtoe in 2010 to 109.5 Mtoe in 2035, in the BAU case. Malaysia's per capita energy demand will increase from 2.56 toe per person in 2010 to 2.80 toe per person in 2035.

Fossil fuels will account for the bulk of Malaysia's primary energy mix: natural gas at 44.0%, oil at 33.3%, and coal at 12.9%. Malaysia is expected to sustain production of oil and natural gas in the medium term if the government's scheme to rejuvenate existing oil fields using enhanced oil recovery techniques and to explore new fields is assumed successful. However, production may begin to decline over the long term.

As to the sectoral contributions to the incremental energy demand growth from 2010 to 2035 shown in Figure 12.5.2, oil demand will demonstrate an increase of 10.4 Mtoe in spite of the government's effort to reduce dependence on oil. An oil demand increase is observed across the sectors except in power and heat generation. The industry sector will contribute to the biggest increase of natural gas. In power and heat generation, low-carbon fuels tend to be used.

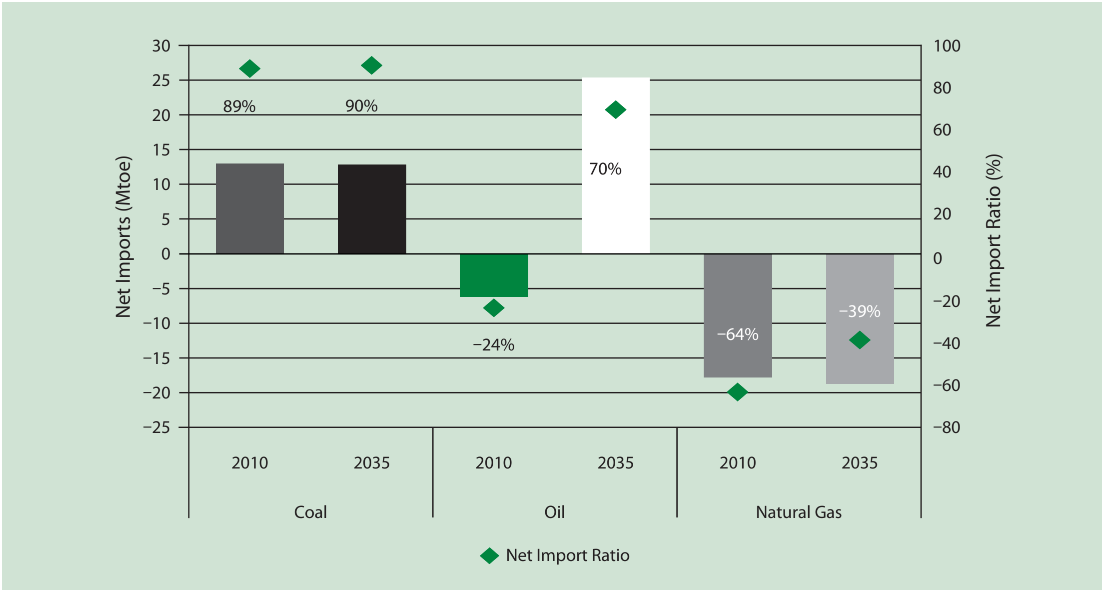
Malaysia is projected to remain a net coal importer and net natural gas exporter over the outlook period (Figure 12.5.3). It will continue to be a major LNG exporter to Asia and the Pacific from the

Figure 12.5.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 12.5.3 Net Imports of Coal, Oil, and Natural Gas and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

Bintulu LNG complex supplied by gas fields off the shores of Sarawak. However, Malaysia has started to work on its first LNG receiving terminal in Malacca to satisfy surging gas demand in Peninsular Malaysia. In terms of oil, Malaysia is projected to become a net oil importer over the medium term.

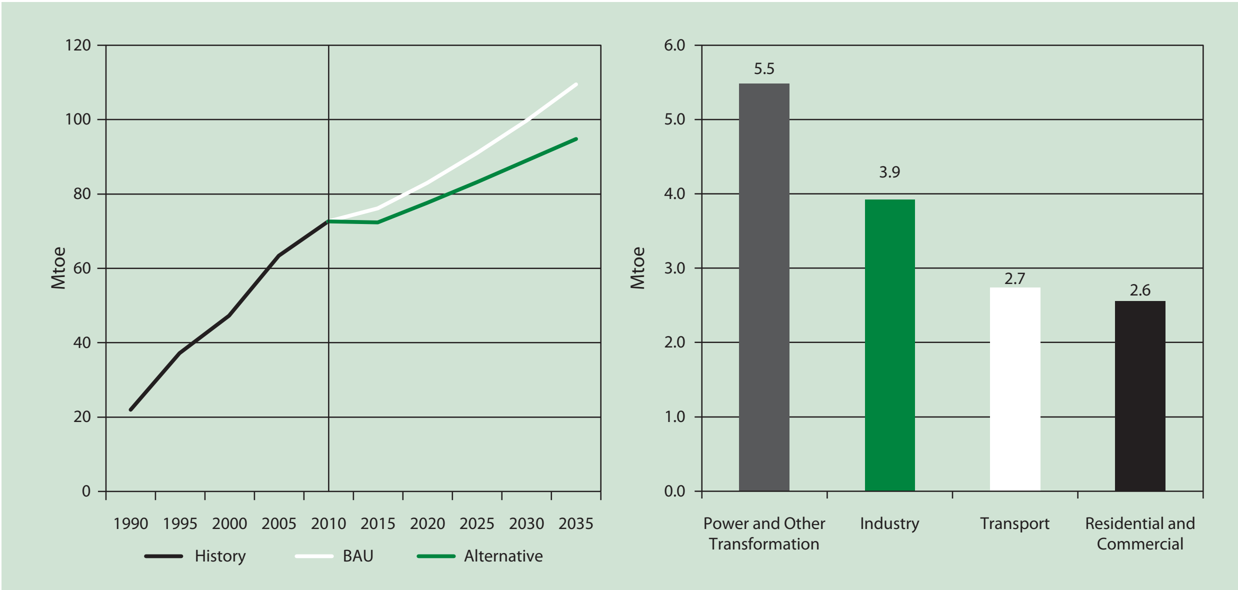
Alternative Case: Energy Savings Potential and Energy Source Diversification

In the alternative case, Malaysia's primary energy demand will reach 93.5 Mtoe in 2035 at an annual growth rate of 1.0% if advanced technologies for energy savings are applied (Figure 12.5.4). Compared with the primary energy demand in the BAU case, Malaysia has the potential to save about 16.0 Mtoe in 2035 (or a 14.6% reduction).

By sector, the power sector is projected to demonstrate the biggest energy savings potential at 6.8 Mtoe, or a 27.9% reduction compared with the BAU case. The thermal efficiency improvement of natural gas- and coal-fired power plants could explain most of the estimated energy savings. The Government of Malaysia will explore supercritical coal technology for new investments to improve the efficiency of coal use and to reduce carbon dioxide emissions (APERC 2012a). The industry sector will follow with a savings potential of 3.9 Mtoe. The energy-intensive industries will contribute 22.3% of the estimated savings potential of the sector. The transport sector's energy savings will result from a shift toward use of more efficient vehicles such as hybrid and electric vehicles. In 2009, the Government of Malaysia launched the National Green Technology Policy, which covers transport as one of the key areas and encourages the use of electric vehicles (APERC 2012a). It is also assumed that current financial measures—100% exemption of import duty and excise duty for hybrid cars less than 2,000 cubic centimeters and electric vehicles—will be extended in the long term.[41] For

[41] In general, the import duty imposed on foreign-manufactured cars is 30% and the excise duty is in the range of 60%– 105%. It was decided to extend the full import and excise duty exemption for hybrid and electric vehicles until December 2013.

Figure 12.5.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)

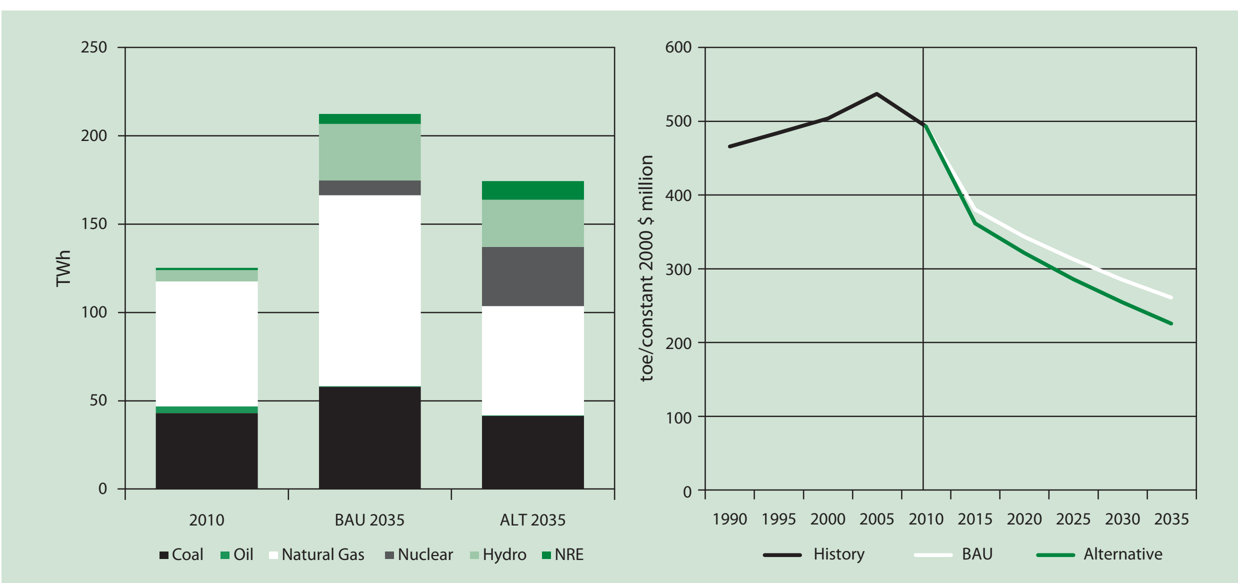


BAU = business-as-usual, Mtoe = million tons of oil equivalent.

the other sectors, a savings potential of 2.6 Mtoe is possible if higher-efficiency appliances such as air conditioners and lighting are used. In absolute terms, the other sectors will have the smallest estimated energy savings potential (2.6 Mtoe) among the sectors.

Figure 12.5.5 compares the electricity generation by energy type between the BAU case and the alternative case. The total electricity generation in 2035 in the alternative case is approximately

Figure 12.5.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

18.0% lower than in the BAU case, as it reflects the lower electricity demand for the residential, commercial, and industry sectors.

In the electricity generation mix, natural gas is likely to retain the dominant share over the outlook period in both cases. The economy's objective to create a more balanced generation mix will result in a reduction of natural gas dependence and expansion of hydro and new and renewable energy through 2035. Hydroelectric generation is projected to grow strongly during the outlook period, based on the development of large hydro projects in Sarawak in the Sarawak Corridor of Renewable Energy initiative, which plans to develop a total of 20,000 MW over 20 years. The share of new and renewable energy, mostly from biomass and solar, will also increase from 1.0% in 2010 to 2.7% in the BAU case, and in the alternative case represent a much larger share at 6.0% in 2035, supported by the implementation of the feed-in tariff mechanisms. The demand for natural gas for power generation in the alternative case is lower than that in the BAU case. This reduction in the demand for natural gas will be taken up mainly by nuclear power.[42]

Primary energy demand per GDP (i.e., energy intensity) will continuously decrease at a moderate pace. The energy intensity will decrease at an annual rate of –2.5% in the BAU case and by –3.1% in the alternative case over the outlook period. Thermal efficiency improvements in power generation and deployment of energy-efficient technologies on the demand side will cause the energy intensity to be reduced in the alternative case.

Energy Policy Implications

Malaysia will continuously seek to ensure long-term energy security to sustain its economic activity and meet growing energy demand. To this end, effective initiatives may be required for both the demand and supply sides. On the demand side, it is essential to strengthen energy efficiency policy and programs to facilitate more prudent use of energy. Rationalizing or phasing out of fuel subsidies will also work to change consumer behavior in relation to energy consumption, and eventually curb energy demand. Since car ownership is not likely to reach saturation level in the near future in Malaysia, a subsidy cut for transport fuels could be crucial to improve energy use in the transport sector. The supply side would call for improved initiatives to maintain oil and gas production through enhanced oil recovery and exploration of marginal fields and to develop viable new and renewable energy resources, such as solar, wind, and biofuel.

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[42] As of January 2012, the government has yet to decide on the construction of a nuclear power plant or its proposed location, facing public concerns about the safety and increasing cost of nuclear power development.

12.6 Myanmar

- *In the BAU case, the primary energy demand of Myanmar is projected to increase from 14.0 Mtoe in 2010 to 30.3 Mtoe in 2035, growing at an annual rate of 3.1%. With this growth, Myanmar's per capita energy demand will reach 0.55 toe per person, compared with 0.29 toe in 2010.*
- *In the alternative case,* Myanmar's primary energy demand will increase at an annual rate of 3.0% through 2035. At the end of the projection period, Myanmar's primary energy demand will reach 29.2 Mtoe, 3.8% lower than in the BAU case.*
- *With Myanmar's re-engagement with the international community, the country is expected to become a major hydrocarbon exporter in the region with growing foreign investment going into its oil and gas sector.*

Recent Energy Trends and Energy Policy Issues

Myanmar is richly endowed with energy resources, particularly oil, natural gas, and hydro. Natural gas is the country's most important source of export revenues, accounting for 38.4% of the country's total export in terms of value in 2009 and 28.4% in 2010.[43] Almost all the foreign investment went to the energy and mining sectors in recent years. According to the government's official statistics,[44] the oil and natural gas, mining, and power sectors collectively attracted about 99.0% of the total foreign investment in 2010, more than half of which went to the oil and natural gas sector.

However, the country's abundant energy resources have not brought much benefit to its population. The country's energy consumption per capita is among the lowest among the Association of Southeast Asian Nations (ASEAN) countries. In 2010, Myanmar's primary energy consumption per capita was 0.29 ton of oil equivalent (toe), well below the subregion's average level of 0.92 toe. At the same time, most of the country's people still rely on conventional biomass to meet their energy needs. Biomass accounts for about 80% of the country's total final energy consumption according to data from the International Energy Agency (IEA 2012). Around 74% of the country's population still has no access to electricity as of 2011 (ADB 2012).

Myanmar has experienced great political and economic reform that is expected to lead to the country's re-engagement with the international community. While Myanmar is on the way to developing its potential, the country is expected to see soaring demand for electricity, which is a fundamental input to every modern economy. Thus, finding ways to guarantee enough investment to the power sector, including power plants and transmission and distribution networks to electrify its households and to facilitate its industrial growth, will be on top of the country's energy policy agenda.

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* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

43 Calculated from the statistics published by the Central Statistical Organization (CSO) of Myanmar, available at http://www.csostat.gov.mm

44 See CSO statistics, available at http://www.csostat.gov.mm/s25MA0201.asp

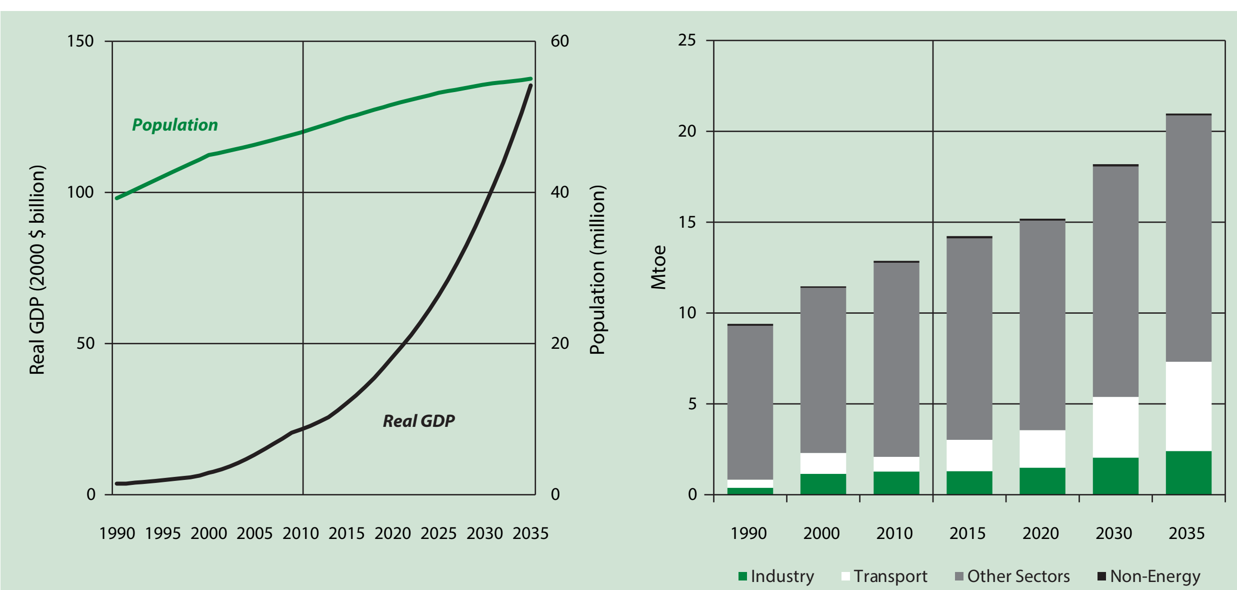
Business-as-Usual Case: Energy Demand Outlook through 2035

Over the outlook period, Myanmar's economy is projected to maintain strong performance, with its gross domestic product (GDP) growing at an annual rate of 7.6%. At the end of the projection period, the country's GDP will reach $135.9 billion (constant 2000 $), more than six times the 2010 level, which was $21.6 billion (Figure 12.6.1). The population is projected to increase at a moderate pace of 0.5% through 2035, reaching 55 million in 2035 from 48 million in 2010.[45]

In the BAU case, the final energy demand of Myanmar is projected to increase at an annual rate of 2.0% through 2035. However, with most of the energy infrastructure under construction, near-term (2010–2020) growth is expected to be lower than that of the longer term (2020–2035), with an average growth rate of 1.7% and 2.2%, respectively. Among the end-use sectors, the other sectors (which include residential, commercial, agriculture, and fishery) will still be the biggest consumers, though their share of the total final energy demand will decline to 64.6% in 2035 from 82.9% in 2010. In contrast, energy demand in the transport sector will see the fastest increase and become the second largest, accounting for 23.4% of the country's final energy demand in 2035. Energy demand in the industry sector will maintain moderate growth at an average annual rate of 2.6%.

The other sectors' energy demand as a whole will grow at a relatively slow pace of 1.0% per year. Within the sector, fuel shifting from noncommercial biomass and oil to electricity and gas will result in divergent growth by energy type. Natural gas, which is abundant locally, will grow at a fast annual rate of 17.3%. Electricity demand will also grow strongly at 4.3% per year. On the

Figure 12.6.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

[45] Statistics of the population of Myanmar might vary a lot depending on the sources because no census has been carried out in the country for decades. To ensure data consistency with other countries, the population statistics from the United Nations are used.

other hand, both noncommercial biomass and oil will grow at less than 1% per year over the projection period, with noncommercial biomass at 0.4% and oil at 0.9% annually.

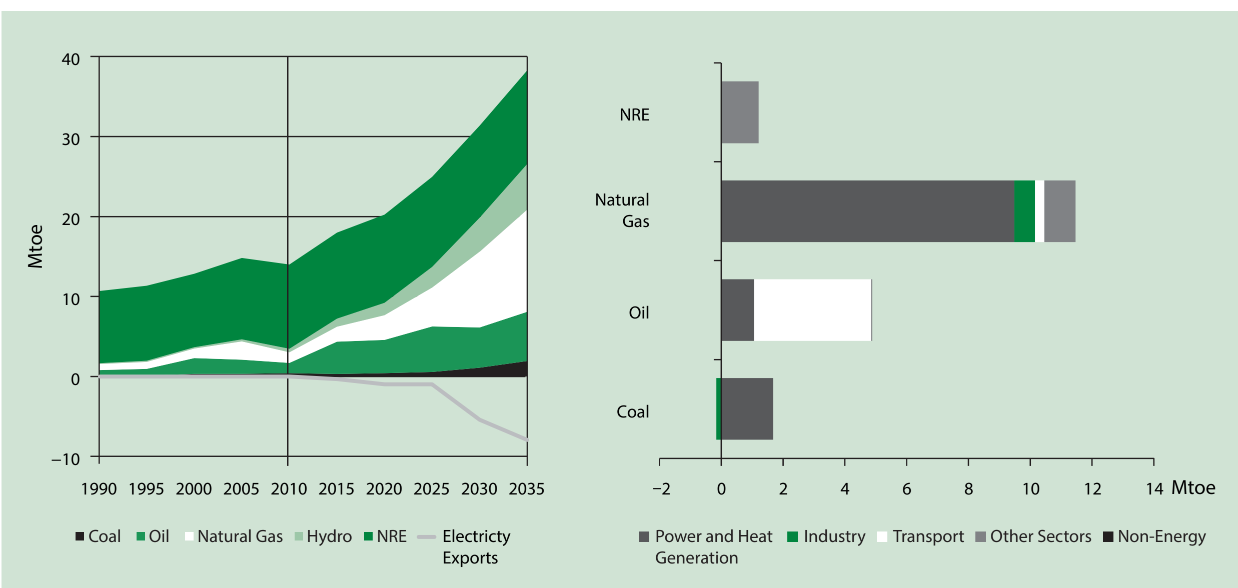
The industry sector's energy demand will grow at a moderate rate of 2.6% through 2035. Since both the country's institutional and infrastructural systems need to be built up to facilitate industry growth, energy demand will see faster growth in the long term at 3.2% (2020–2035), compared with 1.6% per year in the near term (2010–2020). In terms of energy source, demand for electricity and natural gas will both grow strongly, at an annual rate of 5.8% and 4.8%, respectively, through the projection period.

In the transport sector, oil and natural gas are the main energy sources that fuel the transport needs in Myanmar. During the projection period, the country's income level (GDP per capita) will reach $2,473 (constant 2000 $) in 2035, almost 5.5 times the 2010 level of $450. The income growth will boost the country's motorization, which entails fast growth of energy demand in the transport sector at a rate of 7.5% per year. By fuel type, the dominance of oil will be enlarged with its share reaching 90.4% in 2035 from 79.3% in 2010.

In the BAU case, the primary energy demand of Myanmar is projected to increase from 14.0 Mtoe in 2010 to 30.3 Mtoe in 2035, growing at an annual rate of 3.1%. With this growth, Myanmar's per capita energy demand will reach 0.55 toe per person, compared with 0.29 toe per person in 2010.

By energy type, natural gas will account for the largest share in 2035, reaching 42.2% from 9.5% in 2010. Hydropower supply will grow the fastest at a rate of 10.8% through 2035 and its share will increase to 18.7%. However, most of the hydropower is reserved for electricity export to neighboring countries including the People's Republic of China (PRC), India, and Thailand. The share of oil in the primary energy supply will reach 20.3% in 2035. The share of coal in the total

Figure 12.6.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

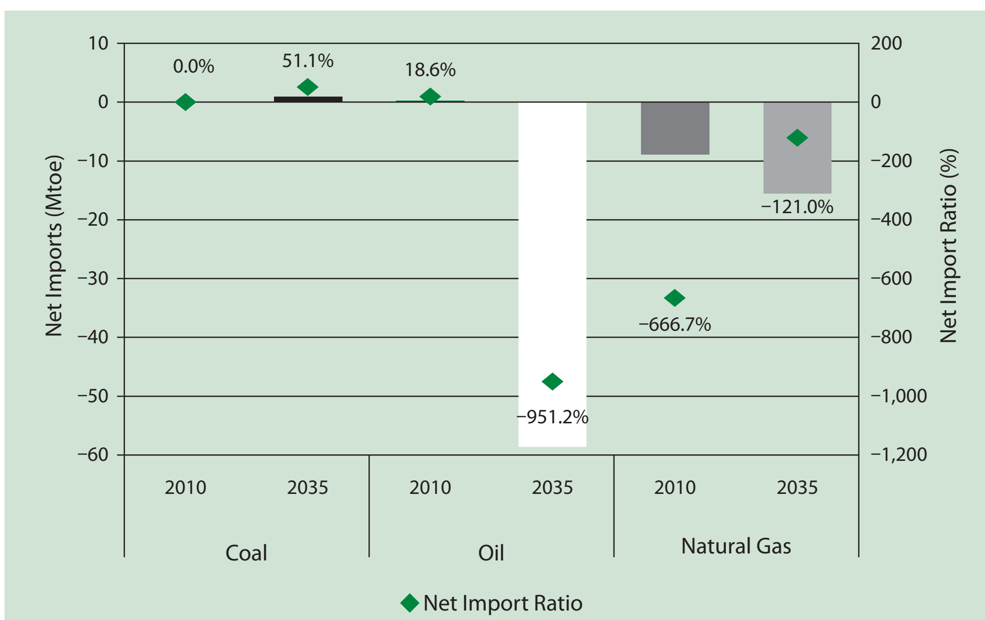
primary energy demand will more than double from 2.9% in 2010 to 6.4% in 2035. The share of "others", comprising noncommercial biomass, electricity imports, and electricity exports, will decline dramatically from 75.3% in 2010 to 12.4% in 2035, reflecting a substantial switch from noncommercial biomass fuels to commercial fuels, and increasing electricity export.

The sectoral contributions to the incremental energy demand growth from 2010 to 2035 are shown in Figure 12.6.2. As the figure presents, natural gas demand will represent the biggest incremental growth at 11.5 Mtoe, driven mainly by electricity demand and also increased demand in the industry and other sectors. Oil demand will be led mostly by the transport sector and coal demand by the power sector.

Myanmar is rich in oil and gas resources. Though estimates vary depending on the source, the country's proven oil reserves were estimated at 0.05 billion barrels by the end of 2012, and natural gas at 0.7 trillion cubic meters according to the United States Energy Information Administration. With the country opening up both economically and politically, the numbers could be boosted by further explorations. Despite the huge potential, most large international oil companies were absent from the country's oil and gas development until recently. Asian firms, especially firms from the PRC, India, and Thailand, have dominated the country's oil and gas sector.

Among the most important energy projects in Myanmar are twin oil and natural gas pipelines to the PRC. The oil pipeline will have a capacity of 12 million tons of crude oil per year. The natural gas pipeline will allow delivery from Myanmar's offshore fields to the PRC with an expected annual capacity of up to 12 billion cubic meters (bcm) of natural gas. Thailand's PTT has signed a 30-year supply deal through its upstream affiliate PTT Exploration and Production (PTTEP) with Myanmar Oil and Gas Enterprise for gas from two offshore blocks of the Zawtika field in the Gulf of Martaban. In the agreement, it was reported that PTTEP would supply

Figure 12.6.3 Net Imports of Coal, Oil, and Natural Gas and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

an initial 240 million cubic feet per day (about 2.5 bcm per year) of natural gas to Thailand and another 60 million cubic feet per day (about 0.6 bcm per year) to Myanmar. Yanada and Yetagon fields, with estimated combined gas reserves of 12 trillion cubic feet (about 0.04 tcm), are two ongoing offshore operations by TOTAL and Petronas Carigali, both exporting gas to Thailand's PTT (Myint 2012).

In the beginning of 2012, in what was said to be its biggest energy tender in years, Myanmar awarded 10 onshore oil and gas blocks to 8 firms, mostly from Asia. However, it was reported that a second round of bidding later in the same year was delayed to meet the transparency standards of North American and European firms, which are expected to play an increasing role in the country's oil and gas sector.

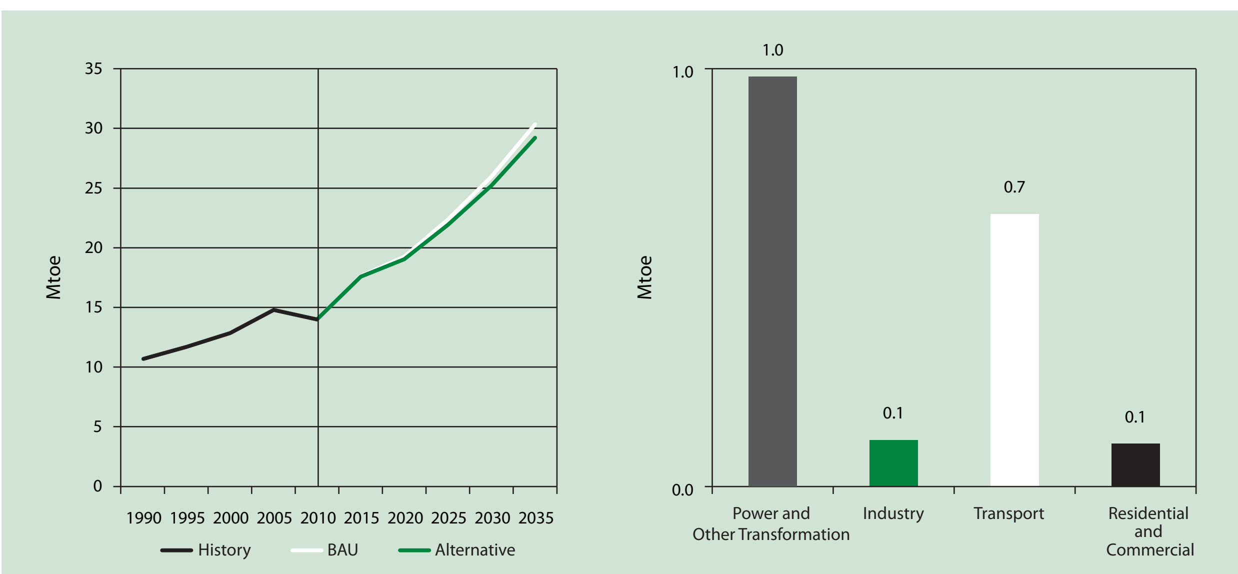
With the development of Myanmar's oil and gas resources, it is expected that the country will eventually become a fossil fuel exporter. In the BAU case, net oil and gas exports by 2035 will reach 58.6 Mtoe and 15.5 Mtoe, respectively (Figure 12.6.3).

Alternative Case: Energy Savings Potential and Energy Source Diversification

In the alternative case, Myanmar's primary energy demand will increase at an annual rate of 3.0% through 2035. With this growth, Myanmar's primary energy demand will reach 29.2 Mtoe, 3.8% lower than in the BAU case in 2035 (Figure 12.6.4).

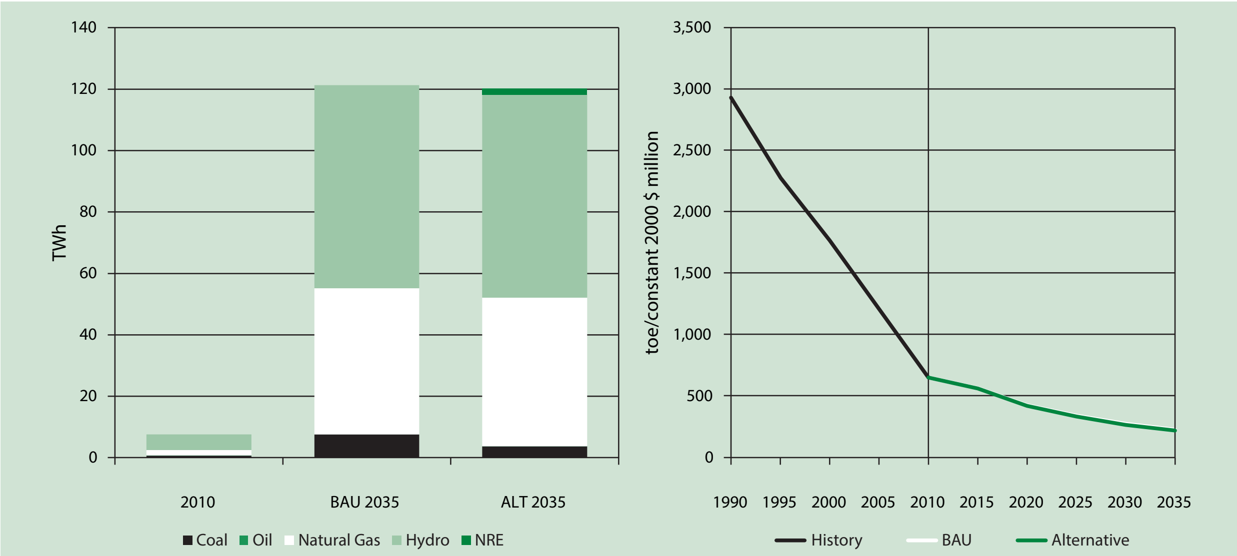
By sector, the power sector represents the biggest energy savings potential at 1.0 Mtoe in 2035, followed by the transport sector. The industry sector and the residential and commercial sectors have a smaller energy savings potential at around 0.1 Mtoe each until 2035.

Figure 12.6.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual case, Mtoe = million tons of oil equivalent.

Figure 12.6.5 Comparison of Electricity Generation in 2035 (left), and Primary Energy Savings by Fuel in 2035 (right)



ALT = alternative case, BAU = business-as-usual case, NRE = new and renewable energy, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

The power sector's energy savings potential comes from final demand savings and deployment of power generation technologies with higher thermal efficiencies. Thermal efficiency improvement is estimated to account for about 71.8% of the total savings potential in the power generation sector. In the alternative case, Myanmar's electricity generation in 2035 will be about 0.8% lower at 120.3 terawatt-hours (TWh) in 2035, compared with 121.3 TWh in the BAU case. Because of the low electrification rate at present, in both cases the demand for electricity is expected to keep growing strongly over the projection period. In the alternative case, more electricity is expected from non-hydro renewable energy sources such as solar, wind, and biomass. Non-hydro renewable power will account for 1.8% of total electricity generation in the alternative case, while in the BAU case little electricity is expected to come from non-hydro renewable sources.

In terms of fuel type in the primary energy supply, due to final energy savings, improvement of thermal power plants, and more installation of renewable energy resources, coal demand is expected to be reduced by 1.0 Mtoe in 2035, oil by 0.5 Mtoe, and natural gas by 0.4 Mtoe compared with the BAU case.

Energy Policy Implications

With the country's re-engagement with international society, Myanmar's economy is expected to maintain strong growth through 2035 driven by increasing export of resource-based commodities, investment in infrastructure, growing foreign direct investment, and others. Construction of infrastructure, especially power generation and transmission and distribution networks, is urgently needed given the country's less than 30% electrification rate at present.

Although Myanmar has large undeveloped hydro potential for power generation, most of the dams are developed by foreign companies and may not be available to meet domestic need. Future electricity supply is expected to be largely generated by gas-fired power plants. However, adding new power generation capacity is only part of the picture. Infrastructure development including extension of electricity transmission and distribution lines delivering electricity from power plants to end users, and gas pipelines transporting gas from production facilities to power stations, will require a great amount of investment.

As in many developing ASEAN countries, conventional biomass is still the most important source for household energy consumption in Myanmar since it is free and easy to access. Efficient use of biomass resources provides a clean and cost-effective way to improve living standards. A study conducted by the Food and Agriculture Organization of the United Nations and the SNV Netherlands Development Organisation on the feasibility of a national program for domestic biogas in Myanmar found that the technical potential amounts to a minimum of 600,000 units for household biogas plants and 5,500 units for community biogas plants (FAO and SNV 2012). The overall conclusion was that a national program on domestic biogas in Myanmar is feasible.

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12.7 Philippines

- *In the BAU case, the primary energy demand of the Philippines is projected to increase from 40.5 Mtoe in 2010 to 82.9 Mtoe in 2035, at an annual rate of 2.9%. In contrast, with the deployment of advanced technologies, primary energy demand in the alternative case,* will increase moderately at 2.3% per year, reaching 71.4 Mtoe in 2035 (or 13.9% lower than BAU).*
- *In view of the expected rise in energy imports for oil and coal, and resulting economic impacts, the Philippines should continue making efforts to handle the growth in energy demand. The Philippine government should formulate measures to realize potential energy savings, especially in the transport, residential, and commercial sectors.*

Recent Energy Trends and Energy Policy Issues

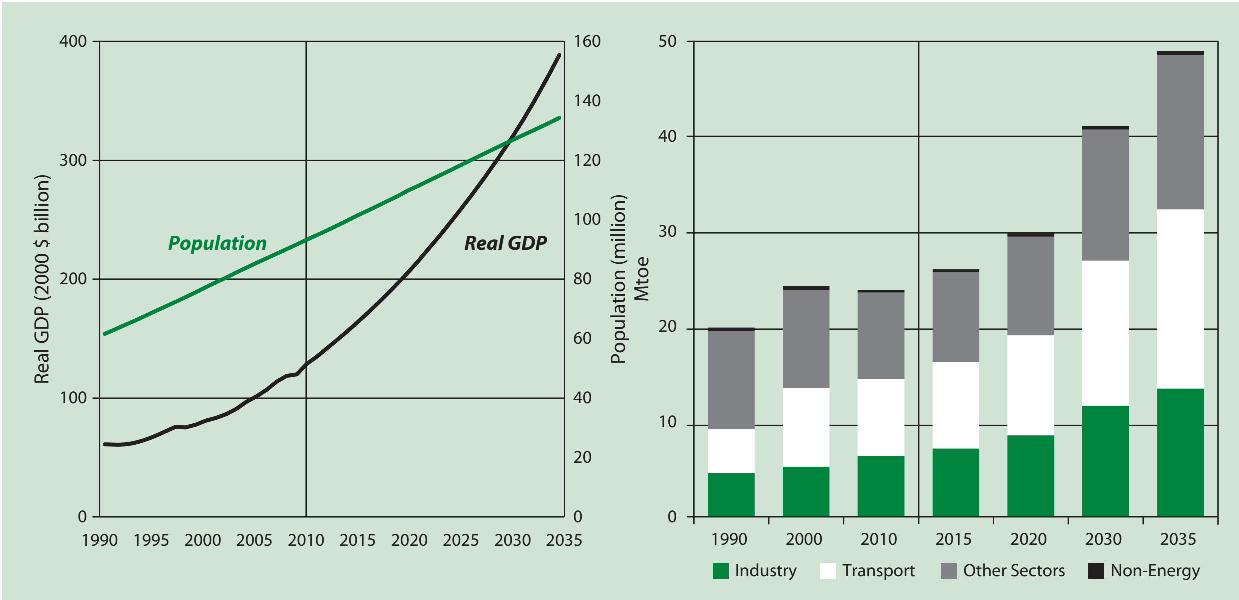
Although the Philippines' economy slowed as the impacts of the global slowdown in 2008–2009 were widely felt, it rebounded to register a fast annual growth of 7.6% in 2010. The recovery in 2010 was led by the increase in private spending, a rebound in exports, and increased election-related spending (CIA website). In contrast to the recovery in 2010, nevertheless, GDP growth slowed to 3.7% in 2011 as a result of decline in exports of electronic products and reduced government spending (ADB 2012). On the supply side, the economy's growth has been supported mainly by the services sector in recent years, with the retail trade, business process outsourcing, and financial and real estate services being the main contributors (ADB 2012). The growth in industry was much affected by the global economy (as well as supply chain disruptions from the March earthquake in Japan and flooding in Thailand) as the exports of the Philippines' main export merchandise—semiconductors—fell by half in 2011.

The primary energy demand of the Philippines has not changed substantially in the recent past. In 2002, primary energy demand accounted for 38.8 Mtoe, against 40.5 Mtoe in 2010, or a 4% increase. This contrasts greatly with the 50% growth in GDP during the same period. In fact, the almost constant level of primary energy demand comes from the substantial decline in crude oil and noncommercial biomass offset by the increase in coal, natural gas, and petroleum products. The decline in crude oil is a result of the shutting down of refineries, and the replacement of noncommercial biomass mainly in the residential sector by commercial energy sources (electricity and gas).

Currently, about 75% of fossil fuel demand is met by imports. Therefore, the Philippines' energy policy agenda should consider ensuring the security of energy supply as important. The Department of Energy is currently putting together the 2012–2030 Philippine Energy Plan, which will reflect how the economy can ensure the delivery of secure, sustainable, sufficient, affordable, and environment-friendly energy to all the economic sectors. In this regard, encouragement in domestic resources exploration and development will continue. As of 2009, an annual Philippine

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

Figure 12.7.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

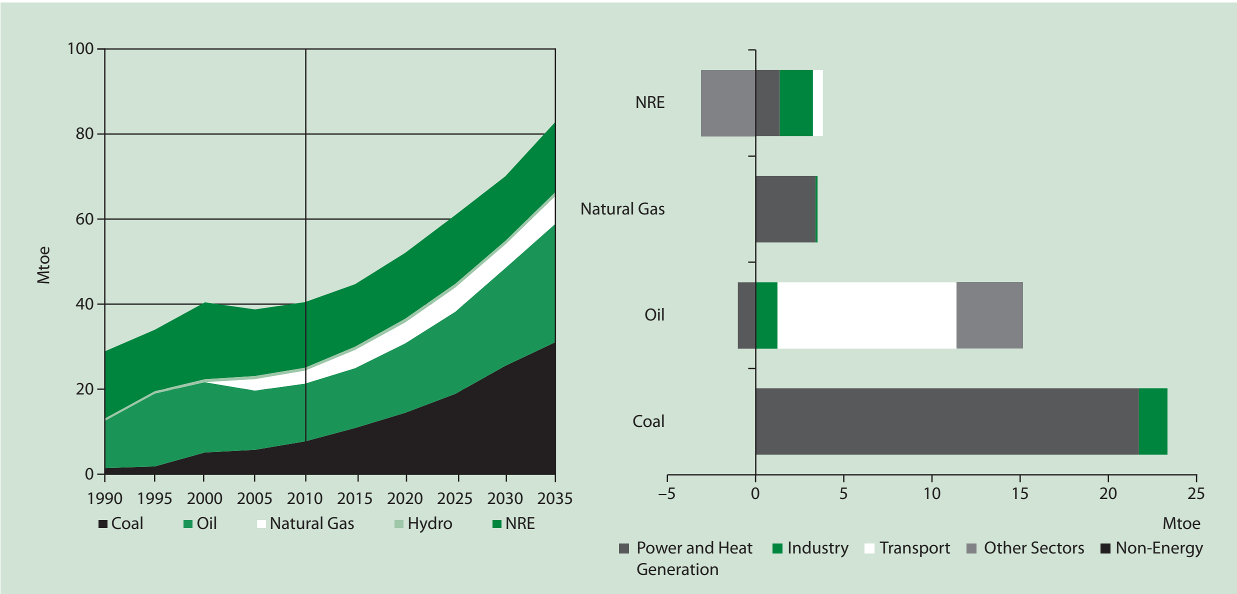
Energy Contracting Round called for 34 service contracts for the exploration of oil concession areas and natural gas deposits and for the development of geothermal resources, and the number of service contacts is expected to increase further in the next 20 years. In addition, the Renewable Energy Act of 2008 specifies policies for the wider deployment of renewable energy as the alternative to fossil fuels. Meanwhile, future policy requirements toward much wider deployment of renewable energy, such as the provision of incentives for the private sector to deploy renewable energy sources, are being developed.

Business-as-Usual Case: Energy Demand Outlook through 2035

The Philippines' GDP is projected to increase from $128.7 billion (constant 2000 $) in 2010 to $388.6 billion in 2035 at an annual rate of 4.5% (Figure 12.7.1). With this growth, the Philippines' GDP will nearly triple during this period. Continued GDP growth will be supported by the export-oriented manufacturing sector, concentrating on electronics, and the services sector. The population of the Philippines is projected to increase from 93.3 million in 2010 to 134.2 million in 2035 at an annual rate of 1.5%—the fastest growth rate among the Southeast Asian economies. Per capita GDP of the Philippines will reach $2,895 in 2035, compared with $1,380 in 2010.

In the BAU case, the final energy demand of the Philippines is projected to increase at 2.9% per year from 2010 to 2035. This growth will translate into a total final energy demand of 49.0 Mtoe in 2035, compared with 23.8 Mtoe in 2010 (Figure 12.7.2). By sector, the transport sector will grow at the fastest pace of 3.5% per year, followed by industry at 3.0% per year over the outlook period. The energy demand of the other sectors (including residential, commercial, agriculture, and fishery) is projected to increase relatively slowly at 2.3% through 2035, as the relatively fast increase in the commercial energy sources (electricity and gas) is offset by the decrease in noncommercial biomass energy sources.

Figure 12.7.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

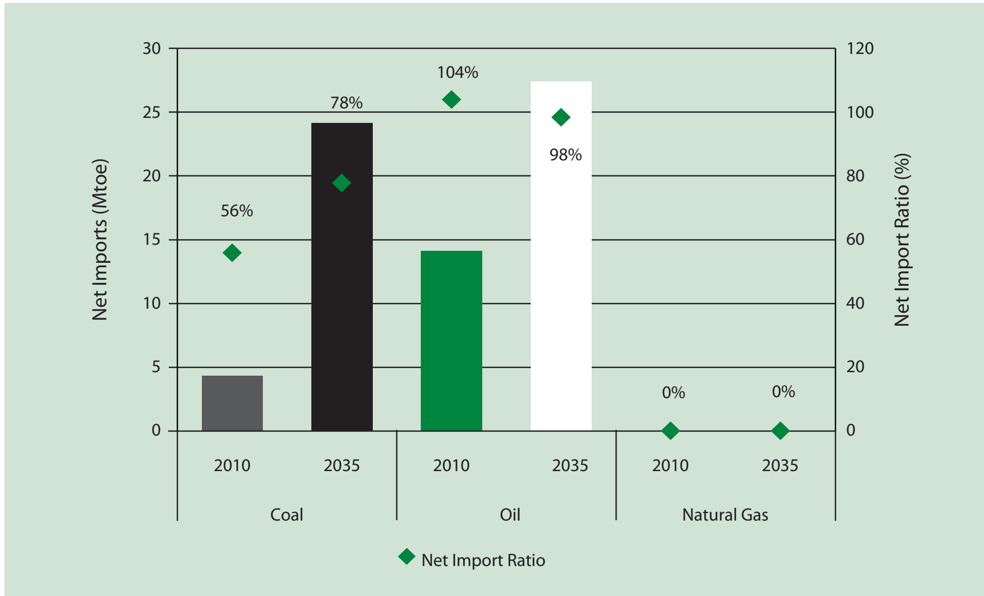
The industry sector's energy demand will maintain about one-fourth of the final energy demand through 2035. The industry subsectors, including food and tobacco and nonmetallic minerals, are the main energy users, collectively accounting for 60% of industry energy demand by 2035. In terms of energy source, coal, currently dominating the sector's energy demand, is projected to be overtaken by electricity sometime after 2015. Natural gas demand represents the fastest growth rate of 4.8%, while its share will represent the smallest at 1% in the economy's industry energy demand in 2035.

The transport sector will account for about 38% of the final energy demand by 2035. The sector's energy demand will reach 18.8 Mtoe in 2035, increasing from 8.4 Mtoe in 2010. Oil products are the main fuel for the transport sector, accounting for 96% in 2035, with the remainder taken up by natural gas. The number of light vehicles is projected to increase with an annual growth rate of 3.4%.

The other sectors' energy demand is projected to increase at an annual rate of 2.3% through 2035, which represents the slowest rate among the final energy demand sectors. The contraction of demand by the other sectors for traditional biomass at an annual rate of –6% will offset the increased demand for electricity and oil.

The primary energy demand of the Philippines is projected to increase from 40.5 Mtoe in 2010 to 82.9 Mtoe in 2035, at an annual rate of 2.9%. Driven by the increased use for power generation, coal demand will overtake oil sometime after 2025 to represent the biggest share of primary energy demand in 2035 at 37.5%. New and renewable energy will account for the third-largest share after coal and oil at 19.9% in 2035. This will result from the continued use of geothermal for power generation, maintaining the installed capacity of 2.8 gigawatts (GW) in 2035. Natural gas will account for the fourth-largest share at 7.9% in 2035. Its demand will more than double from the 2010 level of 3.0 Mtoe to 6.6 Mtoe in 2035.

Figure 12.7.3 Net Energy Imports and Net Energy Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

While new gas fields are projected to come into production and domestic production will be able to meet the domestic demand by 2035, demand for coal and oil needs to be increasingly met by imports. The amount of coal imported will more than quadruple from 4 Mtoe in 2010 to 24 Mtoe in 2035, even though domestic coal production will increase at 2.7% per year through 2035 from 3.5 Mtoe in 2010 (Figure 12.7.3).

Alternative Case: Energy Savings Potential and Energy Source Diversification

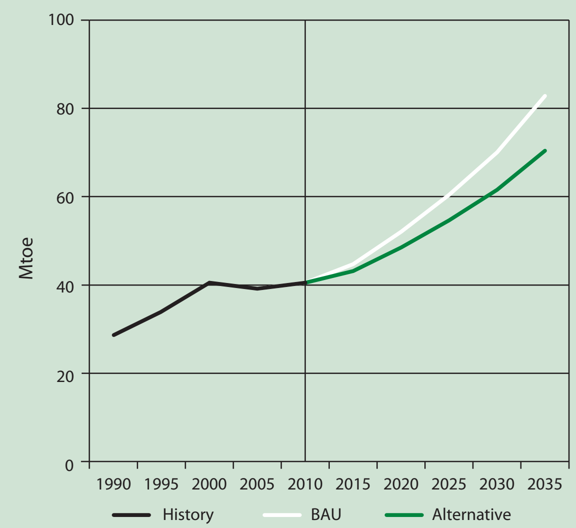
In the alternative case, the Philippines' primary energy demand will increase at an annual rate of 2.3% between 2010 and 2035, compared with the BAU's primary energy demand growth rate of 3.0% during the same period. The primary energy demand in the alternative case will reach 71.4 Mtoe in 2035—11.5 Mtoe lower than in the BAU case in 2035 (Figure 12.7.4).

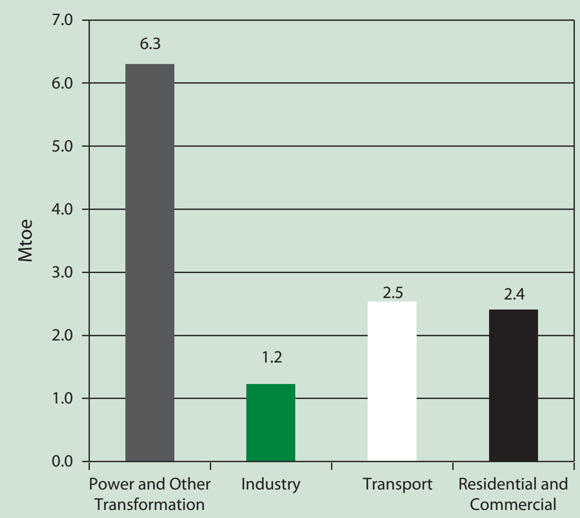
By sector, the power sector has the biggest energy savings potential at 5.3 Mtoe in 2035, followed by the transport sector (2.5 Mtoe), the residential and commercial sectors (2.4 Mtoe), and the industry sector (1.2 Mtoe).

The power sector's energy savings come mainly from the electricity demand savings from the industry and residential and commercial sectors, and resulting lower input fuel requirements. Thermal efficiency improvements in power generation will account for about 15% of total savings.

The transport sector's energy savings will result from a shift toward energy-efficient vehicles, mainly hybrids, from those with internal combustion engines. The residential and commercial sectors' energy savings will come from electricity savings as a result of efficient appliances

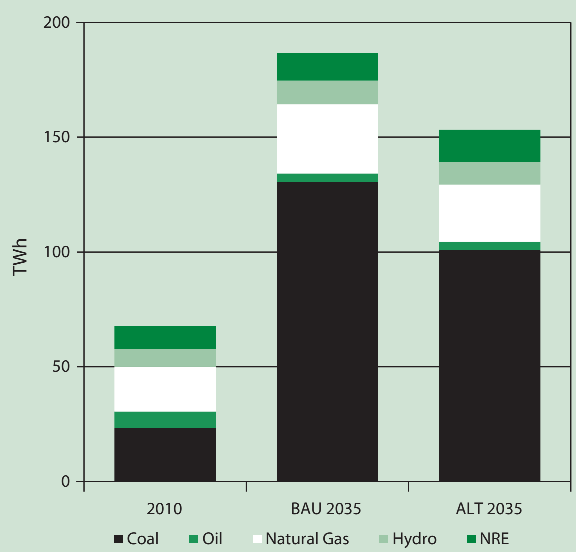
Figure 12.7.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)

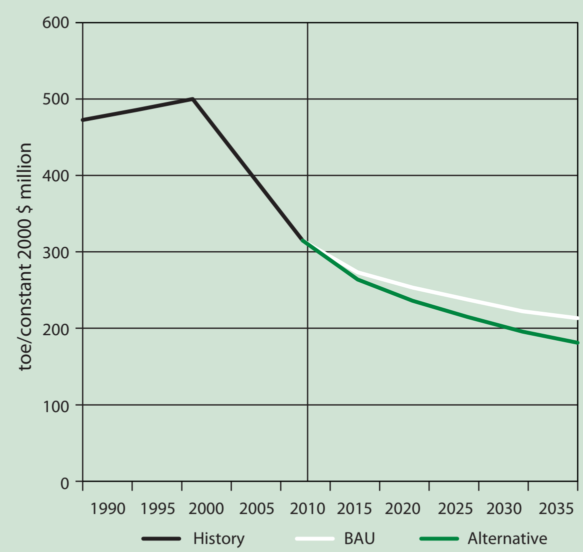




BAU = business as usual, Mtoe = million tons of oil equivalent.

Figure 12.7.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)





ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

deployment. The major appliances that contribute to the electricity savings in the residential and commercial sectors are lighting, refrigerators, and air conditioners.[46]

In the alternative case, the Philippines' electricity generation in 2035 will be about 18% lower at 153 TWh in 2035, compared with 187 TWh in the BAU case. Substantial savings in total generation in 2035 will come from the electricity demand savings in the industry, residential, and commercial sectors.

By energy type, in the alternative case, the share of coal will remain the largest in electricity generation. However, its share will be lower at 66% (compared with the BAU's coal share at 70%) in 2035 (Figure 12.7.5). The share of natural gas will remain the same at 16.2% in 2035 between BAU and the alternative case, while the share of new and renewable energy in the alternative case is higher at 9.2%, in contrast to the BAU's share at 6.5% in 2035. Geothermal will maintain its 2.8 GW of installed capacity in both the BAU case and the alternative case, while in the alternative case, the Philippines is expected to install 1.6 GW of wind, 290 MW of photovoltaic, and 315 MW of biomass generation in line with the 2009 renewable energy policy target.

Energy Policy Implications

In the BAU case, the Philippines' energy demand is projected to more than double from the 2010 level at 40.5 Mtoe reaching 82.9 Mtoe in 2035. The majority of the increases in energy demand will need to be met by imports. Oil imports will increase to 27.4 Mtoe in 2035, from 14.1 Mtoe in 2010, and coal imports will increase substantially to 24.2 Mtoe in 2035, from 4.3 Mtoe in 2010. In view of the future rise in international prices of oil and coal, the economic impacts from the rise in imports are well understood by the government in formulating the 2012–2030 Philippines Energy Plan and Renewable Act. At the same time, the government could realize energy efficiency improvements in the Philippines' economy, particularly in the residential and commercial sectors, and could strengthen its efforts in this sector as a primary means of energy security enhancement. Aside from the current undertakings specified in the National Energy Efficiency and Conservation Program, setting higher standards for appliances and equipment, as well as providing incentives for their deployment, may pave the way for the sector's energy efficiency efforts.

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[46] The Philippines has implemented minimum energy performance standards for air conditioners, compact fluorescent lamps, and linear fluorescent lamps, and plans to expand the capacities for testing laboratories for televisions, washing machines, and refrigerating equipment. Various initiatives related to energy savings in the residential and commercial sectors have been successful; examples include the ADB-led phaseout of incandescent lamps, the IFC-supported efficient lighting initiative program, the GEF/UNDP-supported efficient lighting market transformation program, and the government energy management program.

12.8 Singapore

- *In the BAU case, the primary energy demand of Singapore is projected to increase from 23.7 Mtoe in 2010 to 31.4 Mtoe in 2035, growing at 1.1% per year. Oil will continue to maintain the dominant share at around 65.0% to meet refinery and petrochemical input requirements, followed by natural gas mainly for power generation and industry use at around 31.1% through 2035.*
- *In the alternative case,* primary energy demand is projected to increase at a slower annual rate of 0.7%, reaching 28.4 Mtoe in 2035, 2.9 Mtoe lower than in the BAU case (or 9.4% savings).*

Recent Energy Trends and Energy Policy Issues

Economic growth has been volatile in Singapore in recent years. Being an export-driven economy, Singapore is strongly affected by the global economic situation. After experiencing a slowdown during the global financial crisis (1.5% in 2008, and –0.8% in 2009), the economy rebounded to 14.5% growth in 2010, slowing to 5.6% in 2011 (ADB 2012). The top three exports in 2011 were information technology (IT) products (34.3%), semiconductors (20.3%), and refined oil products (19.6%). On average, GDP grew at an annual rate of 6.4% (2005–2010).

Singapore's total primary energy demand grew at a rate of 5.0% (2005–2010)—slightly lower than the GDP rate—reaching 23.7 Mtoe in 2010. Oil was the main imported fuel with a share of 66.5% in 2010, followed by natural gas at 32.9%. Per capita primary energy demand of Singapore represents a relatively high level at 4.67 toe per person in 2010, compared with Southeast Asia's average of 0.93 toe in the same year, as it reflects the refinery crude oil input requirements that are re-exported.

The Government of Singapore published the *National Energy Policy Report* in 2007, which contains a framework aimed at meeting the economy's objective for economic competitiveness, energy security, and environmental sustainability. The economy has defined the following key energy strategies: (i) promote competitive energy markets, (ii) diversify energy supplies, (iii) improve energy efficiency, (iv) build energy industry and invest in energy research and development, (v) promote greater regional and international cooperation, and (vi) develop a whole-of-government approach.

In 2009, Singapore voluntarily committed to a 16% reduction in carbon dioxide (CO_2) emissions below 2020 business-as-usual (BAU) levels, although it is contingent on a global agreement on climate change. Additionally, the Sustainable Singapore Blueprint was developed, which targets a 35% improvement in energy intensity (per GDP in Singapore $) from 2005 levels by 2030.

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* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

Energy efficiency is an integral component of Singapore's energy policy and the Energy Efficiency Programme Office was established in 2007 to focus on the sectoral approach covering power generation, industry, transport, buildings, and households (APERC 2011).

Business-as-Usual Case: Energy Demand Outlook through 2035

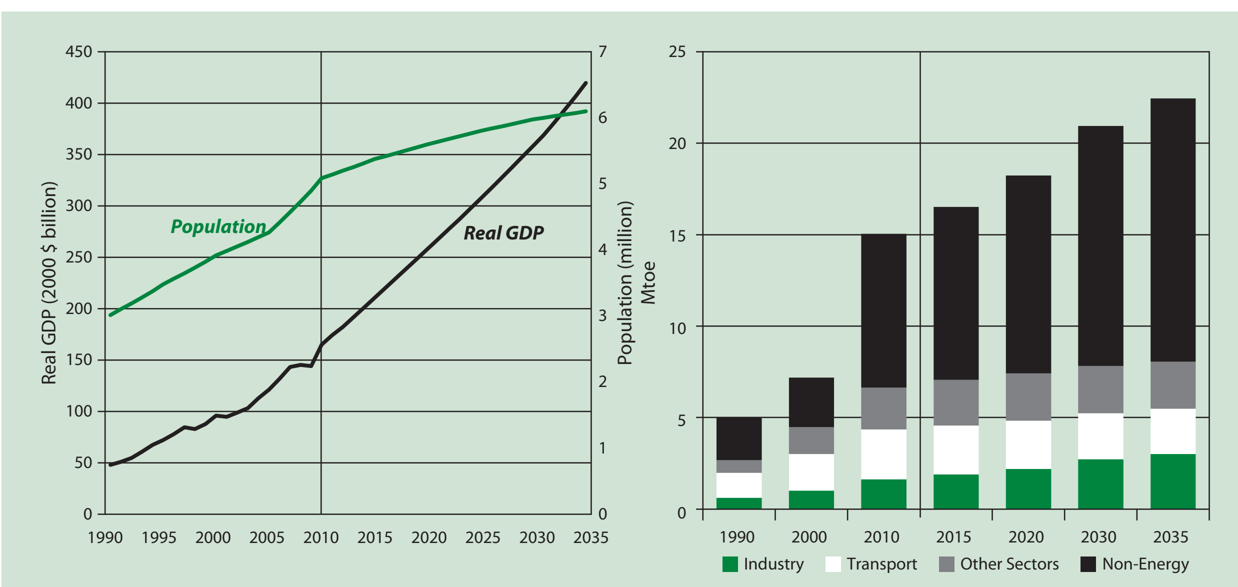
Singapore's GDP is projected to increase from $165.2 billion (constant 2000 $) in 2010 to $419.6 billion in 2035 at an annual rate of 3.8%, a slower rate compared with the historical trend of 6.4% (Figure 12.8.1). At the same time, Singapore's population will grow at a moderate pace of 0.7% through 2035, reaching 6.1 million in 2035, up from 5.1 million in 2010. As a result, Singapore's per capita GDP will represent a high level at $68,809 in 2035, the second highest in Asia and the Pacific after Hong Kong, China.

In the BAU case, the final energy demand of Singapore is projected to reach 22.5 Mtoe in 2035 from 15.0 Mtoe in 2010 growing at 1.6% per year. Singapore's final energy demand is dominated by the non-energy sector (or petrochemical industry inputs) with a 64.2% share in 2035 compared with its 55.9% share in 2010. Building on its locational advantage, nearby the demand center and an established petrochemical and refinery complex, Singapore seeks to further produce petrochemical products, with an intensified focus on high-value-added products in the future.

The industry sector's energy demand will grow at a fast rate of 2.5% per year through 2035, driven by the manufacturing industry, such as IT products and semiconductors. Electricity continues to maintain an approximate 65.0% share in the industry energy demand through 2035.

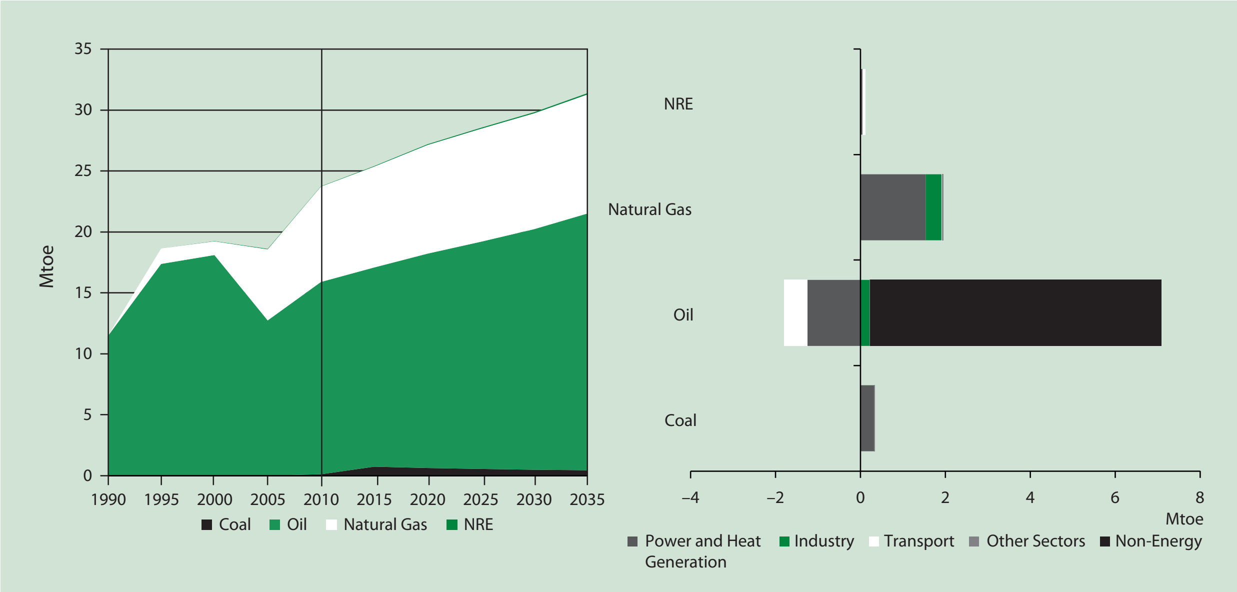
The other sectors' (residential, commercial, agriculture, and fishery) energy demand is projected to increase slowly at 0.5% per year on average through 2035. The growth trend is faster in the

Figure 12.8.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



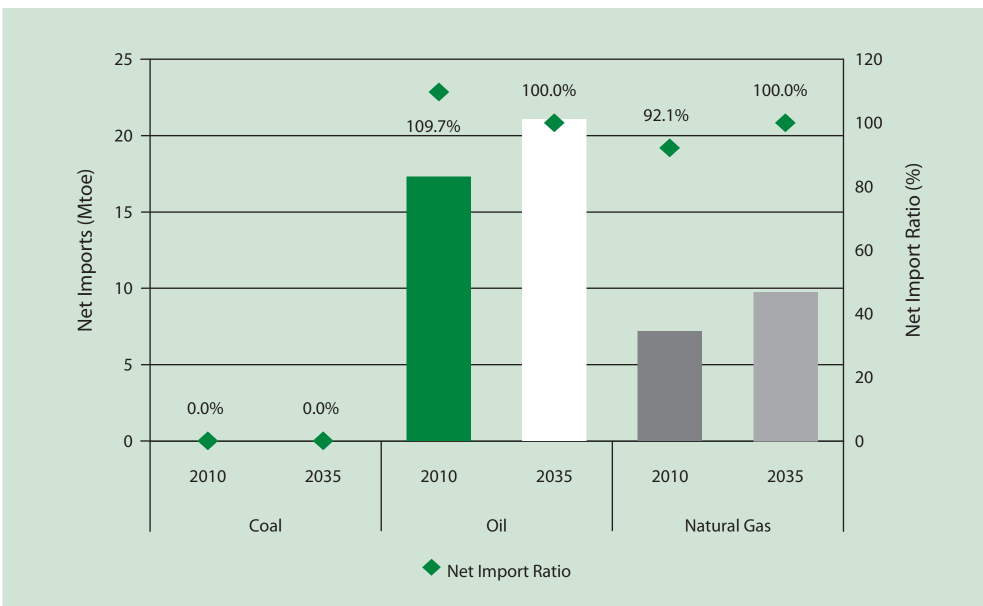
GDP = gross domestic product, Mtoe = million tons of oil equivalent.

Figure 12.8.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 12.8.3 Net Energy Imports and Net Energy Imports Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

first half of the projection period (2010–2020) at 1.3% per year, while its growth will level off some time after 2020 because of slow population growth and energy efficiency improvement in buildings and household appliances.

The transport sector's energy demand is projected to decline from 2.7 Mtoe to 2.5 Mtoe at –0.4% per year. Singapore's continued efforts to control passenger vehicle ownership, as well as to encourage ownership of fuel-efficient vehicles, will result in the declining trends.

The primary energy demand of Singapore is projected to increase from 23.7 Mtoe in 2010 to 31.4 Mtoe in 2035, growing at 1.1% per year (Figure 12.8.2). Oil will continue to maintain the dominant share at around 65.0% to meet refinery and petrochemical input requirements, which will be followed by natural gas, mainly for power generation and industry use, at around 31.1% through 2035.

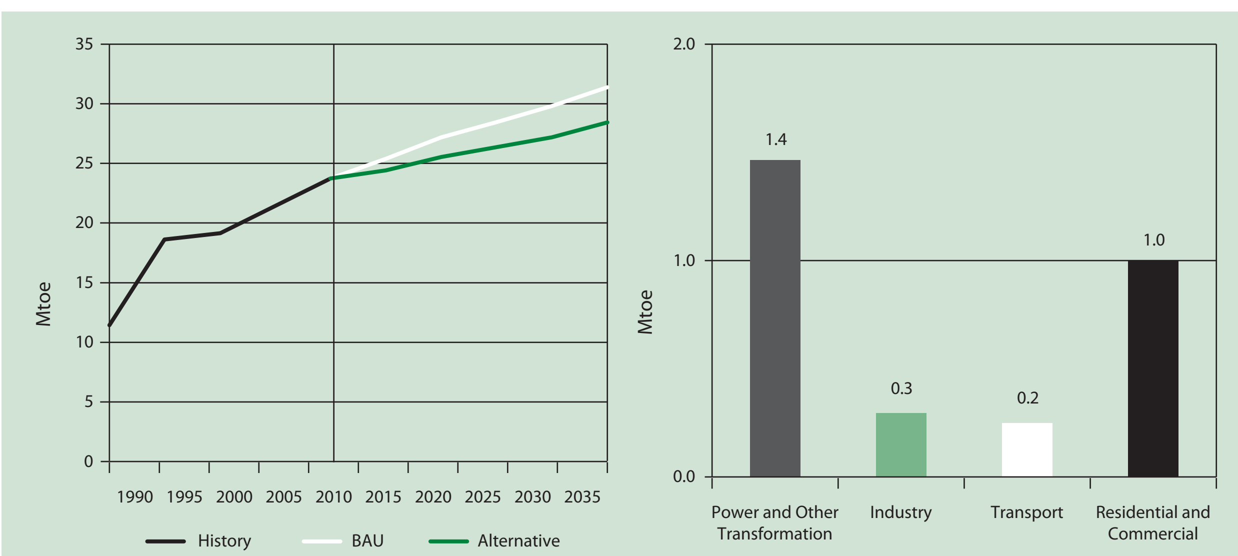
Singapore's first 160 MW biomass clean coal co-generation plant in Jurong Island—the location for petrochemical complexes—became operational in 2013, and this will result in the contribution of coal and biomass in the primary energy mix of Singapore.

Singapore meets almost all its fuel needs with imports. Before 2013, the country relied solely on pipelines to import natural gas from Indonesia. Singapore's first liquefied natural gas (LNG) import terminal (located in Jurong Island) became operational in May 2013, allowing the country to diversify its natural gas sources, and thus enhance energy security.

Alternative Case: Energy Savings Potential and Energy Source Diversification

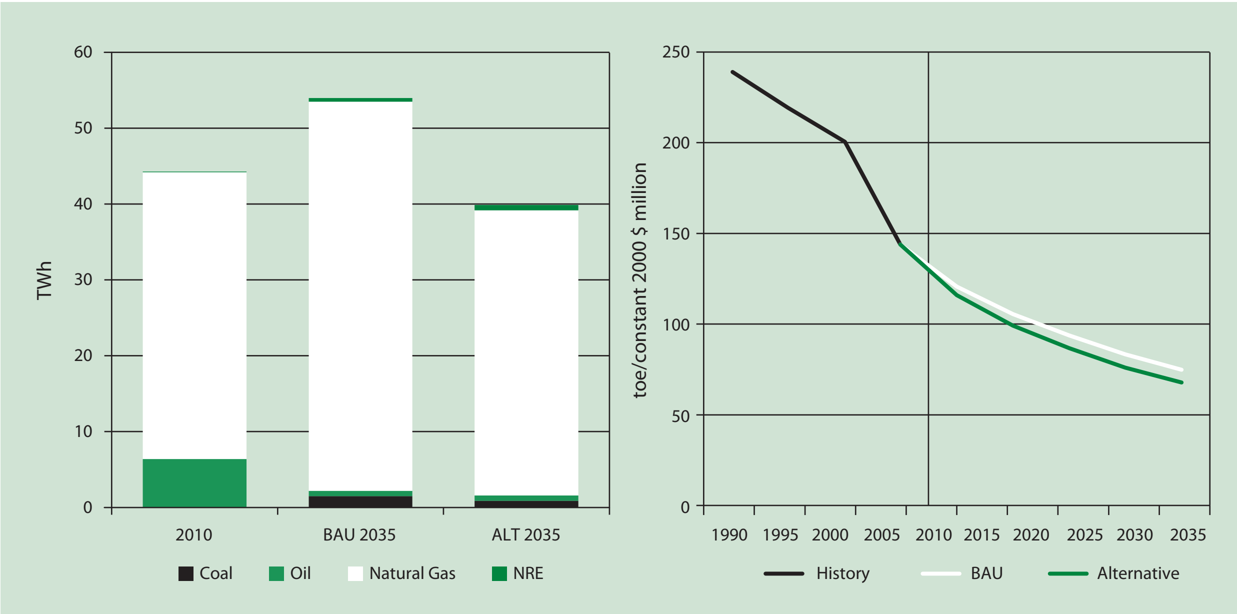
In the alternative case, primary energy demand is projected to increase at a slower annual rate of 0.7%, reaching 28.4 Mtoe in 2035, 2.9 Mtoe or 9.4% lower than the BAU case (Figure 12.8.4).

Figure 12.8.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business as usual, Mtoe = million tons of oil equivalent.

Figure 12.8.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

The biggest savings will come from the power sector (1.4 Mtoe), followed by residential and commercial (1.0 Mtoe), industry (0.3 Mtoe), and transport (0.2 Mtoe).

In the alternative case, Singapore's electricity generation in 2035 will reach 39.9 TWh, which is 26.1% lower than in the BAU case (Figure 12.8.5). The power generation savings are a result of electricity demand savings in the residential, commercial, and industry sectors. In fact, the projected electricity generation in 2035 in the alternative case will be lower than the 2010 level at 44.3 TWh.

By energy type, the electricity generation mix in the alternative case will not differ much from BAU given limited indigenous new and renewable energy resources. Singapore's photovoltaic capacity will reach 32.6 MW in 2035 compared with 21.0 MW in the BAU case, and its biomass generation capacity will reach 607.4 MW, in contrast to 387.4 MW in the BAU case in 2035.

Energy Policy Implications

Building on the locational advantage of its proximity to the demand centers, Singapore's manufacturing activities (including IT and semiconductors) and petrochemical industry will drive the energy demand growth. At the same time, Singapore is seeking to reduce environmental burdens as represented by its CO_2 emissions reduction target. With no indigenous resources, natural gas will continue to be an important energy source, feeding its rising electricity generation needs with a lower environmental burden compared with coal and oil. As the economy's first LNG import terminal becomes operational, the economy will in future increasingly rely on LNG to meet domestic natural gas demand. Cooperation with economies that already import LNG, such as Japan and the Republic of Korea, will continue to be important for sharing experiences and for considering flexible procurement options that can enhance the supply security of Singapore.

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12.9 Thailand

- *In the BAU case, Thailand's primary energy demand is projected to reach 204.8 Mtoe in 2035, increasing from 117.4 Mtoe in 2010, with an average annual growth rate of 2.2%. In contrast, in the alternative case,* it will grow at 1.8% per year, reaching 183.5 Mtoe through 2035 incorporating the deployment of advanced technologies for energy savings. The projected lower primary energy demand in the alternative case suggests that Thailand could have savings potential of about 21.3 Mtoe in 2035, or a 10% reduction compared with the BAU case.*
- *Limited domestic oil and gas resources will make it necessary for Thailand to diversify energy supply sources through utilization of new and renewable energy to improve energy security. At the same time, practical measures need to be in place to help deploy new and renewable energy sources.*

Recent Energy Trends and Energy Policy Issues

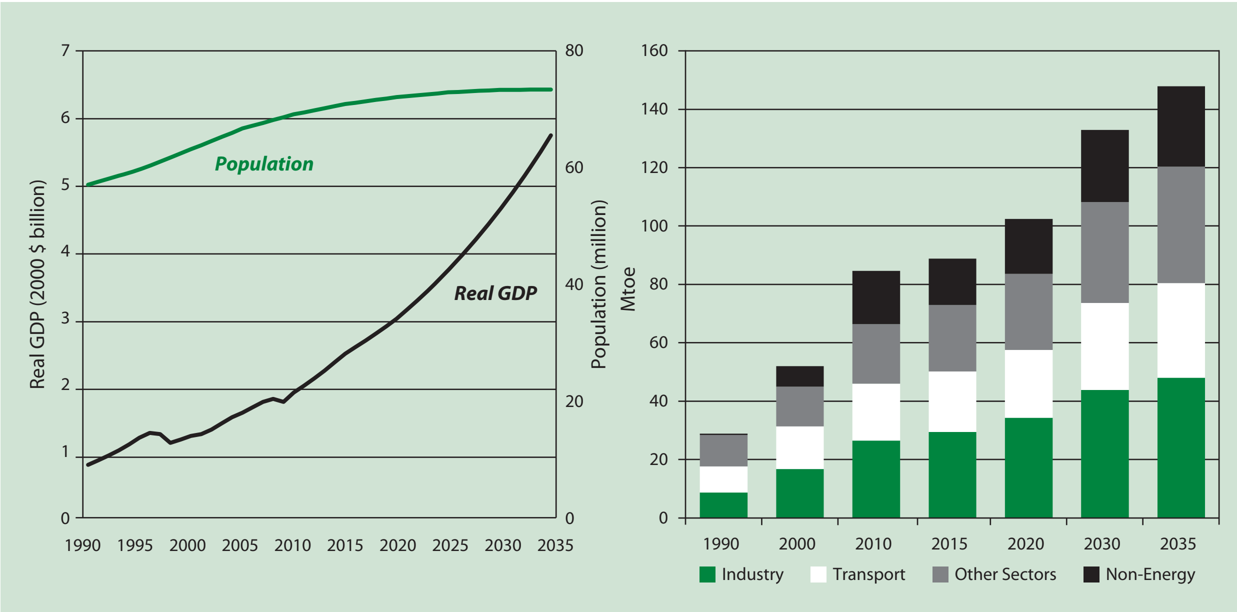
Thailand's economy is influenced by the world economic situation as it is heavily export dependent (Ministry of Energy 2011a). Following the global economic downturn in 2009, Thailand's economy bounced back to 7.8% in 2010, achieving average gross domestic product (GDP) growth at 3.6% per year between 2005 and 2010. Economic performance translated into an increase in primary energy demand with an average annual growth rate of 4.1% over the same period.

Thailand is highly dependent on energy imports. The country faces difficulty in increasing domestic production of oil and natural gas, which will be depleted over the medium term unless new reserves are discovered. To offset the impacts of its increasing energy import dependency, Thailand aims for sustainable energy management in its energy policy and lays out five strategies: energy security, alternative energy, supervising energy prices and safety, energy conservation and efficiency, and environmental protection (APERC 2012a).

A range of measures has been taken to enhance energy security. Thailand encourages developing alternative energy supplies such as biofuels to boost indigenous resources. The Renewable and Alternative Energy Development Plan (2012–2021) sets the framework to increase the share of renewable and alternative energy to account for 25% of total energy consumption by 2021 (Ministry of Energy 2011a). This plan promotes the use of renewable energy (such as wind, solar, and biomass), especially for power and heat generation, and it supports the use of transport biofuels, including ethanol-blended gasoline (gasohol) and biodiesel. Thailand will also attempt to expand its portfolio in energy assets abroad as demonstrated by the assertive stance taken by the national company, PTT Exploration and Production, in the takeover of Cove Energy in 2012. On the demand side, Thailand adopted

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

Figure 12.9.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

a 20-year Energy Efficiency Development Plan 2011–2030, which aims to improve energy intensity by 25% in 2030 compared to the 2010 levels (Ministry of Energy 2011b).[47]

Furthermore, it is critical for Thailand to reduce dependence on natural gas for electricity generation amid dwindling domestic natural gas production. One way is to introduce nuclear power. One nuclear power plant unit with a capacity of 1,000 MW is planned to start operations in 2026, and a second unit in 2027 (Ministry of Energy 2012).[48] In addition, Thailand signed a number of memorandums of understanding with the People's Republic of China, the Lao People's Democratic Republic, and Myanmar to develop power generation projects over the next 20 years so that Thailand can import electricity from these members.

Business-as-Usual Case: Energy Demand Outlook through 2035

Over the outlook period, Thailand's GDP is projected to increase from $187.5 billion (constant 2000 $) in 2010 to $573.5 billion in 2035 with an average annual growth rate of 4.6% (Figure 12.9.1). The population will grow rather slowly at an annual rate of 0.2%, increasing

[47] The energy intensity target was initially set at a 25% reduction by 2030 compared with 2005 levels, but it was revised to meet the new target declared by Asia-Pacific Economic Cooperation (APEC) leaders at the 2011 APEC Summit. The EEDP includes various measures: (i) mandatory requirements via rules, regulations, and standards (e.g., minimum energy performance standards and energy efficiency labeling); (ii) energy conservation promotion and support, such as voluntary agreement and subsidization for investment in energy conservation measures; (iii) public awareness creation and behavioral change; (iv) promotion of technology development and innovation; and (v) human resources and institutional capability development.

[48] Originally, Thailand planned to introduce 5 GW of nuclear power units by 2030, but after the Fukushima accident, public opposition against nuclear increased, and the downward amendment on the nuclear capacity was made in the Power Development Plan released in June 2012.

from 69.1 million in 2010 to 73.4 million in 2035. Thailand's GDP per capita will reach $7,816 in 2035, which is close to triple the 2010 level of $2,713.

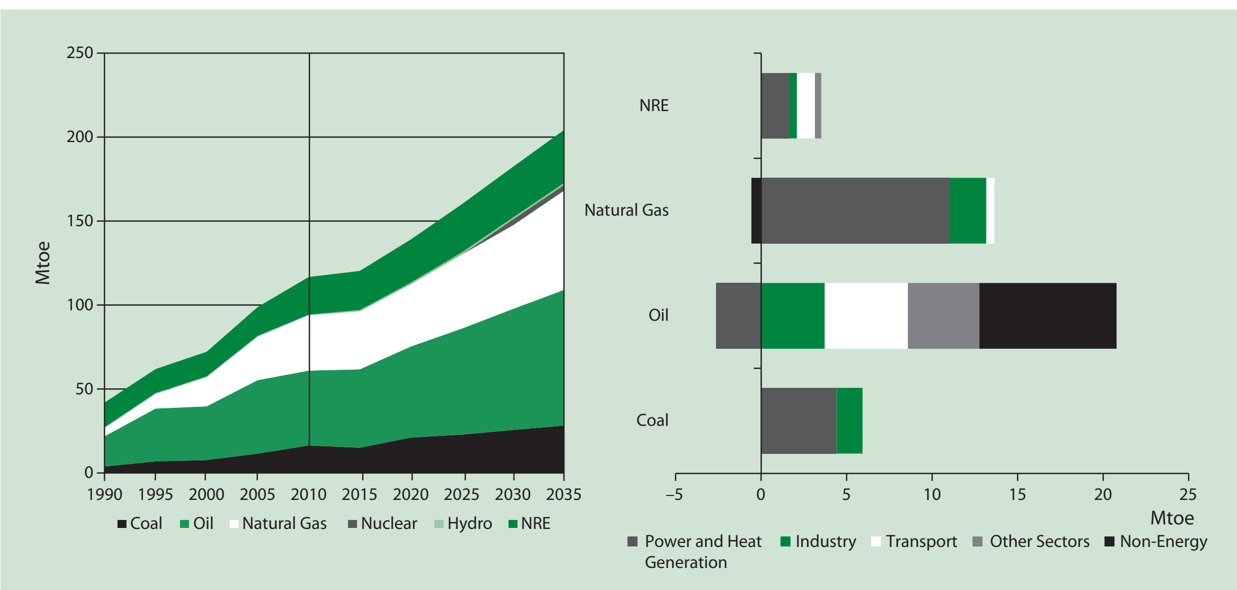
In the BAU case, Thailand's final energy demand is projected to grow at 2.3% per year between 2010 and 2035, increasing from 84.6 Mtoe in 2010 to 147.9 Mtoe in 2035. In terms of the sector's share, the industry sector will account for 32.5% in 2035, followed by the other sectors (including residential, commercial, agriculture, and fishery) at 27.0%, transport at 21.9%, and non-energy use at 18.6%. This structure is unlikely to change over the outlook period, although the industry and other sectors will encroach slightly upon the share of the transport and the non-energy sectors through 2035.

Industry sector energy demand is projected to grow at an average annual rate of 2.4%. Growth in the manufacturing subsectors, particularly food and beverages, chemicals, and nonmetallic minerals, will boost energy demand. Coal is likely to remain dominant through 2035, but growth will be relatively slow at 1.6% per year. In contrast, oil will register the fastest annual growth rate of 5.1% over the outlook period.

The transport sector's energy demand is projected to grow by 2.1% per year over the outlook period, mainly due to increasing vehicle numbers and the increase in vehicle kilometers traveled. However, demand will be moderated by the gradual shift to rapid transit systems in transport modes in urban centers and a modest increase in the use of biofuels and alternative vehicles.

The other sectors' energy demand will increase with an average annual growth rate of 2.7% between 2010 and 2035. Electricity will be dominant at 44.5% in 2035, owing to the increase in

Figure 12.9.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

electric appliance ownership. Energy conservation and efficiency measures are expected to be strengthened to moderate electricity demand.

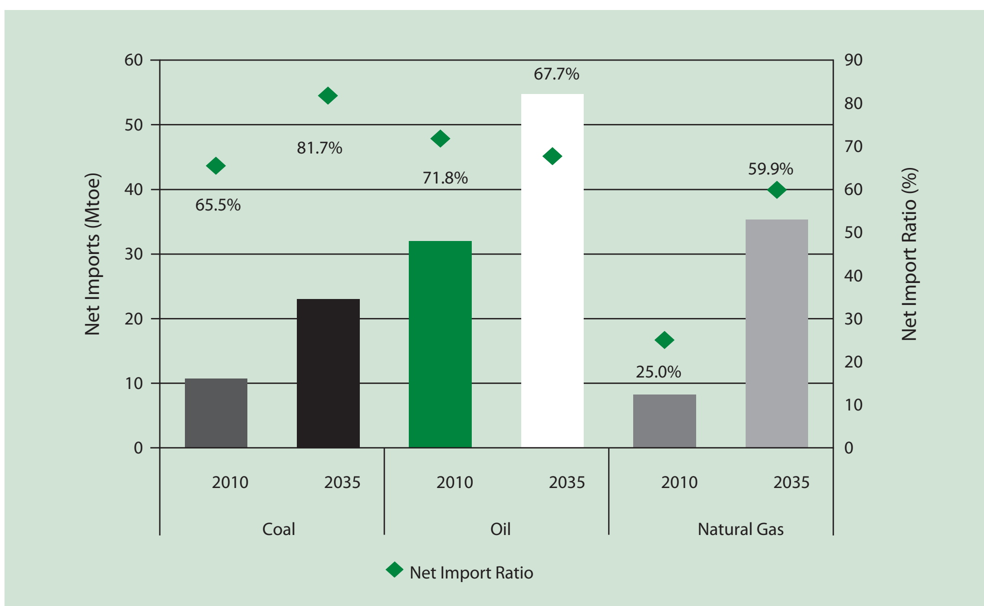
Thailand's primary energy demand is projected to increase from 117.4 Mtoe in 2010 to 204.8 Mtoe in 2035 in the BAU case, with an average annual growth rate of 2.2%. Thailand's per capita energy demand will increase from 1.70 toe per person in 2010 to 2.79 toe per person in 2035, which is higher than the average of the Southeast Asian region at 1.54 toe per person in 2035.

Oil will continue to be the major fuel with a share of 39.5% in 2035, followed by natural gas at 28.8% and coal at 13.8%. While the energy mix is likely to remain almost the same over the outlook period, the projected introduction of nuclear energy from 2026 onward will bring a slight change to the primary energy mix. Hydro is projected to register the fastest annual growth rate of 3.7% through 2035, although its share will be less than 1%.

Figure 12.9.2 shows the sectoral contributions to the incremental growth in energy demand from 2010 to 2035. Oil demand will increase across the sectors, except in power and heat generation. The demand for coal, natural gas, and new and renewable energy for power and heat and generation is expected to increase through 2035.

Thailand is likely to become increasingly dependent on imports of fossil fuels since the domestic production of conventional fuels is not expected to increase to meet growing demand (Figure 12.9.3). In Thailand, the first LNG re-gasification terminal—the Map Ta Phut LNG Terminal, with an initial capacity of 5 million tons a year and extendable to 10 million tons a year—was put into operation in September 2011. Furthermore, the government is considering a second LNG terminal to cope with anticipated natural gas demand growth.

Figure 12.9.3 Net Imports of Coal, Oil and Natural Gas, and Net Import Ratio: Business-as-Usual



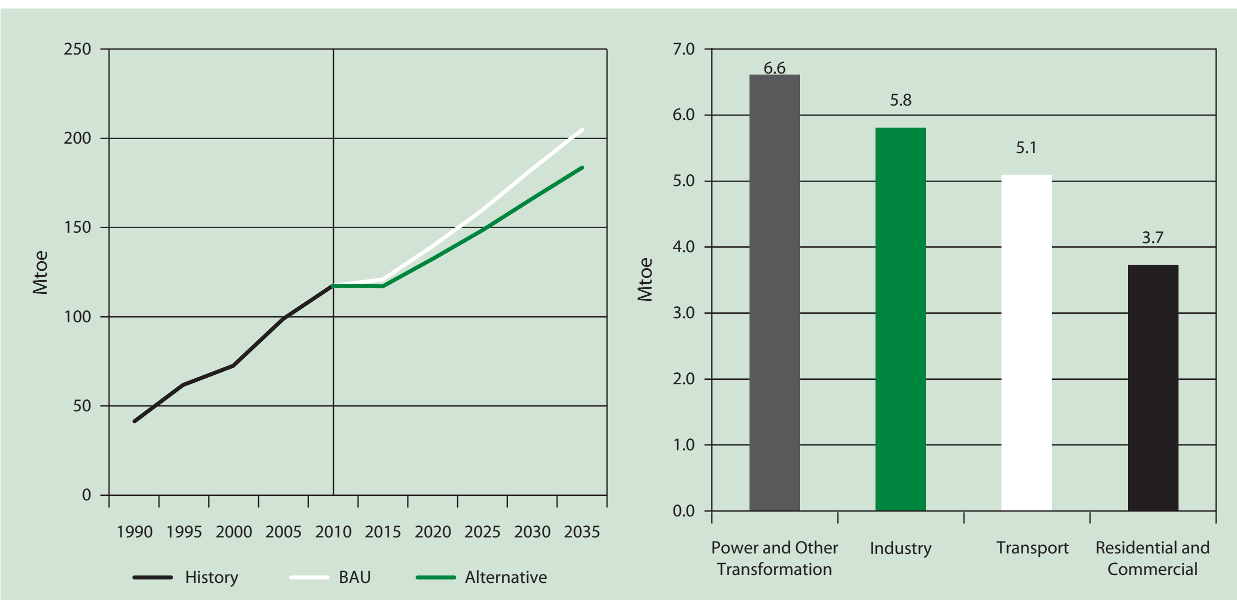
Mtoe = million tons of oil equivalent.

Alternative Case: Energy Savings Potential and Energy Source Diversification

In the alternative case, Thailand's primary energy demand is projected to reach 183.5 Mtoe in 2035 with an average annual growth rate of 1.8% in case advanced technologies for energy savings are deployed (Figure 12.9.4). Compared with the BAU case in 2035, Thailand has the potential to save about 21.3 Mtoe in 2035 (or a 10% reduction).

Among the sectors, the power sector is expected to present the biggest energy savings potential at 6.6 Mtoe. Thermal efficiency improvements could explain most of the estimated savings, while the decline in power generation requirements, as a result of the reduced electricity demand to be attained by deployment of energy savings technology, will also contribute marginally. The industry sector will follow with a savings potential of 5.8 Mtoe. It is assumed that Thailand will extend the current Energy Efficiency Improvement Program for the industry sector in the long term, which includes various measures such as promotion of energy management and financial incentives (APERC 2012b).[49] The four energy-intensive industry subsectors (iron and steel, cement, paper and pulp, and petrochemical) could account for about 41.2% of the estimated energy savings in the sector. Shifts toward more energy-efficient vehicles will enable the transport sector to potentially save 5.1 Mtoe. Thailand's tax scheme, which sets a preferential excise tax for hybrid electric vehicles with less than 3,000 cubic centimeters and electric vehicles of 10%, would facilitate the shifts.[50] For the other sectors, the estimated potential savings will be 3.7 Mtoe, mainly due to deployment of higher-efficiency appliances such as air conditioning and lighting. Thailand has achieved energy efficiency

Figure 12.9.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)

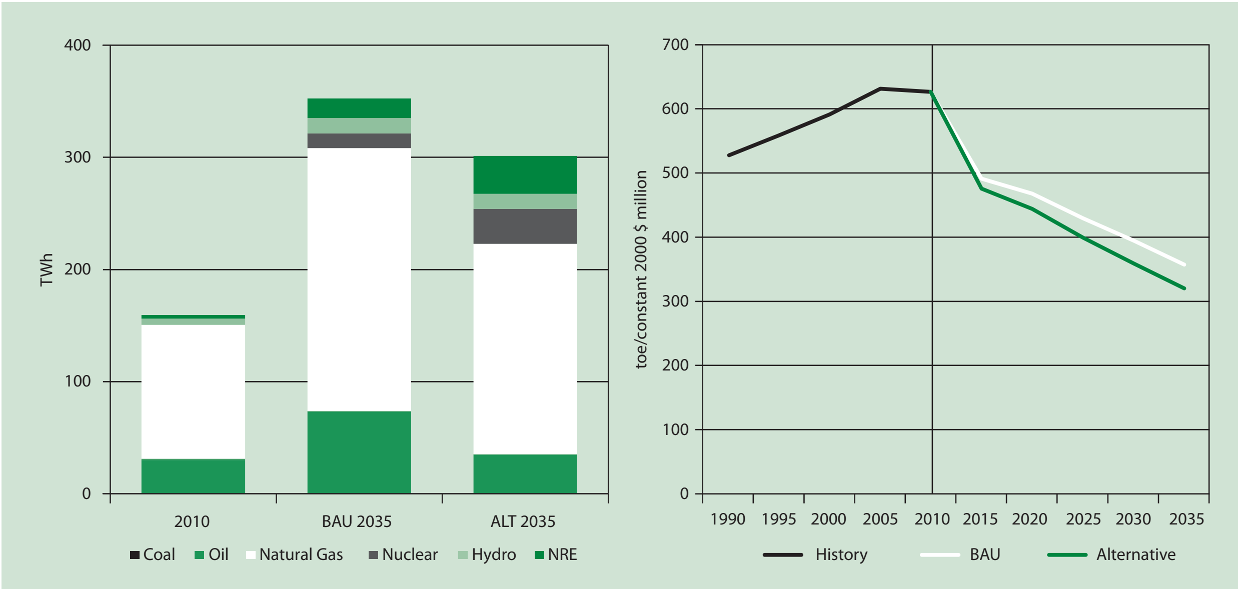


BAU = business as usual, Mtoe = million tons of oil equivalent.

[49] The other measures are technical assistance, standards and regulations, collaboration with major private corporations, and promotion of the energy service company business.

[50] For reference, the excise tax for a passenger car with less than 3,000 cc is 40%.

Figure 12.9.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

improvements of appliances and equipment through a voluntary measure called high energy performance standard to encourage and promote the increased use of highly energy-efficient products in anticipation of the transformation of the appliances market toward high energy efficiency. To further enhance the energy efficiency improvement of appliances and equipment, the minimum energy performance standards have been in place as a mandatory tool, which aims to eliminate products with very low energy efficiencies from the market (APEC 2010; Sangsawang 2010).

Figure 12.9.5 compares electricity generation by energy type between BAU and the alternative case. The total electricity generation in 2035 of the alternative case is estimated to be approximately 14.6% lower than in the BAU case as a result of electricity demand decreases, mainly in the industry and residential and commercial sectors.

In the electricity generation mix, natural gas will account for the largest share through 2035 in both cases, although its share will be reduced from 74.8% in 2010 to 66.5% (BAU) and 62.3% (alternative case) in 2035. In the alternative case, new and renewable energy and nuclear power could take up part of coal's share in 2035. Thailand has good potential for power generation using renewable energy such as solar, wind, and biomass and their combined total installed capacity could reach 10.5 GW in 2035 in the alternative case, compared with 5.1 GW in the BAU case in the same year.

The energy intensity (primary energy demand per GDP) in the alternative case is projected to reach 320 toe per million constant 2000 $, which is 37.1 toe per million constant 2000 $ lower than in the BAU case. The application of advanced technologies to enable energy-efficient use across the sectors may explain the primary difference.

Energy Policy Implications

Growing energy demand and stagnant production of fossil fuels will obligate Thailand to ensure its energy supply to sustain economic development. For that reason, Thailand has taken necessary steps such as acquisition of global energy assets and exploration of alternative energy sources, while setting up a policy framework and designing medium-term plans to facilitate energy-efficient use and new and renewable energy development. Nevertheless, it still seems challenging for Thailand to translate such a policy framework and plans into feasible measures that would work effectively. For instance, it is important to provide incentive programs and mechanisms to encourage investment in renewable energy development because substantial up-front costs are required for power generation projects using renewable energy such as solar and wind. Therefore, the implementation of practical initiatives will be essential to help achieve the policy objectives.

As an environment-conscious member, Thailand is expected to aim for a balance between economic development and environment protection. The prospect of continued heavy reliance on fossil fuels over the outlook period will expedite the pursuit of environment-friendly fuels. However, the introduction of nuclear power involves uncertainty in timing and scale due to raised public concerns about safety issues. New and renewable energy use may be limited since they present disadvantages in cost, scale, and reliability relative to fossil fuels. To reduce CO_2 emissions, Thailand may also intensify energy efficiency measures to suppress energy demand.

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12.10 Viet Nam

- *In the BAU case, the primary energy demand of Viet Nam is projected to increase from 67.7 Mtoe in 2010 to 186.0 Mtoe in 2035, growing at an annual rate of 4.1%. With this growth, Viet Nam's per capita energy demand will reach 1.80 toe per person, compared with 0.77 toe in 2010.*
- *In the alternative case,* Viet Nam's primary energy demand will increase at an annual rate of 3.7% through 2035. With this growth, Viet Nam's primary energy demand will reach 167.9 Mtoe, which is 18.0 Mtoe (or about 9.7%) lower than in the BAU case in 2035.*

Recent Energy Trends and Energy Policy Issues

Viet Nam's energy demand rose rapidly in line with robust economic expansion. During the last decade, Viet Nam was one of the fastest-growing energy consumers among the members of the Asian Development Bank (ADB), with the average annual growth rate of primary energy demand during 2000–2010 exceeding 6%. The final demand for commercial fossil fuel in 2010 was almost 2.5 times that in 2000, and electricity demand has grown nearly four times in the same period. However, the per capita primary energy consumption of Viet Nam is still low, only 0.77 toe in 2010, less than the ADB members' 2010 average of 1.28 toe and the Southeast Asia group's 2010 average of 0.93 toe.

In 2010, the residential and commercial sectors consumed 54.4% of the final energy demand in Viet Nam, a decrease from 2000 at 75.0%, and around 80% of its energy demand is noncommercial energy. At the same time, industry energy demand increased rapidly to triple that of 2000, and its share rose to 25.6% in 2010 from 14.0% in 2000. The share of the transport sector expanded to 16.7% in 2010 from 10.6% in 2000.

During 2000–2010, demand for commercial energy experienced substantial growth, almost tripling in amount and raising its share in the final energy demand from 35.1% in 2000 to 58.2% in 2010.

Oil is the largest energy source in Viet Nam's final and primary energy demand, with its share rising to 24.3% in 2010 from 21.1% in 2000. Viet Nam is currently an exporter of crude oil with the production of offshore oil. However, due to the small domestic refining capacity, it has to import most of the needed petroleum products. In contrast to the expanding demand, oil production in Viet Nam reached its peak of 20.9 Mtoe in 2004. As for total crude oil and petroleum products, Viet Nam became a net importer in 2010. To deal with these issues, the Government of Viet Nam announced in its 2008 national energy strategy the policies of reducing the dependency on oil by improving energy efficiency and diversifying the energy supply, encouraging foreign investments, establishing a strategic oil stockpile system, and developing domestic refineries.

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

Viet Nam has relatively large resources of anthracite coal in the north regions, and exported 11.1 Mtoe of coal (about 40% of the domestic production) in 2010. As the second-largest energy source, coal increased its share in the primary energy demand to 22.8% in 2010 from 11.8% in 2000. About one-third of the primary coal supply was used for power generation in 2010, and industry consumed more than 80% of the final coal demand. Enhancing the exploration and development of coal mining, and raising the share of underground coal production, are the major policies with respect to coal in the national energy strategy.

Natural gas consumption is growing rapidly in Viet Nam to meet the expanding electricity demand. The share of natural gas in the primary energy demand rose to 12.5% in 2010 from 3.0% in 2000. Most of the gas is currently provided by domestic offshore resources. The establishment of a LNG terminal is planned to meet the increasing demand with both domestic production and imported gas.

Electricity's share in the final demand rose from 5.8% in 2000 to 12.9% in 2010. In 2000, 54.8% of Viet Nam's electricity production was from hydropower. In 2010, the share of gas-fired and coal-fired power in power generation respectively increased to 43.0% and 22.9% from 16.4% and 11.8% in 2000, while hydro accounted for 31.9%. In the Power Master Plan VII, which was released in July 2011, Viet Nam maintained the policy to develop nuclear power in the future. The country's first commercial nuclear power station will become operational by 2020 and the development target for nuclear power is 10.7 GW by 2030. In 2010, Viet Nam imported about 5% of the total electricity supply from neighboring countries such as the People's Republic of China, Cambodia, and the Lao People's Democratic Republic. According to the Power Master Plan VII, the share of imported electricity will be maintained around 4% by 2030.

In 2006, the Ministry of Industry and Trade launched the National Energy Efficiency Program for the period 2006–2015, which has set targets to reduce the economy's total energy consumption by 3%–5% annually from 2006 to 2010, rising to 5%–8% annually during 2011–2015 (compared with BAU levels).

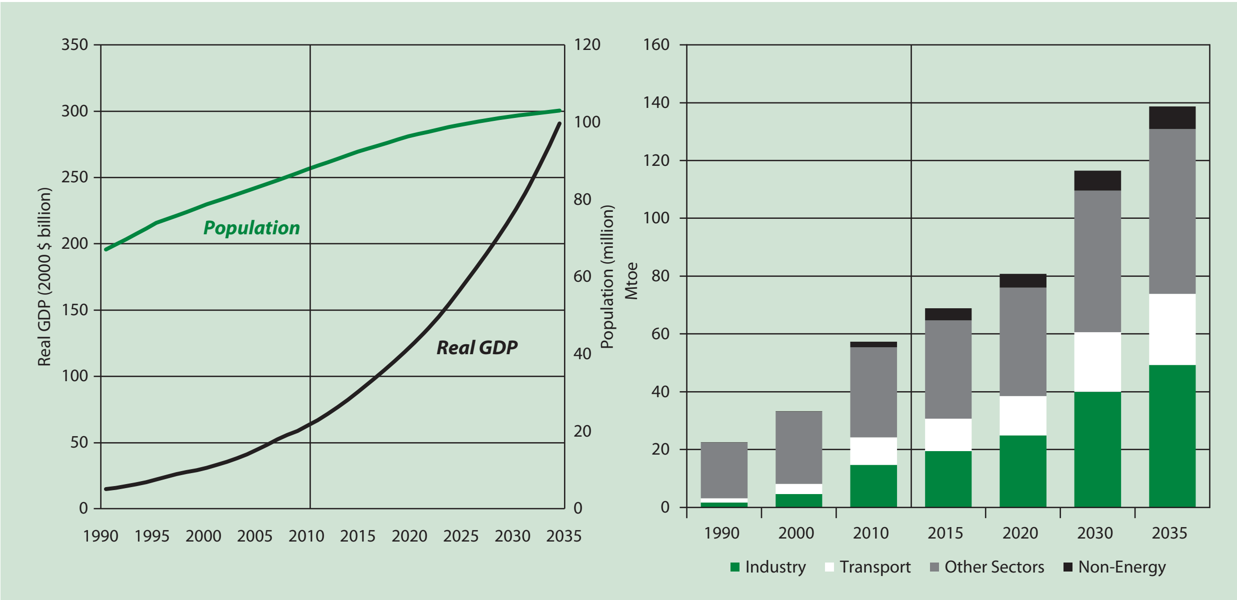
Business-as-Usual Case: Energy Demand Outlook through 2035

Over the outlook period, Viet Nam's GDP is projected to increase at an annual rate of 6.3%. With this growth, GDP will be $290.7 billion (constant 2000 $) in 2035, almost 4.6 times of that in 2010 (Figure 12.10.1). The population is projected to increase at 0.6% through 2035 and reach 103.0 million in 2035 from 87.8 million in 2010. GDP per capita will rise from $715 in 2010 to $2,821 in 2035.

In the BAU case, the final energy demand of Viet Nam is projected to increase at an annual rate of 3.3% through 2035—a slower rate compared with the projected GDP growth rate of 6.3% during the same period. By sector, the other sectors (including residential, commercial, agriculture, and fishery), whose share accounted for the largest in 2010 at 54.4%, will increase moderately at 2.3% as a whole, while its share in final energy demand will decrease to 42.4% in 2035. In contrast, the industry energy demand will increase at 4.6% per year through 2035, and its share will rise from 25.6% in 2010 to 34.8% in 2015. Transport energy demand will increase at 3.3% per year over the outlook period.

Most of the increase in the other sectors' energy demand consists of commercial energy such as fossil fuel and electricity. The demand for noncommercial biomass will be 27.5 Mtoe in

Figure 12.10.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

2035—involving only a small increase from its 2010 value of 24.5 Mtoe. Its share will decline from 77.0% in 2010 to 42.0% in 2035. The share of fossil fuel will increase from 12.2% in 2010 to 29.2% in 2035. Electricity will grow at a relatively fast rate of 6.5% through 2035 and its share will reach 28.7% in 2035, almost triple that in 2010.

Within the industry sector's energy demand, coal will increase at 4.1% per year, and its share will drop from 56.2% in 2010 to 45.7% in 2035. During the same period, electricity's share will rise from 27.2% to 33.0%, with an average growth rate of 5.7%. The growth rate of oil and natural gas will be 5.8% and 7.3% per year, respectively, and the shares will rise to 17.7% and 3.7% in 2035, respectively.

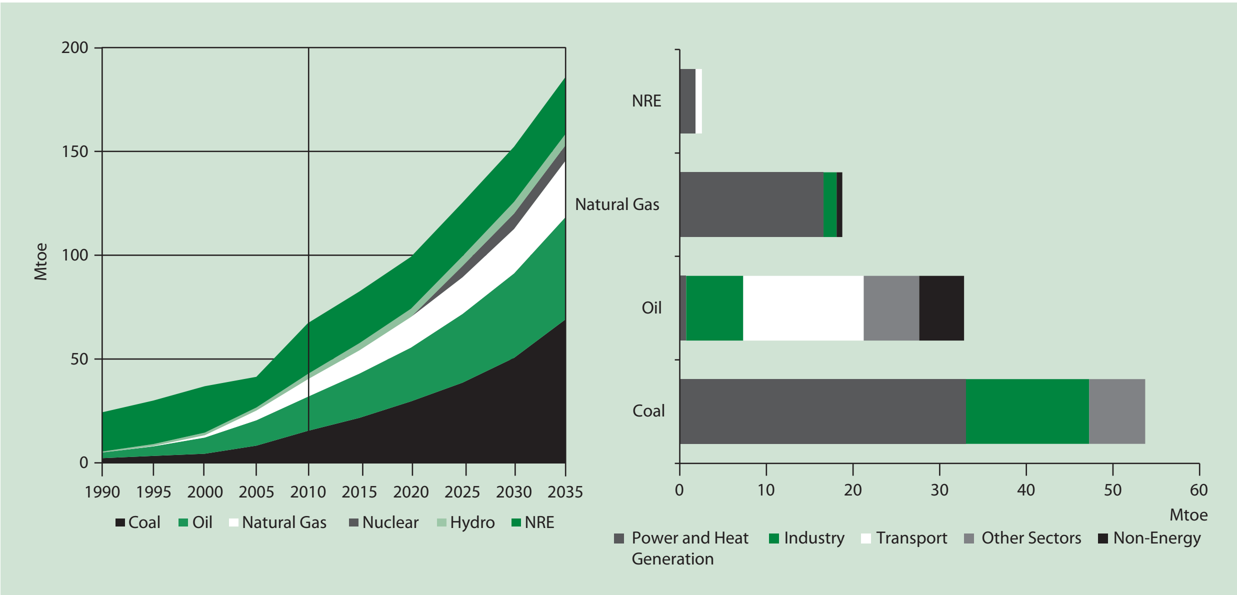
In the transport sector, oil is the main energy source fueling the transport needs in Viet Nam. During the outlook period, the share of oil will maintain a level of around 90%.

In the BAU case, the primary energy demand of Viet Nam is projected to increase from 67.7 Mtoe in 2010 to 186.0 Mtoe in 2035, growing at an annual rate of 4.1%. With this growth, Viet Nam's per capita energy demand will reach 1.80 toe per person, compared with that of 2010 at 0.77 toe.

By energy type, the share of coal in the total primary energy demand will rise to 37.2%, the largest share in 2035, up from 22.8% in 2010. It will be followed by oil at 26.5% and other energy types (which includes noncommercial biomass and new and renewable energy) at 14.8%. Natural gas will increase most rapidly, with a growth rate of 4.8% per year, and its share will reach 14.6% in 2035. The share of hydro is projected to decrease to 2.9% in 2035, and nuclear will account for 4.0% in 2035.

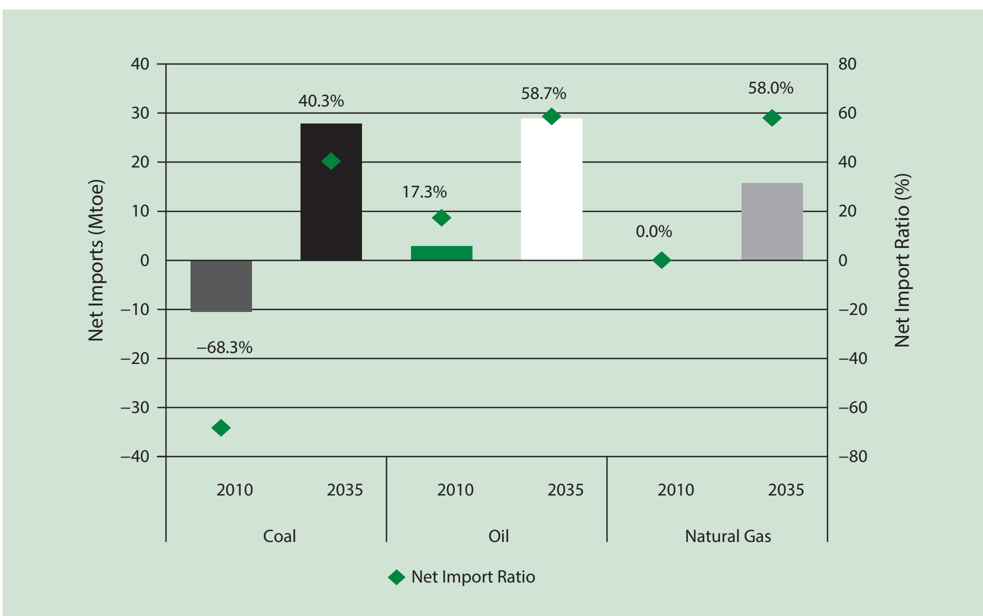
The sectoral contributions to incremental energy demand growth from 2010 to 2035 are shown in Figure 12.10.2. As the figure presents, coal demand will represent the biggest incremental growth at 53.7 Mtoe, mainly driven by increased use by the power sector. Oil demand will be led by the transport sector and rise 32.8 Mtoe over the outlook period. Gas demand will rise 18.8 Mtoe, with most of the increment for power generation.

Figure 12.10.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 12.10.3 Net Imports of Coal, Oil, and Natural Gas and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

Domestic coal production will reach 41.3 Mtoe in 2035, but the demand increase driven by the power sector will surpass the growth of production, thus turning Viet Nam from a coal exporter to an importer. The net import ratio will reach 40% in 2035. In contrast to continuous rapidly rising oil demand, oil production in Viet Nam will stabilize at around 20 Mtoe per year. The country's net import of oil will reach 28.9 Mtoe by 2035, and the net import ratio will be nearly 60%. The situation of gas is similar to that of oil. Domestic production of gas will peak in the 2020s at less than 20 Mtoe and drop to 11.1 Mtoe in 2035. At the same time, the demand for gas will grow even faster at 4.8% per year. As a result, the net import ratio of gas will reach 58% in 2035 (Figure 12.10.3).

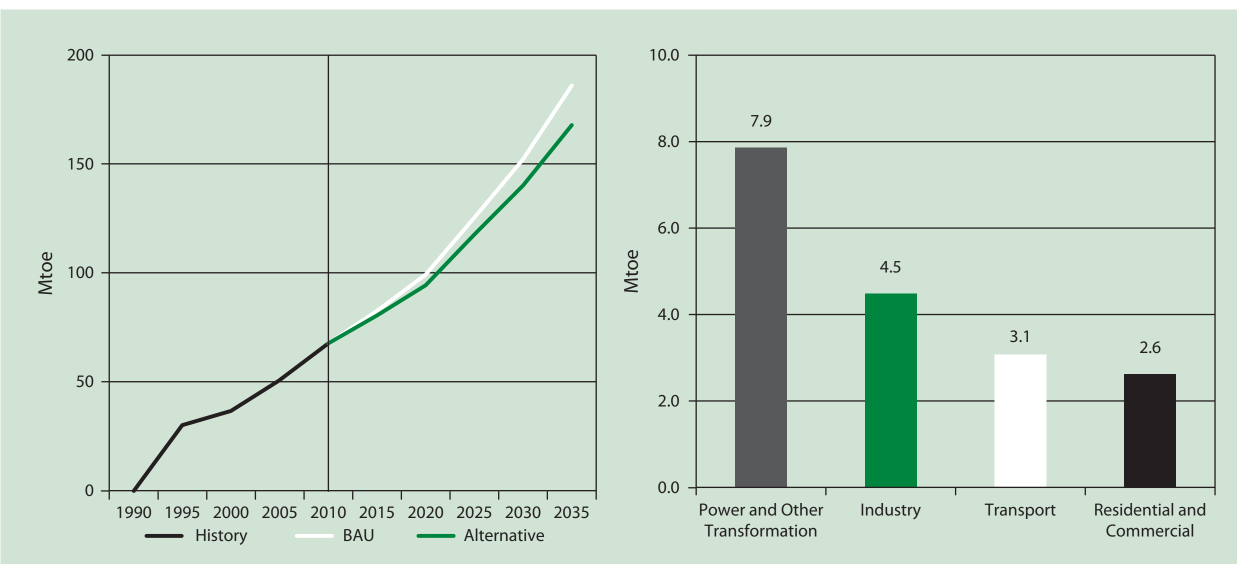
Alternative Case: Energy Savings Potential and Energy Source Diversification

With the deployment of advanced technologies for energy savings, Viet Nam could achieve a less energy-intensive growth in the future. In the alternative case, Viet Nam's primary energy demand will increase at an annual rate of 3.7% through 2035. With this growth, Viet Nam's primary energy demand will reach 167.9 Mtoe, which is 18.0 Mtoe (or about 9.7%) lower than that in the BAU case in 2035 (Figure 12.10.4).

By sector, the power sector represents the biggest energy savings potential at 7.9 Mtoe in 2035, followed by industry at 4.5 Mtoe, transport at 3.1 Mtoe, and residential and commercial at 2.6 Mtoe.

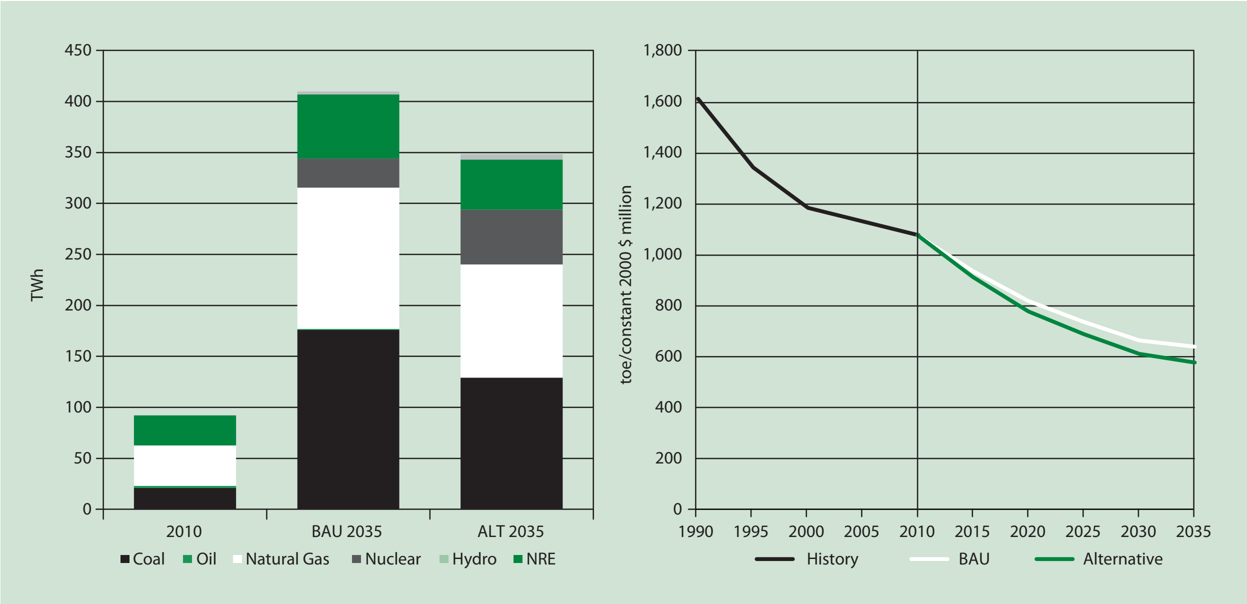
The energy input requirements of the power sector will decrease because of electricity demand savings from the different sectors. Nuclear power development will also result in lower fuel input requirements for power generation.

Figure 12.10.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business as usual, Mtoe = million tons of oil equivalent.

Figure 12.10.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

The industry sector's energy savings at 4.5 Mtoe in 2035 are a result of the deployment of advanced technologies in the various industry subsectors, including cement, refineries, and steel.

The transport sector's energy savings will be 3.1 Mtoe in 2035. This is caused by shifts toward more efficient internal combustion engine and hybrid vehicles.

At the same time, the residential and commercial sectors' energy savings at 2.6 Mtoe in 2035 are mainly due to electricity savings as a result of the deployment of efficient appliances. The major appliances that contribute to the electricity savings are lighting, refrigerators, and air conditioners.

In the alternative case, Viet Nam's electricity generation in 2035 will be about 15% lower at 348.4 TWh in 2035, compared with that of BAU at 409.8 TWh (Figure 12.10.5). Substantial savings in total generation in 2035 will result from the electricity demand savings in the industry, residential, and commercial sectors.

By energy type, electricity generation in the alternative case is more diversified than in the BAU case. In 2035, the share of nuclear will expand to 15.4% and widely cut down the carbon intensity of the power sector. Even in the alternative case, the share of new and renewable energy (wind, solar, and biomass generation) in 2035 will be double that of the BAU case, which is only 1.5% of the total.

Energy Policy Implications

Along with fast economic growth, Viet Nam's energy demand will continue to rise rapidly in the coming decades. However, the increase in domestic production will not be able to catch up with the expanding energy demand, and more resources will need to be imported. In 2010, Viet Nam became a net importer of crude oil and petroleum products. Due to the maturity of its major oil fields, dependency on import oil will keep growing. Demand for natural gas, for which it is currently self-sufficient, will also surpass domestic production in the 2020s. Although coal production will maintain an increasing trend during the outlook period, the available capacity of coal exports will decline with the increasing domestic demand. By 2035, Viet Nam is projected to become a net coal importer.

With the switch from energy exporter to importer, energy security will be raised in priority in Viet Nam's energy policies. From this aspect, enhancing the diversity in energy demand, supply, and import is important. Furthermore, to reduce the risk from the volatility of international energy prices, international cooperation in energy trading at both the government and business levels will be beneficial.

To ensure sufficient energy supply will require enormous investments across all sectors and for all fuels. Great amounts of new infrastructure will be needed in exploration and development of domestic energy resources, power generation, transport and distribution, and import. A competitive energy market will contribute to encouraging domestic and international activity toward meeting these requirements. A rational price system will be valuable in both attracting energy investments and improving energy conservation efforts.

Achieving energy-efficient growth is important in all aspects. For the economy as a whole, the benefit of reducing the energy demand—and thus the investments needed in the energy sector and fuel costs—will often exceed the energy savings investment. For a developing country such as Viet Nam, introducing relatively high-efficiency plants and equipment in the early development stage will be more economical than replacing inefficient ones later on.

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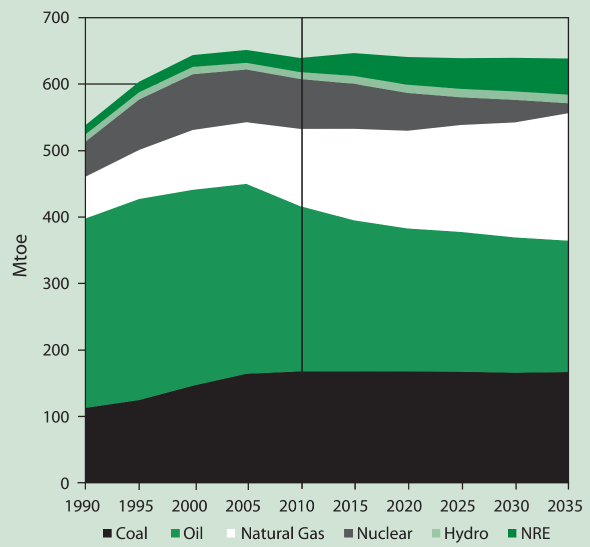
Chapter 13

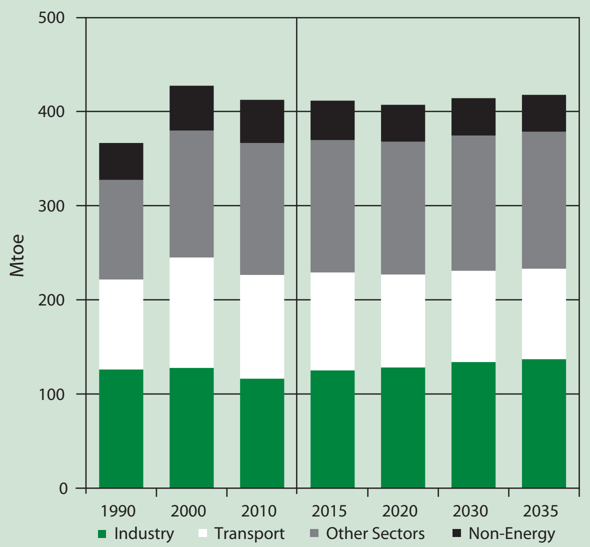
Developed Group

Developed Group

- *In the business-as-usual (BAU) case, the Developed Group's primary energy demand is projected to slightly decline from 639.8 million tons of oil equivalent (Mtoe) in 2010 to 638.7 Mtoe in 2035 (Figure 13.1). Japan's primary energy demand—representing a 73.2% share of the primary energy demand of the Developed Group in 2035—will decline at –0.2% per year through 2035 to offset the primary energy demand growth of Australia (0.7% per year) and New Zealand (0.8% per year).*
- *In the alternative case,* the annual growth rate of primary energy demand will average –0.5% through 2035. The Developed Group has the potential to save about 73.9 Mtoe in 2035 or a 11.6% reduction compared with the BAU case (Figure 13.2). Similarly, the group's electricity generation will be reduced by 16.3% in the alternative case.*

Figure 13.1 Primary Energy Demand (left) and Final Energy Demand (right): Business-as-Usual





Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

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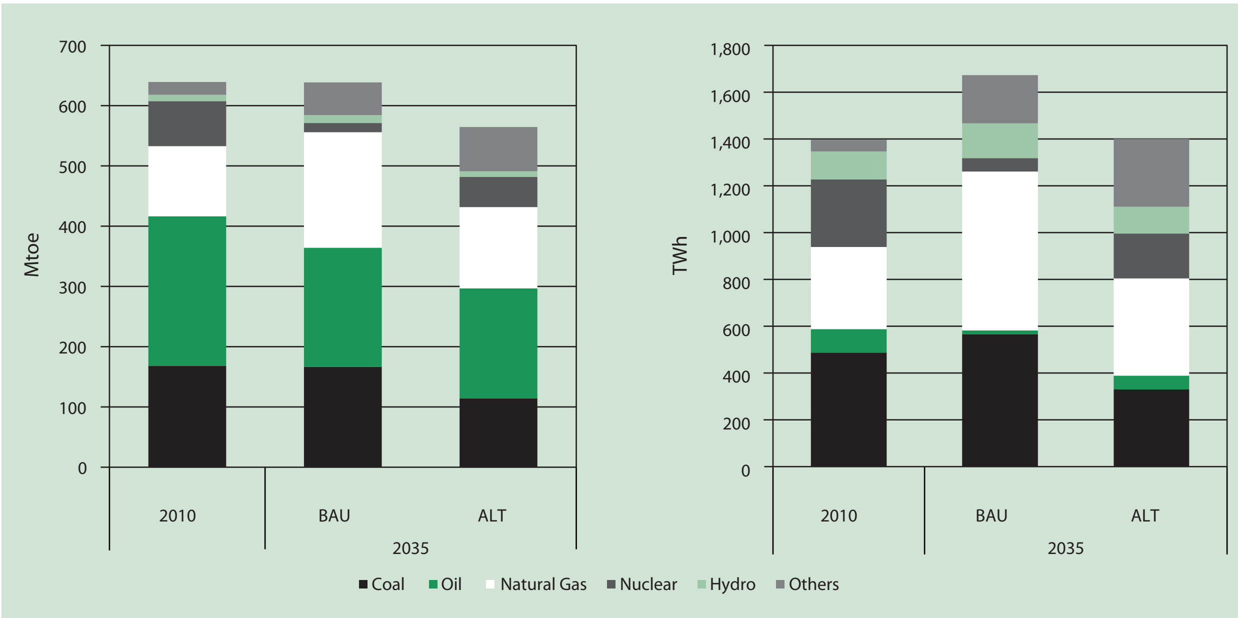
* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

Figure 13.2 Business-as-Usual and the Alternative Case: Primary Energy Demand (left) and Electricity Generation (right)



ALT = alternative case, BAU = business-as-usual case, Mtoe = million tons of oil equivalent, TWh = terawatt-hour.

13.1 Australia

- *In the BAU case, Australia's primary energy demand is projected to increase from 124.7 Mtoe in 2010 to 148.8 Mtoe in 2035, with an average annual growth rate of 0.7%. In the alternative case,* with the application of advanced technologies for energy-efficient use, the average annual growth rate will slow to 0.3%, reaching 133.3 Mtoe in 2035. This means that Australia has a savings potential of about 15.6 Mtoe in 2035 or a 10.5% reduction compared with the BAU case.*
- *With Australia's Clean Energy Future plan, which includes a carbon trading mechanism, it is likely that there will be an improvement in energy efficiency and increased use of clean energy such as natural gas and new and renewable energy, which will result in carbon dioxide (CO_2) emissions reductions in the long term.*

Recent Energy Trends and Energy Policy Issues

Underpinned by a mining boom, Australia maintained solid economic growth at an average annual rate of 2.9% between 2005 and 2010, in spite of a slight dip in 2009 due to the world economic slowdown. Since Australia is rich in mineral resources, the minerals sector is a substantial contributor to the Australian economy, while the services sector accounts for about 70% of gross domestic product (GDP).[51] Australia's annual primary energy demand growth was 0.8% on average over the same period, which indicates a relatively efficient energy intensity.

Australia is the world's ninth-largest energy producer, the largest exporter of coal, and a major exporter of uranium and liquefied natural gas (LNG) (APERC 2012). Natural gas has become particularly important to Australia's economy as a source of export earnings as well as a fuel to meet domestic energy demand. When a number of LNG projects that are currently under development materialize in the future, Australia is likely to become one of the top LNG exporters. Furthermore, production of coal seam gas, which has been expanding rapidly since 2000, is expected to encourage the LNG projects.

On the other hand, environmental concerns are likely to change the energy use in Australia. The Clean Energy Future plan announced in July 2011 aims at a 5% reduction of greenhouse gas emissions by 2020 from 2000 levels and sets a long-term target of reducing net emissions to 80% below 2000 levels by 2050. The plan includes the introduction of a carbon price, the promotion of innovation and investment in renewable energy, promotion of energy efficiency, and the creation of opportunities in the land sector to cut pollution. (APERC 2012). The carbon pricing mechanism establishes a fixed carbon price of A$23 per ton for the period 1 July 2012 to 30 June 2015. From 1 July 2015, the carbon price will become flexible under a modified cap and trade emissions trading scheme in which there will be a lower and upper limit of emissions unit prices for the first 3 years. The introduction of carbon pricing is expected to encourage the use of clean energy such as natural gas and new and renewable fuels.

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* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the business-as-usual (BAU) case. Please refer to Table 1.1 for more details.

[51] Australia is a major world producer of bauxite, coal, gold, copper, nickel, zinc, and iron ore.

In December 2012, Australia released the *Energy White Paper 2012, Australia's energy transformation,* which sets out a strategic policy framework and provides a framework to manage energy security needs (Government of Australia 2012). The Energy White Paper identifies four core policy priorities to support the energy transformation: (i) delivering better energy market outcomes for consumers; (ii) accelerating Australia's clean energy transformation; (iii) developing Australia's critical energy resources, particularly gas resources; and (iv) strengthening the resilience of Australia's energy policy framework. The white paper will guide Australia's future energy policy.

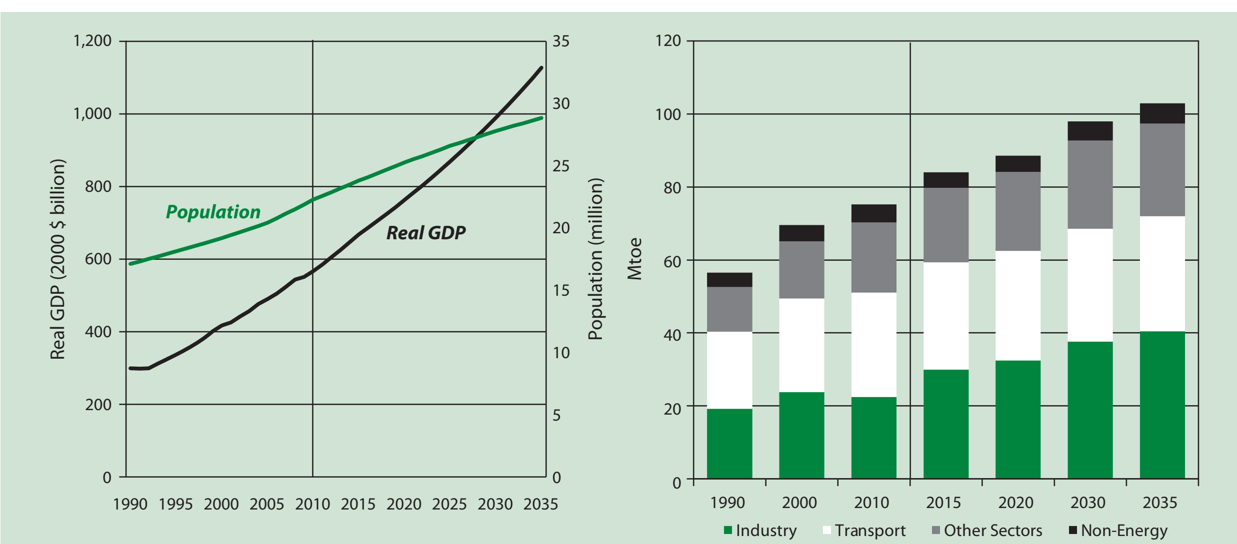
Business-as-Usual Case: Energy Demand Outlook through 2035

Australia's GDP is projected to increase from $565.7 billion (constant 2000 $) in 2010 to $1,125.9 billion in 2035 with an average annual growth rate of 2.8% (Figure 13.1.1). The population will grow moderately at an annual rate of 1.0%, increasing from 22.3 million in 2010 to 28.8 million in 2035. Australia's GDP per capita will reach $39,059 in 2035, which is about 1.5 times higher than the 2010 level of $25,406.

In the BAU case, Australia's final energy demand is projected to grow at 1.3% per year over the outlook period, increasing from 75.3 Mtoe in 2010 to 103.0 Mtoe in 2035. The industry sector will account for 39.3% in 2035, followed by the transport sector at 30.6%, the other sectors (including residential, commercial, agriculture, and fishery) at 24.6%, and non-energy use at 5.5%. While this structure is unlikely to change through 2035, the share of the transport sector will be gradually taken up by the industry sector.

The industry sector's energy demand is projected to grow at an average annual rate of 2.4% between 2010 and 2035. This reflects the steady but relatively moderate growth of Australia's industry sector in general, along with a focus on the services sector. Given that Australia is experiencing a mining boom, however, energy demand in this sector is expected to increase. Combustible fuels are expected to account for the majority of industrial energy demand, with consumption increasing more than 45% over the outlook period.

Figure 13.1.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

The transport sector's energy demand will show a slow growth rate of 0.4% through 2035, mainly because vehicle ownership has very nearly reached saturation level in Australia. The majority of transport-based energy consumption will be of oil products.

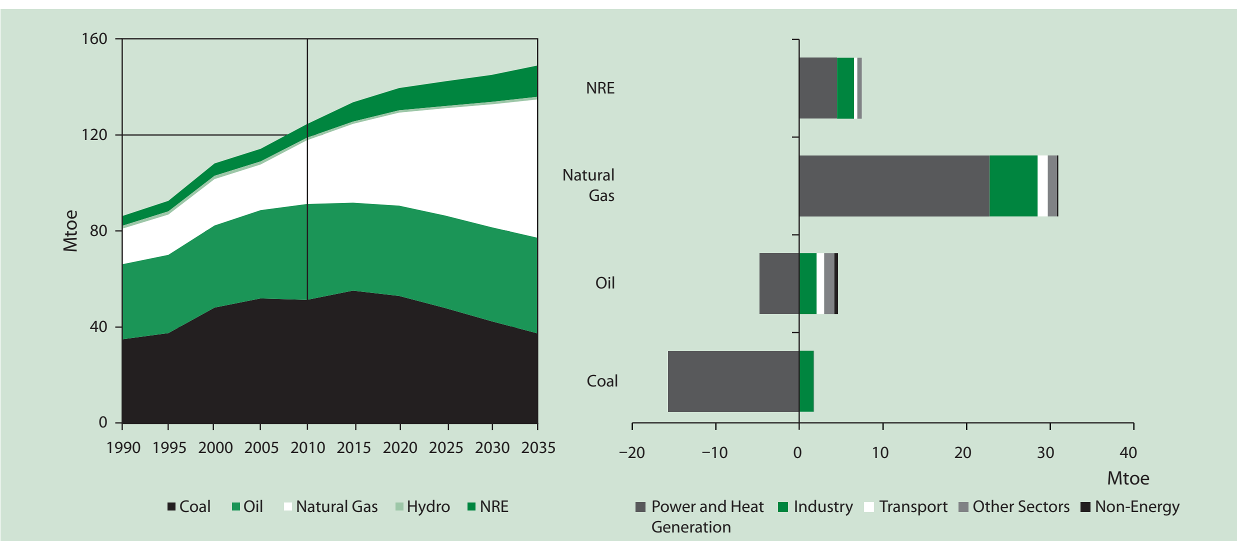
Energy demand in the other sectors is expected to grow at an average annual rate of 1.1% over the outlook period. Electricity will continue to dominate the fuel mix in this sector, accounting for more than half of the other sectors' energy demand in 2035. Efforts of policies promoting energy efficiency within the residential and commercial sectors, such as building codes and mandatory minimum energy performance standards for appliances and equipment, will be offset by a growing population and an increasingly consumer-driven society.

Australia's primary energy demand is projected to increase from 124.7 Mtoe in 2010 to 148.8 Mtoe in 2035 in the BAU case, with an average annual growth rate of 0.7%. Australia's per capita energy demand will gradually decrease from 5.60 tons of oil equivalent (toe) per person in 2010 to 5.16 toe per person in 2035.

Coal will dominate energy supply in most of the first part of the outlook period. Although much of the gas produced will be exported as LNG, predominantly to economies in Asia, natural gas is expected to overtake coal in domestic energy supply in the latter half of the outlook period, accounting for 38.7% of primary energy demand in 2035. Given the potential for significant production of natural gas from unconventional sources, Australia is expected to increase its production of natural gas in the outlook period. Primary demand of natural gas is projected to more than double between 2010 and 2035.

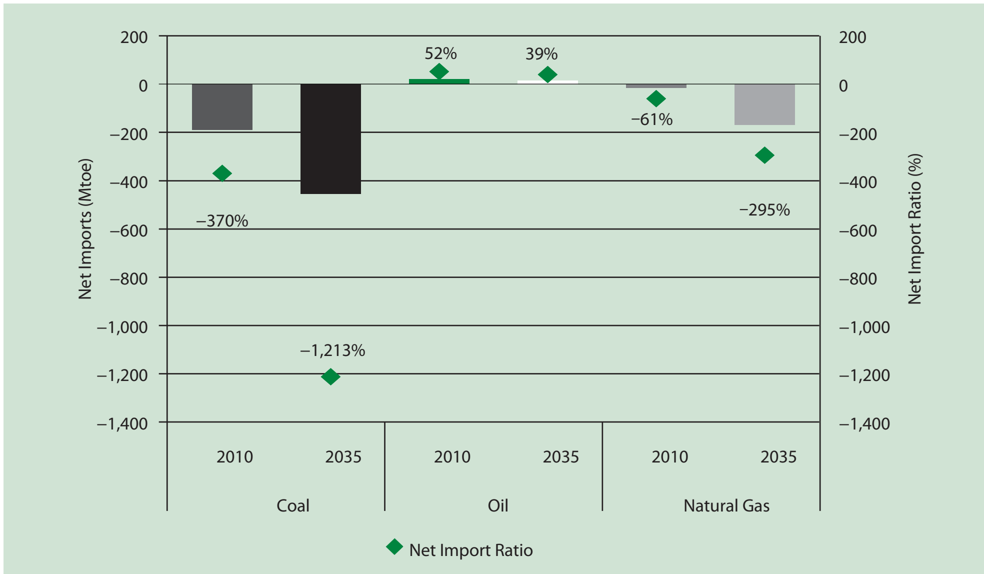
The sectoral contributions to the incremental energy demand growth from 2010 to 2035 shown in Figure 13.1.2 will show an effect of Australia's policy to encourage the use of cleaner energy. Increased demand for natural gas and new and renewable energy is expected across the sectors. The fuel switch toward clean energy will stand out in power and heat generation.

Figure 13.1.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others)

Figure 13.1.3 Net Imports of Coal, Oil, and Natural Gas and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

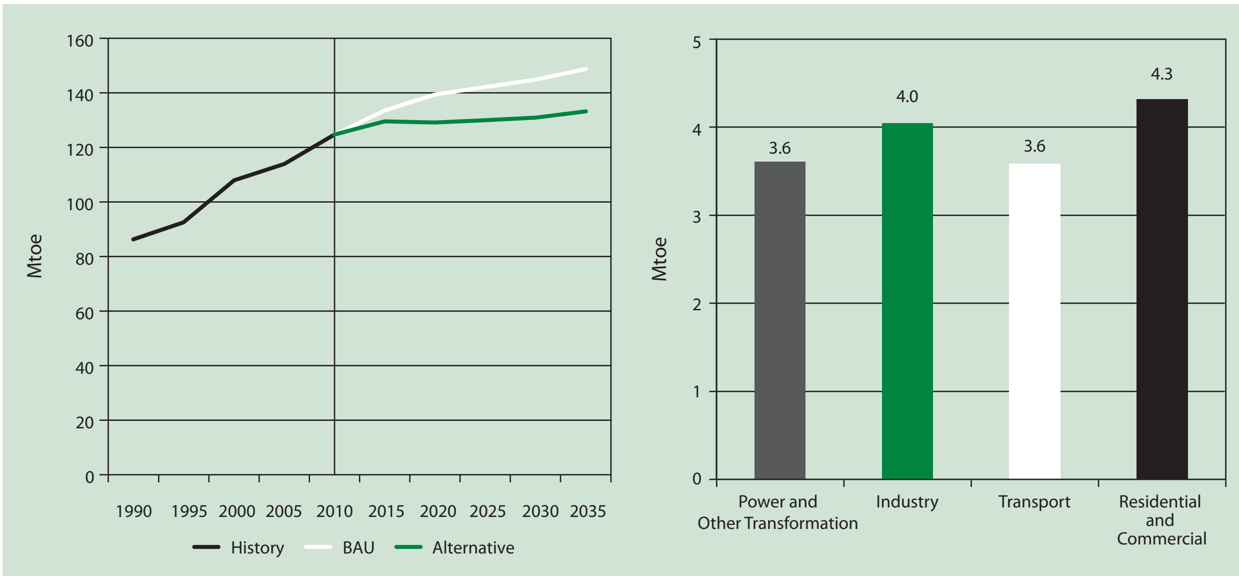
Endowed with significant reserves of coal and natural gas, including nonconventional gas, Australia will remain a net exporter of coal and natural gas through 2035 (Figure 13.1.3). Meanwhile, Australia is likely to continuously depend on oil imports over the outlook period. Australia's oil production has been declining due to natural depletion, lack of new exploration fields coming online, and higher exploration costs for unexplored resources located offshore. In addition, since a large proportion of Australia's oil production is based off the northwest coast, which is closer to the refineries in Asia than to domestic refineries on the east coast, much of the crude oil and condensate production is exported, whereas refinery feedstock is imported. Refinery shutdowns, such as Shell's Clyde in 2012 and Caltex's Kurnell in 2014, will also prompt petroleum products import.

Alternative Case: Energy Savings Potential and Energy Source Diversification

In the alternative case, in which advanced technologies for energy savings are deployed, Australia's primary energy demand will reach 133.3 Mtoe in 2035 with an average annual growth rate of 0.3% (Figure 13.1.4). Compared with the BAU case in 2035, Australia has the potential to save about 15.6 Mtoe in 2035 (or a 10.5% reduction). Australia already has a number of programs and regulatory measures in place to promote energy efficiency, including the National Strategy for Energy Efficiency, released in July 2009.

By sector, the other sectors could present the most energy savings potential at 4.3 Mtoe (or a 22.6% reduction), as deployment of higher-efficiency appliances such as water heaters and air conditioning in the residential sector and lighting in the commercial sector will help curb energy demand of the sectors. The industry sector will offer the second-largest savings potential at 4.0 Mtoe, with the four energy-intensive industry subsectors (iron and steel, cement, paper and pulp, and petrochemical) accounting for about 25.9% of the potential. For

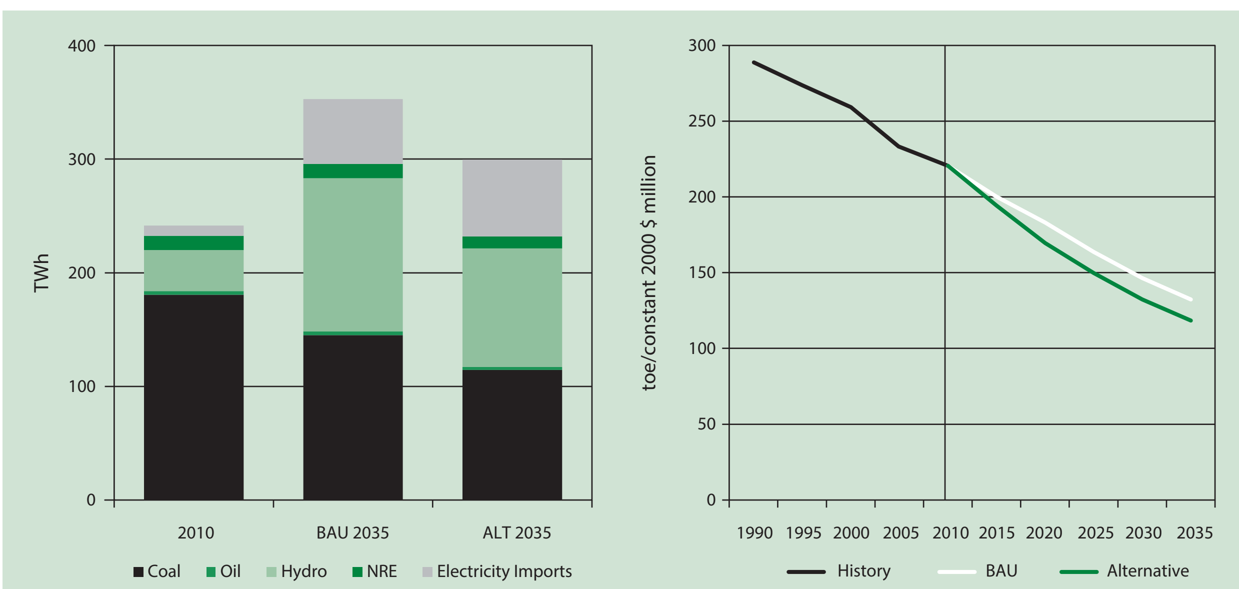
Figure 13.1.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

the power and other sectors, thermal efficiency improvements could contribute to most of the estimated savings of 3.6 Mtoe. The transport sector's energy demand of 3.6 Mtoe could be saved if obstacles that prevent more energy-efficient vehicles from entering the market are overcome. Hybrid and electric vehicles will need price competitiveness against conventional

Figure 13.1.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

vehicles, and further research, development, and demonstration of alternative low-carbon fuels will be necessary to complement or replace conventional oil.

As shown in the comparison of electricity generation by energy type between the BAU case and the alternative case shown in Figure 13.1.5, the total electricity generation in 2035 in the alternative case is approximately 15.1% lower than in the BAU case, mainly due to thermal efficiency improvements of power plants. Coal will dominate the electricity generation mix through 2035 in both cases, although its share will be significantly reduced from 74.8% in 2010 to 41.1% in 2035 in the BAU case and 38.2% in the alternative case. Australia has the Renewable Energy Target, which aims for at least 20% of the electricity supply to be provided by renewable energy sources by 2020.[52] Australia's commitment to energy efficiency and the promotion of renewable energy makes it likely that the country will get close to the target in the BAU case but achieve it in the alternative case. This will bring about a reduction in the role of coal in the electricity generation mix over the outlook period, and increased contributions from natural gas and new and renewable energy, mainly wind.

The energy intensity (primary energy demand per GDP) in the alternative case is projected to reach 118 toe per million constant 2000 $, which is 13.8 toe per million constant 2000 $ lower than in the BAU case. Advanced technologies deployment will accelerate energy intensity improvement in the alternative case.

Energy Policy Implications

As demand for cleaner sources of fuel such as natural gas increases domestically and globally over the outlook period, Australia may wish to expedite regulation and exploration processes to maximize its sizable natural gas resources. Australia's existing reserves will be sufficient to meet the projected natural gas demand including export demand. Still, the viability of LNG projects hold the key to whether Australia is able to produce and export natural gas as planned. Specifically, increasing production costs and delays to exploration and production approval processes are looming concerns as they might require the LNG project plans to change. It is also necessary to pay attention to the recent discussion on LNG pricing in Asia, which could impact the gas price in Asia and the Pacific.

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[52] The Renewable Energy Target is separated into the Large-Scale Renewable Energy Target and the Small-Scale Renewable Energy Scheme to provide greater certainty for households, for large-scale renewable energy projects, and for installers of small-scale renewable energy systems.

13.2 Japan

- *In the BAU case, the primary energy demand of Japan is projected to decline from 496.8 Mtoe in 2010 to 467.5 Mtoe in 2035, at an annual rate of –0.2%. The deployment of advanced technologies across the sectors in the alternative case,* will lead to a faster decline in primary energy demand at 0.7% per year. This suggests that Japan will have an energy savings potential of 54.4 Mtoe (or 11.6% of the BAU case) in 2035.*
- *The future of nuclear power remains the largest uncertainty in Japan's energy outlook, as Japan has not yet reached a consensus on the role of nuclear power after the Fukushima Daiichi Nuclear Power Plant accident. The BAU case assumes that no new nuclear units are built, and that existing nuclear units will continue to operate, but will be phased out at the end of their 40-year life.*

Recent Energy Trends and Energy Policy Issues

After a decade-long recession during the 1990s, the Japanese economy turned to register a recovery trend from the early part of the 2000s when the growth in manufacturing exports revived the industry's investments and private consumption. In fact, from 2000 to 2007, the Japanese economy grew at an annual rate of 1.6% per year. In contrast, starting from 2008, the economy contracted due to the global economic crisis and resulting lower investments and global demand for Japanese manufacturing exports. The government stimulus package, including government spending as well as fiscal incentives for passenger vehicles, electric appliances, and residential buildings, supported the recovery in 2010. Nevertheless, the economy contracted again in 2011 as a result of the Great East Japan Earthquake on 11 March that jolted manufacturing activities.

Peaking in 2004 at 522.5 Mtoe, the total primary energy demand of Japan has been declining since with an average annual rate of –1.9% through 2011, when it reached 458.1 Mtoe. The contributing factors to the negative growth differ by period. From 2004 to 2007, when the economy registered a positive growth rate of 2.1% per year on average, energy intensity improvement—attributed to the deployment of efficient technologies and shifts in industry structure toward services—resulted in a moderate decline of primary energy demand at –0.5% per year. At the same time, from 2008 to 2009, the impacts of the global economic recession were felt greatly, causing a decline in primary energy demand at –4.7% per year. The economic recovery in 2010 increased primary energy demand by 5.2% in 2010, but the impacts of the Great East Japan Earthquake were severe and primary energy demand contracted by 7.8% in 2011.

Endowed with only a small amount of fossil energy sources domestically, Japan's primary energy policy agenda concerns how to secure a stable energy supply at an affordable price level. In this regard, energy source diversification away from imported oil has been promoted with the deployment of nuclear power, coal, and natural gas on the supply side. This has been effectively coupled with the demand-side undertakings to promote energy efficiency

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

and conservation. Nevertheless, repercussions from the tsunami-induced accidents at the Fukushima Daiichi nuclear power plant in 2011 have been felt widely in Japan and called for a re-evaluation and reconsideration of Japanese energy policy.

Of the total installed nuclear capacity at 48 gigawatts (GW), only two units are under operation as of the middle of 2013. The operation of other units has been suspended following regular maintenance. To restart operation of nuclear power plants will require local governments' approval after passing the stress tests that are approved by the Nuclear Regulation Authority.

Lost nuclear capacities have been covered by the increased use of fossil fuel generation, in particular natural gas-fired generation, which has brought additional costs to the Japanese economy. LNG imports amounted to 85.0 million LNG tons in 2011 and in 2012 were estimated to reach 90.0 million LNG tons, up from 70.0 million LNG tons in 2010. In parallel with the rising LNG price in the Asia and the Pacific market, LNG imports expanded the trade deficit to 6.9 trillion yen in 2012.

Moreover, to cope with the tight balance between electricity supply and demand, nationwide energy efficiency and conservation efforts called *setsuden* were carried out in 2011 and 2012 through shifts in industry's operational hours and days and avoidance of unnecessary electricity use in the residential and commercial sectors to lower peak demand during summer and winter.

It was under such circumstances that newly elected Prime Minister Shinzo Abe directed the minister of economy, trade and industry in January 2013 to establish a responsible energy policy after the full re-evaluation and reconsideration of the energy and environmental strategies that had been promulgated by the previous administration. In his policy speech in the 183rd Session of the National Diet[53] in February 2013, the prime minister identified as a priority the formulation of a "responsible energy policy" to ensure energy supply security and lower energy supply costs. He stressed the importance of the introduction of energy efficiency and conservation and renewable energy sources "to the greatest possible extent" to reduce Japan's dependence on nuclear energy. The prime minister also mentioned that deregulation of the electricity system would be implemented to ultimately allow retail competition in the long run. Regarding nuclear power, the current administration seeks to carry out maximum efforts to solicit local governments' understanding and cooperation to restart operations of suspended plants once the operational safety is guaranteed by the Nuclear Regulation Authority.

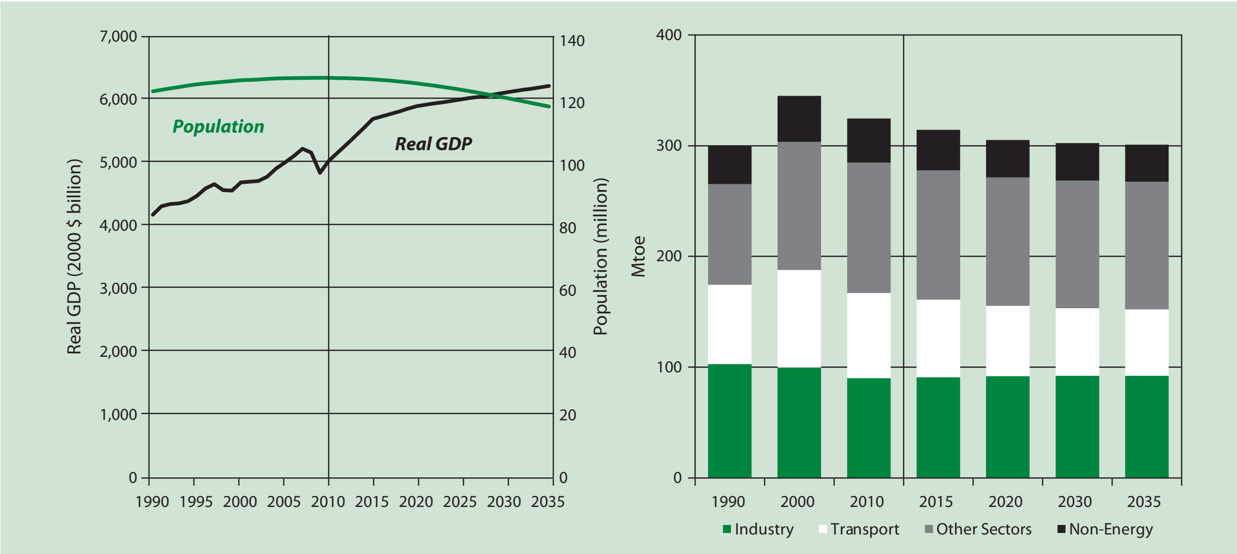
Business-as-Usual Case: Energy Demand Outlook through 2035

Japan's GDP is projected to reach \$6,197.4 billion (constant 2000 \$) in 2035, up from \$5,010.6 billion in 2010, at an average rate of 0.9% per year. The near-term growth will be faster at 1.6% per year (2010–2020), spurred by the structural reform to strengthen industrial competitiveness, mainly for the manufacturing sector. In the long term, the economy is projected to increase slowly at 0.4% per year (2020–2035) as industrial activities are progressively relocated and the working-age population declines domestically.

The population of Japan is projected to decline at an annual rate of –0.3% through 2035, and will reach 117.3 million in 2035, from 126.5 million in 2010 (Figure 13.2.1). As a result, the per

[53] The National Diet is Japan's bicameral legislative body.

Figure 13.2.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

capita GDP of Japan will increase from $39,598.5 in 2010 to $52,812.0 in 2035, which compares with the average of Asia and the Pacific at $35,035.6 in 2035.

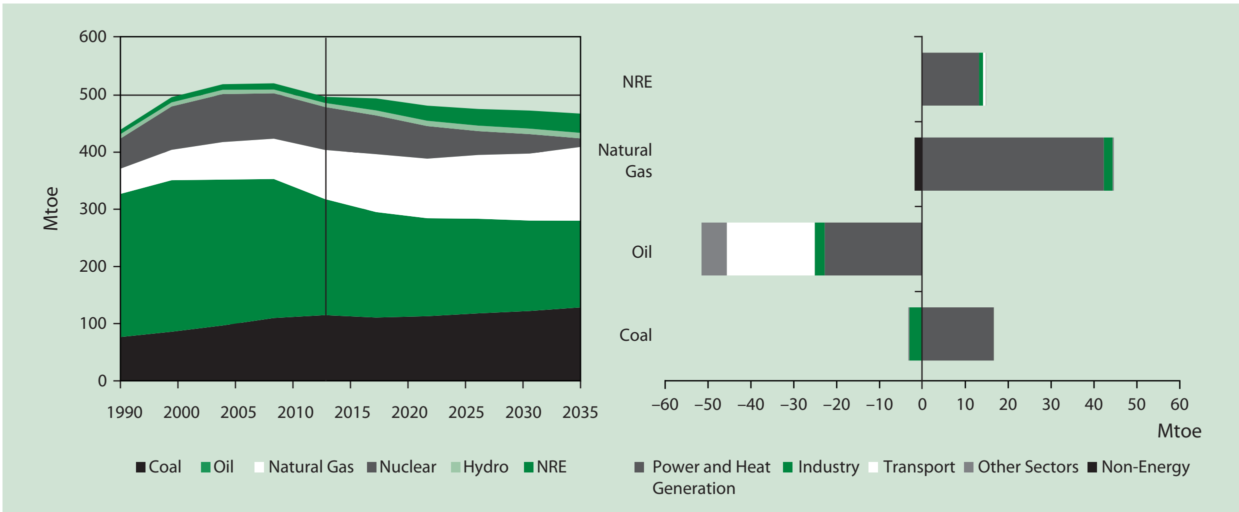
In the BAU case, the final energy demand of Japan is projected to reach 300.9 Mtoe in 2035, declining from 324.6 Mtoe in 2010, at an annual rate of –0.3%. By energy type, because of the shifts in industry structure and ease-of-use factors, electricity and gas will increase respectively at 0.3% and 0.2% through 2035, which contrasts with the projected decline in the demand for coal and oil at an annual rate of –0.5% and –0.7%, respectively, over the outlook period.

The other sectors' (including residential, commercial, agriculture, and fishery) energy demand will continue to dominate the final energy demand, representing a 37.9% share in 2035, up from 36.3% in 2010. The sectors' overall energy demand will decline to 115.2 Mtoe in 2035, from 117.7 Mtoe in 2010, at an average rate of –0.1%. The structure by energy type may not change substantially in the sectors, with electricity dominating with a share of 47.7% in 2035, followed by oil (29.5%) and natural gas (21.3%).

Industry energy demand, representing the second-largest share in the final energy demand sector, will grow slowly at 0.1% per year, reaching 92.4 Mtoe in 2035 compared with the 2010 level of 90.0 Mtoe. The near-term growth will be 0.2% per year (2010–2020) driven by the moderate recovery of the global economy and resulting increases in exports of Japanese manufacturing products. This compares with a slow growth of 0.04% per year in the long term (2020–2035) resulting from the relocation of industrial activities to overseas. In terms of energy source, electricity and natural gas are expected to grow respectively at 0.6% and 0.9% per year through 2035 to occupy respective shares of 36.4% and 10.7% in 2035.

Transport energy demand will decline at an annual rate of –1.0% from 76.9 Mtoe in 2010 to 59.8 Mtoe in 2035. Diffusion of fuel-efficient vehicles, particularly hybrid and plug-in hybrid vehicles, combined with the decline in vehicle stocks (from 66.7 million units in 2010 to 61.4 million units in 2035), will impact the decline in passenger transport energy demand. In freight transport,

Figure 13.2.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual

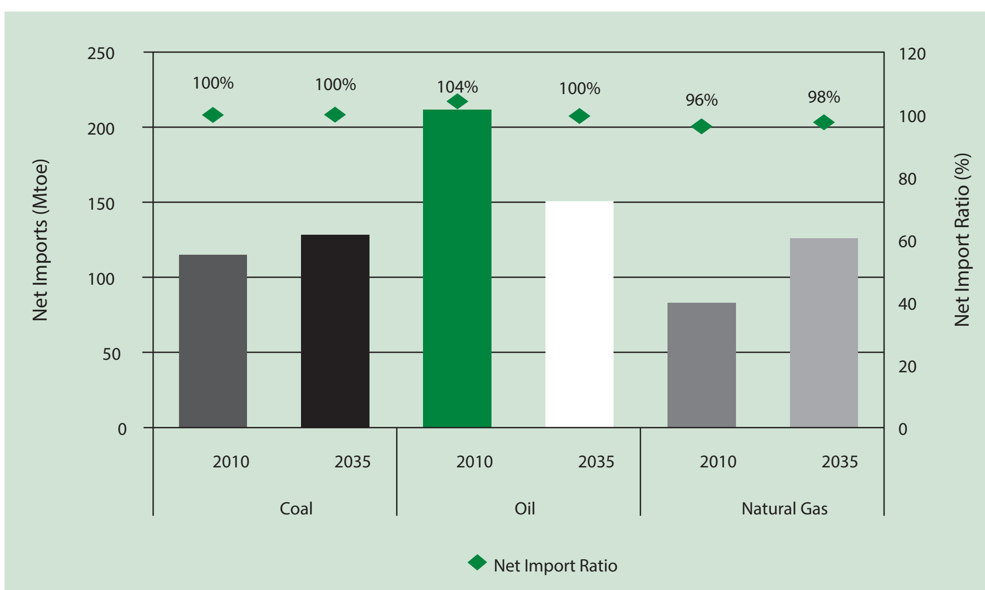


Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

the need for operational improvements will increase along with the tight economic situation, and this will in turn improve the overall energy efficiency for transporting goods and services.

Japan's primary energy demand is projected to decline moderately at –0.2% per year (2010–2035), reaching 467.5 Mtoe in 2035, down from 496.8 Mtoe in 2010 (Figure 13.2.2). In the BAU case, nuclear is assumed to resume operation once current safety reviews

Figure 13.2.3 Net Imports of Coal, Oil, and Natural Gas and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

are completed; nevertheless, there will be no new capacity additions and each unit is assumed to be decommissioned after 40 operational years. The primary energy demand mix is therefore projected to change substantially as the decline in nuclear is offset by the increases in natural gas, coal, and new and renewable energy sources, including wind, solar, biomass, and others.

Fossil fuels will account for the dominant share in primary energy demand, while the growth trends vary by type. Oil will decline at an annual rate of –1.2% resulting from reduced demand in the transport and power sectors. Natural gas, on the other hand, will increase fast at 1.6% per year through 2035 to compensate for the reduced nuclear capacity, and its share will reach 27.6% in 2035, up from 17.3% in 2010. Coal demand is projected to moderately increase at 0.4% per year in order to cover for the reduction in electricity production from nuclear energy resulting from the lowering of total nuclear power plant capacity in the country.

Assisted by the policy measures for energy source diversification, other sources (including geothermal, solar, wind, and other new and renewable energy sources) will increase substantially from 10.7 Mtoe in 2010 to 33.7 Mtoe in 2035, mainly driven by the capacity expansions in solar (45.3 GW in 2035) and wind (9.2 GW in 2035) for generation.

Endowed with few indigenous energy sources, Japan will continue to rely on imports to meet its fossil fuel needs. The BAU case's assumed reduction in nuclear capacity will translate into substantial increases of coal and natural gas for power generation, with their respective imports reaching 186.4 million tons of coal equivalent in 2035 (coal) and 103.3 million LNG tons (natural gas) in 2035 (Figure 13.2.3). Oil imports will decline to 3.0 million barrels per day (mb/d) in 2035, from 4.3 mb/d in 2010.

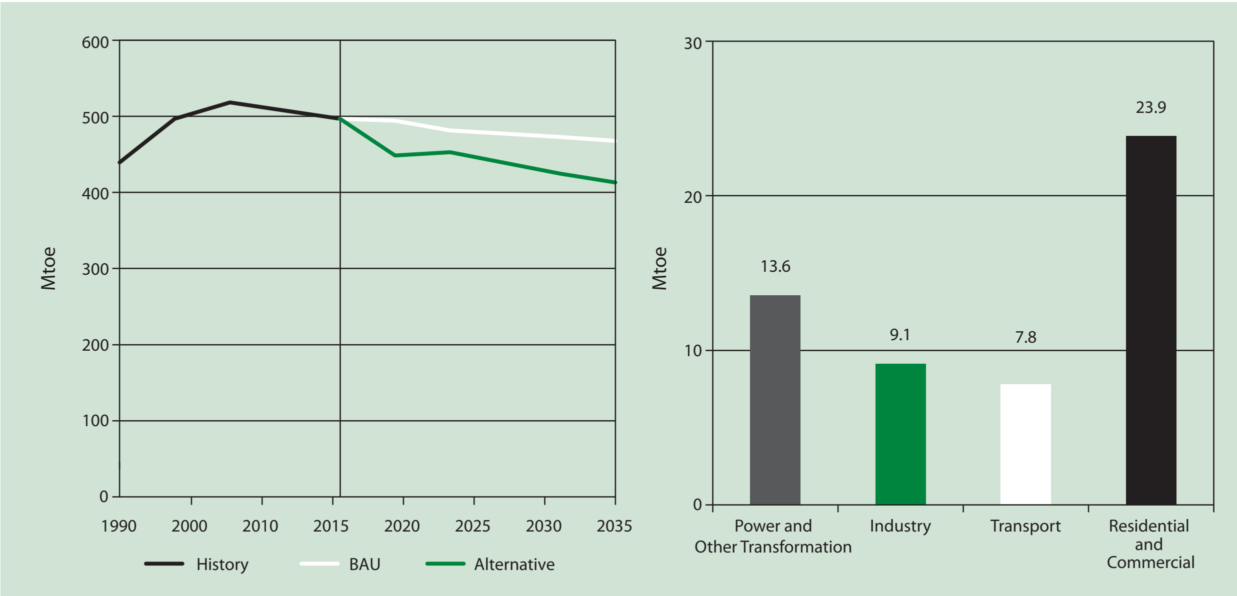
Alternative Case: Energy Savings Potential and Energy Source Diversification

In the alternative case, the primary energy demand of Japan is projected to decline at –0.7% per year, compared with the projected negative growth in the BAU case at –0.2% per year. With this faster decline rate, the primary energy demand in the alternative case is 54.4 Mtoe lower in 2035 or 11.6% in energy savings compared to the BAU case (Figure 13.2.4). The biggest savings will come from the residential and commercial sectors (23.9 Mtoe), followed by the power sector (13.6 Mtoe), the industry sector (9.1 Mtoe), and the transport sector (7.8 Mtoe).

The residential and commercial sectors' savings will mainly result from the residential savings estimated at 17.1 Mtoe, and the remainder from the commercial savings at 6.8 Mtoe in 2035. Technological improvements in space heating, air conditioning, and water heating explain the residential savings, while cooling, lighting, and refrigeration are the major contributors to the commercial energy savings.

The power sector's energy savings will result from thermal efficiency improvement of power generation units, and electricity demand savings. Much of the savings in this sector reflects demand-side electricity savings, while the overall deterioration of thermal efficiency (as a result of the increased nuclear capacity despite the improved thermal efficiency of fossil fuel generation) will offset the savings amount.

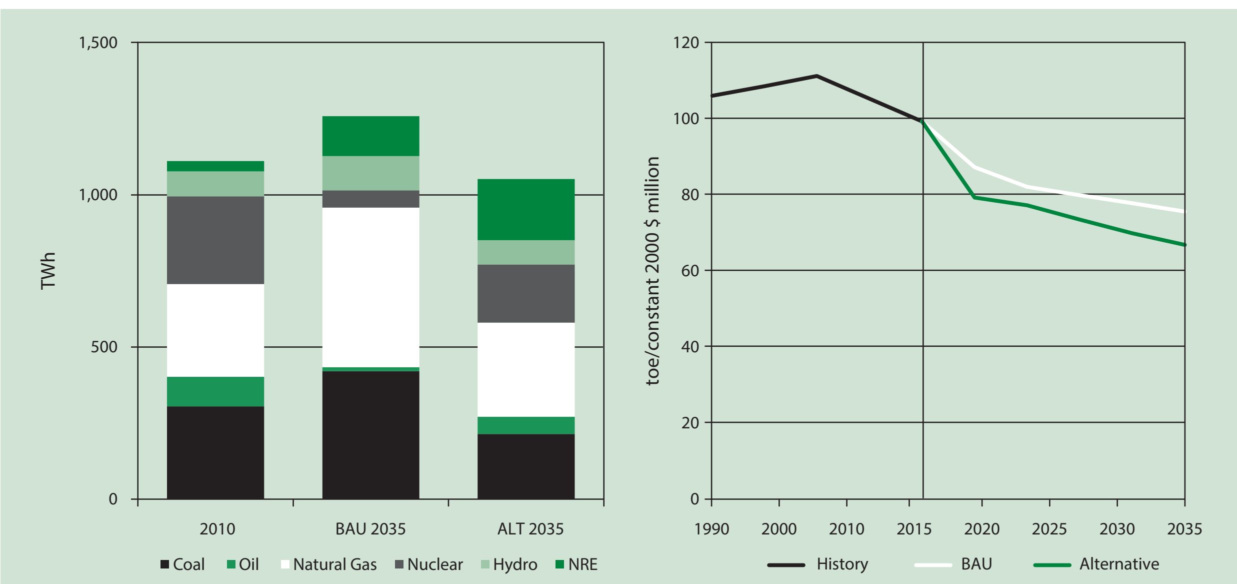
Figure 13.2.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

In the alternative case, Japan's electricity generation in 2035 will be about 16.4% lower at 1,051.3 TWh in 2035, compared with the 2010 level at 1,110.8 TWh (Figure 13.2.5). Substantial savings in total generation in 2035 will come from the electricity demand savings in the industry, residential, and commercial sectors.

Figure 13.2.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

The alternative case assumes that nuclear will gradually become operational after 2013 when the safety reviews are completed. In contrast to the BAU case, the alternative case assumes 50 operational years for the capacities to be decommissioned, thereby making no additional capacity expansions through 2035. Additionally, the alternative case assumes major expansions of new and renewable energy for power generation, with the capacity of solar reaching 67.3 GW and wind 20.3 GW in 2035.

Energy Policy Implications

Although Japan's primary energy demand is projected to decline, even in the BAU case, the dependence on fossil fuels will continue. As domestic fossil fuel resources are scarce, Japan continues to rely on imported sources. In particular, natural gas and coal imports will expand under the assumption that nuclear power will be phased out after 40 operational years. Ensuring stable supplies at reasonable price levels will be critically important to fuel the domestic energy needs.

To cope with the current high LNG price in Asia and the Pacific, efforts are necessary to diversify the source of supplies. Procurement partnerships with other LNG importers in Asia as well as involvement in overseas equity stakes will strengthen the buyers' position to secure imports at a competitive price level.

Coal will be an important energy source fueling the energy needs of Japan, particularly in the power sector. Concerted efforts between the government and private sector toward technological innovations should be strengthened to make progress on the earlier commercialization of clean coal technologies, including advanced ultra-supercritical and integrated coal gasification technologies.

Oil imports will decline from the current level if the assumed technological improvements in fuel economy are realized, while the security of oil supplies will continue to be an important energy policy issue in view of the globally tight balance between oil demand and supply.

Aside from the supply-side efforts toward energy security enhancement, demand-side energy efficiency improvement will be an important cost-effective option to handle energy demand growth. The residential and commercial sectors, specifically, will generate the biggest energy savings potential, as some options can be achieved at a relatively low up-front cost (such as lighting). Combined with efforts by the government and the private sector to manage the daily peak load, which can contribute to lowering installed capacity, demand savings should continue to be promoted through the provision of incentives and efforts to raise public awareness.

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13.3 New Zealand

- *In the BAU case, the primary energy demand of New Zealand is projected to increase from 18.2 Mtoe in 2010 to 22.3 Mtoe in 2035, growing at an annual rate of 0.8%. Over the same period, New Zealand's per capita energy demand will reach 4.17 toe per person, almost the same as the 2010 level.*
- *In the alternative case,* New Zealand's primary energy demand at the end of the outlook period is estimated to be 18.4 Mtoe, almost unchanged from the 2010 level and about 17.5% lower than in the BAU case.*
- *New Zealand is self-sufficient in natural gas at present. Though the country's natural gas reserve is supposed to be prominent, further investment is needed for natural gas development.*

Recent Energy Trends and Energy Policy Issues

New Zealand's economy is heavily dependent on agriculture and associated food processing. Mainly driven by increasing dairy export, the country's economy is expected to maintain a relatively strong growth among the developed countries. However, with no major heavy industries and a small population, the domestic energy market is expected to remain small in the future. Although New Zealand has a modest oil- and gas-producing industry, the country is still partly dependent on imports of oil and oil products. Yet, New Zealand produces a significant quantity of natural gas that could meet all its domestic demand.

In August 2011, the government released the New Zealand Energy Strategy 2011–2021: Developing Our Energy Potential to replace the 2007 New Zealand Energy Strategy. As part of the energy strategy, the government retains the target of 90% of electricity to be generated from renewable sources by 2025, provided security of supply is maintained. In 2010, 55.1% of New Zealand's power generation was from hydropower and another 18.1% came from non-hydro renewable energy sources, mainly geothermal and wind.

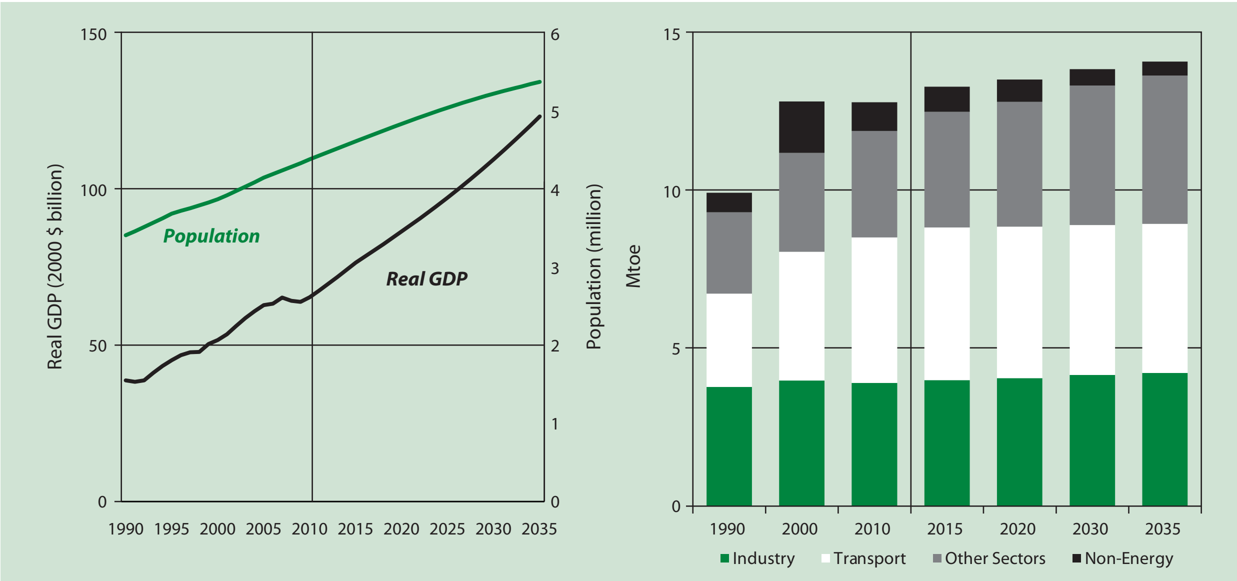
The strategy also includes a revised New Zealand Energy Efficiency and Conservation Strategy 2011–2016. The overall goal of the new strategy is for New Zealand to continue to improve its energy intensity (energy used per unit of GDP) by 1.3% per year to 2016.

Business-as-Usual Case: Energy Demand Outlook through 2035

Over the outlook period, New Zealand's GDP is projected to maintain substantial growth at an annual rate of 2.6%. GDP will reach $122.9 billion (constant 2000 $), nearly double the 2010 level

* The alternative case assumes that advanced technologies are applied by the final energy users and the transformation sector, and new and renewable energy and nuclear power plants are introduced as government plans, holding other conditions same as in the BAU case. Please refer to Table 1.1 for more details.

Figure 13.3.1 Population and GDP (left) and Final Energy Demand (right): Business-as-Usual



GDP = gross domestic product, Mtoe = million tons of oil equivalent.

of $65.3 billion (Figure 13.3.1). The country's population is projected to increase at a moderate rate of 0.8% per year, reaching 5.4 million in 2035 from 4.4 million in 2010.

In the BAU case, the final energy demand of New Zealand is projected to increase at an annual rate of 0.4% through 2035. Transport will remain the largest energy consumer by sector, though with its share declining to 33.6% in 2035 from 36.1% in 2010. With the increase of population, energy consumption in other sectors (including residential, commercial, agriculture, and fishery) will experience the most rapid growth, with its share rising from 26.3% to 33.4% during the projection period. On the other hand, with no heavy industries, though energy consumption in the industry sector is projected to increase slightly, its share will decline to 29.9% at the end of the projection period from 30.5% in 2010.

Vehicle ownership in New Zealand has already reached saturation. Over the outlook period, though energy consumption for transportation will still account for the largest part in final energy consumption, the absolute volume of energy demand will increase slightly from 4.6 Mtoe in 2010 to 4.8 Mtoe in 2020 and then decline to 4.7 Mtoe through 2035. The transport sector's energy demand in New Zealand is projected to grow hardly at all, with an annual growth rate of 0.1% over the outlook period.

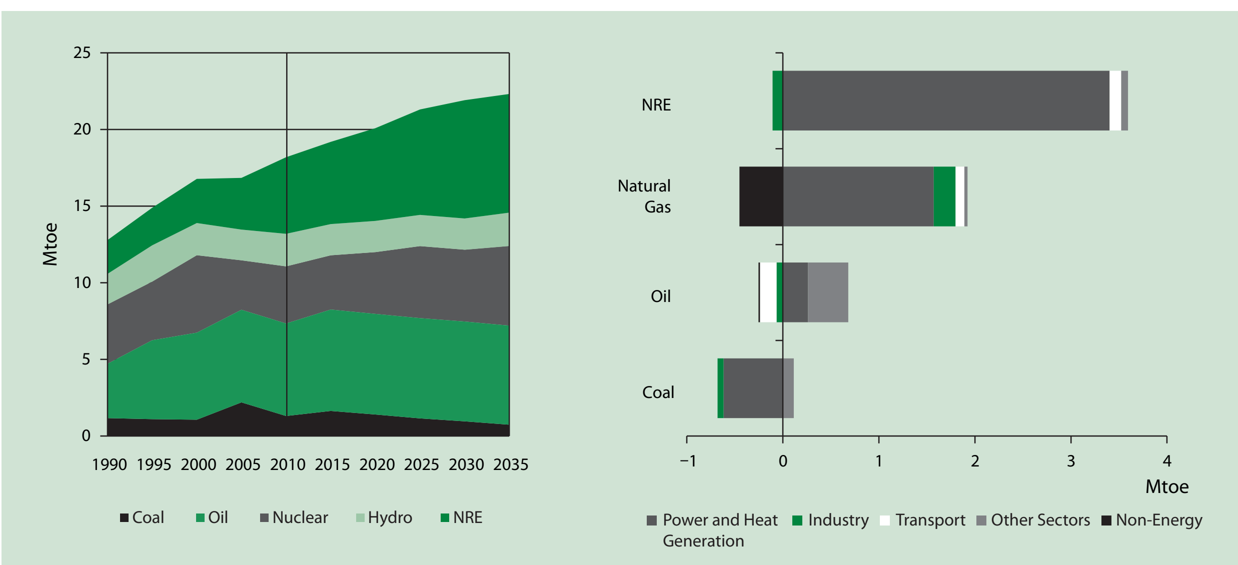
New Zealand's energy efficiency building codes, minimum efficiency performance standards for appliances, and assistance for home insulation and clean heating retrofits will help hold down the growth of residential energy demand. However, these efforts will be offset by a growing population, larger homes, and more appliances. Energy demand from the other sectors is expected to grow the fastest, increasing from 3.4 Mtoe to 4.7 Mtoe over the projection period at an annual rate of 1.3%. Electricity is expected to account for 60.7% of the energy demand of the other sectors in 2035. Following electricity is oil products, accounting for 21.2% in 2035. Oil products are consumed mainly in the agriculture subsector.

Energy demand in the industry sector is projected to grow at an average annual rate of only 0.3% until 2035, reflecting the slow growth of New Zealand's industry generally. New Zealand's heavy industry is dominated by a few big firms. The aluminum and petrochemical industries may be viewed as a way of exporting surplus energy. Their future will depend on the availability of low-cost electricity and gas, respectively. The other industries have competitive advantages in their local or export markets, so their demand is expected to be stable. Some growth in light industry is expected, but it is unlikely to be energy-intensive. Electricity is expected to be the dominating fuel in the sector accounting for 36.6% in 2035, followed by natural gas, which will account for 24.5% at the end of the projection period.

In the BAU case, the primary energy demand of New Zealand is projected to increase from 18.2 Mtoe in 2010 to 22.3 Mtoe in 2035, growing at an annual rate of 0.8% (Figure 13.3.2). With this growth, the economy's per capita energy demand will reach 4.17 toe per person, nearly unchanged from the 2010 level.

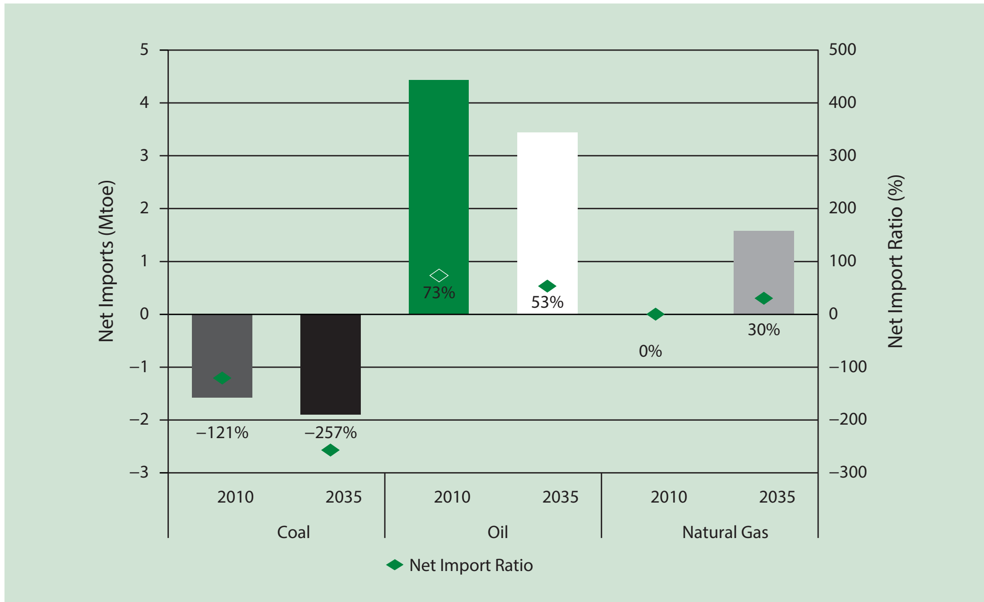
By energy type, the use of non-hydro renewable energy is expected to grow the fastest at an annual rate of 1.8%. With this rate, renewable energy supply will increase to 7.7 Mtoe at the end of the outlook period, accounting for 34.7% in the total primary energy supply, which is the largest share. Geothermal electricity accounted for about 13.1% of New Zealand's electricity production in 2010, and there is significant potential for more. Wind power, which currently accounts for about 3.6% of New Zealand's electricity production in 2010, could also be expanded significantly. More than half of New Zealand's electricity is generated by hydro (55.1% in 2010). However, the good sites for hydro plants have been largely developed, and there is strong environmental opposition to developing the remaining sites. While some small additional hydro projects may be possible, major new hydro projects are unlikely. Primary energy supply from hydro is expected to reach 2.2 Mtoe in 2035, nearly unchanged from the 2010 level of 2.1 Mtoe.

Figure 13.3.2 Primary Energy Demand (left) and Incremental Growth by Energy Type and Sector (right): Business-as-Usual



Mtoe = million tons of oil equivalent, NRE = new and renewable energy.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Figure 13.3.3 Net Imports of Coal, Oil, and Natural Gas and Net Import Ratio: Business-as-Usual



Mtoe = million tons of oil equivalent.

Among the fossil fuels, primary demand for natural gas is expected to grow the fastest at an annual rate of 1.3%, reaching 5.2 Mtoe in 2035 from 3.7 Mtoe in 2010. On the other hand, the demand for coal will decrease dramatically during the outlook period from 1.3 Mtoe to 0.7 Mtoe. The primary energy supply of oil will increase slightly to 6.5 Mtoe in 2035 from 6.0 Mtoe in 2010.

Although New Zealand has a modest oil- and gas-producing industry, the country will still be dependent on imports of oil and oil products (Figure 13.3.3). New Zealand also produces a significant quantity of natural gas. However, only the North Island has a natural gas pipeline and distribution network. New Zealand's gas market is totally isolated from the rest of the world, as there are no facilities for importing natural gas on either island; all of New Zealand's gas is currently domestically produced.

New Zealand's gas and domestic oil come primarily from Taranaki Basin, where there are several offshore fields. Taranaki Basin, covering an area of about 330,000 square kilometers, is currently the only producing basin in New Zealand. The basin remains underexplored compared with many comparable rift complex basins of its size and there remains considerable potential for further discoveries.

The rest of New Zealand is severely underexplored. Nevertheless, frontier basins drilled to date have all yielded discoveries confirming viable petroleum systems. Given that many untested structures mapped have closures bigger than Maui field (New Zealand's largest field in Taranaki Basin), there is considerable potential for commercial hydrocarbon discoveries under New Zealand's largely untouched seabed (New Zealand Petroleum & Minerals 2012).

New Zealand's oil and gas exploration and production activities are largely in private ownership and open to competition. New Zealand generally welcomes investments in oil and gas exploration by foreign firms.

Alternative Case: Energy Savings Potential and Energy Source Diversification

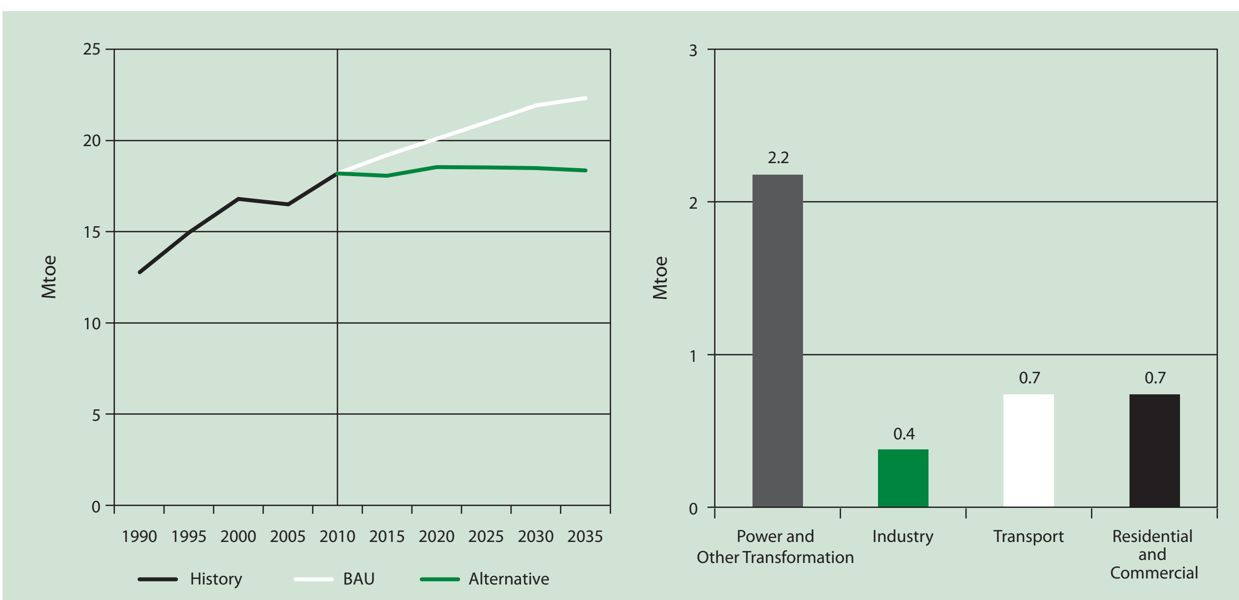
In the alternative case, New Zealand's primary energy demand will stay nearly unchanged through 2035, with growth slower than that in the BAU case (0.8%). Especially in the long term (2020–2035), primary energy demand is expected to decline (at an annual rate of –0.1%) due to substantial energy savings efforts. New Zealand's primary energy demand is projected to reach 18.4 Mtoe, which is 3.9 Mtoe or 17.5% lower than in the BAU case in 2035 (Figure 13.3.4).

By sector, the power sector represents the biggest energy savings potential at 2.2 Mtoe in 2035, representing more than half the total energy savings potential. The primary energy savings potential of the power sector comes from two dimensions. One is the improvement of thermal efficiency of thermal power plants, which means with the same electricity output less input of primary fuels is required. The other is the reduction of electricity demand resulting from energy savings efforts from the final sectors, which will be translated into a reduction of primary energy demand for power generation. It is estimated that more than three-quarters (76.6%) of the primary energy savings potential of the power sector in 2035 comes from thermal efficiency improvement.

The energy savings potential in the residential and commercial sectors is estimated at 0.7 Mtoe in 2035, a 14.9% decrease from the BAU level. In the alternative case, more effective regulation and support policies for high-efficiency appliances are expected to be in place. Water heating is estimated to have the highest energy savings potential in New Zealand.

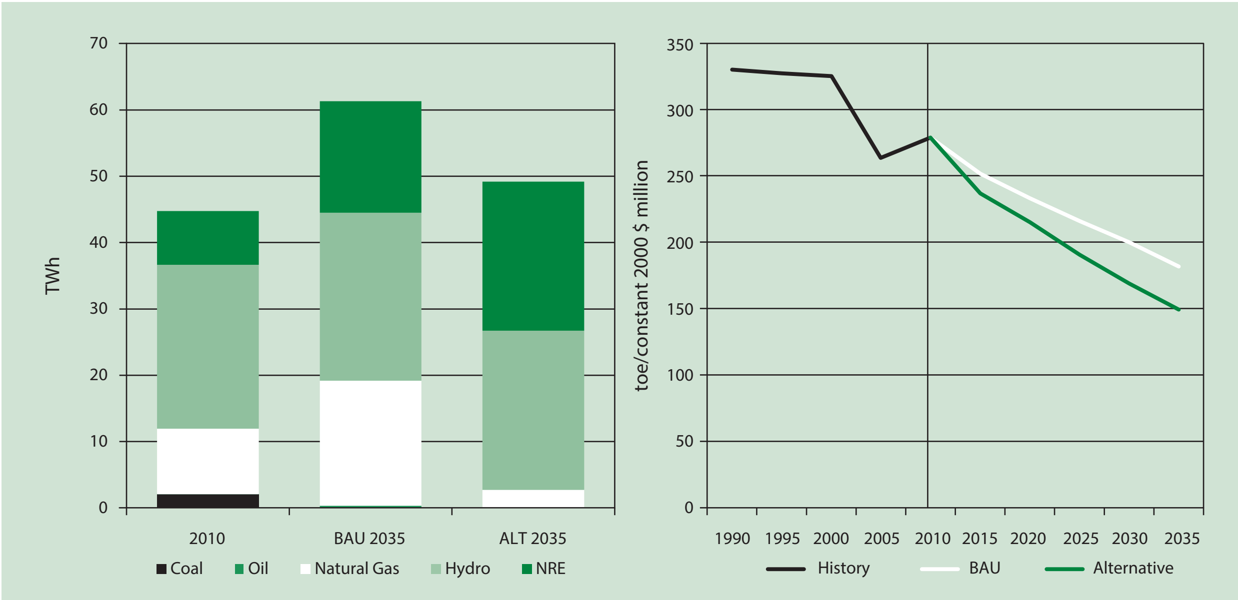
The energy savings potential in the transport sector is estimated at 0.7 Mtoe in 2035, representing a reduction of about 14.9% compared with the BAU energy demand in the sector.

Figure 13.3.4 Comparison of Primary Energy Demand (left) and Sectoral Net Energy Savings in 2035 (right)



BAU = business-as-usual, Mtoe = million tons of oil equivalent.

Figure 13.3.5 Comparison of Electricity Generation in 2035 (left) and Primary Energy per GDP (right)



ALT = alternative case, BAU = business-as-usual case, GDP = gross domestic product, NRE = new and renewable energy, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: NRE includes noncommercial biomass (such as wood and animal waste) and other new and renewable energy sources (such as biomass, geothermal, wind, solar, and others).

Higher vehicle fuel efficiency will be stimulated by stricter fuel efficiency standards in Japan, from which the majority of New Zealand's vehicles are imported in used form, as well as by New Zealand's own vehicle efficiency labeling scheme.

The industry sector will see an energy savings potential estimated at 0.4 Mtoe in 2035. As a country whose economy is heavily dependent on agriculture and associated food processing, New Zealand does not have as much energy-intensive industry as other developed countries. However, as the world's largest dairy exporter, the New Zealand dairy processing industry is particularly energy-consuming, as much of the exported dairy products must be dried or condensed. Another energy-intensive industrial exporter is the aluminum smelter located at Bluff, which accounts for about 12% of New Zealand's electricity consumption (Denne, Twomey, and Hale 2006). There is also one integrated steel mill in New Zealand. The energy savings potential from the industry sector is expected to come from efficiency improvement of these industries.

In the alternative case, New Zealand's electricity generation in 2035 will be about 19.7% lower at 49.2 TWh in 2035, compared with 61.3 TWh in the BAU case (Figure 13.3.5). In the alternative case, renewable energy, especially geothermal and wind power generation, are expected to play a greater role in the power generation portfolio. In 2035, the share of non-hydro renewable power is expected to reach 45.7% of total power generation, compared with 27.4% in the BAU case. The amounts of electricity generation from hydropower in both cases are roughly equal. However, power generation from natural gas in the alternative case is much smaller than in the BAU case. In the alternative case, the share of natural gas power is expected to be 5.5% in the total power supply, much lower than the 30.8% in the BAU case.

Energy Policy Implications

In comparison with other developed countries, renewable energy including hydropower has already been playing a significant role in New Zealand's total energy supply. In 2010, 39.2% of the country's primary energy supply came from hydro and other renewable energy resources, with 73.3% of the country's electricity supplied by renewable power generation (55.1% was hydropower). However, due to site availability limitation and environmental opposition to developing the remaining sites, hydropower is likely to stay constant in the future, which means more geothermal and wind power generation needs to be put online in order to achieve the country's renewable power target (90% by 2025).

On the other hand, increasing the share of renewable power generation means that the role of natural gas for power generation will be squeezed. Compounded with the country's underdeveloped natural gas pipeline network and high dependence on electricity, the future domestic market for natural gas can hardly be called promising. Despite the belief that there is considerable potential for commercial hydrocarbon discoveries under New Zealand's largely untouched seabed, a really major gas discovery would swamp the New Zealand market and require construction of an LNG export facility. However, to attract private investors to finance such large investment, the government's backing is necessary.

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Appendix 1

Historical Performance

Asia and the Pacific
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	6,318.6	8,614.3	12,702.8	3.6
Population (million persons)	3,007.7	3,492.3	3,883.5	1.3
GDP/capita (constant 2000 $/person)	2,101	2,467	3,271	2.2

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	2,382.2	3,101.2	4,985.2	100.0	100.0	100.0	3.8
Coal	852.1	1,066.0	2,301.4	35.8	34.4	46.2	5.1
Oil	704.2	984.2	1,238.2	29.6	31.7	24.8	2.9
Natural Gas	217.6	322.0	566.7	9.1	10.4	11.4	4.9
Nuclear	76.7	132.2	152.3	3.2	4.3	3.1	3.5
Hydro	38.0	48.3	99.5	1.6	1.6	2.0	4.9
Others[a]	493.5	548.6	624.6	20.7	17.7	12.5	1.2

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	1,775.2	2,145.7	3,238.5	100.0	100.0	100.0	3.1
Coal	440.5	358.7	694.3	24.8	16.7	21.4	2.3
Oil	539.6	794.8	1,057.0	30.4	37.0	32.6	3.4
Natural Gas	107.6	140.7	244.6	6.1	6.6	7.6	4.2
Electricity	187.8	304.9	602.8	10.6	14.2	18.6	6.0
Heat	32.0	39.0	79.5	1.8	1.8	2.5	4.7
Others	467.6	507.8	560.3	26.3	23.7	17.3	0.9

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	1,775.2	2,145.7	3,238.5	100.0	100.0	100.0	3.1
Industry	569.2	675.4	1,216.5	32.1	31.5	37.6	3.9
Transport	239.7	359.1	517.7	13.5	16.7	16.0	3.9
Other Sectors	843.1	920.7	1,176.7	47.5	42.9	36.3	1.7
Non-Energy	123.2	190.6	327.7	6.9	8.9	10.1	5.0

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	2,607.9	4,361.7	8,407.8	100.0	100.0	100.0	6.0
Fossil Fuels	1,848.8	3,243.1	6,503.8	70.9	74.4	77.4	6.5
Coal	1,043.3	2,193.1	5,042.0	40.0	50.3	60.0	8.2
Oil	475.0	401.2	270.9	18.2	9.2	3.2	(2.8)
Natural Gas	330.5	648.8	1,190.9	12.7	14.9	14.2	6.6
Nuclear	294.5	507.2	584.5	11.3	11.6	7.0	3.5
Hydro	442.0	561.2	1,156.8	16.9	12.9	13.8	4.9
Others[b]	22.7	50.3	162.5	0.9	1.2	1.9	10.3

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	486.1	807.3	1,573.4	100.0	100.0	100.0	6.0
Coal	294.8	578.0	1,261.4	60.7	71.6	80.2	7.5
Oil	110.7	94.3	67.9	22.8	11.7	4.3	(2.4)
Natural Gas	80.6	135.0	244.0	16.6	16.7	15.5	5.7

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	5,793.7	7,583.0	13,404.0	4.3

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.79	0.89	1.28	2.4
Primary Energy Demand/GDP (toe/million constant 2000 $)	377	360	392	0.2
CO_2/capita (t CO_2/person)	1.93	2.17	3.45	3.0
CO_2 Intensity (t CO_2/constant 2000 $ million)	917	880	1,055	0.7
CO_2/Primary Energy Demand (t CO_2/toe)	2.43	2.45	2.69	0.5

( ) = negative number, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: Figures may not add up to total because of rounding.
[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.
[b] "Others" include geothermal, solar, wind, and renewables.
Sources: Asian Development Bank (ADB). 2008 Survey on Energy and Energy-Related Information in the Pacific. Unpublished; ADB estimates; Asia Pacific Energy Research Centre (APERC). APEC Energy Database. http://www.ieej.or.jp/egeda/database/database-top.html (accessed 29 February 2012); APERC estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); United Nations Statistics Division. 2011. *Energy Balances and Electricity Profiles*. New York; World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Developing Member Countries
Historical Performance

Socioeconomic Indicators				1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)				1,831.0	3,478.4	7,061.1	7.0
Population (million persons)				2,865.0	3,343.6	3,730.3	1.3
GDP/capita (constant 2000 $/person)				639	1,040	1,893	5.6

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	1,843.9	2,457.4	4,345.4	100.0	100.0	100.0	4.4
Coal	739.3	919.9	2,133.8	40.1	37.4	49.1	5.4
Oil	419.1	689.1	989.3	22.7	28.0	22.8	4.4
Natural Gas	154.8	232.1	450.4	8.4	9.4	10.4	5.5
Nuclear	24.0	48.2	77.2	1.3	2.0	1.8	6.0
Hydro	27.1	37.3	89.2	1.5	1.5	2.1	6.1
Others[a]	479.5	530.8	603.3	26.0	21.6	13.9	1.2

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	1,408.6	1,718.2	2,825.8	100.0	100.0	100.0	3.5
Coal	402.9	326.9	662.0	28.6	19.0	23.4	2.5
Oil	322.6	545.2	841.7	22.9	31.7	29.8	4.9
Natural Gas	81.9	103.2	195.4	5.8	6.0	6.9	4.4
Electricity	109.8	205.9	495.9	7.8	12.0	17.6	7.8
Heat	31.8	38.4	78.9	2.3	2.2	2.8	4.6
Others	459.6	498.6	552.0	32.6	29.0	19.5	0.9

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	1,408.6	1,718.2	2,825.8	100.0	100.0	100.0	3.5
Industry	443.3	547.8	1,100.1	31.5	31.9	38.9	4.6
Transport	143.9	241.4	407.5	10.2	14.0	14.4	5.3
Other Sectors	737.3	786.0	1,036.4	52.3	45.7	36.7	1.7
Non-Energy	84.1	143.0	281.8	6.0	8.3	10.0	6.2

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	1,585.9	3,063.7	7,010.7	100.0	100.0	100.0	7.7
Fossil Fuels	1,171.4	2,419.0	5,565.3	73.9	79.0	79.4	8.1
Coal	804.4	1,785.1	4,554.8	50.7	58.3	65.0	9.1
Oil	223.6	262.3	170.2	14.1	8.6	2.4	(1.4)
Natural Gas	143.4	371.6	840.3	9.0	12.1	12.0	9.2
Nuclear	92.2	185.1	296.3	5.8	6.0	4.2	6.0
Hydro	315.3	433.2	1,037.4	19.9	14.1	14.8	6.1
Others[b]	7.1	26.4	111.5	0.4	0.9	1.6	14.8

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	342.2	635.8	1,383.2	100.0	100.0	100.0	7.2
Coal	240.5	487.3	1,154.2	70.3	76.6	83.4	8.2
Oil	59.1	66.3	49.0	17.3	10.4	3.5	(0.9)
Natural Gas	42.6	82.2	179.9	12.4	12.9	13.0	7.5

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	4,337.8	5,904.9	11,716.7	5.1

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.64	0.73	1.16	3.0
Primary Energy Demand/GDP (toe/million constant 2000 $)	1,007	706	615	(2.4)
CO_2 /capita (t CO_2/person)	1.51	1.77	3.14	3.7
CO_2 Intensity (t CO_2/constant 2000 $ million)	2,369	1,698	1,659	(1.8)
CO_2 /Primary Energy Demand (t CO_2/toe)	2.35	2.40	2.70	0.7

( ) = negative number, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: Figures may not add up to total because of rounding.
[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.
[b] "Others" include geothermal, solar, wind, and renewables.
Sources: Asian Development Bank (ADB). 2008 Survey on Energy and Energy-Related Information in the Pacific. Unpublished; ADB estimates; Asia Pacific Energy Research Centre (APERC). APEC Energy Database. http://www.ieej.or.jp/egeda/database/database-top.html (accessed 29 February 2012); APERC estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); United Nations Statistics Division. 2011. *Energy Balances and Electricity Profiles*. New York; World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Central and West Asia
Historical Performance

Socioeconomic Indicators			1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)			125.1	126.4	244.7	3.4
Population (million persons)			191.3	238.4	282.9	2.0
GDP/capita (constant 2000 $/person)			654	530	865	1.4

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	240.6	185.7	248.5	100.0	100.0	100.0	0.2
Coal	50.1	23.4	40.6	20.8	12.6	16.4	(1.0)
Oil	73.2	46.1	54.1	30.4	24.8	21.8	(1.5)
Natural Gas	91.0	84.1	114.8	37.8	45.3	46.2	1.2
Nuclear	0.1	1.0	1.5	0.0	0.6	0.6	16.2
Hydro	5.9	5.8	8.0	2.5	3.1	3.2	1.5
Others[a]	20.4	25.3	29.5	8.5	13.6	11.9	1.9

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	186.8	132.0	174.9	100.0	100.0	100.0	(0.3)
Coal	22.6	5.9	19.2	12.1	4.4	11.0	(0.8)
Oil	50.3	28.5	39.1	26.9	21.6	22.4	(1.2)
Natural Gas	55.9	48.7	57.8	29.9	36.9	33.1	0.2
Electricity	21.1	15.2	20.1	11.3	11.5	11.5	(0.2)
Heat	17.7	9.0	9.5	9.5	6.8	5.4	(3.0)
Others	19.2	24.6	29.1	10.3	18.6	16.7	2.1

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	186.8	132.0	174.9	100.0	100.0	100.0	(0.3)
Industry	54.5	33.2	49.5	29.2	25.1	28.3	(0.5)
Transport	21.9	19.0	25.4	11.7	14.4	14.5	0.7
Other Sectors	103.1	73.9	93.5	55.2	56.0	53.5	(0.5)
Non-Energy	7.3	5.9	6.4	3.9	4.5	3.7	(0.6)

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	278.3	239.2	310.4	100.0	100.0	100.0	0.5
Fossil Fuels	209.3	167.7	211.6	75.2	70.1	68.2	0.1
Coal	68.7	38.4	69.3	24.7	16.1	22.3	0.0
Oil	52.7	48.2	35.2	18.9	20.2	11.3	(2.0)
Natural Gas	87.9	81.0	107.1	31.6	33.9	34.5	1.0
Nuclear	0.3	4.0	5.9	0.1	1.7	1.9	16.2
Hydro	68.7	67.5	92.9	24.7	28.2	29.9	1.5
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	71.4	53.1	59.4	100.0	100.0	100.0	(0.9)
Coal	26.8	15.8	19.2	37.5	29.8	32.3	(1.6)
Oil	16.3	12.5	8.6	22.8	23.6	14.4	(3.2)
Natural Gas	28.4	24.8	31.6	39.7	46.6	53.3	0.5

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	615.7	415.5	580.3	(0.3)

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	1.26	0.78	0.88	(1.8)
Primary Energy Demand/GDP (toe/million constant 2000 $)	1,923	1,469	1,016	(3.1)
CO_2/capita (t CO_2/person)	3.22	1.74	2.05	(2.2)
CO_2 Intensity (t CO_2/constant 2000 $ million)	4,921	3,288	2,372	(3.6)
CO_2/Primary Energy Demand (t CO_2/toe)	2.56	2.24	2.33	(0.5)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); United Nations Statistics Division. 2011. *Energy Balances and Electricity Profiles*. New York; World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Afghanistan
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	3.6	2.7	9.1	4.7
Population (million persons)	13.0	22.9	31.4	4.5
GDP/capita (constant 2000 $/person)	278	119	290	0.2

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	1.2	0.6	0.9	100.0	100.0	100.0	(1.6)
Coal	0.1	0.0	0.0	8.1	0.1	3.5	(5.7)
Oil	0.7	0.1	0.3	54.6	21.5	30.4	(4.4)
Natural Gas	0.2	0.1	0.0	17.4	18.5	0.0	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.1	0.0	0.1	5.4	6.9	6.2	(0.9)
Others[a]	0.2	0.3	0.5	14.5	53.0	59.9	5.6

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.6	0.5	0.7	100.0	100.0	100.0	1.0
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.4	0.1	0.1	69.5	14.3	17.9	(5.7)
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Electricity	0.0	0.1	0.2	5.7	11.7	23.4	8.3
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	0.2	0.3	0.4	24.8	74.0	58.7	5.4

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.6	0.5	0.7	100.0	100.0	100.0	1.0
Industry	0.0	0.0	0.0	0.0	4.5	4.2	…
Transport	0.4	0.1	0.1	69.5	13.6	17.1	(5.9)
Other Sectors	0.2	0.4	0.6	30.5	81.9	78.7	5.9
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	…

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	1.1	0.7	1.2	100.0	100.0	100.0	0.4
Fossil Fuels	0.4	0.2	0.6	32.3	25.0	48.0	2.4
Coal	0.3	0.0	0.1	22.7	0.4	8.8	(4.2)
Oil	0.1	0.2	0.5	9.5	24.7	39.2	7.8
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.8	0.5	0.6	67.7	75.0	52.0	(0.9)
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	0.1	0.0	0.2	100.0	100.0	100.0	2.4
Coal	0.1	0.0	0.0	70.4	1.4	18.3	(4.2)
Oil	0.0	0.0	0.1	29.6	98.6	81.7	7.8
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	2.9	0.7	1.0	(5.5)

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.09	0.03	0.03	(5.8)
Primary Energy Demand/GDP (toe/million constant 2000 $)	338	238	98	(6.0)
CO_2 /capita (t CO_2/person)	0.23	0.03	0.03	(9.6)
CO_2 Intensity (t CO_2/constant 2000 $ million)	813	262	105	(9.7)
CO_2/Primary Energy Demand (t CO_2/toe)	2.41	1.10	1.07	(4.0)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); United Nations Statistics Division. 2011. *Energy Balances and Electricity Profiles*. New York; World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Armenia
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	2.8	1.9	4.1	1.9
Population (million persons)	3.5	3.1	3.1	(0.7)
GDP/capita (constant 2000 $/person)	795	621	1,327	2.6

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	7.7	2.0	2.4	100.0	100.0	100.0	(5.6)
Coal	0.2	0.0	0.0	3.2	0.0	0.0	…
Oil	3.6	0.3	0.4	47.3	14.5	14.4	(11.0)
Natural Gas	3.6	1.1	1.3	46.7	55.9	52.8	(5.0)
Nuclear	0.0	0.5	0.6	0.0	26.1	26.5	…
Hydro	0.1	0.1	0.2	1.7	5.4	9.0	2.5
Others[a]	0.1	(0.0)	(0.1)	1.1	(1.9)	(2.7)	…

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	6.5	1.1	1.8	100.0	100.0	100.0	(6.2)
Coal	0.2	0.0	0.0	3.8	0.0	0.0	…
Oil	2.4	0.3	0.4	36.4	26.6	19.7	(9.1)
Natural Gas	2.7	0.4	1.0	42.5	40.0	57.1	(4.8)
Electricity	0.8	0.3	0.4	12.0	28.2	22.5	(3.2)
Heat	0.3	0.1	0.0	5.2	5.1	0.6	(15.7)
Others	0.0	0.0	0.0	0.1	0.1	0.1	(6.2)

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	6.5	1.1	1.8	100.0	100.0	100.0	(6.2)
Industry	1.8	0.4	0.3	28.2	36.3	17.7	(8.4)
Transport	1.0	0.2	0.5	16.2	18.9	28.0	(3.6)
Other Sectors	3.3	0.5	1.0	51.3	42.6	53.6	(6.0)
Non-Energy	0.3	0.0	0.0	4.2	2.1	0.7	(14.5)

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	10.4	6.0	6.5	100.0	100.0	100.0	(2.3)
Fossil Fuels	8.8	2.7	1.4	85.0	45.2	22.2	(8.7)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	7.1	0.0	0.0	68.6	0.0	0.0	…
Natural Gas	1.7	2.7	1.4	16.4	45.2	22.2	(0.8)
Nuclear	0.0	2.0	2.5	0.0	33.7	38.4	…
Hydro	1.6	1.3	2.6	15.0	21.2	39.4	2.5
Others[b]	0.0	0.0	0.0	0.0	0.0	0.1	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	2.1	0.7	0.3	100.0	100.0	100.0	(9.8)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	1.3	0.0	0.0	61.0	0.0	0.0	…
Natural Gas	0.8	0.7	0.3	39.0	100.0	100.0	(5.4)

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	19.8	3.5	4.1	(7.6)

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	2.17	0.65	0.79	(4.9)
Primary Energy Demand/GDP (toe/million constant 2000 $)	2,730	1,048	596	(7.3)
CO_2 /capita (t CO_2/person)	5.57	1.12	1.32	(7.0)
CO_2 Intensity (t CO_2/constant 2000 $ million)	7,007	1,807	994	(9.3)
CO_2 /Primary Energy Demand (t CO_2/toe)	2.57	1.72	1.67	(2.1)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Azerbaijan
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	9.0	5.3	21.2	4.4
Population (million persons)	7.2	8.0	8.9	1.1
GDP/capita (constant 2000 $/person)	1,257	658	2,389	3.3

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	26.2	11.4	11.8	100.0	100.0	100.0	(3.9)
Coal	0.1	0.0	0.0	0.3	0.0	0.0	…
Oil	12.0	6.3	3.7	45.6	54.7	31.4	(5.7)
Natural Gas	14.2	5.0	7.8	54.3	43.7	66.0	(3.0)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.1	0.1	0.3	0.2	1.2	2.5	8.3
Others[a]	(0.1)	0.0	0.0	(0.5)	0.4	0.1	…

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	16.0	6.7	6.8	100.0	100.0	100.0	(4.2)
Coal	0.1	0.0	0.0	0.6	0.0	0.0	(100.0)
Oil	5.3	1.8	2.7	33.0	26.5	39.6	(3.3)
Natural Gas	9.0	3.2	2.7	56.5	48.3	40.3	(5.8)
Electricity	1.6	1.3	1.1	9.9	19.1	15.6	(2.0)
Heat	0.0	0.4	0.3	0.0	6.0	4.5	…
Others	0.0	0.0	0.0	0.0	0.1	0.0	(100.0)

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	16.0	6.7	6.8	100.0	100.0	100.0	(4.2)
Industry	7.0	2.0	0.7	43.8	29.7	10.4	(10.8)
Transport	1.4	0.7	1.8	8.9	11.1	25.9	1.1
Other Sectors	6.7	3.9	3.8	42.2	58.3	56.3	(2.8)
Non-Energy	0.8	0.1	0.5	5.1	1.0	7.4	(2.3)

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	23.2	18.7	18.7	100.0	100.0	100.0	(1.1)
Fossil Fuels	22.5	17.2	15.3	97.0	91.8	81.6	(1.9)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	22.5	13.5	0.0	97.0	72.0	0.2	(28.1)
Natural Gas	0.0	3.7	15.2	0.0	19.8	81.4	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.7	1.5	3.4	3.0	8.2	18.4	8.3
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	9.3	5.1	3.8	100.0	100.0	100.0	(4.3)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	4.8	3.9	0.0	52.1	76.6	0.5	(24.4)
Natural Gas	4.4	1.2	3.8	47.9	23.4	99.5	(0.8)

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	68.1	30.7	28.2	(4.3)

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	3.66	1.42	1.33	(4.9)
Primary Energy Demand/GDP (toe/million constant 2000 $)	2,915	2,157	558	(7.9)
CO_2/capita (t CO_2/person)	9.51	3.82	3.18	(5.3)
CO_2 Intensity (t CO_2/constant 2000 $ million)	7,567	5,802	1,331	(8.3)
CO_2/Primary Energy Demand (t CO_2/toe)	2.60	2.69	2.39	(0.4)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Georgia
Historical Performance

Energy and Economic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	8.2	3.1	5.6	(1.9)
Population (million persons)	5.5	4.7	4.4	(1.1)
GDP/capita (constant 2000 $/person)	1,502	653	1,295	(0.7)

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	12.4	2.9	3.1	100.0	100.0	100.0	(6.7)
Coal	0.9	0.0	0.0	7.2	0.5	1.6	(13.5)
Oil	5.6	0.7	1.0	45.0	25.3	30.5	(8.5)
Natural Gas	4.6	1.0	1.0	36.7	33.2	32.5	(7.2)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.7	0.5	0.8	5.2	17.6	25.8	1.1
Others[a]	0.7	0.7	0.3	5.9	23.2	9.5	(4.4)

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	9.0	2.3	2.6	100.0	100.0	100.0	(6.0)
Coal	0.6	0.0	0.0	7.2	0.3	1.4	(13.4)
Oil	2.9	0.6	0.9	32.1	27.6	34.3	(5.7)
Natural Gas	2.6	0.5	0.6	28.9	20.2	23.3	(7.0)
Electricity	1.2	0.5	0.6	13.0	23.5	24.0	(3.0)
Heat	1.2	0.0	0.0	13.7	0.0	1.6	(15.6)
Others	0.5	0.6	0.4	5.1	28.1	15.5	(0.6)

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	9.0	2.3	2.6	100.0	100.0	100.0	(6.0)
Industry	4.0	0.4	0.4	44.0	16.3	16.6	(10.5)
Transport	1.3	0.4	0.8	14.9	15.6	28.9	(2.8)
Other Sectors	3.3	1.5	1.3	37.0	67.4	48.8	(4.7)
Non-Energy	0.4	0.0	0.1	4.0	0.7	5.7	(4.4)

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	13.7	7.4	10.1	100.0	100.0	100.0	(1.5)
Fossil Fuels	6.1	1.6	0.8	44.8	21.1	7.5	(9.9)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	4.0	0.3	0.0	29.2	3.7	0.3	(21.5)
Natural Gas	2.1	1.3	0.7	15.6	17.4	7.2	(5.3)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	7.6	5.9	9.4	55.2	78.9	92.5	1.1
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	2.9	0.7	0.3	100.0	100.0	100.0	(10.3)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	2.4	0.2	0.1	81.0	25.6	16.6	(17.1)
Natural Gas	0.6	0.5	0.3	19.0	74.4	83.4	(3.4)

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	30.3	4.5	5.1	(8.5)

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	2.27	0.60	0.72	(5.6)
Primary Energy Demand/GDP (toe/million constant 2000 $)	1,514	926	553	(4.9)
CO_2/capita (t CO_2/person)	5.54	0.94	1.17	(7.5)
CO_2 Intensity (t CO_2/constant 2000 $ million)	3,691	1,443	904	(6.8)
CO_2/Primary Energy Demand (t CO_2/toe)	2.44	1.56	1.63	(2.0)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Kazakhstan
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	26.3	18.3	40.5	2.2
Population (million persons)	16.3	14.9	16.3	(0.0)
GDP/capita (constant 2000 $/person)	1,609	1,230	2,483	2.2

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	73.4	35.7	75.0	100.0	100.0	100.0	0.1
Coal	40.0	19.8	34.5	54.4	55.4	46.0	(0.7)
Oil	20.6	8.4	17.1	28.0	23.4	22.8	(0.9)
Natural Gas	10.7	6.6	22.6	14.5	18.4	30.1	3.8
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.6	0.6	0.7	0.9	1.8	0.9	0.4
Others[a]	1.6	0.3	0.1	2.2	0.9	0.2	(11.2)

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	59.6	21.6	43.7	100.0	100.0	100.0	(1.5)
Coal	15.8	3.9	14.4	26.5	17.8	32.9	(0.5)
Oil	15.1	6.4	14.8	25.3	29.5	33.8	(0.1)
Natural Gas	7.8	2.7	3.2	13.0	12.4	7.3	(4.3)
Electricity	8.3	3.0	4.9	13.9	14.0	11.3	(2.6)
Heat	12.6	5.6	6.4	21.1	25.9	14.6	(3.3)
Others	0.1	0.1	0.1	0.2	0.3	0.1	(4.0)

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	59.6	21.6	43.7	100.0	100.0	100.0	(1.5)
Industry	26.9	9.4	20.0	45.1	43.7	45.7	(1.5)
Transport	5.5	3.3	4.7	9.1	15.4	10.8	(0.7)
Other Sectors	25.5	7.9	18.7	42.8	36.5	42.7	(1.5)
Non-Energy	1.8	1.0	0.3	3.0	4.4	0.8	(7.9)

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	87.4	51.3	82.6	100.0	100.0	100.0	(0.3)
Fossil Fuels	80.0	43.8	74.6	91.6	85.3	90.3	(0.3)
Coal	62.1	35.6	66.7	71.1	69.5	80.7	0.4
Oil	8.7	2.7	0.6	10.0	5.2	0.8	(12.4)
Natural Gas	9.1	5.5	7.3	10.5	10.7	8.9	(1.1)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	7.4	7.5	8.0	8.4	14.7	9.7	0.4
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	28.9	17.8	20.0	100.0	100.0	100.0	(1.8)
Coal	24.1	14.6	18.0	83.4	82.4	90.1	(1.4)
Oil	3.3	0.8	0.2	11.5	4.3	0.9	(13.6)
Natural Gas	1.5	2.4	1.8	5.2	13.3	9.0	1.0

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	241.0	115.8	241.1	0.0

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	4.49	2.40	4.60	0.1
Primary Energy Demand/GDP (toe/million constant 2000 $)	2,793	1,950	1,852	(2.0)
CO_2 /capita (t CO_2/person)	14.74	7.78	14.78	0.0
CO_2 Intensity (t CO_2/constant 2000 $ million)	9,165	6,330	5,952	(2.1)
CO_2 /Primary Energy Demand (t CO_2/toe)	3.28	3.25	3.21	(0.1)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Kyrgyz Republic
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	2.1	1.4	2.0	(0.2)
Population (million persons)	4.4	5.0	5.3	1.0
GDP/capita (constant 2000 $/person)	478	283	375	(1.2)

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	7.5	2.4	2.9	100.0	100.0	100.0	(4.6)
Coal	2.5	0.5	0.5	33.8	20.3	15.5	(8.2)
Oil	3.0	0.4	1.2	39.4	16.9	42.6	(4.2)
Natural Gas	1.5	0.6	0.4	20.3	23.9	13.3	(6.6)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.9	1.2	0.9	11.5	49.0	30.4	0.2
Others[a]	(0.4)	(0.2)	(0.1)	(5.0)	(10.0)	(1.9)	(9.1)

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	6.9	1.8	2.6	100.0	100.0	100.0	(4.7)
Coal	2.1	0.2	0.5	30.1	12.3	17.8	(7.2)
Oil	3.0	0.4	1.2	42.7	22.1	47.7	(4.2)
Natural Gas	0.6	0.2	0.1	8.8	9.0	2.6	(10.5)
Electricity	0.9	0.8	0.6	12.4	43.2	23.9	(1.6)
Heat	0.4	0.2	0.2	5.9	13.1	8.0	(3.3)
Others	0.0	0.0	0.0	0.1	0.2	0.1	(1.7)

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	6.9	1.8	2.6	100.0	100.0	100.0	(4.7)
Industry	2.5	0.5	0.8	36.5	25.6	31.0	(5.5)
Transport	2.0	0.3	0.9	29.3	16.3	33.6	(4.1)
Other Sectors	2.4	1.0	0.9	34.2	57.7	32.7	(5.0)
Non-Energy	0.0	0.0	0.1	0.0	0.4	2.7	…

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	15.7	16.0	11.4	100.0	100.0	100.0	(1.6)
Fossil Fuels	5.7	2.3	1.0	36.5	14.4	9.0	(8.3)
Coal	2.1	0.6	0.3	13.1	4.0	2.3	(9.8)
Oil	0.0	0.0	0.0	0.0	0.0	0.0	…
Natural Gas	3.7	1.7	0.8	23.5	10.4	6.7	(7.6)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	10.0	13.7	10.3	63.5	85.6	91.0	0.2
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	1.4	0.7	0.5	100.0	100.0	100.0	(5.2)
Coal	0.4	0.3	0.1	32.9	38.3	31.5	(5.4)
Oil	0.0	0.0	0.0	0.0	0.0	0.0	…
Natural Gas	0.9	0.4	0.3	67.1	61.7	68.5	(5.1)

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	22.6	4.5	6.3	(6.2)

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	1.70	0.48	0.55	(5.5)
Primary Energy Demand/GDP (toe/million constant 2000 $)	3,565	1,716	1,459	(4.4)
CO_2/capita (t CO_2/person)	5.15	0.91	1.18	(7.1)
CO_2 Intensity (t CO_2/constant 2000 $ million)	10,786	3,213	3,153	(6.0)
CO_2/Primary Energy Demand (t CO_2/toe)	3.03	1.87	2.16	(1.7)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Pakistan
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	50.2	74.0	116.0	4.3
Population (million persons)	111.8	144.5	173.4	2.2
GDP/capita (constant 2000 $/person)	449	512	669	2.0

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	42.8	63.5	84.6	100.0	100.0	100.0	3.5
Coal	2.0	1.9	4.2	4.6	2.9	4.9	3.9
Oil	10.5	19.0	21.0	24.5	29.9	24.8	3.5
Natural Gas	10.1	16.7	27.0	23.5	26.2	31.9	5.0
Nuclear	0.1	0.5	0.9	0.2	0.8	1.1	13.1
Hydro	1.5	1.5	2.7	3.4	2.3	3.2	3.2
Others[a]	18.8	24.0	28.8	43.8	37.8	34.1	2.2

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	36.2	50.9	69.8	100.0	100.0	100.0	3.3
Coal	1.5	1.4	3.9	4.2	2.7	5.5	4.8
Oil	7.7	11.7	12.0	21.4	22.9	17.1	2.2
Natural Gas	6.0	10.2	19.1	16.6	20.0	27.4	6.0
Electricity	2.5	4.2	6.6	6.8	8.2	9.5	5.1
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	18.4	23.5	28.3	51.0	46.2	40.5	2.2

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	36.2	50.9	69.8	100.0	100.0	100.0	3.3
Industry	7.9	11.2	17.7	21.9	21.9	25.3	4.1
Transport	4.5	8.2	11.4	12.4	16.2	16.3	4.8
Other Sectors	21.6	28.7	37.3	59.6	56.4	53.4	2.8
Non-Energy	2.2	2.8	3.5	6.0	5.5	5.0	2.4

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	37.7	68.1	94.5	100.0	100.0	100.0	4.7
Fossil Fuels	20.5	48.9	59.2	54.3	71.8	62.7	5.5
Coal	0.0	0.2	0.1	0.1	0.4	0.1	4.3
Oil	7.7	26.9	33.3	20.6	39.5	35.2	7.6
Natural Gas	12.7	21.8	25.9	33.6	32.0	27.4	3.6
Nuclear	0.3	2.0	3.4	0.8	2.9	3.6	13.1
Hydro	16.9	17.2	31.8	44.9	25.2	33.7	3.2
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	5.8	11.6	14.2	100.0	100.0	100.0	4.6
Coal	0.0	0.1	0.1	0.3	0.8	0.4	5.7
Oil	2.2	6.3	8.0	37.6	54.8	56.1	6.7
Natural Gas	3.6	5.1	6.2	62.1	44.4	43.5	2.7

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	58.4	97.8	135.9	4.3

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.38	0.44	0.49	1.2
Primary Energy Demand/GDP (toe/million constant 2000 $)	853	858	729	(0.8)
CO_2/capita (t CO_2/person)	0.52	0.68	0.78	2.1
CO_2 Intensity (t CO_2/constant 2000 $ million)	1,163	1,322	1,172	0.0
CO_2/Primary Energy Demand (t CO_2/toe)	1.36	1.54	1.61	0.8

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

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Tajikistan
Historical Performance

Socioeconomic Indicators				AAGR (%)
	1990	2000	2010	1990–2010
GDP (constant 2000 $ billion)	2.3	0.9	1.9	(0.8)
Population (million persons)	5.3	6.2	6.9	1.3
GDP/capita (constant 2000 $/person)	426	139	279	(2.1)

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	5.3	2.1	2.3	100.0	100.0	100.0	(4.1)
Coal	0.6	0.0	0.1	11.8	0.6	4.1	(9.0)
Oil	1.8	0.2	0.5	33.4	8.8	23.4	(5.8)
Natural Gas	1.4	0.6	0.3	26.1	29.2	12.9	(7.4)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	1.4	1.2	1.4	26.7	56.1	59.0	(0.2)
Others[a]	0.1	0.1	0.0	1.9	5.3	0.6	(9.6)

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	4.7	1.8	2.0	100.0	100.0	100.0	(4.1)
Coal	0.6	0.0	0.1	13.4	0.7	4.7	(9.0)
Oil	1.7	0.2	0.5	35.9	10.5	26.7	(5.5)
Natural Gas	0.7	0.4	0.1	15.7	21.3	5.0	(9.5)
Electricity	1.5	1.1	1.2	32.6	63.4	59.3	(1.2)
Heat	0.1	0.1	0.1	2.4	4.2	4.3	(1.3)
Others	0.0	0.0	0.0	0.0	0.0	0.0	…

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	4.7	1.8	2.0	100.0	100.0	100.0	(4.1)
Industry	1.0	0.5	0.5	21.1	25.7	26.9	(3.0)
Transport	0.3	0.0	0.1	5.8	1.0	5.2	(4.7)
Other Sectors	3.4	1.3	1.4	73.1	73.2	67.9	(4.5)
Non-Energy	0.0	0.0	0.0	0.0	0.1	0.0	…

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	18.1	14.2	16.4	100.0	100.0	100.0	(0.5)
Fossil Fuels	1.6	0.2	0.6	9.1	1.6	3.4	(5.2)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.0	0.0	0.0	0.0	0.0	0.0	…
Natural Gas	1.6	0.2	0.6	9.1	1.6	3.4	(5.2)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	16.5	14.0	15.8	90.9	98.4	96.6	(0.2)
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	0.7	0.2	0.2	100.0	100.0	100.0	(5.8)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.0	0.0	0.0	0.0	0.0	0.0	…
Natural Gas	0.7	0.2	0.2	100.0	100.0	100.0	(5.8)

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	11.2	2.1	2.7	(6.8)

Energy and Carbon Indicators				AAGR (%)
	1990	2000	2010	1990–2010
Primary Energy Demand/capita (toe/person)	1.00	0.35	0.34	(5.3)
Primary Energy Demand/GDP (toe/million constant 2000 $)	2,349	2,497	1,202	(3.3)
CO_2 /capita (t CO_2/person)	2.11	0.34	0.40	(8.0)
CO_2 Intensity (t CO_2/constant 2000 $ million)	4,948	2,438	1,420	(6.1)
CO_2 /Primary Energy Demand (t CO_2/toe)	2.11	0.98	1.18	(2.8)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

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Turkmenistan
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	6.6	5.0	17.3	4.9
Population (million persons)	3.7	4.5	5.0	1.6
GDP/capita (constant 2000 $/person)	1,799	1,111	3,435	3.3

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	17.6	14.2	21.3	100.0	100.0	100.0	1.0
Coal	0.3	0.0	0.0	1.7	0.0	0.0	(100.0)
Oil	5.4	3.4	4.2	30.7	23.9	19.6	(1.3)
Natural Gas	12.2	10.9	17.3	69.7	76.5	81.4	1.8
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.1	0.0	0.0	0.3	0.0	0.0	(23.8)
Others[a]	(0.4)	(0.1)	(0.2)	(2.4)	(0.5)	(1.0)	(3.5)

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	12.3	8.0	12.2	100.0	100.0	100.0	(0.1)
Coal	0.3	0.0	0.0	2.4	0.0	0.0	(100.0)
Oil	4.6	2.4	2.9	37.1	30.0	24.1	(2.2)
Natural Gas	6.7	5.0	8.3	54.6	62.3	67.8	1.0
Electricity	0.7	0.5	0.8	5.9	6.3	6.5	0.4
Heat	0.0	0.1	0.2	0.0	1.4	1.6	…
Others	0.0	0.0	0.0	0.0	0.0	0.0	…

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	12.3	8.0	12.2	100.0	100.0	100.0	(0.1)
Industry	1.5	0.9	1.4	11.9	10.9	11.9	(0.1)
Transport	3.4	1.9	1.7	27.2	23.2	13.5	(3.5)
Other Sectors	7.5	5.3	9.1	60.9	65.8	74.6	1.0
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	…

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	14.6	9.8	16.7	100.0	100.0	100.0	0.7
Fossil Fuels	13.9	9.8	16.7	95.2	99.9	100.0	0.9
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.0	0.0	0.0	0.0	0.0	0.0	…
Natural Gas	13.9	9.8	16.7	95.2	99.9	100.0	0.9
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.7	0.0	0.0	4.8	0.1	0.0	(23.9)
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	4.3	3.8	7.0	100.0	100.0	100.0	2.5
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.0	0.0	0.0	0.0	0.0	0.0	…
Natural Gas	4.3	3.8	7.0	100.0	100.0	100.0	2.5

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	46.5	36.1	53.6	0.7

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	4.79	3.16	4.23	(0.6)
Primary Energy Demand/GDP (toe/million constant 2000 $)	2,661	2,848	1,230	(3.8)
CO_2 /capita (t CO_2/person)	12.68	8.02	10.62	(0.9)
CO_2 Intensity (t CO_2/constant 2000 $ million)	7,045	7,216	3,093	(4.0)
CO_2 /Primary Energy Demand (t CO_2/toe)	2.65	2.53	2.51	(0.3)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012).

Uzbekistan
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	14.0	13.8	26.9	3.3
Population (million persons)	20.5	24.7	28.2	1.6
GDP/capita (constant 2000 $/person)	683	560	955	1.7

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	46.4	50.7	44.1	100.0	100.0	100.0	(0.3)
Coal	3.4	1.2	1.3	7.3	2.5	3.0	(4.6)
Oil	10.1	7.3	4.7	21.8	14.4	10.7	(3.7)
Natural Gas	32.5	41.6	37.1	70.1	81.9	84.2	0.7
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.6	0.5	0.9	1.2	1.0	2.1	2.5
Others[a]	(0.2)	0.1	(0.0)	(0.4)	0.2	(0.0)	(15.0)

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	35.0	37.3	32.6	100.0	100.0	100.0	(0.3)
Coal	1.3	0.4	0.4	3.6	1.0	1.2	(5.7)
Oil	7.3	4.7	3.6	21.0	12.6	11.0	(3.5)
Natural Gas	19.7	26.2	22.7	56.3	70.3	69.6	0.7
Electricity	3.7	3.4	3.7	10.6	9.2	11.3	(0.0)
Heat	3.0	2.5	2.3	8.5	6.8	7.0	(1.4)
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	35.0	37.3	32.6	100.0	100.0	100.0	(0.3)
Industry	1.9	8.0	7.6	5.4	21.4	23.3	7.2
Transport	2.1	3.9	3.6	5.9	10.5	10.9	2.7
Other Sectors	29.1	23.4	19.6	83.2	62.7	60.1	(2.0)
Non-Energy	1.9	2.0	1.9	5.5	5.4	5.7	(0.2)

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	56.3	46.9	52.3	100.0	100.0	100.0	(0.4)
Fossil Fuels	49.7	41.0	41.4	88.2	87.5	79.3	(0.9)
Coal	4.2	1.9	2.1	7.4	4.1	4.1	(3.3)
Oil	2.5	4.7	0.8	4.4	10.1	1.5	(5.7)
Natural Gas	43.0	34.4	38.5	76.4	73.3	73.7	(0.5)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	6.6	5.9	10.8	11.8	12.5	20.7	2.5
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	16.1	12.7	12.9	100.0	100.0	100.0	(1.1)
Coal	2.1	0.8	0.9	13.2	6.6	7.2	(4.0)
Oil	2.3	1.3	0.2	14.6	10.6	1.7	(11.2)
Natural Gas	11.6	10.5	11.8	72.3	82.8	91.1	0.1

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	114.9	119.8	102.3	(0.6)

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	2.26	2.06	1.57	(1.8)
Primary Energy Demand/GDP (toe/million constant 2000 $)	3,312	3,677	1,639	(3.5)
CO_2 /capita (t CO_2/person)	5.60	4.86	3.63	(2.1)
CO_2 Intensity (t CO_2/constant 2000 $ million)	8,206	8,681	3,803	(3.8)
CO_2 /Primary Energy Demand (t CO_2/toe)	2.48	2.36	2.32	(0.3)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

East Asia
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	1,018.3	2,206.2	4,733.8	8.0
Population (million persons)	1,216.5	1,346.5	1,422.4	0.8
GDP/capita (constant 2000 $/person)	837	1,638	3,328	7.1

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	1,016.4	1,383.8	2,793.0	100.0	100.0	100.0	5.2
Coal	573.4	702.8	1,718.5	56.4	50.8	61.5	5.6
Oil	189.9	364.4	572.7	18.7	26.3	20.5	5.7
Natural Gas	17.4	46.2	143.3	1.7	3.3	5.1	11.1
Nuclear	22.3	42.8	68.8	2.2	3.1	2.5	5.8
Hydro	12.0	19.9	62.8	1.2	1.4	2.2	8.6
Others[a]	201.4	207.7	225.7	19.8	15.0	8.1	0.6

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	766.2	955.7	1,746.3	100.0	100.0	100.0	4.2
Coal	332.1	274.6	529.9	43.3	28.7	30.3	2.4
Oil	149.6	291.8	492.9	19.5	30.5	28.2	6.1
Natural Gas	10.5	24.7	80.3	1.4	2.6	4.6	10.7
Electricity	58.4	129.5	358.1	7.6	13.6	20.5	9.5
Heat	14.2	29.4	69.4	1.8	3.1	4.0	8.3
Others	201.3	205.5	215.7	26.3	21.5	12.4	0.3

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	766.2	955.7	1,746.3	100.0	100.0	100.0	4.2
Industry	274.8	353.5	780.1	35.9	37.0	44.7	5.4
Transport	60.3	123.9	227.0	7.9	13.0	13.0	6.9
Other Sectors	376.6	392.7	547.8	49.2	41.1	31.4	1.9
Non-Energy	54.5	85.5	191.4	7.1	9.0	11.0	6.5

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	847.4	1,859.6	4,991.7	100.0	100.0	100.0	9.3
Fossil Fuels	622.2	1,459.6	3,932.7	73.4	78.5	78.8	9.7
Coal	516.5	1,283.7	3,645.4	61.0	69.0	73.0	10.3
Oil	92.0	110.9	43.3	10.9	6.0	0.9	(3.7)
Natural Gas	13.6	65.0	243.9	1.6	3.5	4.9	15.5
Nuclear	85.8	164.2	264.1	10.1	8.8	5.3	5.8
Hydro	139.5	231.0	730.0	16.5	12.4	14.6	8.6
Others[b]	0.0	4.9	64.7	0.0	0.3	1.3	56.8

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	176.3	368.3	942.5	100.0	100.0	100.0	8.7
Coal	151.3	332.2	883.5	85.8	90.2	93.8	9.2
Oil	22.1	24.6	12.6	12.6	6.7	1.3	(2.8)
Natural Gas	2.9	11.5	46.3	1.7	3.1	4.9	14.8

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	2,721.8	3,748.8	8,330.0	5.8

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.84	1.03	1.96	4.4
Primary Energy Demand/GDP (toe/million constant 2000 $)	998	627	590	(2.6)
CO_2/capita (t CO_2/person)	2.24	2.78	5.86	4.9
CO_2 Intensity (t CO_2/constant 2000 $ million)	2,673	1,699	1,760	(2.1)
CO_2/Primary Energy Demand (t CO_2/toe)	2.68	2.71	2.98	0.5

( ) = negative number, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: Figures may not add up to total because of rounding.
[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.
[b] "Others" include geothermal, solar, wind, and renewables.
Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

People's Republic of China
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	444.6	1,198.5	3,246.0	10.5
Population (million persons)	1,145.2	1,269.1	1,341.3	0.8
GDP/capita (constant 2000 $/person)	388	944	2,420	9.6

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	863.0	1,094.9	2,417.1	100.0	100.0	100.0	5.3
Coal	528.4	625.5	1,595.1	61.2	57.1	66.0	5.7
Oil	110.2	220.4	431.3	12.8	20.1	17.8	7.1
Natural Gas	12.8	20.8	88.6	1.5	1.9	3.7	10.2
Nuclear	0.0	4.4	19.3	0.0	0.4	0.8	…
Hydro	10.9	19.1	62.1	1.3	1.7	2.6	9.1
Others[a]	200.6	204.7	219.5	23.2	18.7	9.1	0.5

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	662.9	769.1	1,512.2	100.0	100.0	100.0	4.2
Coal	315.5	259.9	512.1	47.6	33.8	33.9	2.5
Oil	83.4	177.5	369.0	12.6	23.1	24.4	7.7
Natural Gas	9.0	12.3	57.2	1.4	1.6	3.8	9.7
Electricity	41.4	89.9	296.8	6.2	11.7	19.6	10.3
Heat	13.2	25.5	64.3	2.0	3.3	4.3	8.2
Others	200.4	204.0	212.8	30.2	26.5	14.1	0.3

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	662.9	769.1	1,512.2	100.0	100.0	100.0	4.2
Industry	240.6	293.8	711.9	36.3	38.2	47.1	5.6
Transport	37.0	82.0	182.4	5.6	10.7	12.1	8.3
Other Sectors	342.5	341.1	486.5	51.7	44.3	32.2	1.8
Non-Energy	42.8	52.2	131.5	6.5	6.8	8.7	5.8

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	621.2	1,356.2	4,208.3	100.0	100.0	100.0	10.0
Fossil Fuels	494.5	1,114.0	3,355.1	79.6	82.1	79.7	10.0
Coal	442.8	1,062.1	3,272.8	71.3	78.3	77.8	10.5
Oil	49.0	46.1	13.3	7.9	3.4	0.3	(6.3)
Natural Gas	2.8	5.8	69.0	0.4	0.4	1.6	17.5
Nuclear	0.0	16.7	73.9	0.0	1.2	1.8	…
Hydro	126.7	222.4	722.2	20.4	16.4	17.2	9.1
Others[b]	0.0	3.1	57.1	0.0	0.2	1.4	61.3

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	144.8	292.7	814.9	100.0	100.0	100.0	9.0
Coal	131.8	279.8	794.7	91.0	95.6	97.5	9.4
Oil	12.4	11.6	5.0	8.5	4.0	0.6	(4.5)
Natural Gas	0.6	1.3	15.3	0.4	0.4	1.9	17.5

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	2,315.8	3,037.3	7,458.9	6.0

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.75	0.86	1.80	4.5
Primary Energy Demand/GDP (toe/million constant 2000 $)	1,941	914	745	(4.7)
CO_2/capita (t CO_2/person)	2.02	2.39	5.56	5.2
CO_2 Intensity (t CO_2/constant 2000 $ million)	5,209	2,534	2,298	(4.0)
CO_2/Primary Energy Demand (t CO_2/toe)	2.68	2.77	3.09	0.7

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Hong Kong, China
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	115.2	169.1	251.2	4.0
Population (million persons)	5.8	6.8	7.1	1.0
GDP/capita (constant 2000 $/person)	19,877	24,932	35,611	3.0

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	8.7	13.4	13.4	100.0	100.0	100.0	2.2
Coal	5.5	3.7	6.2	63.6	27.9	46.6	0.6
Oil	3.3	6.4	3.2	37.6	47.6	24.0	(0.1)
Natural Gas	0.0	2.5	3.1	0.0	18.3	23.5	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	…
Others[a]	(0.1)	0.8	0.8	(1.2)	6.2	5.9	…

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	5.2	9.2	6.7	100.0	100.0	100.0	1.3
Coal	0.3	0.6	0.0	6.2	6.1	0.0	(100.0)
Oil	2.8	5.5	2.4	53.4	59.4	35.8	(0.7)
Natural Gas	0.0	0.0	0.7	0.0	0.0	9.8	…
Electricity	2.0	3.1	3.6	39.4	33.9	53.8	2.9
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	0.1	0.1	0.0	1.0	0.6	0.6	(1.9)

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	5.2	9.2	6.7	100.0	100.0	100.0	1.3
Industry	1.5	1.8	0.4	29.7	19.6	5.7	(6.8)
Transport	1.5	3.7	2.1	28.5	40.7	32.0	1.9
Other Sectors	2.0	3.5	4.2	38.9	38.1	62.2	3.7
Non-Energy	0.2	0.1	0.0	2.9	1.6	0.0	(100.0)

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	28.9	31.3	38.3	100.0	100.0	100.0	1.4
Fossil Fuels	28.9	31.3	38.3	100.0	100.0	100.0	1.4
Coal	28.4	18.9	23.8	98.2	60.4	62.1	(0.9)
Oil	0.5	0.2	0.1	1.8	0.5	0.3	(7.4)
Natural Gas	0.0	12.2	14.4	0.0	39.1	37.6	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	…
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	6.2	6.7	8.3	100.0	100.0	100.0	1.4
Coal	6.1	4.2	5.4	98.4	63.0	65.7	(0.6)
Oil	0.1	0.0	0.0	1.6	0.6	0.4	(4.9)
Natural Gas	0.0	2.5	2.8	0.0	36.4	33.9	…

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	34.5	41.6	42.6	1.1

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	1.49	1.97	1.89	1.2
Primary Energy Demand/GDP (toe/million constant 2000 $)	75	79	53	(1.7)
CO_2/capita (t CO_2/person)	5.95	6.13	6.04	0.1
CO_2 Intensity (t CO_2/constant 2000 $ million)	299	246	170	(2.8)
CO_2/Primary Energy Demand (t CO_2/toe)	3.98	3.10	3.19	(1.1)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

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Republic of Korea
Historical Performance

Socioeconomic Indicators							AAGR (%)
				1990	2000	2010	1990–2010
GDP (constant 2000 $ billion)				295.6	533.4	800.2	5.1
Population (million persons)				43.0	46.0	48.2	0.6
GDP/capita (constant 2000 $/person)				6,878	11,598	16,607	4.5

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	93.1	188.1	250.0	100.0	100.0	100.0	5.1
Coal	25.6	41.9	73.4	27.5	22.3	29.4	5.4
Oil	49.7	99.0	95.1	53.4	52.7	38.0	3.3
Natural Gas	2.7	17.0	38.7	2.9	9.0	15.5	14.2
Nuclear	13.8	28.4	38.7	14.8	15.1	15.5	5.3
Hydro	0.5	0.3	0.3	0.6	0.2	0.1	(2.7)
Others[a]	0.7	1.4	3.8	0.8	0.8	1.5	8.5

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	64.9	127.1	157.4	100.0	100.0	100.0	4.5
Coal	11.7	9.1	9.5	18.1	7.1	6.1	(1.0)
Oil	43.7	79.9	81.9	67.3	62.8	52.0	3.2
Natural Gas	0.7	10.9	20.4	1.0	8.6	12.9	18.6
Electricity	8.1	22.6	38.6	12.5	17.8	24.5	8.1
Heat	0.0	3.3	4.3	0.0	2.6	2.8	…
Others	0.7	1.3	2.7	1.1	1.0	1.7	6.7

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	64.9	127.1	157.4	100.0	100.0	100.0	4.5
Industry	19.3	38.5	44.8	29.7	30.3	28.4	4.3
Transport	14.6	26.3	29.9	22.5	20.7	19.0	3.7
Other Sectors	24.3	37.3	44.4	37.5	29.4	28.2	3.1
Non-Energy	6.7	25.0	38.4	10.4	19.7	24.4	9.1

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	105.4	288.5	496.7	100.0	100.0	100.0	8.1
Fossil Fuels	46.1	175.4	341.4	43.8	60.8	68.7	10.5
Coal	17.7	111.4	219.3	16.8	38.6	44.1	13.4
Oil	18.9	34.6	18.9	17.9	12.0	3.8	0.0
Natural Gas	9.6	29.5	103.2	9.1	10.2	20.8	12.6
Nuclear	52.9	109.0	148.6	50.2	37.8	29.9	5.3
Hydro	6.4	4.0	3.7	6.0	1.4	0.7	(2.7)
Others[b]	0.0	0.1	2.9	0.0	0.0	0.6	49.0

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	12.5	36.6	74.8	100.0	100.0	100.0	9.4
Coal	6.0	25.7	52.3	47.7	70.3	69.8	11.5
Oil	4.5	6.4	4.7	36.0	17.6	6.3	0.2
Natural Gas	2.0	4.4	17.9	16.3	12.1	23.9	11.5

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	245.6	441.3	560.0	4.2

Energy and Carbon Indicators				AAGR (%)
	1990	2000	2010	1990–2010
Primary Energy Demand/capita (toe/person)	2.17	4.09	5.19	4.5
Primary Energy Demand/GDP (toe/million constant 2000 $)	315	353	312	(0.0)
CO_2 /capita (t CO_2/person)	5.71	9.60	11.62	3.6
CO_2 Intensity (t CO_2/constant 2000 $ million)	831	827	700	(0.9)
CO_2 /Primary Energy Demand (t CO_2/toe)	2.64	2.35	2.24	(0.8)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Mongolia
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	1.1	1.1	2.2	3.5
Population (million persons)	2.2	2.4	2.7	1.1
GDP/capita (constant 2000 $/person)	502	456	796	2.3

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	3.4	2.4	3.3	100.0	100.0	100.0	(0.2)
Coal	2.5	1.8	2.3	72.9	76.8	69.6	(0.4)
Oil	0.8	0.4	0.8	24.1	18.4	25.3	0.0
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	…
Others[a]	0.1	0.1	0.2	3.1	4.8	5.1	2.4

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	3.0	1.5	2.3	100.0	100.0	100.0	(1.3)
Coal	1.0	0.3	0.3	33.7	19.0	15.2	(5.2)
Oil	0.7	0.4	0.8	24.2	26.6	33.5	0.3
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Electricity	0.2	0.2	0.3	8.2	11.2	13.3	1.1
Heat	1.0	0.6	0.8	32.1	39.5	34.2	(1.0)
Others	0.1	0.1	0.1	1.8	3.7	3.7	2.4

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	3.0	1.5	2.3	100.0	100.0	100.0	(1.3)
Industry	1.2	0.5	0.8	38.8	31.3	34.1	(1.9)
Transport	0.5	0.3	0.5	17.6	21.7	20.8	(0.5)
Other Sectors	1.3	0.7	1.0	43.0	46.8	45.0	(1.1)
Non-Energy	0.0	0.0	0.0	0.7	0.1	0.1	(9.3)

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	3.5	3.0	4.5	100.0	100.0	100.0	1.3
Fossil Fuels	3.5	3.0	4.5	100.0	100.0	100.0	1.3
Coal	3.2	2.9	4.3	92.4	97.1	96.0	1.5
Oil	0.3	0.1	0.2	7.6	2.9	4.0	(1.9)
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	…
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	1.6	1.6	2.0	100.0	100.0	100.0	1.1
Coal	1.5	1.5	1.9	93.5	97.9	96.8	1.2
Oil	0.1	0.0	0.1	6.5	2.1	3.2	(2.4)
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	12.3	8.5	11.6	(0.3)

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	1.56	0.98	1.19	(1.3)
Primary Energy Demand/GDP (toe/million constant 2000 $)	3,106	2,149	1,497	(3.6)
CO_2 /capita (t CO_2/person)	5.62	3.53	4.21	(1.4)
CO_2 Intensity (t CO_2/constant 2000 $ million)	11,198	7,746	5,286	(3.7)
CO_2 /Primary Energy Demand (t CO_2/toe)	3.61	3.60	3.53	(0.1)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: Figures may not add up to total because of rounding.
[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.
[b] "Others" include geothermal, solar, wind, and renewables.
Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Taipei,China
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	161.8	304.1	434.3	5.1
Population (million persons)	20.4	22.2	23.1	0.6
GDP/capita (constant 2000 $/person)	7,951	13,688	18,797	4.4

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	48.2	85.1	109.3	100.0	100.0	100.0	4.2
Coal	11.4	29.9	41.4	23.6	35.1	37.9	6.7
Oil	25.9	38.1	42.2	53.6	44.8	38.6	2.5
Natural Gas	1.9	6.0	13.0	3.8	7.1	11.9	10.2
Nuclear	8.6	10.0	10.8	17.8	11.8	9.9	1.2
Hydro	0.5	0.4	0.4	1.1	0.5	0.3	(2.1)
Others[a]	0.0	0.7	1.5	0.1	0.8	1.4	20.9

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	30.2	48.8	67.7	100.0	100.0	100.0	4.1
Coal	3.6	4.8	7.8	11.9	9.9	11.6	4.0
Oil	19.1	28.6	38.8	63.3	58.5	57.4	3.6
Natural Gas	0.9	1.6	2.1	2.9	3.2	3.1	4.5
Electricity	6.6	13.8	18.8	21.9	28.2	27.7	5.4
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	0.0	0.1	0.2	0.1	0.2	0.2	8.4

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	30.2	48.8	67.7	100.0	100.0	100.0	4.1
Industry	12.3	19.0	22.3	40.8	39.0	32.9	3.0
Transport	6.7	11.5	12.2	22.2	23.6	18.0	3.0
Other Sectors	6.4	10.1	11.7	21.2	20.7	17.2	3.1
Non-Energy	4.8	8.1	21.6	15.9	16.7	31.9	7.8

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	88.4	180.6	243.9	100.0	100.0	100.0	5.2
Fossil Fuels	49.1	135.8	193.5	55.6	75.2	79.3	7.1
Coal	24.5	88.3	125.3	27.7	48.9	51.4	8.5
Oil	23.4	30.0	10.8	26.5	16.6	4.4	(3.8)
Natural Gas	1.2	17.5	57.3	1.4	9.7	23.5	21.1
Nuclear	32.9	38.5	41.6	37.2	21.3	17.1	1.2
Hydro	6.4	4.6	4.2	7.2	2.5	1.7	(2.1)
Others[b]	0.0	1.7	4.7	0.0	0.9	1.9	44.4

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	11.2	30.8	42.5	100.0	100.0	100.0	6.9
Coal	5.9	20.9	29.3	52.6	68.0	68.9	8.3
Oil	5.1	6.5	2.8	45.0	21.0	6.7	(2.8)
Natural Gas	0.3	3.4	10.4	2.4	11.0	24.4	20.1

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	113.6	220.2	256.9	4.2

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	2.37	3.83	4.73	3.5
Primary Energy Demand/GDP (toe/million constant 2000 $)	298	280	252	(0.8)
CO_2 /capita (t CO_2/person)	5.58	9.91	11.12	3.5
CO_2 Intensity (t CO_2/constant 2000 $ million)	702	724	592	(0.9)
CO_2 /Primary Energy Demand (t CO_2/toe)	2.36	2.59	2.35	(0.0)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Pacific
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	5.0	7.3	9.6	3.4
Population (million persons)	5.9	8.2	10.2	2.8
GDP/capita (constant 2000 $/person)	845	894	942	0.5

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	1.7	2.1	3.6	100.0	100.0	100.0	3.9
Coal	0.0	0.0	0.0	1.1	0.6	0.0	(14.9)
Oil	1.2	1.5	2.4	72.0	70.9	66.2	3.5
Natural Gas	0.1	0.1	0.3	4.3	5.6	8.3	7.4
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.1	0.1	0.2	4.5	6.3	4.4	3.7
Others[a]	0.3	0.4	0.8	18.0	16.6	21.0	4.7

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.9	1.4	2.2	100.0	100.0	100.0	4.6
Coal	0.0	0.0	0.0	1.3	0.8	0.0	(13.1)
Oil	0.7	1.1	1.5	73.0	73.6	70.1	4.4
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Electricity	0.2	0.3	0.4	20.4	18.5	19.3	4.3
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	0.0	0.1	0.2	5.3	7.1	10.9	8.4

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.9	1.4	2.2	100.0	100.0	100.0	4.6
Industry	0.3	0.6	0.8	30.1	43.1	38.2	5.9
Transport	0.4	0.5	0.8	42.3	37.3	37.8	4.0
Other Sectors	0.2	0.3	0.5	27.5	18.8	24.0	3.9
Non-Energy	0.0	0.0	0.0	0.1	0.8	0.0	(100.0)

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	2.4	3.6	5.4	100.0	100.0	100.0	4.1
Fossil Fuels	1.5	1.9	3.2	63.3	52.4	58.3	3.7
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	1.5	1.5	2.4	63.3	41.2	43.6	2.2
Natural Gas	0.0	0.4	0.8	0.0	11.2	14.7	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.9	1.5	1.8	37.1	42.8	33.4	3.5
Others[b]	0.0	0.2	0.5	0.0	5.6	8.3	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	0.4	0.5	1.0	100.0	100.0	100.0	4.1
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.4	0.4	0.8	100.0	77.5	83.2	3.1
Natural Gas	0.0	0.1	0.2	0.0	22.5	16.8	…

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	3.7	4.7	7.9	3.9

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.28	0.26	0.35	1.1
Primary Energy Demand/GDP (toe/million constant 2000 $)	335	290	371	0.5
CO_2 /capita (t CO_2/person)	0.63	0.57	0.77	1.0
CO_2 Intensity (t CO_2/constant 2000 $ million)	747	641	820	0.5
CO_2 /Primary Energy Demand (t CO_2/toe)	2.23	2.21	2.21	(0.0)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank (ADB). 2008 Survey on Energy and Energy-Related Information in the Pacific. Unpublished; Asia Pacific Energy Research Centre (APERC). APEC Energy Database. http://www.ieej.or.jp/egeda/database/database-top.html (accessed 29 February 2012); APERC estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); United Nations Statistics Division. 2011. *Energy Balances and Electricity Profiles*. New York; World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Fiji
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	1.3	1.7	1.9	2.0
Population (million persons)	0.7	0.8	0.9	0.8
GDP/capita (constant 2000 $/person)	1,786	2,094	2,259	1.2

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.5	0.5	0.6	100.0	100.0	100.0	1.3
Coal	0.0	0.0	0.0	3.4	2.2	0.1	(14.7)
Oil	0.2	0.3	0.4	48.8	47.4	59.8	2.3
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.0	0.0	0.1	6.7	9.2	10.1	3.3
Others[a]	0.2	0.2	0.2	41.1	41.3	30.1	(0.3)

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.2	0.3	0.4	100.0	100.0	100.0	3.3
Coal	0.0	0.0	0.0	4.6	4.2	0.2	(12.7)
Oil	0.2	0.2	0.4	75.8	75.3	82.2	3.7
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Electricity	0.0	0.0	0.1	16.1	17.7	15.8	3.2
Heat	0.0	0.0	0.0	0.0	0.0	0.0	….
Others	0.0	0.0	0.0	3.5	2.8	1.8	0.0

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.2	0.3	0.4	100.0	100.0	100.0	3.3
Industry	0.1	0.1	0.2	24.9	42.8	41.0	5.9
Transport	0.1	0.1	0.2	51.7	38.3	39.1	1.8
Other Sectors	0.1	0.1	0.1	23.3	18.9	19.9	2.4
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	…

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.5	0.7	0.9	100.0	100.0	100.0	3.3
Fossil Fuels	0.1	0.1	0.1	17.6	17.4	10.5	0.6
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.1	0.1	0.1	17.6	17.4	10.5	0.6
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.4	0.6	0.7	82.4	82.6	83.6	3.3
Others[b]	0.0	0.0	0.1	0.0	0.0	5.9	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	0.0	0.0	0.0	100.0	100.0	100.0	0.3
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.0	0.0	0.0	100.0	100.0	100.0	0.3
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	0.8	0.8	1.2	1.9

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.67	0.66	0.74	0.5
Primary Energy Demand/GDP (toe/million constant 2000 $)	378	314	327	(0.7)
CO_2 /capita (t CO_2/person)	1.10	1.01	1.36	1.1
CO_2 Intensity (t CO_2/constant 2000 $ million)	616	484	602	(0.1)
CO_2 /Primary Energy Demand (t CO_2/toe)	1.63	1.54	1.84	0.6

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); United Nations Statistics Division. 2011. *Energy Balances and Electricity Profiles*. New York; World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Papua New Guinea
Historical Performance

Energy and Economic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	2.4	3.5	5.1	3.9
Population (million persons)	4.2	5.4	6.9	2.5
GDP/capita (constant 2000 $/person)	567	655	744	1.4

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.9	1.1	2.2	100.0	100.0	100.0	4.8
Coal	0.0	0.0	0.0	0.1	0.0	0.0	…
Oil	0.8	0.9	1.5	86.9	80.9	67.5	3.5
Natural Gas	0.1	0.1	0.3	8.3	10.6	13.5	7.4
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.0	0.1	0.1	4.6	7.1	3.9	3.9
Others[a]	0.0	0.0	0.3	0.0	1.4	15.1	…

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.5	0.9	1.2	100.0	100.0	100.0	4.3
Coal	0.0	0.0	0.0	0.2	0.0	0.0	…
Oil	0.4	0.7	1.0	73.6	78.0	76.5	4.5
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Electricity	0.1	0.2	0.3	26.2	22.0	23.5	3.7
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	0.0	0.0	0.0	0.0	0.0	0.7	…

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.5	0.9	1.3	100.0	100.0	100.0	4.3
Industry	0.2	0.5	0.6	35.1	54.5	51.3	6.3
Transport	0.2	0.3	0.5	38.6	34.8	37.9	4.2
Other Sectors	0.1	0.1	0.1	26.1	9.3	10.8	(0.2)
Non-Energy	0.0	0.0	0.0	0.2	1.4	0.0	…

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	1.8	2.4	3.7	100.0	100.0	100.0	3.7
Fossil Fuels	1.3	1.3	2.3	72.6	54.8	62.2	2.9
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	1.3	0.9	1.5	72.6	37.9	40.5	0.7
Natural Gas	0.0	0.4	0.8	0.0	16.9	21.6	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.5	0.9	1.0	27.9	37.9	27.0	3.5
Others[b]	0.0	0.2	0.4	0.0	8.4	10.8	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	0.3	0.3	0.7	100.0	100.0	100.0	3.6
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.3	0.2	0.5	100.0	65.1	76.5	2.2
Natural Gas	0.0	0.1	0.2	0.0	34.9	23.5	…

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	2.4	2.9	5.2	3.9

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.21	0.21	0.32	2.2
Primary Energy Demand/GDP (toe/million constant 2000 $)	367	319	434	0.8
CO_2 /capita (t CO_2/person)	0.58	0.54	0.76	1.4
CO_2 Intensity (t CO_2/constant 2000 $ million)	1,025	821	1,025	0.0
CO_2 /Primary Energy Demand (t CO_2/toe)	2.79	2.57	2.36	(0.8)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: Figures may not add up to total because of rounding.
[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.
[b] "Others" include geothermal, solar, wind, and renewables.
Sources: Asia Pacific Energy Research Centre (APERC). APEC Energy Database. http://www.ieej.or.jp/egeda/database/database-top.html (accessed 29 February 2012); APERC estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Timor-Leste
Historical Performance

Energy and Economic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	…	0.3	0.4	…
Population (million persons)	0.7	0.8	1.1	2.1
GDP/capita (constant 2000 $/person)	…	381	396	…

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	…	…	0.1	…	…	100.0	…
Coal	…	…	0.0	…	…	0.0	…
Oil	…	…	0.1	…	…	99.8	…
Natural Gas	…	…	0.0	…	…	0.0	…
Nuclear	…	…	0.0	…	…	0.0	…
Hydro	…	…	0.0	…	…	0.2	…
Others[a]	…	…	0.0	…	…	0.0	…

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	…	…	0.0	…	…	100.0	…
Coal	…	…	0.0	…	…	0.0	…
Oil	…	…	0.0	…	…	69.2	…
Natural Gas	…	…	0.0	…	…	0.0	…
Electricity	…	…	0.0	…	…	30.8	…
Heat	…	…	0.0	…	…	0.0	…
Others	…	…	0.0	…	…	0.0	…

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	…	…	0.0	…	…	100.0	…
Industry	…	…	0.0	…	…	0.0	…
Transport	…	…	0.0	…	…	69.2	…
Other Sectors	…	…	0.0	…	…	30.8	…
Non-Energy	…	…	0.0	…	…	0.0	…

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	…	…	0.2	…	…	100.0	…
Fossil Fuels	…	…	0.2	…	…	99.0	…
Coal	…	…	0.0	…	…	0.0	…
Oil	…	…	0.2	…	…	99.0	…
Natural Gas	…	…	0.0	…	…	0.0	…
Nuclear	…	…	0.0	…	…	0.0	…
Hydro	…	…	0.0	…	…	1.0	…
Others[b]	…	…	0.0	…	…	0.0	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	…	…	0.1	…	…	100.0	…
Coal	…	…	0.0	…	…	0.0	…
Oil	…	…	0.1	…	…	100.0	…
Natural Gas	…	…	0.0	…	…	0.0	…

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	…	…	0.3	…

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	…	…	0.08	…
Primary Energy Demand/GDP (toe/million constant 2000 $)	…	…	198	…
CO_2 /capita (t CO_2/person)	…	…	0.24	…
CO_2 Intensity (t CO_2/constant 2000 $ million)	…	…	606	…
CO_2 /Primary Energy Demand (t CO_2/toe)	…	…	3.05	…

… = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); United Nations Statistics Division. 2011. *Energy Balances and Electricity Profiles*. New York; World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Other Pacific Islands
Historical Performance

Energy and Economic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	1.3	1.8	2.1	2.6
Population (million persons)	1.0	1.2	1.4	1.8
GDP/capita (constant 2000 $/person)	…	1,530	1,550	…

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.3	0.5	0.6	100.0	100.0	100.0	3.8
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.2	0.3	0.4	67.2	73.9	63.5	3.5
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.0	0.0	0.0	0.6	1.2	1.0	6.6
Others[a]	0.1	0.1	0.2	32.2	24.9	35.5	4.3

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.1	0.3	0.5	100.0	100.0	100.0	6.6
Coal	00	0.0	0.0	0.0	0.0	0.0	…
Oil	0.1	0.2	0.2	66.4	58.7	43.2	4.3
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Electricity	0.0	0.0	0.1	4.1	8.3	10.7	11.8
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	0.0	0.1	0.2	29.5	33.1	46.2	9.0

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.1	0.3	0.5	100.0	100.0	100.0	6.6
Industry	0.0	0.0	0.0	18.4	8.2	5.6	0.5
Transport	0.1	0.1	0.2	41.3	44.0	33.3	5.5
Other Sectors	0.1	0.1	0.3	40.3	47.8	61.1	8.8
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	…

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.2	0.5	0.7	100.0	100.0	100.0	6.8
Fossil Fuels	0.2	0.5	0.6	89.0	87.6	89.5	6.9
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.2	0.5	0.6	89.0	87.6	89.5	6.9
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.0	0.1	0.1	11.0	12.4	10.5	6.6
Others[b]	0.0	0.0	0.0	0.0	0.0	0.1	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	0.1	0.2	0.2	100.0	100.0	100.0	5.5
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.1	0.2	0.2	100.0	100.0	100.0	5.5
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	0.5	1.0	1.2	4.8

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.31	0.40	0.46	2.0
Primary Energy Demand/GDP (toe/million constant 2000 $)	…	262	296	…
CO_2 /capita (t CO_2/person)	0.50	0.84	0.89	3.0
CO_2 Intensity (t CO_2/constant 2000 $ million)	…	551	576	…
CO_2 /Primary Energy Demand (t CO_2/toe)	1.59	2.10	1.95	1.0

… = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank (ADB). 2008 Survey on Energy and Energy-Related Information in the Pacific. Unpublished; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); United Nations Statistics Division. 2011. *Energy Balances and Electricity Profiles*. New York; World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

South Asia
Historical Performance

Energy and Economic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	313.4	530.2	1,083.1	6.4
Population (million persons)	1,016.2	1,227.5	1,425.1	1.7
GDP/capita (constant 2000 $/person)	308	432	760	4.6

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	341.7	493.5	745.5	100.0	100.0	100.0	4.0
Coal	103.7	162.1	289.4	30.4	32.8	38.8	5.3
Oil	64.9	120.4	172.9	19.0	24.4	23.2	5.0
Natural Gas	14.3	30.4	69.2	4.2	6.2	9.3	8.2
Nuclear	1.6	4.4	6.8	0.5	0.9	0.9	7.5
Hydro	6.7	7.1	11.4	2.0	1.4	1.5	2.7
Others[a]	150.5	169.1	195.6	44.0	34.3	26.2	1.3

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	274.1	350.5	501.1	100.0	100.0	100.0	3.1
Coal	42.1	34.1	76.6	15.4	9.7	15.3	3.0
Oil	55.6	101.8	136.9	20.3	29.0	27.3	4.6
Natural Gas	7.5	13.2	29.0	2.7	3.8	5.8	7.0
Electricity	18.9	33.2	65.6	6.9	9.5	13.1	6.4
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	149.9	168.1	192.9	54.7	48.0	38.5	1.3

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	274.1	350.5	501.1	100.0	100.0	100.0	3.1
Industry	72.1	91.1	158.9	26.3	26.0	31.7	4.0
Transport	28.6	35.1	61.7	10.4	10.0	12.3	3.9
Other Sectors	160.3	192.9	240.7	58.5	55.0	48.0	2.1
Non-Energy	13.1	31.3	39.7	4.8	8.9	7.9	5.7

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	302.8	587.6	1,023.6	100.0	100.0	100.0	6.3
Fossil Fuels	218.5	485.6	843.2	72.2	82.6	82.4	7.0
Coal	191.6	386.8	653.7	63.3	65.8	63.9	6.3
Oil	10.4	29.0	33.7	3.4	4.9	3.3	6.0
Natural Gas	16.5	69.8	155.9	5.4	11.9	15.2	11.9
Nuclear	6.1	16.9	26.3	2.0	2.9	2.6	7.5
Hydro	78.1	82.0	132.1	25.8	14.0	12.9	2.7
Others[b]	0.0	3.0	22.0	0.0	0.5	2.2	38.6

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	64.4	143.3	250.4	100.0	100.0	100.0	7.0
Coal	55.6	120.3	201.7	86.3	83.9	80.5	6.7
Oil	3.7	10.5	13.3	5.8	7.3	5.3	6.6
Natural Gas	5.1	12.5	35.5	8.0	8.7	14.2	10.1

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	608.1	994.7	1,727.8	5.4

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.34	0.40	0.52	2.2
Primary Energy Demand/GDP (toe/million constant 2000 $)	1,090	931	688	(2.3)
CO_2/capita (t CO_2/person)	0.60	0.81	1.21	3.6
CO_2 Intensity (t CO_2/constant 2000 $ million)	1,940	1,876	1,595	(1.0)
CO_2/Primary Energy Demand (t CO_2/toe)	1.78	2.02	2.32	1.3

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); United Nations Statistics Division. 2011. *Energy Balances and Electricity Profiles*. New York; World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Bangladesh
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	29.5	47.1	83.0	5.3
Population (million persons)	105.3	129.6	148.7	1.7
GDP/capita (constant 2000 $/person)	280	364	558	3.5

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	12.7	18.6	31.1	100.0	100.0	100.0	4.6
Coal	0.3	0.3	0.6	2.2	1.8	2.0	4.1
Oil	1.8	3.2	5.1	14.1	17.3	16.3	5.3
Natural Gas	3.7	7.4	16.5	29.2	39.6	53.1	7.7
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.1	0.1	0.1	0.6	0.4	0.5	3.2
Others[a]	6.9	7.6	8.7	53.9	40.9	28.1	1.2

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	11.0	15.3	22.9	100.0	100.0	100.0	3.7
Coal	0.3	0.3	0.4	2.6	2.2	1.7	1.8
Oil	1.6	2.7	4.3	14.3	17.8	18.7	5.1
Natural Gas	1.9	3.6	6.1	16.9	23.3	26.6	6.1
Electricity	0.4	1.1	3.4	3.7	7.0	14.8	11.2
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	6.9	7.6	8.7	62.5	49.7	38.1	1.2

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	11.0	15.3	22.9	100.0	100.0	100.0	3.7
Industry	1.0	1.9	4.1	8.8	12.3	17.8	7.4
Transport	0.5	1.0	3.0	5.0	6.5	13.0	8.9
Other Sectors	8.1	10.0	14.0	73.7	65.4	61.3	2.8
Non-Energy	1.4	2.4	1.8	12.5	15.7	7.9	1.4

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	7.7	15.8	42.3	100.0	100.0	100.0	8.9
Fossil Fuels	6.8	14.8	40.7	88.6	94.0	96.1	9.3
Coal	0.0	0.0	0.6	0.0	0.0	1.5	…
Oil	0.3	1.0	2.0	4.3	6.5	4.6	9.3
Natural Gas	6.5	13.8	38.1	84.3	87.5	89.9	9.2
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.9	0.9	1.7	11.4	6.0	3.9	3.2
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	1.8	3.6	10.3	100.0	100.0	100.0	9.2
Coal	0.0	0.0	0.2	0.0	0.0	2.1	…
Oil	0.1	0.4	0.7	6.5	9.7	6.8	9.4
Natural Gas	1.7	3.3	9.4	93.5	90.3	91.1	9.0

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	12.1	22.5	52.3	7.6

Energy and Economic Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.12	0.14	0.21	2.8
Primary Energy Demand/GDP (toe/million constant 2000 $)	432	395	374	(0.7)
CO_2 /capita (t CO_2/person)	0.11	0.17	0.35	5.8
CO_2 Intensity (t CO_2/constant 2000 $ million)	409	476	631	2.2
CO_2 /Primary Energy Demand (t CO_2/toe)	0.95	1.21	1.69	2.9

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011* . http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Bhutan
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	0.3	0.4	1.0	6.9
Population (million persons)	0.6	0.6	0.7	1.3
GDP/capita (constant 2000 $/person)	465	749	1,347	5.5

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.9	1.1	1.4	100.0	100.0	100.0	2.3
Coal	0.0	0.0	0.1	1.4	4.3	9.4	12.5
Oil	0.0	0.1	0.1	3.2	4.8	5.7	5.3
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.1	0.2	0.6	14.9	14.6	43.8	7.9
Others[a]	0.7	0.8	0.6	80.5	76.3	41.0	(1.1)

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.3	1.1	1.4	100.0	100.0	100.0	7.7
Coal	0.0	0.0	0.1	4.0	4.3	9.1	12.2
Oil	0.0	0.1	0.1	4.0	4.8	5.7	9.7
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Electricity	0.0	0.0	0.1	4.1	3.2	7.6	11.0
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	0.3	0.9	1.1	88.0	87.6	77.6	7.0

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.3	1.1	1.4	100.0	100.0	100.0	7.7
Industry	0.0	0.1	0.1	5.1	4.8	10.6	11.7
Transport	0.0	0.0	0.1	0.6	3.6	4.9	19.3
Other Sectors	0.3	1.0	1.2	94.3	91.6	84.4	7.1
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	…

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	1.6	1.8	7.2	100.0	100.0	100.0	7.9
Fossil Fuels	0.0	0.0	0.0	0.4	0.0	0.3	6.0
Coal	0.0	0.0	0.0	0.0	0.0	0.2	…
Oil	0.0	0.0	0.0	0.4	0.0	0.1	(1.9)
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	1.6	1.8	7.2	99.6	100.0	99.7	7.9
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	0.0	0.0	0.0	100.0	…	100.0	6.3
Coal	0.0	0.0	0.0	0.0	…	78.8	-
Oil	0.0	0.0	0.0	100.0	…	21.2	(1.6)
Natural Gas	0.0	0.0	0.0	0.0	…	0.0	-

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	0.1	0.5	0.8	8.9

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	1.61	1.87	1.94	0.9
Primary Energy Demand/GDP (toe/million constant 2000 $)	3,465	2,492	1,438	(4.3)
CO_2 /capita (t CO_2/person)	0.25	0.83	1.07	7.5
CO_2 Intensity (t CO_2/constant 2000 $ million)	539	1,112	794	2.0
CO_2 /Primary Energy Demand (t CO_2 /toe)	0.16	0.45	0.55	6.5

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); United Nations Statistics Division. 2011. *Energy Balances and Electricity Profiles*. New York; World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

India
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	270.5	460.2	963.4	6.6
Population (million persons)	873.8	1,053.9	1,224.6	1.7
GDP/capita (constant 2000 $/person)	310	437	787	4.8

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	316.7	457.2	692.7	100.0	100.0	100.0	4.0
Coal	103.4	161.5	288.4	32.6	35.3	41.6	5.3
Oil	61.4	112.7	162.3	19.4	24.7	23.4	5.0
Natural Gas	10.6	23.1	52.7	3.3	5.0	7.6	8.4
Nuclear	1.6	4.4	6.8	0.5	1.0	1.0	7.5
Hydro	6.2	6.4	9.8	1.9	1.4	1.4	2.4
Others[a]	133.6	149.2	172.5	42.2	32.6	24.9	1.3

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	251.7	318.6	457.5	100.0	100.0	100.0	3.0
Coal	41.8	33.5	75.8	16.6	10.5	16.6	3.0
Oil	52.6	95.7	128.3	20.9	30.0	28.1	4.6
Natural Gas	5.6	9.7	22.9	2.2	3.0	5.0	7.3
Electricity	18.2	31.6	61.1	7.2	9.9	13.4	6.2
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	133.5	148.1	169.3	53.0	46.5	37.0	1.2

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	251.7	318.6	457.5	100.0	100.0	100.0	3.0
Industry	70.3	87.1	152.1	27.9	27.3	33.2	3.9
Transport	27.1	32.0	55.5	10.8	10.0	12.1	3.6
Other Sectors	142.7	170.7	212.0	56.7	53.6	46.3	2.0
Non-Energy	11.7	28.8	37.9	4.6	9.0	8.3	6.1

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	289.4	561.2	959.9	100.0	100.0	100.0	6.2
Fossil Fuels	211.6	466.8	797.2	73.1	83.2	83.1	6.9
Coal	191.6	386.8	653.0	66.2	68.9	68.0	6.3
Oil	10.0	24.1	26.4	3.5	4.3	2.8	5.0
Natural Gas	10.0	56.0	117.8	3.4	10.0	12.3	13.1
Nuclear	6.1	16.9	26.3	2.1	3.0	2.7	7.5
Hydro	71.7	74.5	114.4	24.8	13.3	11.9	2.4
Others[b]	0.0	3.0	22.0	0.0	0.5	2.3	38.6

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	62.6	138.7	238.8	100.0	100.0	100.0	6.9
Coal	55.6	120.3	201.5	88.7	86.7	84.4	6.7
Oil	3.6	9.2	11.3	5.7	6.6	4.7	5.9
Natural Gas	3.5	9.3	26.0	5.5	6.7	10.9	10.6

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	590.8	957.5	1,656.9	5.3

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.36	0.43	0.57	2.2
Primary Energy Demand/GDP (toe/million constant 2000 $)	1,171	994	719	(2.4)
CO_2 /capita (t CO_2/person)	0.68	0.91	1.35	3.5
CO_2 Intensity (t CO_2/constant 2000 $ million)	2,184	2,081	1,720	(1.2)
CO_2 /Primary Energy Demand (t CO_2/toe)	1.87	2.09	2.39	1.3

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Maldives
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	…	0.6	1.2	…
Population (million persons)	0.2	0.3	0.3	1.8
GDP/capita (constant 2000 $/person)	…	2,285	3,887	…

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.0	0.2	0.3	100.0	100.0	100.0	8.8
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.0	0.2	0.3	100.0	100.0	100.0	8.8
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	…
Others[a]	0.0	0.0	0.0	0.0	0.0	0.0	…

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.0	0.1	0.2	100.0	100.0	100.0	8.9
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.0	0.1	0.2	95.8	94.4	95.5	8.9
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Electricity	0.0	0.0	0.0	4.2	5.6	4.5	9.2
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	0.0	0.0	0.0	0.0	0.0	0.0	…

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.0	0.1	0.2	100.0	100.0	100.0	8.9
Industry	0.0	0.0	0.0	0.0	0.0	0.0	…
Transport	0.0	0.1	0.2	86.0	90.7	95.0	9.5
Other Sectors	0.0	0.0	0.0	14.0	9.3	5.0	3.4
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	…

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.0	0.1	0.1	100.0	100.0	100.0	8.9
Fossil Fuels	0.0	0.1	0.1	100.0	100.0	99.6	8.9
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.0	0.1	0.1	100.0	100.0	99.6	8.9
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	…
Others[b]	0.0	0.0	0.0	0.0	0.0	0.4	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	0.0	0.0	0.0	100.0	100.0	100.0	9.7
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.0	0.0	0.0	100.0	100.0	100.0	9.7
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	0.1	0.5	0.8	9.1

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.22	0.58	0.82	6.8
Primary Energy Demand/GDP (toe/million constant 2000 $)	…	253	210	…
CO_2 /capita (t CO_2/person)	0.64	1.74	2.51	7.1
CO_2 Intensity (t CO_2/constant 2000 $ million)	…	762	646	…
CO_2 /Primary Energy Demand (t CO_2/toe)	2.93	3.02	3.08	0.3

… = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); United Nations Statistics Division. 2011. *Energy Balances and Electricity Profiles*. New York; World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Nepal
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	3.4	5.5	8.0	4.4
Population (million persons)	19.1	24.4	30.0	2.3
GDP/capita (constant 2000 $/person)	177	225	267	2.1

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	5.8	8.1	10.2	100.0	100.0	100.0	2.9
Coal	0.0	0.3	0.2	0.8	3.2	2.0	7.4
Oil	0.2	0.7	1.0	4.2	8.8	9.6	7.2
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.1	0.1	0.3	1.3	1.7	2.7	6.7
Others[a]	5.4	7.0	8.8	93.6	86.3	85.7	2.4

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	5.8	8.0	10.1	100.0	100.0	100.0	2.9
Coal	0.0	0.3	0.2	0.7	3.2	2.0	8.2
Oil	0.2	0.7	1.0	4.2	8.6	9.7	7.2
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Electricity	0.1	0.1	0.2	0.9	1.4	2.3	8.0
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	5.4	7.0	8.7	94.2	86.8	86.0	2.4

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	5.8	8.0	10.1	100.0	100.0	100.0	2.9
Industry	0.1	0.4	0.4	1.8	4.7	3.6	6.4
Transport	0.1	0.3	0.6	1.9	3.4	6.2	9.0
Other Sectors	5.5	7.4	9.1	96.2	91.8	90.2	2.5
Non-Energy	0.0	0.0	0.0	0.1	0.1	0.0	…

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.9	1.7	3.2	100.0	100.0	100.0	6.7
Fossil Fuels	0.0	0.0	0.0	0.1	1.6	0.1	5.6
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.0	0.0	0.0	0.1	1.6	0.1	5.6
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.9	1.6	3.2	99.9	98.4	99.9	6.7
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	0.0	0.0	0.0	…	100.0	100.0	…
Coal	0.0	0.0	0.0	…	0.0	0.0	…
Oil	0.0	0.0	0.0	…	100.0	100.0	…
Natural Gas	0.0	0.0	0.0	…	0.0	0.0	…

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	0.9	3.2	3.8	7.3

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.30	0.33	0.34	0.6
Primary Energy Demand/GDP (toe/million constant 2000 $)	1,715	1,476	1,277	(1.5)
CO_2/capita (t CO_2/person)	0.05	0.13	0.13	4.9
CO_2 Intensity (t CO_2/constant 2000 $ million)	275	578	478	2.8
CO_2/Primary Energy Demand (t CO_2/toe)	0.16	0.39	0.37	4.3

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Sri Lanka
Historical Performance

Socioeconomic Indicators							AAGR (%)
				1990	2000	2010	1990–2010
GDP (constant 2000 $ billion)				9.8	16.3	26.5	5.1
Population (million persons)				17.3	18.7	20.8	0.9
GDP/capita (constant 2000 $/person)				565	870	1,274	4.1

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	5.5	8.3	9.9	100.0	100.0	100.0	3.0
Coal	0.0	0.0	0.1	0.1	0.0	0.7	14.0
Oil	1.3	3.6	4.3	24.0	43.0	43.2	6.0
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.3	0.3	0.5	4.9	3.3	4.9	3.0
Others[a]	3.9	4.5	5.1	71.0	53.7	51.2	1.3

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	5.3	7.4	8.9	100.0	100.0	100.0	2.6
Coal	0.0	0.0	0.1	0.1	0.0	0.7	13.9
Oil	1.2	2.5	3.0	22.2	34.0	33.6	4.8
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Electricity	0.2	0.4	0.8	4.2	5.7	8.9	6.5
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	3.9	4.4	5.1	73.4	60.4	56.8	1.3

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	5.3	7.4	8.9	100.0	100.0	100.0	2.6
Industry	0.8	1.7	2.2	14.8	23.3	25.1	5.4
Transport	0.8	1.7	2.3	15.4	22.9	25.9	5.3
Other Sectors	3.7	3.8	4.3	69.2	52.0	48.2	0.8
Non-Energy	0.0	0.1	0.1	0.6	1.9	0.9	5.0

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	3.2	7.0	10.8	100.0	100.0	100.0	6.3
Fossil Fuels	0.0	3.8	5.1	0.2	54.2	47.5	41.4
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.0	3.8	5.1	0.2	54.2	47.5	41.4
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	3.1	3.2	5.6	99.8	45.6	52.3	3.0
Others[b]	0.0	0.0	0.0	0.0	0.2	0.2	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	0.0	1.0	1.3	100.0	100.0	100.0	38.5
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.0	1.0	1.3	100.0	100.0	100.0	38.5
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…

Carbon Dioxide Emissions	Mt CO_2						AAGR (%)
	1990	2000	2010				1990–2010
Total	4.0	10.6	13.1				6.1

Energy and Carbon Indicators				AAGR (%)
	1990	2000	2010	1990–2010
Primary Energy Demand/capita (toe/person)	0.32	0.44	0.47	2.0
Primary Energy Demand/GDP (toe/million constant 2000 $)	563	511	372	(2.0)
CO_2 /capita (t CO_2/person)	0.23	0.56	0.63	5.2
CO_2 Intensity (t CO_2/constant 2000 $ million)	408	648	494	1.0
CO_2 /Primary Energy Demand (t CO_2/toe)	0.72	1.27	1.33	3.1

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Southeast Asia
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	369.2	608.3	989.8	5.1
Population (million persons)	435.1	523.0	589.7	1.5
GDP/capita (constant 2000 $/person)	849	1,163	1,679	3.5

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	243.5	392.3	554.8	100.0	100.0	100.0	4.2
Coal	12.1	31.6	85.3	5.0	8.1	15.4	10.2
Oil	89.9	156.7	187.3	36.9	40.0	33.8	3.7
Natural Gas	32.1	71.2	122.8	13.2	18.1	22.1	6.9
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	2.4	4.4	6.9	1.0	1.1	1.2	5.4
Others[a]	107.0	128.3	151.7	43.9	32.7	27.3	1.8

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	180.7	278.7	401.3	100.0	100.0	100.0	4.1
Coal	6.1	12.3	36.3	3.4	4.4	9.0	9.4
Oil	66.4	122.0	171.2	36.7	43.8	42.7	4.9
Natural Gas	8.0	16.5	28.2	4.4	5.9	7.0	6.5
Electricity	11.2	27.6	51.6	6.2	9.9	12.9	8.0
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	89.2	100.3	114.0	49.3	36.0	28.4	1.2

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	180.7	278.7	401.3	100.0	100.0	100.0	4.1
Industry	41.6	69.4	110.7	23.0	24.9	27.6	5.0
Transport	32.7	62.9	92.5	18.1	22.6	23.0	5.3
Other Sectors	97.1	126.1	153.9	53.7	45.3	38.3	2.3
Non-Energy	9.2	20.2	44.2	5.1	7.3	11.0	8.1

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	155.0	373.7	679.6	100.0	100.0	100.0	7.7
Fossil Fuels	119.9	304.3	574.7	77.3	81.4	84.6	8.2
Coal	27.6	76.2	186.4	17.8	20.4	27.4	10.0
Oil	66.9	72.7	55.7	43.2	19.4	8.2	(0.9)
Natural Gas	25.3	155.5	332.5	16.3	41.6	48.9	13.7
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	28.1	51.1	80.6	18.1	13.7	11.9	5.4
Others[b]	7.0	18.3	24.4	4.5	4.9	3.6	6.4

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	29.6	70.5	130.0	100.0	100.0	100.0	7.7
Coal	6.9	19.0	49.8	23.3	27.0	38.3	10.4
Oil	16.5	18.2	13.8	55.8	25.8	10.6	(0.9)
Natural Gas	6.2	33.2	66.4	20.8	47.2	51.1	12.6

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	388.5	741.2	1,070.8	5.2

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.56	0.75	0.94	2.6
Primary Energy Demand/GDP (toe/million constant 2000 $)	660	645	561	(0.8)
CO_2 /capita (t CO_2/person)	0.89	1.42	1.82	3.6
CO_2 Intensity (t CO_2/constant 2000 $ million)	1,052	1,218	1,082	0.1
CO_2 /Primary Energy Demand (t CO_2/toe)	1.60	1.89	1.93	1.0

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; Government of Lao People's Democratic Republic (Lao PDR), Ministry of Energy and Mines. *Energy Balances of Lao PDR from 1990 to 2010*. Unpublished; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Brunei Darussalam
Historical Performance

Socioeconomic Indicators			1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)			4.8	6.0	6.9	1.8
Population (million persons)			0.3	0.3	0.4	2.3
GDP/capita (constant 2000 $/person)			19,075	18,350	17,225	(0.5)

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	1.8	2.5	3.2	100.0	100.0	100.0	3.0
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.1	0.6	0.8	4.8	24.6	23.9	11.6
Natural Gas	1.7	1.8	2.4	95.1	75.4	76.1	1.8
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	…
Others[a]	0.0	0.0	0.0	0.1	0.0	0.0	(6.3)

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.4	0.6	1.2	100.0	100.0	100.0	6.3
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.3	0.4	0.6	74.6	63.3	52.2	4.5
Natural Gas	0.0	0.0	0.3	0.0	0.0	24.9	…
Electricity	0.1	0.2	0.3	24.8	36.7	22.8	5.9
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	0.0	0.0	0.0	0.6	0.0	0.1	(6.3)

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.4	0.6	1.2	100.0	100.0	100.0	6.3
Industry	0.1	0.1	0.2	17.3	12.3	19.2	6.9
Transport	0.2	0.3	0.4	53.6	47.6	34.6	4.1
Other Sectors	0.1	0.2	0.3	24.3	36.3	25.8	6.7
Non-Energy	0.0	0.0	0.2	4.8	3.9	20.4	14.3

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	1.2	2.5	3.6	100.0	100.0	100.0	5.8
Fossil Fuels	1.2	2.5	3.6	100.0	100.0	100.0	5.8
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.0	0.0	0.0	0.9	0.9	0.0	…
Natural Gas	1.2	2.5	3.6	99.1	99.1	100.0	5.8
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	…
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	0.5	0.9	1.2	100.0	100.0	100.0	5.0
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.0	0.0	0.0	0.7	0.6	0.0	…
Natural Gas	0.5	0.9	1.2	99.3	99.4	100.0	5.0

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	4.1	6.1	7.4	2.9

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	6.99	7.50	7.92	0.6
Primary Energy Demand/GDP (toe/million constant 2000 $)	366	409	460	1.1
CO_2 /capita (t CO_2/person)	16.44	18.75	18.52	0.6
CO_2 Intensity (t CO_2/constant 2000 $ million)	862	1,022	1,075	1.1
CO_2 /Primary Energy Demand (t CO_2/toe)	2.35	2.50	2.34	(0.0)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: Figures may not add up to total because of rounding.
[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.
[b] "Others" include geothermal, solar, wind, and renewables.
Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Cambodia
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	…	3.7	7.9	…
Population (million persons)	…	12.4	14.1	…
GDP/capita (constant 2000 $/person)	…	294	559	…

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	…	3.4	5.0	…	100.0	100.0	…
Coal	…	0.0	0.0	…	0.0	0.2	…
Oil	…	0.7	1.3	…	20.3	25.4	…
Natural Gas	…	0.0	0.0	…	0.0	0.0	…
Nuclear	…	0.0	0.0	…	0.0	0.0	…
Hydro	…	0.0	0.0	…	0.0	0.0	…
Others[a]	…	2.7	3.7	…	79.7	74.3	…

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	…	3.0	4.3	…	100.0	100.0	…
Coal	…	0.0	0.0	…	0.0	0.0	…
Oil	…	0.5	1.0	…	18.1	23.1	…
Natural Gas	…	0.0	0.0	…	0.0	0.0	…
Electricity	…	0.0	0.2	…	1.1	4.1	…
Heat	…	0.0	0.0	…	0.0	0.0	…
Others	…	2.4	3.1	…	80.8	72.8	…

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	…	3.0	4.3	…	100.0	100.0	…
Industry	…	0.6	0.9	…	20.6	21.0	…
Transport	…	0.4	0.6	…	14.7	14.8	…
Other Sectors	…	1.9	2.7	…	64.3	63.8	…
Non-Energy	…	0.0	0.0	…	0.4	0.4	…

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	…	0.4	1.0	…	100.0	100.0	…
Fossil Fuels	…	0.4	0.9	…	99.8	95.1	…
Coal	…	0.0	0.0	…	0.0	3.1	…
Oil	…	0.4	0.9	…	99.8	92.0	…
Natural Gas	…	0.0	0.0	…	0.0	0.0	…
Nuclear	…	0.0	0.0	…	0.0	0.0	…
Hydro	…	0.0	0.0	…	0.0	2.6	…
Others[b]	…	0.0	0.0	…	0.2	2.3	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	…	0.1	0.2	…	100.0	100.0	…
Coal	…	0.0	0.0	…	0.0	3.2	…
Oil	…	0.1	0.2	…	100.0	96.8	…
Natural Gas	…	0.0	0.0	…	0.0	0.0	…

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	…	2.1	3.9	…

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	…	0.27	0.36	…
Primary Energy Demand/GDP (toe/million constant 2000 $)	…	934	636	…
CO_2 /capita (t CO_2/person)	…	0.17	0.28	…
CO_2 Intensity (t CO_2/constant 2000 $ million)	…	573	494	…
CO_2 /Primary Energy Demand (t CO_2/toe)	…	0.61	0.78	…

… = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Indonesia
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	109.2	165.0	258.6	4.4
Population (million persons)	184.3	213.4	237.2	1.3
GDP/capita (constant 2000 $/person)	592	773	1,090	3.1

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	101.3	155.7	207.8	100.0	100.0	100.0	3.7
Coal	3.5	12.4	30.5	3.5	7.9	14.7	11.4
Oil	33.4	58.2	66.9	32.9	37.4	32.2	3.5
Natural Gas	18.5	26.8	38.8	18.3	17.2	18.7	3.8
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.5	0.9	1.5	0.5	0.6	0.7	5.8
Others[a]	45.4	57.5	70.0	44.8	36.9	33.7	2.2

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	79.8	116.6	156.4	100.0	100.0	100.0	3.4
Coal	2.1	3.6	12.9	2.7	3.1	8.2	9.4
Oil	26.6	46.3	61.8	33.4	39.7	39.5	4.3
Natural Gas	6.6	11.5	15.8	8.3	9.9	10.1	4.4
Electricity	2.4	6.8	12.7	3.0	5.8	8.1	8.6
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	42.0	48.3	53.2	52.6	41.4	34.0	1.2

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	79.8	116.6	156.4	100.0	100.0	100.0	3.4
Industry	20.3	28.9	45.8	25.4	24.8	29.3	4.2
Transport	10.7	21.9	35.9	13.4	18.8	22.9	6.2
Other Sectors	43.6	58.0	65.8	54.7	49.8	42.1	2.1
Non-Energy	5.2	7.8	8.9	6.5	6.7	5.7	2.7

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	32.7	93.4	169.8	100.0	100.0	100.0	8.6
Fossil Fuels	25.8	78.5	142.7	79.1	84.1	84.0	8.9
Coal	9.8	34.0	68.1	29.9	36.4	40.1	10.2
Oil	15.3	18.7	34.5	46.9	20.0	20.3	4.1
Natural Gas	0.7	25.8	40.0	2.2	27.6	23.6	22.1
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	5.7	10.0	17.7	17.5	10.7	10.4	5.8
Others[b]	1.1	4.9	9.5	3.4	5.2	5.6	11.2

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	6.5	18.8	35.9	100.0	100.0	100.0	8.9
Coal	2.3	8.4	18.7	35.7	44.7	52.2	11.0
Oil	4.0	4.6	8.5	61.0	24.6	23.7	3.9
Natural Gas	0.2	5.8	8.6	3.2	30.8	24.1	20.4

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	146.9	271.2	392.7	5.0

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.55	0.73	0.88	2.4
Primary Energy Demand/GDP (toe/million constant 2000 $)	928	943	804	(0.7)
CO_2/capita (t CO_2/person)	0.80	1.27	1.66	3.7
CO_2 Intensity (t CO_2/constant 2000 $ million)	1,346	1,643	1,519	0.6
CO_2/Primary Energy Demand (t CO_2/toe)	1.45	1.74	1.89	1.3

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Lao People's Democratic Republic
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	1.0	1.7	3.5	6.7
Population (million persons)	4.2	5.3	6.2	2.0
GDP/capita (constant 2000 $/person)	227	326	560	4.6

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	1.2	1.7	2.8	100.0	100.0	100.0	4.3
Coal	0.0	0.0	0.2	0.0	0.0	5.6	…
Oil	0.2	0.3	0.6	13.6	17.2	22.7	7.0
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.1	0.3	0.7	5.9	17.9	26.0	12.3
Others[a]	1.0	1.1	1.3	80.5	64.9	45.6	1.4

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	1.1	1.5	2.4	100.0	100.0	100.0	3.9
Coal	0.0	0.0	0.1	0.0	0.0	4.5	…
Oil	0.2	0.3	0.5	14.9	18.1	22.7	6.1
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Electricity	0.0	0.1	0.2	1.3	3.7	8.9	14.5
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	0.9	1.2	1.5	83.8	78.2	64.0	2.5

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	1.1	1.5	2.4	100.0	100.0	100.0	3.9
Industry	0.0	0.1	0.2	3.6	4.2	9.8	9.3
Transport	0.2	0.3	0.5	14.7	17.7	21.6	6.0
Other Sectors	0.9	1.2	1.6	81.7	78.1	68.6	3.0
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.1	…

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	0.8	3.4	8.4	100.0	100.0	100.0	12.4
Fossil Fuels	0.0	0.0	0.0	0.0	0.0	0.0	…
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	0.0	0.0	0.0	0.0	0.0	0.0	…
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.8	3.4	8.4	100.0	100.0	100.0	12.4
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	0.0	0.0	0.0	…	…	…	…
Coal	0.0	0.0	0.0	…	…	…	…
Oil	0.0	0.0	0.0	…	…	…	…
Natural Gas	0.0	0.0	0.0	…	…	…	…

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	0.5	0.9	2.6	8.5

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.29	0.31	0.45	2.3
Primary Energy Demand/GDP (toe/million constant 2000 $)	1,258	954	804	(2.2)
CO_2/capita (t CO_2/person)	0.12	0.16	0.41	6.4
CO_2 Intensity (t CO_2/constant 2000 $ million)	525	502	736	1.7
CO_2/Primary Energy Demand (t CO_2/toe)	0.42	0.53	0.92	4.0

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; Government of Lao People's Democratic Republic (Lao PDR), Ministry of Energy and Mines. *Energy Balances of Lao PDR from 1990 to 2010*. Unpublished; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Malaysia
Historical Performance

Socioeconomic Indicators							AAGR (%)
				1990	2000	2010	1990–2010
GDP (constant 2000 $ billion)				47.2	93.8	147.3	5.9
Population (million persons)				18.2	23.4	28.4	2.2
GDP/capita (constant 2000 $/person)				2,593	4,006	5,185	3.5

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	22.0	47.3	72.6	100.0	100.0	100.0	6.2
Coal	1.0	1.8	14.6	4.7	3.7	20.1	14.1
Oil	12.4	20.6	26.0	56.3	43.6	35.8	3.8
Natural Gas	6.1	21.7	28.1	27.8	45.9	38.6	7.9
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.3	0.6	0.6	1.6	1.3	0.8	2.5
Others[a]	2.1	2.5	3.4	9.6	5.3	4.7	2.4

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	13.8	28.9	43.3	100.0	100.0	100.0	5.9
Coal	0.4	0.6	1.8	3.0	2.2	4.2	7.7
Oil	9.4	18.0	24.6	68.0	62.4	56.8	5.0
Natural Gas	1.0	3.5	5.6	7.1	12.0	13.0	9.1
Electricity	1.7	5.3	9.5	12.5	18.2	22.0	9.0
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	1.3	1.5	1.7	9.4	5.2	4.0	1.4

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	13.8	28.9	43.3	100.0	100.0	100.0	5.9
Industry	5.3	10.9	13.0	38.1	37.7	30.1	4.7
Transport	4.8	10.5	14.4	35.2	36.3	33.3	5.6
Other Sectors	2.9	5.4	9.7	21.0	18.7	22.5	6.3
Non-Energy	0.8	2.1	6.1	5.6	7.3	14.2	10.9

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	23.0	69.2	125.3	100.0	100.0	100.0	8.8
Fossil Fuels	19.0	61.8	117.5	82.7	89.3	93.8	9.5
Coal	2.8	4.6	43.1	12.3	6.6	34.4	14.6
Oil	11.5	3.3	3.7	50.0	4.8	2.9	(5.5)
Natural Gas	4.7	54.0	70.8	20.4	77.9	56.5	14.5
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	4.0	7.4	6.5	17.3	10.7	5.2	2.5
Others[b]	0.0	0.0	1.3	0.0	0.0	1.0	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	4.8	13.0	30.0	100.0	100.0	100.0	9.5
Coal	0.6	1.1	13.0	12.9	8.8	43.4	16.4
Oil	3.0	1.0	0.7	61.8	7.4	2.5	(6.7)
Natural Gas	1.2	10.9	16.2	25.3	83.8	54.1	13.8

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	52.2	111.7	185.9	6.6

Energy and Carbon Indicators				AAGR (%)
	1990	2000	2010	1990–2010
Primary Energy Demand/capita (toe/person)	1.21	2.02	2.56	3.8
Primary Energy Demand/GDP (toe/million constant 2000 $)	466	504	493	0.3
CO_2/capita (t CO_2/person)	2.86	4.77	6.54	4.2
CO_2 Intensity (t CO_2/constant 2000 $ million)	1,105	1,191	1,262	0.7
CO_2/Primary Energy Demand (t CO_2/toe)	2.37	2.36	2.56	0.4

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Myanmar
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	3.6	7.3	21.6	9.3
Population (million persons)	39.3	45.0	48.0	1.0
GDP/capita (constant 2000 $/person)	93	162	450	8.2

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	10.7	12.8	14.0	100.0	100.0	100.0	1.4
Coal	0.1	0.3	0.4	0.6	2.5	2.9	9.5
Oil	0.7	2.0	1.3	6.8	15.4	9.2	2.9
Natural Gas	0.8	1.2	1.3	7.1	9.3	9.5	2.8
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.1	0.2	0.4	1.0	1.3	3.1	7.5
Others[a]	9.0	9.2	10.5	84.5	71.5	75.3	0.8

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	9.4	11.5	12.9	100.0	100.0	100.0	1.6
Coal	0.1	0.3	0.2	0.5	2.8	1.8	7.9
Oil	0.6	1.5	1.0	6.2	13.3	8.0	2.8
Natural Gas	0.2	0.3	0.6	2.4	2.8	4.6	5.0
Electricity	0.1	0.3	0.5	1.6	2.4	4.2	6.6
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	8.4	9.0	10.5	89.2	78.6	81.4	1.1

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	9.4	11.5	12.9	100.0	100.0	100.0	1.6
Industry	0.4	1.2	1.3	4.2	10.0	10.0	6.1
Transport	0.4	1.2	0.8	4.7	10.1	6.3	3.1
Other Sectors	8.5	9.1	10.7	90.1	79.1	82.9	1.2
Non-Energy	0.1	0.1	0.1	1.0	0.8	0.8	0.6

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	2.5	5.1	7.5	100.0	100.0	100.0	5.7
Fossil Fuels	1.3	3.2	2.4	51.9	63.0	32.3	3.3
Coal	0.0	0.0	0.7	1.6	0.0	8.9	15.1
Oil	0.3	0.7	0.0	10.9	13.5	0.4	(10.0)
Natural Gas	1.0	2.5	1.7	39.3	49.5	23.0	2.9
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	1.2	1.9	5.1	48.1	37.0	67.7	7.5
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	0.5	0.9	0.7	100.0	100.0	100.0	1.8
Coal	0.0	0.0	0.2	2.4	0.0	24.7	14.3
Oil	0.1	0.2	0.0	12.6	20.6	1.1	(9.8)
Natural Gas	0.4	0.7	0.5	85.0	79.4	74.2	1.1

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	4.1	9.9	8.4	3.7

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.27	0.29	0.29	0.4
Primary Energy Demand/GDP (toe/million constant 2000 $)	2,928	1,765	649	(7.3)
CO_2/capita (t CO_2/person)	0.10	0.22	0.18	2.7
CO_2 Intensity (t CO_2/constant 2000 $ million)	1,113	1,362	391	(5.1)
CO_2/Primary Energy Demand (t CO_2/toe)	0.38	0.77	0.60	2.3

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Philippines
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	61.1	81.0	128.7	3.8
Population (million persons)	61.6	77.3	93.3	2.1
GDP/capita (constant 2000 $/person)	991	1,048	1,380	1.7

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	28.9	40.4	40.5	100.0	100.0	100.0	1.7
Coal	1.4	5.1	7.7	5.0	12.6	19.1	8.8
Oil	11.1	16.5	13.6	38.5	40.9	33.6	1.0
Natural Gas	0.0	0.0	3.0	0.0	0.0	7.5	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.5	0.7	0.7	1.8	1.7	1.7	1.3
Others[a]	15.8	18.1	15.4	54.8	44.8	38.1	(0.1)

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	19.9	24.3	23.8	100.0	100.0	100.0	0.9
Coal	0.8	0.9	2.0	3.8	3.6	8.3	4.9
Oil	8.3	13.4	11.5	41.5	55.1	48.1	1.7
Natural Gas	0.0	0.0	0.1	0.0	0.0	0.3	…
Electricity	1.8	3.1	4.8	9.2	13.0	20.0	4.9
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	9.1	6.9	5.5	45.5	28.4	23.3	(2.4)

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	19.9	24.3	23.8	100.0	100.0	100.0	0.9
Industry	4.6	5.3	6.4	23.1	21.8	26.9	1.7
Transport	4.6	8.3	8.0	23.2	34.1	33.8	2.8
Other Sectors	10.3	10.3	9.1	51.7	42.4	38.4	(0.6)
Non-Energy	0.4	0.4	0.2	2.0	1.7	0.9	(2.9)

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	26.3	45.3	67.7	100.0	100.0	100.0	4.8
Fossil Fuels	14.4	25.9	49.9	54.6	57.1	73.7	6.4
Coal	1.9	16.7	23.3	7.3	36.8	34.4	13.3
Oil	12.4	9.2	7.1	47.2	20.3	10.5	(2.8)
Natural Gas	0.0	0.0	19.5	0.0	0.0	28.8	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	6.1	7.8	7.8	23.0	17.2	11.5	1.3
Others[b]	5.9	11.6	10.0	22.4	25.7	14.8	2.7

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	2.6	6.1	9.7	100.0	100.0	100.0	6.7
Coal	0.5	4.2	5.5	19.2	68.1	56.6	12.7
Oil	2.1	1.9	1.5	80.8	31.8	15.2	(1.8)
Natural Gas	0.0	0.0	2.7	0.0	0.1	28.2	…

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	38.4	69.6	75.1	3.4

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.47	0.52	0.43	(0.4)
Primary Energy Demand/GDP (toe/million constant 2000 $)	473	499	315	(2.0)
CO_2/capita (t CO_2/person)	0.62	0.90	0.81	1.3
CO_2 Intensity (t CO_2/constant 2000 $ million)	629	859	584	(0.4)
CO_2/Primary Energy Demand (t CO_2/toe)	1.33	1.72	1.86	1.7

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Singapore
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	48.0	95.9	165.2	6.4
Population (million persons)	3.0	3.9	5.1	2.6
GDP/capita (constant 2000 $/person)	15,906	24,474	32,476	3.6

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	11.5	19.2	23.7	100.0	100.0	100.0	3.7
Coal	0.0	0.0	0.1	0.2	0.0	0.5	8.8
Oil	11.4	18.1	15.8	99.8	94.1	66.5	1.6
Natural Gas	0.0	1.1	7.8	0.0	5.8	32.9	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	…
Others[a]	0.0	0.0	0.0	0.0	0.1	0.1	…

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	5.0	7.2	15.0	100.0	100.0	100.0	5.7
Coal	0.1	0.1	0.1	1.3	1.5	0.8	3.1
Oil	3.8	4.7	11.1	76.4	65.9	73.8	5.5
Natural Gas	0.0	0.0	0.6	0.0	0.0	4.3	…
Electricity	1.1	2.3	3.2	22.3	32.7	21.0	5.4
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	0.0	0.0	0.0	0.0	0.0	0.1	…

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	5.0	7.2	15.0	100.0	100.0	100.0	5.7
Industry	0.6	1.0	1.6	12.4	14.1	10.8	5.0
Transport	1.4	2.0	2.7	27.2	27.7	18.1	3.6
Other Sectors	0.7	1.5	2.3	14.0	20.5	15.1	6.1
Non-Energy	2.3	2.7	8.4	46.4	37.7	55.9	6.7

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	15.7	31.7	44.3	100.0	100.0	100.0	5.3
Fossil Fuels	15.7	31.6	44.2	100.0	99.8	99.8	5.3
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…
Oil	15.7	25.7	6.4	100.0	81.3	14.4	(4.4)
Natural Gas	0.0	5.9	37.8	0.0	18.5	85.3	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	…
Others[b]	0.0	0.1	0.1	0.0	0.2	0.2	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	4.4	7.8	8.5	100.0	100.0	100.0	3.3
Coal	0.0	0.0	0.0	0.0	0.0	0.0	(100.0)
Oil	4.4	6.7	2.0	100.0	85.7	24.1	(3.8)
Natural Gas	0.0	1.1	6.4	0.0	14.3	75.9	…

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	28.1	49.9	45.4	2.4

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	3.80	4.91	4.67	1.0
Primary Energy Demand/GDP (toe/million constant 2000 $)	239	201	144	(2.5)
CO_2 /capita (t CO_2/person)	9.31	12.72	8.92	(0.2)
CO_2 Intensity (t CO_2/constant 2000 $ million)	585	520	275	(3.7)
CO_2 /Primary Energy Demand (t CO_2/toe)	2.45	2.59	1.91	(1.2)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Thailand
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	79.4	122.7	187.5	4.4
Population (million persons)	57.1	63.2	69.1	1.0
GDP/capita (constant 2000 $/person)	1,391	1,943	2,713	3.4

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	41.9	72.4	117.4	100.0	100.0	100.0	5.3
Coal	3.8	7.7	16.4	9.1	10.6	13.9	7.5
Oil	18.0	32.0	44.6	42.8	44.2	37.9	4.6
Natural Gas	5.0	17.4	32.9	11.9	24.0	28.0	9.9
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.4	0.5	0.5	1.0	0.7	0.4	0.5
Others[a]	14.7	14.8	22.4	35.1	20.5	19.1	2.1

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	28.9	52.0	84.6	100.0	100.0	100.0	5.5
Coal	1.3	3.5	9.2	4.5	6.8	10.9	10.2
Oil	14.9	30.4	43.5	51.7	58.5	51.5	5.5
Natural Gas	0.1	1.1	4.6	0.5	2.1	5.4	19.1
Electricity	3.3	7.6	12.8	11.4	14.6	15.2	7.0
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	9.2	9.4	14.4	31.8	18.0	17.0	2.3

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	28.9	52.0	84.6	100.0	100.0	100.0	5.5
Industry	8.7	16.7	26.5	30.0	32.2	31.3	5.7
Transport	9.0	14.6	19.5	31.2	28.1	23.0	3.9
Other Sectors	10.8	13.6	20.4	37.4	26.2	24.2	3.2
Non-Energy	0.4	7.0	18.2	1.4	13.5	21.5	20.9

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	44.2	96.0	159.5	100.0	100.0	100.0	6.6
Fossil Fuels	39.2	88.2	150.6	88.7	91.9	94.4	7.0
Coal	11.1	17.8	30.0	25.0	18.5	18.8	5.1
Oil	10.4	10.0	1.2	23.5	10.4	0.7	(10.3)
Natural Gas	17.8	60.4	119.3	40.2	62.9	74.8	10.0
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	5.0	6.0	5.5	11.3	6.3	3.5	0.5
Others[b]	0.0	1.7	3.4	0.0	1.8	2.1	50.2

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	8.9	19.2	29.8	100.0	100.0	100.0	6.2
Coal	2.5	4.2	6.9	28.6	21.6	23.2	5.1
Oil	2.6	2.3	0.3	28.6	12.2	0.9	(10.7)
Natural Gas	3.8	12.7	22.7	42.9	66.2	75.9	9.3

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	97.3	176.3	224.0	4.3

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.73	1.15	1.70	4.3
Primary Energy Demand/GDP (toe/million constant 2000 $)	529	590	626	0.9
CO_2 /capita (t CO_2/person)	1.70	2.79	3.24	3.3
CO_2 Intensity (t CO_2/constant 2000 $ million)	1,226	1,437	1,195	(0.1)
CO_2 /Primary Energy Demand (t CO_2/toe)	2.32	2.44	1.91	(1.0)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: Figures may not add up to total because of rounding.
[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.
[b] "Others" include geothermal, solar, wind, and renewables.
Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Viet Nam
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	15.0	31.2	62.8	7.4
Population (million persons)	67.1	78.8	87.8	1.4
GDP/capita (constant 2000 $/person)	224	396	715	6.0

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	24.3	36.9	67.7	100.0	100.0	100.0	5.3
Coal	2.2	4.4	15.4	9.1	11.8	22.8	10.2
Oil	2.7	7.8	16.4	11.2	21.1	24.3	9.4
Natural Gas	0.0	1.1	8.4	0.0	3.0	12.5	49.5
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	0.5	1.3	2.5	1.9	3.4	3.7	8.9
Others[a]	18.9	22.4	24.9	77.8	60.6	36.8	1.4

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	22.5	33.3	57.3	100.0	100.0	100.0	4.8
Coal	1.3	3.2	10.0	5.9	9.7	17.4	10.6
Oil	2.3	6.5	15.5	10.4	19.6	27.0	9.9
Natural Gas	0.0	0.0	0.5	0.0	0.1	0.9	…
Electricity	0.5	1.9	7.4	2.4	5.8	12.9	14.1
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	18.3	21.6	24.0	81.4	64.9	41.8	1.4

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	22.5	33.3	57.3	100.0	100.0	100.0	4.8
Industry	1.7	4.7	14.7	7.6	14.0	25.6	11.3
Transport	1.4	3.5	9.5	6.2	10.6	16.6	10.1
Other Sectors	19.4	25.0	31.2	86.1	75.0	54.4	2.4
Non-Energy	0.0	0.1	1.9	0.1	0.4	3.4	23.7

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	8.7	26.6	92.4	100.0	100.0	100.0	12.6
Fossil Fuels	3.3	12.0	62.8	38.2	45.2	68.0	15.8
Coal	2.0	3.1	21.2	23.1	11.8	22.9	12.5
Oil	1.3	4.5	1.9	15.0	17.0	2.1	1.9
Natural Gas	0.0	4.4	39.7	0.1	16.4	43.0	55.3
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	5.4	14.6	29.5	61.8	54.8	31.9	8.9
Others[b]	0.0	0.0	0.1	0.0	0.0	0.1	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	1.3	3.6	13.9	100.0	100.0	100.0	12.7
Coal	0.9	1.1	5.5	69.8	32.3	39.3	9.5
Oil	0.4	1.3	0.5	30.0	36.8	3.6	1.3
Natural Gas	0.0	1.1	7.9	0.2	30.9	57.2	49.1

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	17.0	43.5	125.5	10.5

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	0.36	0.47	0.77	3.8
Primary Energy Demand/GDP (toe/million constant 2000 $)	1,618	1,184	1,077	(2.0)
CO_2 /capita (t CO_2/person)	0.25	0.55	1.43	9.0
CO_2 Intensity (t CO_2/constant 2000 $ million)	1,135	1,395	1,996	2.9
CO_2 /Primary Energy Demand (t CO_2/toe)	0.70	1.18	1.85	5.0

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Developed Group
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	4,487.6	5,135.9	5,641.7	1.2
Population (million persons)	142.7	148.7	153.2	0.4
GDP/capita (constant 2000 $/person)	31,438	34,529	36,832	0.8

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	538.3	643.8	639.8	100.0	100.0	100.0	0.9
Coal	112.8	146.1	167.6	20.9	22.7	26.2	2.0
Oil	285.2	295.0	248.9	53.0	45.8	38.9	(0.7)
Natural Gas	62.8	90.0	116.2	11.7	14.0	18.2	3.1
Nuclear	52.7	83.9	75.1	9.8	13.0	11.7	1.8
Hydro	10.9	11.0	10.3	2.0	1.7	1.6	(0.3)
Others[a]	14.0	17.8	21.3	2.6	2.8	3.3	2.1

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	366.5	427.5	412.6	100.0	100.0	100.0	0.6
Coal	37.7	31.8	32.3	10.3	7.4	7.8	(0.8)
Oil	217.0	249.6	215.3	59.2	58.4	52.2	(0.0)
Natural Gas	25.7	37.5	49.3	7.0	8.8	11.9	3.3
Electricity	78.0	99.0	106.8	21.3	23.1	25.9	1.6
Heat	0.2	0.5	0.6	0.1	0.1	0.1	5.5
Others	8.0	9.2	8.3	2.2	2.2	2.0	0.2

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	366.5	427.5	412.6	100.0	100.0	100.0	0.6
Industry	125.8	127.5	116.3	34.3	29.8	28.2	(0.4)
Transport	95.8	117.7	110.2	26.1	27.5	26.7	0.7
Other Sectors	105.8	134.8	140.3	28.9	31.5	34.0	1.4
Non-Energy	39.1	47.6	45.9	10.7	11.1	11.1	0.8

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	1,022.0	1,298.0	1,397.1	100.0	100.0	100.0	1.6
Fossil Fuels	677.4	824.1	938.5	66.3	63.5	67.2	1.6
Coal	238.8	408.0	487.3	23.4	31.4	34.9	3.6
Oil	251.4	138.9	100.6	24.6	10.7	7.2	(4.5)
Natural Gas	187.2	277.2	350.6	18.3	21.4	25.1	3.2
Nuclear	202.3	322.0	288.2	19.8	24.8	20.6	1.8
Hydro	126.6	128.0	119.4	12.4	9.9	8.5	(0.3)
Others[b]	15.6	23.9	51.0	1.5	1.8	3.6	6.1

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	143.9	171.5	190.1	100.0	100.0	100.0	1.4
Coal	54.3	90.7	107.2	37.8	52.9	56.4	3.5
Oil	51.5	28.0	18.9	35.8	16.3	9.9	(4.9)
Natural Gas	38.0	52.8	64.1	26.4	30.8	33.7	2.6

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	1,455.9	1,678.0	1,687.3	0.7

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	3.77	4.33	4.18	0.5
Primary Energy Demand/GDP (toe/million constant 2000 $)	120	125	113	(0.3)
CO_2 /capita (t CO_2/person)	10.20	11.28	11.02	0.4
CO_2 Intensity (t CO_2/constant 2000 $ million)	324	327	299	(0.4)
CO_2 /Primary Energy Demand (t CO_2/toe)	2.70	2.61	2.64	(0.1)

( ) = negative number, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: Figures may not add up to total because of rounding.
[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.
[b] "Others" include geothermal, solar, wind, and renewables.
Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Australia
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	298.7	416.9	565.7	3.2
Population (million persons)	17.1	19.2	22.3	1.3
GDP/capita (constant 2000 $/person)	17,469	21,753	25,406	2.0

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	86.2	108.1	124.7	100.0	100.0	100.0	1.9
Coal	35.0	48.2	51.4	40.6	44.5	41.2	1.9
Oil	31.2	34.2	39.9	36.2	31.6	32.0	1.2
Natural Gas	14.8	19.3	26.5	17.1	17.8	21.2	3.0
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	. . .
Hydro	1.2	1.4	1.1	1.4	1.3	0.9	(0.6)
Others[a]	4.0	5.1	5.7	4.7	4.7	4.5	1.7

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	56.6	69.6	75.3	100.0	100.0	100.0	1.4
Coal	4.5	4.2	3.0	7.9	6.0	4.0	(1.9)
Oil	29.0	34.7	38.1	51.3	49.9	50.6	1.4
Natural Gas	8.6	11.4	13.1	15.3	16.4	17.5	2.1
Electricity	11.1	14.9	17.3	19.6	21.4	23.0	2.2
Heat	0.0	0.0	0.0	0.0	0.0	0.0	. . .
Others	3.3	4.4	3.7	5.9	6.4	4.9	0.5

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	56.6	69.6	75.3	100.0	100.0	100.0	1.4
Industry	19.2	23.8	22.4	34.0	34.2	29.8	0.8
Transport	21.1	25.7	28.6	37.3	36.9	38.0	1.5
Other Sectors	12.3	15.7	19.2	21.7	22.6	25.5	2.3
Non-Energy	4.0	4.4	5.0	7.0	6.4	6.7	1.2

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	154.3	209.9	241.5	100.0	100.0	100.0	2.3
Fossil Fuels	139.4	192.3	220.1	90.3	91.6	91.1	2.3
Coal	121.5	174.2	180.7	78.7	83.0	74.8	2.0
Oil	3.6	1.8	3.2	2.3	0.9	1.3	(0.6)
Natural Gas	14.4	16.2	36.2	9.3	7.7	15.0	4.7
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	. . .
Hydro	14.1	16.4	12.5	9.2	7.8	5.2	(0.6)
Others[b]	0.8	1.2	9.0	0.5	0.6	3.7	13.2

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	33.2	46.6	54.3	100.0	100.0	100.0	2.5
Coal	28.8	42.0	45.0	86.7	90.2	83.0	2.3
Oil	0.9	0.5	0.9	2.8	1.1	1.6	(0.5)
Natural Gas	3.5	4.1	8.4	10.5	8.7	15.5	4.5

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	257.2	327.5	376.6	1.9

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	5.04	5.64	5.60	0.6
Primary Energy Demand/GDP (toe/million constant 2000 $)	289	259	220	(1.4)
CO_2 /capita (t CO_2/person)	15.05	17.09	16.91	0.6
CO_2 Intensity (t CO_2/constant 2000 $ million)	861	786	666	(1.3)
CO_2 /Primary Energy Demand (t CO_2/toe)	2.98	3.03	3.02	0.1

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Japan
Historical Performance

Socioeconomic Indicators				1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)				4,150.3	4,667.4	5,010.6	0.9
Population (million persons)				122.3	125.7	126.5	0.2
GDP/capita (constant 2000 $/person)				33,949	37,126	39,599	0.8

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	439.3	518.9	496.8	100.0	100.0	100.0	0.6
Coal	76.6	96.9	115.0	17.4	18.7	23.1	2.0
Oil	250.4	255.2	203.0	57.0	49.2	40.9	(1.0)
Natural Gas	44.2	65.7	86.0	10.1	12.7	17.3	3.4
Nuclear	52.7	83.9	75.1	12.0	16.2	15.1	1.8
Hydro	7.7	7.5	7.1	1.7	1.4	1.4	(0.4)
Others[a]	7.7	9.8	10.7	1.8	1.9	2.2	1.6

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	300.1	345.1	324.6	100.0	100.0	100.0	0.4
Coal	32.3	27.1	28.7	10.8	7.8	8.8	(0.6)
Oil	184.0	209.6	171.4	61.3	60.7	52.8	(0.4)
Natural Gas	15.2	23.1	34.5	5.1	6.7	10.6	4.2
Electricity	64.5	81.2	86.2	21.5	23.5	26.5	1.5
Heat	0.2	0.5	0.6	0.1	0.2	0.2	5.5
Others	3.9	3.7	3.3	1.3	1.1	1.0	(0.7)

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	300.1	345.1	324.6	100.0	100.0	100.0	0.4
Industry	102.8	99.7	90.0	34.3	28.9	27.7	(0.7)
Transport	71.8	87.9	76.9	23.9	25.5	23.7	0.4
Other Sectors	90.9	115.9	117.7	30.3	33.6	36.3	1.3
Non-Energy	34.5	41.5	39.9	11.5	12.0	12.3	0.7

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	835.5	1,049.0	1,110.8	100.0	100.0	100.0	1.4
Fossil Fuels	531.7	620.7	706.5	63.6	59.2	63.6	1.4
Coal	116.7	232.3	304.5	14.0	22.1	27.4	4.9
Oil	247.9	137.1	97.5	29.7	13.1	8.8	(4.6)
Natural Gas	167.1	251.3	304.5	20.0	24.0	27.4	3.0
Nuclear	202.3	322.0	288.2	24.2	30.7	25.9	1.8
Hydro	89.3	87.3	82.2	10.7	8.3	7.4	(0.4)
Others[b]	12.3	19.0	33.8	1.5	1.8	3.0	5.2

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	109.3	122.7	133.6	100.0	100.0	100.0	1.0
Coal	25.4	48.3	61.6	23.2	39.4	46.1	4.5
Oil	50.6	27.5	18.0	46.3	22.4	13.5	(5.0)
Natural Gas	33.3	46.9	54.0	30.5	38.2	40.4	2.4

Carbon Dioxide Emissions	Mt CO_2						AAGR (%)
	1990	2000	2010				1990–2010
Total	1,175.7	1,321.1	1,280.4				0.4

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	3.59	4.13	3.93	0.5
Primary Energy Demand/GDP (toe/million constant 2000 $)	106	111	99	(0.3)
CO_2 /capita (t CO_2/person)	9.62	10.51	10.12	0.3
CO_2 Intensity (t CO_2/constant 2000 $ million)	283	283	256	(0.5)
CO_2 /Primary Energy Demand (t CO_2/toe)	2.68	2.55	2.58	(0.2)

( ) = negative number, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: Figures may not add up to total because of rounding.
[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.
[b] "Others" include geothermal, solar, wind, and renewables.
Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

New Zealand
Historical Performance

Socioeconomic Indicators	1990	2000	2010	AAGR (%) 1990–2010
GDP (constant 2000 $ billion)	38.7	51.6	65.3	2.6
Population (million persons)	3.4	3.9	4.4	1.3
GDP/capita (constant 2000 $/person)	11,394	13,375	14,943	1.4

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	12.8	16.8	18.2	100.0	100.0	100.0	1.8
Coal	1.2	1.1	1.3	9.1	6.3	7.2	0.6
Oil	3.6	5.7	6.0	27.8	33.8	33.2	2.7
Natural Gas	3.9	5.1	3.7	30.3	30.1	20.5	(0.2)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	2.0	2.1	2.1	15.6	12.5	11.7	0.3
Others[a]	2.2	2.9	5.0	17.2	17.2	27.5	4.2

Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	9.9	12.8	12.8	100.0	100.0	100.0	1.3
Coal	0.9	0.5	0.6	9.0	3.8	4.7	(2.0)
Oil	4.0	5.3	5.9	40.6	41.4	46.0	1.9
Natural Gas	1.8	3.0	1.7	18.2	23.3	13.0	(0.4)
Electricity	2.4	2.9	3.4	24.5	23.0	26.5	1.7
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…
Others	0.8	1.1	1.3	7.7	8.4	9.8	2.5

Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	9.9	12.8	12.8	100.0	100.0	100.0	1.3
Industry	3.8	4.0	3.9	38.0	31.0	30.5	0.2
Transport	3.0	4.1	4.6	29.9	31.8	36.1	2.2
Other Sectors	2.6	3.1	3.4	25.9	24.5	26.3	1.4
Non-Energy	0.6	1.6	0.9	6.2	12.7	7.1	2.0

Power Generation Output	TWh			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Total	32.2	39.2	44.8	100.0	100.0	100.0	1.7
Fossil Fuels	6.4	11.1	11.9	19.8	28.4	26.6	3.2
Coal	0.7	1.5	2.1	2.1	3.9	4.6	5.8
Oil	0.0	0.0	0.0	0.0	0.0	0.0	(6.7)
Natural Gas	5.7	9.6	9.9	17.7	24.4	22.0	2.8
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…
Hydro	23.2	24.4	24.7	72.0	62.4	55.1	0.3
Others[b]	2.6	3.6	8.1	8.2	9.3	18.1	5.8

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)
	1990	2000	2010	1990	2000	2010	1990–2010
Fossil Fuels	1.4	2.2	2.2	100.0	100.0	100.0	2.3
Coal	0.2	0.4	0.5	11.9	17.2	22.1	5.5
Oil	0.0	0.0	0.0	0.4	0.0	0.0	…
Natural Gas	1.2	1.8	1.7	87.7	82.8	77.9	1.7

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)
	1990	2000	2010	1990–2010
Total	22.9	29.5	30.3	1.4

Energy and Carbon Indicators	1990	2000	2010	AAGR (%) 1990–2010
Primary Energy Demand/capita (toe/person)	3.76	4.35	4.17	0.5
Primary Energy Demand/GDP (toe/million constant 2000 $)	330	325	279	(0.9)
CO_2/capita (t CO_2/person)	6.75	7.64	6.93	0.1
CO_2 Intensity (t CO_2/constant 2000 $ million)	592	571	464	(1.3)
CO_2/Primary Energy Demand (t CO_2/toe)	1.79	1.76	1.66	(0.4)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; International Energy Agency. 2012. *Energy Balances of OECD and Non-OECD Countries (CD-ROM)*. Paris; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm (accessed April 2012); World Bank. World Development Indicators. http://data.worldbank.org.data-catalog/world-development-indicators (accessed April 2012).

Appendix 2

Outlook Cases

Asia and the Pacific Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	16,459.5	20,389.6	35,035.6	4.8	3.7	4.1
Population (million persons)	4,072.9	4,239.8	4,589.6	0.9	0.5	0.7
GDP/capita (constant 2000 $/person)	4,041	4,809	7,634	3.9	3.1	3.4

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	5,599.4	6,229.1	8,358.3	100.0	100.0	100.0	2.3	2.0	2.1	5,353.9	5,701.0	7,063.1	100.0	100.0	100.0	1.4	1.4	1.4
Coal	2,510.9	2,688.2	3,516.3	44.8	43.2	42.1	1.6	1.8	1.7	2,320.1	2,201.4	2,290.8	43.3	38.6	32.4	(0.4)	0.3	(0.0)
Oil	1,358.5	1,514.6	1,973.0	24.3	24.3	23.6	2.0	1.8	1.9	1,353.0	1,477.7	1,797.4	25.3	25.9	25.4	1.8	1.3	1.5
Natural Gas	720.6	855.2	1,463.2	12.9	13.7	17.5	4.2	3.6	3.9	667.9	768.7	1,160.1	12.5	13.5	16.4	3.1	2.8	2.9
Nuclear	210.9	277.3	362.3	3.8	4.5	4.3	6.2	1.8	3.5	193.1	346.5	657.4	3.6	6.1	9.3	8.6	4.4	6.0
Hydro	128.8	168.1	205.3	2.3	2.7	2.5	5.4	1.3	2.9	151.8	154.7	207.2	2.8	2.7	2.9	4.5	2.0	3.0
Others[a]	669.8	725.8	838.4	12.0	11.7	10.0	1.5	1.0	1.2	668.0	752.1	950.4	12.5	13.2	13.5	1.9	1.6	1.7
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	3,641.0	4,073.7	5,400.9	100.0	100.0	100.0	2.3	1.9	2.1	3,564.5	3,859.1	4,840.3	100.0	100.0	100.0	1.8	1.5	1.6
Coal	727.8	762.4	777.1	20.0	18.7	14.4	0.9	0.1	0.5	705.0	695.6	676.4	19.8	18.0	14.0	0.0	(0.2)	(0.1)
Oil	1,190.9	1,340.3	1,788.0	32.7	32.9	33.1	2.4	1.9	2.1	1,181.7	1,309.5	1,631.7	33.2	33.9	33.7	2.2	1.5	1.8
Natural Gas	305.0	373.5	639.0	8.4	9.2	11.8	4.3	3.6	3.9	299.6	360.0	592.6	8.4	9.3	12.2	3.9	3.4	3.6
Electricity	753.8	898.8	1,390.3	20.7	22.1	25.7	4.1	3.0	3.4	719.6	807.6	1,156.7	20.2	20.9	23.9	3.0	2.4	2.6
Heat	95.8	116.1	178.3	2.6	2.8	3.3	3.9	2.9	3.3	91.8	104.2	144.8	2.6	2.7	3.0	2.7	2.2	2.4
Others	568.1	582.9	626.4	15.6	14.3	11.6	0.4	0.5	0.4	567.0	580.8	620.6	15.9	15.1	12.8	0.4	0.4	0.4
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	3,641.0	4,073.6	5,400.9	100.0	100.0	100.0	2.3	1.9	2.1	3,564.5	3,859.1	4,840.3	100.0	100.0	100.0	1.8	1.5	1.6
Industry	1,332.8	1,447.0	1,771.4	36.6	35.5	32.8	1.8	1.4	1.5	1,283.0	1,305.3	1,536.7	36.0	33.8	31.7	0.7	1.1	0.9
Transport	591.5	679.6	1,003.2	16.2	16.7	18.6	2.8	2.6	2.7	588.8	667.1	893.8	16.5	17.3	18.5	2.6	2.0	2.2
Other Sectors	1,379.6	1,582.6	2,196.4	37.9	38.8	40.7	3.0	2.2	2.5	1,355.5	1,522.2	1,980.0	38.0	39.4	40.9	2.6	1.8	2.1
Non-Energy	337.1	364.5	429.8	9.3	8.9	8.0	1.1	1.1	1.1	337.1	364.5	429.8	9.5	9.4	8.9	1.1	1.1	1.1

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Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	10,488.3	12,383.4	18,531.9	100.0	100.0	100.0	3.9	2.7	3.2	10,017.6	11,136.7	15,428.6	100.0	100.0	100.0	2.9	2.2	2.5
Fossil Fuels	7,679.8	8,525.5	13,421.2	73.2	68.8	72.4	2.7	3.1	2.9	6,969.7	6,900.0	8,052.5	69.6	62.0	52.2	0.6	1.0	0.9
Coal	5,887.3	6,465.5	9,870.9	56.1	52.2	53.3	2.5	2.9	2.7	5,321.9	5,131.8	5,629.5	53.1	46.1	36.5	0.2	0.6	0.4
Oil	251.0	236.2	191.5	2.4	1.9	1.0	(1.4)	(1.4)	(1.4)	285.2	236.1	160.2	2.8	2.1	1.0	(1.4)	(2.6)	(2.1)
Natural Gas	1,541.5	1,823.7	3,358.8	14.7	14.7	18.1	4.4	4.2	4.2	1,362.6	1,532.1	2,262.7	13.6	13.8	14.7	2.6	2.6	2.6
Nuclear	813.6	1,068.3	1,394.5	7.8	8.6	7.5	6.2	1.8	3.5	742.3	1,330.4	2,525.1	7.4	11.9	16.4	8.6	4.4	6.0
Hydro	1,497.6	1,956.1	2,391.9	14.3	15.8	12.9	5.4	1.4	2.9	1,765.9	1,797.9	2,409.4	17.6	16.1	15.6	4.5	2.0	3.0
Others[b]	497.2	833.6	1,324.3	4.7	6.7	7.1	17.8	3.1	8.8	539.7	1,108.4	2,441.7	5.4	10.0	15.8	21.2	5.4	11.4

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	1,797.9	1,947.4	2,866.1	100.0	100.0	100.0	2.2	2.6	2.4	1,610.8	1,514.2	1,641.0	100.0	100.0	100.0	(0.4)	0.5	0.2
Coal	1,422.6	1,523.5	2,174.8	79.1	78.2	75.9	1.9	2.4	2.2	1,270.6	1,159.5	1,201.1	78.9	76.6	73.2	(0.8)	0.2	(0.2)
Oil	62.0	59.5	49.5	3.4	3.1	1.7	(1.3)	(1.2)	(1.3)	67.0	55.8	38.0	4.2	3.7	2.3	(1.9)	(2.5)	(2.3)
Natural Gas	313.3	364.5	641.7	17.4	18.7	22.4	4.1	3.8	3.9	273.2	298.9	401.8	17.0	19.7	24.5	2.0	2.0	2.0

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)			Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	14,769.2	16,184.8	22,112.6	1.9	2.1	2.0	13,872.9	13,940.6	16,008.3	0.4	0.9	0.7

Energy and Carbon Indicators				AAGR (%)						AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/ capita (toe/person)	1.37	1.47	1.82	1.4	1.4	1.4	1.31	1.34	1.54	0.5	0.9	0.7
Primary Energy Demand/ GDP (toe/constant 2000 \$ million)	340	306	239	(2.5)	(1.6)	(2.0)	325	280	202	(3.3)	(2.2)	(2.6)
CO_2/capita (t CO_2/person)	3.63	3.82	4.82	1.0	1.6	1.3	3.41	3.29	3.49	(0.5)	0.4	0.0
CO_2 Intensity (t CO_2/million constant 2000 \$)	897	794	631	(2.8)	(1.5)	(2.0)	843	684	457	(4.2)	(2.7)	(3.3)
CO_2/Primary Energy Demand (t CO_2/toe)	2.64	2.60	2.65	(0.3)	0.1	(0.1)	2.59	2.45	2.27	(0.9)	(0.5)	(0.7)

( ) = negative number, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: Figures may not add up to total because of rounding.
[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.
[b] "Others" include geothermal, solar, wind, and renewables.
Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; Council for Economic Planning and Development. 2012. Population Projection for [Taipei,China] from 2012–2060. Available at http://www.cepd.gov.tw/encontent/m1.aspx?sNo=0001457; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Developing Member Countries
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	10,044.1	13,628.5	27,589.3	6.8	4.8	5.6
Population (million persons)	3,918.5	4,084.4	4,438.1	0.9	0.6	0.7
GDP/capita (constant 2000 $/person)	2,563	3,337	6,216	5.8	4.2	4.9

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	4,952.6	5,588.2	7,719.6	100.0	100.0	100.0	2.5	2.2	2.3	4,757.4	5,100.3	6,498.3	100.0	100.0	100.0	1.6	1.6	1.6
Coal	2,343.3	2,520.7	3,349.6	47.3	45.1	43.4	1.7	1.9	1.8	2,166.5	2,060.2	2,176.5	45.5	40.4	33.5	(0.4)	0.4	0.1
Oil	1,130.8	1,299.1	1,775.2	22.8	23.2	23.0	2.8	2.1	2.4	1,119.5	1,261.9	1,615.1	23.5	24.7	24.9	2.5	1.7	2.0
Natural Gas	582.9	708.2	1,271.3	11.8	12.7	16.5	4.6	4.0	4.2	545.2	645.0	1,025.0	11.5	12.6	15.8	3.7	3.1	3.3
Nuclear	143.1	220.4	347.3	2.9	3.9	4.5	11.1	3.1	6.2	158.8	278.6	607.4	3.3	5.5	9.3	13.7	5.3	8.6
Hydro	117.1	155.8	192.5	2.4	2.8	2.5	5.7	1.4	3.1	126.0	142.9	197.4	2.6	2.8	3.0	4.8	2.2	3.2
Others[a]	635.4	684.1	783.9	12.8	12.2	10.2	1.3	0.9	1.1	641.5	711.9	877.1	13.5	14.0	13.5	1.7	1.4	1.5
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	3,229.3	3,666.2	4,983.0	100.0	100.0	100.0	2.6	2.1	2.3	3,164.7	3,475.6	4,476.9	100.0	100.0	100.0	2.1	1.7	1.9
Coal	695.3	730.2	746.1	21.5	19.9	15.0	1.0	0.1	0.5	673.9	665.9	648.4	21.3	19.2	14.5	0.1	(0.2)	(0.1)
Oil	981.8	1,141.0	1,597.1	30.4	31.1	32.1	3.1	2.3	2.6	975.5	1,117.3	1,464.5	30.8	32.1	32.7	2.9	1.8	2.2
Natural Gas	255.0	321.6	580.1	7.9	8.8	11.6	5.1	4.0	4.4	251.2	311.3	540.0	7.9	9.0	12.1	4.8	3.7	4.2
Electricity	644.1	785.8	1,266.6	19.9	21.4	25.4	4.7	3.2	3.8	615.5	705.3	1,054.0	19.5	20.3	23.5	3.6	2.7	3.1
Heat	95.2	115.5	177.7	2.9	3.1	3.6	3.9	2.9	3.3	91.2	103.6	144.2	2.9	3.0	3.2	2.8	2.2	2.4
Others	558.3	572.4	613.9	17.3	15.6	12.3	0.4	0.5	0.4	557.5	570.9	609.0	17.6	16.4	13.6	0.3	0.4	0.4
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	3,229.3	3,666.2	4,983.0	100.0	100.0	100.0	2.6	2.1	2.3	3,164.7	3,475.6	4,476.9	100.0	100.0	100.0	2.1	1.7	1.9
Industry	1,207.9	1,318.7	1,634.4	37.4	36.0	32.8	1.8	1.4	1.6	1,164.1	1,187.6	1,413.2	36.8	34.2	31.6	0.8	1.2	1.0
Transport	487.3	581.1	907.2	15.1	15.9	18.2	3.6	3.0	3.3	485.2	570.8	809.9	15.3	16.4	18.1	3.4	2.4	2.8
Other Sectors	1,238.8	1,441.2	2,051.2	38.4	39.3	41.2	3.4	2.4	2.8	1,220.1	1,392.0	1,863.6	38.6	40.1	41.6	3.0	2.0	2.4
Non-Energy	295.3	325.3	390.2	9.1	8.9	7.8	1.4	1.2	1.3	295.3	325.3	390.2	9.3	9.4	8.7	1.4	1.2	1.3

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Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	8,977.8	10,828.1	16,859.9	100.0	100.0	100.0	4.4	3.0	3.6	8,577.3	9,719.1	14,028.6	100.0	100.0	100.0	3.3	2.5	2.8
Fossil Fuels	6,644.3	7,452.1	12,161.1	74.0	68.8	72.1	3.0	3.3	3.2	6,016.8	5,993.4	7,248.5	70.1	61.7	51.7	0.7	1.3	1.1
Coal	5,355.4	5,923.6	9,305.5	59.7	54.7	55.2	2.7	3.1	2.9	4,850.1	4,695.5	5,301.1	56.5	48.3	37.8	0.3	0.8	0.6
Oil	184.2	178.7	174.4	2.1	1.7	1.0	0.5	(0.2)	0.1	170.1	138.5	100.4	2.0	1.4	0.7	(2.0)	(2.1)	(2.1)
Natural Gas	1,104.8	1,349.9	2,681.2	12.3	12.5	15.9	4.9	4.7	4.8	996.6	1,159.5	1,847.1	11.6	11.9	13.2	3.3	3.2	3.2
Nuclear	553.6	849.7	1,337.2	6.2	7.8	7.9	11.1	3.1	6.2	610.7	1,069.7	2,333.3	7.1	11.0	16.6	13.7	5.3	8.6
Hydro	1,360.8	1,812.8	2,242.2	15.2	16.7	13.3	5.7	1.4	3.1	1,465.7	1,660.5	2,295.3	17.1	17.1	16.4	4.8	2.2	3.2
Others[b]	419.0	713.5	1,119.4	4.7	6.6	6.6	20.4	3.0	9.7	484.0	995.5	2,151.5	5.6	10.2	15.3	24.5	5.3	12.6
Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	1,590.9	1,735.2	2,627.3	100.0	100.0	100.0	2.3	2.8	2.6	1,420.3	1,336.7	1,491.8	100.0	100.0	100.0	(0.3)	0.7	0.3
Coal	1,307.0	1,407.3	2,058.1	82.2	81.1	78.3	2.0	2.6	2.3	1,167.5	1,066.8	1,133.6	82.2	79.8	76.0	(0.8)	0.4	(0.1)
Oil	49.6	48.8	46.3	3.1	2.8	1.8	(0.1)	(0.4)	(0.2)	45.7	37.8	27.0	3.2	2.8	1.8	(2.6)	(2.2)	(2.4)
Natural Gas	234.3	279.1	523.0	14.7	16.1	19.9	4.5	4.3	4.4	207.0	232.1	331.2	14.6	17.4	22.2	2.6	2.4	2.5
Carbon Dioxide Emissions	Mt CO_2			AAGR (%)						Mt CO_2			AAGR (%)					
	2015	2020	2035	2010–2020		2020–2035		2010–2035		2015	2020	2035	2010–2020		2020–2035		2010–2035	
Total	13,210.8	14,634.2	20,514.5	2.2		2.3		2.3		12,387.2	12,547.6	14,798.7	0.7		1.1		0.9	
Energy and Carbon Indicators							AAGR (%)									AAGR (%)		
				2015	2020	2035	2010–2020	2020–2035	2010–2035				2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/ capita (toe/person)				1.26	1.37	1.74	1.6	1.6	1.6				1.21	1.25	1.46	0.7	1.1	0.9
Primary Energy Demand/ GDP (toe/constant 2000 $ million)				493	410	280	(4.0)	(2.5)	(3.1)				474	374	236	(4.9)	(3.0)	(3.8)
CO_2/capita ($t\ CO_2$/person)				3.37	3.58	4.62	1.3	1.7	1.6				3.16	3.07	3.33	(0.2)	0.5	0.2
CO_2 Intensity ($t\ CO_2$/million constant 2000 $)				1,315	1,074	744	(4.3)	(2.4)	(3.2)				1,233	921	536	(5.7)	(3.5)	(4.4)
CO_2/Primary Energy Demand ($t\ CO_2$/toe)				2.67	2.62	2.66	(0.3)	0.1	(0.1)				2.60	2.46	2.28	(0.9)	(0.5)	(0.7)

( ) = negative number, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: Figures may not add up to total because of rounding.
[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.
[b] "Others" include geothermal, solar, wind, and renewables.
Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; Council for Economic Planning and Development. 2012. Population Projection for [Taipei,China] from 2012–2060. Available at http://www.cepd.gov.tw/encontent/m1.aspx?sNo=0001457; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Central and West Asia Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	317.1	410.0	732.3	5.3	3.9	4.5
Population (million persons)	307.9	332.5	398.0	1.6	1.2	1.4
GDP/capita (constant 2000 $/person)	1,030	1,233	1,840	3.6	2.7	3.1

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	270.2	298.7	385.8	100.0	100.0	100.0	1.9	1.7	1.8	263.6	284.2	348.2	100.0	100.0	100.0	1.4	1.4	1.4
Coal	42.5	49.0	66.7	15.7	16.4	17.3	1.9	2.1	2.0	40.8	44.3	54.6	15.5	15.6	15.7	0.9	1.4	1.2
Oil	60.6	67.0	87.3	22.4	22.4	22.6	2.2	1.8	1.9	58.5	62.3	74.7	22.2	21.9	21.5	1.4	1.2	1.3
Natural Gas	130.0	142.8	186.2	48.1	47.8	48.3	2.2	1.8	2.0	125.9	133.8	157.9	47.8	47.1	45.4	1.5	1.1	1.3
Nuclear	1.8	3.1	4.2	0.7	1.0	1.1	7.1	2.1	4.1	3.0	6.6	17.7	1.1	2.3	5.1	15.7	6.8	10.3
Hydro	8.7	10.3	15.1	3.2	3.4	3.9	2.6	2.6	2.6	8.7	10.1	14.8	3.3	3.6	4.3	2.4	2.6	2.5
Others[a]	26.6	26.6	26.6	9.8	8.9	6.9	(1.0)	(0.0)	(0.4)	26.7	27.2	28.6	10.1	9.6	8.2	(0.8)	0.3	(0.1)
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	196.1	217.8	283.2	100.0	100.0	100.0	2.2	1.8	1.9	192.5	209.9	261.9	100.0	100.0	100.0	1.8	1.5	1.6
Coal	20.9	24.0	33.7	10.7	11.0	11.9	2.2	2.3	2.3	20.3	22.8	30.0	10.6	10.9	11.5	1.7	1.9	1.8
Oil	46.2	52.1	70.4	23.6	23.9	24.9	2.9	2.0	2.4	45.6	50.8	65.5	23.7	24.2	25.0	2.6	1.7	2.1
Natural Gas	67.1	75.5	100.7	34.2	34.7	35.6	2.7	1.9	2.2	65.8	72.8	94.9	34.2	34.7	36.3	2.3	1.8	2.0
Electricity	24.6	28.9	42.2	12.5	13.3	14.9	3.7	2.6	3.0	23.6	26.6	36.0	12.2	12.7	13.8	2.8	2.1	2.4
Heat	10.8	10.6	9.7	5.5	4.9	3.4	1.1	(0.6)	0.1	10.7	10.4	9.0	5.6	4.9	3.4	0.9	(1.0)	(0.2)
Others	26.6	26.7	26.6	13.6	12.2	9.4	(0.9)	(0.0)	(0.4)	26.6	26.6	26.5	13.8	12.7	10.1	(0.9)	(0.0)	(0.4)
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	196.1	217.8	283.2	100.0	100.0	100.0	2.2	1.8	1.9	192.5	209.9	261.9	100.0	100.0	100.0	1.8	1.5	1.6
Industry	55.6	64.9	95.4	28.4	29.8	33.7	2.7	2.6	2.7	53.9	61.1	86.0	28.0	29.1	32.8	2.1	2.3	2.2
Transport	32.5	37.7	54.5	16.6	17.3	19.3	4.0	2.5	3.1	32.2	36.8	51.3	16.7	17.6	19.6	3.8	2.2	2.8
Other Sectors	101.0	107.9	125.3	51.5	49.5	44.3	1.4	1.0	1.2	99.5	104.7	116.7	51.7	49.9	44.5	1.1	0.7	0.9
Non-Energy	7.0	7.3	8.0	3.6	3.3	2.8	1.2	0.6	0.8	7.0	7.3	8.0	3.6	3.5	3.0	1.2	0.6	0.8

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Central and West Asia Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	373.7	436.5	631.3	100.0	100.0	100.0	3.5	2.5	2.9	358.8	402.1	540.1	100.0	100.0	100.0	2.6	2.0	2.2
Fossil Fuels	264.2	304.4	438.5	70.7	69.7	69.5	3.7	2.5	3.0	243.5	251.1	274.3	67.9	62.4	50.8	1.7	0.6	1.0
Coal	81.1	96.8	138.3	21.7	22.2	21.9	3.4	2.4	2.8	77.0	83.7	108.0	21.5	20.8	20.0	1.9	1.7	1.8
Oil	45.7	46.8	50.4	12.2	10.7	8.0	2.9	0.5	1.4	39.4	32.7	18.3	11.0	8.1	3.4	(0.7)	(3.8)	(2.6)
Natural Gas	137.4	160.8	249.8	36.8	36.8	39.6	4.1	3.0	3.4	127.1	134.7	147.9	35.4	33.5	27.4	2.3	0.6	1.3
Nuclear	7.1	11.7	16.0	1.9	2.7	2.5	7.1	2.1	4.1	11.5	25.4	67.9	3.2	6.3	12.6	15.7	6.8	10.3
Hydro	101.7	119.6	175.3	27.2	27.4	27.8	2.6	2.6	2.6	100.9	117.9	172.1	28.1	29.3	31.9	2.4	2.6	2.5
Others[b]	0.7	0.8	1.5	0.2	0.2	0.2	59.2	4.1	23.4	2.8	7.7	25.8	0.8	1.9	4.8	98.8	8.4	38.1
Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	68.2	75.4	99.2	100.0	100.0	100.0	2.4	1.8	2.1	62.8	62.2	60.8	100.0	100.0	100.0	0.5	(0.1)	0.1
Coal	21.6	25.0	33.0	31.7	33.1	33.2	2.7	1.9	2.2	20.4	21.5	24.6	32.6	34.6	40.5	1.1	0.9	1.0
Oil	10.9	11.2	12.3	16.0	14.8	12.3	2.7	0.6	1.4	9.4	7.8	4.7	15.0	12.6	7.7	(0.9)	(3.3)	(2.4)
Natural Gas	35.7	39.2	54.0	52.3	52.0	54.4	2.2	2.2	2.2	32.9	32.8	31.5	52.5	52.8	51.8	0.4	(0.3)	(0.0)
Carbon Dioxide Emissions	Mt CO_2			AAGR (%)						Mt CO_2			AAGR (%)					
	2015	2020	2035	2010–2020			2020–2035		2010–2035	2015	2020	2035	2010–2020			2020–2035		2010–2035
Total	642.1	717.0	949.2	2.1			1.9		2.0	619.3	662.4	796.5	1.3			1.2		1.3
Energy and Carbon Indicators							AAGR (%)									AAGR (%)		
				2015	2020	2035	2010–2020	2020–2035	2010–2035				2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)				0.88	0.90	0.97	0.2	0.5	0.4				0.86	0.85	0.87	(0.3)	0.2	(0.0)
Primary Energy Demand/GDP (toe/constant 2000 $ million)				852	729	527	(3.3)	(2.1)	(2.6)				831	693	475	(3.7)	(2.5)	(3.0)
CO_2/capita ($t CO_2$/person)				2.09	2.16	2.38	0.5	0.7	0.6				2.01	1.99	2.00	(0.3)	0.0	(0.1)
CO_2 Intensity ($t CO_2$/million constant 2000 $)				2,025	1,749	1,296	(3.0)	(2.0)	(2.4)				1,953	1,616	1,088	(3.8)	(2.6)	(3.1)
CO_2/Primary Energy Demand ($t CO_2$/toe)				2.38	2.40	2.46	0.3	0.2	0.2				2.35	2.33	2.29	(0.0)	(0.1)	(0.1)

( ) = negative number, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision.* http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Afghanistan
Outlook Cases

Socioeconomic Indicators	Mtoe 2015	Mtoe 2020	Mtoe 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035
GDP (constant 2000 $ billion)	12.6	18.1	47.7	7.1	6.7	6.8
Population (million persons)	36.7	42.1	59.0	3.0	2.3	2.6
GDP/capita (constant 2000 $/person)	343	429	808	4.0	4.3	4.2

	Business-as-Usual Case									Alternative Case								
	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
Primary Energy Demand	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	1.2	1.7	4.3	100.0	100.0	100.0	6.6	6.4	6.5	1.2	1.6	3.8	100.0	100.0	100.0	6.0	6.0	6.0
Coal	0.0	0.1	0.3	3.9	4.5	6.5	9.4	9.0	9.2	0.0	0.1	0.3	3.9	4.5	6.7	8.6	8.9	8.8
Oil	0.5	0.8	3.1	39.2	49.5	73.3	11.9	9.2	10.3	0.4	0.8	2.6	37.6	47.4	68.8	10.8	8.7	9.5
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.1	0.0	0.0	2.5	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.1	0.1	0.1	5.0	4.0	3.3	2.0	5.0	3.8	0.1	0.1	0.2	5.5	4.7	4.7	3.0	6.0	4.8
Others[a]	0.6	0.7	0.7	51.8	42.0	16.9	2.9	0.2	1.2	0.6	0.7	0.7	53.1	43.5	17.3	2.6	(0.3)	0.8
	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
Final Energy Demand By Source	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	0.9	1.2	2.2	100.0	100.0	100.0	4.7	4.3	4.5	0.9	1.1	2.0	100.0	100.0	100.0	4.4	4.0	4.1
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.2	0.3	0.7	20.0	22.9	32.6	7.3	6.8	7.0	0.2	0.3	0.7	20.2	23.2	33.6	7.1	6.6	6.8
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Electricity	0.2	0.4	1.0	26.2	30.4	44.5	7.4	7.0	7.2	0.2	0.3	0.9	25.9	30.1	44.9	7.0	6.8	6.9
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	0.5	0.5	0.5	53.8	46.7	22.9	2.3	(0.5)	0.6	0.5	0.5	0.4	53.9	46.7	21.5	2.0	(1.2)	0.0
	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
Final Energy Demand By Sector	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	0.9	1.2	2.2	100.0	100.0	100.0	4.7	4.3	4.5	0.9	1.1	2.0	100.0	100.0	100.0	4.4	4.0	4.1
Industry	0.0	0.1	0.1	4.3	4.6	6.0	5.5	6.3	6.0	0.0	0.1	0.1	4.3	4.5	6.2	5.0	6.3	5.8
Transport	0.2	0.2	0.7	18.9	21.5	30.1	7.1	6.7	6.8	0.2	0.2	0.6	19.1	21.8	30.9	7.0	6.4	6.6
Other Sectors	0.7	0.9	1.4	76.8	73.9	63.9	4.0	3.3	3.6	0.7	0.8	1.3	76.7	73.7	62.9	3.7	2.9	3.2
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…

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Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	1.9	3.0	11.0	100.0	100.0	100.0	9.4	9.0	9.2	1.8	2.8	10.1	100.0	100.0	100.0	8.6	8.9	8.8
Fossil Fuels	1.2	2.2	9.4	62.4	74.2	85.3	14.3	10.0	11.7	1.0	2.0	8.1	58.6	69.5	79.7	12.7	9.9	11.0
Coal	0.2	0.3	1.0	8.8	8.8	8.8	9.4	9.0	9.2	0.2	0.2	0.9	8.8	8.8	8.8	8.6	8.9	8.8
Oil	1.0	2.0	8.4	53.6	65.4	76.5	15.1	10.2	12.1	0.9	1.7	6.7	49.8	60.7	66.5	13.5	9.6	11.1
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.5	0.0	0.0	4.4	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.7	0.8	1.6	37.7	25.8	14.7	2.0	5.0	3.8	0.7	0.9	2.1	41.4	30.5	20.3	3.0	6.0	4.8
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	0.3	0.6	2.7	100.0	100.0	100.0	14.3	10.0	11.7	0.3	0.6	2.3	100.0	100.0	100.0	12.7	9.8	11.0
Coal	0.0	0.1	0.3	14.1	11.8	10.3	9.4	9.0	9.2	0.0	0.1	0.3	15.0	12.6	11.2	8.6	8.9	8.8
Oil	0.3	0.6	2.4	85.9	88.2	89.7	15.1	10.2	12.1	0.3	0.5	1.9	85.0	87.4	84.6	13.5	9.6	11.1
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.1	0.0	0.0	4.2	…	…	…

Carbon Dioxide Emissions	$Mt\ CO_2$			AAGR (%)			$Mt\ CO_2$			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	1.6	2.9	10.7	11.6	9.2	10.2	1.5	2.6	9.3	10.5	8.9	9.5

Energy and Carbon Indicators				AAGR (%)						AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)	0.03	0.04	0.07	3.5	4.0	3.8	0.03	0.04	0.06	2.9	3.6	3.3
Primary Energy Demand/GDP (toe/constant 2000 $ million)	96	93	89	(0.5)	(0.3)	(0.3)	92	88	80	(1.1)	(0.6)	(0.8)
CO_2/capita ($t\ CO_2$/person)	0.04	0.07	0.18	8.4	6.8	7.4	0.04	0.06	0.16	7.3	6.4	6.8
CO_2 Intensity ($t\ CO_2$/million constant 2000 $)	130	158	224	4.2	2.4	3.1	121	143	194	3.2	2.1	2.5
CO_2/Primary Energy Demand ($t\ CO_2$/toe)	1.36	1.70	2.51	4.7	2.6	3.5	1.31	1.63	2.44	4.3	2.7	3.3

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision.* http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Armenia
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	5.3	6.9	12.1	5.3	3.9	4.4
Population (million persons)	3.1	3.1	3.1	0.2	(0.2)	(0.0)
GDP/capita (constant 2000 $/person)	1,681	2,184	3,953	5.1	4.0	4.5

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	3.7	4.4	7.2	100.0	100.0	100.0	6.1	3.3	4.4	3.6	4.3	6.8	100.0	100.0	100.0	5.8	3.1	4.2
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.5	0.5	0.5	12.2	10.8	7.6	3.1	0.9	1.7	0.4	0.5	0.5	12.2	10.5	6.8	2.5	0.1	1.1
Natural Gas	2.4	3.1	4.6	64.0	69.4	64.5	9.0	2.8	5.2	2.4	3.0	4.5	64.9	70.5	66.5	8.9	2.7	5.1
Nuclear	0.7	0.7	1.8	18.0	14.9	24.6	0.1	6.8	4.1	0.6	0.6	1.6	17.8	14.6	23.6	(0.4)	6.4	3.7
Hydro	0.2	0.2	0.2	6.0	5.2	3.3	0.5	0.2	0.3	0.2	0.2	0.2	5.4	4.7	2.9	(1.0)	(0.1)	(0.5)
Others[a]	0.0	0.0	0.0	(0.3)	(0.3)	0.0	(16.1)	(176.2)	(179.2)	0.0	0.0	0.0	(0.3)	(0.3)	0.2	(16.1)	(201.1)	(193.8)
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	3.0	3.7	6.0	100.0	100.0	100.0	7.5	3.3	5.0	2.9	3.6	5.7	100.0	100.0	100.0	7.1	3.2	4.7
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.5	0.5	0.5	15.1	12.9	9.0	3.1	0.9	1.7	0.4	0.5	0.5	15.2	12.7	8.1	2.5	0.1	1.1
Natural Gas	2.0	2.6	4.6	68.3	71.3	76.0	10.0	3.7	6.2	2.0	2.6	4.4	68.8	72.4	78.3	9.7	3.7	6.1
Electricity	0.5	0.6	0.9	15.7	15.1	14.5	3.3	3.0	3.2	0.4	0.5	0.7	15.2	14.2	13.2	2.3	2.6	2.5
Heat	0.0	0.0	0.0	0.8	0.7	0.4	8.8	0.1	3.5	0.0	0.0	0.0	0.9	0.7	0.4	8.5	(0.0)	3.3
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	3.0	3.7	6.0	100.0	100.0	100.0	7.5	3.3	5.0	2.9	3.6	5.7	100.0	100.0	100.0	7.1	3.2	4.7
Industry	0.8	1.1	1.9	28.1	29.5	31.8	13.2	3.8	7.5	0.8	1.0	1.8	27.8	29.1	32.0	12.6	3.8	7.3
Transport	0.9	1.0	1.2	31.8	27.7	19.5	7.4	0.9	3.5	0.9	1.0	1.1	32.3	28.2	19.5	7.2	0.7	3.2
Other Sectors	1.2	1.5	2.9	38.6	41.8	48.1	4.9	4.3	4.5	1.1	1.5	2.7	38.5	41.6	47.8	4.4	4.1	4.3
Non-Energy	0.0	0.0	0.0	1.4	1.1	0.7	13.0	(0.2)	4.9	0.0	0.0	0.0	1.5	1.1	0.7	13.0	(0.2)	4.9

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Armenia Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case: TWh 2015	TWh 2020	TWh 2035	Share (%) 2015	Share (%) 2020	Share (%) 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035	Alternative Case: TWh 2015	TWh 2020	TWh 2035	Share (%) 2015	Share (%) 2020	Share (%) 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035
Total	6.8	7.5	10.0	100.0	100.0	100.0	1.5	1.9	1.7	6.7	7.1	9.0	100.0	100.0	100.0	0.9	1.6	1.3
Fossil Fuels	1.7	2.3	0.3	24.9	30.5	2.9	4.8	(13.0)	(6.3)	1.9	2.4	0.3	28.1	33.6	3.3	5.2	(13.0)	(6.1)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Natural Gas	1.7	2.3	0.3	24.9	30.5	2.9	4.8	(13.0)	(6.3)	1.9	2.4	0.3	28.1	33.6	3.3	5.2	(13.0)	(6.1)
Nuclear	2.5	2.5	6.8	37.2	33.6	67.8	0.1	6.8	4.1	2.5	2.4	6.1	37.2	33.6	67.8	(0.4)	6.4	3.7
Hydro	2.6	2.7	2.7	37.8	35.6	27.5	0.5	0.2	0.3	2.3	2.3	2.3	34.5	32.5	25.1	(1.0)	(0.1)	(0.5)
Others[b]	0.0	0.0	0.2	0.1	0.3	1.9	12.5	15.0	14.0	0.0	0.0	0.3	0.1	0.3	3.8	12.5	19.7	16.8

Thermal Power Generation Input	Business-as-Usual Case: Mtoe 2015	Mtoe 2020	Mtoe 2035	Share (%) 2015	Share (%) 2020	Share (%) 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035	Alternative Case: Mtoe 2015	Mtoe 2020	Mtoe 2035	Share (%) 2015	Share (%) 2020	Share (%) 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035
Fossil Fuels	0.3	0.4	0.1	100.0	100.0	100.0	4.8	(13.0)	(6.3)	0.4	0.4	0.1	100.0	100.0	100.0	5.2	(13.1)	(6.2)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Natural Gas	0.3	0.4	0.1	100.0	100.0	100.0	4.8	(13.0)	(6.3)	0.4	0.4	0.1	100.0	100.0	100.0	5.2	(13.1)	(6.2)

Carbon Dioxide Emissions	Business-as-Usual Case: Mt CO_2 2015	Mt CO_2 2020	Mt CO_2 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035	Alternative Case: Mt CO_2 2015	Mt CO_2 2020	Mt CO_2 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035
Total	6.8	8.5	12.4	7.7	2.5	4.6	6.8	8.4	11.9	7.4	2.4	4.4

Energy and Carbon Indicators	Business-as-Usual Case: 2015	2020	2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035	Alternative Case: 2015	2020	2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035
Primary Energy Demand/ capita (toe/person)	1.17	1.41	2.33	5.9	3.4	4.4	1.16	1.36	2.20	5.6	3.3	4.2
Primary Energy Demand/ GDP (toe/constant 2000 $ million)	699	644	590	0.8	(0.6)	(0.0)	690	624	557	0.5	(0.8)	(0.3)
CO_2/capita ($t\ CO_2$/person)	2.17	2.72	4.04	7.5	2.7	4.6	2.16	2.66	3.86	7.2	2.5	4.4
CO_2 Intensity ($t\ CO_2$/million constant 2000 $)	1,290	1,244	1,022	2.3	(1.3)	0.1	1,285	1,216	976	2.0	(1.5)	(0.1)
CO_2/Primary Energy Demand ($t\ CO_2$/toe)	1.85	1.93	1.73	1.5	(0.7)	0.1	1.86	1.95	1.75	1.6	(0.7)	0.2

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Azerbaijan
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	25.2	32.3	61.8	4.3	4.4	4.4
Population (million persons)	9.4	9.8	10.4	1.0	0.4	0.6
GDP/capita (constant 2000 $/person)	2,694	3,299	5,943	3.3	4.0	3.7

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	13.4	14.9	20.8	100.0	100.0	100.0	2.3	2.2	2.3	13.0	14.2	18.9	100.0	100.0	100.0	1.8	1.9	1.9
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	4.2	4.9	7.8	31.4	32.8	37.4	2.8	3.1	3.0	4.2	4.8	7.3	32.0	33.6	38.5	2.6	2.8	2.7
Natural Gas	9.0	9.9	12.8	67.3	66.0	61.7	2.3	1.8	2.0	8.7	9.2	11.4	66.6	65.0	60.4	1.7	1.4	1.5
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.2	0.2	0.2	1.5	1.4	1.0	(3.7)	0.2	(1.4)	0.2	0.2	0.2	1.5	1.4	1.1	(3.7)	0.2	(1.4)
Others[a]	(0.0)	(0.0)	(0.0)	(0.2)	(0.1)	(0.1)	…	0.1	(201.8)	(0.0)	(0.0)	(0.0)	(0.2)	(0.1)	(0.0)	…	(4.1)	(198.0)
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	8.6	9.8	14.2	100.0	100.0	100.0	3.7	2.5	3.0	8.4	9.5	13.2	100.0	100.0	100.0	3.3	2.2	2.7
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	3.5	4.1	6.5	40.9	41.8	45.9	4.3	3.1	3.6	3.5	4.0	6.1	41.4	42.5	46.4	4.1	2.8	3.3
Natural Gas	3.2	3.6	4.6	36.9	36.2	32.3	2.6	1.7	2.1	3.1	3.5	4.4	37.3	36.9	33.5	2.4	1.6	1.9
Electricity	1.4	1.7	2.6	16.5	16.9	18.0	4.5	2.9	3.6	1.3	1.5	2.2	15.6	15.7	16.8	3.4	2.7	3.0
Heat	0.5	0.5	0.5	5.8	5.2	3.8	5.2	0.3	2.3	0.5	0.5	0.4	5.7	5.0	3.3	4.4	(0.5)	1.4
Others	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	8.6	9.8	14.2	100.0	100.0	100.0	3.7	2.5	3.0	8.4	9.5	13.2	100.0	100.0	100.0	3.3	2.2	2.7
Industry	1.1	1.1	1.3	12.5	11.4	9.0	4.7	0.9	2.4	1.0	1.0	1.0	12.3	10.9	7.8	3.9	(0.1)	1.5
Transport	2.5	3.0	5.3	29.2	30.8	37.0	5.6	3.7	4.5	2.5	3.0	5.0	29.6	31.4	37.7	5.3	3.5	4.2
Other Sectors	4.4	5.0	6.8	51.2	50.8	47.8	2.7	2.1	2.3	4.3	4.8	6.3	50.8	50.5	47.9	2.2	1.9	2.0
Non-Energy	0.6	0.7	0.9	7.1	6.9	6.2	3.0	1.7	2.2	0.6	0.7	0.9	7.3	7.2	6.6	3.0	1.7	2.2

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Azerbaijan Outlook Cases *continued*

Power Generation Output	BAU TWh 2015	BAU TWh 2020	BAU TWh 2035	BAU Share (%) 2015	BAU Share (%) 2020	BAU Share (%) 2035	BAU AAGR (%) 2010–2020	BAU AAGR (%) 2020–2035	BAU AAGR (%) 2010–2035	Alt TWh 2015	Alt TWh 2020	Alt TWh 2035	Alt Share (%) 2015	Alt Share (%) 2020	Alt Share (%) 2035	Alt AAGR (%) 2010–2020	Alt AAGR (%) 2020–2035	Alt AAGR (%) 2010–2035
Total	23.4	26.6	38.5	100.0	100.0	100.0	3.6	2.5	2.9	21.9	24.2	33.9	100.0	100.0	100.0	2.6	2.3	2.4
Fossil Fuels	21.1	24.2	36.0	90.0	91.0	93.6	4.7	2.7	3.5	19.6	21.8	31.3	89.3	89.8	92.3	3.6	2.4	2.9
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.5	0.5	0.7	2.2	1.8	1.8	31.1	2.7	13.2	0.5	0.4	0.6	2.2	1.7	1.8	29.8	2.4	12.6
Natural Gas	20.6	23.7	35.3	87.8	89.2	91.8	4.5	2.7	3.4	19.1	21.4	30.7	87.2	88.1	90.5	3.4	2.4	2.8
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	2.3	2.4	2.4	10.0	8.9	6.3	(3.7)	0.2	(1.4)	2.3	2.4	2.4	10.7	9.7	7.2	(3.7)	0.2	(1.4)
Others[b]	0.0	0.0	0.0	0.0	0.1	0.1	44.1	0.0	15.7	0.0	0.1	0.2	0.0	0.4	0.6	58.9	4.1	23.3

Thermal Power Generation Input	BAU Mtoe 2015	BAU Mtoe 2020	BAU Mtoe 2035	BAU Share (%) 2015	BAU Share (%) 2020	BAU Share (%) 2035	BAU AAGR (%) 2010–2020	BAU AAGR (%) 2020–2035	BAU AAGR (%) 2010–2035	Alt Mtoe 2015	Alt Mtoe 2020	Alt Mtoe 2035	Alt Share (%) 2015	Alt Share (%) 2020	Alt Share (%) 2035	Alt AAGR (%) 2010–2020	Alt AAGR (%) 2020–2035	Alt AAGR (%) 2010–2035
Fossil Fuels	5.0	5.5	7.5	100.0	100.0	100.0	3.6	2.1	2.7	4.6	4.9	6.3	100.0	100.0	100.0	2.5	1.6	2.0
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.1	0.1	0.2	2.6	2.2	2.3	20.6	2.5	9.3	0.1	0.1	0.1	2.6	2.2	2.3	19.3	2.2	8.7
Natural Gas	4.8	5.3	7.3	97.4	97.8	97.7	3.4	2.1	2.6	4.5	4.8	6.1	97.4	97.8	97.7	2.3	1.6	1.9

Carbon Dioxide Emissions	BAU Mt CO_2 2015	BAU Mt CO_2 2020	BAU Mt CO_2 2035	BAU AAGR (%) 2010–2020	BAU AAGR (%) 2020–2035	BAU AAGR (%) 2010–2035	Alt Mt CO_2 2015	Alt Mt CO_2 2020	Alt Mt CO_2 2035	Alt AAGR (%) 2010–2020	Alt AAGR (%) 2020–2035	Alt AAGR (%) 2010–2035
Total	32.3	36.1	51.2	2.5	2.4	2.4	31.3	34.3	46.5	2.0	2.0	2.0

Energy and Carbon Indicators	BAU 2015	BAU 2020	BAU 2035	BAU AAGR (%) 2010–2020	BAU AAGR (%) 2020–2035	BAU AAGR (%) 2010–2035	Alt 2015	Alt 2020	Alt 2035	Alt AAGR (%) 2010–2020	Alt AAGR (%) 2020–2035	Alt AAGR (%) 2010–2035
Primary Energy Demand/capita (toe/person)	1.43	1.53	2.00	1.4	1.8	1.6	1.39	1.45	1.82	0.9	1.5	1.2
Primary Energy Demand/GDP (toe/constant 2000 $ million)	532	463	336	(1.9)	(2.1)	(2.0)	515	440	305	(2.3)	(2.4)	(2.4)
CO_2/capita (t CO_2/person)	3.45	3.69	4.93	1.5	1.9	1.8	3.34	3.51	4.47	1.0	1.6	1.4
CO_2 Intensity (t CO_2/million constant 2000 $)	1,281	1,120	829	(1.7)	(2.0)	(1.9)	1,239	1,064	751	(2.2)	(2.3)	(2.3)
CO_2/Primary Energy Demand (t CO_2/toe)	2.41	2.42	2.47	0.1	0.1	0.1	2.40	2.41	2.46	0.1	0.1	0.1

BAU = Business-as-Usual Case; Alt = Alternative Case.

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision.* http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Georgia
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	7.4	9.0	14.6	4.8	3.3	3.9
Population (million persons)	4.2	4.1	3.6	(0.7)	(0.8)	(0.8)
GDP/capita (constant 2000 $/person)	1,747	2,218	4,071	5.5	4.1	4.7

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	2.9	3.3	4.5	100.0	100.0	100.0	0.5	2.2	1.5	2.7	3.1	4.2	100.0	100.0	100.0	(0.2)	2.1	1.2
Coal	0.1	0.1	0.1	3.2	2.8	2.0	6.6	0.0	2.6	0.1	0.1	0.1	3.4	3.0	2.2	6.6	0.0	2.6
Oil	1.1	1.4	2.4	37.0	42.3	54.0	3.8	3.8	3.8	1.1	1.4	2.3	39.0	44.6	56.2	3.7	3.7	3.7
Natural Gas	0.8	0.9	1.1	27.7	26.4	23.9	(1.6)	1.5	0.3	0.7	0.7	0.9	24.1	23.2	21.7	(3.5)	1.7	(0.4)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.7	0.8	0.9	25.2	24.0	20.9	(0.2)	1.2	0.7	0.7	0.8	0.9	26.6	25.0	21.6	(0.5)	1.1	0.5
Others[a]	0.3	0.2	0.1	9.5	7.2	2.5	(2.2)	(4.8)	(3.8)	0.3	0.2	0.1	9.7	7.2	1.9	(3.0)	(6.4)	(5.1)
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	2.3	2.7	4.1	100.0	100.0	100.0	0.5	2.7	1.8	2.3	2.7	3.8	100.0	100.0	100.0	0.1	2.5	1.5
Coal	0.1	0.1	0.1	4.0	3.4	2.3	9.8	0.0	3.8	0.1	0.1	0.1	4.0	3.5	2.4	9.8	0.0	3.8
Oil	1.1	1.4	2.4	45.4	49.9	58.8	4.3	3.8	4.0	1.1	1.3	2.3	45.7	50.7	59.7	4.1	3.6	3.8
Natural Gas	0.3	0.3	0.6	11.0	12.0	14.1	(6.0)	3.7	(0.3)	0.2	0.3	0.5	10.8	11.6	13.9	(6.6)	3.7	(0.5)
Electricity	0.6	0.7	0.8	26.8	24.6	19.5	0.7	1.1	0.9	0.6	0.6	0.7	26.8	24.5	19.2	0.4	0.8	0.7
Heat	0.0	0.0	0.0	0.0	0.0	0.0	(100.0)	…	(100.0)	0.0	0.0	0.0	0.0	0.0	0.0	(100.0)	…	(100.0)
Others	0.4	0.3	0.3	15.0	11.9	6.5	(2.1)	(1.4)	(1.7)	0.3	0.3	0.2	14.8	11.7	6.0	(2.7)	(1.9)	(2.2)
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	2.3	2.7	4.1	100.0	100.0	100.0	0.5	2.7	1.8	2.3	2.7	3.8	100.0	100.0	100.0	0.1	2.5	1.5
Industry	0.4	0.5	0.7	18.0	18.0	18.1	1.3	2.7	2.1	0.4	0.5	0.7	17.9	17.7	18.1	0.8	2.6	1.9
Transport	0.8	1.0	1.4	35.1	34.9	35.0	2.4	2.7	2.6	0.8	0.9	1.4	35.3	35.3	35.2	2.2	2.5	2.4
Other Sectors	1.1	1.3	1.9	46.9	47.2	46.9	0.1	2.6	1.6	1.1	1.2	1.8	46.8	47.0	46.6	(0.2)	2.4	1.4
Non-Energy	0.0	0.0	0.0	0.3	0.3	0.2	(25.9)	0.0	(11.3)	0.0	0.0	0.0	0.3	0.3	0.2	(25.9)	0.0	(11.3)

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Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	9.7	10.3	12.2	100.0	100.0	100.0	0.2	1.1	0.7	9.6	10.1	11.6	100.0	100.0	100.0	(0.1)	1.0	0.6
Fossil Fuels	1.1	1.1	1.1	11.8	11.1	9.4	4.2	0.0	1.7	1.1	1.1	1.1	12.0	11.4	9.9	4.2	0.0	1.7
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.0	0.0	0.0	0.4	0.4	0.3	2.0	0.0	0.8	0.0	0.0	0.0	0.4	0.4	0.3	2.0	0.0	0.8
Natural Gas	1.1	1.1	1.1	11.4	10.7	9.1	4.3	0.0	1.7	1.1	1.1	1.1	11.6	11.0	9.5	4.3	0.0	1.7
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	8.5	9.2	11.0	88.2	88.9	90.6	(0.2)	1.2	0.7	8.4	8.9	10.5	88.0	88.6	90.1	(0.5)	1.1	0.5
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…

Thermal Power Generation Input	Business-as-Usual Case									Alternative Case								
	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	0.4	0.4	0.4	100.0	100.0	100.0	1.6	(0.5)	0.3	0.3	0.3	0.2	100.0	100.0	100.0	(2.7)	(0.7)	(1.5)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.0	0.0	0.0	0.0	0.0	0.0	(100.0)	…	(100.0)	0.0	0.0	0.0	0.0	0.0	0.0	(100.0)	…	(100.0)
Natural Gas	0.4	0.4	0.4	100.0	100.0	100.0	3.5	(0.5)	1.1	0.3	0.3	0.2	100.0	100.0	100.0	(0.9)	(0.7)	(0.8)

Carbon Dioxide Emissions	Business-as-Usual Case						Alternative Case					
	Mt CO_2			AAGR (%)			Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	5.5	6.6	10.4	2.7	3.0	2.9	5.2	6.2	9.7	2.0	3.0	2.6

Energy and Carbon Indicators	Business-as-Usual Case						Alternative Case					
				AAGR (%)						AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)	0.69	0.81	1.26	1.2	3.0	2.3	0.65	0.75	1.16	0.5	2.9	2.0
Primary Energy Demand/GDP (toe/constant 2000 \$ million)	394	364	310	(4.1)	(1.1)	(2.3)	370	340	286	(4.8)	(1.1)	(2.6)
CO_2/capita (t CO_2/person)	1.31	1.63	2.89	3.4	3.9	3.7	1.22	1.53	2.70	2.7	3.9	3.4
CO_2 Intensity (t CO_2/million constant 2000 \$)	750	736	711	(2.0)	(0.2)	(1.0)	699	688	663	(2.7)	(0.2)	(1.2)
CO_2/Primary Energy Demand (t CO_2/toe)	1.90	2.02	2.29	2.2	0.8	1.4	1.89	2.02	2.32	2.2	0.9	1.4

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Kazakhstan
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	54.7	68.5	110.7	5.4	3.2	4.1
Population (million persons)	16.9	17.3	18.1	0.6	0.3	0.4
GDP/capita (constant 2000 $/person)	3,243	3,956	6,126	4.8	3.0	3.7

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	79.3	87.7	108.0	100.0	100.0	100.0	1.6	1.4	1.5	77.6	83.9	96.1	100.0	100.0	100.0	1.1	0.9	1.0
Coal	34.3	39.1	51.2	43.2	44.6	47.4	1.3	1.8	1.6	32.9	35.2	41.2	42.4	41.9	42.9	0.2	1.1	0.7
Oil	18.8	20.5	23.5	23.8	23.4	21.7	1.8	0.9	1.3	18.7	20.1	22.3	24.1	24.0	23.2	1.6	0.7	1.1
Natural Gas	25.2	27.1	32.3	31.8	30.9	29.9	1.8	1.2	1.4	25.0	26.5	30.3	32.2	31.5	31.6	1.6	0.9	1.2
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	1.1	1.1	0.0	1.3	1.1	…	0.0	…
Hydro	0.8	0.9	0.9	1.1	1.0	0.8	2.2	0.3	1.0	0.8	0.9	0.9	1.1	1.0	0.9	2.2	0.3	1.0
Others[a]	0.2	0.2	0.2	0.2	0.2	0.2	1.2	0.4	0.7	0.2	0.2	0.2	0.2	0.2	0.2	2.2	1.3	1.7
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	50.8	56.0	68.6	100.0	100.0	100.0	2.5	1.4	1.8	49.7	53.7	61.4	100.0	100.0	100.0	2.1	0.9	1.4
Coal	14.6	16.2	21.1	28.8	29.0	30.7	1.2	1.8	1.5	14.2	15.4	18.1	28.6	28.7	29.5	0.7	1.1	0.9
Oil	18.0	19.6	22.6	35.3	35.0	32.9	2.8	1.0	1.7	17.8	19.2	21.5	35.8	35.8	35.0	2.7	0.7	1.5
Natural Gas	3.7	4.2	5.4	7.3	7.6	7.9	2.9	1.7	2.1	3.6	4.0	4.8	7.3	7.5	7.8	2.3	1.1	1.6
Electricity	6.7	8.0	11.6	13.2	14.4	16.9	5.0	2.5	3.5	6.4	7.4	9.7	12.9	13.7	15.8	4.1	1.8	2.7
Heat	7.7	7.8	7.9	15.2	14.0	11.4	2.1	0.0	0.8	7.6	7.6	7.3	15.3	14.2	11.9	1.8	(0.3)	0.5
Others	0.1	0.1	0.1	0.1	0.1	0.1	0.4	0.0	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.4	0.0	0.2
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	50.8	56.0	68.6	100.0	100.0	100.0	2.5	1.4	1.8	49.7	53.7	61.4	100.0	100.0	100.0	2.1	0.9	1.4
Industry	22.9	26.0	34.6	45.1	46.4	50.5	2.7	1.9	2.2	22.1	24.3	29.2	44.4	45.3	47.5	2.0	1.2	1.5
Transport	6.5	7.4	9.5	12.8	13.3	13.9	4.7	1.7	2.9	6.4	7.3	9.0	12.9	13.6	14.7	4.5	1.4	2.6
Other Sectors	21.0	22.2	24.1	41.4	39.6	35.1	1.7	0.5	1.0	20.9	21.7	22.9	42.0	40.5	37.3	1.5	0.3	0.8
Non-Energy	0.4	0.4	0.4	0.7	0.6	0.5	0.4	0.0	0.2	0.4	0.4	0.4	0.7	0.7	0.6	0.4	0.0	0.2

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Kazakhstan Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case TWh			Share (%)			AAGR (%)			Alternative Case TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	95.7	115.4	167.0	100.0	100.0	100.0	3.4	2.5	2.9	91.6	105.8	139.4	100.0	100.0	100.0	2.5	1.9	2.1
Fossil Fuels	85.8	105.3	156.4	89.7	91.2	93.7	3.5	2.7	3.0	81.6	91.2	124.0	89.0	86.3	89.0	2.0	2.1	2.1
Coal	76.2	91.2	129.6	79.7	79.1	77.6	3.2	2.4	2.7	72.5	79.1	102.8	79.1	74.8	73.7	1.7	1.8	1.7
Oil	0.1	0.4	0.4	0.1	0.3	0.3	(5.1)	1.1	(1.5)	0.1	0.3	0.3	0.1	0.3	0.2	(6.5)	0.5	(2.4)
Natural Gas	9.4	13.7	26.4	9.8	11.8	15.8	6.4	4.5	5.2	9.0	11.8	20.9	9.8	11.2	15.0	4.9	3.9	4.3
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	4.2	4.2	0.0	4.0	3.0	…	0.0	…
Hydro	9.8	10.0	10.4	10.3	8.6	6.2	2.2	0.3	1.0	9.8	10.0	10.4	10.7	9.4	7.5	2.2	0.3	1.0
Others[b]	0.1	0.1	0.2	0.1	0.1	0.1	418.4	2.7	96.3	0.2	0.4	0.8	0.2	0.3	0.6	468.1	5.4	106.8

Thermal Power Generation Input	Business-as-Usual Case Mtoe			Share (%)			AAGR (%)			Alternative Case Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	21.8	25.9	35.6	100.0	100.0	100.0	2.6	2.1	2.3	20.7	22.5	27.3	100.0	100.0	100.0	1.2	1.3	1.3
Coal	19.6	22.9	30.1	90.1	88.1	84.5	2.4	1.8	2.1	18.7	19.8	23.1	90.1	88.2	84.6	1.0	1.0	1.0
Oil	0.0	0.1	0.1	0.2	0.4	0.3	(5.6)	0.8	(1.8)	0.0	0.1	0.1	0.2	0.4	0.3	(7.0)	0.2	(2.7)
Natural Gas	2.1	3.0	5.4	9.7	11.5	15.2	5.1	4.1	4.5	2.0	2.6	4.1	9.7	11.4	15.1	3.6	3.2	3.4

Carbon Dioxide Emissions	Business-as-Usual Case Mt CO_2			AAGR (%)			Alternative Case Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	251.7	280.2	349.3	1.5	1.5	1.5	245.3	262.3	302.0	0.8	0.9	0.9

Energy and Carbon Indicators	Business-as-Usual Case 2015	2020	2035	AAGR (%) 2010–2020	2020–2035	2010–2035	Alternative Case 2015	2020	2035	AAGR (%) 2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)	4.70	5.06	5.97	1.0	1.1	1.1	4.60	4.85	5.32	0.5	0.6	0.6
Primary Energy Demand/GDP (toe/constant 2000 $ million)	1,450	1,280	975	(3.6)	(1.8)	(2.5)	1,418	1,225	868	(4.0)	(2.3)	(3.0)
CO_2/capita ($t\ CO_2$/person)	14.92	16.17	19.33	0.9	1.2	1.1	14.54	15.14	16.71	0.2	0.7	0.5
CO_2 Intensity ($t\ CO_2$/million constant 2000 $)	4,600	4,089	3,156	(3.7)	(1.7)	(2.5)	4,483	3,828	2,728	(4.3)	(2.2)	(3.1)
CO_2/Primary Energy Demand ($t\ CO_2$/toe)	3.17	3.20	3.24	(0.1)	0.1	0.0	3.16	3.12	3.14	(0.3)	0.0	(0.1)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Kyrgyz Republic Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	2.6	3.1	4.5	4.3	2.6	3.3
Population (million persons)	5.6	6.0	6.9	1.2	1.0	1.1
GDP/capita (constant 2000 $/person)	453	509	647	3.1	1.6	2.2

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	4.1	4.6	5.9	100.0	100.0	100.0	4.6	1.7	2.9	3.9	4.3	5.3	100.0	100.0	100.0	4.0	1.4	2.4
Coal	0.9	1.1	1.4	23.2	23.8	24.3	9.2	1.9	4.7	0.9	1.0	1.3	23.1	23.6	25.1	8.4	1.8	4.4
Oil	1.3	1.5	2.4	31.4	33.7	40.3	2.2	2.9	2.6	1.2	1.5	2.0	31.4	33.7	38.1	1.6	2.3	2.0
Natural Gas	0.9	1.0	1.0	22.9	21.3	16.1	9.7	(0.2)	3.7	0.9	0.9	0.8	22.4	20.3	15.4	8.5	(0.4)	3.1
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.9	1.0	1.2	23.1	21.6	19.7	1.1	1.1	1.1	0.9	1.0	1.2	23.8	23.0	21.9	1.1	1.1	1.1
Others[a]	(0.0)	(0.0)	(0.0)	(0.6)	(0.5)	(0.4)	(8.0)	0.0	(3.3)	(0.0)	(0.0)	(0.0)	(0.6)	(0.6)	(0.4)	(8.0)	0.0	(3.3)
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	3.2	3.7	5.2	100.0	100.0	100.0	3.5	2.3	2.8	3.1	3.5	4.7	100.0	100.0	100.0	3.0	2.0	2.4
Coal	0.6	0.7	1.1	19.2	20.1	21.5	4.8	2.8	3.6	0.6	0.7	1.1	19.2	20.1	22.6	4.3	2.8	3.4
Oil	1.2	1.5	2.3	38.0	39.9	44.7	1.7	3.1	2.5	1.2	1.4	2.0	37.7	39.3	41.6	1.0	2.4	1.8
Natural Gas	0.3	0.3	0.3	8.7	8.0	5.7	16.0	0.0	6.2	0.3	0.3	0.3	8.9	8.3	6.1	16.0	(0.1)	6.1
Electricity	0.9	0.9	1.2	27.0	25.6	22.7	4.2	1.5	2.6	0.8	0.9	1.1	27.0	25.6	23.8	3.7	1.5	2.4
Heat	0.2	0.2	0.3	6.9	6.3	5.4	1.1	1.2	1.2	0.2	0.2	0.3	7.1	6.6	5.8	1.0	1.2	1.1
Others	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	3.2	3.7	5.2	100.0	100.0	100.0	3.5	2.3	2.8	3.1	3.5	4.7	100.0	100.0	100.0	3.0	2.0	2.4
Industry	1.0	1.3	1.9	33.1	34.3	36.1	4.5	2.7	3.4	1.0	1.2	1.8	33.0	34.1	37.6	4.0	2.7	3.2
Transport	1.0	1.3	2.2	31.9	35.5	41.6	4.1	3.4	3.7	1.0	1.2	1.8	31.5	34.7	39.0	3.4	2.8	3.0
Other Sectors	1.0	1.0	1.1	32.6	28.1	20.6	1.9	0.2	0.9	1.0	1.0	1.0	33.1	28.9	21.5	1.7	(0.0)	0.7
Non-Energy	0.1	0.1	0.1	2.4	2.2	1.7	1.2	0.8	0.9	0.1	0.1	0.1	2.4	2.3	1.9	1.2	0.8	0.9

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Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	13.9	14.6	16.6	100.0	100.0	100.0	2.6	0.8	1.5	13.7	14.3	16.1	100.0	100.0	100.0	2.3	0.8	1.4
Fossil Fuels	3.0	3.1	3.0	21.5	21.3	18.1	11.8	(0.3)	4.4	2.8	2.8	2.6	20.5	19.3	15.9	10.5	(0.5)	3.8
Coal	0.8	0.8	0.8	5.5	5.5	4.7	11.9	(0.3)	4.4	0.7	0.7	0.7	5.3	5.0	4.1	10.5	(0.5)	3.8
Oil	0.0	0.0	0.0	0.0	0.0	0.0	…	(0.3)	…	0.0	0.0	0.0	0.0	0.0	0.0	…	(0.5)	…
Natural Gas	2.2	2.3	2.2	16.0	15.8	13.5	11.8	(0.3)	4.4	2.1	2.1	1.9	15.3	14.4	11.8	10.5	(0.5)	3.8
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	10.9	11.5	13.6	78.5	78.7	81.9	1.1	1.1	1.1	10.9	11.5	13.6	79.5	80.7	84.1	1.1	1.1	1.1
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	1.0	1.0	1.0	100.0	100.0	100.0	8.2	(0.3)	3.0	0.9	0.9	0.8	100.0	100.0	100.0	6.7	(0.7)	2.2
Coal	0.3	0.4	0.3	34.0	34.0	33.6	9.1	(0.4)	3.3	0.3	0.3	0.3	34.3	34.8	33.8	7.7	(0.9)	2.5
Oil	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Natural Gas	0.7	0.7	0.7	66.0	66.0	66.4	7.8	(0.3)	2.9	0.6	0.6	0.5	65.7	65.2	66.2	6.2	(0.6)	2.1
Carbon Dioxide Emissions	Mt CO_2			AAGR (%)						Mt CO_2			AAGR (%)					
	2015	2020	2035	2010–2020		2020–2035		2010–2035		2015	2020	2035	2010–2020		2020–2035		2010–2035	
Total	9.6	11.1	15.0	5.8		2.0		3.5		9.2	10.3	13.2	5.0		1.7		3.0	
Energy and Carbon Indicators							AAGR (%)									AAGR (%)		
				2015	2020	2035	2010–2020	2020–2035	2010–2035				2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)				0.72	0.76	0.85	3.4	0.8	1.8				0.70	0.72	0.77	2.8	0.5	1.4
Primary Energy Demand/GDP (toe/constant 2000 $ million)				1,593	1,498	1,320	0.3	(0.8)	(0.4)				1,545	1,412	1,189	(0.3)	(1.1)	(0.8)
CO_2/capita (t CO_2/person)				1.71	1.85	2.16	4.6	1.1	2.4				1.64	1.72	1.90	3.8	0.7	1.9
CO_2 Intensity (t CO_2/million constant 2000 $)				3,768	3,635	3,343	1.4	(0.6)	0.2				3,621	3,374	2,940	0.7	(0.9)	(0.3)
CO_2/Primary Energy Demand (t CO_2/toe)				2.36	2.43	2.53	1.2	0.3	0.6				2.34	2.39	2.47	1.0	0.2	0.5

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision.* http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Pakistan
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	140.4	174.6	269.6	4.2	2.9	3.4
Population (million persons)	189.3	204.8	245.9	1.7	1.2	1.4
GDP/capita (constant 2000 $/person)	742	852	1,097	2.5	1.7	2.0

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	95.4	107.5	145.8	100.0	100.0	100.0	2.4	2.1	2.2	92.7	101.1	130.9	100.0	100.0	100.0	1.8	1.7	1.8
Coal	5.8	7.3	12.1	6.1	6.8	8.3	5.7	3.5	4.3	5.5	6.6	10.4	5.9	6.5	7.9	4.7	3.1	3.7
Oil	25.0	27.3	34.1	26.2	25.4	23.4	2.7	1.5	2.0	23.3	23.5	25.0	25.2	23.3	19.1	1.1	0.4	0.7
Natural Gas	34.5	40.5	63.9	36.1	37.7	43.8	4.2	3.1	3.5	32.4	35.5	45.1	35.0	35.1	34.5	2.8	1.6	2.1
Nuclear	1.2	2.4	2.4	1.2	2.2	1.6	10.4	0.0	4.0	2.4	4.9	15.0	2.5	4.8	11.5	18.6	7.8	12.0
Hydro	3.1	4.2	7.6	3.3	3.9	5.2	4.5	3.9	4.2	3.1	4.2	7.6	3.4	4.2	5.8	4.5	3.9	4.2
Others[a]	25.8	25.8	25.8	27.0	24.0	17.7	(1.1)	0.0	(0.4)	25.9	26.3	27.8	28.0	26.0	21.3	(0.9)	0.4	(0.1)
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	76.9	86.4	117.6	100.0	100.0	100.0	2.2	2.1	2.1	75.4	83.1	109.1	100.0	100.0	100.0	1.7	1.8	1.8
Coal	5.1	6.4	10.8	6.6	7.5	9.2	5.3	3.5	4.2	4.9	6.1	10.2	6.5	7.4	9.3	4.7	3.5	4.0
Oil	14.2	16.6	25.0	18.5	19.2	21.3	3.3	2.8	3.0	13.9	16.0	22.8	18.5	19.3	20.9	3.0	2.4	2.6
Natural Gas	23.9	28.0	41.6	31.1	32.4	35.4	3.9	2.7	3.2	23.2	26.5	38.3	30.8	31.9	35.1	3.3	2.5	2.8
Electricity	8.0	9.6	14.5	10.3	11.1	12.3	3.7	2.8	3.2	7.6	8.7	12.1	10.1	10.5	11.1	2.7	2.2	2.4
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	25.7	25.7	25.7	33.5	29.8	21.9	(0.9)	0.0	(0.4)	25.7	25.7	25.7	34.1	31.0	23.6	(0.9)	0.0	(0.4)
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	76.9	86.4	117.6	100.0	100.0	100.0	2.2	2.1	2.1	75.4	83.1	109.1	100.0	100.0	100.0	1.7	1.8	1.8
Industry	18.7	23.2	38.8	24.3	26.8	33.0	2.8	3.5	3.2	18.2	22.0	36.6	24.1	26.4	33.5	2.2	3.5	3.0
Transport	14.8	17.5	26.6	19.2	20.2	22.6	4.4	2.8	3.4	14.6	17.1	25.1	19.4	20.6	23.0	4.1	2.6	3.2
Other Sectors	39.5	41.6	47.6	51.4	48.1	40.5	1.1	0.9	1.0	38.7	39.8	42.8	51.3	48.0	39.2	0.7	0.5	0.6
Non-Energy	3.9	4.2	4.6	5.1	4.8	3.9	1.8	0.7	1.1	3.9	4.2	4.6	5.2	5.0	4.2	1.8	0.7	1.1

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Pakistan Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	126.3	152.0	229.7	100.0	100.0	100.0	4.9	2.8	3.6	120.6	138.1	192.1	100.0	100.0	100.0	3.9	2.2	2.9
Fossil Fuels	84.8	92.9	131.4	67.1	61.1	57.2	4.6	2.3	3.2	72.7	63.0	22.2	60.3	45.7	11.6	0.6	(6.7)	(3.9)
Coal	1.4	1.7	3.2	1.1	1.1	1.4	34.1	4.4	15.4	1.2	1.1	0.5	1.0	0.8	0.3	29.0	(4.9)	7.5
Oil	43.0	42.4	35.2	34.0	27.9	15.3	2.4	(1.2)	0.2	36.9	28.7	5.9	30.6	20.8	3.1	(1.5)	(10.0)	(6.7)
Natural Gas	40.4	48.9	93.1	32.0	32.2	40.5	6.6	4.4	5.3	34.7	33.2	15.7	28.7	24.0	8.2	2.5	(4.9)	(2.0)
Nuclear	4.6	9.2	9.2	3.6	6.0	4.0	10.4	0.0	4.0	9.1	18.8	57.6	7.5	13.6	30.0	18.6	7.8	12.0
Hydro	36.3	49.2	88.0	28.8	32.4	38.3	4.5	3.9	4.2	36.3	49.2	88.0	30.1	35.7	45.8	4.5	3.9	4.2
Others[b]	0.6	0.6	1.1	0.5	0.4	0.5	…	3.7	…	2.5	7.0	24.3	2.1	5.1	12.6	…	8.6	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	19.6	21.0	27.9	100.0	100.0	100.0	4.0	1.9	2.7	16.7	14.1	4.5	100.0	100.0	100.0	(0.0)	(7.3)	(4.5)
Coal	0.7	0.8	1.3	3.6	3.9	4.7	31.1	3.3	13.6	0.6	0.5	0.2	3.4	3.6	4.4	24.9	(6.0)	5.3
Oil	10.2	10.0	8.2	51.9	47.4	29.3	2.3	(1.3)	0.1	8.7	6.8	1.4	52.3	47.9	30.4	(1.6)	(10.1)	(6.8)
Natural Gas	8.7	10.3	18.4	44.5	48.7	66.0	5.2	4.0	4.5	7.4	6.8	3.0	44.4	48.5	65.2	1.1	(5.4)	(2.9)

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)			Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	171.4	197.8	291.5	3.8	2.6	3.1	160.1	171.8	212.6	2.4	1.4	1.8

Energy and Carbon Indicators	Business-as-Usual Case						Alternative Case					
				AAGR (%)						AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)	0.50	0.52	0.59	0.7	0.8	0.8	0.49	0.49	0.53	0.1	0.5	0.3
Primary Energy Demand/GDP (toe/constant 2000 $ million)	680	616	541	(1.7)	(0.9)	(1.2)	660	579	485	(2.3)	(1.2)	(1.6)
CO_2/capita (t CO_2/person)	0.91	0.97	1.19	2.1	1.4	1.7	0.85	0.84	0.86	0.7	0.2	0.4
CO_2 Intensity (t CO_2/million constant 2000 $)	1,221	1,133	1,081	(0.3)	(0.3)	(0.3)	1,141	984	788	(1.7)	(1.5)	(1.6)
CO_2/Primary Energy Demand (t CO_2/toe)	1.80	1.84	2.00	1.4	0.6	0.9	1.73	1.70	1.62	0.6	(0.3)	0.0

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Tajikistan
Outlook Cases

Socioeconomic Indicators	Mtoe 2015	Mtoe 2020	Mtoe 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035
GDP (constant 2000 $ billion)	2.7	3.7	7.4	6.8	4.7	5.6
Population (million persons)	7.4	8.0	9.5	1.5	1.2	1.3
GDP/capita (constant 2000 $/person)	363	467	783	5.3	3.5	4.2

Business-as-Usual Case

	Mtoe			Share (%)			AAGR (%)		
Primary Energy Demand	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	2.7	3.2	4.8	100.0	100.0	100.0	3.3	2.7	2.9
Coal	0.2	0.2	0.3	6.1	5.8	5.4	7.0	2.1	4.1
Oil	0.7	0.9	1.5	25.5	28.1	31.2	5.3	3.4	4.1
Natural Gas	0.2	0.2	0.3	8.6	7.7	5.4	(1.8)	0.3	(0.6)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	1.6	1.9	2.8	59.7	58.2	57.9	3.2	2.6	2.9
Others[a]	0.0	0.0	0.0	0.2	0.2	0.1	(9.3)	0.3	(3.7)
Final Energy Demand By Source	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	2.5	2.9	4.3	100.0	100.0	100.0	3.8	2.6	3.1
Coal	0.1	0.1	0.2	4.3	4.1	3.6	2.5	1.7	2.0
Oil	0.7	0.9	1.5	27.7	30.6	34.1	5.2	3.4	4.1
Natural Gas	0.2	0.2	0.2	7.4	6.6	4.6	6.8	0.2	2.8
Electricity	1.4	1.6	2.4	57.2	55.8	55.7	3.2	2.6	2.9
Heat	0.1	0.1	0.1	3.5	3.0	2.0	0.1	0.0	0.0
Others	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Final Energy Demand By Sector	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	2.5	2.9	4.3	100.0	100.0	100.0	3.8	2.6	3.1
Industry	0.8	1.0	1.7	30.3	32.8	40.1	5.9	4.0	4.8
Transport	0.1	0.1	0.2	4.8	4.8	4.8	3.1	2.7	2.8
Other Sectors	1.6	1.8	2.4	64.8	62.4	55.1	2.9	1.8	2.3
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Alternative Case

	Mtoe			Share (%)			AAGR (%)		
Primary Energy Demand	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	2.6	3.1	4.4	100.0	100.0	100.0	2.8	2.5	2.6
Coal	0.2	0.2	0.2	6.1	5.9	5.3	6.6	1.8	3.7
Oil	0.7	0.9	1.5	26.2	29.4	33.3	5.2	3.4	4.1
Natural Gas	0.2	0.2	0.2	7.2	6.3	3.8	(4.3)	(0.8)	(2.2)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	1.6	1.8	2.5	59.9	58.0	57.3	2.6	2.4	2.5
Others[a]	0.0	0.0	0.0	0.5	0.5	0.4	1.0	0.7	0.8
Final Energy Demand By Source	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	2.4	2.8	4.1	100.0	100.0	100.0	3.4	2.5	2.9
Coal	0.1	0.1	0.1	4.4	4.2	3.6	2.2	1.4	1.7
Oil	0.7	0.9	1.5	28.1	31.6	35.9	5.2	3.4	4.1
Natural Gas	0.2	0.2	0.2	7.3	6.4	4.0	6.1	(0.7)	1.9
Electricity	1.4	1.5	2.2	56.7	54.9	54.5	2.6	2.4	2.5
Heat	0.1	0.1	0.1	3.6	3.1	2.2	0.1	0.0	0.0
Others	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Final Energy Demand By Sector	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	2.4	2.8	4.1	100.0	100.0	100.0	3.4	2.5	2.9
Industry	0.7	0.9	1.6	30.0	32.2	40.4	5.3	4.0	4.5
Transport	0.1	0.1	0.2	4.9	4.9	4.8	2.8	2.4	2.6
Other Sectors	1.6	1.8	2.2	65.1	62.9	54.8	2.7	1.5	2.0
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	19.2	22.1	32.7	100.0	100.0	100.0	3.0	2.6	2.8	18.7	21.0	30.0	100.0	100.0	100.0	2.5	2.4	2.4
Fossil Fuels	0.4	0.4	0.6	2.0	1.9	1.8	(2.8)	2.1	0.1	0.3	0.3	0.4	1.4	1.4	1.3	(6.6)	2.2	(1.4)
Coal	0.2	0.3	0.4	1.2	1.2	1.3	…	2.8	…	0.2	0.3	0.4	1.2	1.2	1.3	…	2.6	…
Oil	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Natural Gas	0.1	0.2	0.2	0.8	0.7	0.5	(12.1)	0.6	(4.7)	0.0	0.0	0.0	0.2	0.2	0.1	(25.1)	(2.0)	(12.0)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	18.8	21.7	32.1	98.0	98.1	98.2	3.2	2.6	2.9	18.3	20.6	29.5	98.0	98.1	98.2	2.6	2.4	2.5
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.1	0.1	0.1	0.6	0.6	0.4	…	0.9	…
Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	0.1	0.1	0.2	100.0	100.0	100.0	(4.8)	1.9	(0.8)	0.1	0.1	0.1	100.0	100.0	100.0	(9.5)	2.0	(2.8)
Coal	0.1	0.1	0.1	52.6	54.9	63.0	…	2.8	…	0.1	0.1	0.1	80.8	84.9	92.2	…	2.6	…
Oil	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Natural Gas	0.1	0.1	0.1	47.4	45.1	37.0	(12.1)	0.6	(4.7)	0.0	0.0	0.0	19.2	15.1	7.8	(25.1)	(2.4)	(12.2)

Carbon Dioxide Emissions	Business-as-Usual Case						Alternative Case					
	Mt CO_2			AAGR (%)			Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	3.3	4.1	6.2	4.1	2.8	3.3	3.2	3.9	5.8	3.7	2.7	3.1

Energy and Carbon Indicators	Business-as-Usual Case						Alternative Case					
				AAGR (%)						AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)	0.37	0.40	0.50	1.8	1.5	1.6	0.36	0.38	0.47	1.3	1.3	1.3
Primary Energy Demand/GDP (toe/constant 2000 $ million)	1,007	862	643	(3.3)	(1.9)	(2.5)	977	821	598	(3.7)	(2.1)	(2.8)
CO_2/capita (t CO_2/person)	0.45	0.51	0.65	2.6	1.6	2.0	0.43	0.49	0.62	2.2	1.5	1.8
CO_2 Intensity (t CO_2/million constant 2000 $)	1,231	1,099	834	(2.5)	(1.8)	(2.1)	1,188	1,052	788	(3.0)	(1.9)	(2.3)
CO_2/Primary Energy Demand (t CO_2/toe)	1.22	1.27	1.30	0.8	0.1	0.4	1.22	1.28	1.32	0.8	0.2	0.4

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: Figures may not add up to total because of rounding.
[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.
[b] "Others" include geothermal, solar, wind, and renewables.
Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision.* http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Turkmenistan
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	25.9	35.8	77.4	7.5	5.3	6.2
Population (million persons)	5.4	5.7	6.3	1.2	0.7	0.9
GDP/capita (constant 2000 $/person)	4,836	6,314	12,317	6.3	4.6	5.2

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	21.6	22.9	28.2	100.0	100.0	100.0	0.7	1.4	1.1	21.2	22.2	26.0	100.0	100.0	100.0	0.4	1.1	0.8
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	3.8	4.2	5.4	17.8	18.1	19.2	(0.1)	1.8	1.0	3.8	4.1	5.2	17.9	18.5	20.0	(0.2)	1.6	0.9
Natural Gas	18.0	19.0	23.0	83.2	82.8	81.6	0.9	1.3	1.1	17.6	18.3	21.0	83.1	82.5	80.8	0.5	0.9	0.8
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	3.3	2.8	3.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	2.3	2.4
Others[a]	(0.2)	(0.2)	(0.2)	(1.0)	(0.9)	(0.8)	0.4	0.3	0.4	(0.2)	(0.2)	(0.2)	(1.0)	(1.0)	(0.9)	0.4	0.3	0.4
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	13.3	14.5	18.5	100.0	100.0	100.0	1.8	1.6	1.7	13.2	14.2	17.5	100.0	100.0	100.0	1.5	1.4	1.5
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	3.2	3.4	4.3	23.9	23.5	23.5	1.5	1.6	1.6	3.2	3.4	4.1	23.9	23.7	23.4	1.4	1.3	1.3
Natural Gas	9.0	9.8	12.0	67.5	67.1	64.8	1.7	1.4	1.5	8.9	9.6	11.6	67.7	67.5	65.9	1.5	1.2	1.3
Electricity	0.9	1.1	1.8	7.1	7.8	9.9	3.7	3.3	3.4	0.9	1.0	1.5	6.9	7.3	8.8	2.7	2.7	2.7
Heat	0.2	0.2	0.3	1.5	1.5	1.8	1.4	2.8	2.2	0.2	0.2	0.3	1.5	1.6	1.9	1.4	2.8	2.2
Others	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	13.3	14.5	18.5	100.0	100.0	100.0	1.8	1.6	1.7	13.2	14.2	17.5	100.0	100.0	100.0	1.5	1.4	1.5
Industry	1.8	2.2	4.0	13.6	15.4	21.9	4.5	4.0	4.2	1.7	2.1	3.6	13.1	14.5	20.6	3.6	3.8	3.7
Transport	1.9	2.1	2.9	14.4	14.5	15.9	2.5	2.2	2.3	1.9	2.1	2.8	14.4	14.6	15.8	2.3	1.9	2.1
Other Sectors	9.6	10.2	11.5	72.1	70.0	62.3	1.1	0.8	0.9	9.6	10.1	11.2	72.6	71.0	63.6	1.0	0.7	0.8
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…

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Turkmenistan Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	20.0	23.2	34.9	100.0	100.0	100.0	3.4	2.8	3.0	19.4	21.6	30.2	100.0	100.0	100.0	2.6	2.3	2.4
Fossil Fuels	20.0	23.2	34.9	100.0	100.0	100.0	3.4	2.8	3.0	19.4	21.6	30.2	100.0	100.0	100.0	2.6	2.3	2.4
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Natural Gas	20.0	23.2	34.9	100.0	100.0	100.0	3.4	2.8	3.0	19.4	21.6	30.2	100.0	100.0	100.0	2.6	2.3	2.4
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	3.4	2.8	3.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	2.3	2.4
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	0.0	…
Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	6.9	7.1	8.8	100.0	100.0	100.0	0.1	1.4	0.9	6.6	6.5	7.2	100.0	100.0	100.0	(0.7)	0.7	0.1
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Natural Gas	6.9	7.1	8.8	100.0	100.0	100.0	0.1	1.4	0.9	6.6	6.5	7.2	100.0	100.0	100.0	(0.7)	0.7	0.1

Carbon Dioxide Emissions	BAU Mt CO_2			BAU AAGR (%)			Alt. Mt CO_2			Alt. AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	53.9	57.4	70.6	0.7	1.4	1.1	53.2	55.5	65.5	0.4	1.1	0.8

Energy and Carbon Indicators	BAU 2015	BAU 2020	BAU 2035	BAU AAGR (%) 2010–2020	BAU AAGR (%) 2020–2035	BAU AAGR (%) 2010–2035	Alt. 2015	Alt. 2020	Alt. 2035	Alt. AAGR (%) 2010–2020	Alt. AAGR (%) 2020–2035	Alt. AAGR (%) 2010–2035
Primary Energy Demand/capita (toe/person)	4.02	4.05	4.48	(0.4)	0.7	0.2	3.96	3.91	4.14	(0.8)	0.4	(0.1)
Primary Energy Demand/GDP (toe/constant 2000 $ million)	831	641	364	(6.3)	(3.7)	(4.8)	819	620	336	(6.6)	(4.0)	(5.1)
CO_2/capita (t CO_2/person)	10.05	10.13	11.24	(0.5)	0.7	0.2	9.91	9.80	10.42	(0.8)	0.4	(0.1)
CO_2 Intensity (t CO_2/million constant 2000 $)	2,079	1,605	913	(6.4)	(3.7)	(4.8)	2,049	1,553	846	(6.7)	(4.0)	(5.1)
CO_2/Primary Energy Demand (t CO_2/toe)	2.50	2.50	2.51	(0.0)	0.0	(0.0)	2.50	2.51	2.51	(0.0)	0.0	0.0

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Uzbekistan
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	40.3	58.0	126.4	8.0	5.3	6.4
Population (million persons)	29.9	31.6	35.2	1.1	0.7	0.9
GDP/capita (constant 2000 $/person)	1,350	1,839	3,589	6.8	4.6	5.4

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	45.9	48.5	56.4	100.0	100.0	100.0	1.0	1.0	1.0	44.9	46.5	51.8	100.0	100.0	100.0	0.5	0.7	0.6
Coal	1.2	1.2	1.3	2.6	2.5	2.3	(0.9)	0.5	(0.0)	1.2	1.1	1.1	2.6	2.4	2.2	(1.8)	0.1	(0.6)
Oil	4.7	5.0	6.6	10.3	10.4	11.7	0.6	1.8	1.3	4.7	4.9	6.0	10.4	10.5	11.5	0.3	1.4	0.9
Natural Gas	38.9	41.2	47.3	84.9	85.0	84.0	1.1	0.9	1.0	38.1	39.4	43.6	84.8	84.9	84.1	0.6	0.7	0.6
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	1.0	1.0	1.1	2.2	2.2	2.0	1.1	0.6	0.8	1.0	1.0	1.1	2.2	2.2	2.2	1.1	0.6	0.8
Others[a]	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	0.5	0.6	0.6	(0.0)	0.0	(0.0)	(0.0)	0.0	(0.0)	…	(234.3)	(9.1)
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	34.6	36.8	42.5	100.0	100.0	100.0	1.2	1.0	1.1	34.1	35.8	40.3	100.0	100.0	100.0	0.9	0.8	0.9
Coal	0.4	0.4	0.4	1.0	1.0	1.0	(0.3)	0.9	0.4	0.4	0.4	0.4	1.0	1.0	1.0	(0.5)	0.8	0.3
Oil	3.8	3.9	4.5	10.9	10.7	10.6	0.9	0.9	0.9	3.7	3.8	4.1	10.9	10.6	10.2	0.6	0.5	0.6
Natural Gas	24.5	26.5	31.5	70.7	71.8	74.1	1.5	1.2	1.3	24.2	25.9	30.5	70.9	72.4	75.6	1.3	1.1	1.2
Electricity	4.0	4.3	5.5	11.6	11.8	13.0	1.7	1.6	1.7	3.9	4.0	4.8	11.3	11.2	11.8	0.9	1.1	1.0
Heat	2.1	1.7	0.5	5.9	4.7	1.3	(2.7)	(7.5)	(5.6)	2.1	1.7	0.5	6.0	4.8	1.3	(2.7)	(7.5)	(5.6)
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	34.6	36.8	42.5	100.0	100.0	100.0	1.2	1.0	1.1	34.1	35.8	40.3	100.0	100.0	100.0	0.9	0.8	0.9
Industry	8.1	8.5	10.2	23.4	23.1	24.0	1.2	1.2	1.2	7.9	8.0	9.5	23.0	22.5	23.6	0.6	1.1	0.9
Transport	3.8	4.0	4.6	10.8	10.8	10.8	1.1	1.0	1.1	3.7	3.9	4.4	10.9	10.8	10.8	0.9	0.8	0.8
Other Sectors	20.9	22.4	25.8	60.3	60.8	60.5	1.3	0.9	1.1	20.6	21.9	24.5	60.4	61.3	60.8	1.1	0.7	0.9
Non-Energy	1.9	1.9	1.9	5.5	5.3	4.6	0.4	0.0	0.2	1.9	1.9	1.9	5.6	5.4	4.8	0.4	0.0	0.2

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Uzbekistan Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case: TWh			Share (%)			AAGR (%)			Alternative Case: TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	56.9	61.8	78.7	100.0	100.0	100.0	1.7	1.6	1.6	54.8	57.2	67.6	100.0	100.0	100.0	0.9	1.1	1.0
Fossil Fuels	45.2	49.7	65.4	79.5	80.3	83.0	1.8	1.8	1.8	43.2	44.9	54.1	78.7	78.6	80.1	0.8	1.3	1.1
Coal	2.3	2.6	3.4	4.1	4.2	4.3	1.8	1.8	1.8	2.2	2.3	2.8	4.1	4.1	4.1	0.8	1.3	1.1
Oil	1.0	1.6	5.7	1.8	2.6	7.2	7.7	8.8	8.3	1.0	1.5	4.7	1.8	2.5	6.9	6.6	8.1	7.5
Natural Gas	41.8	45.5	56.3	73.5	73.6	71.5	1.7	1.4	1.5	39.9	41.1	46.6	72.8	72.0	69.0	0.7	0.8	0.8
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	11.7	12.2	13.4	20.5	19.7	17.0	1.1	0.6	0.8	11.7	12.2	13.4	21.3	21.3	19.8	1.1	0.6	0.8
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…	0.0	…	0.0	0.1	0.1	0.0	0.2	0.1	…	0.0	…

Thermal Power Generation Input	Business-as-Usual Case: Mtoe			Share (%)			AAGR (%)			Alternative Case: Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	12.8	13.3	15.2	100.0	100.0	100.0	0.3	0.9	0.7	12.3	11.9	12.0	100.0	100.0	100.0	(0.8)	0.1	(0.3)
Coal	0.8	0.8	0.9	6.6	6.3	5.8	(1.2)	0.4	(0.2)	0.8	0.7	0.7	6.5	6.1	5.9	(2.4)	(0.2)	(1.1)
Oil	0.3	0.4	1.4	2.2	3.2	9.2	6.9	8.2	7.7	0.3	0.4	1.2	2.2	3.2	9.6	5.8	7.6	6.9
Natural Gas	11.7	12.0	12.9	91.2	90.5	85.0	0.2	0.5	0.4	11.2	10.8	10.2	91.2	90.6	84.5	(0.9)	(0.4)	(0.6)

Carbon Dioxide Emissions	Business-as-Usual Case: Mt CO_2			AAGR (%)			Alternative Case: Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	105.9	112.3	131.7	0.9	1.1	1.0	103.6	107.1	120.1	0.5	0.8	0.6

Energy and Carbon Indicators	Business-as-Usual Case			AAGR (%)			Alternative Case			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)	1.53	1.54	1.60	(0.2)	0.3	0.1	1.50	1.47	1.47	(0.6)	(0.0)	(0.3)
Primary Energy Demand/GDP (toe/constant 2000 $ million)	1,137	836	446	(6.5)	(4.1)	(5.1)	1,114	800	410	(6.9)	(4.4)	(5.4)
CO_2/capita ($t CO_2$/person)	3.54	3.56	3.74	(0.2)	0.3	0.1	3.47	3.39	3.41	(0.7)	0.0	(0.3)
CO_2 Intensity ($t CO_2$/million constant 2000 $)	2,625	1,934	1,042	(6.5)	(4.0)	(5.0)	2,568	1,845	950	(7.0)	(4.3)	(5.4)
CO_2/Primary Energy Demand ($t CO_2$/toe)	2.31	2.31	2.34	(0.0)	0.1	0.0	2.31	2.30	2.32	(0.1)	0.0	0.0

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision.* http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

East Asia
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	6,846.6	9,379.6	19,328.2	7.1	4.9	5.8
Population (million persons)	1,452.7	1,472.3	1,467.5	0.3	(0.0)	0.1
GDP/capita (constant 2000 $/person)	4,713	6,371	13,171	6.7	5.0	5.7

Primary Energy Demand	Business-as-Usual Case									Alternative Case								
	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	3,162.0	3,509.5	4,656.3	100.0	100.0	100.0	2.3	1.9	2.1	3,023.3	3,142.3	3,802.4	100.0	100.0	100.0	1.2	1.3	1.2
Coal	1,824.8	1,890.7	2,364.0	57.7	53.9	50.8	1.0	1.5	1.3	1,685.5	1,525.6	1,511.7	55.7	48.5	39.8	(1.2)	(0.1)	(0.5)
Oil	647.5	739.2	937.3	20.5	21.1	20.1	2.6	1.6	2.0	642.6	719.6	851.4	21.3	22.9	22.4	2.3	1.1	1.6
Natural Gas	226.4	298.9	628.0	7.2	8.5	13.5	7.6	5.1	6.1	205.2	269.0	487.2	6.8	8.6	12.8	6.5	4.0	5.0
Nuclear	128.0	188.8	274.5	4.0	5.4	5.9	10.6	2.5	5.7	142.6	227.0	422.9	4.7	7.2	11.1	12.7	4.2	7.5
Hydro	83.6	115.3	128.6	2.6	3.3	2.8	6.3	0.7	2.9	93.1	103.2	136.9	3.1	3.3	3.6	5.1	1.9	3.2
Others[a]	251.7	276.5	323.8	8.0	7.9	7.0	2.1	1.1	1.5	254.2	297.8	392.3	8.4	9.5	10.3	2.8	1.9	2.2
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	2,006.2	2,267.8	2,952.1	100.0	100.0	100.0	2.6	1.8	2.1	1,962.6	2,124.9	2,613.5	100.0	100.0	100.0	2.0	1.4	1.6
Coal	550.9	570.6	536.3	27.5	25.2	18.2	0.7	(0.4)	0.0	535.9	519.1	464.2	27.3	24.4	17.8	(0.2)	(0.7)	(0.5)
Oil	570.6	655.9	838.4	28.4	28.9	28.4	2.9	1.6	2.1	567.3	640.7	761.4	28.9	30.2	29.1	2.7	1.2	1.8
Natural Gas	117.2	161.9	336.0	5.8	7.1	11.4	7.3	5.0	5.9	115.9	156.4	309.7	5.9	7.4	11.8	6.9	4.7	5.5
Electricity	466.4	555.3	836.6	23.2	24.5	28.3	4.5	2.8	3.5	446.2	495.3	696.6	22.7	23.3	26.7	3.3	2.3	2.7
Heat	84.4	104.8	168.0	4.2	4.6	5.7	4.2	3.2	3.6	80.5	93.2	135.3	4.1	4.4	5.2	3.0	2.5	2.7
Others	216.8	219.2	235.0	10.8	9.7	8.0	0.2	0.5	0.3	216.7	218.9	232.9	11.0	10.3	8.9	0.1	0.4	0.3
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	2,006.2	2,267.8	2,952.1	100.0	100.0	100.0	2.6	1.8	2.1	1,962.6	2,124.9	2,613.5	100.0	100.0	100.0	2.0	1.4	1.6
Industry	845.7	892.1	981.9	42.2	39.3	33.3	1.4	0.6	0.9	815.4	787.6	821.1	41.5	37.1	31.4	0.1	0.3	0.2
Transport	277.5	333.2	480.9	13.8	14.7	16.3	3.9	2.5	3.0	276.9	328.0	425.5	14.1	15.4	16.3	3.7	1.7	2.5
Other Sectors	689.5	835.8	1,259.1	34.4	36.9	42.7	4.3	2.8	3.4	676.7	802.6	1,136.9	34.5	37.8	43.5	3.9	2.3	3.0
Non-Energy	193.6	206.7	230.1	9.6	9.1	7.8	0.8	0.7	0.7	193.6	206.7	230.1	9.9	9.7	8.8	0.8	0.7	0.7

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East Asia Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	6,299.6	7,376.1	10,577.5	100.0	100.0	100.0	4.0	2.4	3.0	6,023.8	6,575.9	8,805.2	100.0	100.0	100.0	2.8	2.0	2.3
Fossil Fuels	4,496.2	4,725.3	7,153.6	71.4	64.1	67.6	1.9	2.8	2.4	4,029.4	3,706.1	3,945.4	66.9	56.4	44.8	(0.6)	0.4	0.0
Coal	4,066.2	4,200.7	5,979.7	64.5	56.9	56.5	1.4	2.4	2.0	3,658.3	3,256.4	3,200.7	60.7	49.5	36.4	(1.1)	(0.1)	(0.5)
Oil	48.3	38.6	27.5	0.8	0.5	0.3	(1.1)	(2.2)	(1.8)	46.8	30.9	22.9	0.8	0.5	0.3	(3.3)	(2.0)	(2.5)
Natural Gas	381.6	486.0	1,146.4	6.1	6.6	10.8	7.1	5.9	6.4	324.3	418.7	721.8	5.4	6.4	8.2	5.6	3.7	4.4
Nuclear	495.5	728.7	1,057.3	7.9	9.9	10.0	10.7	2.5	5.7	548.5	871.9	1,622.7	9.1	13.3	18.4	12.7	4.2	7.5
Hydro	972.1	1,342.2	1,501.3	15.4	18.2	14.2	6.3	0.7	2.9	1,083.3	1,200.3	1,592.2	18.0	18.3	18.1	5.1	1.9	3.2
Others[b]	335.8	579.9	865.3	5.3	7.9	8.2	24.5	2.7	10.9	362.6	797.7	1,644.9	6.0	12.1	18.7	28.6	4.9	13.8

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	1,036.9	1,061.2	1,536.1	100.0	100.0	100.0	1.2	2.5	2.0	915.0	784.1	805.0	100.0	100.0	100.0	(1.8)	0.2	(0.6)
Coal	948.3	955.4	1,308.9	91.5	90.0	85.2	0.8	2.1	1.6	839.8	697.5	679.7	91.8	89.0	84.4	(2.3)	(0.2)	(1.0)
Oil	12.1	9.8	7.2	1.2	0.9	0.5	(2.5)	(2.1)	(2.2)	11.7	7.8	5.9	1.3	1.0	0.7	(4.8)	(1.8)	(3.0)
Natural Gas	76.5	96.1	220.1	7.4	9.1	14.3	7.6	5.7	6.4	63.5	78.9	119.4	6.9	10.1	14.8	5.5	2.8	3.9

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)			Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	9,127.3	9,799.9	12,989.3	1.6	1.9	1.8	8,510.8	8,223.7	9,019.7	(0.1)	0.6	0.3

Energy and Carbon Indicators				AAGR (%)						AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)	2.18	2.38	3.17	2.0	1.9	1.9	2.08	2.13	2.59	0.8	1.3	1.1
Primary Energy Demand/GDP (toe/constant 2000 $ million)	462	374	241	(4.5)	(2.9)	(3.5)	442	335	197	(5.5)	(3.5)	(4.3)
CO_2/capita (t CO_2/person)	6.28	6.66	8.85	1.3	1.9	1.7	5.86	5.59	6.15	(0.5)	0.6	0.2
CO_2 Intensity (t CO_2/million constant 2000 $)	1,333	1,045	672	(5.1)	(2.9)	(3.8)	1,243	877	467	(6.7)	(4.1)	(5.2)
CO_2/Primary Energy Demand (t CO_2/toe)	2.89	2.79	2.79	(0.7)	(0.0)	(0.3)	2.82	2.62	2.37	(1.3)	(0.7)	(0.9)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: Figures may not add up to total because of rounding.
[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.
[b] "Others" include geothermal, solar, wind, and renewables.
Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; Council for Economic Planning and Development. 2012. Population Projection for [Taipei,China] from 2012–2060. Available at http://www.cepd.gov.tw/encontent/m1.aspx?sNo=0001457; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

People's Republic of China
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	4,922.8	7,083.0	15,871.9	8.1	5.5	6.6
Population (million persons)	1,369.7	1,387.8	1,381.6	0.3	(0.0)	0.1
GDP/capita (constant 2000 $/person)	3,594	5,104	11,488	7.7	5.6	6.4

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	2,771.5	3,098.0	4,218.1	100.0	100.0	100.0	2.5	2.1	2.3	2,646.2	2,759.4	3,418.7	100.0	100.0	100.0	1.3	1.4	1.4
Coal	1,708.4	1,766.2	2,239.5	61.6	57.0	53.1	1.0	1.6	1.4	1,584.6	1,439.4	1,448.2	59.9	52.2	42.4	(1.0)	0.0	(0.4)
Oil	499.9	589.0	787.1	18.0	19.0	18.7	3.2	2.0	2.4	496.8	572.0	709.0	18.8	20.7	20.7	2.9	1.4	2.0
Natural Gas	163.6	233.5	551.7	5.9	7.5	13.1	10.2	5.9	7.6	147.8	209.1	413.0	5.6	7.6	12.1	9.0	4.6	6.4
Nuclear	72.1	127.0	202.2	2.6	4.1	4.8	20.8	3.2	9.9	77.4	147.7	336.5	2.9	5.4	9.8	22.6	5.6	12.1
Hydro	82.8	114.5	127.8	3.0	3.7	3.0	6.3	0.7	2.9	92.4	102.3	135.6	3.5	3.7	4.0	5.1	1.9	3.2
Others[a]	244.6	267.9	309.8	8.8	8.6	7.3	2.0	1.0	1.4	247.0	288.9	376.4	9.3	10.5	11.0	2.8	1.8	2.2
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	1,766.1	2,016.7	2,684.5	100.0	100.0	100.0	2.9	1.9	2.3	1,727.1	1,884.3	2,369.6	100.0	100.0	100.0	2.2	1.5	1.8
Coal	535.7	555.7	522.3	30.3	27.6	19.5	0.8	(0.4)	0.1	521.3	505.2	451.4	30.2	26.8	19.1	(0.1)	(0.7)	(0.5)
Oil	444.1	526.6	707.3	25.1	26.1	26.3	3.6	2.0	2.6	441.6	513.6	639.1	25.6	27.3	27.0	3.4	1.5	2.2
Natural Gas	93.9	136.9	307.4	5.3	6.8	11.5	9.1	5.5	7.0	93.0	132.3	283.3	5.4	7.0	12.0	8.7	5.2	6.6
Electricity	400.0	483.0	753.7	22.6	24.0	28.1	5.0	3.0	3.8	382.5	429.1	626.3	22.1	22.8	26.4	3.8	2.6	3.0
Heat	78.7	98.8	161.4	4.5	4.9	6.0	4.4	3.3	3.8	75.0	87.5	129.0	4.3	4.6	5.4	3.1	2.6	2.8
Others	213.6	215.7	231.0	12.1	10.7	8.6	0.1	0.5	0.3	213.6	215.6	229.4	12.4	11.4	9.7	0.1	0.4	0.3
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	1,766.1	2,016.7	2,684.5	100.0	100.0	100.0	2.9	1.9	2.3	1,727.1	1,884.3	2,369.6	100.0	100.0	100.0	2.2	1.5	1.8
Industry	776.7	819.8	902.8	44.0	40.7	33.6	1.4	0.6	1.0	749.5	721.5	749.3	43.4	38.3	31.6	0.1	0.3	0.2
Transport	233.0	288.1	436.7	13.2	14.3	16.3	4.7	2.8	3.6	232.5	283.8	386.6	13.5	15.1	16.3	4.5	2.1	3.1
Other Sectors	621.6	762.0	1,176.6	35.2	37.8	43.8	4.6	2.9	3.6	610.3	732.4	1,065.2	35.3	38.9	45.0	4.2	2.5	3.2
Non-Energy	134.8	146.7	168.5	7.6	7.3	6.3	1.1	0.9	1.0	134.8	146.7	168.5	7.8	7.8	7.1	1.1	0.9	1.0

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Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	5,461.7	6,467.2	9,542.4	100.0	100.0	100.0	4.4	2.6	3.3	5,222.6	5,744.5	7,925.1	100.0	100.0	100.0	3.2	2.2	2.6
Fossil Fuels	3,895.1	4,081.9	6,443.8	71.3	63.1	67.5	2.0	3.1	2.6	3,503.6	3,214.2	3,468.8	67.1	56.0	43.8	(0.4)	0.5	0.1
Coal	3,662.6	3,762.9	5,546.9	67.1	58.2	58.1	1.4	2.6	2.1	3,326.8	2,969.8	2,996.9	63.7	51.7	37.8	(1.0)	0.1	(0.4)
Oil	26.1	19.1	14.0	0.5	0.3	0.1	3.7	(2.0)	0.2	25.9	12.0	9.1	0.5	0.2	0.1	(1.0)	(1.8)	(1.5)
Natural Gas	206.4	299.9	882.9	3.8	4.6	9.3	15.8	7.5	10.7	150.9	232.4	462.8	2.9	4.0	5.8	12.9	4.7	7.9
Nuclear	276.8	487.3	776.1	5.1	7.5	8.1	20.8	3.2	9.9	297.1	566.9	1,291.5	5.7	9.9	16.3	22.6	5.6	12.1
Hydro	963.2	1,331.4	1,486.5	17.6	20.6	15.6	6.3	0.7	2.9	1,075.0	1,189.9	1,576.9	20.6	20.7	19.9	5.1	1.9	3.2
Others[b]	326.6	566.6	836.0	6.0	8.8	8.8	25.8	2.6	11.3	346.9	773.5	1,587.9	6.6	13.5	20.0	29.8	4.9	14.2
Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	903.3	920.9	1,389.1	100.0	100.0	100.0	1.2	2.8	2.2	801.7	682.3	712.3	100.0	100.0	100.0	(1.8)	0.3	(0.5)
Coal	853.2	854.8	1,213.6	94.5	92.8	87.4	0.7	2.4	1.7	764.1	634.1	635.3	95.3	92.9	89.2	(2.2)	0.0	(0.9)
Oil	6.7	4.9	3.6	0.7	0.5	0.3	(0.1)	(2.0)	(1.3)	6.7	3.1	2.3	0.8	0.5	0.3	(4.6)	(2.0)	(3.0)
Natural Gas	43.4	61.2	171.9	4.8	6.6	12.4	14.9	7.1	10.2	30.9	45.1	74.7	3.9	6.6	10.5	11.4	3.4	6.6
Carbon Dioxide Emissions	Mt CO_2			AAGR (%)						Mt CO_2			AAGR (%)					
	2015	2020	2035	2010–2020		2020–2035		2010–2035		2015	2020	2035	2010–2020		2020–2035		2010–2035	
Total	8,246.3	8,876.1	12,045.0	1.8		2.1		1.9		7,709.7	7,472.7	8,345.8	0.0		0.7		0.5	
Energy and Carbon Indicators							AAGR (%)									AAGR (%)		
				2015	2020	2035	2010–2020	2020–2035	2010–2035				2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/ capita (toe/person)				2.02	2.23	3.05	2.2	2.1	2.1				1.93	1.99	2.47	1.0	1.5	1.3
Primary Energy Demand/ GDP (toe/constant 2000 $ million)				563	437	266	(5.2)	(3.3)	(4.0)				538	390	215	(6.3)	(3.9)	(4.8)
CO_2/capita (t CO_2/person)				6.02	6.40	8.72	1.4	2.1	1.8				5.63	5.38	6.04	(0.3)	0.8	0.3
CO_2 Intensity (t CO_2/million constant 2000 $)				1,675	1,253	759	(5.9)	(3.3)	(4.3)				1,566	1,055	526	(7.5)	(4.5)	(5.7)
CO_2/Primary Energy Demand (t CO_2/toe)				2.98	2.87	2.86	(0.7)	(0.0)	(0.3)				2.91	2.71	2.44	(1.3)	(0.7)	(0.9)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision.* http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Hong Kong, China
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	342.1	409.1	667.4	5.0	3.3	4.0
Population (million persons)	7.4	7.8	8.7	1.0	0.8	0.9
GDP/capita (constant 2000 $/person)	46,034	52,431	76,333	3.9	2.5	3.1

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	15.2	16.2	17.6	100.0	100.0	100.0	2.0	0.5	1.1	12.1	12.0	11.3	100.0	100.0	100.0	(1.1)	(0.4)	(0.7)
Coal	7.7	7.2	4.9	50.4	44.1	27.7	1.4	(2.5)	(1.0)	5.4	5.4	4.2	44.4	45.0	37.0	(1.4)	(1.7)	(1.6)
Oil	2.5	2.5	2.3	16.5	15.1	13.2	(2.6)	(0.4)	(1.3)	2.4	2.3	1.9	19.7	19.2	16.4	(3.3)	(1.4)	(2.2)
Natural Gas	4.3	5.8	9.6	28.1	35.9	54.6	6.4	3.4	4.6	3.6	3.5	4.5	29.6	29.3	39.4	1.1	1.6	1.4
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others[a]	0.8	0.8	0.8	5.1	4.8	4.6	(0.1)	0.2	0.1	0.8	0.8	0.8	6.4	6.5	7.2	(0.1)	0.3	0.2
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	6.9	7.3	8.2	100.0	100.0	100.0	0.8	0.8	0.8	6.5	6.5	5.7	100.0	100.0	100.0	(0.4)	(0.8)	(0.6)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	2.2	2.1	2.0	31.0	29.0	24.3	(1.2)	(0.4)	(0.7)	2.1	2.0	1.6	31.4	30.6	27.6	(1.9)	(1.4)	(1.6)
Natural Gas	0.7	0.7	0.9	10.0	10.0	10.4	1.0	1.1	1.0	0.7	0.7	0.8	10.6	11.3	14.7	1.0	1.0	1.0
Electricity	4.0	4.4	5.3	58.3	60.2	64.1	2.0	1.2	1.5	3.7	3.7	3.2	57.2	57.1	55.0	0.2	(1.0)	(0.5)
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	0.0	0.1	0.1	0.7	0.8	1.0	4.5	2.2	3.1	0.0	0.1	0.1	0.8	0.9	1.3	4.5	1.8	2.9
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	6.9	7.3	8.2	100.0	100.0	100.0	0.8	0.8	0.8	6.5	6.5	5.7	100.0	100.0	100.0	(0.4)	(0.8)	(0.6)
Industry	0.4	0.4	0.4	5.6	5.4	4.9	0.2	0.2	0.2	0.4	0.4	0.4	5.6	5.4	6.3	(0.8)	0.2	(0.2)
Transport	2.1	2.1	2.0	30.3	28.3	23.9	(0.4)	(0.3)	(0.4)	2.0	1.9	1.6	30.7	30.1	28.2	(1.0)	(1.2)	(1.1)
Other Sectors	4.5	4.8	5.8	64.1	66.3	71.2	1.5	1.3	1.4	4.2	4.2	3.8	63.7	64.4	65.5	(0.0)	(0.7)	(0.4)
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…

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Hong Kong, China Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	44.3	48.7	60.4	100.0	100.0	100.0	2.4	1.4	1.8	38.2	38.3	38.3	100.0	100.0	100.0	0.0	0.0	0.0
Fossil Fuels	44.3	48.7	60.4	100.0	100.0	100.0	2.4	1.4	1.8	38.2	38.3	38.2	100.0	100.0	99.7	0.0	(0.0)	(0.0)
Coal	28.8	25.9	17.7	65.0	53.2	29.3	0.9	(2.5)	(1.2)	25.7	25.8	20.1	67.3	67.4	52.5	0.8	(1.7)	(0.7)
Oil	0.1	0.1	0.1	0.2	0.2	0.2	(1.1)	0.0	(0.5)	0.1	0.1	0.1	0.3	0.3	0.3	(1.1)	0.0	(0.5)
Natural Gas	15.4	22.7	42.6	34.8	46.6	70.5	4.7	4.3	4.4	12.4	12.4	18.0	32.5	32.4	47.0	(1.5)	2.5	0.9
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	(100.0)	…	(100.0)	0.0	0.0	0.1	0.0	0.0	0.3	(100.0)	…	20.2

Thermal Power Generation Input	Mtoe (BAU)			Share (%)			AAGR (%)			Mtoe (Alternative)			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	11.3	11.7	12.5	100.0	100.0	100.0	3.6	0.4	1.7	8.2	8.1	7.5	100.0	100.0	100.0	(0.1)	(0.5)	(0.4)
Coal	8.3	7.4	5.1	73.2	63.1	40.5	3.2	(2.5)	(0.3)	5.8	5.8	4.5	70.4	71.3	59.7	0.7	(1.7)	(0.7)
Oil	0.0	0.0	0.0	0.3	0.3	0.3	(0.7)	0.0	(0.3)	0.0	0.0	0.0	0.4	0.4	0.5	(0.7)	0.0	(0.3)
Natural Gas	3.0	4.3	7.4	26.5	36.6	59.2	4.4	3.7	4.0	2.4	2.3	3.0	29.1	28.3	39.8	(1.9)	1.8	0.3

Carbon Dioxide Emissions	$Mt\ CO_2$ (BAU)			AAGR (%)			$Mt\ CO_2$ (Alternative)			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	48.1	49.6	48.9	1.5	(0.1)	0.6	37.1	36.6	32.7	(1.5)	(0.7)	(1.1)

Energy and Carbon Indicators	BAU 2015	2020	2035	AAGR (%) 2010–2020	2020–2035	2010–2035	Alternative 2015	2020	2035	AAGR (%) 2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)	2.05	2.08	2.01	0.9	(0.2)	0.2	1.63	1.53	1.29	(2.1)	(1.1)	(1.5)
Primary Energy Demand/GDP (toe/constant 2000 $ million)	45	40	26	(2.9)	(2.7)	(2.8)	35	29	17	(5.8)	(3.6)	(4.5)
CO_2/capita ($t\ CO_2$/person)	6.48	6.36	5.60	0.5	(0.8)	(0.3)	4.99	4.69	3.74	(2.5)	(1.5)	(1.9)
CO_2 Intensity ($t\ CO_2$/million constant 2000 $)	141	121	73	(3.3)	(3.3)	(3.3)	108	89	49	(6.2)	(3.9)	(4.8)
CO_2/Primary Energy Demand ($t\ CO_2$/toe)	3.16	3.06	2.78	(0.4)	(0.6)	(0.5)	3.06	3.06	2.89	(0.4)	(0.4)	(0.4)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, $Mt\ CO_2$ = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, $t\ CO_2$ = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Republic of Korea
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	976.6	1,160.9	1,684.1	3.8	2.5	3.0
Population (million persons)	49.1	49.8	50.0	0.3	0.0	0.2
GDP/capita (constant 2000 $/person)	19,881	23,306	33,649	3.4	2.5	2.9

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	250.9	264.9	284.0	100.0	100.0	100.0	0.6	0.5	0.5	242.5	247.3	250.8	100.0	100.0	100.0	(0.1)	0.1	0.0
Coal	67.3	76.1	76.1	26.8	28.7	26.8	0.4	(0.0)	0.1	53.7	45.9	35.3	22.1	18.6	14.1	(4.6)	(1.7)	(2.9)
Oil	93.7	94.7	93.4	37.4	35.7	32.9	(0.0)	(0.1)	(0.1)	93.0	92.9	86.8	38.4	37.6	34.6	(0.2)	(0.5)	(0.4)
Natural Gas	43.1	40.9	39.4	17.2	15.4	13.9	0.6	(0.3)	0.1	40.7	38.7	39.8	16.8	15.7	15.9	0.0	0.2	0.1
Nuclear	42.8	48.4	67.2	17.1	18.3	23.7	2.3	2.2	2.2	50.9	64.7	80.3	21.0	26.2	32.0	5.3	1.4	3.0
Hydro	0.2	0.2	0.2	0.1	0.1	0.1	(4.2)	(1.9)	(2.8)	0.2	0.2	0.2	0.1	0.1	0.1	(4.6)	0.3	(1.7)
Others[a]	3.7	4.5	7.7	1.5	1.7	2.7	1.8	3.6	2.9	4.0	4.8	8.5	1.7	2.0	3.4	2.6	3.8	3.3
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	159.1	165.7	174.0	100.0	100.0	100.0	0.5	0.3	0.4	156.1	159.2	160.6	100.0	100.0	100.0	0.1	0.1	0.1
Coal	8.2	8.0	7.4	5.1	4.8	4.3	(1.7)	(0.5)	(1.0)	7.8	7.4	6.8	5.0	4.6	4.2	(2.5)	(0.5)	(1.3)
Oil	82.8	84.3	84.0	52.1	50.9	48.3	0.3	(0.0)	0.1	82.4	82.8	77.6	52.8	52.0	48.3	0.1	(0.4)	(0.2)
Natural Gas	20.3	21.7	24.4	12.7	13.1	14.0	0.6	0.8	0.7	19.9	20.7	22.4	12.7	13.0	14.0	0.2	0.5	0.4
Electricity	40.4	43.8	49.2	25.4	26.4	28.3	1.3	0.8	1.0	38.8	40.5	43.7	24.8	25.5	27.2	0.5	0.5	0.5
Heat	4.9	5.1	5.6	3.1	3.1	3.2	1.7	0.6	1.0	4.7	4.8	5.3	3.0	3.0	3.3	1.1	0.6	0.8
Others	2.6	2.8	3.1	1.6	1.7	1.8	0.3	0.8	0.6	2.5	2.6	2.8	1.6	1.6	1.8	(0.3)	0.6	0.2
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	159.1	165.7	174.0	100.0	100.0	100.0	0.5	0.3	0.4	156.1	159.2	160.6	100.0	100.0	100.0	0.1	0.1	0.1
Industry	44.4	46.4	50.0	27.9	28.0	28.8	0.4	0.5	0.4	42.2	42.1	45.4	27.0	26.5	28.3	(0.6)	0.5	0.1
Transport	29.1	28.8	27.0	18.3	17.4	15.5	(0.4)	(0.4)	(0.4)	29.0	28.3	23.3	18.6	17.8	14.5	(0.5)	(1.3)	(1.0)
Other Sectors	47.7	51.5	56.6	30.0	31.1	32.5	1.5	0.6	1.0	47.0	49.8	51.5	30.1	31.3	32.1	1.2	0.2	0.6
Non-Energy	37.9	38.9	40.4	23.8	23.5	23.2	0.1	0.2	0.2	37.9	38.9	40.4	24.3	24.4	25.1	0.1	0.2	0.2

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	Business-as-Usual Case									Alternative Case								
Power Generation Output	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	513.7	554.6	615.7	100.0	100.0	100.0	1.1	0.7	0.9	493.5	513.3	545.8	100.0	100.0	100.0	0.3	0.4	0.4
Fossil Fuels	344.1	362.7	347.9	67.0	65.4	56.5	0.6	(0.3)	0.1	288.1	252.6	213.7	58.4	49.2	39.2	(3.0)	(1.1)	(1.9)
Coal	215.8	258.0	275.1	42.0	46.5	44.7	1.6	0.4	0.9	167.7	148.3	113.6	34.0	28.9	20.8	(3.8)	(1.8)	(2.6)
Oil	14.2	9.2	1.2	2.8	1.7	0.2	(7.0)	(12.7)	(10.4)	13.4	8.9	1.6	2.7	1.7	0.3	(7.3)	(10.8)	(9.4)
Natural Gas	114.1	95.5	71.6	22.2	17.2	11.6	(0.8)	(1.9)	(1.5)	107.0	95.4	98.5	21.7	18.6	18.0	(0.8)	0.2	(0.2)
Nuclear	164.3	185.9	258.0	32.0	33.5	41.9	2.3	2.2	2.2	195.5	248.4	308.0	39.6	48.4	56.4	5.3	1.4	3.0
Hydro	2.8	2.4	1.8	0.5	0.4	0.3	(4.2)	(1.9)	(2.8)	2.6	2.3	2.4	0.5	0.4	0.4	(4.6)	0.3	(1.7)
Others[b]	2.5	3.6	8.0	0.5	0.6	1.3	2.2	5.5	4.2	7.3	10.0	21.7	1.5	1.9	4.0	13.2	5.3	8.4
Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	74.3	77.2	71.3	100.0	100.0	100.0	0.3	(0.5)	(0.2)	60.7	50.5	39.5	100.0	100.0	100.0	(3.9)	(1.6)	(2.5)
Coal	49.2	56.8	57.4	66.2	73.6	80.4	0.8	0.1	0.4	37.8	31.4	23.0	62.3	62.3	58.3	(5.0)	(2.1)	(3.2)
Oil	3.2	2.1	0.3	4.3	2.7	0.4	(7.8)	(12.8)	(10.8)	3.0	2.0	0.4	5.0	3.9	0.9	(8.3)	(10.8)	(9.8)
Natural Gas	21.9	18.3	13.7	29.5	23.7	19.2	0.2	(1.9)	(1.0)	19.9	17.1	16.1	32.7	33.8	40.8	(0.5)	(0.4)	(0.4)
Carbon Dioxide Emissions	Mt CO_2			AAGR (%)						Mt CO_2			AAGR (%)					
	2015	2020	2035	2010–2020		2020–2035		2010–2035		2015	2020	2035	2010–2020		2020–2035		2010–2035	
Total	539.2	568.8	556.7	0.2		(0.1)		(0.0)		477.4	438.5	375.7	(2.4)		(1.0)		(1.6)	
Energy and Carbon Indicators							AAGR (%)									AAGR (%)		
				2015	2020	2035	2010–2020	2020–2035	2010–2035				2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)				5.1	5.3	5.7	0.2	0.4	0.4				4.94	4.96	5.01	(0.4)	0.1	(0.1)
Primary Energy Demand/GDP (toe/constant 2000 $ million)				257	228	169	(3.1)	(2.0)	(2.4)				248	213	149	(3.8)	(2.4)	(2.9)
CO_2/capita (t CO_2/person)				10.98	11.42	11.12	(0.2)	(0.2)	(0.2)				9.72	8.80	7.51	(2.7)	(1.1)	(1.7)
CO_2 Intensity (t CO_2/million constant 2000 $)				552	490	331	(3.5)	(2.6)	(3.0)				489	378	223	(6.0)	(3.5)	(4.5)
CO_2/Primary Energy Demand (t CO_2/toe)				2.15	2.15	1.96	(0.4)	(0.6)	(0.5)				1.97	1.77	1.50	(2.3)	(1.1)	(1.6)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: Figures may not add up to total because of rounding.
[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.
[b] "Others" include geothermal, solar, wind, and renewables.
Sources: Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Mongolia
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	3.4	5.4	12.7	9.4	5.9	7.3
Population (million persons)	3.0	3.2	3.6	1.4	0.9	1.1
GDP/capita (constant 2000 $/person)	1,158	1,700	3,511	7.9	5.0	6.1

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	4.2	5.8	12.1	100.0	100.0	100.0	6.0	5.0	5.4	4.1	5.3	9.8	100.0	100.0	100.0	4.9	4.2	4.5
Coal	3.1	4.4	9.1	74.4	74.5	74.9	6.7	5.0	5.7	3.0	3.8	6.6	73.5	71.8	67.2	5.2	3.7	4.3
Oil	1.0	1.4	2.9	23.7	23.9	24.0	5.4	5.0	5.1	1.0	1.3	2.8	24.2	25.5	28.5	5.0	5.0	5.0
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.0	0.0	0.0	0.4	0.4	0.3	…	3.5	…	0.0	0.0	0.0	0.4	0.5	0.4	…	3.5	…
Others[a]	0.1	0.1	0.1	1.5	1.2	0.7	(8.3)	1.1	(2.8)	0.1	0.1	0.4	1.9	2.1	3.8	(3.8)	8.4	3.3
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	2.7	3.4	6.0	100.0	100.0	100.0	4.1	3.9	4.0	2.7	3.3	5.7	100.0	100.0	100.0	3.8	3.7	3.7
Coal	0.5	0.4	0.4	16.5	12.5	7.3	2.1	0.2	1.0	0.4	0.4	0.4	16.6	12.5	7.2	1.8	(0.1)	0.7
Oil	0.9	1.3	2.9	34.6	39.4	47.5	5.8	5.2	5.4	0.9	1.3	2.7	34.4	39.2	48.0	5.4	5.1	5.2
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Electricity	0.5	0.7	1.7	16.7	20.6	27.5	8.7	5.9	7.0	0.4	0.7	1.5	16.4	20.0	26.4	8.1	5.6	6.6
Heat	0.8	0.9	1.0	30.2	26.0	16.9	1.3	0.9	1.1	0.8	0.9	1.0	30.5	26.6	17.7	1.2	1.0	1.0
Others	0.1	0.1	0.0	2.0	1.6	0.8	(4.4)	(0.7)	(2.2)	0.1	0.1	0.0	2.0	1.6	0.8	(4.4)	(0.7)	(2.2)
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	2.7	3.4	6.0	100.0	100.0	100.0	4.1	3.9	4.0	2.7	3.3	5.7	100.0	100.0	100.0	3.8	3.7	3.7
Industry	0.9	1.1	2.4	31.0	33.2	39.6	3.8	5.1	4.6	0.8	1.1	2.2	30.7	32.4	39.1	3.2	5.0	4.3
Transport	0.7	0.9	1.8	23.7	26.6	29.7	6.7	4.6	5.5	0.6	0.9	1.7	23.7	26.7	30.4	6.4	4.6	5.3
Other Sectors	1.2	1.4	1.9	45.1	40.1	30.7	2.9	2.0	2.4	1.2	1.3	1.7	45.5	40.8	30.4	2.7	1.7	2.1
Non-Energy	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0

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Mongolia Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case: TWh			Share (%)			AAGR (%)			Alternative Case: TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	6.8	10.1	23.1	100.0	100.0	100.0	8.5	5.7	6.8	6.6	9.5	21.0	100.0	100.0	100.0	7.9	5.4	6.4
Fossil Fuels	6.5	9.6	22.2	95.9	95.2	96.2	7.9	5.7	6.6	6.1	8.6	16.7	92.9	89.8	79.6	6.7	4.6	5.4
Coal	6.3	9.5	22.1	93.7	93.8	95.6	8.2	5.8	6.8	6.0	8.4	16.6	90.7	88.3	79.0	7.0	4.6	5.5
Oil	0.1	0.1	0.1	2.2	1.4	0.6	(2.3)	(0.7)	(1.3)	0.1	0.1	0.1	2.2	1.5	0.6	(2.3)	(0.7)	(1.3)
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.2	0.3	0.5	3.0	2.8	2.1	…	3.5	…	0.2	0.3	0.5	3.1	3.0	2.3	…	3.5	…
Others[b]	0.1	0.2	0.4	1.1	1.9	1.8	…	5.0	…	0.3	0.7	3.8	4.0	7.2	18.1	…	12.1	…

Thermal Power Generation Input	Business-as-Usual Case: Mtoe			Share (%)			AAGR (%)			Alternative Case: Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	2.7	4.0	8.7	100.0	100.0	100.0	7.3	5.3	6.1	2.6	3.4	6.2	100.0	100.0	100.0	5.7	4.0	4.7
Coal	2.7	3.9	8.6	98.1	98.8	99.5	7.5	5.4	6.2	2.5	3.4	6.2	98.0	98.6	99.3	5.9	4.1	4.8
Oil	0.1	0.0	0.0	1.9	1.2	0.5	(2.4)	(0.7)	(1.4)	0.1	0.0	0.0	2.0	1.4	0.7	(2.4)	(0.7)	(1.4)
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…

Carbon Dioxide Emissions	Business-as-Usual Case: Mt CO_2			AAGR (%)			Alternative Case: Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	15.5	21.5	44.8	6.4	5.0	5.6	14.8	19.1	34.5	5.2	4.0	4.5

Energy and Carbon Indicators	Business-as-Usual Case: 2015	2020	2035	AAGR (%) 2010–2020	2020–2035	2010–2035	Alternative Case: 2015	2020	2035	AAGR (%) 2010–2020	2020–2035	2010–2035
Primary Energy Demand/ capita (toe/person)	1.42	1.85	3.35	4.5	4.0	4.2	1.37	1.67	2.70	3.4	3.3	3.3
Primary Energy Demand/ GDP (toe/constant 2000 $ million)	1,230	1,088	953	(3.1)	(0.9)	(1.8)	1,184	980	769	(4.1)	(1.6)	(2.6)
CO_2/capita ($t\ CO_2$/person)	5.23	6.81	12.40	4.9	4.1	4.4	5.00	6.04	9.55	3.7	3.1	3.3
CO_2 Intensity ($t\ CO_2$/million constant 2000 $)	4,516	4,004	3,531	(2.7)	(0.8)	(1.6)	4,321	3,556	2,721	(3.9)	(1.8)	(2.6)
CO_2/Primary Energy Demand ($t\ CO_2$/toe)	3.67	3.68	3.70	0.4	0.0	0.2	3.65	3.63	3.54	0.3	(0.2)	0.0

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Taipei,China
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	601.7	721.2	1,092.1	5.2	2.8	3.8
Population (million persons)	23.5	23.7	23.5	0.3	(0.1)	0.1
GDP/capita (constant 2000 $/person)	25,650	30,426	46,513	4.9	2.9	3.7

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	120.2	124.5	124.5	100.0	100.0	100.0	1.3	0.0	0.5	118.4	118.4	111.9	100.0	100.0	100.0	0.8	(0.4)	0.1
Coal	38.2	36.9	34.4	31.8	29.6	27.7	(1.1)	(0.5)	(0.7)	38.8	31.1	17.5	32.8	26.3	15.7	(2.8)	(3.8)	(3.4)
Oil	50.3	51.6	51.6	41.9	41.5	41.5	2.0	(0.0)	0.8	49.4	51.1	50.9	41.7	43.2	45.5	1.9	(0.0)	0.8
Natural Gas	15.4	18.7	27.3	12.8	15.0	21.9	3.7	2.5	3.0	13.1	17.6	30.1	11.1	14.9	26.9	3.1	3.6	3.4
Nuclear	13.1	13.4	5.1	10.9	10.8	4.1	2.2	(6.2)	(3.0)	14.3	14.6	6.1	12.1	12.3	5.5	3.0	(5.7)	(2.3)
Hydro	0.5	0.5	0.6	0.4	0.4	0.5	4.2	0.5	2.0	0.5	0.7	1.1	0.4	0.6	1.0	6.9	3.1	4.6
Others[a]	2.6	3.2	5.4	2.1	2.6	4.4	8.0	3.5	5.3	2.3	3.2	6.2	1.9	2.7	5.6	7.9	4.5	5.9
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	71.4	74.7	79.4	100.0	100.0	100.0	1.0	0.4	0.6	70.2	71.7	71.9	100.0	100.0	100.0	0.6	0.0	0.2
Coal	6.6	6.5	6.2	9.2	8.7	7.8	(1.9)	(0.3)	(1.0)	6.3	6.0	5.5	9.0	8.4	7.7	(2.6)	(0.6)	(1.4)
Oil	40.5	41.6	42.2	56.7	55.7	53.2	0.7	0.1	0.3	40.3	41.1	40.4	57.5	57.4	56.2	0.6	(0.1)	0.2
Natural Gas	2.3	2.6	3.3	3.2	3.5	4.2	2.2	1.6	1.9	2.3	2.6	3.2	3.3	3.6	4.4	1.9	1.5	1.6
Electricity	21.5	23.4	26.8	30.1	31.3	33.8	2.2	0.9	1.4	20.7	21.4	22.0	29.5	29.8	30.6	1.3	0.2	0.6
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	0.5	0.6	0.7	0.7	0.8	0.9	14.3	1.7	6.5	0.5	0.6	0.6	0.7	0.8	0.9	14.0	0.6	5.8
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	71.4	74.7	79.4	100.0	100.0	100.0	1.0	0.4	0.6	70.2	71.7	71.9	100.0	100.0	100.0	0.6	0.0	0.2
Industry	23.3	24.3	26.3	32.7	32.5	33.2	0.9	0.5	0.7	22.5	22.6	23.7	32.1	31.5	33.0	0.1	0.3	0.2
Transport	12.7	13.2	13.5	17.8	17.7	17.0	0.9	0.1	0.4	12.7	13.1	12.3	18.1	18.3	17.1	0.7	(0.4)	0.0
Other Sectors	14.4	16.0	18.3	20.2	21.5	23.1	3.2	0.9	1.8	14.0	14.9	14.7	20.0	20.8	20.4	2.5	(0.1)	0.9
Non-Energy	20.9	21.1	21.3	29.3	28.3	26.8	(0.2)	0.0	(0.1)	20.9	21.1	21.3	29.8	29.5	29.6	(0.2)	0.0	(0.1)

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Taipei,China Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case TWh			Share (%)			AAGR (%)			Alternative Case TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	273.1	295.5	335.9	100.0	100.0	100.0	1.9	0.9	1.3	262.9	270.3	275.0	100.0	100.0	100.0	1.0	0.1	0.5
Fossil Fuels	206.2	222.4	279.3	75.5	75.3	83.1	1.4	1.5	1.5	193.4	192.4	208.0	73.6	71.2	75.6	(0.1)	0.5	0.3
Coal	152.7	144.4	117.9	55.9	48.9	35.1	1.4	(1.3)	(0.2)	132.1	104.1	53.5	50.2	38.5	19.5	(1.8)	(4.3)	(3.3)
Oil	7.8	10.1	12.1	2.9	3.4	3.6	(0.7)	1.2	0.4	7.3	9.8	12.0	2.8	3.6	4.4	(1.0)	1.4	0.4
Natural Gas	45.7	67.9	149.3	16.7	23.0	44.4	1.7	5.4	3.9	54.0	78.5	142.5	20.5	29.0	51.8	3.2	4.1	3.7
Nuclear	54.4	55.5	23.2	19.9	18.8	6.9	2.9	(5.6)	(2.3)	55.9	56.6	23.2	21.3	20.9	8.4	3.1	(5.8)	(2.3)
Hydro	5.9	8.1	12.5	2.2	2.7	3.7	6.8	2.9	4.5	5.5	7.8	12.4	2.1	2.9	4.5	6.4	3.1	4.4
Others[b]	6.6	9.5	20.9	2.4	3.2	6.2	7.4	5.4	6.2	8.1	13.5	31.4	3.1	5.0	11.4	11.2	5.8	7.9

Thermal Power Generation Input	Business-as-Usual Case Mtoe			Share (%)			AAGR (%)			Alternative Case Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	45.3	47.4	54.5	100.0	100.0	100.0	1.1	0.9	1.0	41.8	39.8	39.5	100.0	100.0	100.0	(0.7)	(0.1)	(0.3)
Coal	35.0	32.5	24.3	77.2	68.5	44.6	1.0	(1.9)	(0.7)	29.6	22.8	10.7	70.8	57.3	27.1	(2.5)	(4.9)	(3.9)
Oil	2.1	2.7	3.2	4.5	5.6	5.9	(0.6)	1.2	0.5	1.9	2.6	3.2	4.6	6.5	8.0	(0.9)	1.3	0.4
Natural Gas	8.3	12.3	27.0	18.2	25.9	49.5	1.7	5.4	3.9	10.3	14.4	25.6	24.6	36.2	64.9	3.3	3.9	3.7

Carbon Dioxide Emissions	Business-as-Usual Case Mt CO_2			AAGR (%)			Alternative Case Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	278.1	283.9	293.7	1.0	0.2	0.5	271.8	256.7	231.0	(0.0)	(0.7)	(0.4)

Energy and Carbon Indicators	Business-as-Usual Case 2015	2020	2035	AAGR (%) 2010–2020	2020–2035	2010–2035	Alternative Case 2015	2020	2035	AAGR (%) 2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)	5.12	5.25	5.30	1.1	0.1	0.5	5.05	4.99	4.77	0.5	(0.3)	0.0
Primary Energy Demand/GDP (toe/constant 2000 $ million)	200	173	114	(3.7)	(2.7)	(3.1)	197	164	102	(4.2)	(3.1)	(3.5)
CO_2/capita (t CO_2/person)	11.85	11.97	12.51	0.7	0.3	0.5	11.58	10.83	9.84	(0.3)	(0.6)	(0.5)
CO_2 Intensity (t CO_2/million constant 2000 $)	462	394	269	(4.0)	(2.5)	(3.1)	452	356	212	(5.0)	(3.4)	(4.0)
CO_2/Primary Energy Demand (t CO_2/toe)	2.31	2.28	2.36	(0.3)	0.2	0.0	2.30	2.17	2.06	(0.8)	(0.3)	(0.5)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; Council for Economic Planning and Development. 2012. Population Projection for [Taipei,China] from 2012–2060. Available at http://www.cepd.gov.tw/encontent/m1.aspx?sNo=0001457; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Pacific
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	13.3	15.9	24.1	5.1	2.8	3.7
Population (million persons)	11.4	12.5	16.3	2.1	1.8	1.9
GDP/capita (constant 2000 $/person)	1,170	1,265	1,472	3.0	1.0	1.8

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	5.1	5.9	8.8	100.0	100.0	100.0	5.2	2.7	3.7	5.2	6.0	8.3	100.0	100.0	100.0	5.3	2.2	3.5
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil	2.7	3.0	4.0	51.8	49.6	45.2	2.2	2.0	2.1	2.6	2.8	3.6	49.9	46.6	43.0	1.7	1.7	1.7
Natural Gas	1.4	1.7	2.7	27.0	28.7	31.2	19.1	3.2	9.3	1.4	1.7	2.5	27.1	28.3	30.5	19.0	2.7	9.0
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.2	0.3	0.5	3.9	4.3	5.3	4.9	4.1	4.5	0.2	0.3	0.4	3.2	4.6	5.0	5.7	2.9	4.0
Others[a]	0.9	1.0	1.6	17.3	17.4	18.4	3.2	3.1	3.1	1.0	1.2	1.8	19.8	20.5	21.5	5.0	2.6	3.5
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	2.6	3.1	4.8	100.0	100.0	100.0	3.4	2.9	3.1	2.6	3.0	4.4	100.0	100.0	100.0	3.1	2.6	2.8
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil	1.8	2.1	3.1	68.0	67.0	64.1	2.9	2.6	2.7	1.8	2.0	2.9	68.5	68.0	65.7	2.8	2.4	2.5
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	17.0	…	0.0	0.0	0.0	0.0	0.0	0.1	…	17.0	…
Electricity	0.5	0.7	1.2	20.8	21.9	25.6	4.7	4.0	4.3	0.5	0.6	1.1	20.5	21.5	25.3	4.2	3.7	3.9
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	0.3	0.3	0.5	11.1	11.0	10.3	3.5	2.5	2.9	0.3	0.3	0.4	11.0	10.5	8.9	2.7	1.4	1.9
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	2.6	3.1	4.8	100.0	100.0	100.0	3.4	2.9	3.1	2.6	3.0	4.4	100.0	100.0	100.0	3.0	2.6	2.8
Industry	1.0	1.2	2.2	37.8	39.8	46.2	3.8	4.0	3.9	1.0	1.2	2.1	37.7	40.0	47.5	3.5	3.8	3.7
Transport	1.0	1.1	1.4	37.1	35.2	29.7	2.6	1.8	2.1	1.0	1.1	1.3	37.6	36.0	30.4	2.6	1.4	1.9
Other Sectors	0.7	0.8	1.2	25.1	25.0	24.2	3.8	2.7	3.1	0.6	0.7	1.0	24.7	24.0	22.1	3.1	2.0	2.4
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…

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Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	6.9	8.6	15.2	100.0	100.0	100.0	4.6	3.9	4.2	6.7	8.0	14.0	100.0	100.0	100.0	3.9	3.8	3.9
Fossil Fuels	4.0	4.9	8.4	58.0	56.9	55.4	4.4	3.7	4.0	3.7	4.2	6.8	55.6	52.7	48.9	2.9	3.3	3.1
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	2.5	2.6	2.7	36.2	30.0	18.0	0.8	0.4	0.6	2.3	2.2	2.0	34.7	27.7	14.6	(0.7)	(0.5)	(0.6)
Natural Gas	1.5	2.3	5.7	21.8	26.9	37.4	11.1	6.2	8.2	1.4	2.0	4.8	20.8	25.0	34.3	9.6	6.0	7.4
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	2.3	2.9	5.4	33.5	34.4	35.5	4.9	4.1	4.5	2.2	2.6	5.2	32.5	33.0	37.5	3.8	4.7	4.3
Others[b]	0.6	0.7	1.4	8.6	8.7	9.1	5.1	4.2	4.6	0.8	1.1	1.9	11.9	14.3	13.7	9.8	3.5	5.9

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	1.1	1.3	1.9	100.0	100.0	100.0	2.8	2.7	2.8	1.1	1.1	1.5	100.0	100.0	100.0	1.6	1.8	1.7
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.8	0.9	0.9	75.0	67.8	47.7	0.7	0.3	0.5	0.8	0.7	0.7	72.6	65.0	46.1	(0.9)	(0.5)	(0.7)
Natural Gas	0.3	0.4	1.0	25.0	32.2	52.3	9.7	6.1	7.5	0.3	0.4	0.8	27.4	35.0	53.9	9.4	4.7	6.6

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)			Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	11.4	13.0	18.5	5.1	2.4	3.5	11.2	12.4	16.7	4.6	2.0	3.0

Energy and Carbon Indicators				AAGR (%)						AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/ capita (toe/person)	0.45	0.47	0.54	3.1	0.9	1.8	0.46	0.48	0.51	3.2	0.5	1.5
Primary Energy Demand/ GDP (toe/constant 2000 $ million)	386	375	367	0.1	(0.1)	(0.0)	389	377	347	0.2	(0.6)	(0.3)
CO_2/capita ($t\ CO_2$/person)	1.00	1.04	1.13	3.0	0.6	1.5	0.98	0.99	1.02	2.5	0.2	1.1
CO_2 Intensity ($t\ CO_2$/million constant 2000 $)	856	819	769	(0.0)	(0.4)	(0.3)	840	780	696	(0.5)	(0.8)	(0.7)
CO_2/Primary Energy Demand ($t\ CO_2$/toe)	2.22	2.19	2.09	(0.1)	(0.3)	(0.2)	2.16	2.07	2.00	(0.7)	(0.2)	(0.4)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision.* http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Fiji
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	2.1	2.3	2.8	1.8	1.2	1.4
Population (million persons)	0.9	0.9	1.0	0.7	0.4	0.5
GDP/capita (constant 2000 $/person)	2,377	2,529	2,855	1.1	0.8	0.9

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	0.7	0.7	0.9	100.0	100.0	100.0	1.2	1.4	1.3	0.7	0.8	0.9	100.0	100.0	100.0	1.8	0.9	1.3
Coal	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0
Oil	0.4	0.4	0.5	60.2	60.9	60.1	1.4	1.3	1.3	0.4	0.4	0.5	58.4	55.4	55.5	1.1	0.9	1.0
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.1	0.1	0.1	10.5	11.0	11.9	2.1	1.9	2.0	0.1	0.1	0.1	8.1	7.0	9.4	(1.8)	2.9	1.0
Others[a]	0.2	0.2	0.2	29.2	27.9	27.8	0.4	1.3	1.0	0.2	0.3	0.3	33.4	37.5	35.1	4.1	0.4	1.9
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	0.5	0.5	0.6	100.0	100.0	100.0	1.6	1.8	1.7	0.4	0.5	0.6	100.0	100.0	100.0	1.2	1.4	1.3
Coal	0.0	0.0	0.0	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.0	0.0	0.0
Oil	0.4	0.4	0.5	81.6	81.1	80.7	1.4	1.7	1.6	0.4	0.4	0.5	81.8	81.4	80.2	1.1	1.3	1.2
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Electricity	0.1	0.1	0.1	16.5	17.2	18.0	2.4	2.0	2.2	0.1	0.1	0.1	16.3	16.8	18.4	1.9	2.0	2.0
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	0.0	0.0	0.0	1.7	1.6	1.2	0.0	0.0	0.0	0.0	0.0	0.0	1.8	1.6	1.3	0.0	0.0	0.0
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	0.5	0.5	0.6	100.0	100.0	100.0	1.6	1.8	1.7	0.4	0.5	0.6	100.0	100.0	100.0	1.2	1.4	1.3
Industry	0.2	0.2	0.3	43.9	44.5	41.8	2.4	1.3	1.7	0.2	0.2	0.3	43.6	43.7	43.0	1.9	1.3	1.5
Transport	0.2	0.2	0.2	36.3	35.4	33.1	0.6	1.3	1.0	0.2	0.2	0.2	36.6	36.1	31.2	0.4	0.4	0.4
Other Sectors	0.1	0.1	0.2	19.8	20.1	25.1	1.7	3.3	2.6	0.1	0.1	0.2	19.8	20.2	25.8	1.4	3.1	2.4
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…

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Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	1.0	1.1	1.5	100.0	100.0	100.0	2.2	1.9	2.0	1.0	1.1	1.4	100.0	100.0	100.0	1.7	1.9	1.8
Fossil Fuels	0.1	0.1	0.0	10.4	9.4	0.8	1.1	(13.7)	(8.1)	0.1	0.1	0.0	14.2	9.3	0.8	0.5	(13.7)	(8.3)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.1	0.1	0.0	10.4	9.4	0.8	1.1	(13.7)	(8.1)	0.1	0.1	0.0	14.2	9.3	0.8	0.5	(13.7)	(8.3)
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.8	0.9	1.2	82.8	82.8	82.8	2.1	1.9	2.0	0.7	0.6	0.9	68.6	58.7	68.0	(1.8)	2.9	1.0
Others[b]	0.1	0.1	0.2	6.8	7.9	16.5	5.3	7.0	6.3	0.2	0.3	0.4	17.3	31.9	31.2	20.5	1.7	8.9

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	0.0	0.0	0.0	100.0	100.0	100.0	1.1	(13.7)	(8.1)	0.0	0.0	0.0	100.0	100.0	100.0	0.5	(13.7)	(8.3)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.0	0.0	0.0	100.0	100.0	100.0	1.1	(13.7)	(8.1)	0.0	0.0	0.0	100.0	100.0	100.0	0.5	(13.7)	(8.3)
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)			Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	1.2	1.3	1.6	1.4	1.3	1.3	1.2	1.3	1.5	1.1	0.9	1.0

Energy and Carbon Indicators				AAGR (%)						AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/ capita (toe/person)	0.75	0.78	0.91	0.5	1.0	0.8	0.78	0.83	0.90	1.2	0.5	0.8
Primary Energy Demand/ GDP (toe/constant 2000 $ million)	314	308	317	(0.6)	0.2	(0.1)	327	329	315	0.0	(0.3)	(0.2)
CO_2/capita (t CO_2/person)	1.38	1.46	1.67	0.7	0.9	0.8	1.40	1.42	1.53	0.4	0.5	0.5
CO_2 Intensity (t CO_2/million constant 2000 $)	581	578	586	(0.4)	0.1	(0.1)	588	560	537	(0.7)	(0.3)	(0.5)
CO_2/Primary Energy Demand (t CO_2/toe)	1.85	1.87	1.85	0.2	(0.1)	0.0	1.80	1.70	1.71	(0.8)	0.0	(0.3)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Papua New Guinea
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	8.0	9.9	16.2	6.8	3.4	4.7
Population (million persons)	7.6	8.5	11.1	2.1	1.8	1.9
GDP/capita (constant 2000 $/person)	1,044	1,164	1,466	4.6	1.5	2.7

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	3.6	4.3	6.7	100.0	100.0	100.0	6.8	3.0	4.5	3.7	4.4	6.6	100.0	100.0	100.0	7.0	2.7	4.4
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	1.7	1.9	2.7	46.5	44.1	39.7	2.3	2.3	2.3	1.6	1.8	2.6	44.7	42.0	39.1	2.1	2.2	2.2
Natural Gas	1.4	1.7	2.7	38.4	40.0	41.1	19.1	3.2	9.3	1.4	1.7	2.5	38.2	38.8	38.8	19.0	2.7	9.0
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.1	0.2	0.3	3.3	3.8	5.1	6.6	5.1	5.7	0.1	0.2	0.3	2.7	4.6	4.6	8.8	2.7	5.1
Others[a]	0.4	0.5	0.9	11.7	12.1	14.1	4.5	4.1	4.2	0.5	0.6	1.1	14.3	14.6	17.5	6.7	4.0	5.0
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	1.5	1.9	3.2	100.0	100.0	100.0	4.1	3.6	3.8	1.5	1.8	3.0	100.0	100.0	100.0	3.9	3.4	3.6
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	1.1	1.3	2.1	73.4	71.7	66.7	3.4	3.1	3.2	1.1	1.3	2.0	73.8	72.3	67.6	3.4	2.9	3.1
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.1	…	17.0	…	0.0	0.0	0.0	0.0	0.0	0.1	…	17.0	…
Electricity	0.4	0.5	1.0	25.5	26.8	30.9	5.5	4.6	4.9	0.4	0.5	0.9	25.0	26.1	29.9	5.0	4.4	4.6
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	0.0	0.0	0.1	1.1	1.5	2.3	13.2	6.5	9.1	0.0	0.0	0.1	1.2	1.5	2.4	13.2	6.5	9.1
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	1.5	1.9	3.2	100.0	100.0	100.0	4.0	3.6	3.8	1.5	1.8	3.0	100.0	100.0	100.0	3.9	3.4	3.6
Industry	0.8	1.0	1.9	49.4	52.0	59.7	4.2	4.5	4.4	0.8	1.0	1.8	49.3	51.9	59.1	4.0	4.3	4.2
Transport	0.6	0.6	0.8	37.4	34.3	26.7	3.0	1.8	2.3	0.6	0.6	0.8	37.9	34.9	27.8	3.0	1.8	2.3
Other Sectors	0.2	0.3	0.4	13.2	13.7	13.7	6.6	3.6	4.8	0.2	0.2	0.4	12.8	13.1	13.1	6.0	3.4	4.4
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…

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Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	4.9	6.3	12.2	100.0	100.0	100.0	5.5	4.5	4.9	4.8	5.9	11.4	100.0	100.0	100.0	4.8	4.5	4.6
Fossil Fuels	3.0	3.8	7.2	61.2	60.3	59.0	5.1	4.4	4.7	2.8	3.4	6.2	58.3	57.6	54.4	4.0	4.1	4.0
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	1.5	1.5	1.5	30.6	23.8	12.3	0.0	0.0	0.0	1.4	1.4	1.4	29.2	23.7	12.3	(0.7)	0.0	(0.3)
Natural Gas	1.5	2.3	5.7	30.6	36.5	46.7	11.1	6.2	8.2	1.4	2.0	4.8	29.2	33.9	42.1	9.6	6.0	7.4
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	1.4	1.9	4.0	28.6	30.2	32.8	6.6	5.1	5.7	1.4	1.8	3.9	29.2	30.5	34.2	6.1	5.3	5.6
Others[b]	0.5	0.6	1.0	10.2	9.5	8.2	4.1	3.5	3.7	0.6	0.7	1.3	12.5	11.9	11.4	5.8	4.2	4.8
Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	0.8	0.9	1.5	100.0	100.0	100.0	3.1	3.3	3.2	0.8	0.9	1.3	100.0	100.0	100.0	2.6	2.5	2.5
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.5	0.5	0.5	65.3	56.4	34.6	0.0	0.0	0.0	0.5	0.5	0.5	62.5	55.6	38.5	(0.6)	0.0	(0.3)
Natural Gas	0.3	0.4	1.0	34.7	43.6	65.4	9.7	6.1	7.5	0.3	0.4	0.8	37.5	44.4	61.5	9.4	4.7	6.6
Carbon Dioxide Emissions	Mt CO_2			AAGR (%)						Mt CO_2			AAGR (%)					
	2015	2020	2035	2010–2020			2020–2035		2010–2035	2015	2020	2035	2010–2020		2020–2035		2010–2035	
Total	8.4	9.8	14.6	6.5			2.7		4.2	8.3	9.6	13.9	6.3		2.5		4.0	
Energy and Carbon Indicators							AAGR (%)									AAGR (%)		
				2015	2020	2035	2010–2020	2020–2035	2010–2035				2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)				0.47	0.50	0.61	4.6	1.2	2.5				0.48	0.52	0.59	4.8	0.9	2.5
Primary Energy Demand/GDP (toe/constant 2000 $ million)				452	434	413	(0.0)	(0.3)	(0.2)				459	444	404	0.2	(0.6)	(0.3)
CO_2/capita (t CO_2/person)				1.10	1.16	1.32	4.3	0.9	2.2				1.09	1.14	1.25	4.1	0.6	2.0
CO_2 Intensity (t CO_2/million constant 2000 $)				1,053	994	902	(0.3)	(0.7)	(0.5)				1,042	977	854	(0.5)	(0.9)	(0.7)
CO_2/Primary Energy Demand (t CO_2/toe)				2.33	2.29	2.18	(0.3)	(0.3)	(0.3)				2.27	2.20	2.11	(0.7)	(0.3)	(0.4)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Timor-Leste
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	0.6	0.8	1.4	6.4	3.3	4.6
Population (million persons)	1.3	1.5	2.2	3.0	2.7	2.8
GDP/capita (constant 2000 $/person)	496	548	605	3.3	0.7	1.7

Business-as-Usual Case

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	0.1	0.2	0.3	100.0	100.0	100.0	6.2	3.6	4.6
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.1	0.2	0.3	99.1	98.2	98.1	6.0	3.5	4.5
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.0	0.0	0.0	0.9	1.7	1.7	34.4	3.7	15.0
Others[a]	0.0	0.0	0.0	0.0	0.1	0.2	…	11.2	…
Final Energy Demand By Source	**Mtoe**			**Share (%)**			**AAGR (%)**		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	0.1	0.1	0.1	100.0	100.0	100.0	6.5	3.5	4.7
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.0	0.1	0.1	68.8	68.4	67.2	6.4	3.3	4.6
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Electricity	0.0	0.0	0.0	31.2	31.6	32.8	6.8	3.7	4.9
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Final Energy Demand By Sector	**Mtoe**			**Share (%)**			**AAGR (%)**		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	0.1	0.1	0.1	100.0	100.0	100.0	6.5	3.5	4.7
Industry	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Transport	0.0	0.1	0.1	68.8	68.4	67.2	6.4	3.3	4.6
Other Sectors	0.0	0.0	0.0	31.2	31.6	32.8	6.8	3.7	4.9
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…

Alternative Case

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	0.1	0.1	0.1	100.0	100.0	100.0	2.9	1.2	1.9
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.1	0.1	0.1	95.2	87.0	76.6	1.5	0.3	0.8
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.0	0.0	0.0	4.4	10.0	17.9	55.5	5.1	23.0
Others[a]	0.0	0.0	0.0	0.5	2.9	5.5	…	5.6	…
Final Energy Demand By Source	**Mtoe**			**Share (%)**			**AAGR (%)**		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	0.1	0.1	0.1	100.0	100.0	100.0	6.1	2.4	3.9
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.0	0.1	0.1	69.3	69.9	70.0	6.2	2.4	3.9
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Electricity	0.0	0.0	0.0	30.7	30.1	30.0	5.9	2.4	3.8
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Final Energy Demand By Sector	**Mtoe**			**Share (%)**			**AAGR (%)**		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	0.1	0.1	0.1	100.0	100.0	100.0	6.1	2.4	3.9
Industry	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Transport	0.0	0.1	0.1	69.3	69.9	70.0	6.2	2.4	3.9
Other Sectors	0.0	0.0	0.0	30.7	30.1	30.0	5.9	2.4	3.8
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…

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Timor-Leste Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	0.2	0.3	0.6	100.0	100.0	100.0	6.8	3.7	4.9	0.2	0.3	0.4	100.0	100.0	100.0	5.9	2.4	3.8
Fossil Fuels	0.2	0.3	0.5	94.4	89.7	89.0	5.7	3.7	4.5	0.2	0.1	0.1	73.9	45.4	20.0	(2.1)	(3.1)	(2.7)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.2	0.3	0.5	94.4	89.7	89.0	5.7	3.7	4.5	0.2	0.1	0.1	73.9	45.4	20.0	(2.1)	(3.1)	(2.7)
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.0	0.0	0.1	5.5	10.0	10.0	34.5	3.7	15.1	0.1	0.1	0.3	24.0	47.0	70.0	55.6	5.1	23.0
Others[b]	0.0	0.0	0.0	0.1	0.3	1.0	…	11.3	…	0.0	0.0	0.0	2.1	7.6	10.0	…	4.3	…
Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	0.1	0.1	0.2	100.0	100.0	100.0	5.7	3.7	4.5	0.1	0.0	0.0	100.0	100.0	100.0	(2.5)	(4.0)	(3.4)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.1	0.1	0.2	100.0	100.0	100.0	5.7	3.7	4.5	0.1	0.0	0.0	100.0	100.0	100.0	(2.5)	(4.0)	(3.4)
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Carbon Dioxide Emissions	Mt CO_2			AAGR (%)						Mt CO_2			AAGR (%)					
	2015	2020	2035	2010–2020		2020–2035		2010–2035		2015	2020	2035	2010–2020		2020–2035		2010–2035	
Total	0.4	0.5	0.8	6.0		3.5		4.5		0.3	0.3	0.3	0.5		(0.8)		(0.3)	
Energy and Carbon Indicators							AAGR (%)									AAGR (%)		
				2015	2020	2035	2010–2020	2020–2035	2010–2035				2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)				0.10	0.11	0.12	3.1	0.9	1.7				0.09	0.08	0.06	(0.1)	(1.4)	(0.9)
Primary Energy Demand/GDP (toe/constant 2000 $ million)				196	194	200	(0.2)	0.2	0.0				173	142	104	(3.3)	(2.1)	(2.6)
CO_2/capita (t CO_2/person)				0.30	0.32	0.36	2.9	0.9	1.7				0.25	0.19	0.11	(2.4)	(3.4)	(3.0)
CO_2 Intensity (t CO_2/million constant 2000 $)				595	583	600	(0.4)	0.2	(0.0)				499	343	185	(5.5)	(4.0)	(4.6)
CO_2/Primary Energy Demand (t CO_2/toe)				3.03	3.00	3.00	(0.2)	(0.0)	(0.1)				2.89	2.41	1.78	(2.3)	(2.0)	(2.1)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision.* http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Other Pacific Islands
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	2.5	2.9	3.7	2.9	1.8	2.2
Population (million persons)	1.5	1.6	2.1	1.7	1.5	1.6
GDP/capita (constant 2000 $/person)	1,677	1,740	1,797	1.2	0.2	0.6

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	0.7	0.8	1.0	100.0	100.0	100.0	2.3	1.4	1.8	0.7	0.7	0.8	100.0	100.0	100.0	1.5	0.4	0.8
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.4	0.5	0.5	61.7	59.3	54.1	1.6	0.8	1.1	0.4	0.4	0.4	61.4	58.2	55.7	0.6	0.1	0.3
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.0	0.0	0.0	1.0	1.0	1.2	2.9	2.5	2.7	0.0	0.0	0.0	1.0	1.0	1.2	2.0	1.5	1.7
Others[a]	0.3	0.3	0.4	37.3	39.7	44.6	3.4	2.2	2.7	0.3	0.3	0.3	37.6	40.8	43.1	2.9	0.8	1.6
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	0.6	0.6	0.8	100.0	100.0	100.0	2.6	1.7	2.0	0.6	0.6	0.6	100.0	100.0	100.0	2.0	0.6	1.1
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.2	0.3	0.3	42.5	41.8	39.8	2.3	1.3	1.7	0.2	0.3	0.3	43.1	43.3	42.8	2.0	0.5	1.1
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Electricity	0.1	0.1	0.1	10.3	10.0	9.5	2.0	1.3	1.6	0.1	0.1	0.1	10.2	9.8	9.4	1.1	0.3	0.6
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	0.3	0.3	0.4	47.2	48.2	50.6	3.0	2.0	2.4	0.3	0.3	0.3	46.8	46.9	47.8	2.1	0.7	1.3
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	0.6	0.6	0.8	100.0	100.0	100.0	2.6	1.7	2.0	0.6	0.6	0.6	100.0	100.0	100.0	2.0	0.6	1.1
Industry	0.0	0.0	0.0	5.8	5.6	5.3	2.6	1.2	1.8	0.0	0.0	0.0	5.8	5.7	6.2	2.1	1.2	1.6
Transport	0.2	0.2	0.3	33.2	32.9	31.8	2.5	1.4	1.9	0.2	0.2	0.2	33.7	34.5	34.3	2.4	0.5	1.3
Other Sectors	0.3	0.4	0.5	61.1	61.5	62.9	2.7	1.8	2.2	0.3	0.4	0.4	60.5	59.8	59.4	1.8	0.5	1.0
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…

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Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	0.8	0.8	1.0	100.0	100.0	100.0	2.0	1.3	1.6	0.7	0.8	0.8	100.0	100.0	100.0	1.1	0.2	0.6
Fossil Fuels	0.7	0.7	0.7	86.4	81.5	72.7	1.0	0.5	0.7	0.6	0.6	0.5	84.8	76.7	69.2	(0.4)	(0.4)	(0.4)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.7	0.7	0.7	86.4	81.5	72.7	1.0	0.5	0.7	0.6	0.6	0.5	84.8	76.7	69.2	(0.4)	(0.4)	(0.4)
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.1	0.1	0.1	10.7	11.4	13.6	2.9	2.5	2.7	0.1	0.1	0.1	10.7	11.4	13.7	2.0	1.5	1.7
Others[b]	0.0	0.1	0.1	2.9	7.1	13.7	66.4	5.9	26.9	0.0	0.1	0.1	4.5	11.9	17.1	…	2.7	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	0.2	0.2	0.2	100.0	100.0	100.0	0.8	0.0	0.4	0.2	0.2	0.2	100.0	100.0	100.0	(1.2)	(0.5)	(0.8)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.2	0.2	0.2	100.0	100.0	100.0	0.8	0.0	0.4	0.2	0.2	0.2	100.0	100.0	100.0	(1.2)	(0.5)	(0.8)
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)			Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	1.3	1.4	1.4	1.1	0.3	0.6	1.3	1.2	1.1	(0.6)	(0.1)	(0.3)

Energy and Carbon Indicators				AAGR (%)						AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)	0.48	0.49	0.48	0.6	(0.1)	0.1	0.47	0.45	0.38	(0.3)	(1.1)	(0.8)
Primary Energy Demand/GDP (toe/constant 2000 $ million)	287	279	264	(0.6)	(0.4)	(0.4)	278	256	210	(1.4)	(1.3)	(1.4)
CO_2/capita (t CO_2/person)	0.89	0.84	0.69	(0.6)	(1.3)	(1.0)	0.84	0.71	0.56	(2.3)	(1.6)	(1.9)
CO_2 Intensity (t CO_2/million constant 2000 $)	532	481	385	(1.8)	(1.5)	(1.6)	501	407	309	(3.4)	(1.8)	(2.5)
CO_2/Primary Energy Demand (t CO_2/toe)	1.86	1.72	1.46	(1.2)	(1.1)	(1.2)	1.80	1.59	1.47	(2.0)	(0.5)	(1.1)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.
Note: Figures may not add up to total because of rounding.
[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.
[b] "Others" include geothermal, solar, wind, and renewables.
Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

South Asia
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	1,532.0	2,148.9	4,227.2	7.1	4.6	5.6
Population (million persons)	1,521.8	1,612.7	1,833.3	1.2	0.9	1.0
GDP/capita (constant 2000 $/person)	1,007	1,332	2,306	5.8	3.7	4.5

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	904.7	1,072.4	1,558.6	100.0	100.0	100.0	3.7	2.5	3.0	872.6	998.5	1,343.8	100.0	100.0	100.0	3.0	2.0	2.4
Coal	363.9	433.9	641.2	40.2	40.5	41.1	4.1	2.6	3.2	334.4	356.5	397.3	38.3	35.7	29.6	2.1	0.7	1.3
Oil	214.7	257.4	383.3	23.7	24.0	24.6	4.1	2.7	3.2	212.2	249.3	355.9	24.3	25.0	26.5	3.7	2.4	2.9
Natural Gas	89.3	111.6	196.6	9.9	10.4	12.6	4.9	3.8	4.3	86.3	102.3	166.5	9.9	10.2	12.4	4.0	3.3	3.6
Nuclear	13.3	28.5	55.8	1.5	2.7	3.6	15.3	4.6	8.8	13.2	44.9	125.0	1.5	4.5	9.3	20.7	7.1	12.3
Hydro	15.3	18.1	26.2	1.7	1.7	1.7	4.8	2.5	3.4	15.3	18.1	26.0	1.8	1.8	1.9	4.8	2.5	3.4
Others[a]	208.2	223.0	255.4	23.0	20.8	16.4	1.3	0.9	1.1	211.2	227.3	273.1	24.2	22.8	20.3	1.5	1.2	1.3
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	585.4	677.2	974.0	100.0	100.0	100.0	3.1	2.5	2.7	575.6	654.0	896.9	100.0	100.0	100.0	2.7	2.1	2.4
Coal	83.8	88.4	99.8	14.3	13.1	10.3	1.4	0.8	1.1	79.5	79.8	83.8	13.8	12.2	9.3	0.4	0.3	0.4
Oil	175.2	212.9	336.3	29.9	31.4	34.5	4.5	3.1	3.7	174.2	210.0	318.9	30.3	32.1	35.6	4.4	2.8	3.4
Natural Gas	35.0	41.1	66.5	6.0	6.1	6.8	3.5	3.3	3.4	34.8	40.8	65.9	6.0	6.2	7.3	3.5	3.2	3.3
Electricity	88.7	121.6	237.5	15.1	18.0	24.4	6.4	4.6	5.3	84.5	110.2	194.7	14.7	16.9	21.7	5.3	3.9	4.4
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	203.0	213.6	234.3	34.7	31.5	24.1	1.0	0.6	0.8	203.0	213.5	234.1	35.3	32.6	26.1	1.0	0.6	0.8
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	585.4	677.2	974.0	100.0	100.0	100.0	3.1	2.5	2.7	575.6	654.0	896.9	100.0	100.0	100.0	2.7	2.1	2.4
Industry	174.2	204.1	296.9	29.8	30.1	30.5	2.5	2.5	2.5	167.6	191.1	269.1	29.1	29.2	30.0	1.9	2.3	2.1
Transport	77.7	97.2	192.8	13.3	14.4	19.8	4.7	4.7	4.7	76.9	94.9	178.7	13.4	14.5	19.9	4.4	4.3	4.3
Other Sectors	283.0	316.3	408.8	48.3	46.7	42.0	2.8	1.7	2.1	280.7	308.4	373.5	48.8	47.2	41.6	2.5	1.3	1.8
Non-Energy	50.5	59.6	75.6	8.6	8.8	7.8	4.1	1.6	2.6	50.5	59.6	75.6	8.8	9.1	8.4	4.1	1.6	2.6

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South Asia Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	1,462.7	1,971.4	3,644.9	100.0	100.0	100.0	6.8	4.2	5.2	1,396.1	1,788.7	2,990.2	100.0	100.0	100.0	5.7	3.5	4.4
Fossil Fuels	1,190.3	1,571.3	2,958.6	81.4	79.7	81.2	6.4	4.3	5.1	1,095.9	1,283.3	1,849.6	78.5	71.7	61.9	4.3	2.5	3.2
Coal	914.1	1,203.7	2,286.9	62.5	61.1	62.7	6.3	4.4	5.1	834.6	967.9	1,332.5	59.8	54.1	44.6	4.0	2.2	2.9
Oil	54.0	70.2	82.6	3.7	3.6	2.3	7.6	1.1	3.7	49.5	53.9	48.4	3.5	3.0	1.6	4.8	(0.7)	1.5
Natural Gas	222.2	297.3	589.2	15.2	15.1	16.2	6.7	4.7	5.5	211.8	261.5	468.7	15.2	14.6	15.7	5.3	4.0	4.5
Nuclear	51.0	109.3	214.1	3.5	5.5	5.9	15.3	4.6	8.8	50.7	172.5	479.5	3.6	9.6	16.0	20.7	7.1	12.3
Hydro	178.1	210.8	305.0	12.2	10.7	8.4	4.8	2.5	3.4	178.0	210.3	302.9	12.7	11.8	10.1	4.8	2.5	3.4
Others[b]	43.3	80.0	167.2	3.0	4.1	4.6	13.8	5.0	8.4	71.6	122.6	358.3	5.1	6.9	12.0	18.7	7.4	11.8

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	330.4	411.9	654.0	100.0	100.0	100.0	5.1	3.1	3.9	301.1	329.4	389.0	100.0	100.0	100.0	2.8	1.1	1.8
Coal	264.5	326.8	514.1	80.1	79.3	78.6	4.9	3.1	3.8	239.3	257.9	286.2	79.5	78.3	73.6	2.5	0.7	1.4
Oil	17.3	22.0	23.2	5.2	5.3	3.5	5.2	0.4	2.3	15.9	16.8	13.6	5.3	5.1	3.5	2.4	(1.4)	0.1
Natural Gas	48.5	63.2	116.8	14.7	15.3	17.9	5.9	4.2	4.9	45.9	54.7	89.1	15.2	16.6	22.9	4.4	3.3	3.8

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)			Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	2,166.4	2,600.1	3,961.4	4.2	2.8	3.4	2,034.9	2,247.0	2,840.8	2.7	1.6	2.0

Energy and Carbon Indicators				AAGR (%)						AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/ capita (toe/person)	0.59	0.66	0.85	2.4	1.7	2.0	0.57	0.62	0.73	1.7	1.1	1.4
Primary Energy Demand/ GDP (toe/constant 2000 $ million)	591	499	369	(3.2)	(2.0)	(2.5)	570	465	318	(3.9)	(2.5)	(3.0)
CO_2/capita ($t\ CO_2$/person)	1.42	1.61	2.16	2.9	2.0	2.3	1.34	1.39	1.55	1.4	0.7	1.0
CO_2 Intensity ($t\ CO_2$/million constant 2000 $)	1,414	1,210	937	(2.7)	(1.7)	(2.1)	1,328	1,046	672	(4.1)	(2.9)	(3.4)
CO_2/Primary Energy Demand ($t\ CO_2$/toe)	2.39	2.42	2.54	0.5	0.3	0.4	2.33	2.25	2.11	(0.3)	(0.4)	(0.4)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision.* http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Bangladesh
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	111.4	144.6	243.0	5.7	3.5	4.4
Population (million persons)	158.3	167.3	187.1	1.2	0.7	0.9
GDP/capita (constant 2000 $/person)	704	864	1,299	4.5	2.8	3.4

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	39.9	49.3	77.6	100.0	100.0	100.0	4.7	3.1	3.7	38.8	46.6	68.8	100.0	100.0	100.0	4.2	2.6	3.2
Coal	1.1	2.2	18.8	2.8	4.5	24.2	13.5	15.3	14.6	1.1	1.7	10.3	2.8	3.6	15.0	10.4	12.8	11.8
Oil	10.9	16.9	20.1	27.4	34.2	25.9	12.8	1.2	5.7	10.6	14.1	15.9	27.2	30.2	23.1	10.8	0.8	4.7
Natural Gas	18.5	20.4	27.5	46.4	41.4	35.5	2.2	2.0	2.1	17.8	17.4	21.8	45.9	37.2	31.7	0.5	1.5	1.1
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	3.7	9.1	0.0	7.8	13.3	…	6.3	…
Hydro	0.2	0.2	0.4	0.4	0.5	0.6	4.5	4.5	4.5	0.2	0.2	0.4	0.5	0.5	0.6	4.5	4.5	4.5
Others[a]	9.2	9.6	10.8	23.0	19.5	13.9	1.0	0.8	0.8	9.2	9.6	11.2	23.6	20.6	16.3	1.0	1.0	1.0
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	28.3	33.4	50.3	100.0	100.0	100.0	3.8	2.8	3.2	27.6	32.2	47.1	100.0	100.0	100.0	3.5	2.6	2.9
Coal	0.4	0.4	0.4	1.4	1.2	0.8	(0.1)	0.3	0.1	0.4	0.4	0.4	1.3	1.2	0.8	(0.6)	0.2	(0.1)
Oil	5.6	7.3	12.5	20.0	22.0	24.8	5.5	3.6	4.4	5.6	7.1	11.6	20.1	22.1	24.6	5.2	3.3	4.1
Natural Gas	8.6	10.1	16.2	30.3	30.3	32.1	5.2	3.2	4.0	8.4	9.9	15.7	30.3	30.7	33.2	4.9	3.1	3.8
Electricity	4.5	6.0	10.8	16.1	17.8	21.4	5.8	4.0	4.7	4.2	5.3	9.0	15.2	16.4	19.0	4.6	3.6	4.0
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	9.1	9.5	10.5	32.3	28.6	20.9	0.9	0.6	0.7	9.1	9.5	10.5	33.1	29.6	22.3	0.9	0.6	0.7
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	28.3	33.4	50.3	100.0	100.0	100.0	3.8	2.8	3.2	27.6	32.2	47.1	100.0	100.0	100.0	3.5	2.6	2.9
Industry	6.7	8.4	14.6	23.6	25.1	29.1	7.4	3.8	5.2	6.3	7.9	13.8	22.9	24.6	29.3	6.9	3.8	5.0
Transport	3.9	5.2	9.7	13.9	15.7	19.3	5.8	4.2	4.8	3.8	5.1	9.0	13.9	15.8	19.1	5.5	3.9	4.5
Other Sectors	15.3	17.2	22.9	54.1	51.6	45.6	2.1	1.9	2.0	15.1	16.7	21.2	54.6	51.7	45.0	1.7	1.6	1.7
Non-Energy	2.4	2.6	3.1	8.3	7.7	6.1	3.5	1.3	2.2	2.4	2.6	3.1	8.5	7.9	6.5	3.5	1.3	2.2

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Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	62.1	83.3	157.0	100.0	100.0	100.0	7.0	4.3	5.4	59.0	75.5	131.1	100.0	100.0	100.0	5.9	3.7	4.6
Fossil Fuels	59.7	80.1	148.9	96.2	96.2	94.8	7.0	4.2	5.3	56.6	58.0	82.4	95.8	76.8	62.8	3.6	2.4	2.9
Coal	2.3	6.0	69.2	3.7	7.1	44.0	25.0	17.8	20.6	2.2	4.3	38.2	3.7	5.7	29.2	21.0	15.7	17.8
Oil	15.2	29.2	26.8	24.5	35.0	17.1	31.0	(0.6)	11.0	14.4	21.1	14.8	24.4	28.0	11.3	26.8	(2.3)	8.4
Natural Gas	42.2	45.0	53.0	68.0	54.0	33.7	1.7	1.1	1.3	40.0	32.6	29.3	67.7	43.1	22.3	(1.6)	(0.7)	(1.0)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	14.0	35.0	0.0	18.6	26.7	…	6.3	…
Hydro	2.1	2.6	5.0	3.3	3.1	3.2	4.5	4.5	4.5	2.1	2.6	5.0	3.5	3.4	3.8	4.5	4.5	4.5
Others[b]	0.3	0.6	3.1	0.5	0.7	2.0	…	12.0	…	0.4	0.9	8.7	0.7	1.2	6.6	…	16.3	…

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	15.5	21.2	36.9	100.0	100.0	100.0	7.4	3.8	5.2	14.7	15.3	19.9	100.0	100.0	100.0	4.0	1.8	2.7
Coal	0.7	1.8	18.4	4.8	8.7	49.8	23.7	16.6	19.4	0.7	1.3	9.9	4.8	8.6	49.9	19.6	14.5	16.5
Oil	5.1	9.4	7.4	32.9	44.1	20.1	29.6	(1.6)	9.9	4.8	6.8	4.1	32.9	44.3	20.5	25.4	(3.3)	7.3
Natural Gas	9.7	10.0	11.1	62.2	47.2	30.1	0.6	0.7	0.7	9.2	7.2	5.9	62.2	47.1	29.6	(2.6)	(1.3)	(1.9)

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)			Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	75.6	102.1	192.8	6.9	4.3	5.4	72.6	84.3	132.9	4.9	3.1	3.8

Energy and Carbon Indicators	Business-as-Usual Case			AAGR (%)			Alternative Case			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)	0.25	0.29	0.41	3.5	2.3	2.8	0.24	0.28	0.37	2.9	1.9	2.3
Primary Energy Demand/GDP (toe/constant 2000 $ million)	358	341	319	(0.9)	(0.4)	(0.6)	348	323	283	(1.5)	(0.9)	(1.1)
CO_2/capita (t CO_2/person)	0.48	0.61	1.03	5.7	3.5	4.4	0.46	0.50	0.71	3.6	2.3	2.8
CO_2 Intensity (t CO_2/million constant 2000 $)	679	707	793	1.1	0.8	0.9	652	583	547	(0.8)	(0.4)	(0.6)
CO_2/Primary Energy Demand (t CO_2/toe)	1.89	2.07	2.48	2.1	1.2	1.6	1.87	1.81	1.93	0.7	0.4	0.5

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision.* http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Bhutan
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	1.4	2.0	3.8	7.3	4.5	5.6
Population (million persons)	0.8	0.8	0.9	1.3	0.7	1.0
GDP/capita (constant 2000 $/person)	1,818	2,388	4,126	5.9	3.7	4.6

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	1.6	1.7	1.7	100.0	100.0	100.0	1.8	0.1	0.8	1.5	1.5	1.5	100.0	100.0	100.0	0.8	(0.3)	0.2
Coal	0.2	0.2	0.2	11.0	12.0	11.6	4.3	(0.2)	1.6	0.2	0.2	0.2	11.0	12.2	11.6	3.5	(0.6)	1.0
Oil	0.1	0.1	0.2	6.1	6.5	9.3	3.1	2.5	2.7	0.1	0.1	0.1	6.3	6.9	9.9	2.8	2.1	2.4
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.6	0.6	0.6	39.8	36.8	36.3	0.0	0.0	0.0	0.6	0.6	0.6	41.1	40.3	42.2	0.0	0.0	0.0
Others[a]	0.7	0.7	0.7	43.2	44.7	42.9	2.6	(0.2)	0.9	0.6	0.6	0.5	41.6	40.6	36.3	0.7	(1.1)	(0.3)
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	1.5	1.6	1.7	100.0	100.0	100.0	1.7	0.0	0.7	1.5	1.5	1.4	100.0	100.0	100.0	0.8	(0.4)	0.1
Coal	0.2	0.2	0.2	10.8	11.9	11.6	4.5	(0.2)	1.7	0.2	0.2	0.2	10.8	12.0	11.5	3.6	(0.7)	1.0
Oil	0.1	0.1	0.2	6.1	6.5	9.4	3.1	2.5	2.7	0.1	0.1	0.1	6.3	6.9	10.1	2.8	2.1	2.4
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Electricity	0.2	0.2	0.4	10.0	12.7	21.7	7.2	3.6	5.0	0.1	0.2	0.3	10.1	13.1	21.9	6.5	3.1	4.4
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	1.1	1.1	0.9	73.1	68.8	57.3	0.5	(1.2)	(0.5)	1.1	1.0	0.8	72.8	67.9	56.5	(0.6)	(1.6)	(1.2)
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	1.5	1.6	1.7	100.0	100.0	100.0	1.7	0.0	0.7	1.5	1.5	1.4	100.0	100.0	100.0	0.8	(0.4)	0.1
Industry	0.2	0.2	0.4	12.8	15.1	22.0	5.3	2.6	3.7	0.2	0.2	0.3	13.0	15.7	22.2	4.8	2.0	3.1
Transport	0.1	0.1	0.1	5.4	5.8	8.7	3.5	2.7	3.0	0.1	0.1	0.1	5.5	6.2	9.5	3.2	2.4	2.7
Other Sectors	1.2	1.3	1.1	81.8	79.1	69.2	1.1	(0.9)	(0.1)	1.2	1.2	1.0	81.5	78.1	68.4	0.0	(1.3)	(0.8)
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…

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Bhutan Outlook Cases *continued*

Business-as-Usual Case

Power Generation Output	TWh 2015	TWh 2020	TWh 2035	Share (%) 2015	Share (%) 2020	Share (%) 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035
Total	7.2	7.2	7.2	100.0	100.0	100.0	0.0	0.0	0.0
Fossil Fuels	0.0	0.0	0.0	0.3	0.3	0.3	0.0	0.0	0.0
Coal	0.0	0.0	0.0	0.2	0.2	0.2	0.0	0.0	0.0
Oil	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	7.2	7.2	7.2	99.7	99.7	99.7	0.0	0.0	0.0
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.5	0.7

Thermal Power Generation Input	Mtoe 2015	Mtoe 2020	Mtoe 2035	Share (%) 2015	Share (%) 2020	Share (%) 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035
Fossil Fuels	0.0	0.0	0.0	100.0	100.0	100.0	0.0	0.0	0.0
Coal	0.0	0.0	0.0	78.8	78.8	78.8	0.0	0.0	0.0
Oil	0.0	0.0	0.0	21.2	21.2	21.2	0.0	0.0	0.0
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…

Carbon Dioxide Emissions	Mt CO_2 2015	Mt CO_2 2020	Mt CO_2 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035
Total	1.0	1.1	1.3	3.9	0.7	2.0

Energy and Carbon Indicators	2015	2020	2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035
Primary Energy Demand/capita (toe/person)	1.98	2.02	1.84	0.4	(0.6)	(0.2)
Primary Energy Demand/GDP (toe/constant 2000 $ million)	1,088	847	445	(5.2)	(4.2)	(4.6)
CO_2/capita (t CO_2/person)	1.24	1.38	1.37	2.6	(0.0)	1.0
CO_2 Intensity (t CO_2/million constant 2000 $)	681	577	333	(3.1)	(3.6)	(3.4)
CO_2/Primary Energy Demand (t CO_2/toe)	0.63	0.68	0.75	2.1	0.6	1.2

Alternative Case

Power Generation Output	TWh 2015	TWh 2020	TWh 2035	Share (%) 2015	Share (%) 2020	Share (%) 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035
Total	7.2	7.2	7.2	100.0	100.0	100.0	0.0	0.0	0.0
Fossil Fuels	0.0	0.0	0.0	0.3	0.3	0.3	0.0	0.0	0.0
Coal	0.0	0.0	0.0	0.2	0.2	0.2	0.0	0.0	0.0
Oil	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	7.2	7.2	7.2	99.7	99.7	99.7	0.0	0.0	0.0
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.5	0.7

Thermal Power Generation Input	Mtoe 2015	Mtoe 2020	Mtoe 2035	Share (%) 2015	Share (%) 2020	Share (%) 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035
Fossil Fuels	0.0	0.0	0.0	100.0	100.0	100.0	0.0	0.0	0.0
Coal	0.0	0.0	0.0	78.8	78.8	78.8	0.0	0.0	0.0
Oil	0.0	0.0	0.0	21.2	21.2	21.2	0.0	0.0	0.0
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…

Carbon Dioxide Emissions	Mt CO_2 2015	Mt CO_2 2020	Mt CO_2 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035
Total	0.9	1.1	1.1	3.3	0.3	1.5

Energy and Carbon Indicators	2015	2020	2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035
Primary Energy Demand/capita (toe/person)	1.91	1.85	1.58	(0.5)	(1.0)	(0.8)
Primary Energy Demand/GDP (toe/constant 2000 $ million)	1,052	773	383	(6.0)	(4.6)	(5.2)
CO_2/capita (t CO_2/person)	1.21	1.29	1.21	1.9	(0.4)	0.5
CO_2 Intensity (t CO_2/million constant 2000 $)	666	541	294	(3.8)	(4.0)	(3.9)
CO_2/Primary Energy Demand (t CO_2/toe)	0.63	0.70	0.77	2.4	0.6	1.3

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision.* http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

India
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	1,372.1	1,940.4	3,877.0	7.3	4.7	5.7
Population (million persons)	1,308.2	1,386.9	1,579.8	1.3	0.9	1.0
GDP/capita (constant 2000 $/person)	1,049	1,399	2,454	5.9	3.8	4.7

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	839.7	994.2	1,441.6	100.0	100.0	100.0	3.7	2.5	3.0	809.2	924.3	1,239.2	100.0	100.0	100.0	2.9	2.0	2.4
Coal	360.7	428.3	616.9	43.0	43.1	42.8	4.0	2.5	3.1	331.5	352.1	383.3	41.0	38.1	30.9	2.0	0.6	1.1
Oil	197.4	232.9	351.6	23.5	23.4	24.4	3.7	2.8	3.1	195.5	228.2	330.0	24.2	24.7	26.6	3.5	2.5	2.9
Natural Gas	70.8	91.2	169.1	8.4	9.2	11.7	5.6	4.2	4.8	68.5	85.0	144.7	8.5	9.2	11.7	4.9	3.6	4.1
Nuclear	13.3	28.5	55.8	1.6	2.9	3.9	15.3	4.6	8.8	13.2	41.3	115.8	1.6	4.5	9.3	19.7	7.1	12.0
Hydro	13.8	16.4	23.8	1.6	1.7	1.6	5.2	2.5	3.6	13.8	16.4	23.8	1.7	1.8	1.9	5.2	2.5	3.6
Others[a]	183.7	196.9	224.5	21.9	19.8	15.6	1.3	0.9	1.1	186.7	201.3	241.7	23.1	21.8	19.5	1.6	1.2	1.4
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	534.7	618.8	891.0	100.0	100.0	100.0	3.1	2.5	2.7	525.8	597.3	818.7	100.0	100.0	100.0	2.7	2.1	2.4
Coal	83.0	87.4	98.7	15.5	14.1	11.1	1.4	0.8	1.1	78.7	79.0	82.7	15.0	13.2	10.1	0.4	0.3	0.3
Oil	164.7	199.5	314.4	30.8	32.2	35.3	4.5	3.1	3.6	163.8	197.0	298.6	31.1	33.0	36.5	4.4	2.8	3.4
Natural Gas	26.4	30.9	50.3	4.9	5.0	5.6	3.0	3.3	3.2	26.4	30.9	50.2	5.0	5.2	6.1	3.0	3.3	3.2
Electricity	82.7	113.8	223.5	15.5	18.4	25.1	6.4	4.6	5.3	78.9	103.3	183.1	15.0	17.3	22.4	5.4	3.9	4.5
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	178.0	187.1	204.1	33.3	30.2	22.9	1.0	0.6	0.8	178.0	187.1	204.1	33.8	31.3	24.9	1.0	0.6	0.8
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	534.7	618.8	891.0	100.0	100.0	100.0	3.1	2.5	2.7	525.8	597.3	818.7	100.0	100.0	100.0	2.7	2.1	2.4
Industry	164.2	191.8	276.3	30.7	31.0	31.0	2.3	2.5	2.4	158.1	179.5	249.7	30.1	30.0	30.5	1.7	2.2	2.0
Transport	70.2	87.5	175.8	13.1	14.1	19.7	4.7	4.8	4.7	69.5	85.4	162.9	13.2	14.3	19.9	4.4	4.4	4.4
Other Sectors	252.3	282.5	366.5	47.2	45.7	41.1	2.9	1.7	2.2	250.2	275.5	333.6	47.6	46.1	40.7	2.7	1.3	1.8
Non-Energy	48.1	57.0	72.5	9.0	9.2	8.1	4.2	1.6	2.6	48.1	57.0	72.5	9.1	9.5	8.9	4.2	1.6	2.6

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India Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	1,373.8	1,855.3	3,437.3	100.0	100.0	100.0	6.8	4.2	5.2	1,311.4	1,683.5	2,816.6	100.0	100.0	100.0	5.8	3.5	4.4
Fossil Fuels	1,120.1	1,476.4	2,785.5	81.5	79.6	81.0	6.4	4.3	5.1	1,030.1	1,214.1	1,751.9	78.6	72.1	62.2	4.3	2.5	3.2
Coal	907.0	1,189.2	2,203.0	66.0	64.1	64.1	6.2	4.2	5.0	828.2	957.0	1,284.9	63.2	56.8	45.6	3.9	2.0	2.7
Oil	33.2	34.9	46.3	2.4	1.9	1.3	2.8	1.9	2.3	30.2	28.1	27.7	2.3	1.7	1.0	0.6	(0.1)	0.2
Natural Gas	180.0	252.3	536.2	13.1	13.6	15.6	7.9	5.2	6.3	171.8	229.0	439.4	13.1	13.6	15.6	6.9	4.4	5.4
Nuclear	51.0	109.3	214.1	3.7	5.9	6.2	15.3	4.6	8.8	50.7	158.5	444.4	3.9	9.4	15.8	19.7	7.1	12.0
Hydro	160.0	190.8	276.3	11.6	10.3	8.0	5.2	2.5	3.6	160.0	190.8	276.3	12.2	11.3	9.8	5.2	2.5	3.6
Others[b]	42.7	78.8	161.3	3.1	4.2	4.7	13.6	4.9	8.3	70.6	120.2	343.9	5.4	7.1	12.2	18.5	7.3	11.6
Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	311.9	386.5	610.2	100.0	100.0	100.0	4.9	3.1	3.8	283.8	310.9	364.7	100.0	100.0	100.0	2.7	1.1	1.7
Coal	262.2	322.1	490.8	84.1	83.3	80.4	4.8	2.8	3.6	237.2	254.4	273.2	83.6	81.8	74.9	2.4	0.5	1.2
Oil	10.9	11.2	13.8	3.5	2.9	2.3	(0.1)	1.4	0.8	9.9	9.0	8.2	3.5	2.9	2.3	(2.2)	(0.6)	(1.2)
Natural Gas	38.8	53.2	105.7	12.5	13.8	17.3	7.4	4.7	5.8	36.8	47.5	83.2	12.9	15.3	22.8	6.2	3.8	4.8
Carbon Dioxide Emissions	Mt CO_2			AAGR (%)						Mt CO_2			AAGR (%)					
	2015	2020	2035	2010–2020		2020–2035		2010–2035		2015	2020	2035	2010–2020		2020–2035		2010–2035	
Total	2,063.4	2,461.5	3,711.1	4.0		2.8		3.3		1,936.4	2,130.9	2,662.4	2.5		1.5		1.9	
Energy and Carbon Indicators							AAGR (%)									AAGR (%)		
				2015	2020	2035	2010–2020	2020–2035	2010–2035				2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)				0.64	0.72	0.91	2.4	1.6	1.9				0.62	0.67	0.78	1.7	1.1	1.3
Primary Energy Demand/GDP (toe/constant 2000 $ million)				612	512	372	(3.3)	(2.1)	(2.6)				590	476	320	(4.0)	(2.6)	(3.2)
CO_2/capita (t CO_2/person)				1.58	1.77	2.35	2.8	1.9	2.2				1.48	1.54	1.69	1.3	0.6	0.9
CO_2 Intensity (t CO_2/million constant 2000 $)				1,504	1,269	957	(3.0)	(1.9)	(2.3)				1,411	1,098	687	(4.4)	(3.1)	(3.6)
CO_2/Primary Energy Demand (t CO_2/toe)				2.46	2.48	2.57	0.3	0.3	0.3				2.39	2.31	2.15	(0.4)	(0.5)	(0.4)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Maldives
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	1.6	2.0	3.9	5.2	4.4	4.7
Population (million persons)	0.3	0.4	0.4	1.2	0.6	0.9
GDP/capita (constant 2000 $/person)	4,708	5,704	9,864	3.9	3.7	3.8

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	0.3	0.4	0.6	100.0	100.0	100.0	4.1	3.5	3.7	0.3	0.4	0.5	100.0	100.0	100.0	3.4	2.8	3.1
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.3	0.4	0.6	99.9	97.8	97.6	3.9	3.5	3.6	0.3	0.4	0.5	99.8	97.4	94.3	3.2	2.6	2.8
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others[a]	0.0	0.0	0.0	0.1	2.2	2.4	71.2	3.8	26.8	0.0	0.0	0.0	0.2	2.6	5.7	72.5	8.3	30.5
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	0.3	0.4	0.6	100.0	100.0	100.0	4.3	3.6	3.9	0.3	0.3	0.5	100.0	100.0	100.0	3.7	3.0	3.3
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.3	0.3	0.6	95.9	96.3	97.3	4.4	3.7	4.0	0.3	0.3	0.5	95.9	96.5	97.4	3.8	3.1	3.4
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Electricity	0.0	0.0	0.0	4.1	3.7	2.7	2.2	1.6	1.8	0.0	0.0	0.0	4.1	3.5	2.6	1.2	0.9	1.0
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	0.3	0.4	0.6	100.0	100.0	100.0	4.3	3.6	3.9	0.3	0.3	0.5	100.0	100.0	100.0	3.7	3.0	3.3
Industry	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Transport	0.3	0.3	0.6	95.5	95.9	97.0	4.4	3.7	4.0	0.3	0.3	0.5	95.4	96.1	97.1	3.8	3.1	3.4
Other Sectors	0.0	0.0	0.0	4.5	4.1	3.0	2.2	1.6	1.9	0.0	0.0	0.0	4.6	3.9	2.9	1.3	1.0	1.1
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…

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Maldives Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	0.1	0.2	0.2	100.0	100.0	100.0	2.2	1.6	1.8	0.1	0.1	0.2	100.0	100.0	100.0	1.2	0.9	1.0
Fossil Fuels	0.1	0.1	0.1	97.7	77.2	60.8	(0.4)	(0.0)	(0.2)	0.1	0.1	0.0	95.8	69.6	0.0	(2.4)	(100.0)	(100.0)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.1	0.1	0.1	97.7	77.2	60.8	(0.4)	(0.0)	(0.2)	0.1	0.1	0.0	95.8	69.6	0.0	(2.4)	(100.0)	(100.0)
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others[b]	0.0	0.0	0.1	2.3	22.8	39.2	55.0	5.3	22.9	0.0	0.0	0.2	4.2	30.4	100.0	57.9	9.2	26.6
Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	0.0	0.0	0.0	100.0	100.0	100.0	(0.4)	(0.0)	(0.2)	0.0	0.0	0.0	100.0	100.0	…	(2.4)	(100.0)	(100.0)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	…	…	…	…
Oil	0.0	0.0	0.0	100.0	100.0	100.0	(0.4)	(0.0)	(0.2)	0.0	0.0	0.0	100.0	100.0	…	(2.4)	(100.0)	(100.0)
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	…	…	…	…
Carbon Dioxide Emissions	Mt CO_2			AAGR (%)						Mt CO_2			AAGR (%)					
	2015	2020	2035	2010–2020		2020–2035		2010–2035		2015	2020	2035	2010–2020		2020–2035		2010–2035	
Total	1.0	1.2	1.9	3.9		3.5		3.6		1.0	1.1	1.6	3.2		2.6		2.8	
Energy and Carbon Indicators							AAGR (%)									AAGR (%)		
				2015	2020	2035	2010–2020	2020–2035	2010–2035				2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)				0.94	1.08	1.64	2.9	2.8	2.8				0.92	1.01	1.40	2.2	2.2	2.2
Primary Energy Demand/GDP (toe/constant 2000 $ million)				199	190	166	(1.0)	(0.9)	(0.9)				195	178	142	(1.6)	(1.5)	(1.6)
CO_2/capita ($t CO_2$/person)				2.89	3.26	4.94	2.6	2.8	2.7				2.83	3.05	4.05	1.9	1.9	1.9
CO_2 Intensity ($t CO_2$/million constant 2000 $)				613	572	500	(1.2)	(0.9)	(1.0)				601	534	411	(1.9)	(1.7)	(1.8)
CO_2/Primary Energy Demand ($t CO_2$/toe)				3.08	3.01	3.01	(0.2)	(0.0)	(0.1)				3.08	3.00	2.90	(0.3)	(0.2)	(0.2)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Nepal
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	9.8	12.0	20.0	4.1	3.5	3.7
Population (million persons)	32.6	35.2	42.0	1.6	1.2	1.4
GDP/capita (constant 2000 $/person)	302	340	476	2.5	2.3	2.3

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	11.4	12.7	16.6	100.0	100.0	100.0	2.2	1.8	2.0	11.4	12.6	16.3	100.0	100.0	100.0	2.1	1.7	1.9
Coal	0.2	0.3	0.5	2.0	2.2	2.9	3.2	3.7	3.5	0.2	0.3	0.4	1.9	2.1	2.7	2.6	3.7	3.2
Oil	1.1	1.3	2.1	9.9	10.5	12.4	3.1	3.0	3.0	1.1	1.3	1.9	9.8	10.4	11.9	2.8	2.7	2.7
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.4	0.5	1.0	3.4	4.0	6.2	6.2	4.9	5.4	0.4	0.5	0.9	3.3	3.7	5.3	5.3	4.2	4.6
Others[a]	9.7	10.5	13.1	84.8	83.3	78.5	1.9	1.4	1.6	9.7	10.5	13.0	85.0	83.9	80.1	1.9	1.4	1.6
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	11.3	12.5	16.3	100.0	100.0	100.0	2.1	1.8	1.9	11.2	12.4	16.0	100.0	100.0	100.0	2.1	1.7	1.8
Coal	0.2	0.3	0.5	2.0	2.2	2.9	3.2	3.7	3.5	0.2	0.3	0.4	2.0	2.1	2.8	2.6	3.7	3.2
Oil	1.1	1.3	2.1	9.9	10.6	12.6	3.0	3.0	3.0	1.1	1.3	1.9	9.9	10.4	12.0	2.8	2.7	2.7
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Electricity	0.3	0.4	0.9	2.9	3.4	5.4	6.2	4.9	5.4	0.3	0.4	0.7	2.8	3.2	4.6	5.3	4.2	4.7
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	9.6	10.5	12.9	85.2	83.7	79.1	1.9	1.4	1.6	9.6	10.5	12.9	85.3	84.3	80.6	1.9	1.4	1.6
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	11.3	12.5	16.3	100.0	100.0	100.0	2.1	1.8	1.9	11.2	12.4	16.0	100.0	100.0	100.0	2.1	1.7	1.8
Industry	0.4	0.5	1.0	3.9	4.4	6.0	4.0	4.0	4.0	0.4	0.5	0.9	3.8	4.2	5.8	3.5	4.0	3.8
Transport	0.7	0.9	1.5	6.5	7.1	9.1	3.6	3.5	3.5	0.7	0.9	1.4	6.4	7.0	8.6	3.3	3.2	3.2
Other Sectors	10.1	11.1	13.8	89.6	88.5	84.9	1.9	1.5	1.7	10.1	11.0	13.7	89.7	88.9	85.6	1.9	1.4	1.6
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…

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Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	4.5	5.9	12.1	100.0	100.0	100.0	6.3	4.9	5.5	4.3	5.4	10.1	100.0	100.0	100.0	5.4	4.2	4.7
Fossil Fuels	0.0	0.0	0.1	0.4	0.4	0.4	23.4	4.9	12.0	0.0	0.0	0.0	0.4	0.4	0.4	22.3	3.7	10.8
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.0	0.0	0.1	0.4	0.4	0.4	23.4	4.9	12.0	0.0	0.0	0.0	0.4	0.4	0.4	22.3	3.7	10.8
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	4.4	5.9	12.1	99.6	99.6	99.6	6.2	4.9	5.4	4.3	5.4	10.0	99.6	99.6	98.7	5.3	4.2	4.6
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.1	0.0	0.0	0.9	…	…	…
Thermal Power Generation Input	**Mtoe**			**Share (%)**			**AAGR (%)**			**Mtoe**			**Share (%)**			**AAGR (%)**		
	2015	**2020**	**2035**	**2015**	**2020**	**2035**	**2010–2020**	**2020–2035**	**2010–2035**	**2015**	**2020**	**2035**	**2015**	**2020**	**2035**	**2010–2020**	**2020–2035**	**2010–2035**
Fossil Fuels	0.0	0.0	0.0	100.0	100.0	100.0	21.0	3.9	10.4	0.0	0.0	0.0	100.0	100.0	100.0	20.0	2.7	9.3
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.0	0.0	0.0	100.0	100.0	100.0	21.0	3.9	10.4	0.0	0.0	0.0	100.0	100.0	100.0	20.0	2.7	9.3
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Carbon Dioxide Emissions	**Mt CO_2**			**AAGR (%)**						**Mt CO_2**			**AAGR (%)**					
	2015	**2020**	**2035**	**2010–2020**		**2020–2035**		**2010–2035**		**2015**	**2020**	**2035**	**2010–2020**		**2020–2035**		**2010–2035**	
Total	4.4	5.2	8.2	3.1		3.1		3.1		4.3	5.0	7.7	2.8		2.9		2.8	
Energy and Carbon Indicators							**AAGR (%)**									**AAGR (%)**		
				2015	**2020**	**2035**	**2010–2020**	**2020–2035**	**2010–2035**				**2015**	**2020**	**2035**	**2010–2020**	**2020–2035**	**2010–2035**
Primary Energy Demand/capita (toe/person)				0.35	0.36	0.40	0.5	0.6	0.6				0.35	0.36	0.39	0.5	0.5	0.5
Primary Energy Demand/GDP (toe/constant 2000 $ million)				1,160	1,058	833	(1.9)	(1.6)	(1.7)				1,157	1,050	815	(1.9)	(1.7)	(1.8)
CO_2/capita ($t\ CO_2$/person)				0.13	0.15	0.20	1.5	1.9	1.7				0.13	0.14	0.18	1.1	1.7	1.5
CO_2 Intensity ($t\ CO_2$/million constant 2000 $)				443	433	411	(1.0)	(0.3)	(0.6)				438	420	385	(1.3)	(0.6)	(0.9)
CO_2/Primary Energy Demand ($t\ CO_2$/toe)				0.38	0.41	0.49	0.9	1.3	1.1				0.38	0.40	0.47	0.7	1.1	0.9

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Sri Lanka
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	35.7	48.0	79.6	6.1	3.4	4.5
Population (million persons)	21.6	22.2	23.1	0.6	0.3	0.4
GDP/capita (constant 2000 $/person)	1,650	2,160	3,448	5.4	3.2	4.1

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	11.8	14.2	20.3	100.0	100.0	100.0	3.7	2.4	2.9	11.4	13.0	17.5	100.0	100.0	100.0	2.8	2.0	2.3
Coal	1.6	2.9	4.9	13.8	20.4	24.2	45.6	3.6	18.7	1.4	2.2	3.1	12.6	16.9	17.9	41.7	2.4	16.6
Oil	4.8	5.7	8.7	40.9	40.5	42.9	3.0	2.8	2.9	4.6	5.2	7.4	40.4	40.1	42.5	2.1	2.4	2.3
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.4	0.4	0.4	3.2	2.7	1.9	(2.4)	0.0	(1.0)	0.4	0.4	0.4	3.3	2.9	2.2	(2.4)	0.0	(1.0)
Others[a]	5.0	5.2	6.3	42.0	36.4	31.0	0.2	1.4	0.9	5.0	5.2	6.6	43.7	40.0	37.4	0.3	1.5	1.0
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	9.3	10.5	14.1	100.0	100.0	100.0	1.6	2.0	1.9	9.2	10.2	13.2	100.0	100.0	100.0	1.3	1.8	1.6
Coal	0.1	0.1	0.1	0.5	0.5	0.4	(2.7)	(0.0)	(1.1)	0.0	0.0	0.0	0.5	0.4	0.3	(4.3)	0.1	(1.7)
Oil	3.4	4.3	6.7	37.0	40.6	47.2	3.6	3.0	3.3	3.4	4.1	6.1	36.8	40.2	46.4	3.2	2.7	2.9
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Electricity	0.9	1.2	1.9	10.1	11.5	13.6	4.4	3.1	3.6	0.9	1.1	1.5	9.5	10.3	11.7	2.9	2.6	2.7
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	5.2	5.3	5.9	56.0	50.6	41.5	0.5	0.6	0.6	5.2	5.3	5.9	56.7	52.3	44.3	0.5	0.6	0.6
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	9.3	10.5	14.1	100.0	100.0	100.0	1.6	2.0	1.9	9.2	10.2	13.2	100.0	100.0	100.0	1.3	1.8	1.6
Industry	2.6	3.1	4.7	28.3	29.6	32.9	3.3	2.7	3.0	2.6	2.9	4.4	28.0	28.9	33.1	2.8	2.7	2.7
Transport	2.5	3.2	5.1	27.4	30.4	35.8	3.3	3.1	3.2	2.5	3.1	4.7	27.5	30.5	35.6	3.0	2.8	2.9
Other Sectors	4.1	4.2	4.4	43.8	39.6	30.9	(0.3)	0.3	0.1	4.0	4.1	4.1	44.0	40.1	30.9	(0.5)	0.0	(0.2)
Non-Energy	0.0	0.0	0.0	0.5	0.4	0.3	(5.2)	(0.1)	(2.2)	0.0	0.0	0.0	0.5	0.5	0.3	(5.2)	(0.1)	(2.2)

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Sri Lanka Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	15.0	19.6	31.2	100.0	100.0	100.0	6.2	3.1	4.3	14.0	16.9	25.1	100.0	100.0	100.0	4.6	2.7	3.4
Fossil Fuels	10.3	14.6	24.1	68.4	74.5	77.3	11.1	3.4	6.4	9.0	11.1	15.3	64.3	65.6	60.7	8.1	2.1	4.5
Coal	4.8	8.6	14.8	31.9	43.9	47.4	…	3.7	…	4.2	6.5	9.3	30.0	38.7	37.2	…	2.4	…
Oil	5.5	6.0	9.3	36.5	30.6	29.9	1.6	3.0	2.4	4.8	4.6	5.9	34.3	26.9	23.5	(1.1)	1.7	0.6
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	4.4	4.4	4.4	29.4	22.5	14.1	(2.4)	0.0	(1.0)	4.4	4.4	4.4	31.4	26.0	17.5	(2.4)	0.0	(1.0)
Others[b]	0.3	0.6	2.7	2.2	3.0	8.6	40.1	10.7	21.6	0.6	1.4	5.5	4.3	8.4	21.8	53.2	9.4	25.2

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	2.9	4.2	6.9	100.0	100.0	100.0	12.6	3.3	6.9	2.5	3.2	4.4	100.0	100.0	100.0	9.6	2.1	5.0
Coal	1.6	2.8	4.9	55.1	67.3	70.9	…	3.7	…	1.4	2.2	3.1	55.1	67.3	70.9	…	2.4	…
Oil	1.3	1.4	2.0	44.9	32.7	29.1	0.7	2.5	1.8	1.1	1.0	1.3	44.9	32.7	29.1	(2.0)	1.3	(0.1)
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)			Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	21.1	28.9	46.2	8.2	3.2	5.2	19.7	24.7	35.1	6.5	2.4	4.0

Energy and Carbon Indicators				AAGR (%)						AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)	0.55	0.64	0.88	3.0	2.2	2.5	0.53	0.59	0.76	2.2	1.7	1.9
Primary Energy Demand/GDP (toe/constant 2000 $ million)	331	295	256	(2.3)	(1.0)	(1.5)	320	272	220	(3.1)	(1.4)	(2.1)
CO_2/capita (t CO_2/person)	0.98	1.30	2.00	7.5	2.9	4.7	0.91	1.11	1.52	5.8	2.1	3.6
CO_2 Intensity (t CO_2/million constant 2000 $)	593	604	580	2.0	(0.3)	0.6	552	515	441	0.4	(1.0)	(0.5)
CO_2/Primary Energy Demand (t CO_2/toe)	1.79	2.04	2.27	4.4	0.7	2.2	1.73	1.89	2.01	3.6	0.4	1.7

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Southeast Asia Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	1,335.2	1,674.1	3,277.6	5.4	4.6	4.9
Population (million persons)	624.7	654.4	723.0	1.0	0.7	0.8
GDP/capita (constant 2000 $/person)	2,137	2,558	4,533	4.3	3.9	4.1

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	610.6	701.5	1,110.2	100.0	100.0	100.0	2.4	3.1	2.8	592.8	669.3	995.6	100.0	100.0	100.0	1.9	2.7	2.4
Coal	112.1	147.1	277.7	18.4	21.0	25.0	5.6	4.3	4.8	105.9	133.8	212.8	17.9	20.0	21.4	4.6	3.1	3.7
Oil	205.3	232.5	363.2	33.6	33.1	32.7	2.2	3.0	2.7	203.5	227.8	329.5	34.3	34.0	33.1	2.0	2.5	2.3
Natural Gas	135.9	153.1	257.8	22.3	21.8	23.2	2.2	3.5	3.0	126.4	138.1	210.7	21.3	20.6	21.2	1.2	2.9	2.2
Nuclear	0.0	0.0	12.8	0.0	0.0	1.2	…	…	…	0.0	0.0	41.9	0.0	0.0	4.2	…	…	…
Hydro	9.2	11.8	22.1	1.5	1.7	2.0	5.5	4.2	4.7	8.7	11.2	19.2	1.5	1.7	1.9	4.9	3.7	4.2
Others[a]	148.0	157.0	176.5	24.2	22.4	15.9	0.3	0.8	0.6	148.3	158.4	181.4	25.0	23.7	18.2	0.4	0.9	0.7
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	438.9	500.4	768.9	100.0	100.0	100.0	2.2	2.9	2.6	431.4	483.8	700.2	100.0	100.0	100.0	1.9	2.5	2.3
Coal	39.8	47.2	76.3	9.1	9.4	9.9	2.7	3.3	3.0	38.2	44.2	70.4	8.9	9.1	10.1	2.0	3.1	2.7
Oil	188.0	218.0	348.9	42.8	43.6	45.4	2.4	3.2	2.9	186.7	213.7	315.8	43.3	44.2	45.1	2.2	2.6	2.5
Natural Gas	35.7	43.1	76.8	8.1	8.6	10.0	4.4	3.9	4.1	34.8	41.3	69.5	8.1	8.5	9.9	3.9	3.5	3.7
Electricity	63.9	79.4	149.0	14.6	15.9	19.4	4.4	4.3	4.3	60.7	72.5	125.6	14.1	15.0	17.9	3.5	3.7	3.6
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	111.5	112.7	117.6	25.4	22.5	15.3	(0.1)	0.3	0.1	110.9	111.7	115.1	25.7	23.1	16.4	(0.2)	0.2	0.0
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	438.9	500.4	768.9	100.0	100.0	100.0	2.2	2.9	2.6	431.4	483.8	700.2	100.0	100.0	100.0	1.9	2.5	2.3
Industry	131.5	156.4	258.0	30.0	31.3	33.6	3.5	3.4	3.4	126.2	146.6	235.0	29.3	30.3	33.6	2.8	3.2	3.1
Transport	98.5	111.9	177.6	22.4	22.4	23.1	1.9	3.1	2.6	98.3	110.0	153.1	22.8	22.7	21.9	1.7	2.2	2.0
Other Sectors	164.6	180.4	256.8	37.5	36.1	33.4	1.6	2.4	2.1	162.6	175.6	235.6	37.7	36.3	33.6	1.3	2.0	1.7
Non-Energy	44.3	51.7	76.6	10.1	10.3	10.0	1.6	2.7	2.2	44.3	51.7	76.6	10.3	10.7	10.9	1.6	2.7	2.2

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Southeast Asia Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	834.9	1,035.5	1,991.0	100.0	100.0	100.0	4.3	4.5	4.4	791.9	944.4	1,679.1	100.0	100.0	100.0	3.3	3.9	3.7
Fossil Fuels	689.6	846.2	1,601.9	82.6	81.7	80.5	3.9	4.3	4.2	644.2	748.7	1,172.4	81.4	79.3	69.8	2.7	3.0	2.9
Coal	294.0	422.4	900.6	35.2	40.8	45.2	8.5	5.2	6.5	280.2	387.4	659.9	35.4	41.0	39.3	7.6	3.6	5.2
Oil	33.6	20.4	11.1	4.0	2.0	0.6	(9.5)	(4.0)	(6.2)	32.0	18.7	8.6	4.0	2.0	0.5	(10.3)	(5.1)	(7.2)
Natural Gas	362.0	403.4	690.2	43.4	39.0	34.7	2.0	3.6	3.0	332.0	342.6	503.9	41.9	36.3	30.0	0.3	2.6	1.7
Nuclear	0.0	0.0	49.8	0.0	0.0	2.5	…	…	…	0.0	0.0	163.2	0.0	0.0	9.7	…	…	…
Hydro	106.6	137.3	255.3	12.8	13.3	12.8	5.5	4.2	4.7	101.4	129.3	222.8	12.8	13.7	13.3	4.8	3.7	4.2
Others[b]	38.6	52.0	84.0	4.6	5.0	4.2	7.9	3.2	5.1	46.3	66.4	120.6	5.8	7.0	7.2	10.5	4.1	6.6

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	154.3	185.4	336.0	100.0	100.0	100.0	3.6	4.0	3.9	140.2	159.9	235.5	100.0	100.0	100.0	2.1	2.6	2.4
Coal	72.6	100.2	202.1	47.1	54.0	60.2	7.2	4.8	5.8	68.0	89.9	143.1	48.5	56.2	60.8	6.1	3.1	4.3
Oil	8.4	5.0	2.7	5.4	2.7	0.8	(9.6)	(4.0)	(6.3)	7.9	4.6	2.1	5.6	2.9	0.9	(10.4)	(5.2)	(7.3)
Natural Gas	73.3	80.2	131.2	47.5	43.3	39.0	1.9	3.3	2.8	64.3	65.4	90.4	45.9	40.9	38.4	(0.2)	2.2	1.2

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)			Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	1,263.6	1,504.3	2,596.1	3.5	3.7	3.6	1,211.1	1,402.1	2,124.9	2.7	2.8	2.8

Energy and Carbon Indicators				AAGR (%)						AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)	0.98	1.07	1.54	1.3	2.4	2.0	0.95	1.02	1.38	0.8	2.0	1.5
Primary Energy Demand/GDP (toe/constant 2000 $ million)	457	419	339	(2.9)	(1.4)	(2.0)	444	400	304	(3.3)	(1.8)	(2.4)
CO_2/capita (t CO_2/person)	2.02	2.30	3.59	2.4	3.0	2.8	1.94	2.14	2.94	1.7	2.1	1.9
CO_2 Intensity (t CO_2/million constant 2000 $)	946	899	792	(1.8)	(0.8)	(1.2)	907	838	648	(2.5)	(1.7)	(2.0)
CO_2/Primary Energy Demand (t CO_2/toe)	2.07	2.14	2.34	1.1	0.6	0.8	2.04	2.09	2.13	0.8	0.1	0.4

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision.* http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Brunei Darussalam
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	7.6	8.2	10.5	1.8	1.6	1.7
Population (million persons)	0.4	0.5	0.5	1.6	1.1	1.3
GDP/capita (constant 2000 $/person)	17,448	17,674	19,125	0.3	0.5	0.4

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	3.2	3.1	3.1	100.0	100.0	100.0	(0.1)	(0.1)	(0.1)	3.1	2.9	2.7	100.0	100.0	100.0	(0.8)	(0.4)	(0.6)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.8	0.8	0.9	25.0	26.4	29.8	1.0	0.7	0.8	0.8	0.8	0.8	25.4	27.4	28.9	0.5	(0.0)	0.2
Natural Gas	2.3	2.3	2.1	73.4	71.8	67.9	(0.6)	(0.5)	(0.6)	2.2	2.0	1.8	72.8	70.4	65.4	(1.6)	(0.9)	(1.2)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others[a]	0.1	0.1	0.1	1.7	1.8	2.3	56.9	1.6	20.9	0.1	0.1	0.2	1.8	2.2	5.7	59.2	6.1	24.8
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	1.5	1.6	1.7	100.0	100.0	100.0	2.6	0.5	1.3	1.5	1.5	1.5	100.0	100.0	100.0	2.2	0.1	0.9
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.7	0.7	0.8	43.9	44.6	45.9	1.0	0.7	0.8	0.7	0.7	0.7	44.0	44.8	44.2	0.6	(0.0)	0.2
Natural Gas	0.6	0.6	0.6	37.3	36.6	34.5	6.6	0.1	2.6	0.6	0.6	0.6	37.9	37.6	37.6	6.5	0.1	2.6
Electricity	0.3	0.3	0.3	18.6	18.6	19.0	0.5	0.7	0.6	0.3	0.3	0.3	17.9	17.3	17.5	(0.6)	0.2	(0.1)
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	0.0	0.0	0.0	0.2	0.3	0.6	20.8	6.2	11.8	0.0	0.0	0.0	0.2	0.3	0.7	20.8	6.2	11.8
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	1.5	1.6	1.7	100.0	100.0	100.0	2.6	0.5	1.3	1.5	1.5	1.5	100.0	100.0	100.0	2.2	0.1	0.9
Industry	0.3	0.3	0.3	18.1	18.4	19.5	2.2	0.9	1.4	0.3	0.3	0.3	17.5	17.4	19.2	1.2	0.7	0.9
Transport	0.4	0.5	0.5	29.3	29.8	30.7	1.1	0.7	0.8	0.4	0.5	0.4	29.7	30.5	29.1	0.9	(0.2)	0.2
Other Sectors	0.3	0.3	0.3	20.9	20.8	20.9	0.4	0.5	0.5	0.3	0.3	0.3	20.4	20.0	19.7	(0.4)	(0.0)	(0.2)
Non-Energy	0.5	0.5	0.5	31.6	30.9	28.9	7.0	0.0	2.7	0.5	0.5	0.5	32.3	32.1	31.9	7.0	0.0	2.7

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Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	3.7	3.7	4.0	100.0	100.0	100.0	0.3	0.5	0.4	3.5	3.3	3.4	100.0	100.0	100.0	(0.9)	0.2	(0.2)
Fossil Fuels	3.5	3.5	3.8	94.6	94.6	95.0	(0.3)	0.5	0.2	3.3	3.1	3.0	94.3	93.9	88.2	(1.5)	(0.2)	(0.7)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Natural Gas	3.5	3.5	3.8	94.6	94.6	95.0	(0.3)	0.5	0.2	3.3	3.1	3.0	94.3	93.9	88.2	(1.5)	(0.2)	(0.7)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others[b]	0.2	0.2	0.2	5.4	5.4	5.0	…	0.0	…	0.2	0.2	0.4	5.7	6.1	11.8	…	4.7	…
Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	0.9	0.9	0.7	100.0	100.0	100.0	(3.4)	(0.9)	(1.9)	0.8	0.7	0.6	100.0	100.0	100.0	(5.0)	(1.7)	(3.0)
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Natural Gas	0.9	0.9	0.7	100.0	100.0	100.0	(3.4)	(0.9)	(1.9)	0.8	0.7	0.6	100.0	100.0	100.0	(5.0)	(1.7)	(3.0)
Carbon Dioxide Emissions	Mt CO_2			AAGR (%)						Mt CO_2			AAGR (%)					
	2015	2020	2035		2010–2020		2020–2035		2010–2035	2015	2020	2035		2010–2020		2020–2035		2010–2035
Total	6.8	6.7	6.6		(0.9)		(0.1)		(0.5)	6.5	6.1	5.5		(1.9)		(0.7)		(1.2)
Energy and Carbon Indicators							AAGR (%)									AAGR (%)		
				2015	2020	2035	2010–2020	2020–2035	2010–2035				2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)				7.39	6.76	5.64	(1.6)	(1.2)	(1.4)				7.04	6.24	5.02	(2.4)	(1.4)	(1.8)
Primary Energy Demand/GDP (toe/constant 2000 $ million)				424	382	295	(1.8)	(1.7)	(1.8)				404	353	262	(2.6)	(2.0)	(2.2)
CO_2/capita (t CO_2/person)				15.79	14.44	12.07	(2.5)	(1.2)	(1.7)				14.93	13.12	10.08	(3.4)	(1.7)	(2.4)
CO_2 Intensity (t CO_2/million constant 2000 $)				905	817	631	(2.7)	(1.7)	(2.1)				855	742	527	(3.6)	(2.3)	(2.8)
CO_2/Primary Energy Demand (t CO_2/toe)				2.14	2.14	2.14	(0.9)	0.0	(0.4)				2.12	2.10	2.01	(1.0)	(0.3)	(0.6)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Cambodia
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	11.3	16.1	40.8	7.4	6.4	6.8
Population (million persons)	15.0	15.8	17.8	1.1	0.8	0.9
GDP/capita (constant 2000 $/person)	751	1,016	2,296	6.2	5.6	5.8

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	5.2	5.9	8.9	100.0	100.0	100.0	1.6	2.8	2.3	5.1	5.6	7.7	100.0	100.0	100.0	1.1	2.2	1.7
Coal	0.3	0.5	1.1	5.8	8.7	12.8	50.7	5.4	21.6	0.3	0.4	0.4	5.1	6.6	4.7	46.0	(0.1)	16.3
Oil	2.2	2.6	4.4	41.6	44.9	48.8	7.5	3.4	5.0	2.1	2.5	3.9	41.3	44.9	51.0	7.1	3.0	4.6
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.0	0.1	0.8	0.5	1.7	8.9	45.8	15.0	26.4	0.0	0.1	0.8	0.5	1.7	10.2	45.8	15.0	26.4
Others[a]	2.7	2.6	2.6	52.1	44.7	29.6	(3.5)	0.0	(1.4)	2.7	2.6	2.6	53.1	46.7	34.0	(3.5)	0.0	(1.4)
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	4.5	5.1	8.1	100.0	100.0	100.0	1.8	3.2	2.6	4.5	5.0	7.5	100.0	100.0	100.0	1.7	2.7	2.3
Coal	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Oil	1.8	2.3	4.4	39.7	44.7	53.5	8.8	4.4	6.1	1.8	2.3	3.9	39.7	45.1	52.7	8.7	3.8	5.7
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Electricity	0.3	0.5	1.4	6.3	9.1	17.7	10.2	7.9	8.8	0.3	0.4	1.2	6.0	8.0	16.1	8.7	7.6	8.0
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	2.4	2.4	2.3	54.0	46.2	28.8	(2.7)	(0.0)	(1.1)	2.4	2.4	2.3	54.3	46.9	31.3	(2.7)	(0.0)	(1.1)
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	4.5	5.1	8.1	100.0	100.0	100.0	1.8	3.2	2.6	4.5	5.0	7.5	100.0	100.0	100.0	1.7	2.7	2.3
Industry	0.9	1.0	1.2	20.4	19.0	14.6	0.8	1.4	1.1	0.9	1.0	1.2	20.4	19.0	15.4	0.7	1.3	1.0
Transport	0.8	1.1	2.6	17.4	20.8	32.4	5.3	6.3	5.9	0.8	1.0	2.3	17.4	20.8	30.2	5.2	5.3	5.2
Other Sectors	2.8	3.1	4.3	62.2	60.3	53.0	1.2	2.3	1.9	2.8	3.0	4.1	62.2	60.2	54.4	1.1	2.0	1.6
Non-Energy	0.0	0.0	0.0	0.0	0.0	0.0	(100.0)	…	(100.0)	0.0	0.0	0.0	0.0	0.0	0.0	(100.0)	…	(100.0)

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Cambodia Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	2.9	4.6	14.2	100.0	100.0	100.0	16.6	7.7	11.2	2.8	4.0	11.9	100.0	100.0	100.0	15.1	7.4	10.4
Fossil Fuels	2.6	3.5	4.9	88.9	75.4	35.0	14.0	2.3	6.8	2.3	2.6	1.6	81.9	63.3	13.7	10.5	(3.0)	2.2
Coal	1.2	2.1	4.9	40.7	44.8	35.0	52.2	6.0	22.5	1.0	1.5	1.6	37.5	37.6	13.7	47.6	0.4	17.2
Oil	1.4	1.4	0.0	48.1	30.6	0.0	4.5	(100.0)	(100.0)	1.2	1.0	0.0	44.3	25.7	0.0	1.3	(100.0)	(100.0)
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.3	1.1	9.2	10.9	24.4	65.0	45.8	15.0	26.5	0.3	1.1	9.2	11.6	27.9	77.4	45.8	15.0	26.5
Others[b]	0.0	0.0	0.0	0.2	0.1	0.0	(12.6)	0.0	(5.2)	0.2	0.4	1.1	6.6	8.8	8.9	31.5	7.5	16.5
Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	0.7	0.9	1.1	100.0	100.0	100.0	13.3	1.8	6.2	0.6	0.6	0.4	100.0	100.0	100.0	9.8	(3.6)	1.5
Coal	0.3	0.5	1.1	45.4	59.0	100.0	51.5	5.4	21.9	0.3	0.4	0.4	45.3	58.8	100.0	46.7	(0.1)	16.5
Oil	0.4	0.4	0.0	54.6	41.0	0.0	4.0	(100.0)	(100.0)	0.3	0.3	0.0	54.7	41.2	0.0	0.8	(100.0)	(100.0)
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Carbon Dioxide Emissions	Mt CO_2			AAGR (%)						Mt CO_2			AAGR (%)					
	2015	2020	2035	2010–2020		2020–2035		2010–2035		2015	2020	2035	2010–2020		2020–2035		2010–2035	
Total	7.8	10.1	17.9	10.0		3.8		6.3		7.5	9.2	13.6	9.0		2.6		5.1	
Energy and Carbon Indicators							AAGR (%)									AAGR (%)		
				2015	2020	2035	2010–2020	2020–2035	2010–2035				2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/ capita (toe/person)				0.35	0.37	0.50	0.4	2.0	1.4				0.34	0.36	0.44	(0.0)	1.4	0.8
Primary Energy Demand/ GDP (toe/constant 2000 $ million)				461	365	219	(5.4)	(3.4)	(4.2)				453	350	190	(5.8)	(4.0)	(4.7)
CO_2/capita ($t\ CO_2$/person)				0.52	0.64	1.01	8.8	3.1	5.3				0.50	0.58	0.76	7.8	1.8	4.2
CO_2 Intensity ($t\ CO_2$/million constant 2000 $)				695	630	438	2.5	(2.4)	(0.5)				665	574	333	1.5	(3.6)	(1.6)
CO_2/Primary Energy Demand ($t\ CO_2$/toe)				1.51	1.72	2.00	8.3	1.0	3.9				1.47	1.64	1.75	7.8	0.4	3.3

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision.* http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Indonesia
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	371.4	472.7	985.0	6.2	5.0	5.5
Population (million persons)	251.9	262.6	285.8	1.0	0.6	0.7
GDP/capita (constant 2000 $/person)	1,474	1,800	3,446	5.1	4.4	4.7

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	230.9	267.0	445.4	100.0	100.0	100.0	2.5	3.5	3.1	225.6	258.3	403.3	100.0	100.0	100.0	2.2	3.0	2.7
Coal	46.4	58.9	128.3	20.1	22.1	28.8	6.8	5.3	5.9	44.1	54.8	99.0	19.5	21.2	24.5	6.0	4.0	4.8
Oil	72.3	80.6	134.2	31.3	30.2	30.1	1.9	3.5	2.8	71.7	79.2	121.4	31.8	30.7	30.1	1.7	2.9	2.4
Natural Gas	43.8	52.9	92.2	19.0	19.8	20.7	3.2	3.8	3.5	41.3	49.3	80.5	18.3	19.1	20.0	2.4	3.3	3.0
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	11.7	0.0	0.0	2.9	…	…	…
Hydro	1.1	2.1	3.7	0.5	0.8	0.8	3.3	3.8	3.6	1.0	2.0	2.8	0.4	0.8	0.7	2.8	2.3	2.5
Others[a]	67.3	72.4	87.0	29.2	27.1	19.5	0.3	1.2	0.9	67.5	72.8	87.9	29.9	28.2	21.8	0.4	1.3	0.9
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	169.1	192.2	305.2	100.0	100.0	100.0	2.1	3.1	2.7	167.0	187.8	280.3	100.0	100.0	100.0	1.8	2.7	2.4
Coal	13.0	15.4	26.3	7.7	8.0	8.6	1.8	3.6	2.9	12.7	14.8	24.7	7.6	7.9	8.8	1.4	3.4	2.6
Oil	66.5	77.4	131.6	39.3	40.2	43.1	2.3	3.6	3.1	66.1	76.1	119.2	39.6	40.5	42.5	2.1	3.0	2.7
Natural Gas	21.3	26.3	49.4	12.6	13.7	16.2	5.2	4.3	4.6	20.9	25.6	46.4	12.5	13.6	16.6	4.9	4.1	4.4
Electricity	16.8	22.1	46.9	10.0	11.5	15.4	5.7	5.1	5.4	16.1	20.4	38.6	9.7	10.9	13.8	4.8	4.3	4.5
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	51.3	51.0	50.9	30.4	26.5	16.7	(0.4)	(0.0)	(0.2)	51.2	50.8	50.4	30.6	27.1	18.0	(0.5)	(0.1)	(0.2)
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	169.1	192.2	305.2	100.0	100.0	100.0	2.1	3.1	2.7	167.0	187.8	280.3	100.0	100.0	100.0	1.8	2.7	2.4
Industry	53.9	64.3	111.4	31.9	33.4	36.5	3.4	3.7	3.6	52.5	62.0	104.4	31.4	33.0	37.3	3.1	3.5	3.3
Transport	35.4	40.1	68.6	20.9	20.9	22.5	1.1	3.6	2.6	35.4	39.5	59.2	21.2	21.0	21.1	1.0	2.7	2.0
Other Sectors	69.8	75.7	104.2	41.3	39.4	34.1	1.4	2.2	1.9	69.2	74.1	95.7	41.4	39.5	34.1	1.2	1.7	1.5
Non-Energy	10.0	12.1	21.0	5.9	6.3	6.9	3.1	3.7	3.5	10.0	12.1	21.0	6.0	6.5	7.5	3.1	3.7	3.5

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Indonesia Outlook Cases *continued*

	Business-as-Usual Case									Alternative Case								
Power Generation Output	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	221.3	286.0	607.1	100.0	100.0	100.0	5.4	5.1	5.2	211.8	263.7	498.5	100.0	100.0	100.0	4.5	4.3	4.4
Fossil Fuels	191.2	236.1	519.0	86.4	82.6	85.5	5.2	5.4	5.3	180.8	212.4	369.4	85.4	80.5	74.1	4.1	3.8	3.9
Coal	131.4	179.1	438.0	59.4	62.6	72.1	10.2	6.1	7.7	127.8	172.5	336.5	60.3	65.4	67.5	9.7	4.6	6.6
Oil	20.5	9.9	4.7	9.3	3.5	0.8	(11.7)	(4.8)	(7.7)	19.9	9.5	3.5	9.4	3.6	0.7	(12.1)	(6.4)	(8.7)
Natural Gas	39.3	47.1	76.3	17.8	16.5	12.6	1.6	3.3	2.6	33.1	30.4	29.4	15.6	11.5	5.9	(2.7)	(0.2)	(1.2)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	44.8	0.0	0.0	9.0	…	…	…
Hydro	12.6	24.5	43.1	5.7	8.6	7.1	3.3	3.8	3.6	12.2	23.5	32.3	5.8	8.9	6.5	2.9	2.1	2.4
Others[b]	17.5	25.4	45.0	7.9	8.9	7.4	10.4	3.9	6.4	18.8	27.8	52.0	8.9	10.5	10.4	11.4	4.3	7.1
Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	47.9	56.9	118.6	100.0	100.0	100.0	4.7	5.0	4.9	43.3	48.7	80.7	100.0	100.0	100.0	3.1	3.4	3.3
Coal	33.4	43.5	102.0	69.8	76.4	85.9	8.8	5.8	7.0	31.4	40.0	74.3	72.5	82.2	92.1	7.9	4.2	5.7
Oil	4.9	2.4	1.1	10.3	4.2	0.9	(11.9)	(4.9)	(7.8)	4.8	2.3	0.8	11.0	4.7	1.0	(12.3)	(6.8)	(9.0)
Natural Gas	9.5	11.0	15.5	19.9	19.4	13.1	2.5	2.3	2.4	7.1	6.4	5.6	16.4	13.1	6.9	(3.0)	(0.9)	(1.7)
Carbon Dioxide Emissions	Mt CO_2			AAGR (%)						Mt CO_2			AAGR (%)					
	2015	2020	2035		2010–2020		2020–2035		2010–2035	2015	2020	2035		2010–2020		2020–2035		2010–2035
Total	481.8	572.5	1,080.3		3.8		4.3		4.1	464.9	543.8	897.6		3.3		3.4		3.4
Energy and Carbon Indicators							AAGR (%)									AAGR (%)		
				2015	2020	2035	2010–2020	2020–2035	2010–2035				2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)				0.92	1.02	1.56	1.5	2.9	2.3				0.90	0.98	1.41	1.2	2.4	1.9
Primary Energy Demand/GDP (toe/constant 2000 $ million)				622	565	452	(3.5)	(1.5)	(2.3)				607	546	409	(3.8)	(1.9)	(2.7)
CO_2/capita (t CO_2/person)				1.91	2.18	3.78	2.8	3.7	3.4				1.85	2.07	3.14	2.3	2.8	2.6
CO_2 Intensity (t CO_2/million constant 2000 $)				1,297	1,211	1,097	(2.2)	(0.7)	(1.3)				1,252	1,150	911	(2.7)	(1.5)	(2.0)
CO_2/Primary Energy Demand (t CO_2/toe)				2.09	2.14	2.43	1.3	0.8	1.0				2.06	2.11	2.23	1.1	0.4	0.7

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Lao People's Democratic Republic
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	5.0	6.9	13.2	7.1	4.4	5.5
Population (million persons)	6.6	7.0	8.0	1.3	0.9	1.0
GDP/capita (constant 2000 $/person)	753	980	1,647	5.8	3.5	4.4

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	4.1	5.1	7.9	100.0	100.0	100.0	6.3	3.0	4.3	4.0	5.0	7.4	100.0	100.0	100.0	6.1	2.6	4.0
Coal	1.7	2.4	3.3	42.1	45.9	42.1	31.3	2.4	13.1	1.7	2.3	3.2	42.1	46.0	43.7	31.0	2.3	12.9
Oil	0.8	1.1	2.2	19.4	21.4	27.8	5.7	4.8	5.1	0.8	1.1	1.9	19.4	21.5	25.3	5.5	3.7	4.4
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	1.2	1.3	1.5	29.3	25.9	19.1	6.2	0.9	3.0	1.2	1.3	1.4	29.2	25.6	18.6	5.9	0.5	2.6
Others[a]	0.4	0.3	0.9	9.1	6.7	11.0	(12.2)	6.4	(1.5)	0.4	0.3	0.9	9.3	6.9	12.5	(12.2)	6.8	(1.3)
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	3.0	3.7	6.0	100.0	100.0	100.0	4.5	3.4	3.8	2.9	3.6	5.6	100.0	100.0	100.0	4.3	3.0	3.5
Coal	0.2	0.2	0.6	5.2	6.3	10.5	8.0	7.0	7.4	0.2	0.2	0.6	5.2	6.0	10.7	7.4	7.0	7.2
Oil	0.8	1.1	2.2	26.4	30.0	36.7	7.4	4.8	5.8	0.8	1.1	1.9	26.4	30.1	33.5	7.3	3.7	5.1
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Electricity	0.3	0.4	0.7	9.6	10.3	11.5	6.0	4.2	4.9	0.3	0.3	0.6	9.2	9.6	11.4	5.1	4.2	4.5
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	1.7	2.0	2.5	58.8	53.5	41.3	2.6	1.6	2.0	1.7	2.0	2.5	59.2	54.3	44.4	2.6	1.6	2.0
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	3.0	3.7	6.0	100.0	100.0	100.0	4.5	3.4	3.8	2.9	3.6	5.6	100.0	100.0	100.0	4.3	3.0	3.5
Industry	0.4	0.5	1.2	12.0	14.0	19.9	8.2	5.8	6.8	0.3	0.5	1.1	11.7	13.5	20.3	7.7	5.8	6.6
Transport	0.7	1.0	2.1	24.9	28.2	34.2	7.2	4.7	5.7	0.7	1.0	1.8	24.9	28.2	31.4	7.1	3.7	5.1
Other Sectors	1.9	2.1	2.8	63.1	57.8	45.9	2.7	1.8	2.2	1.9	2.1	2.7	63.3	58.2	48.2	2.6	1.7	2.1
Non-Energy	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0

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	Business-as-Usual Case									Alternative Case								
Power Generation Output	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	20.1	24.1	28.7	100.0	100.0	100.0	11.1	1.2	5.0	19.9	23.7	27.9	100.0	100.0	100.0	10.9	1.1	4.9
Fossil Fuels	6.3	8.7	11.0	31.3	35.9	38.5	…	1.6	…	6.3	8.7	11.0	31.6	36.6	39.6	…	1.6	…
Coal	6.3	8.7	11.0	31.3	35.9	38.5	…	1.6	…	6.3	8.7	11.0	31.6	36.6	39.6	…	1.6	…
Oil	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	13.8	15.5	17.6	68.7	64.1	61.5	6.2	0.9	3.0	13.6	15.0	16.1	68.1	63.1	57.8	5.9	0.5	2.6
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…	0.0	…	0.0	0.1	0.7	0.2	0.3	2.6	…	15.7	…
Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	1.5	2.1	2.7	100.0	100.0	100.0	…	1.6	…	1.5	2.1	2.6	100.0	100.0	100.0	…	1.6	…
Coal	1.5	2.1	2.7	100.0	100.0	100.0	…	1.6	…	1.5	2.1	2.6	100.0	100.0	100.0	…	1.6	…
Oil	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Carbon Dioxide Emissions	Mt CO_2			AAGR (%)						Mt CO_2			AAGR (%)					
	2015	2020	2035	2010–2020		2020–2035		2010–2035		2015	2020	2035	2010–2020		2020–2035		2010–2035	
Total	9.2	12.7	20.0	17.4		3.1		8.6		9.1	12.5	18.6	17.2		2.7		8.3	
Energy and Carbon Indicators							AAGR (%)									AAGR (%)		
				2015	2020	2035	2010–2020	2020–2035	2010–2035				2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)				0.61	0.73	0.99	4.9	2.1	3.2				0.60	0.71	0.93	4.7	1.8	2.9
Primary Energy Demand/GDP (toe/constant 2000 $ million)				812	744	602	(0.8)	(1.4)	(1.1)				803	729	564	(1.0)	(1.7)	(1.4)
CO_2/capita (t CO_2/person)				1.38	1.80	2.50	15.9	2.2	7.5				1.37	1.77	2.32	15.7	1.8	7.2
CO_2 Intensity (t CO_2/million constant 2000 $)				1,836	1,842	1,518	9.6	(1.3)	2.9				1,817	1,806	1,411	9.4	(1.6)	2.6
CO_2/Primary Energy Demand (t CO_2/toe)				2.26	2.48	2.52	10.5	0.1	4.1				2.26	2.48	2.50	10.5	0.1	4.1

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision.* http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Malaysia
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	200.1	241.5	419.8	5.1	3.8	4.3
Population (million persons)	30.7	33.0	39.2	1.5	1.1	1.3
GDP/capita (constant 2000 $/person)	6,514	7,323	10,721	3.5	2.6	2.9

Business-as-Usual Case

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	76.1	83.0	109.5	100.0	100.0	100.0	1.3	1.9	1.7
Coal	15.1	19.2	14.2	19.8	23.1	12.9	2.8	(2.0)	(0.1)
Oil	26.8	29.1	36.4	35.2	35.1	33.3	1.1	1.5	1.4
Natural Gas	29.6	29.2	48.1	38.9	35.2	44.0	0.4	3.4	2.2
Nuclear	0.0	0.0	2.0	0.0	0.0	1.8	…	…	…
Hydro	0.9	0.9	2.9	1.2	1.1	2.6	4.9	8.1	6.8
Others[a]	3.7	4.6	5.9	4.9	5.6	5.4	3.2	1.6	2.2
Final Energy Demand By Source									
Total	46.3	51.4	68.9	100.0	100.0	100.0	1.7	2.0	1.9
Coal	1.8	2.0	2.6	4.0	3.9	3.8	1.0	1.8	1.5
Oil	25.1	27.6	34.5	54.2	53.7	50.1	1.1	1.5	1.4
Natural Gas	7.1	8.0	11.7	15.3	15.5	17.0	3.6	2.6	3.0
Electricity	10.4	11.9	17.7	22.5	23.1	25.7	2.2	2.7	2.5
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	1.9	1.9	2.3	4.0	3.8	3.3	1.3	1.0	1.1
Final Energy Demand By Sector									
Total	46.3	51.4	68.9	100.0	100.0	100.0	1.7	2.0	1.9
Industry	16.7	18.9	27.6	36.0	36.7	40.1	3.8	2.6	3.0
Transport	15.6	17.1	20.6	33.7	33.3	29.9	1.7	1.2	1.4
Other Sectors	10.1	11.2	15.8	21.7	21.8	22.9	1.4	2.3	2.0
Non-Energy	4.0	4.2	4.9	8.6	8.1	7.1	(3.8)	1.1	(0.9)

Alternative Case

Primary Energy Demand	Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	72.4	77.7	94.8	100.0	100.0	100.0	0.7	1.3	1.1
Coal	14.7	18.5	10.3	20.2	23.8	10.8	2.4	(3.8)	(1.4)
Oil	26.5	28.3	31.8	36.6	36.4	33.5	0.8	0.8	0.8
Natural Gas	26.3	24.7	35.6	36.3	31.9	37.5	(1.3)	2.4	1.0
Nuclear	0.0	0.0	8.0	0.0	0.0	8.4	…	…	…
Hydro	0.9	0.9	2.4	1.2	1.2	2.5	4.9	6.8	6.0
Others[a]	4.0	5.3	6.8	5.6	6.8	7.2	4.5	1.7	2.8
Final Energy Demand By Source									
Total	45.1	48.9	59.7	100.0	100.0	100.0	1.2	1.3	1.3
Coal	1.8	1.9	2.3	3.9	3.8	3.8	0.2	1.3	0.8
Oil	24.8	26.7	29.9	54.9	54.6	50.1	0.8	0.8	0.8
Natural Gas	6.9	7.5	10.3	15.2	15.4	17.3	3.0	2.1	2.5
Electricity	9.9	10.8	14.5	21.8	22.1	24.3	1.3	2.0	1.7
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	1.9	1.9	2.2	4.1	3.9	3.6	1.2	0.8	0.9
Final Energy Demand By Sector									
Total	45.1	48.9	59.7	100.0	100.0	100.0	1.2	1.3	1.3
Industry	15.9	17.5	23.7	35.1	35.7	39.7	3.0	2.1	2.4
Transport	15.6	16.8	17.8	34.5	34.4	29.9	1.5	0.4	0.9
Other Sectors	9.7	10.5	13.2	21.6	21.4	22.2	0.8	1.6	1.2
Non-Energy	4.0	4.2	4.9	8.8	8.5	8.2	(3.8)	1.1	(0.9)

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Malaysia Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	125.1	142.4	212.5	100.0	100.0	100.0	1.3	2.7	2.1	117.3	129.7	174.3	100.0	100.0	100.0	0.3	2.0	1.3
Fossil Fuels	113.6	129.0	166.4	90.8	90.6	78.3	0.9	1.7	1.4	104.8	113.9	103.6	89.3	87.8	59.4	(0.3)	(0.6)	(0.5)
Coal	52.0	71.1	58.0	41.6	49.9	27.3	5.1	(1.3)	1.2	51.1	68.9	41.4	43.6	53.1	23.8	4.8	(3.3)	(0.2)
Oil	1.2	0.3	0.3	1.0	0.2	0.1	(22.2)	0.0	(9.5)	1.2	0.3	0.3	1.0	0.2	0.2	(22.2)	0.0	(9.5)
Natural Gas	60.4	57.6	108.1	48.3	40.4	50.9	(2.0)	4.3	1.7	52.5	44.7	61.9	44.8	34.5	35.5	(4.5)	2.2	(0.5)
Nuclear	0.0	0.0	8.3	0.0	0.0	3.9	…	…	…	0.0	0.0	33.4	0.0	0.0	19.2	…	…	…
Hydro	10.0	9.9	32.0	8.0	7.0	15.1	4.3	8.1	6.6	9.7	9.5	26.8	8.3	7.3	15.4	3.9	7.2	5.8
Others[b]	1.5	3.5	5.8	1.2	2.5	2.7	10.5	3.4	6.2	2.8	6.3	10.5	2.4	4.9	6.0	17.2	3.5	8.8
Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	27.2	29.7	33.5	100.0	100.0	100.0	(0.1)	0.8	0.4	23.8	25.1	18.8	100.0	100.0	100.0	(1.8)	(1.9)	(1.8)
Coal	13.2	17.2	11.6	48.6	57.9	34.5	2.8	(2.6)	(0.5)	12.9	16.6	8.0	54.2	66.1	42.6	2.5	(4.7)	(1.9)
Oil	0.4	0.1	0.1	1.5	0.3	0.3	(18.6)	0.0	(7.9)	0.4	0.1	0.1	1.7	0.4	0.5	(18.2)	0.0	(7.7)
Natural Gas	13.6	12.4	21.9	49.9	41.8	65.2	(2.7)	3.9	1.2	10.5	8.4	10.7	44.1	33.5	56.9	(6.4)	1.6	(1.7)
Carbon Dioxide Emissions	Mt CO_2			AAGR (%)						Mt CO_2			AAGR (%)					
	2015	2020	2035	2010–2020			2020–2035		2010–2035	2015	2020	2035	2010–2020		2020–2035		2010–2035	
Total	200.8	222.5	267.6	1.8			1.2		1.5	190.3	206.6	208.3	1.1		0.1		0.5	
Energy and Carbon Indicators							AAGR (%)									AAGR (%)		
				2015	2020	2035	2010–2020	2020–2035	2010–2035				2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)				2.48	2.52	2.80	(0.2)	0.7	0.4				2.36	2.35	2.42	(0.8)	0.2	(0.2)
Primary Energy Demand/GDP (toe/constant 2000 $ million)				380	344	261	(3.5)	(1.8)	(2.5)				362	322	226	(4.2)	(2.3)	(3.1)
CO_2/capita (t CO_2/person)				6.54	6.75	6.83	0.3	0.1	0.2				6.20	6.26	5.32	(0.4)	(1.1)	(0.8)
CO_2 Intensity (t CO_2/million constant 2000 $)				1,003	921	637	(3.1)	(2.4)	(2.7)				951	855	496	(3.8)	(3.6)	(3.7)
CO_2/Primary Energy Demand (t CO_2/toe)				2.64	2.68	2.44	0.5	(0.6)	(0.2)				2.63	2.66	2.20	0.4	(1.3)	(0.6)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Myanmar
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	31.4	45.7	135.9	7.8	7.5	7.6
Population (million persons)	49.9	51.7	55.0	0.7	0.4	0.5
GDP/capita (constant 2000 $/person)	630	885	2,473	7.0	7.1	7.1

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	17.6	19.2	30.3	100.0	100.0	100.0	3.2	3.1	3.1	17.6	19.0	29.2	100.0	100.0	100.0	3.1	2.9	3.0
Coal	0.3	0.4	1.9	1.8	2.1	6.4	0.0	10.9	6.4	0.3	0.3	1.0	1.7	1.4	3.3	(4.0)	8.8	3.5
Oil	4.0	4.2	6.2	22.9	21.6	20.3	12.5	2.7	6.5	4.0	4.1	5.6	22.9	21.7	19.3	12.4	2.1	6.1
Natural Gas	1.9	3.1	12.8	10.6	16.1	42.2	8.8	9.9	9.5	1.8	2.9	12.4	10.3	15.5	42.6	8.3	10.1	9.3
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	1.0	1.5	5.7	5.7	8.0	18.7	13.4	9.1	10.8	1.0	1.5	5.7	5.7	8.1	19.5	13.4	9.1	10.8
Others[a]	10.4	10.0	3.8	59.0	52.1	12.4	(0.5)	(6.3)	(4.0)	10.4	10.1	4.5	59.3	53.3	15.3	(0.4)	(5.3)	(3.4)
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	14.2	15.2	21.0	100.0	100.0	100.0	1.7	2.2	2.0	14.2	15.1	20.1	100.0	100.0	100.0	1.6	1.9	1.8
Coal	0.1	0.1	0.1	1.0	0.7	0.4	(7.4)	(2.4)	(4.4)	0.1	0.1	0.1	1.0	0.7	0.3	(8.1)	(2.5)	(4.8)
Oil	1.9	2.1	4.9	13.1	14.1	23.1	7.7	5.6	6.4	1.9	2.1	4.2	13.0	14.0	20.7	7.5	4.6	5.8
Natural Gas	0.8	1.0	2.6	5.5	6.8	12.3	5.6	6.3	6.0	0.8	1.0	2.5	5.4	6.5	12.2	5.2	6.3	5.8
Electricity	0.7	0.9	1.8	4.8	5.8	8.5	5.2	4.8	4.9	0.7	0.9	1.7	4.8	5.7	8.6	4.8	4.8	4.8
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	10.8	11.0	11.7	75.6	72.5	55.7	0.5	0.4	0.4	10.8	11.0	11.7	75.8	73.1	58.1	0.5	0.4	0.4
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	14.2	15.2	21.0	100.0	100.0	100.0	1.7	2.2	2.0	14.2	15.1	20.1	100.0	100.0	100.0	1.6	1.9	1.8
Industry	1.3	1.5	2.4	9.2	9.9	11.5	1.6	3.2	2.6	1.3	1.4	2.3	9.1	9.5	11.4	1.1	3.2	2.4
Transport	1.7	2.1	4.9	12.1	13.6	23.4	9.8	5.9	7.5	1.7	2.0	4.3	12.1	13.5	21.1	9.6	5.0	6.8
Other Sectors	11.1	11.5	13.6	77.9	75.8	64.6	0.8	1.1	1.0	11.1	11.5	13.5	78.0	76.3	66.9	0.7	1.1	0.9
Non-Energy	0.1	0.1	0.1	0.8	0.8	0.6	0.9	0.0	0.4	0.1	0.1	0.1	0.8	0.8	0.6	0.9	0.0	0.4

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Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	15.3	26.0	121.3	100.0	100.0	100.0	13.2	10.8	11.7	15.2	25.5	120.3	100.0	100.0	100.0	13.0	10.9	11.7
Fossil Fuels	3.6	8.1	55.1	23.8	31.0	45.5	12.7	13.7	13.3	3.5	7.2	52.1	22.8	28.2	43.3	11.4	14.1	13.0
Coal	0.7	1.2	7.5	4.4	4.7	6.2	6.2	12.9	10.2	0.7	0.7	3.7	4.4	2.8	3.1	0.5	11.7	7.1
Oil	0.0	0.0	0.0	0.2	0.0	0.0	(15.1)	(28.0)	(23.1)	0.0	0.0	0.0	0.2	0.0	0.0	(15.1)	(28.0)	(23.1)
Natural Gas	2.9	6.8	47.6	19.2	26.2	39.2	14.7	13.8	14.2	2.7	6.5	48.3	18.1	25.4	40.2	14.1	14.3	14.2
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	11.7	18.0	66.1	76.2	69.0	54.5	13.4	9.1	10.8	11.7	18.0	66.1	77.0	70.4	55.0	13.4	9.1	10.8
Others[b]	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.3	2.1	0.3	1.3	1.8	…	12.9	…

Thermal Power Generation Input	Business-as-Usual Case									Alternative Case								
	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	1.0	2.1	11.8	100.0	100.0	100.0	11.2	12.2	11.8	1.0	1.9	10.6	100.0	100.0	100.0	9.9	12.2	11.3
Coal	0.2	0.3	1.9	16.2	14.4	15.8	5.4	12.9	9.8	0.2	0.2	0.9	16.9	9.1	8.5	(0.5)	11.7	6.7
Oil	0.0	0.0	0.0	0.8	0.1	0.0	(15.1)	(28.0)	(23.1)	0.0	0.0	0.0	0.9	0.1	0.0	(15.1)	(28.0)	(23.1)
Natural Gas	0.8	1.8	9.9	83.0	85.5	84.2	12.8	12.0	12.4	0.8	1.7	9.7	82.2	90.8	91.5	12.2	12.3	12.2

Carbon Dioxide Emissions	Business-as-Usual Case						Alternative Case					
	Mt CO_2			AAGR (%)			Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	17.7	21.4	56.3	9.7	6.7	7.9	17.5	20.4	50.1	9.2	6.2	7.4

Energy and Carbon Indicators	Business-as-Usual Case						Alternative Case					
				AAGR (%)						AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)	0.35	0.37	0.55	2.5	2.7	2.6	0.35	0.37	0.53	2.4	2.5	2.4
Primary Energy Demand/GDP (toe/constant 2000 $ million)	561	421	223	(4.2)	(4.1)	(4.2)	559	416	215	(4.3)	(4.3)	(4.3)
CO_2/capita (t CO_2/person)	0.36	0.41	1.02	8.9	6.2	7.3	0.35	0.39	0.91	8.4	5.7	6.8
CO_2 Intensity (t CO_2/million constant 2000 $)	565	467	414	1.8	(0.8)	0.2	558	446	368	1.3	(1.3)	(0.2)
CO_2/Primary Energy Demand (t CO_2/toe)	1.01	1.11	1.86	6.3	3.5	4.6	1.00	1.07	1.71	5.9	3.2	4.3

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asian Development Bank estimates; Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision.* http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Philippines
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	163.6	205.5	388.6	4.8	4.3	4.5
Population (million persons)	101.4	109.7	134.2	1.6	1.4	1.5
GDP/capita (constant 2000 $/person)	1,613	1,872	2,895	3.1	2.9	3.0

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	44.7	52.1	82.9	100.0	100.0	100.0	2.5	3.1	2.9	43.2	48.5	70.4	100.0	100.0	100.0	1.8	2.5	2.2
Coal	10.9	14.4	31.1	24.3	27.7	37.5	6.5	5.2	5.7	10.0	12.3	24.0	23.1	25.4	34.1	4.8	4.5	4.6
Oil	14.1	16.3	27.8	31.5	31.4	33.6	1.9	3.6	2.9	14.0	15.9	24.4	32.3	32.8	34.6	1.6	2.9	2.4
Natural Gas	4.3	4.9	6.6	9.6	9.5	7.9	4.9	1.9	3.1	4.0	4.4	5.3	9.3	9.0	7.5	3.7	1.2	2.2
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.7	0.9	0.9	1.7	1.7	1.1	2.5	0.2	1.1	0.7	0.8	0.8	1.7	1.7	1.2	2.1	0.1	0.9
Others[a]	14.7	15.5	16.5	32.9	29.8	19.9	0.0	0.4	0.3	14.5	15.1	15.9	33.6	31.1	22.6	(0.2)	0.4	0.1
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	26.0	29.8	49.0	100.0	100.0	100.0	2.3	3.4	2.9	25.4	28.3	42.8	100.0	100.0	100.0	1.7	2.8	2.4
Coal	2.2	2.5	3.6	8.3	8.4	7.4	2.4	2.5	2.4	2.1	2.3	3.3	8.1	8.1	7.7	1.4	2.5	2.1
Oil	13.0	15.3	26.7	50.0	51.2	54.6	2.9	3.8	3.4	12.9	14.9	23.3	50.7	52.5	54.5	2.6	3.0	2.9
Natural Gas	0.1	0.1	0.2	0.3	0.3	0.4	3.3	4.4	4.0	0.1	0.1	0.2	0.3	0.3	0.4	2.3	4.6	3.7
Electricity	6.0	7.5	13.5	23.2	25.2	27.6	4.7	4.0	4.3	5.7	6.8	11.1	22.6	24.0	26.0	3.7	3.3	3.5
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	4.7	4.4	4.9	18.2	14.8	10.0	(2.3)	0.7	(0.5)	4.7	4.2	4.5	18.3	14.9	10.4	(2.7)	0.4	(0.9)
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	26.0	29.8	49.0	100.0	100.0	100.0	2.3	3.4	2.9	25.4	28.3	42.8	100.0	100.0	100.0	1.7	2.8	2.4
Industry	7.2	8.6	13.5	27.5	28.7	27.6	2.9	3.1	3.0	6.8	7.7	12.3	26.8	27.4	28.7	1.9	3.1	2.6
Transport	9.1	10.5	18.8	35.0	35.3	38.4	2.7	3.9	3.5	9.1	10.3	16.3	35.7	36.6	38.0	2.5	3.1	2.9
Other Sectors	9.4	10.4	16.3	36.2	34.8	33.2	1.3	3.0	2.3	9.2	9.9	13.9	36.3	34.9	32.4	0.8	2.3	1.7
Non-Energy	0.3	0.3	0.4	1.2	1.1	0.8	4.4	0.8	2.2	0.3	0.3	0.4	1.2	1.2	0.9	4.4	0.8	2.2

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Philippines Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	83.4	103.8	186.8	100.0	100.0	100.0	4.4	4.0	4.1	79.1	94.0	153.3	100.0	100.0	100.0	3.3	3.3	3.3
Fossil Fuels	64.4	82.3	164.4	77.2	79.3	88.0	5.1	4.7	4.9	59.5	71.6	129.4	75.2	76.2	84.4	3.7	4.0	3.9
Coal	39.3	54.5	130.4	47.1	52.5	69.8	8.9	6.0	7.1	36.0	46.8	100.9	45.5	49.8	65.8	7.2	5.3	6.0
Oil	4.0	3.9	3.8	4.8	3.8	2.0	(5.8)	(0.2)	(2.5)	3.9	3.7	3.6	4.9	3.9	2.3	(6.3)	(0.2)	(2.7)
Natural Gas	21.1	23.9	30.2	25.3	23.0	16.2	2.0	1.6	1.8	19.6	21.1	24.9	24.8	22.4	16.2	0.8	1.1	1.0
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	8.7	10.0	10.3	10.4	9.6	5.5	2.5	0.2	1.1	8.5	9.6	9.8	10.7	10.2	6.4	2.1	0.1	0.9
Others[b]	10.3	11.5	12.1	12.4	11.1	6.5	1.4	0.3	0.8	11.1	12.8	14.1	14.0	13.6	9.2	2.5	0.6	1.4
Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	13.9	17.7	35.0	100.0	100.0	100.0	6.2	4.6	5.3	12.8	15.3	27.0	100.0	100.0	100.0	4.6	3.8	4.2
Coal	9.0	12.3	28.1	64.5	69.1	80.3	8.3	5.7	6.7	8.2	10.4	21.4	63.8	67.9	79.4	6.5	4.9	5.6
Oil	1.0	0.9	0.9	6.9	5.2	2.6	(4.6)	(0.2)	(2.0)	0.9	0.9	0.9	7.3	5.8	3.2	(4.9)	(0.3)	(2.1)
Natural Gas	4.0	4.6	6.0	28.6	25.7	17.1	5.2	1.8	3.2	3.7	4.0	4.7	28.9	26.3	17.4	3.9	1.0	2.2
Carbon Dioxide Emissions	Mt CO_2			AAGR (%)						Mt CO_2			AAGR (%)					
	2015	2020	2035	2010–2020		2020–2035		2010–2035		2015	2020	2035	2010–2020		2020–2035		2010–2035	
Total	95.2	117.7	222.6	4.6		4.3		4.4		90.6	106.8	180.9	3.6		3.6		3.6	
Energy and Carbon Indicators							AAGR (%)									AAGR (%)		
				2015	2020	2035	2010–2020	2020–2035	2010–2035				2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)				0.44	0.47	0.62	0.9	1.8	1.4				0.43	0.44	0.52	0.2	1.1	0.8
Primary Energy Demand/GDP (toe/constant 2000 $ million)				273	253	213	(2.1)	(1.1)	(1.5)				264	236	181	(2.8)	(1.8)	(2.2)
CO_2/capita (t CO_2/person)				0.94	1.07	1.66	2.9	2.9	2.9				0.89	0.97	1.35	1.9	2.2	2.1
CO_2 Intensity (t CO_2/million constant 2000 $)				582	573	573	(0.2)	(0.0)	(0.1)				554	520	466	(1.2)	(0.7)	(0.9)
CO_2/Primary Energy Demand (t CO_2/toe)				2.13	2.26	2.69	2.0	1.2	1.5				2.10	2.20	2.57	1.7	1.0	1.3

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Singapore
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	210.6	257.9	419.6	4.6	3.3	3.8
Population (million persons)	5.4	5.6	6.1	1.0	0.6	0.7
GDP/capita (constant 2000 $/person)	39,188	46,087	68,809	3.6	2.7	3.0

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	25.4	27.2	31.4	100.0	100.0	100.0	1.4	1.0	1.1	24.4	25.5	28.4	100.0	100.0	100.0	0.7	0.7	0.7
Coal	0.7	0.6	0.4	2.9	2.3	1.4	18.4	(2.3)	5.5	0.7	0.5	0.3	2.7	2.0	1.1	15.8	(3.4)	3.9
Oil	16.3	17.6	21.1	64.4	64.7	67.1	1.1	1.2	1.2	16.3	17.5	20.7	66.8	68.5	72.8	1.0	1.1	1.1
Natural Gas	8.3	8.9	9.8	32.6	32.8	31.1	1.3	0.6	0.9	7.4	7.5	7.3	30.3	29.3	25.7	(0.5)	(0.2)	(0.3)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others[a]	0.0	0.1	0.1	0.2	0.3	0.4	9.4	3.5	5.8	0.0	0.1	0.1	0.2	0.3	0.4	9.2	3.9	6.0
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	16.5	18.2	22.5	100.0	100.0	100.0	1.9	1.4	1.6	16.2	17.6	20.9	100.0	100.0	100.0	1.6	1.2	1.3
Coal	0.1	0.1	0.1	0.7	0.7	0.6	0.4	0.3	0.4	0.1	0.1	0.1	0.7	0.7	0.6	(0.1)	0.3	0.2
Oil	12.1	13.5	16.8	73.2	73.7	75.0	1.9	1.5	1.7	12.1	13.4	16.5	74.5	76.3	78.7	1.9	1.4	1.6
Natural Gas	0.7	0.8	1.0	4.4	4.4	4.6	2.1	1.7	1.9	0.7	0.7	0.9	4.3	4.3	4.5	1.5	1.6	1.6
Electricity	3.5	3.8	4.4	21.5	21.0	19.4	1.9	0.9	1.3	3.3	3.3	3.2	20.2	18.5	15.4	0.3	(0.0)	0.1
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	0.0	0.0	0.1	0.2	0.2	0.3	8.2	3.5	5.3	0.0	0.0	0.1	0.2	0.2	0.3	8.0	2.5	4.7
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	16.5	18.2	22.5	100.0	100.0	100.0	1.9	1.4	1.6	16.2	17.6	20.9	100.0	100.0	100.0	1.6	1.2	1.3
Industry	1.9	2.2	3.0	11.5	12.0	13.4	3.0	2.2	2.5	1.8	2.0	2.7	11.1	11.3	13.0	2.0	2.1	2.1
Transport	2.7	2.7	2.5	16.2	14.6	11.0	(0.3)	(0.5)	(0.4)	2.7	2.6	2.2	16.5	15.0	10.6	(0.4)	(1.1)	(0.8)
Other Sectors	2.5	2.6	2.6	15.0	14.1	11.4	1.3	(0.0)	0.5	2.3	2.1	1.6	14.1	12.1	7.6	(0.6)	(1.9)	(1.4)
Non-Energy	9.5	10.8	14.4	57.3	59.4	64.2	2.6	1.9	2.2	9.5	10.8	14.4	58.3	61.6	68.8	2.6	1.9	2.2

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Singapore Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	48.3	50.8	54.0	100.0	100.0	100.0	1.4	0.4	0.8	44.7	43.1	39.9	100.0	100.0	100.0	(0.3)	(0.5)	(0.4)
Fossil Fuels	48.1	50.5	53.5	99.6	99.4	99.1	1.3	0.4	0.8	44.5	42.8	39.2	99.6	99.3	98.2	(0.3)	(0.6)	(0.5)
Coal	2.7	2.3	1.5	5.6	4.5	2.8	…	(2.8)	…	2.4	1.8	0.9	5.4	4.2	2.3	…	(4.5)	…
Oil	4.3	2.9	0.7	8.9	5.7	1.3	(7.6)	(9.0)	(8.5)	4.2	2.8	0.7	9.4	6.5	1.8	(7.9)	(8.8)	(8.5)
Natural Gas	41.1	45.3	51.3	85.1	89.2	95.0	1.8	0.8	1.2	37.9	38.2	37.6	84.8	88.6	94.2	0.1	(0.1)	(0.0)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others[b]	0.2	0.3	0.5	0.4	0.6	0.9	11.6	3.5	6.6	0.2	0.3	0.7	0.4	0.7	1.8	11.6	5.8	8.1

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	9.3	9.4	9.2	100.0	100.0	100.0	1.0	(0.1)	0.3	8.3	7.8	6.7	100.0	100.0	100.0	(0.8)	(1.1)	(1.0)
Coal	0.6	0.5	0.3	6.7	5.4	3.5	…	(3.1)	…	0.6	0.4	0.2	6.6	4.9	2.7	…	(5.0)	…
Oil	1.1	0.8	0.2	12.0	8.2	2.1	(9.4)	(8.9)	(9.1)	1.1	0.7	0.2	13.1	9.3	2.7	(9.8)	(8.9)	(9.3)
Natural Gas	7.5	8.1	8.7	81.3	86.4	94.5	2.3	0.5	1.2	6.7	6.7	6.3	80.3	85.7	94.6	0.4	(0.4)	(0.1)

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)			Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	43.5	44.2	45.1	(0.3)	0.1	(0.0)	41.1	40.0	37.7	(1.2)	(0.4)	(0.7)

Energy and Carbon Indicators				AAGR (%)						AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)	4.73	4.86	5.15	0.4	0.4	0.4	4.55	4.56	4.66	(0.2)	0.1	(0.0)
Primary Energy Demand/GDP (toe/constant 2000 $ million)	121	105	75	(3.1)	(2.3)	(2.6)	116	99	68	(3.7)	(2.5)	(3.0)
CO_2/capita (t CO_2/person)	8.09	7.89	7.40	(1.2)	(0.4)	(0.7)	7.64	7.15	6.19	(2.2)	(1.0)	(1.5)
CO_2 Intensity (t CO_2/million constant 2000 $)	207	171	108	(4.6)	(3.1)	(3.7)	195	155	90	(5.5)	(3.6)	(4.4)
CO_2/Primary Energy Demand (t CO_2/toe)	1.71	1.62	1.44	(1.6)	(0.8)	(1.1)	1.68	1.57	1.33	(2.0)	(1.1)	(1.4)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Thailand
Outlook Cases

Socioeconomic Indicators	Mtoe 2015	Mtoe 2020	Mtoe 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035
GDP (constant 2000 $ billion)	246.1	298.5	573.5	4.8	4.5	4.6
Population (million persons)	70.9	72.1	73.4	0.4	0.1	0.2
GDP/capita (constant 2000 $/person)	3,473	4,140	7,816	4.3	4.3	4.3

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	120.8	139.6	204.8	100.0	100.0	100.0	1.7	2.6	2.2	117.1	132.5	183.5	100.0	100.0	100.0	1.2	2.2	1.8
Coal	15.0	21.1	28.2	12.4	15.1	13.8	2.6	2.0	2.2	14.4	18.4	18.3	12.3	13.9	10.0	1.2	(0.1)	0.4
Oil	46.7	54.2	80.8	38.6	38.8	39.5	2.0	2.7	2.4	46.4	53.3	74.8	39.6	40.2	40.8	1.8	2.3	2.1
Natural Gas	34.6	37.0	59.1	28.6	26.5	28.8	1.2	3.2	2.4	31.6	32.9	46.0	27.0	24.9	25.1	(0.0)	2.3	1.3
Nuclear	0.0	0.0	3.4	0.0	0.0	1.7	…	…	…	0.0	0.0	8.2	0.0	0.0	4.5	…	…	…
Hydro	0.8	1.1	1.2	0.7	0.8	0.6	8.3	0.8	3.7	0.8	1.0	1.1	0.7	0.8	0.6	7.7	0.6	3.4
Others[a]	23.8	26.2	32.1	19.7	18.8	15.7	1.6	1.4	1.4	23.8	26.8	35.1	20.3	20.3	19.1	1.8	1.8	1.8
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	88.8	102.4	147.9	100.0	100.0	100.0	1.9	2.5	2.3	86.7	98.2	133.2	100.0	100.0	100.0	1.5	2.1	1.8
Coal	9.4	10.6	12.2	10.6	10.3	8.3	1.4	1.0	1.1	8.9	9.8	10.8	10.3	10.0	8.1	0.6	0.6	0.6
Oil	45.8	53.3	79.5	51.6	52.0	53.7	2.0	2.7	2.4	45.6	52.4	73.5	52.6	53.4	55.2	1.9	2.3	2.1
Natural Gas	3.8	4.8	8.7	4.3	4.7	5.9	0.4	4.1	2.6	3.6	4.3	6.1	4.2	4.4	4.6	(0.6)	2.4	1.2
Electricity	15.2	18.0	29.2	17.1	17.5	19.7	3.4	3.3	3.3	14.3	16.3	25.0	16.5	16.7	18.8	2.4	2.9	2.7
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	14.6	15.8	18.2	16.4	15.4	12.3	0.9	0.9	0.9	14.2	15.2	16.9	16.4	15.5	12.7	0.5	0.7	0.6
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	88.8	102.4	147.9	100.0	100.0	100.0	1.9	2.5	2.3	86.7	98.2	133.2	100.0	100.0	100.0	1.5	2.1	1.8
Industry	29.5	34.4	48.0	33.2	33.5	32.5	2.6	2.3	2.4	28.0	31.8	42.2	32.3	32.4	31.7	1.8	1.9	1.9
Transport	20.7	23.2	32.4	23.3	22.7	21.9	1.8	2.3	2.1	20.7	22.7	27.3	23.8	23.1	20.5	1.5	1.2	1.4
Other Sectors	22.8	26.0	39.9	25.7	25.4	27.0	2.4	2.9	2.7	22.3	24.8	36.2	25.7	25.3	27.1	2.0	2.5	2.3
Non-Energy	15.8	18.8	27.5	17.8	18.4	18.6	0.3	2.6	1.7	15.8	18.8	27.5	18.2	19.2	20.6	0.3	2.6	1.7

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Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	186.6	219.8	352.7	100.0	100.0	100.0	3.3	3.2	3.2	175.9	199.4	301.2	100.0	100.0	100.0	2.3	2.8	2.6
Fossil Fuels	168.6	196.8	308.3	90.4	89.5	87.4	2.7	3.0	2.9	154.4	170.1	222.9	87.8	85.3	74.0	1.2	1.8	1.6
Coal	24.3	46.2	73.2	13.0	21.0	20.8	4.4	3.1	3.6	23.7	37.7	34.7	13.5	18.9	11.5	2.3	(0.6)	0.6
Oil	0.6	0.6	0.5	0.3	0.3	0.1	(6.5)	(1.2)	(3.4)	0.6	0.5	0.5	0.3	0.3	0.2	(8.2)	0.0	(3.4)
Natural Gas	143.7	150.0	234.6	77.0	68.2	66.5	2.3	3.0	2.7	130.1	131.9	187.7	74.0	66.1	62.3	1.0	2.4	1.8
Nuclear	0.0	0.0	13.0	0.0	0.0	3.7	…	…	…	0.0	0.0	31.3	0.0	0.0	10.4	…	…	…
Hydro	9.3	12.3	13.8	5.0	5.6	3.9	8.3	0.8	3.7	8.8	11.8	13.2	5.0	5.9	4.4	7.9	0.8	3.5
Others[b]	8.7	10.7	17.6	4.7	4.9	5.0	12.1	3.4	6.8	12.7	17.5	33.8	7.2	8.8	11.2	17.8	4.5	9.6

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	32.8	38.8	60.0	100.0	100.0	100.0	2.7	2.9	2.8	29.9	33.3	41.0	100.0	100.0	100.0	1.1	1.4	1.3
Coal	5.6	10.4	16.0	17.1	26.9	26.6	4.2	2.9	3.4	5.5	8.6	7.5	18.4	25.8	18.3	2.2	(0.9)	0.3
Oil	0.2	0.1	0.1	0.5	0.4	0.2	(6.3)	(0.4)	(2.8)	0.1	0.1	0.1	0.5	0.4	0.3	(6.9)	(0.5)	(3.1)
Natural Gas	27.1	28.3	43.9	82.4	72.7	73.2	2.2	3.0	2.7	24.3	24.6	33.4	81.1	73.8	81.4	0.8	2.1	1.6

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)			Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	235.5	279.1	414.1	2.2	2.7	2.5	225.6	256.1	325.7	1.4	1.6	1.5

Energy and Carbon Indicators				AAGR (%)						AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/ capita (toe/person)	1.70	1.94	2.79	1.3	2.5	2.0	1.65	1.84	2.50	0.8	2.1	1.6
Primary Energy Demand/ GDP (toe/constant 2000 $ million)	491	468	357	(2.9)	(1.8)	(2.2)	476	444	320	(3.4)	(2.2)	(2.7)
CO_2/capita ($t\ CO_2$/person)	3.32	3.87	5.64	1.8	2.5	2.2	3.18	3.55	4.44	0.9	1.5	1.3
CO_2 Intensity ($t\ CO_2$/million constant 2000 $)	957	935	722	(2.4)	(1.7)	(2.0)	916	858	568	(3.3)	(2.7)	(2.9)
CO_2/Primary Energy Demand ($t\ CO_2$/toe)	1.95	2.00	2.02	0.5	0.1	0.2	1.93	1.93	1.77	0.1	(0.6)	(0.3)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Viet Nam
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	88.1	121.1	290.7	6.8	6.0	6.3
Population (million persons)	92.4	96.4	103.0	0.9	0.4	0.6
GDP/capita (constant 2000 $/person)	953	1,257	2,821	5.8	5.5	5.6

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	82.6	99.3	186.0	100.0	100.0	100.0	3.9	4.3	4.1	80.5	94.3	167.9	100.0	100.0	100.0	3.4	3.9	3.7
Coal	21.7	29.6	69.1	26.2	29.8	37.2	6.8	5.8	6.2	19.9	26.3	56.4	24.7	27.9	33.6	5.5	5.2	5.3
Oil	21.3	25.9	49.3	25.8	26.1	26.5	4.7	4.4	4.5	20.9	25.1	44.1	26.0	26.6	26.2	4.3	3.8	4.0
Natural Gas	11.2	14.8	27.2	13.6	14.9	14.6	5.8	4.2	4.8	11.7	14.3	21.9	14.6	15.1	13.0	5.4	2.9	3.9
Nuclear	0.0	0.0	7.4	0.0	0.0	4.0	…	…	…	0.0	0.0	14.0	0.0	0.0	8.3	…	…	…
Hydro	3.5	4.0	5.4	4.2	4.0	2.9	4.5	2.1	3.1	3.1	3.5	4.2	3.9	3.7	2.5	3.3	1.2	2.0
Others[a]	24.9	25.1	27.5	30.2	25.2	14.8	0.1	0.6	0.4	24.9	25.1	27.3	30.9	26.6	16.3	0.1	0.6	0.4
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	68.9	80.8	138.7	100.0	100.0	100.0	3.5	3.7	3.6	67.8	77.9	128.5	100.0	100.0	100.0	3.1	3.4	3.3
Coal	12.9	16.2	30.7	18.7	20.1	22.1	5.0	4.3	4.6	12.4	15.0	28.6	18.2	19.3	22.3	4.2	4.4	4.3
Oil	20.3	24.8	47.6	29.5	30.7	34.3	4.8	4.4	4.6	20.1	24.2	42.8	29.7	31.0	33.3	4.6	3.9	4.2
Natural Gas	1.4	1.5	2.7	2.0	1.9	1.9	12.1	3.7	7.0	1.3	1.5	2.5	2.0	1.9	1.9	11.6	3.6	6.7
Electricity	10.3	14.1	33.1	15.0	17.4	23.8	6.6	5.9	6.2	9.9	13.1	29.3	14.7	16.8	22.8	5.8	5.5	5.7
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	24.0	24.1	24.7	34.9	29.8	17.8	0.0	0.2	0.1	24.0	24.1	24.6	35.4	30.9	19.1	0.0	0.1	0.1
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	68.9	80.8	138.7	100.0	100.0	100.0	3.5	3.7	3.6	67.8	77.9	128.5	100.0	100.0	100.0	3.1	3.4	3.3
Industry	19.5	24.9	49.3	28.3	30.8	35.5	5.4	4.7	5.0	18.5	22.5	44.8	27.3	28.9	34.8	4.4	4.7	4.6
Transport	11.3	13.6	24.6	16.4	16.9	17.7	3.6	4.0	3.9	11.3	13.4	21.5	16.6	17.2	16.7	3.5	3.2	3.3
Other Sectors	33.9	37.5	57.1	49.2	46.4	41.2	1.9	2.8	2.4	33.8	37.2	54.5	49.9	47.7	42.4	1.8	2.6	2.3
Non-Energy	4.2	4.8	7.8	6.1	5.9	5.6	9.5	3.3	5.7	4.2	4.8	7.8	6.2	6.2	6.0	9.5	3.3	5.7

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Viet Nam Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	128.1	174.2	409.8	100.0	100.0	100.0	6.5	5.9	6.1	121.7	157.9	348.4	100.0	100.0	100.0	5.5	5.4	5.5
Fossil Fuels	87.7	127.8	315.4	68.5	73.4	77.0	7.4	6.2	6.7	84.9	116.4	240.2	69.8	73.7	68.9	6.4	4.9	5.5
Coal	36.1	57.2	176.0	28.2	32.8	42.9	10.4	7.8	8.8	31.2	48.8	129.1	25.6	30.9	37.1	8.7	6.7	7.5
Oil	1.6	1.4	1.1	1.2	0.8	0.3	(3.0)	(1.6)	(2.2)	0.9	0.9	0.0	0.7	0.6	0.0	(7.2)	…	…
Natural Gas	50.0	69.2	138.3	39.0	39.7	33.7	5.7	4.7	5.1	52.8	66.7	111.1	43.4	42.2	31.9	5.3	3.5	4.2
Nuclear	0.0	0.0	28.5	0.0	0.0	7.0	…	…	…	0.0	0.0	53.7	0.0	0.0	15.4	…	…	…
Hydro	40.2	46.0	63.1	31.4	26.4	15.4	4.5	2.1	3.1	36.6	40.8	49.3	30.1	25.8	14.2	3.3	1.3	2.1
Others[b]	0.2	0.4	2.8	0.2	0.2	0.7	14.9	13.9	14.3	0.2	0.7	5.2	0.2	0.4	1.5	21.5	14.3	17.1

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	19.0	26.9	63.3	100.0	100.0	100.0	6.8	5.9	6.3	18.1	24.3	47.2	100.0	100.0	100.0	5.8	4.5	5.0
Coal	8.8	13.4	38.5	46.1	49.6	60.8	9.4	7.3	8.1	7.5	11.3	27.8	41.4	46.5	58.9	7.6	6.2	6.7
Oil	0.4	0.3	0.3	2.1	1.3	0.4	(3.6)	(1.3)	(2.2)	0.2	0.2	0.0	1.1	0.8	0.0	(8.7)	…	…
Natural Gas	9.9	13.2	24.5	51.8	49.1	38.8	5.2	4.2	4.6	10.4	12.8	19.4	57.5	52.7	41.1	4.9	2.8	3.6

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)			Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	165.2	217.3	465.6	5.6	5.2	5.4	158.1	200.6	386.9	4.8	4.5	4.6

Energy and Carbon Indicators				AAGR (%)						AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)	0.89	1.03	1.80	2.9	3.8	3.5	0.87	0.98	1.63	2.4	3.5	3.0
Primary Energy Demand/GDP (toe/constant 2000 $ million)	937	820	640	(2.7)	(1.6)	(2.1)	913	778	578	(3.2)	(2.0)	(2.5)
CO_2/capita (t CO_2/person)	1.79	2.26	4.52	4.7	4.7	4.7	1.71	2.08	3.75	3.8	4.0	3.9
CO_2 Intensity (t CO_2/million constant 2000 $)	1,875	1,794	1,602	(1.1)	(0.8)	(0.9)	1,794	1,656	1,331	(1.8)	(1.4)	(1.6)
CO_2/Primary Energy Demand (t CO_2/toe)	2.00	2.19	2.50	1.7	0.9	1.2	1.96	2.13	2.30	1.4	0.5	0.9

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Developed Group
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	6,415.4	6,761.2	7,446.3	1.8	0.6	1.1
Population (million persons)	154.5	155.4	151.5	0.1	(0.2)	(0.0)
GDP/capita (constant 2000 $/person)	41,533	43,507	49,139	1.7	0.8	1.2

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	646.9	641.0	638.7	100.0	100.0	100.0	0.0	(0.0)	(0.0)	596.4	600.7	564.8	100.0	100.0	100.0	(0.6)	(0.4)	(0.5)
Coal	167.6	167.5	166.7	25.9	26.1	26.1	(0.0)	(0.0)	(0.0)	153.5	141.3	114.3	25.7	23.5	20.2	(1.7)	(1.4)	(1.5)
Oil	227.7	215.5	197.8	35.2	33.6	31.0	(1.4)	(0.6)	(0.9)	233.6	215.8	182.3	39.2	35.9	32.3	(1.4)	(1.1)	(1.2)
Natural Gas	137.6	147.0	191.9	21.3	22.9	30.0	2.4	1.8	2.0	122.7	123.7	135.1	20.6	20.6	23.9	0.6	0.6	0.6
Nuclear	67.8	57.0	14.9	10.5	8.9	2.3	(2.7)	(8.5)	(6.3)	34.3	67.9	50.0	5.8	11.3	8.8	(1.0)	(2.0)	(1.6)
Hydro	11.8	12.3	12.9	1.8	1.9	2.0	1.8	0.3	0.9	25.8	11.8	9.8	4.3	2.0	1.7	1.4	(1.2)	(0.2)
Others[a]	34.4	41.7	54.5	5.3	6.5	8.5	6.9	1.8	3.8	26.5	40.2	73.3	4.4	6.7	13.0	6.5	4.1	5.1
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	411.7	407.4	417.9	100.0	100.0	100.0	(0.1)	0.2	0.1	399.8	383.5	363.4	100.0	100.0	100.0	(0.7)	(0.4)	(0.5)
Coal	32.5	32.2	31.0	7.9	7.9	7.4	(0.0)	(0.3)	(0.2)	31.0	29.7	28.0	7.8	7.7	7.7	(0.8)	(0.4)	(0.6)
Oil	209.1	199.3	190.9	50.8	48.9	45.7	(0.8)	(0.3)	(0.5)	206.1	192.2	167.3	51.6	50.1	46.0	(1.1)	(0.9)	(1.0)
Natural Gas	50.0	51.8	58.9	12.2	12.7	14.1	0.5	0.9	0.7	48.4	48.7	52.6	12.1	12.7	14.5	(0.1)	0.5	0.3
Electricity	109.7	113.0	123.7	26.6	27.7	29.6	0.6	0.6	0.6	104.1	102.3	102.7	26.0	26.7	28.3	(0.4)	0.0	(0.2)
Heat	0.6	0.6	0.6	0.1	0.1	0.1	(0.1)	0.0	(0.0)	0.6	0.6	0.6	0.1	0.1	0.2	(0.1)	0.0	(0.0)
Others	9.8	10.5	12.5	2.4	2.6	3.0	2.4	1.2	1.7	9.5	9.9	11.6	2.4	2.6	3.2	1.8	1.1	1.3
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	411.7	407.4	417.9	100.0	100.0	100.0	(0.1)	0.2	0.1	399.8	383.5	363.4	100.0	100.0	100.0	(0.7)	(0.4)	(0.5)
Industry	124.8	128.3	137.1	30.3	31.5	32.8	1.0	0.4	0.7	118.9	117.7	123.5	29.7	30.7	34.0	0.1	0.3	0.2
Transport	104.2	98.5	96.0	25.3	24.2	23.0	(1.1)	(0.2)	(0.5)	103.6	96.3	83.9	25.9	25.1	23.1	(1.3)	(0.9)	(1.1)
Other Sectors	140.8	141.4	145.3	34.2	34.7	34.8	0.1	0.2	0.1	135.4	130.2	116.4	33.9	34.0	32.0	(0.7)	(0.7)	(0.7)
Non-Energy	41.8	39.3	39.5	10.2	9.6	9.5	(1.5)	0.0	(0.6)	41.8	39.3	39.5	10.5	10.2	10.9	(1.5)	0.0	(0.6)

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Power Generation Output	Business-as-Usual Case: TWh 2015	TWh 2020	TWh 2035	Share (%) 2015	Share (%) 2020	Share (%) 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035	Alternative Case: TWh 2015	TWh 2020	TWh 2035	Share (%) 2015	Share (%) 2020	Share (%) 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035
Total	1,510.5	1,555.3	1,672.0	100.0	100.0	100.0	1.1	0.5	0.7	1,440.4	1,417.6	1,400.0	100.0	100.0	100.0	0.1	(0.1)	0.0
Fossil Fuels	1,035.5	1,073.3	1,260.1	68.6	69.0	75.4	1.4	1.1	1.2	952.9	906.6	803.9	66.2	64.0	57.4	(0.3)	(0.8)	(0.6)
Coal	532.0	542.0	565.4	35.2	34.8	33.8	1.1	0.3	0.6	471.8	436.4	328.5	32.8	30.8	23.5	(1.1)	(1.9)	(1.6)
Oil	66.8	57.5	17.1	4.4	3.7	1.0	(5.4)	(7.8)	(6.8)	115.1	97.6	59.9	8.0	6.9	4.3	(0.3)	(3.2)	(2.1)
Natural Gas	436.7	473.8	677.6	28.9	30.5	40.5	3.1	2.4	2.7	366.0	372.6	415.6	25.4	26.3	29.7	0.6	0.7	0.7
Nuclear	260.0	218.6	57.3	17.2	14.1	3.4	(2.7)	(8.5)	(6.3)	131.6	260.7	191.8	9.1	18.4	13.7	(1.0)	(2.0)	(1.6)
Hydro	136.8	143.3	149.7	9.1	9.2	9.0	1.8	0.3	0.9	300.2	137.4	114.1	20.8	9.7	8.1	1.4	(1.2)	(0.2)
Others[b]	78.2	120.1	204.9	5.2	7.7	12.3	9.0	3.6	5.7	55.7	112.9	290.2	3.9	8.0	20.7	8.3	6.5	7.2

Thermal Power Generation Input	Business-as-Usual Case: Mtoe 2015	Mtoe 2020	Mtoe 2035	Share (%) 2015	Share (%) 2020	Share (%) 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035	Alternative Case: Mtoe 2015	Mtoe 2020	Mtoe 2035	Share (%) 2015	Share (%) 2020	Share (%) 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035
Fossil Fuels	207.0	212.2	238.8	100.0	100.0	100.0	1.1	0.8	0.9	190.5	177.5	149.1	100.0	100.0	100.0	(0.7)	(1.2)	(1.0)
Coal	115.5	116.1	116.7	55.8	54.7	48.9	0.8	0.0	0.3	103.0	92.7	67.5	54.1	52.2	45.3	(1.4)	(2.1)	(1.8)
Oil	12.4	10.7	3.3	6.0	5.0	1.4	(5.5)	(7.6)	(6.8)	21.2	18.0	11.0	11.1	10.2	7.4	(0.5)	(3.2)	(2.1)
Natural Gas	79.0	85.4	118.8	38.2	40.2	49.7	2.9	2.2	2.5	66.3	66.7	70.6	34.8	37.6	47.3	0.4	0.4	0.4

Carbon Dioxide Emissions	Business-as-Usual Case: Mt CO_2 2015	Mt CO_2 2020	Mt CO_2 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035	Alternative Case: Mt CO_2 2015	Mt CO_2 2020	Mt CO_2 2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035
Total	1,558.4	1,550.5	1,598.1	(0.8)	0.2	(0.2)	1,485.6	1,392.9	1,209.6	(1.9)	(0.9)	(1.3)

Energy and Carbon Indicators	Business-as-Usual Case: 2015	2020	2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035	Alternative Case: 2015	2020	2035	AAGR (%) 2010–2020	AAGR (%) 2020–2035	AAGR (%) 2010–2035
Primary Energy Demand/capita (toe/person)	4.19	4.12	4.21	(0.1)	0.1	0.0	3.86	3.87	3.73	(0.8)	(0.2)	(0.5)
Primary Energy Demand/GDP (toe/constant 2000 $ million)	101	95	86	(1.8)	(0.7)	(1.1)	93	89	76	(2.4)	(1.0)	(1.6)
CO_2/capita (t CO_2/person)	10.09	9.98	10.55	(1.0)	0.4	(0.2)	9.62	8.96	7.98	(2.0)	(0.8)	(1.3)
CO_2 Intensity (t CO_2/million constant 2000 $)	243	229	215	(2.6)	(0.4)	(1.3)	232	206	162	(3.7)	(1.6)	(2.4)
CO_2/Primary Energy Demand (t CO_2/toe)	2.41	2.42	2.50	(0.9)	0.2	(0.2)	2.49	2.32	2.14	(1.3)	(0.5)	(0.8)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Australia
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	667.5	762.2	1,125.9	3.0	2.6	2.8
Population (million persons)	23.8	25.2	28.8	1.3	0.9	1.0
GDP/capita (constant 2000 $/person)	28,055	30,198	39,059	1.6	1.7	1.7

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	133.5	139.5	148.8	100.0	100.0	100.0	1.0	0.4	0.7	129.6	129.2	133.3	100.0	100.0	100.0	0.3	0.2	0.3
Coal	55.2	53.0	37.4	41.4	38.0	25.1	0.3	(2.3)	(1.3)	51.8	43.9	29.6	40.0	33.9	22.2	(1.6)	(2.6)	(2.2)
Oil	36.6	37.6	39.8	27.4	26.9	26.7	(0.6)	0.4	(0.0)	36.3	36.5	35.0	28.0	28.3	26.3	(0.9)	(0.3)	(0.5)
Natural Gas	32.8	38.7	57.6	24.5	27.7	38.7	3.9	2.7	3.2	30.2	31.8	47.5	23.3	24.6	35.7	1.9	2.7	2.4
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	1.0	1.0	1.1	0.7	0.7	0.7	(0.8)	0.7	0.1	0.9	0.9	0.9	0.7	0.7	0.7	(1.7)	0.1	(0.6)
Others[a]	8.0	9.2	13.0	6.0	6.6	8.7	5.0	2.3	3.4	10.5	16.1	20.2	8.1	12.4	15.2	11.0	1.5	5.2
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	84.0	88.6	103.0	100.0	100.0	100.0	1.5	1.0	1.3	81.9	83.9	91.0	100.0	100.0	100.0	1.0	0.5	0.8
Coal	4.5	4.6	4.8	5.3	5.2	4.7	4.2	0.3	1.8	4.3	4.2	4.3	5.2	5.0	4.8	3.3	0.2	1.4
Oil	39.2	40.3	42.7	46.7	45.5	41.5	0.6	0.4	0.5	38.9	39.3	37.6	47.5	46.8	41.4	0.3	(0.3)	(0.0)
Natural Gas	14.8	16.3	21.4	17.7	18.4	20.8	2.2	1.8	2.0	14.3	15.3	19.5	17.5	18.2	21.4	1.5	1.6	1.6
Electricity	20.6	22.2	27.3	24.5	25.0	26.5	2.5	1.4	1.8	19.7	20.1	22.9	24.1	24.0	25.2	1.5	0.9	1.1
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	4.8	5.2	6.5	5.8	5.9	6.3	3.5	1.5	2.3	4.7	5.0	6.1	5.7	5.9	6.7	3.0	1.3	2.0
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	84.0	88.6	103.0	100.0	100.0	100.0	1.6	1.0	1.3	81.9	83.9	91.0	100.0	100.0	100.0	1.1	0.5	0.8
Industry	29.9	32.4	40.5	35.6	36.6	39.3	3.8	1.5	2.4	28.4	29.5	36.4	34.7	35.1	40.0	2.8	1.4	2.0
Transport	29.5	30.0	31.5	35.1	33.9	30.6	0.5	0.3	0.4	29.4	29.6	28.0	35.9	35.3	30.7	0.3	(0.4)	(0.1)
Other Sectors	20.4	21.6	25.3	24.3	24.4	24.6	1.2	1.1	1.1	19.9	20.3	21.0	24.2	24.2	23.1	0.5	0.2	0.4
Non-Energy	4.2	4.5	5.6	5.0	5.1	5.5	(1.1)	1.5	0.4	4.2	4.5	5.6	5.1	5.4	6.2	(1.1)	1.5	0.4

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Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	289.8	311.4	352.8	100.0	100.0	100.0	2.3	0.8	1.5	278.9	284.9	299.5	100.0	100.0	100.0	1.5	0.3	0.9
Fossil Fuels	263.7	278.8	283.2	91.0	89.5	80.3	2.4	0.1	1.0	242.1	222.3	221.4	86.8	78.0	73.9	0.1	(0.0)	0.0
Coal	205.5	201.2	145.1	70.9	64.6	41.1	1.1	(2.2)	(0.9)	191.8	167.5	114.5	68.8	58.8	38.2	(0.8)	(2.5)	(1.8)
Oil	3.3	3.2	3.3	1.1	1.0	0.9	0.1	0.2	0.2	3.1	2.9	2.7	1.1	1.0	0.9	(0.9)	(0.5)	(0.6)
Natural Gas	54.9	74.4	134.8	18.9	23.9	38.2	7.5	4.0	5.4	47.2	51.9	104.2	16.9	18.2	34.8	3.7	4.8	4.3
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	11.2	11.5	12.7	3.9	3.7	3.6	(0.8)	0.7	0.1	10.8	10.5	10.6	3.9	3.7	3.5	(1.7)	0.1	(0.6)
Others[b]	14.9	21.1	56.9	5.1	6.8	16.1	8.9	6.8	7.7	26.0	52.1	67.5	9.3	18.3	22.5	19.2	1.7	8.4

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	61.4	62.4	56.7	100.0	100.0	100.0	1.3	(0.6)	0.2	56.7	49.4	43.4	100.0	100.0	100.0	(0.9)	(0.9)	(0.9)
Coal	49.3	47.0	31.7	80.3	75.4	55.8	0.4	(2.6)	(1.4)	46.2	38.5	24.5	81.5	78.0	56.5	(1.5)	(3.0)	(2.4)
Oil	0.7	0.7	0.7	1.2	1.2	1.3	(1.7)	0.2	(0.6)	0.7	0.7	0.6	1.2	1.3	1.4	(2.5)	(0.4)	(1.3)
Natural Gas	11.3	14.6	24.3	18.5	23.4	42.9	5.7	3.4	4.3	9.8	10.2	18.2	17.3	20.6	42.1	1.9	4.0	3.2

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)			Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	395.5	402.7	389.0	0.6	(0.2)	0.1	375.0	347.3	319.9	(0.7)	(0.5)	(0.7)

Energy and Carbon Indicators				AAGR (%)						AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)	5.61	5.53	5.16	(0.1)	(0.5)	(0.3)	5.45	5.12	4.62	(0.8)	(0.7)	(0.7)
Primary Energy Demand/GDP (toe/constant 2000 $ million)	200	183	132	(1.7)	(2.1)	(1.9)	194	170	118	(2.4)	(2.4)	(2.4)
CO_2/capita (t CO_2/person)	16.62	15.95	13.49	(0.5)	(1.1)	(0.9)	15.76	13.76	11.10	(1.9)	(1.4)	(1.6)
CO_2 Intensity (t CO_2/million constant 2000 $)	593	528	345	(2.1)	(2.8)	(2.5)	562	456	284	(3.4)	(3.1)	(3.2)
CO_2/Primary Energy Demand (t CO_2/toe)	2.96	2.89	2.61	(0.4)	(0.7)	(0.6)	2.89	2.69	2.40	(1.1)	(0.8)	(0.9)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

Japan
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	5,671.6	5,876.0	6,197.4	1.6	0.4	0.9
Population (million persons)	126.1	124.8	117.3	(0.1)	(0.4)	(0.3)
GDP/capita (constant 2000 $/person)	44,987	47,082	52,812	1.6	0.8	1.1

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	494.1	481.4	467.5	100.0	100.0	100.0	(0.3)	(0.2)	(0.2)	448.7	452.9	413.1	100.0	100.0	100.0	(0.8)	(0.6)	(0.7)
Coal	110.7	113.1	128.5	22.4	23.5	27.5	(0.2)	0.9	0.4	100.2	96.3	84.0	22.3	21.3	20.3	(1.8)	(0.9)	(1.2)
Oil	184.5	171.4	151.6	37.3	35.6	32.4	(1.7)	(0.8)	(1.2)	191.1	173.3	141.8	42.6	38.3	34.3	(1.6)	(1.3)	(1.4)
Natural Gas	101.3	104.3	129.1	20.5	21.7	27.6	1.9	1.4	1.6	89.1	89.5	85.6	19.9	19.8	20.7	0.4	(0.3)	(0.0)
Nuclear	67.8	57.0	14.9	13.7	11.8	3.2	(2.7)	(8.5)	(6.3)	34.3	67.9	50.0	7.6	15.0	12.1	(1.0)	(2.0)	(1.6)
Hydro	8.8	9.3	9.6	1.8	1.9	2.1	2.8	0.2	1.2	22.8	8.8	6.8	5.1	1.9	1.7	2.2	(1.7)	(0.1)
Others[a]	21.0	26.4	33.7	4.3	5.5	7.2	9.5	1.6	4.7	11.3	17.1	44.9	2.5	3.8	10.9	4.8	6.7	5.9
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	314.5	305.3	300.9	100.0	100.0	100.0	(0.6)	(0.1)	(0.3)	305.2	287.2	260.0	100.0	100.0	100.0	(1.1)	(0.7)	(0.9)
Coal	27.4	27.0	25.5	8.7	8.8	8.5	(0.6)	(0.4)	(0.5)	26.2	24.9	23.1	8.6	8.7	8.9	(1.4)	(0.5)	(0.9)
Oil	163.8	152.9	142.2	52.1	50.1	47.3	(1.1)	(0.5)	(0.7)	161.3	147.3	124.4	52.9	51.3	47.8	(1.5)	(1.1)	(1.3)
Natural Gas	33.5	33.9	36.0	10.7	11.1	12.0	(0.2)	0.4	0.2	32.5	31.9	31.7	10.6	11.1	12.2	(0.8)	(0.0)	(0.3)
Electricity	85.5	87.0	92.0	27.2	28.5	30.6	0.1	0.4	0.3	80.9	78.7	76.0	26.5	27.4	29.2	(0.9)	(0.2)	(0.5)
Heat	0.6	0.6	0.6	0.2	0.2	0.2	(0.1)	0.0	(0.0)	0.6	0.6	0.6	0.2	0.2	0.2	(0.1)	0.0	(0.0)
Others	3.7	4.0	4.6	1.2	1.3	1.5	1.7	1.0	1.3	3.6	3.7	4.3	1.2	1.3	1.7	1.1	0.9	1.0
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	314.5	305.3	300.9	100.0	100.0	100.0	(0.6)	(0.1)	(0.3)	305.2	287.2	260.0	100.0	100.0	100.0	(1.2)	(0.7)	(0.9)
Industry	90.9	91.8	92.4	28.9	30.1	30.7	0.2	0.0	0.1	86.7	84.7	83.3	28.4	29.5	32.0	(0.6)	(0.1)	(0.3)
Transport	70.0	63.6	59.8	22.2	20.8	19.9	(1.9)	(0.4)	(1.0)	69.6	62.3	52.0	22.8	21.7	20.0	(2.1)	(1.2)	(1.6)
Other Sectors	116.8	115.8	115.2	37.1	37.9	38.3	(0.2)	(0.0)	(0.1)	112.0	106.3	91.4	36.7	37.0	35.1	(1.0)	(1.0)	(1.0)
Non-Energy	36.8	34.0	33.5	11.7	11.1	11.1	(1.6)	(0.1)	(0.7)	36.8	34.0	33.5	12.1	11.8	12.9	(1.6)	(0.1)	(0.7)

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Japan Outlook Cases *continued*

Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	1,173.7	1,193.2	1,257.9	100.0	100.0	100.0	0.7	0.4	0.5	1,115.6	1,087.1	1,051.3	100.0	100.0	100.0	(0.2)	(0.2)	(0.2)
Fossil Fuels	758.6	779.3	957.7	64.6	65.3	76.1	1.0	1.4	1.2	698.6	678.4	579.8	62.6	62.4	55.2	(0.4)	(1.0)	(0.8)
Coal	323.2	338.4	420.3	27.5	28.4	33.4	1.1	1.5	1.3	277.0	267.2	214.0	24.8	24.6	20.4	(1.3)	(1.5)	(1.4)
Oil	62.9	53.9	13.5	5.4	4.5	1.1	(5.7)	(8.8)	(7.6)	112.0	94.7	57.2	10.0	8.7	5.4	(0.3)	(3.3)	(2.1)
Natural Gas	372.5	387.0	523.9	31.7	32.4	41.7	2.4	2.0	2.2	309.6	316.5	308.7	27.8	29.1	29.4	0.4	(0.2)	0.1
Nuclear	260.0	218.6	57.3	22.2	18.3	4.6	(2.7)	(8.5)	(6.3)	131.6	260.7	191.8	11.8	24.0	18.2	(1.0)	(2.0)	(1.6)
Hydro	101.9	108.1	111.7	8.7	9.1	8.9	2.8	0.2	1.2	264.8	102.6	79.5	23.7	9.4	7.6	2.2	(1.7)	(0.1)
Others[b]	53.2	87.2	131.2	4.5	7.3	10.4	9.9	2.8	5.6	20.6	45.4	200.2	1.8	4.2	19.0	3.0	10.4	7.4

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	143.0	147.0	178.7	100.0	100.0	100.0	0.9	1.3	1.2	131.5	126.9	105.4	100.0	100.0	100.0	(0.5)	(1.2)	(0.9)
Coal	65.4	68.5	85.0	45.7	46.6	47.6	1.1	1.5	1.3	56.0	53.7	43.0	42.6	42.3	40.8	(1.4)	(1.5)	(1.4)
Oil	11.5	9.9	2.5	8.1	6.7	1.4	(5.8)	(8.9)	(7.7)	20.5	17.4	10.4	15.6	13.7	9.9	(0.4)	(3.4)	(2.2)
Natural Gas	66.1	68.6	91.2	46.2	46.7	51.0	2.4	1.9	2.1	54.9	55.9	52.0	41.8	44.0	49.3	0.4	(0.5)	(0.2)

Carbon Dioxide Emissions	Mt CO_2			AAGR (%)			Mt CO_2			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	1,129.9	1,114.6	1,175.4	(1.3)	0.4	(0.3)	1,079.6	1,019.2	866.8	(2.1)	(1.1)	(1.5)

Energy and Carbon Indicators			AAGR (%)						AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)	3.92	3.86	3.98	(0.2)	0.2	0.1	3.56	3.63	3.52	(0.7)	(0.2)	(0.4)
Primary Energy Demand/GDP (toe/constant 2000 $ million)	87	82	75	(1.7)	(0.5)	(1.0)	79	77	67	(2.3)	(1.0)	(1.5)
CO_2/capita (t CO_2/person)	8.96	8.93	10.02	(1.1)	0.8	(0.0)	8.56	8.17	7.39	(1.9)	(0.7)	(1.2)
CO_2 Intensity (t CO_2/million constant 2000 $)	199	190	190	(2.7)	(0.0)	(1.1)	190	173	140	(3.5)	(1.4)	(2.3)
CO_2/Primary Energy Demand (t CO_2/toe)	2.29	2.32	2.51	(1.0)	0.6	(0.1)	2.41	2.25	2.10	(1.2)	(0.5)	(0.8)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

New Zealand
Outlook Cases

Socioeconomic Indicators	Mtoe			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035
GDP (constant 2000 $ billion)	76.3	86.2	122.9	2.8	2.4	2.6
Population (million persons)	4.6	4.8	5.4	1.0	0.7	0.8
GDP/capita (constant 2000 $/person)	16,583	17,873	22,941	1.6	1.7	1.7

	Business-as-Usual Case									Alternative Case								
Primary Energy Demand	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	19.2	20.1	22.3	100.0	100.0	100.0	0.9	0.7	0.8	18.1	18.5	18.4	100.0	100.0	100.0	0.2	(0.1)	0.0
Coal	1.6	1.4	0.7	8.5	7.0	3.3	0.7	(4.2)	(2.3)	1.5	1.1	0.7	8.4	6.1	3.7	(1.4)	(3.3)	(2.5)
Oil	6.6	6.6	6.5	34.5	32.7	29.0	0.8	(0.1)	0.3	6.2	6.0	5.5	34.4	32.2	29.9	(0.1)	(0.5)	(0.4)
Natural Gas	3.5	4.0	5.2	18.4	20.1	23.3	0.8	1.7	1.3	3.4	2.4	1.9	19.0	12.7	10.6	(4.5)	(1.3)	(2.6)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	2.0	2.0	2.2	10.6	10.1	9.7	(0.4)	0.4	0.1	2.1	2.1	2.1	11.7	11.3	11.2	(0.2)	(0.1)	(0.1)
Others[a]	5.4	6.1	7.7	27.9	30.1	34.7	1.9	1.7	1.8	4.8	7.0	8.2	26.6	37.7	44.5	3.4	1.0	2.0
Final Energy Demand By Source	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	13.3	13.5	14.1	100.0	100.0	100.0	0.5	0.3	0.4	12.7	12.4	12.3	100.0	100.0	100.0	(0.3)	(0.0)	(0.2)
Coal	0.6	0.6	0.6	4.5	4.5	4.6	0.2	0.4	0.3	0.6	0.6	0.6	4.5	4.5	4.9	(0.6)	0.5	0.0
Oil	6.1	6.1	6.0	46.2	45.4	43.0	0.4	(0.1)	0.1	5.9	5.7	5.2	46.4	45.8	42.4	(0.4)	(0.5)	(0.5)
Natural Gas	1.7	1.6	1.6	12.6	12.1	11.1	(0.2)	(0.3)	(0.2)	1.6	1.5	1.4	12.6	12.2	11.2	(0.9)	(0.7)	(0.8)
Electricity	3.6	3.9	4.4	27.3	28.5	31.6	1.3	1.0	1.1	3.5	3.5	3.8	27.2	28.0	30.9	0.2	0.6	0.5
Heat	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Others	1.2	1.3	1.3	9.4	9.4	9.5	0.1	0.4	0.3	1.2	1.2	1.2	9.3	9.3	10.0	(0.8)	0.4	(0.1)
Final Energy Demand By Sector	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	13.3	13.5	14.1	100.0	100.0	100.0	0.6	0.3	0.4	12.7	12.4	12.3	100.0	100.0	100.0	(0.3)	(0.0)	(0.2)
Industry	4.0	4.0	4.2	30.0	29.9	29.9	0.4	0.3	0.3	3.7	3.6	3.8	29.5	29.1	31.2	(0.8)	0.4	(0.1)
Transport	4.8	4.8	4.7	36.4	35.6	33.6	0.4	(0.1)	0.1	4.6	4.4	4.0	36.3	35.5	32.4	(0.5)	(0.6)	(0.6)
Other Sectors	3.7	3.9	4.7	27.6	29.2	33.4	1.6	1.2	1.3	3.6	3.7	4.0	28.0	29.6	32.9	0.9	0.6	0.7
Non-Energy	0.8	0.7	0.4	6.0	5.3	3.1	(2.3)	(3.2)	(2.9)	0.8	0.7	0.4	6.3	5.8	3.6	(2.3)	(3.2)	(2.9)

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Power Generation Output	Business-as-Usual Case									Alternative Case								
	TWh			Share (%)			AAGR (%)			TWh			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	47.0	50.7	61.3	100.0	100.0	100.0	1.1	1.3	1.3	45.9	45.6	49.2	100.0	100.0	100.0	0.2	0.5	0.4
Fossil Fuels	13.2	15.2	19.2	28.1	30.0	31.3	2.5	1.6	1.9	12.2	5.9	2.7	26.6	12.9	5.5	(6.8)	(5.1)	(5.8)
Coal	3.3	2.4	0.0	7.0	4.7	0.0	1.5	…	…	3.0	1.7	0.0	6.5	3.7	0.0	(1.9)	…	…
Oil	0.6	0.4	0.3	1.3	0.8	0.5	69.9	(1.9)	22.2	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Natural Gas	9.3	12.4	18.9	19.8	24.5	30.8	2.3	2.8	2.6	9.2	4.2	2.7	20.0	9.2	5.5	(8.2)	(2.9)	(5.0)
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Hydro	23.7	23.7	25.3	50.4	46.7	41.3	(0.4)	0.4	0.1	24.6	24.3	24.0	53.6	53.3	48.8	(0.2)	(0.1)	(0.1)
Others[b]	10.1	11.8	16.8	21.5	23.3	27.4	3.8	2.4	2.9	9.1	15.4	22.5	19.8	33.8	45.7	6.6	2.6	4.2

Thermal Power Generation Input	Mtoe			Share (%)			AAGR (%)			Mtoe			Share (%)			AAGR (%)		
	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Fossil Fuels	2.6	2.8	3.3	100.0	100.0	100.0	2.2	1.1	1.6	2.3	1.1	0.4	100.0	100.0	100.0	(6.1)	(6.3)	(6.5)
Coal	0.8	0.6	0.0	32.0	21.9	0.0	2.3	…	…	0.8	0.4	0.0	32.4	39.2	0.0	(1.2)	…	…
Oil	0.1	0.1	0.1	5.6	3.3	2.6	…	(0.6)	…	0.0	0.0	0.0	0.0	0.0	0.0	…	…	…
Natural Gas	1.6	2.1	3.3	62.4	74.8	97.4	1.9	2.9	2.5	1.6	0.7	0.4	67.6	60.8	100.0	(9.0)	(3.1)	(5.5)

Carbon Dioxide Emissions	$Mt\ CO_2$			AAGR (%)			$Mt\ CO_2$			AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Total	33.0	33.3	33.7	0.9	0.1	0.4	31.0	26.5	22.9	(1.2)	(1.0)	(1.1)

Energy and Carbon Indicators				AAGR (%)						AAGR (%)		
	2015	2020	2035	2010–2020	2020–2035	2010–2035	2015	2020	2035	2010–2020	2020–2035	2010–2035
Primary Energy Demand/capita (toe/person)	4.17	4.16	4.17	(0.0)	0.0	(0.0)	3.93	3.85	3.43	(0.7)	(0.8)	(0.7)
Primary Energy Demand/GDP (toe/constant 2000 $ million)	252	233	182	(1.6)	(1.6)	(1.6)	237	215	149	(2.3)	(2.4)	(2.4)
CO_2/capita ($t\ CO_2$/person)	7.17	6.90	6.29	(0.0)	(0.6)	(0.4)	6.74	5.48	4.27	(2.1)	(1.7)	(1.8)
CO_2 Intensity ($t\ CO_2$/million constant 2000 $)	433	386	274	(1.7)	(2.3)	(2.0)	406	307	186	(3.7)	(3.3)	(3.5)
CO_2/Primary Energy Demand ($t\ CO_2$/toe)	1.72	1.66	1.51	(0.0)	(0.6)	(0.4)	1.72	1.43	1.25	(1.4)	(0.9)	(1.1)

( ) = negative number, … = no data or not applicable, AAGR = average annual growth rate, CO_2 = carbon dioxide, GDP = gross domestic product, Mt CO_2 = million tons of carbon dioxide, Mtoe = million tons of oil equivalent, t CO_2 = ton of carbon dioxide, toe = ton of oil equivalent, TWh = terawatt-hour.

Note: Figures may not add up to total because of rounding.

[a] "Others" include geothermal energy, solar energy, wind energy, and other renewable energy, and electricity exports and imports.

[b] "Others" include geothermal, solar, wind, and renewables.

Sources: Asia Pacific Energy Research Centre estimates; United Nations. *World Urbanization Prospects: The 2011 Revision*. http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

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Energy Outlook for Asia and the Pacific

This report attempts to identify policy, social, infrastructure, and technology issues that must be addressed to meet the future energy needs of members of the Asian Development Bank (ADB) in Asia and the Pacific. Two cases of the projected energy demand and supply up to 2035 for ADB members in Asia and the Pacific are presented: (i) a business-as-usual case, which reflects the impact of existing policies and current technology levels on future energy demand and energy choice and which assumes that current trends in the development of new and renewable energy sources will continue into the future; and (ii) an alternative case that considers the potential for energy savings on both the demand and supply sides through the deployment of advanced and low-carbon technologies to increase energy security in the region. For both outlook cases, carbon dioxide emissions generated and the investments required on the supply and demand sides were estimated.

About Asia-Pacific Economic Cooperation

Asia-Pacific Economic Cooperation was established in 1989 to further enhance economic growth and prosperity for the region and to strengthen the Asia-Pacific community. APEC has 21 members, referred to as member economies.

APEC operates as a cooperative, multilateral economic and trade forum. It is the only international intergovernmental grouping in the world committed to reducing barriers to trade and investment without requiring its members to enter into legally binding obligations. APEC achieves its goals by promoting dialogue and arriving at decisions on a consensus basis, giving equal weight to the views of all members.

About the Asia Pacific Energy Research Centre

The Asia Pacific Energy Research Centre (APERC) was established in July 1996 in Tokyo as an affiliate of the Institute of Energy Economics, Japan, pursuant to the Action Agenda adopted by the APEC Economic Leaders at the Osaka Summit in November 1995. The Government of Japan generously agreed to host and finance the center.

The primary objective of APERC is to foster understanding among APEC economies of global, regional, and domestic energy demand and supply trends, energy infrastructure development, energy regulatory reform, and related policy issues in view of regional prosperity. APERC advocates rational energy policy formulation and enhances capacity building in energy research in the region, following APEC's Non-binding Energy Policy Principles for furthering energy security, economic growth, and environmental quality.

About the Asian Development Bank

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to two-thirds of the world's poor: 1.7 billion people who live on less than $2 a day, with 828 million struggling on less than $1.25 a day. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

Based in Manila, ADB is owned by 67 members, including 48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

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