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Pacific Perspectives on the Challenges to Energy Security and the Sustainable Use of Energy

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FINAL VERSION

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Abbreviations and Acronyms

ACP	Africa, Caribbean and Pacific
ADB	Asian Development Bank
ADMIRE	Acting for the Development of Marshall Islands Renewable Energies (UNDP/GEF)
APEC	Asia-Pacific Economic Cooperation
c.i.f.	Cost, insurance and freight
Compact	Compact(s) of Free Association between USA and FSM, RMI and Palau
CPI	Consumer Price Index
CROP	Council of Regional Organisations of the Pacific
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
DSM	Demand Side Management (in reference to energy efficiency)
EC	European Commission
EDF	European Development Fund
EDWG	Pacific Energy Donor/International Financial Institutions Working Group
EE	Energy Efficiency
EESCO	Energy Efficiency Service Company
EIB	European Investment Bank
EPO	ESCAP Pacific Office
ESMAP	Energy Sector Management Assistance Programme (WB)
EU	European Union
EUEI	European Union Energy Initiative
FAESP	Framework for Action on Energy Security in the Pacific
FIC	Forum Island Countries
GDP	Gross Domestic Product
GEF	Global Environment Facility
HDI	Human Development Index (UNDP)
HH	Households
HIES	Household Income and Expenditure Survey
IEA	International Energy Agency
IISD	International Institute for Sustainable Development
IMF	International Monetary Fund
IRENA	International Renewable Energy Association
IUCN	International Union for the Conservation of Nature
JICA	Japan International Cooperation Agency
KTOE	Kilotonnes of Oil Equivalent
kW	kilowatt (thousand watts)
kWh	kilowatt hour
kWp	kilowatts peak (peak output of RE system)
MDG	Millennium Development Goals
MW	Megawatt (thousand kW)
NERM	National Energy Roadmap (Vanuatu)

North-REP	North Pacific ACP Renewable Energy &Energy Efficiency Project(EC/SPC)
ODA	Official Development Assistance
PACC	Pacific Adaptation to Climate Change
PDMC	Pacific Developing Member Country (of ADB)
PEAG	Pacific Energy Advisory Group
PEC	Pacific Environment Community Fund (PIFS/Japan)
PEEP2	Promoting Energy Efficiency in the Pacific (ADB, phase 2)
PEOG	Pacific Energy Oversight Group
PFTAC	Pacific Financial Technical Assistance Centre (of the IMF)
PIC	Pacific Island Country
PICT	Pacific Island Country or Territory
PIFS	Pacific Islands Forum Secretariat
PIGGAREP	Pacific Islands Greenhouse Gas Abatement through Renewable Energy Project (SPREP/UNDP GEF
PIREP	Pacific Islands Renewable Energy Project (SPREP/UNDP GEF 2003-2005)
PPA	Pacific Power Association (or Power Purchase Agreement)
PV	Photovoltaic
RE	Renewable Energy
RESCO	Renewable Energy Service Company
SEDREA	Sustainable Economic Development through Renewable Energy Applications (UNDP/GEF; Palau)
SEIAPI	Sustainable Energy Industries Association of the Pacific Islands
SHS	Solar Home System(s)
SIDS	Small Island Developing States
SIDS-DOCK	Small Island Developing States Energy Docking
SMEC	Snowy Mountains Engineering Corporation (Australia)
SPC	Secretariat of the Pacific Community
SPREP	Secretariat of the Pacific Regional Environment Programme
TERM	Tonga Energy Road Map
TOE	Tonnes of Oil Equivalent
UNDP	United Nations Development Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations Office for Disaster Risk Reduction
USAID	United States Agency for International Development
USDOI	United States Department of the Interior
USP	The University of the South Pacific
WB	World Bank

Executive Summary

Background. This paper describes challenges and opportunities for enhancing energy security and more sustainable use of energy in the Pacific islands subregion of ESCAP. The Pacific is small in population but covers a huge geographical area: there are only 10 million people on thousands of islands in the fourteen ESCAP member and seven associate member states, widely scattered across a third of the earth's surface area. Nearly 80% of the households of Pacific Island Countries and Territories (PICTs) have no access to grid-connected electricity but this is misleading as energy and development statistics in the subregion are heavily skewed by Papua New Guinea (PNG) with nearly 70% of the islands' population, 84% of land area and the widest natural resource base. PNG, with much of its population in nearly inaccessible mountainous areas, has an electrification rate of only 12% whereas for most PICTs, 50-100% of households are electrified.

Pacific economies and energy use. In terms of economies, resources and social conditions, the PICTs vary tremendously. Of nine PICs included in UNDP's 2012 Human Development Index, two are ranked as high human development, five as medium and two as low. Per capita GNPs vary widely, averaging about $3000 in 2009. Poverty rates are estimated as 29-53% for most very small north Pacific states and 13-29% for the southern Pacific PICTs. In 2009, seven island economies were ranked by the Asian Development Bank (ADB) as among the ten most vulnerable in the Asia-Pacific region to oil price volatility. This is unsurprising as the subregion is overwhelmingly dependent on imported petroleum fuels for its commercial energy use: 95% overall and 99% if the larger economies of PNG and Fiji are excluded. Although the data are inconsistent, it also appears that the PICTs may be using far more energy per unit of GDP between 2000-2005 than from 1990-1995, diverging from the overall Asia-Pacific trend of decreasing energy intensity.

Energy resources. Only PNG has proven (and developed) oil and gas resources, most hydropower potential and development are in the larger Melanesian countries (PNG, Fiji, Solomon Islands, Vanuatu), perhaps half of the PICTs have geothermal potential (which has only been developed in PNG), and less than that have appreciable biomass energy potential. Nearly all PICTs have some potential for biofuel production based on coconut oil. The wind resource is limited and decreases towards the equator, with small wind farms operating only in Fiji and Vanuatu. Solar potential varies but is good throughout the subregion, with many thousands of small stand-alone solar PV systems and perhaps twenty or so grid-connected PV systems operating or nearing construction. There are huge potential ocean energy resources, particularly Ocean Thermal Energy Conversion but OTEC is extremely high-tech and many years, if not decades, away from commercial development, especially at the small PICT scales. Seawave energy is variable, increasing away from the equator. A seawave system is planned for the Federated States of Micronesia and being considered in Tonga.

Energy policies and plans. Most PICTs have very ambitious goals for replacing a high percentage of diesel-fueled electricity generation with renewable energy: hydropower in the few countries with a resource, and relatively small-scale biofuels in others, with solar as the most practical in most PICTs. Although electricity consumes considerably less petroleum fuel than transport, little has been done to address transport fuel use, and practical options are limited. Efforts to improve the efficiency of energy use have increased but most plans focus on expanding and extending energy supply. Nearly all PICTs have recent national energy policies, but very few have developed implementation plans with clear priorities, budgets, sources of funding, and responsibilities, although a few national energy roadmaps are being developed with the assistance of development and financing agencies.

Development challenges. There are numerous well-known challenges faced by the PICTs including weak economic growth coupled with inequality of growth, small populations, small physical size, limited resources, geographic dispersion and isolation from markets, high susceptibility to increases in food and energy prices and instability in global financial markets, environmental and ecological fragility, and high vulnerability to natural disasters and global climate change with low capacity to manage the resulting risks.

Energy challenges. Challenges to improving energy sustainability and security include: i) the limited range of indigenous energy resources; ii) the high cost of developing energy resources and extending service to remote populations; iii) poor quality of energy data and trends, particularly patterns of end-use; iv) a small base of skilled people to address the issues; v) weak bargaining positions with petroleum suppliers; vi) high past dependence on development agencies for most energy infrastructure finance; and vii) electricity charges which are often below actual cost, leaving inadequate resources for effective maintenance. Many of the institutions, laws, technical standards, and regulatory systems are out-dated. It will be a challenge to develop energy infrastructure which is both affordable and resilient to unknown but possibly severe climate change and other future impacts, such as natural disasters. Although considerable thought has been given by the SPC to suitable indicators of energy security, it is also a challenge to further develop these into quantifiable mechanisms to measure or estimate changes over time of short-term and longer-term energy security for the PICTs individually and the subregion.

Energy opportunities. Despite challenges, there are significant and practical opportunities to increase energy sustainability and security in the Pacific through regional / subregional cooperation. Governments, (sub)regional organisations, NGOs, and development partners are well aware of the high costs of petroleum dependency and in 2010, the Pacific leaders strongly endorsed a twenty-year *Framework for Action on Energy Security in the Pacific* (FAESP) and an associated implementation plan which were developed through wide consultation with governments, power utilities, donors and financial institutions and the private sector. There is a long history of cooperation among the PICTs and leaders have established mechanisms through the Secretariat of the Pacific Community (SPC), other Council of Regional Organisations of the Pacific (CROP) agencies and development partners for cooperation, coordination and dialogue for implementing the framework. There is a new private sector 'Sustainable Energy Industries Association of the Pacific Islands' which is working closely with CROP agencies on sustainable energy standards and training. In 2008, key development agencies active in the subregion established a Pacific Energy Donor / International Financial Institutions Working Group (EDWG), which meets as a group with PIC governments and CROP agencies to coordinate energy sector activities, many of which are financed through the Pacific Region Infrastructure Facility, with some of the same members. In brief, there is strong political commitment to address the Pacific's energy challenges and significant financial support from development partners.

Proposed actions in the Pacific. There is no need for new political commitments from Pacific leaders or additional actions beyond those already endorsed by leaders through the subregion's *Pacific Plan*, communiqués from the annual summit of Pacific leaders and the FAESP. Proposed actions are already explicit or implicit in the above documents. These include support for a range of Pacific regional initiatives and regional standards: i) energy sector training programmes at tertiary and technician level, ii) incentives and regulations to incorporate energy efficiency into utility investments where these are more cost effective than new generation, iii) more effective life-line tariffs and other practical approaches to improve energy access for low-income and rural people; iv) development of common technical standards for renewable energy and energy efficiency design, installation, operations and maintenance; v) improved petroleum contracting and advisory services, including publication of a regional fuel price monitor; vi) common standards for independent power producers and power purchase agreements; vii) a subregional programme of support for further developing energy policies, plans and their monitoring and evaluation; viii) improved supply-side and demand-side energy data collection and analysis; ix) common fuel and fuel storage and distribution standards, including biofuels; x) practical Pacific methodologies for assessing the economic and financial viability of proposed energy sector investments, with mechanisms for assessing the extent and type of additional investment justified to improve resilience to uncertainty, including climate change; xii) development of a common methodology to determine trends in both short-term and longer-term energy security of PICTs; xiii) support for action plans for energy use in road transport; and xiv) development of a regional programme to better define key energy resources in a cost-effective manner.

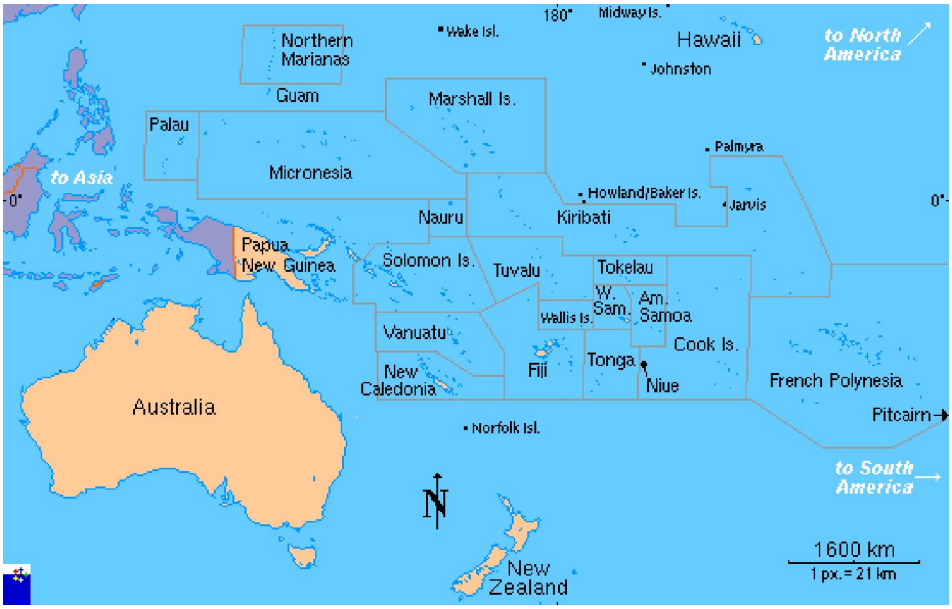
Chapter I: Introduction

1. Description of the Pacific Subregion

Background. There are fourteen ESCAP Members in the Pacific Subregion and seven Associate Members.[1] This perspective includes Pacific Island Countries and Territories (PICTs), but primarily the Pacific Island Countries (PICs): the Cook Islands, Fiji, Kiribati, the Marshall Islands, Micronesia (Federated States of), Nauru, Niue, Palau, Papua New Guinea (PNG), Samoa, the Solomon Islands, Tonga, Tuvalu and Vanuatu.

The subregion and its development challenges have been well described in numerous recent studies, including several prepared by ESCAP,[2] the Forum Secretariat[3] and ADB[4] in 2012. This introduction summarises information from these and other analyses that may be useful for considering the subregion's energy security. Figure 1.1 illustrates the vast geographical area of the Pacific, with over 3,000 islands spread over an area of sea covering nearly one-third of the planet's surface, extending about 8,000 km from Palau to French Polynesia.

Figure 1.1: Map of Pacific Subregion



Copyright: FOTW Oceania map http://www.crwflags.com/fotw/flags/g%28ocea.html#map

[1] ESCAP Pacific Members are Australia, Fiji, Kiribati, the Marshall Islands, Micronesia (Federated States of), Nauru, New Zealand, Palau, Papua New Guinea, Samoa, the Solomon Islands, Tonga, Tuvalu and Vanuatu. Pacific Associate Members are American Samoa, the Cook Islands, French Polynesia, Guam, New Caledonia, Niue, and the Northern Mariana Islands. Source: http://www.unescap.org/about/member.asp.

[2] *Economic and Social Survey of Asia and the Pacific 2012: Pursuing Shared Prosperity in an Era of Turbulence and High Commodity Prices* http://www.unescap.org/pdd/publications/survey2012/download/index.asp, *Green Economy in a Blue World: Pacific Perspectives* (September) http://www.unescap.org/EPOC/pdf/Pacific-Perspectives-2012.pdf and *Green Growth, Resources and Resilience: Environmental Sustainability in Asia and the Pacific* (with ADB & UNEP). http://www.unescap.org/esd/environment/flagpubs/GGRAP/documents/Full-Report.pdf.

[3] *Pacific Regional MDGs Tracking Report* (Pacific Islands Forum Secretariat, August 2012) http://www.forumsec.org/resources/uploads/attachments/documents/MDG%20Track%20Rpt%20web%202012.pdf

[4] *Pacific Economic Monitor* (July) http://www.adb.org/publications/series/pacific-economic-monitor and *Key Indicators for Asia and the Pacific 2012, 43rd Edition* http://www.adb.org/sites/default/files/pub/2012/ki2012.pdf.

Population and geography. Among ESCAP members and associate members, land areas range from only 21 km^2 (Nauru) to 463,00 km^2 (PNG). Mt. Wilhelm in PNG, at 4,905 m, is the highest point in the islands, whereas some of the atoll PICTs have a maximum elevation above sea level at low tide of under 5 m, with land area sometimes reduced by half during high tides. Distances within individual countries also vary tremendously. Nauru and Niue are single isolated island states, with any location accessible within roughly a half-hour drive. Kiribati, at the other extreme, has only 103,000 people living on 33 widely scattered low atolls (811 km^2) spread over 4,200 km of ocean from East to West and 2,000 km from North to South.

Table 1.1 summarises populations, land area and sea area of PICTs. The Melanesian states account for 88% of PICT population and 98% of land area, with PNG alone accounting for 69% and 84% respectively. Any analyses of Pacific subregional energy issues which average overall data from the PICTs or PICs will inevitably heavily skew the findings toward PNG and to a lesser extent Melanesia. It will not be representative of most of the countries.[5]

Table 1.1: PICT Populations (mid 2011), Land Area and Sea Area

Pacific Island Country or Territory	Last population census	Population at last census	Land area (km^2)	Sea Area (km^2)	Population in mid 2011
Melanesia			**542,377**	**5,810,000**	**8,797,410**
Fiji Islands	2007	837,271	18,273	1,290,000	851,745
New Caledonia	2009	245,580	18,576		252,331
Papua New Guinea	2000	5,190,786	462,840	3,120,000	6,888,297
Solomon Islands	2009	515,870	30,407	1,340,000	553,254
Vanuatu	2009	234,023	12,281	60,000	251,784
Micronesia			**3,156**	**9,610,000**	**546,491**
Fed States of Micronesia	2010	102,624	701	2,980,000	102,360
Guam	2000	154,805	541		192,090
Kiribati	2005	92,533	811	3,550,000	102,697
Marshall Islands	1999	50,840	181	2,131,000	54,999
Nauru	2006	9,233	21	320,000	10,185
Northern Mariana Islands	2000	69,221	457		63,517
Palau	2005	19,907	444	629,000	20,643
Polynesia			**7,986**	**4,230,000**	**668,470**
American Samoa	2000	57,291	199		66,692
Cook Islands	2006	15,324	237	1,830,000	15,576
French Polynesia	2007	259,706	3,521		271,831
Niue	2006	1,625	259	390,000	1,446
Pitcairn Islands	2007	66	5		66
Samoa	2006	180,741	2,935	120,000	183,617
Tokelau	2006	1,151	12	290,000	1,162
Tonga	2006	101,991	650	700,000	103,682
Tuvalu	2002	9,561	26	900,000	11,206
Wallis & Futuna	2008	13,445	142		13,193
TOTAL			**553,519**	**19,650,000**	**10,012,371**

Adapted from SPC-SDP_populations_data_sheet_2011.xls (2011) http://www.spc.int/sdp/ & Hannesson (2008) for sea area.

[5] For example, a 2011 report states that "Of the nearly 10 million people living in the Pacific Island Countries, an estimated 8 million do not have access to electricity …" which is true but is not applicable to the bulk of PICTs.

Sea area coverage in Table 1.1 is incomplete but it shows that about 98% of the PICT area is ocean. PICT economic development requires optimising sustainable returns[6] from the vast sea resources, including fisheries and minerals, which for much of the region are far greater than land resources.

PICT economies and vulnerability. As shown in Table 1.2, recent per capita PIC GNPs and GDPs have averaged roughly US$3,000 and $3,300 respectively but in 2010 average per capita 'growth' was negative 0.5% and was estimated by ADB to be only +1.5% in 2011, due in part to the impacts on the Pacific of the global financial crisis. With slow economic growth, governments may be reluctant to raise electricity tariffs sufficiently to meet costs of generation and supply, which are often well below full costs. This can affect the security of energy supply.

All PICs, even PNG with indigenous petroleum and natural gas resources, are highly vulnerable to the effects of high-cost petroleum fuels, with the smaller north Pacific PICs and atoll countries being particularly vulnerable. The Asian Development Bank (ADB) has argued[7] that seven PIC economies are among the 10 most vulnerable in the Asia-Pacific region to oil price volatility.

Table 1.2: Economic Indicators for Independent Pacific Island Countries

Pacific Island Country	**GNP per capita** US$; 2009	**GDP per capita** US$	year	**GDP growth rate per capita** % 2010	2011e	**Current account balance** % GDP; 2010	**High exposure to fuel price rises**
Cook Islands	n.a.	10,875	2008	-2.2%	-0.8%	4.9%	√
Fiji	3,840	3,499	2008	-0.3%	0.0%	-2.3%	√
Kiribati	1,830	1,490	2008	-1.2%	0.1%	-13.7%	√
Marshall Islands	3,060	2,851	2007	-1.0%	0.0%	-10.5%	√
Micronesia (FSM)	2,500	2,183	2007	-7.6%	n.a.	-17.0%	√
Nauru	n.a.	2,071	2006/7	0.0%	1.9%	n.a.	√
Palau	6,220	8,423	2007	1.4%	n.a.	-9.5%	√
Papua New Guinea	1,180	897	2006	4.8%	6.2%	-26.6%	√
Samoa	2,840	2,672	2008	-0.3%	2.7%	-8.1%	√
Solomon Islands	n.a.	1,014	2008	1.6%	5.2%	-20.0%	√
Tonga	3,260	2,629	2007/8	-1.5%	0.2%	-5.6%	√
Tuvalu	n.a.	1,831	2002	-0.5%	-0.5%	n.a.	√
Vanuatu	2,620	2,218	2007	0.7%	1.2%	-2.4%%	√
PIC average	*3,039*	*3,281*		*-0.5%*	*1.5%*		

Notes: e = estimated; n.a. = not available;

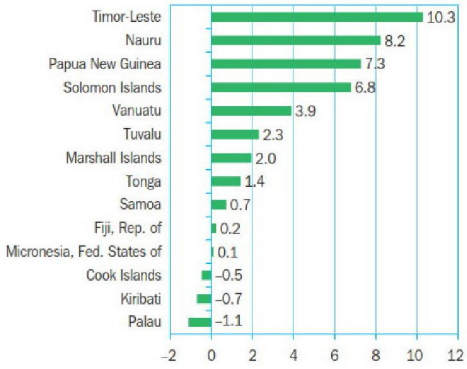
Sources: *Asian Development Outlook 2011* (ADB, 2011),*Pacific Economic Monitor* (ADB, February 2011). GNPs from ADB; GDPs from *Pocket Summary 2010* (SPC). For exposure to fuel prices, see footnote 5

[6] In 2012, the theme for the annual meeting of leaders of Forum island states (FICs) was "Large Oceans Island States – the Pacific Challenge" with discussions aimed at striking a balance between sustaining the development of marine resources with the interests of preservation and conservation. Leaders agreed that as 'Large Ocean Island States', FICs have a leading role to play in management of the Pacific Ocean, in accordance with the precautionary approach of Rio Principle 15.

[7] See *Oil Price Vulnerability in the Pacific*, Pacific Economic Bulletin Vol 23 No 2 (Theodore Levantis, 2008) ;
ii) *Australian Aid Program Perspectives on Rising Fuel Prices in the Pacific* (AusAID, 2008); *Taking Control of Oil* (ADB, 2009) and *Overcoming Vulnerability to Rising Oil Prices: Options for Asia and the Pacific* (UNDP, 2007). Also see *Macroeconomic Impact of Energy Prices in the Pacific* (PFTAC, 2010). The ADB argued that seven PIC economies were among the 10 most vulnerable in the Asia-Pacific region to oil price volatility.

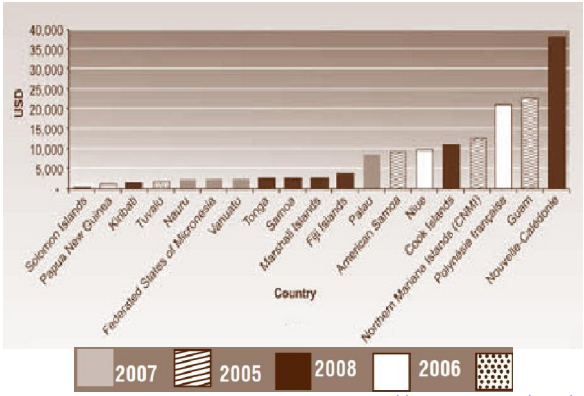
Figure 1.2 illustrates the wide range of growth in real GDP over the past five years for ADB's Pacific Developing Member Countries (PMDCs, which includes Timor Leste), from -1.1% for Palau to +8.2% for Nauru. Figure 1.3 shows graphically the huge range in per capita GDP ranging from US$1,000 to $38,000 covering Pacific territories as well as independent states. Among independent PICs, the range is about $1,000 to $11,000.[8]

Figure 1.2: Average Annual Growth Rates of Real GDP in Pacific - Latest Five Years



Source: *Key Indicators for Asia & Pacific* (ADB, 2012)

Figure 1.3: Approximate GDP per Capita for Selected PICTs



Source: *Pocket Summary* (SPC, 2010) http://www.spc.int/sdp/

Pacific HDI and poverty. UNDP's 2012 Human Development Index (HDI) covers 187 countries including 9 PICs, of which two (Palau and Tonga) are ranked along with Australia and New Zealand as 'high human development countries', five are medium and two (the Solomon Islands and Papua New Guinea) low. As Table 1.3 shows, for all PICs for which data are available, the HDI has improved since 1990.

Table 1.3: Human Development Index & Related Indices for Pacific Countries

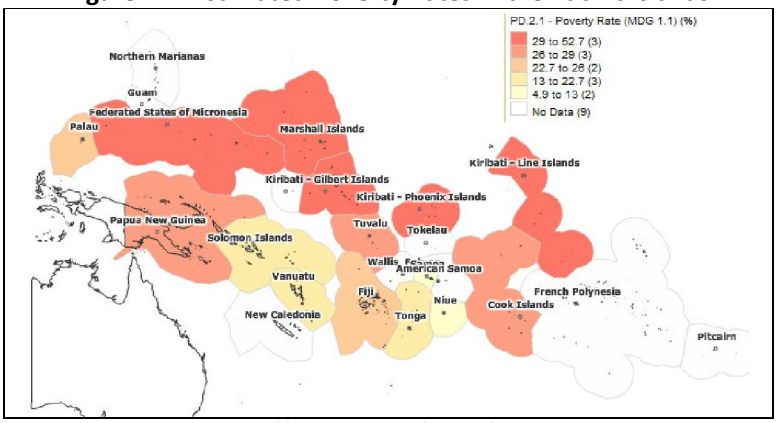
HDI Rank for Pacific Countries		HDI Trends 1990 - 2011			Inequality-adjusted HDI	Gender Inequality Index	
		Value			Value	Rank	Value
		1990	2000	2011	2011		2011
2	Australia	0.873	0.906	0.929	0.856	18	0.136
5	New Zealand	0.828	0.878	0.908	..	32	0.195
49	Palau	..	0.774	0.782	..	..	..
90	Tonga	0.649	0.681	0.704	..	..	..
99	Samoa	..	0.657	0.688	..	..	..
100	Fiji	0.624	0.668	0.688	..	..	..
116	Micronesia (FSM)	..	..	0.636	0.390	..	..
122	Kiribati	..	..	0.624	..	..	..
125	Vanuatu	..	..	0.617	..	..	..
142	Solomon Islands	..	0.479	0.510	..	..	..
153	Papua New Guinea	0.368	0.423	0.466	..	140	0.674
	Marshall Islands	..	..	..	..	..	..
	Nauru	..	..	..	..	..	..
	Tuvalu	..	..	..	..	..	..

Source: *Asia Pacific Human Development Report* (UNDP, 2012)

[8] These data are not strictly comparable as the years range from 2005-2008.

The Human Development Report has very limited data on poverty in the subregion.[9] However, SPC (Figure 1.4) indicates a generally higher proportion of poverty in the small northern Pacific island states than those in the south. According to the 2010-2020 Pacific subregional energy framework[10] "Energy security exists when all people at all times have access to sufficient sustainable sources of clean and affordable energy and services to enhance their social and economic well-being" which strongly suggests that energy security must be addressed if poverty rates are to be substantially reduced.

Figure 1.4: Estimated Poverty Rates in the Pacific Islands



Adapted from SPC: http://www.spc.int/prism/online-mapping

As Table 1.4 shows, a high percentage of Pacific Islanders live in their coastal zones, with very few (excluding PNG) living at 1500 metres or higher. Unsurprisingly, the majority of PICTs are believed to be in a high or extreme risk to the impacts of climate change[11] and this has implications for their long-term energy security.

Table 1.4: Location of Pacific Populations

HDI Rank for Pacific Countries		Population in Coastal Zone (% of total)		Population Living in Elevated Areas (% of total population)			
				1500-3000 meters		3000-5000 meters	
		1990	2000	1990	2000	1990	2000
2	Australia	11.9	12.1	0.03	0.03	0.00	0.00
5	New Zealand	14.7	14.7	0.20	0.20	0.00	0.00
49	Palau	52.3	51.5	0.00	0.00	0.00	0.00
90	Tonga	43.2	43.0	0.00	0.00	0.00	0.00
99	Samoa	23.6	23.6	1.16	1.16	0.00	0.00
100	Fiji	16.7	17.6	0.00	0.00	0.00	0.00
116	Micronesia (FSM)	31.9	31.2	0.00	0.00	0.00	0.00
122	Kiribati	100.0	100.0	0.00	0.00	0.00	0.00
125	Vanuatu	4.6	4.5	0.00	0.00	0.00	0.00
142	Solomon Islands	18.3	19.5	0.26	0.22	0.00	0.00
153	Papua New Guinea	2.6	2.7	28.20	28.20	1.97	1.97
	Marshall Islands	99.8	99.8	0.00	0.00	0.00	0.00
	Nauru	42.0	42.0	0.00	0.00	0.00	0.00
	Tuvalu	99.6	99.5	0.00	0.00	0.00	0.00

Source: As for Table 1.3

[9] The *Pacific Regional MDGs Tracking Report* (PIFS, 2012) has a chapter on combatting poverty but it was received too late to incorporate into this overview.

[10] *Towards an Energy Secure Pacific: A Framework for Action on Energy Security in the Pacific: 2010-2020* (SPC, 2011).

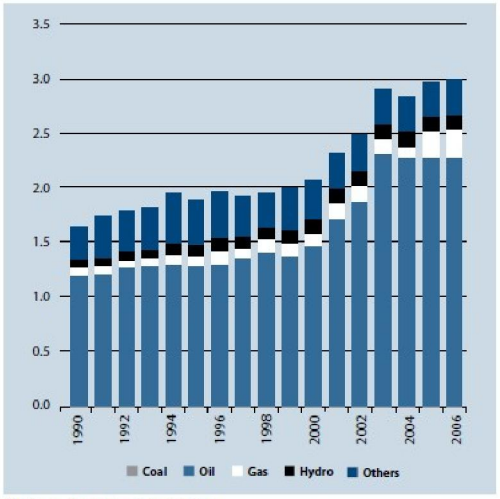
[11] A set of 15 peer-reviewed reports released in November 2011 on vulnerability and climate change projections for ADB's Pacific DMCs prepared by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is available from the Pacific Climate Change Science Programme: http://www.cawcr.gov.au/projects/PCCSP.

2. Energy Situation in the Pacific

Energy supply and consumption. Figure 1.5 below shows the PDMC total energy supply (fossil fuels and local energy such as hydro and biomass) from 1990-2006 and the primary energy mix in 2006. Total energy grew at an estimated rate of 3.8% per year during the period and for 2006, fossil fuels accounted for 85% of the total, with petroleum contributing 76%.

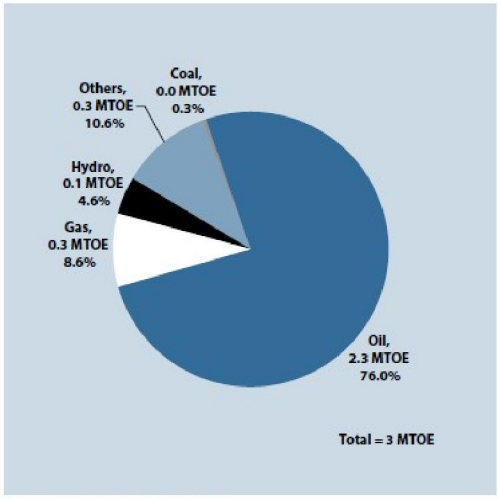
Figure 1.5: Primary Energy Supply in ADB Pacific Developing Member States

Energy Supply: 1990-2006



MTOE = million tons of oil equivalent.

Energy Mix: 2006



MTOE = million tons of oil equivalent.

Source: Framework for Action on Energy Security in the Pacific 2010-2020 (SPC, 2010) from Energy Statistics in Asia and the Pacific 1990-2006 (ADB, 2009).

Biomass energy, shown as 'other', was estimated to account for under 11% of the subregion's energy supply, which is probably a substantial underestimate. There have been very limited measurements of actual Pacific biomass energy use since the 1980s. The 1992 World Bank/UN Pacific Regional Energy Assessment (PREA) estimated biomass as 50% of total supply. The 2005 UNDP/GEF/SPREP Pacific Islands Renewable Energy Project (PIREP) reports were unable to accurately estimate biomass energy supply or consumption due to poor data. However, biomass was estimated to account for about 50-60% of supply for the larger island countries, but far less for some small PICTs.

Petroleum dependency. As Figure 1.6 illustrates,[12] the Pacific Islands are extremely dependent on imported petroleum for commercial energy.[13] *The Pacific islands subregion has the highest petroleum fuel dependency of any region or subregion in the world*, exceeding by far that of the Caribbean island states. The percentage of petroleum fuels used for transport is probably an overestimate, and it varies considerably by country, but most

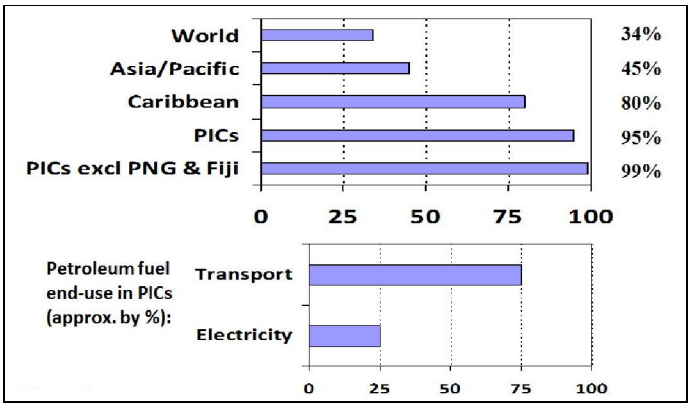
[12] Figure 1.6 is indicative only as PIC petroleum import data are often unreliable and inconsistent. Transport and electricity end use are approximate. The data are from *Key World Energy Statistics* (IEA, 2009) and *Energy Statistics in Asia and the Pacific 1990-2006* (ADB, 2009) except the Caribbean from *Trends in Sustainable Development - SIDS* (UN, 2010).

[13] Oil production in PNG began in 1991 with peak output in 1993 with all crude oil exported. PNG's gas reserves are estimated to be many times larger than oil. The subregion's only current oil refinery - there was one in Guam some years ago - came on-stream in 2004 (relying on imported crude oil) and mainly serves the domestic PNG market with some exports. Source: *Facilitating Private Sector Participation in the Promotion of Energy Security: Draft Final PNG Country Review* (SPC/BizClim, 2012).

likely exceeds 60% of the total for all PICs. Although there are various opportunities for reducing petroleum fuel imports for electricity generation, any serious efforts to substantially reduce the volume of fuel imports must address transport, which dominates petroleum fuel use in the region.

For a region overwhelmingly dependent on imported petroleum fuels, data showing trends in total and retained petroleum imports by volume are surprisingly incomplete and inconsistent. Petroleum end-use data, where available, are often crude estimates for most PICs.[14] Table 1.5 indicates petroleum fuel imports in Kilotonnes of Oil Equivalent (KTOE). The data come from a variety of sources which are often inconsistent; they should be considered indicative only.

Figure 1.6:
PIC Extreme Petroleum Dependency and End-Use



Source: *The Case for Increased Investment in Energy Efficiency in the Pacific Islands* (Johnston, 2010)

Table 1.5: Indicative PIC Petroleum Fuel Imports in KTOE

PIC	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cook Isl	14.7		16.3	10.1	9.31	15.8	25.3	26.7	22.7			
Fiji		209.90	479.6	458.8	501.4	605.6					434.8	
FSM		49.2	58.0	45.5			41.8	42.9	47.5	42.5	56.9	40.0
Kiribati		14.7	15.27	17.3	16.8	18.98	17.7	18.3	17.7	17.8	17.0	18.2
Marsh Isl					55.8		33.9	30.4	35.1	32.4		
Nauru	15.9	4.8	11.8	21.6	12.5			8.4	6.4	8.9	8.7	8.8
Niue	1.8						2.2	2.1	2.0	3.2	1.8	1.9
Palau	30.0	64.3	48.4	46.7	46.4	54.3	56.2		54.9	52.6	44.2	46.0
Samoa	51.3	58.3	62.1	65.7	66.2	67.0	66.3	65.9	69.2			
Sol Isl	59.6	59.6	70.9	59.0	63.9	63.9	63.9	65.0				
Tonga	36.1	33.4	30.2	32.6	40.7	38.6			45.0			
Tuvalu								2.3	4.2	2.6	3.5	3.0
Vanuatu	24.2	36.3	38.8	31.7	35.4		18.4	18.4	33.1	31.0		

Note: The above data are total fuel imports, except for Fiji which is retained imports. Fiji typically re-exports about 40% of imported fuel to other PICs so this approach avoids double counting. Table excludes Papua New Guinea

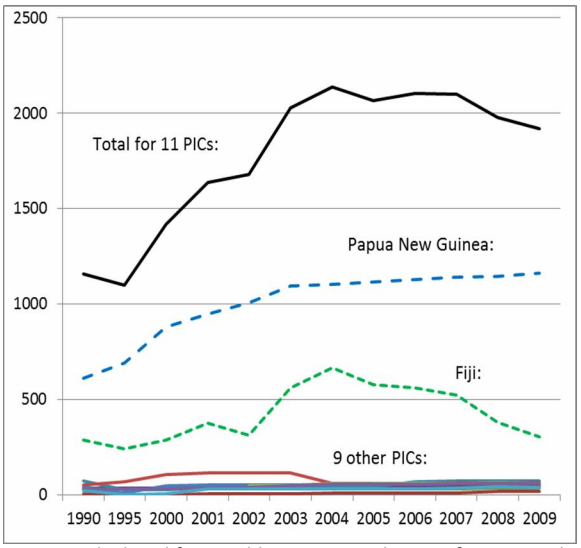
Sources: large number including PIREP reports (2005), Energy data book spread sheets (ADB, 2009), draft IRENA PIC reports (2012), SPC Country Energy Security Indicator Profiles 2009 (2012), SPC's PRISM database, UN data, etc.

[14] There have been several studies of gaps and inconsistences regarding PIC petroleum data and energy data in general. See for example *Energy Statistics' Collection / Analysis in the Pacific* (internal background paper prepared for ADB Johnston, 2009). Fuel imports by value are generally available but imports by volume are not readily available. For the smaller PICs, even accurate import volumes for a specific year can be misleading. They do not indicate actual consumption during the year because infrequent shipments may, for example, result in delivery in January one year but December the next year, skewing the apparent consumption for both years, specially when changes in end-of-year stock levels are unavailable.

Figure 1.7 shows total energy use by ADB's PDMCs[15] from 2003-2009 as hovering around 2000 kilotonnes per year. Papua New Guinea typically accounts for about 60% of the total and PNG and Fiji combined 80%.

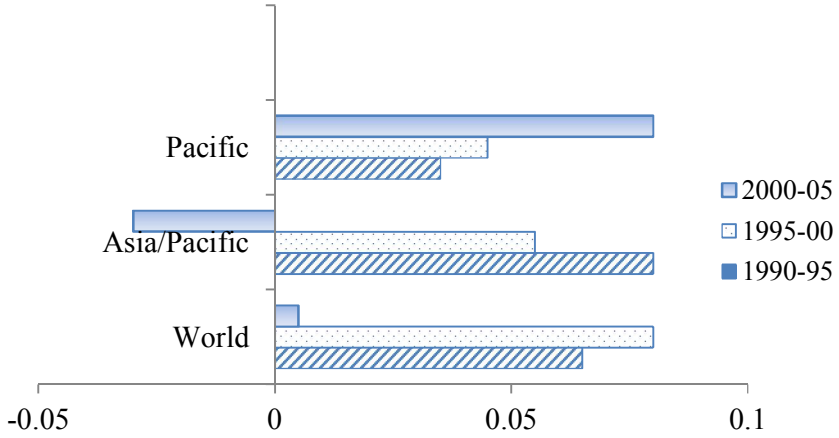
The energy decoupling factor relates the rate of GDP growth to the rate of change in energy resource use.[16] As Figure 1.8 illustrates, the Pacific subregion has been using steadily more energy per unit of GDP between 1990-1995 and 2000-2005, whereas the Asia/Pacific region overall has been shifting to increased energy efficiency.

Figure 1.7: PIC Energy Use in KTOE



Source: Calculated from Table 6.4, *Key Indicators for Asia and the Pacific* (ADB, 2012); KTOE = Kilotonnes of Oil Equivalent

Figure 1.8: Decoupling Index for Energy Use, 1995-2005



However, for most of the individual PICs for which data are available (Table 1.6), GDP per unit of energy use appears to be relatively static or increasing. This may be because Figure 1.8 is skewed by the high energy use of PNG, with energy-intensive extractive industries.

[15] In addition to PNG and Fiji, the figure includes Kiribati, Marshall Islands, Nauru, Palau, Samoa, Solomon Islands, Timor-Leste Tonga and Vanuatu. There were no data for FSM and Tuvalu.

[16] "For economic growth to be decoupled from resource use and to be environmentally sustainable, the amount of resources used to produce one unit of GDP … must decline over time. If this measure is increasing over time, the economy is growing along a less energy efficient path and could become more vulnerable to resource risks in the future." From *Green Growth, Resources and Resilience: Environmental Sustainability in Asia and the Pacific* (ESCAP, UNEP & UNDP, 2012). Some would argue that measuring GDP/energy use may be inappropriate for PICs, especially where the structure of the economy may have changed during the period.

Table 1.6: GDP per Unit of Energy Use ($/kg of oil equivalent)

PIC	1990	2004	2005	2006	2007
Fiji	8.8	5.3	6.2	6.5	6.9
Kiribati	19.6	26.8	26.9	21.9	20.0
Samoa	9.8	11.8	12.1	12.4	12.9
Solomon Islands	13.6	15.9	16.8	17.7	18.0
Timor-Leste		15.7	16.7	15.9	17.2
Tonga	11.3	7.4	7.3	7.3	7.1
Vanuatu	21.6	23.4	24.6	25.6	24.1

Source: *Key Indicators for Asia and the Pacific* (ADB, 2012).
GDP is in constant 2005 $ PPP (purchasing power parity)

PICT energy resources. Only PNG has proven reserves of oil and natural gas and none are known to have domestic sources of coal. The subregion's renewable energy resource is summarised in Box 1.

Box 1: Renewable Energy Resources in the Pacific Islands

Although renewable energy resources are abundant in the region, they remain underutilised and produce – even including large hydro – less than 10% of the total energy use in the Pacific

Solar. All of the Island states have an excellent solar resource which slightly increases toward the equator. The primary problem with solar energy is it is not predictable and can vary widely over the span of a few seconds as clouds obscure the sun. The resource can vary significantly locally, due to cloud conditions. Many PICs have a dry season and a rainy season with less solar energy available during the rainy season. Solar data is often available from ground mounted solarimeters. If not, the US National Aeronautics & Space Administration (NASA) provides monthly satellite solar data free on the Internet.

Wind. Wind energy has had limited use in the Pacific, especially for grid based generation, although both Fiji and Vanuatu have grid-connected wind farms. The wind resource tends to increase away from the equator. Many of the islands are in the paths of cyclones/typhoons and the average wind energy resource is usually not very good. Only recently (with the high cost of diesel fuel) have wind energy systems become cost effective in parts of the sub region.

Hydro.PNG and Fiji have sufficient land area and mountains to support larger scale hydropower installations. The Solomon Islands and Vanuatu are both divided into many small islands, none of which can support major hydro development, although smaller hydro for provincial centers or villages may be reasonable. Hydro sites that include at least 4-6 hours of water storage are of particular interest since they could be used for pumped hydro energy storage from wind or solar energy.

Bioenergy. Except for Nauru, all PICs have some potential for biofuel production using coconut oil as the feed stock. Coconut oil has a number of advantages over planting of other crops for biofuel. Palm oil as a feed stock for biodiesel and ethanol for blending with gasoline are possible options for parts of Melanesia. Coconut husks and shells are traditional biomass energy sources for cooking and copra drying. On a larger scale, they have also been used as feedstock for power generation at coconut processing plants. Low lying islands, such as atoll islands, have limited biomass resources, mainly the waste from coconut processing. Currently all biomass generated electricity in the PICs is generated privately and sold through a Power Purchase Agreement (PPA) to utilities (PNG, Fiji) or directly to villagers surrounding the facility.

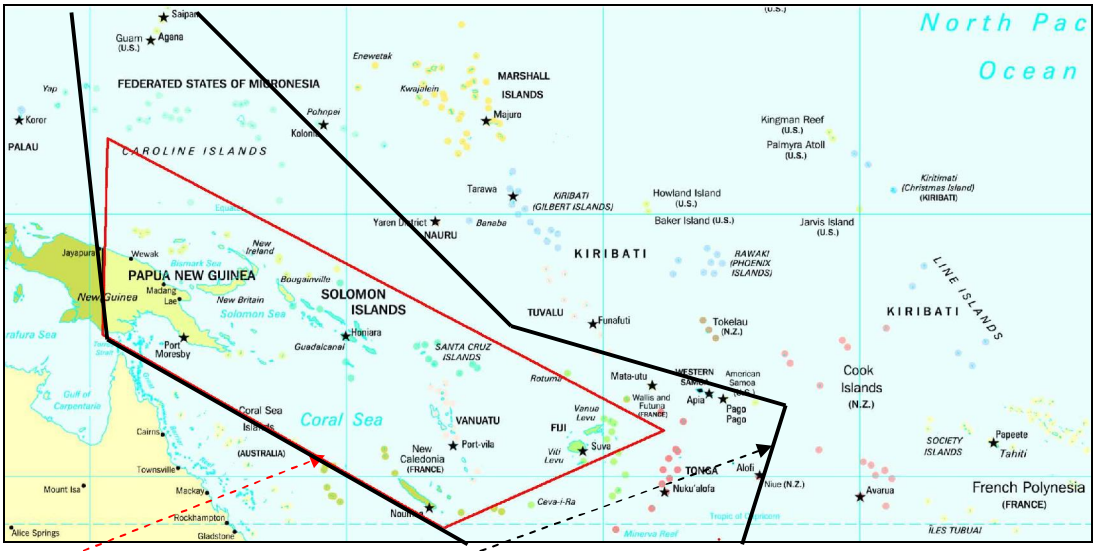
Geothermal. The area lying between Vanuatu and Tonga in the south and running north and east is where most accessible geothermal resources are located in the Pacific. To date only PNG produces electricity from geothermal. Development has been proposed in Vanuatu and long discussed in Fiji.

Ocean Energy. Although clearly there are huge energy resources in the ocean surrounding the islands, to date there have been no ocean energy installations, though a wave energy installation is planned for Kosrae (FSM) and is being seriously considered for Tonga. Wave energy tends to increase as one moves away from the equator and can experience serious problems due to the impact of tropical storms. Ocean Thermal Energy Conversion (OTEC) opportunities increase as one moves toward the equator but have yet to be cost effective in practice.

Source: slightly edited from *Status of Renewable Energy in the Pacific Island Countries - Regional Overview* (draft, IRENA, July 2012)

The areas of the Pacific with significant potential geothermal energy and significant biomass for energy (combustion, gasification, conversion to biofuels) is shown in Figure 1.9.

Figure 1.9: Pacific Islands with Significant Biomass and Geothermal Energy Resource



Biomass = area within inner boundary; **Geothermal** = area within outer boundary. Source: adapted from IRENA, 2012

Renewable energy goals. Most PICs have very ambitious goals and timescales for the percentage of electricity to be generated from renewable energy. In general, there is a lack of clear priorities, no detailed costing of RE options and likely costs relative to diesel based generation, and sometimes only limited dialogue between energy planning authorities and the power utilities.[17]

Table 1.7: Renewable Energy Goals of Pacific Island Countries

Pacific Island Countries & Territories	Renewable Energy Electricity Generation	Renewable Energy Electricity Targets (Primary Energy)	
	Approx % of Total	% of Total	Year
Cook Islands	<1%	50%; 100%	2015; 2020
Fiji	67% (2010)	90%	2015
FSM		Urban 10% Rural 50%	2020
Kiribati (unofficial)	<1%	10% - 30%	unspecified
Marshall Islands	1%	20%	2020
Nauru	<1%	50%	2015
Niue	3%	100%	2020
Palau	3%	20%	2020
Papua New Guinea	46%	No Targets Set	
Samoa	42%	+ 20	2030
Solomon Islands	<1%	50%	2015
Tokelau	1%	100%	2012
Tonga	<1%	50%	2012
Tuvalu	2%	100%	2020
Vanuatu	19%	25%	2012

Source: IRENA Islands Initiative Presentation (Herbert Wade; Vanuatu, 15 July 2012) slightly updated

[17] Matthew Dornan of Australia National University (ANU) argues that these ambitious "renewable energy targets can be viewed as a means of attracting donor funds …" with "political benefits for Pacific island governments, and image-related benefits for external donors" even for PICs with no cost-effective RE resources. "It is time that donors responded only to sensible energy plans and targets, and not to those that are politically motivated." Source: *Renewable energy targets in the Pacific: Why are unrealistic targets adopted?* (Dornan, 2012). However some observers familiar with various donor-supported PIC national energy roadmap efforts feel that development agencies are responding to this issue.

Chapter II: Major Challenges Relevant to Enhancing Energy Security and the Sustainable Use of Energy in the Pacific

1. Major Sustainable Development Challenges

The standard understanding of sustainable development is that of the Brundtland Commission "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987) with its three associated pillars of economic growth, social development and environmental protection.[18] There are studies challenging this approach and its relevance to the Pacific in the long term but this paper is not the place to debate the concept of sustainable development. The Brundtland approach is accepted, as articulated in *Green Economy in a Blue World: Pacific Perspectives* (ESCAP; September 2012), a vision for achieving more environmentally sustainable and socially equitable development for the Pacific, and which forms the basis of this section.

The ESCAP report summarises challenges to sustainable development faced by PICs in achieving the Millennium Development Goals (MDGs). In brief, "overall economic performance in the Pacific has been weak; and while there has been some social progress, there are still significant gaps. Environmental degradation and climate change are threatening progress. The Rio+20 Summit reinforced the global commitment toward balancing the economic, social and environmental pillars of sustainable development through the green economy approach, including enabling policy, legal, regulatory and institutional frameworks." The introductory section of the report, 'Challenges facing the Pacific' is paraphrased and summarised below:

- Pacific island countries are economically vulnerable and ecologically fragile. Their small populations, small size, limited resources, geographic dispersion and isolation from markets places them at a disadvantage economically, prevents economies of scale and increases exposure to external conditions.
- Pacific island countries are highly susceptible to increases in food and energy prices and instability in global financial markets.
- Environmental degradation, climate variability, sea level rises, and increasing prevalence of natural disasters have made Pacific nations even more vulnerable. Food security, the land and marine resources, and the livelihood opportunities of people are increasingly threatened.
- Natural resources (e.g. energy, minerals, water and land) are limited in most PICs. Natural resources constraints have led to a high dependence on foreign inputs and put pressure on available natural capital. The ability of PICs to easily import resources is made difficult by their remoteness and small economic size, which increases the cost of importing and limits their ability to attract imports. Overcoming resource constraints is a major challenge which has resulted in poor management decisions and a decline in the ecosystem goods and services provided by natural capital.

[18] A recent fourth pillar being discussed is governance to support and implement sustainability policies. The development of revised sustainable development goals for the post-2015 period are the subject of current regional and international discussions and will be developed during 2013-2014.

- The dependence of Pacific countries on fossil fuels for their energy needs presents a major threat to energy security and economic stability. The recent global fuel crisis had such a profound impact that some PICs used significant foreign exchange reserves to import petroleum products.
- Weak economic growth in recent decades coupled with inequality of growth has hampered the success in achieving MDGs. In the Pacific, the National Basic Needs Poverty Line of each country (the minimum income needed to buy sufficient food and meet basic requirements) is the primary measure of poverty. Although some PICs have recorded declining poverty, most are not on-track to meet MDG1 goals and many have experienced an increase in the poverty rate.
- Substantial progress has been made in providing universal education, improving healthcare, enhancing coastal and marine resource management, and developing strategies for disaster risk management. Most PICs have achieved or almost achieved universal primary education (MDG2), there have been significant improvements in child health and maternal health (MDG4 and 5), and some progress has been made in gender equality (MDG3) and eliminating HIV/AIDS, tuberculosis and malaria (MDG6). However, in 2011 the Forum considered the Pacific to be in the midst of a non-communicable disease epidemic.
- There has been mixed progress with MDG7, ensuring environmental stability. Many PICs have not made significant progress in increasing access to improved water or basic sanitation. The lack of suitable land, especially on atolls, for landfills is a major constraint in waste management and disposal; improper disposal of waste in the Pacific threatens fragile marine and terrestrial ecosystems.
- Pacific governments face fiscal challenges from falling revenues, high debt levels, and in turn reduced capacity to finance much needed investments in infrastructure, and economic and social services.[19] These problems may be exacerbated by the harsh impacts anticipated from climate change, which threaten to seriously impede efforts to achieve sustainable development.
- The Pacific region is particularly vulnerable to climate change induced sea-level rise and increased frequency and intensity of natural disasters. Challenges include intense flooding threatening water supply, coastal infrastructure and land areas; and climate variability and increased frequency and intensity of natural disasters which could have negative impacts on food security, coral reef and forest biodiversity, and the spread of certain diseases.
- Population growth and increasing urbanisation rates exacerbate the challenges faced by PICs. Many small islands have limited capacity to adapt to the projected impacts of climate change due to constraints in financial resources, available technology, inadequate human resources and expertise, and limited infrastructure and institutions.

A recent World Bank report agrees that "Pacific island countries continue to be among the most vulnerable in the world: they combine high exposure to frequent and damaging

[19] Infrastructure deterioration in a number of PICs is alarming. In Fiji in late 2012, a survey by the newly-established Fiji Roads Authority determined that at least 30 bridges) were in a dangerous state, requiring some (including several heavily-used bridges in central Suva) to be immediately closed. Urgent repairs will cost many millions of dollars.

natural hazards with low capacity to manage the resulting risks. Their vulnerability is exacerbated by poorly planned socioeconomic development, which has increased exposure and disaster losses, and by climate change, which has increased the magnitude of cyclones, droughts, and flooding." The report[20] notes that "the institutional rigidity of donor organisations makes cooperation and partnership more difficult. … Joint programming of climate change adaptation and disaster risk reduction activities by donors and implementing agencies is not widespread." Although donor cooperation and coordination have improved markedly in recent years in the energy sector, the conclusions are also valid for the energy sector.

Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) recently completed a sustainability assessment of 14 PICs.[21] Key conclusions, reiterating points made above, are:

- For larger resource-rich high islands (with substantial resources in energy, minerals, and water) development may be constrained as much by institutional problems and lack of capital and expertise as by the lack of natural resources per se, although energy resources of most PICs are largely in the form of potential for renewable energy.
- For PICs composed almost exclusively of low islands (e.g. atolls) adaptive capacity is acutely constrained by lack of natural resources. On some, sourcing fresh water adequate for subsistence agriculture can be a challenge. This limits both the potential to raise crops for export (to pay for the petroleum imports upon which most PICs are heavily reliant), and cropping for biofuels production to substitute for petroleum. They have no potential for hydroelectricity, and typically have poor wind power potential, worsened by the threat posed to wind turbines by periodic tropical cyclones. These islands appear exceptionally vulnerable to any negative effects on water supplies and extreme weather events that climate change may bring.
- Agriculture, forestry and fisheries resources of the PICs are generally under increasing pressure, especially where population growth rates are high and land is limited. Traditional farming systems are tending to give way to more commercial enterprises as economies monetise and food production shifts focus from subsistence towards exports. In underperforming PICs, development constraints commonly include land limitations, land tenure issues, poor infrastructure, high transportation costs, limited access to improved technology and market information, the lack of extension services, poor market access (local and international), fluctuating commodity prices, and incidence of natural disasters. Sector growth is likely to come through encouraging niche markets (e.g. organics) and private sector investment, and maximising the advantage offered by the disease free status held by several countries. Many PICs would also greatly benefit from a focus on expansion of the smallholder sub-sector and the better harnessing of offshore resources by local commercial fishing industries.
- Food security for many PICs has been influenced by market changes and changes in traditional customs and farming systems. For some PICs (e.g. PNG and the Solomon Islands) food security is not a concern at a national level, although this can differ at the

[20] The report is *Acting Today For Tomorrow: A Policy and Practice Note for Climate and Disaster Resilient Development in the Pacific Islands Region* (WB, 2012)

[21] *Sustainability Assessment of Selected Countries in the Pacific Islands* (CSIRO, 2011).

household level and within the country. A worrying trend is that demand for food is increasingly being met by imports, often of a lesser nutritional quality, exposing people to the volatility of international commodity prices. PICs with very limited potential growth in agricultural (e.g. Kiribati, Palau and Tuvalu) should focus on local food production to ensure their own food security.

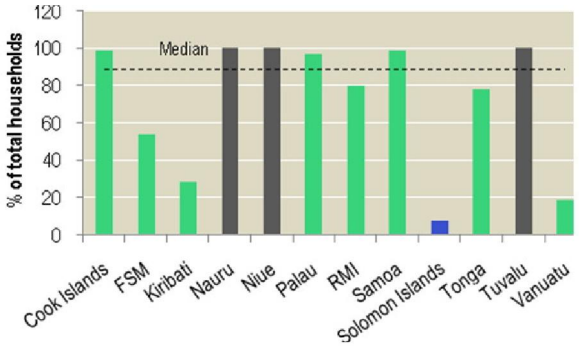
Despite receiving the highest overseas development assistance per capita globally, economic progress in the region has been limited, suggesting perhaps deep-rooted challenges. Poor governance within the subregion is a key factor, with PICS in Melanesia, Micronesia and Polynesia experiencing political disruptions, votes of no confidence in governments, and instability. The subregion has long prided itself on regional solidarity through dialogue and compromise — the 'Pacific Way' — yet maintaining this cohesion in the midst of a changing geo-political climate is a challenge. Sub-groupings in Melanesia (the Melanesian Spearhead Group), Polynesia and Micronesia are becoming more influential and assertive and China is assuming a greater role compared to traditional development partners. The challenges facing the Pacific are not only significant, they are changing at a more rapid pace than in the recent past.

2. Major Energy Challenges

Regional coordination. From a Pacific subregional perspective, a major energy sector challenge is developing and implementing effective mechanisms for real cooperation and coordination among the numerous donors, agencies and other key players. As discussed later, there is a *Framework for Action on Energy Security in the Pacific* (FAESP), which has been endorsed by Pacific leaders at the regional level. There have been complementary efforts at the national level for coordinated assistance by development agencies to work together with a number of PICs to develop national whole-of-sector energy roadmaps and follow-up implementation plans, through what is referred to as a common 'many partners one team' approach. These are commendable in concept, but not always operationally as effective as they could be. This section discusses national challenges and returns to the subregional perspective later.

Access to Energy Services. Only about 20% of PIC households have access to electricity, but this is highly skewed by low rates in PNG, the Solomon Islands and Vanuatu, which account for nearly 80% of the PIC population. The rugged geography and remoteness of much of the population of these PICs result in very high electricity investment and O&M costs. For most PICs (Figure 2.1) electrification rates are between 50% and nearly 100%. For FSM and Kiribati, electrification is also very expensive, with small populations on many islands spread over a huge area of sea.

Figure 2.1:
Access to Electricity in the Pacific Islands



Source: *Pacific Infrastructure Performance Indicators* (PRIF, 2011)
Note: PNG not shown but about 12% (source: draft PNG energy security report (SPC/BizClim, 2012)

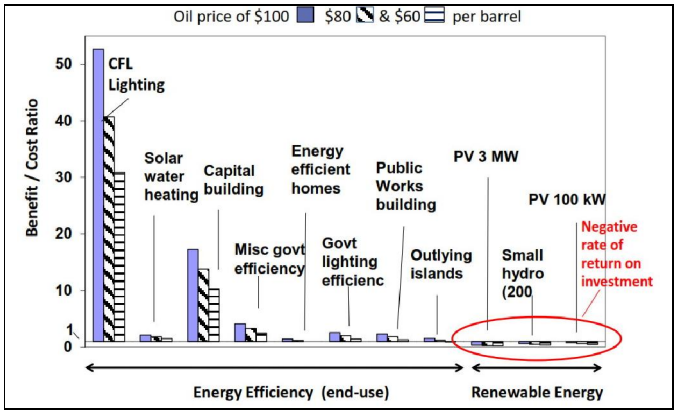
Provision of liquid fuels to rural areas (the high lands of mountainous states and remote islands in general) for power generation, lighting, cooking is also a serious challenge. For some islands, shipping is both infrequent and highly irregular. Where there is an adequate physical supply, costs - unless heavily subsidised - can be far higher than in urban centres. Figure 2.2 shows the use of small boats to transport diesel fuel and LPG within the remote province of Torba in Vanuatu.

Figure 2.2: Transporting Fuel in Remote Vanuatu

Source: Solomone Fifita, SPC

Energy Efficiency. The PICs are heavily dependent on loans and grants from development agencies for the development of energy infrastructure. Most of the grant assistance to the PICTs between about 1990 and 2010 has been to expand the energy supply, much of it for renewable energy. During that period about $20 was spend on renewable energy for every dollar spent for improving PIC demand side energy efficiency (EE).[22] In recent years increased efforts have gone into support for EE[23] but there is still a considerable imbalance, especially considering that it is often more cost effective to save energy than invest in new supply, particularly in those PICs which already have a high level of access to electricity. An assessment in Palau several years ago of various proposed and actual investments (see Figure 2.3) concluded that every EE investment considered was a better economic choice than any of the renewable energy options. This was true for a range of petroleum prices and discount rates.[24] Palau has relatively few

Figure 2.3: Relative Benefits & Costs of Energy Investments - Palau (2008)



Source: *The Case for Increased Investment in Energy Efficiency in the Pacific Islands* (Johnston, 2010)

[22] This estimate is based on preparatory work by the author in 2010 for what eventually became the *Framework for Action on Energy Security in the Pacific*. There were extensive discussions with development agencies and CROP agencies and literature searches. A senior AusAID official dealing with energy at the time, Brian Dawson, agreed that this was a reasonable estimate. Demand side energy efficiency refers to efficiency improvements by energy consumers and excludes utility investments to improve 'supply side' efficiency.

[23] For example IUCN Oceania's regional programme has several EE components including planned efforts through national development banks for improving home and small business energy efficiency in a number of PICs. The €14.5m SPC/EU North-REP Micronesian energy programme emphasises RE but includes EE. SPREP's UNDP/GEF 'Pacific Islands Greenhouse Gas Abatement through Renewable Energy Project' (PIGGAREP) has expanded from solely RE to include some EE with support from the multi-agency 'Small Island Developing States Energy Docking' (SIDS-DOC) programme. Australia has provided funds to SPC for a 'Pacific Appliance Labelling and Standards' Programme (PALS). ADB's $10 m 2012-2014 'Promoting Energy Efficiency in the Pacific' (PEEP phase 2) supports EE policies and investments for 5 PICs.

[24] This was based on work done for ADB in late 2008. The conclusion was valid for a range of discount rates. Net benefits were also higher for all EE investments. The topic is covered in more detail in *Cost Benefit Analysis of Investments in Renewable Energy and Energy Efficiency in the Pacific* by Thomas Jensen (UNDP Pacific Center, October 2012).

options for RE development compared to some other PICs but the study does illustrate that national energy investment programmes should not ignore EE.[25]

Although PIC energy policies and action plans all include improved energy efficiency as an objective, this is often no more than lip service, with nearly all proposed investments for expansion or extension of energy supply. Traditionally, the PIC electric power utilities have largely ignored demand-side EE improvements unless donor-funded although some energy audits have been carried out for major consumers with limited impact. However, in the past several years, there have been a number of workshops and training courses on demand side EE through the Pacific Power Association (PPA), whose current Strategic Plan for 2011-2016 includes support to member utilities for demand and supply side efficiency among PPA's priorities. PPA, with donor support, has carried out detailed studies on opportunities, costs and benefits for a number of supply-side efficiency improvements.

There are a range of challenges in all PICTs to improving energy efficiency. These include:

- Unlike energy supply, there are very few people with experience and skills in energy auditing, or specifying, implementing and guaranteeing EE improvements.
- Improving demand-side energy efficiency (improved Demand Side Management or DSM) is skill-intensive (it is easier to install one new generating system than improve efficiency in dozens of buildings or businesses), which is especially a difficult in very small countries.
- The financial institutions (private and development banks) have until very recently had no experience in evaluating EE proposals.
- There are no Energy Efficiency Service Companies (EESCOs) in any PIC, capable of providing the full range of serves generally required for successful EE.[26] If EESCOs are not viable in Fiji, PNG or Samoa, they are unlikely to be practical for the rest of the subregion.[27]
- Governments, utilities, regional organisations and donors continue to provide far more analysis and support for energy supply (including RE) than for EE. Every PIC utility has some sort of investment plan but none include DSM EE within these planned investments.

Renewable Energy. Until recently, renewable energy (RE) investments in the PICTs focussed on: i) loan finance (and some grants) for sizeable grid-connected hydropower developments for power utilities (Fiji, PNG and Samoa); ii) studies and resource assessments throughout the region for RE (ocean thermal energy, seawave potential, geothermal, hydro, wind,

[25] *Marginalization of End-Use Technologies in Energy Innovation for Climate Protection* (Nature Climate Change, October 2012; DOI: 10.1038/NCLIMATE1576) argues that EE outperforms RE in terms of broader social, environmental and energy security benefits, and the potential for GHG emission reductions. EE offers higher potential cost reductions and higher social returns.

[26] EESCOs differ but typically provide marketing services for prospective clients, carry out energy audits and recommend savings programmes, provide energy audit training, assist clients specify equipment and find finance for EE improvements, Install the equipment and train users in its operation and maintenance, and monitor actual savings. EESCOs often provide guarantees of minimal savings. The *Technical Assistance Consultant's Report for the Pacific Subregional Renewable Energy and Energy Efficiency Programme* (REEP; ADB; 2006) provided an analysis of the potential for EESCOs in Fiji and Samoa, with a recommended investment programme that did not eventuate.

[27] ADB's 'Promoting Energy Efficiency in the Pacific' (PEEP, phase 2, 2012-2014) is assessing the potential for EESCOs in five PICs including PNG and Samoa.

solar); and iii) investment in many small-scale RE systems for rural communities (biogas, improved biomass cooking stoves and ovens, biomass gasification, micro-hydro, wind, biofuels, solar photovoltaics, solar crop drying, solar water heating).[28] There has also been private commercial investment (PNG) in geothermal energy.

In the past twenty years or so, the most lasting and visible RE investments have been in stand-alone solar home systems (SHS) which provide relatively small amounts of electricity from solar photovoltaics (PV) to many thousands of PIC households throughout the region. There are also hundreds of larger stand-alone PV systems supplying rural schools, health centres and community halls.[29] Small-scale PV systems continue to increase in number but during the last several years, the focus (in terms of finance) has shifted to larger grid-connected PV systems (Figure 2.4) through support from Japan, the ADB, the World Bank, the EU's EDF assistance, and others.[30]

Figure 2.4: Grid-connected PV system in Niue

Source: Solomone Fifita, SPC

The challenges facing development of RE in the Pacific have been well-documented in many reports.[31] The challenges are numerous and include:

- Most national energy policies covering RE are relatively up-to-date but legislation and regulatory frameworks are generally out-dated and inadequate. Much utility legislation dates to the 1970s with only minor subsequent amendments. There is a range of technical, policy and contractual changes needed to encourage RE that is appropriate for Pacific conditions, including those dealing with Feed-In Tariffs (FITs), Net-metering, Independent Power Producers (IPPs) and Power Purchase Agreement (PPA).[32]
- Most PICs have formal goals for RE and/or for reducing the volume or cost of fuel imports but there are seldom practical and achievable action plans with priorities, budgets, assessment of least-cost approaches, clear responsibilities, etc. Except for

[28] The history of RE experiences in the PICs is provided in some detail in 15 national reports and a regional overview in the *Pacific Regional Energy Assessment 2004* reports of the UNDP/GEF/SPREP Pacific Islands Renewable Energy Programme (PIREP) series published in 2005. These are still available from SPREP at http://www.sprep.org/Pacific-Islands-Greenhouse-Gas-Abatement-through-Renewable-Energy-Project/pirep-documents

[29] There have been many national and regional efforts over the years. Major recent examples are the current regional UNDP/GEF/SPREP *Pacific Islands Greenhouse Gas Abatement through Renewable Energy Project* (PIGGAREP), the EU's *Support to the Energy Sector in Five ACP Pacific Islands* (REP-5; €12.3m; 2006-2010) and the EU/SPC's current *North Pacific ACP Renewable Energy and Energy Efficiency Project* (North-REP; €14.5m).

[30] The largest of these is a programme concentrating on grid-based PV and seawater desalination from PV through the Japanese-funded *Pacific Environment Community Fund* (PEC), with ¥6.8 billion (about US$66m) for Forum Island Countries.

[31] Those listed in the PIREP reports of 2005 (footnote 28) mostly remain valid. Also see *Status of Renewable Energy in the Pacific Island Countries*, currently being finalised by IRENA, and available by early 2013 at http://www.irena.org/.

[32] A FIT is a price that is guaranteed over a certain period of time or a pricing formula set for a specified period, at which power producers can sell renewably generated electricity into the grid. Net metering allows a two-way flow of electricity between the utility's distribution grid and customers who have their own generation, and is often used to encourage households and small business to invest in relatively small-scale RE. In the Pacific, this is likely to be solar PV.

some power utility investments, energy sector plans and priority actions are seldom integrated into the national budgeting process.

- Initial investment costs are often high and energy production can be uncertain (especially where the resource has been poorly assessed).
- Even when loan finance can be justified through fuel savings, donors still provide grant finance, possibly exacerbating government reluctance to allocate their own funds for RE.[33]
- Uncertain costs and sometimes social and environmental impacts (including water needs and potential conflicts with food production) for some types of biofuel production.
- Resource assessments are often insufficient for making investment decisions (wind, biomass/biofuel crops, ocean energy, geothermal) although this is less of an issue with solar insolation.
- There is a lack of consistent standards and guidelines for RE system design, installation, grid connection, and operations and maintenance (O&M). Some standards are being developed[34] but more are needed (e.g. for biofuel that is compatible with existing gensets).
- Taxes, hidden subsidies, import duties, investment incentives, etc. are often inconsistent and can bias investments in favour of fossil fuel energy systems.
- The capacity to operate and maintain RE systems is weak, particularly for off-grid installations on remote islands.

IF renewable energy is to play a significant role in reducing petroleum fuel imports for electricity generation in the Pacific, the emphasis needs to shift to commercial development and grid-connected RE:

- Many past PICT RE projects were justified by petroleum fuel (and associated GHG) reductions and poverty reduction through income generation. Some have had a positive impact in providing modern energy access to rural communities but with insignificant fuel savings and little or no impact on income generation and poverty alleviation.[35]
- and Most PICs with a significant and growing share of RE for power generation have developed the resource to a large extent through loan finance (e.g. Fiji, PNG and Samoa) or relied on private utilities (French Polynesia and to some extent Vanuatu);
- Significant fuel savings from RE can only be achieved with larger-scale grid-connected systems.

Energy for transport. Air, sea and surface transport in the Pacific is essentially 100% petroleum-fueled and accounts for more petroleum fuel use than power generation. There have been numerous trials of diesel fuel and coconut oil blends for road transport, and for

[33] Examples arguably include the NZ government financed 'Let There be light' solar project in Tonga (T$12m with annual savings of T$0.5m) and the NZ-financed three-atoll Tokelau PV system. Returns on investment were probably fairly low and pay-back periods were probably quite long however.

[34] In September 2012, the Sustainable Energy Industries Association of the Pacific Islands (SEIAPI) and the Pacific Power Association (PPA) released regional guidelines for grid-connected and off-grid PV system design and installation: http://sids-l.iisd.org/news/seiapi-and-ppa-release-solar-pv-technical-guidelines-for-industry-and-utilities/

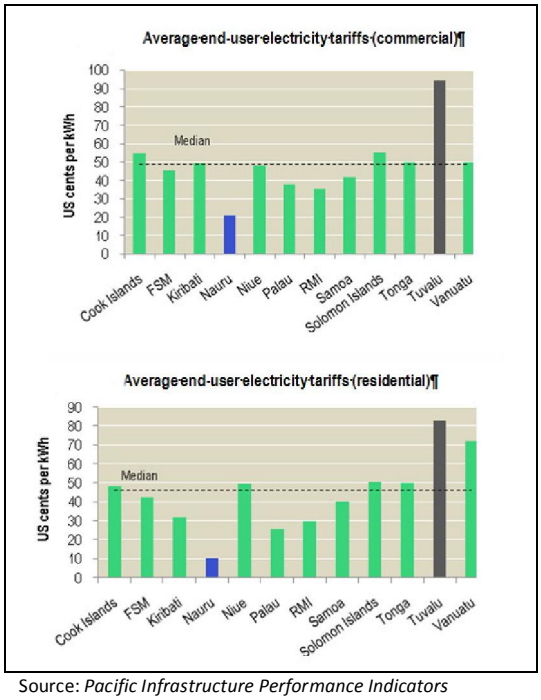
[35] See *Energy and Poverty in the Pacific Island Countries: Challenges and the Way Forward* (UNDP Bangkok, 2007) which found no evidence of income generation in the rural Pacific through RE or other energy investments. The report is available from http://regionalcentrebangkok.undp.or.th/practices/energy_env/rep-por/documents/GAP_Reports/Pacific.pdf

some years Vanuatu used biofuels extensively for minibuses. These small-scale uses continue but the impact on petroleum fuel imports is negligible. The challenges for replacing petrol and diesel fuel with local energy are considerable. These include:

- Unlike electric power, with investments in a small number of generating plants and management by at most several utilities, transport energy use is distributed among thousands of vehicles, often poorly maintained, with minimal government policy and limited regulation;
- Transport energy use is influenced by road design and quality, traffic flow patterns, the quality and cost of mass transport systems (in the Pacific mainly buses and mini-buses), and numerous other factors. Energy use is seldom a consideration in government policy.
- Issues of land access, location and quality (including rainfall and nutrients) can limit practical options for growing biomass suitable for conversion to transport fuels. In many smaller PICTs, coconuts are the main biofuel resource, and this is often too limited to have a major impact on fuel imports.
- Electricity (being largely diesel fuel based) is too expensive to be an option for electric vehicles.

Energy Trade. There is very limited energy trade among the island states. As the PICs are separated by vast expansions of ocean, there is no prospect for interconnected electricity grid systems. As noted, Fiji re-exports about 40% of its gross petroleum product imports to neighbouring countries and Papua New Guinea exports a small amount of petroleum fuel. PNG has vast amounts of natural gas and plans to produce Liquefied Natural Gas (LNG) from 2014, with an initial investment cost of about $15 billion. By 2015, exports of LNG to Asia from a facility near Port Moresby are expected to be about 3.3 million tonnes (4 million TOE) growing to 10 m tonnes (12.2 m TOE) by 2019 and afterwards.[36] The PIC market for gas (Liquefied Petroleum Gas or LPG) is very small and there are no plans for exports to the subregion. Presumably the challenges would be significant.

Figure 2.5: Electricity Tariffs for Selected PICs (US¢/kWh; 2010)



Source: *Pacific Infrastructure Performance Indicators* (PRIF, 2011) from Pacific Power Association

Energy Pricing, Subsidies and Taxation. As most PIC power utilities are 100% (or nearly 100%) diesel fuel based, high oil prices result in high costs of electricity supply. Figure 2.5 summarises electricity tariffs for selected PICs in 2010.[37] The median residential charge for

[36] The source is *Facilitating Private Sector Participation in the Promotion of Energy Security: Papua New Guinea County Review* (draft final report; SPC/BizClim; 2012)

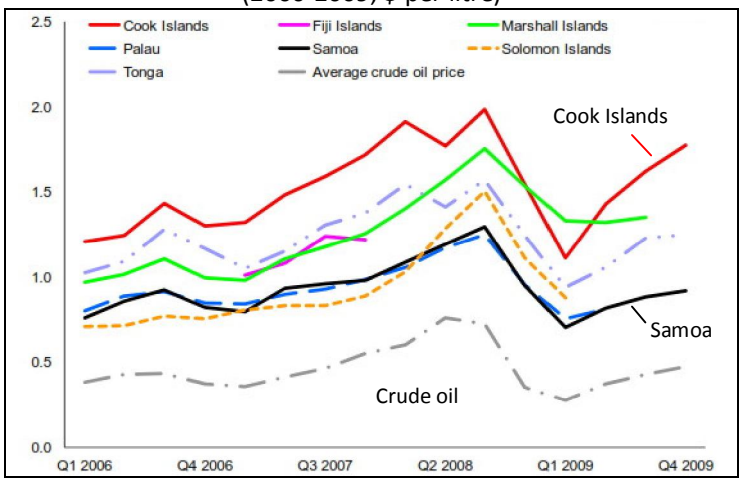
[37] Some data of Figure 2.3 are higher than the published tariffs as the figure includes costs which are sometimes omitted, e.g. minimum monthly charges, value added tax or other taxes, fuel surcharges, etc. The calculations were based on household consumption of 200 kWh/month and commercial consumption of 500 kWh/month. Note that Tuvalu appears to be cost of supply, not the tariff, which is about half the actual utility's cost of generation and supply.

the PICs included was US 45.6 ¢/kWh with a slightly lower average of 44.5 ¢/kWh. If Fiji (23¢) and PNG (28¢) were included, the median and average residential charges drop to 41¢ and 39¢ respectively.[38] This was somewhat higher than household tariffs charged by Caribbean island utilities, with an average of 36.6 ¢/kWh. Note that the median PIC commercial tariff shown at the top of Figure 2.3 was (and is) higher than the residential rate; the commercial sector subsidises household electricity consumers throughout the subregion.

Although electricity charges are high, many PIC power utilities are selling at a price which is lower than the actual cost of generation, transmission and distribution, which suggests that assets may be deteriorating due to insufficient funds for proper operations and maintenance. This is not sustainable in the long terms without subsidies or higher charges and is endangering energy security. In 2010, the median value of return on total operating assets reported by 21 PIC power utilities was only 1% with a third reporting losses. Actual returns were probably somewhat lower.[39] There is a financial incentive for those utilities which sell power below cost to implement supply-side and demand-side energy efficiency improvements, but utilities have been slow to incorporate EE into their activities.

Fuel prices in the Pacific are also relatively high by international standards, reflecting remoteness and small markets. As Figure 2.6 illustrates, fuel prices track crude oil prices (bottom dashed line) in part as there are no government subsidies to reduce the cost burden on consumers when import prices increase. For some years (long before the period shown in Figure 2.6), Samoa has had lower prices than other PICs,[40] even in the much larger market of Fiji, from which much of its fuel is sourced. This is due to national ownership of storage, and consistent policies over several decades with a national supply contract, which has allowed Samoa to negotiate better terms of supply than other PICs.

Figure 2.6: Average Pacific Retail Price of Petroleum Fuel
(2006-2009; $ per litre)



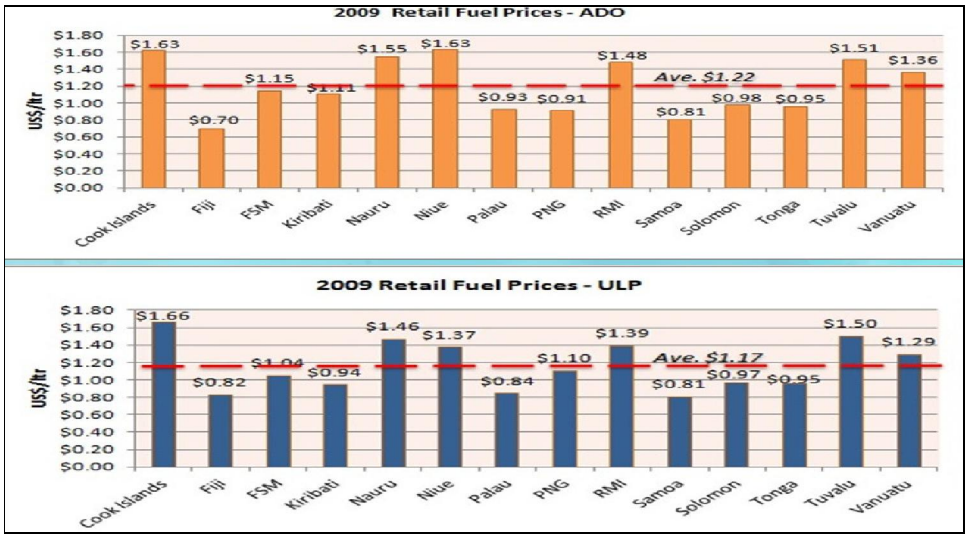
Source: *Macroeconomic Impact of Energy Prices in the Pacific* (PFTAC, 2010)

Figure 2.7 shows the wide range of retail prices for diesel fuel and gasoline for PICs in 2009. Some of the difference is due to the variation in the import duties and taxes imposed by governments. Unfortunately, recent fuel taxes were not readily available for most PICs. In

[38] SPC indicates an average tariff of 35¢/kWh in 2009, which seems to be consistent with these results. Source: *Energy Security Situation of Forum Island Countries* (presentation at the *Pacific High-level Policy Dialogue on the Role of Macroeconomic Policy and Energy Security in Supporting Sustainable Development in the Pacific*; Nadi; 8-9 October 2012)
[39] The source is *Performance Benchmarking for Pacific Power Utilities* (Pacific Power Association, 2011).
[40] Figure 2.4 shows retail prices. If c.i.f. price data were available (price net of all taxes, duties and in-country margins), the Samoan price advantage would probably be clearer.

the past, the Pacific Islands Forum Secretariat (PIFS) produced a very useful quarterly *Pacific Fuel Price Monitor*, which unfortunately ceased publication in 2004.

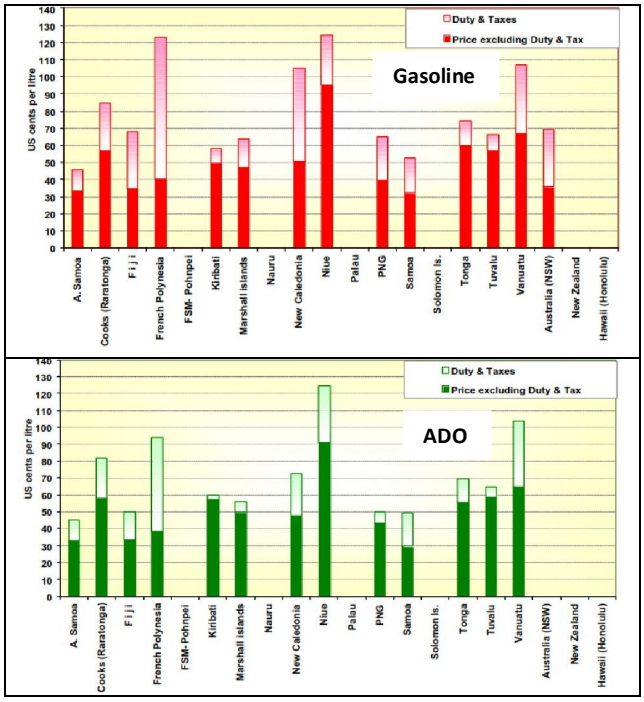
Figure 2.7: PIC Retail Petroleum Fuel Prices in 2009



Note: ADO = Automotive Diesel Oil; ULP = Unleaded Petrol (Gasoline)
Source: *Energy Security Situation of Forum Island Countries* (SPC presentation at Pacific High-level Policy Dialogue on the Role of Macroeconomic Policy and Energy Security; Nadi; 8-9 October 2012)

Figure 2.8 shows the huge impact of duties and taxes on wholesale fuel prices at that time, particularly for diesel and gasoline. Prices have changed since then, but the effects of duties ad taxes on relative prices is broadly similar today.

Figure 2.8: PIC Fuel Prices and Taxes
(wholesale in US¢ per litre; August 2004)



Source: *Pacific Fuel Price Monitor* (Edition 9, PIFS December 2004)

PICs generally aim to maintain fuel stocks sufficient for 3-4 months of imports. ADB has estimated that a shock of about 30% to oil prices (at levels in 2000) would result in a loss of over one month's worth of import coverage in most PICs, considerably reducing short-term energy security (PFTAC, 2010).

There have been various energy subsidies within the subregion, some of which are not transparent. Some examples follow:

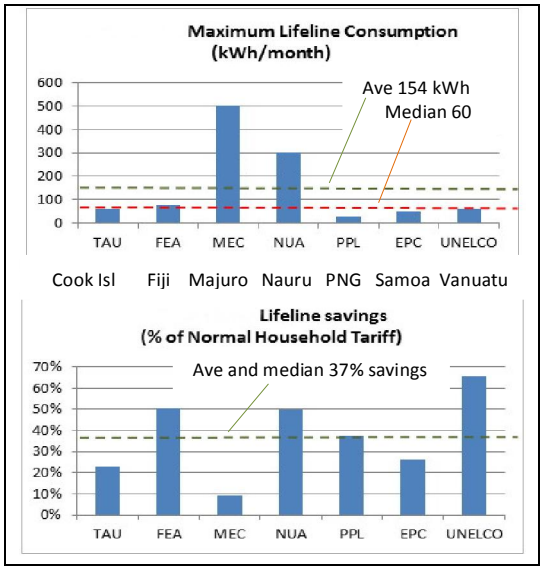
- Several PICs have received direct subsidies from Japan specifically to offset high fuel prices. These include Tuvalu and Nauru with grants of US$ 1 million several years ago.

- There have been targeted concessions such as those in the past to the commercial fishing industries of Fiji and Tonga.
- For some years, the Marshalls Energy Company subsidised its electricity operations significantly from profits from fuel bunkering operations.
- Urban electricity consumers in the Pacific often cross-subsidise rural consumers (as in Fiji with a national tariff but much higher supply costs to rural consumers and islands other than the main island of Viti Levu) and commercial electricity consumers generally cross-subsidise household consumers (as businesses often have a higher tariff but are less expensive to supply).
- Some PICs subsidise part of the base price of fuel sold in outer islands as well as a freight subsidy (e.g. Kiribati) and where fuel is price-controlled, the formulas do not always pass full costs (especially kerosene) to remote or outer island consumers.
- Diesel fuel used by power utilities is often free of import duty, which is in effect a subsidy.
- Several power utilities (Figure 2.9) provide a lifeline tariff meant to subsidises low income households.[41]

Among the energy pricing related challenges for PICs are these:

- Allowing or improving public access to information on the determination of electricity tariffs.
- Determining an equitable tariff structure for electricity supplies that provides sufficient revenue to the utility for adequate expansion, operations and maintenance, while being affordable to consumers.
- Developing lifeline tariffs that provide substantial benefits to targeted low-income consumers without greatly reducing utility revenue.
- Negotiating and implementing fair national petroleum price contracts with fuel suppliers.

Figure 2.9: PIC Lifeline Tariffs in 2010



Source Benchmarking Report (PPA, 2011)

- Determining and implementing a fair and transparent mechanism for fuel price regulation or control.
- Developing import duty and tax mechanisms which promote the desired, more sustainable, direction of energy sector development.
- Generally determining the types and magnitudes of energy subsidies that can deliver the social results desired at minimum cost.

[41] However most are poorly designed, providing relatively low benefits to low-income people often at high cost to the utility. FEA (Fiji) and UNELCO (Vanuatu) have the most effective life-line tariffs.

Energy and Adaptation to Climate Change. The PICs are highly vulnerable to the impacts of expected climate change. As shown in Table 2.1, electricity generation, transmission and distribution through the grid, and electricity end-use can all experience impacts from climate change (or severe weather conditions), ranging from modest to quite severe.

Table 2.1: Indicative Impacts of Climate Change on Generation, Transmission & End Use

Technology	Δ Air temp	Δ Water temp	Δ Water Availability	Δ Wind speed	Δ Sea level	Floods	Heat waves	Storms
Oil	**1**	**2**	**1-3**	**-**	**-**	**3**	**1**	**-**
Natural Gas	**1**	**2**	**1-3**	**-**	**-**	**3**	**1**	**-**
Hydropower	**-**	**-**	**1-3**	**-**	**-**	**3**	**-**	**1**
Wind	**-**	**-**	**-**	**1-3**	**3***	**-**	**-**	**1**
Photovoltaic (PV)	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**
CSP/Solar tracking	**-**	**-**	**-**	**2**	**-**	**1**	**1**	**2**
Biomass/Biofuel	**1**	**2**	**-**	**-**	**3***	**3**	**1**	**-**
Geothermal	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**
Ocean	**-**	**1**	**-**	**-**	**1**	**N/A**	**-**	**3**
T&D grids	**3**	**-**	**-**	**1**	**3***	**1-2**	**1**	**2-3**
End Use	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**-**

Notes: **3**=Severe Impact; **2**=Medium Impact; **1**=Limited Impact; **-** = No Significant Impact; **N/A** = Not Applicable
CSP = Concentrating Solar Power; Δ = 'change in'; ***=**coastal or low-lying areas; T&D = transmission & distribution
Source: Adapted from *Climate Risk and Adaptation in the Electric Power Sector* (ADB, 2012)

Vulnerability to climate change is exacerbated by some common practices in the Pacific, all of which (and many more) are discussed in the ADB source document for Table 2.1:

- Most electric power lines are overhead and often close to trees, susceptible to high winds and storms.
- Power generation is usually located in low-lying areas and subject to flooding or sea level rise damage.
- Fuel pipes and tanks are often only several meters from the sea, and subject to damage or destruction from storms.
- Biomass production for power generation or biofuel conversion is subject to the full range of vulnerabilities of agricultural systems in general, including effects of changing rainfall patterns and winds.
- Where climate change increases cloud cover or even the speed of cloud movement, PV output can suffer significantly, especially if a single inverter services the entire PV array
- Climate modelling might significantly improve the efficiency of hydropower generation in several older PIC hydro systems, where rainfall patterns have changed in catchment areas in recent decades.[42]

A challenge for PIC governments, utilities and those who develop proposals for energy investments (including development agencies) is the extent to which it makes sense to incur additional initial costs to design energy systems that are resilient to the expected impacts of climate change. The additional costs (often modest) are up-front but the negative impacts

[42] In PNG and Fiji, very preliminary assessments suggest that regulating catchment outflows and other improvements might reduce fuel use for power generation by up to 15%. Source: Source: Box 9 of *Climate Risk and Adaptation in the Electric Power Sector* (ADB, 2012)

may be several decades away and the net benefits of building in resilience (or costs of not doing so) will often not be adequately reflected in standard economic analyses.[43]

In addition, the probability, severity, location and timing of specific negative climate change impacts will often be highly uncertain, and this applies equally to coping with broader natural disasters. Good decision-making will require a range of improved methodologies for analysis.[44] Energy infrastructure[45] is very expensive and is generally meant to operate for several decades or more. However difficult in practice, anticipating and accounting for climate change impacts should be part of the efforts to improve energy security.

3. Linkages Between Sustainable Development and Energy Challenges

For the Pacific, there are numerous linkages between sustainable development and the challenges faced in the provision of energy services to Pacific islanders:

- Socially equitable development requires greatly improved access to modern energy services (cooking, lighting, cooling, transport, etc.). for those in the region who lack such services, particularly in Melanesia and in remote locations in many PICTs.
- There needs to be more balance between expenditure on new energy supplies and on more efficient use of existing energy. In rural areas, this suggests that supply and efficiency should be considered together — broadly a whole-of-sector approach for energy advocated by development partners — for all energy investments (which can reduce the initial costs substantially, especially for RE). In urban areas, utilities should carefully assess DSM options before investing in new generation. If governments introduce Minimum Energy Performance Standards (MEPS) for lights, appliances, buildings and vehicles, less energy is required for the same or improved service. More balance between supply and efficiency should reduce the costs of energy services in $/household/month (although often not in $/kWh of electricity or $/litre of fuel). This approach can also reduce the environmental burden on existing energy resources.
- Renewable energy is not always the best economic approach and if poorly planned can increase pressure on ecosystems (e.g. for some types of biofuel development in water-poor locations). However, further development of indigenous RE resources can substantially reduce the imports and use of petroleum fuels and increase PIC resilience. Increased attention to, and investment in, improving local capacities through training and institution building, developing equitable and transparent legal tools for promoting RE, establishing RE standards contractually and technically, and assuring transparent subsidies (where desirable) can all contribute to more rational and appropriate energy futures.
- Petroleum imports will continue to dominate subregional energy use for some years. Improved negotiation and implementation of petroleum supply contracts should reduce

[43] Development agencies and governments often use discount rates of 10-12% in project analyses. Even if likely climate impacts are known, quite severe and can seriously endanger (or destroy) the energy system, an impact a decade or more in the future can have a negligible effect on calculated benefit/cost ratios or net benefits at high discount rates.

[44] "It is impossible to define the 'best' solution or to prescribe any particular methodology in general. Instead, a menu of methodologies is required, together with some indications on which strategies are most appropriate in which contexts." from *Investment Decision Making Under Deep Uncertainty - Application To Climate Change* (WB, September 2012).

[45] The arguments applies more broadly to the issue of planning, design, construction and maintenance of climate-resilient and disaster-resilient infrastructure in general.

costs (at least slightly) releasing funds for more investment in development. There have been discussions and attempts to arrange PIC multi-country bulk fuel purchases for nearly 30 years but this has proved to be very difficult to accomplish.[46]

- Investing in climate resilient energy systems now will reduce energy costs in the long term but the costs and benefits of effective adaptation for specific cases are not always clear.
- Rational energy policies and implementation plans require an accurate time series of a range of energy data but the petroleum companies supplying the Pacific are far more reluctant to provide sales data (by location, by type of end-use) than they were 10 or 20 years ago. Good data on biomass energy use and energy end-use in general are scarce. For small PICTs, it has long been a challenge to generate accurate national energy balances, despite long-term efforts by the SPC (and previously SOPAC and the PIFS).
- Equitable development requires good transport systems. Although transport use dominates imported energy use in the Pacific, there has been almost no effort at developing policies and workable plans for reducing these imports. With many thousands of road vehicles and ships travelling vast distances within individual PICs and throughout the region, improving transport energy efficiency is a huge challenge.

4. The Concept and Measurement of Energy Security in the Pacific

Until this section, the concept of energy security in the PIC context has not been discussed. Governments and others may assume that less reliance on petroleum imports, a higher percentage of energy from local renewable resources, improved efficiency of energy use, affordability and a range of sources for petroleum fuels automatically improve security. However, these goals can often compete. The definition of energy security often depends on the biases of the organisation or individual who has provided the definition, and there may be different short-term and long-term dimensions. Regardless of the definition adopted, changes in PIC energy security over time may not be straightforward to quantify. As energy security is a cornerstone of both PIC national energy policies and the regional FAESP framework, the understanding may need to be clarified. This section raises the issues rather than suggests a definitive solution.

There have been recent assessments of energy security for at least four PICs:

- *National Energy Security Situation Report, Fiji* (SMEC, 2010); and
- *Facilitating Private Sector Participation in the Promotion of Energy Security in Papua New Guinea, the Solomon Islands and Vanuatu: Country Review Reports* (SPC/EU BizClim; drafts; 2012).

For the Fiji assessment, improved energy security is understood to mean "laying a solid foundation of an affordable, stable and secure source of energy for the future economic

[46] There were several studies and advisory services on regional bulk purchasing from the mid-1980s by East-West Center (Hawaii) petroleum adviser Dr Fereidun Fesharaki through the UNDP-funded ESCAP 'Pacific Energy Development Programme' (PEDP; 1983-1991). Recently Pacific Island Forum countries have been working through the Forum Secretariat (PIFS) on a bulk purchase agreement involving the development of joint import infrastructure and pooling of purchases to benefit from bulk discounts.

growth and prosperity of Fiji"[47] but the other three reports provide no explanation of the concept (probably because, despite the title, the reports do not really assess energy security and the TOR did not require them to do so).

Annex 4 summarises some common understandings of energy security, the most broadly accepted being that of the International Energy Agency (IEA): "uninterrupted physical availability at a price which is affordable, while respecting environment concerns." For the PIC regional energy strategy, the *Framework for Action on Energy Security in the Pacific* or FAESP, which has been formally endorsed by the region's leaders, "Energy security depends on the availability, accessibility, affordability, stability, and uses of energy" and "Energy security exists when all people at all times have access to sufficient sustainable sources of clean and affordable energy and services to enhance their social and economic well-being." The regional goal is "secured supply, efficient production and use of energy for sustainable development" (FAESP, SPC 2011).

The SPC is producing a series of *Country Energy Security Indicator Profiles* consistent with the FAESP, and endorsed by PICT Ministers of Energy, using a 2009 baseline, from which future years are to be benchmarked. There are 36 separate indicators in 12 categories chosen after a consultative process with PICTs, regional organisations, the private sector and development partners. SPC appreciates that this is an initial effort and some indicators may be revised in the future. As shown in Table 2.2, six national profiles have been completed (as of September 2012).[48] Some indicators are inevitably subjective and some might not be particularly indicative of security,[49] but it is a commendable effort.

If PIC energy security is to be quantified, there may be useful additions. For example, the IEA is concerned that the global demand for diesel/gasoil is growing much faster than the industry can meet demand and this is expected to continue over the IEA's medium-term 2012-2017 forecasting period.[50] As PICs are extremely dependent on diesel fuel for power generation and heavy transport, higher diesel fuel prices (or constrained availability) may well have short-to-medium-term energy security impacts and should perhaps be reflected in regional indicators. There may be scope for SPC and the PRIF secretariat (see chapter III, section 3) to cooperate in developing a consistent set of quantifiable indicators.

[47] The report goes on to say that "the five principal issues of energy security from a national perspective are: domestic production capacity of alternative fuels; dependence on imports; the degree of import concentration; fuel stock relative to imports and current usage; and the ability to secure an alternative source for petroleum imports in the event of an interruption from one or more supplies." It is essentially a short-medium term approach based on petroleum fuel security.

[48] A seventh report, for Samoa, has apparently been completed but was not available as this report was being finalised.

[49] For example, a low electricity tariff may be due to an unsustainable tariff in which the price is below cost, and which provides insufficient revenue for effective operations and maintenance. A seventh report, for Samoa, was received too late to incorporate in Table 2.2.

[50] Source: *Medium Term Oil Market Report* (IEA, 12 October 2012) http://www.iea.org/publications/medium-termreports/ as reported in http://www.energybulletin.net/stories/2012-10-15/peak-oil-review-oct-15.

Table 2.2: SPC's Energy Security Indicators for Pacific Island States (2009 data)

Indicator	Cook Isl	Fiji	Kiribati	Nauru	Niue	Palau
Access to Energy						
1: Electrification rate (grid connected;%)	97%	72%	44%	100%	99%	98%
2: Access to small scale power rural (households; %)	10%	12%	36%	1%	1%	1%
3: Access to modern energy rural (households; %)	92%	86%	51%	100%	100%	88%
4: Access to modern energy urban (households; %)	100%	96%	80%	100%	100%	99%
Affordability						
5: Macro-economic affordability (fuel imports % of GDP)	28%	13%	9%	8.5%	20%	12%
6: Electricity tariff (average; US$/kWh)	0.44	0.17	0.44	0.14	0.43	0.32
7: Electricity lifeline (% of average. tariff)	75%	62.8%	none	43.5%	82.5%	79.4%
8: Household energy expenditure (% of income)	28%	25%	15%	14.5%	27.9%	16.8%
Efficiency and Productivity						
9: Energy intensity (MJ/US$ of GDP)	4.54	8.4	6.2	6.7	4.8	11.35
10: Productive power use (% for commerce & industry)	65%	71%	56%	44%	19%	67%
Environmental Quality						
11: Carbon footprint(tonnes of CO_2 emissions)	66,939	1.31 m	55,180	25,735	5,514	131,273
12: Diesel fuel quality (parts/million of sulphur)	5000; 10	500	5000	500	10	5000; 50
Leadership, Governance, Coordination and Partnership						
13: Status of energy admin (0-3; see note below table)	1	2	1	0	0	1
14: Legislation (1=subsector; 2=adopted; 3= updated)	3	2	2	2	2	1
15: Co-ordination & consultation (0-1)	1	1	1	1	1	1
Capacity Development, Planning, Policy and Regulatory Frameworks						
16: Energy planning status (0-3)	2	3	1	1	1	1
17: Energy sector regulation (0-3)	1	1	0	1	0	0
18: Framework enabling private sector participation (0-3)	1	1	0	0	0	0
19: Private sector contribution by IPP/PPA(%)	n.a.	2%	0	0	0	0
Energy Production & Supply (Petroleum and Other Liquid Fuels)						
20: Fuel supply security (days)	30	70	25	73	60	308
21: Fuel supply diversity (% local)	0.05%	0	0	0	0	0
22: Fuel supply chain arrangements ** (0-2)	0	0	0	1	0	1
Renewable Energy						
23: RE share (kWh; % of total)	0.03%	8.81%	0.1%	0.05%	0.3%	0.05%
24: Renewable resource knowledge (0-3)	1	2	1	1	1	1
25: LC* RE plan (0-2; none, being prepared; operational)	0	1	1	0	0	0
Energy Conversion (Electricity)						
26: Generation efficiency (kWh/litre of fuel)	3.81	4.10	3.8	2.5	4.1	3.48
27: Distribution losses (%)	11.6%	11%	19.8%	34%	13%	20.6%
28: Lost Supply (SAIDI; hours)	0.82	16.8	n.a.	n.a.	414	0.46
29: Clean electricity contribution (RE % of total kW)	0.3%	61%	0	0.3%	2%	0.3%
End-use Energy Consumption / Energy Efficiency & Conservation						
30: Retail & wholesale fuel price (US$/l; ADO) ***	1.63; 1.32	0.7;0.8	1.11; 1.05	1.55; 1.27	1.63;1.51	0.93; n.a.
31: Energy efficiency legislative framework (0-3)	0	1	0	0	0	0
32: Appliance energy efficiency labelling (0-2)	0	1	0	0	0	0
Energy Data & Information						
33: Availability of a national energy balance (0-3)	0	1	2	0	2	1
Financing, Monitoring and Evaluation						
34: Energy Portfolio (US$ millions)	14.2	70	4.8	4.8	5.5	2.7
35: Financing information available(none=0; low =1; high= 3)	2	2	2	1	2	2
36: Monitoring framework (no 0; yes 1)	0	1	0	0	0	0

Notes: ***ADO = Automotive Diesel Oil (reports also include petrol, kerosene & LPG) Some data rounded off
IPP/PPA = Independent Power Producer/Power Purchase Agreement MJ = megajoules of energy m = million
SAIDI = System Average Interruption Duration Index, a reliability indicator *LC = Least Cost n.a = Not Available
Status of energy administration: 0 = none; 1 = Energy Office; 2 = Energy Department; 3 = Energy Ministry
**Fuel supply chain arrangements: 1 = took part in joint procurement; 2 = scheme is operational

The Brookings Institute (Annex 4) argues that energy security means having access to the requisite volumes of energy at affordable prices with an implicit assumption that access should be impervious to disruptions, with alternative supplies readily available at affordable prices, in sufficient quantities and within a short time but notes that:

- for governments, energy security implies policies and standby measures (supply diversification, a certain volume of stocks) that can be implemented in the event of a supply disruption at a cost that its citizens consider reasonable.
- for private citizens, energy security hinges on access to readily available resources in sufficient volume at affordable prices.
- for growing urban communities (where blackouts and brownouts can be common), energy security simply means 'keeping the lights on'.
- For the poor, energy security has profound implications on daily lives. A basic supply of commercial energy sources and electricity can empower women and girls, ensure better education for children, and improve health and healthcare. Energy security is about guaranteeing access.

In a discussion note for a 2011 ESCAP electronic forum on energy security, KV Ramani (Annex 4) notes that the preferences of various groups regarding the meaning of energy security do not easily resonate with each other:

- policymakers strive for balance between economic, social and environmental goals, with compromises consistent with the development status of their countries.
- Developing countries, with low levels of energy consumption and high levels of poverty, stress the need for increasing energy consumption, for which fossil fuels are the most ready solutions.
- Developed countries with high levels of energy consumption look for technical solutions to improve energy efficiency and diversify away from fossil fuels, without eroding their development status.

The IEA approach is short-to-medium term and was developed for high-income member countries. There is also a long term IEA perspective (Annex 4) which emphasises the root causes of energy insecurity including energy disruptions linked to extreme weather conditions or accidents, and fossil fuel concentration (for which increased security requires a shift away from fossil fuels or diversifying sources, supply routes and means of supply).

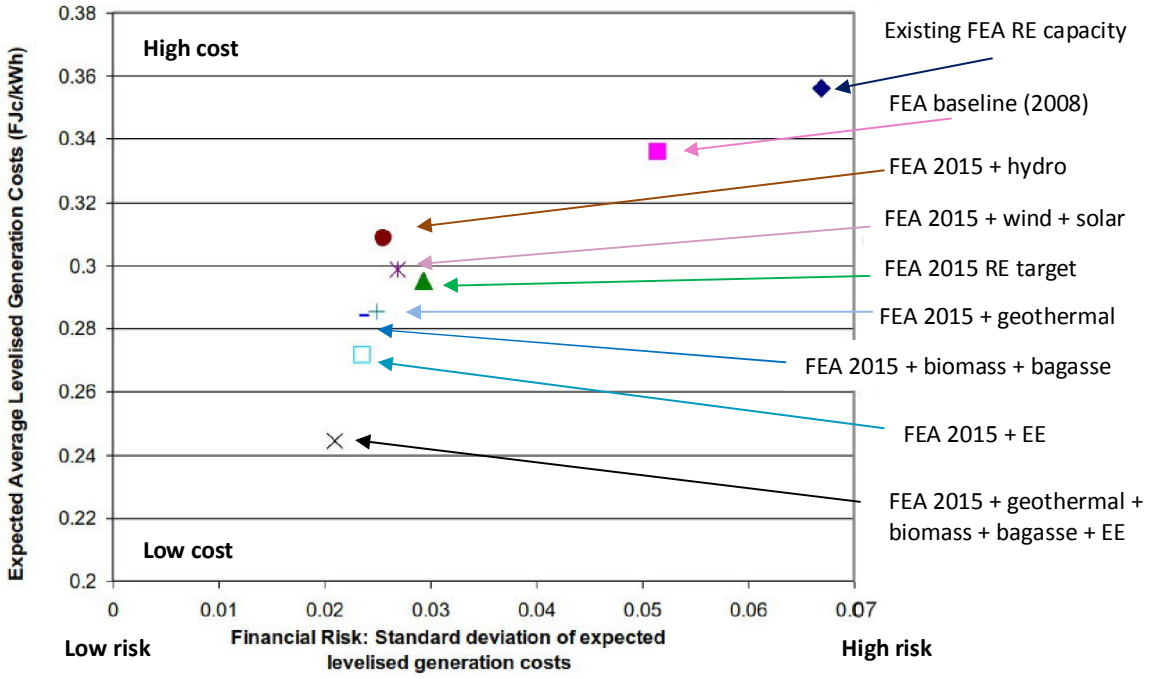
These suggest that assessing energy security in the Pacific should carefully consider energy security from several perspectives (governments, urban dwellers, the poor), and both the short-term and longer term, which may require different indicators.

There may also be issues regarding an appropriate methodology for assessing energy security in extremely petroleum-dependent island states. A recent Australian National University paper[51] argues that there has been no rigorous analysis of the risk mitigation benefits of RE in island states. A Fiji case study applies portfolio theory to scenarios of future electricity generation, with investments assessed on the basis of their impact on both

[51] The study assumes a crude oil price of $125 in 2020 and includes the effects of intermittent supply (e.g. from wind power). See Figure 2.7 for the source.

generation cost and financial risk for the grid. The paper concludes that in Fiji there are significant cost reduction and risk mitigation benefits associated with investments in RE technologies. Scenarios with lower expected average costs generally also have lower cost risks, and these benefits tend to increase with the extent of RE and EE in the overall portfolio (particularly for low-cost RE, e.g. geothermal, energy efficiency, biomass and bagasse). "In Fiji, the findings suggest that further investment in low-cost, low-risk renewable technologies should be encouraged on energy security grounds, and with the goal of lowering generation costs in the electricity grid." The analysis is illustrated in Figure 2.10 below.

Figure 2.10: Cost & Risks of FEA 2015 Portfolio with Additional Investment in RE & EE



Source: *Small States, High Oil Prices: The Risk Mitigation Benefits of Renewable Technologies in the Pacific* (Matthew Dornan & Frank Jotzo, 2012) EE = improved appliances (A/C & refrigeration)

According to the authors, "the results also suggest that investment in low-cost, low-risk technologies should be prioritised over investment in hydro-power… . More broadly, the results highlight the importance of considering financial risk as well as generation cost when planning investments in electricity generation capacity. This is relevant in other PICs. … The electricity sector in the majority of [island states] is dominated by oil-based power generation. As a result, this sector is vulnerable to oil price increases and oil price volatility." Perhaps measures of energy security in the PICs should consider addressing the issue of financial risks of various alternative investments.

It might be useful if a subset of the SPC energy security indicators (shown in Table 2.2), perhaps modified, could be used to generate a consolidated index or small set of indicators that quantify changes in PIC energy security over time. The IEA has developed a tool to evaluate short-term security of energy supply.[52] It is 'a generic assessment framework which

[52] *The IEA Model of Short-term Energy Security (MOSES): Primary Energy Sources & Secondary Fuels* (Working Paper, 2012).

can be used as a starting point for national studies' based on about 30 indicators. It would probably not be applicable to PICs in its current form but perhaps some similar measurement tool might be practical.[53] [54]

Table 2.3: Dimensions of Short-term Energy Security Measured by MOSES

	Risks	Resilience
External	***External risks:*** risks associated with potential disruptions of energy imports	***External resilience:*** ability to respond to disruptions of energy imports by substituting with other suppliers or supply routes
Domestic	***Domestic risks:*** risks arising in connection with domestic production and transformation of energy	***Domestic resilience:*** domestic ability to respond to disruptions in energy supply such as fuel stocks.

A 2012 paper by Robin Craig (see Annex 4), discussing the concept of sustainability under climate change, raises points equally relevant to energy security and how it might be perceived in the Pacific:

> So, what *should* we pursue, if not sustainability?
>
> *Adaptability*, for one—that is, the ability to change (foods, jobs, health regimes, industries, *etc*.) in response to, and preferably in tandem with, climate change impacts. Nostalgic conservatism will be, sometimes literally, a dead end.
>
> *Resilience*, for two—that is, the ability to absorb change without losing overall functionality, such as food production, water supply and sanitation, law and order, individual and cultural self-expression. … As Charles Darwin emphasized, "It's not the strongest of the species that survives, nor the most intelligent, but the one most responsive to change."

Energy security and sustainable energy are really two sides of the same coin.

[53] For the Pacific Power Association's 2011 power utility benchmarking report, a fairly simple composite has been developed to compare the technical performance of member utilities. It is a work in progress but should serve as a useful starting point to assess performance changes over time. Perhaps something similar could be developed to assess PIC energy security.

[54] It should be noted however, that preparation of a comprehensive index can be extremely complicated and time consuming. An Oil Price Vulnerability Index (OPVI) developed by UNDP requires 39-pages document to describe, (See : http://asia-pacific.undp.org/practices/energy_env/rep-por/documents/Oil-Price_Vulnerability_Index%20_OPVI_%20for_the_Devloping_Countries_of_Asia_and_the_Pacific-Full_Technical_Paper.pdf. The type of index suggested here should be considerably simpler.

Chapter III: Opportunities for the Pacific Subregion to Enhance Energy Security and the Sustainable Use of Energy

There are a number of driving forces, national and regional initiatives, and donor initiatives that could help remove or reduce barriers to improved energy security and sustainable use of energy in the Pacific, and in some cases are already doing so.

1. Driving Forces that Could Remove the Barriers

Unlike some regions, a key driver to remove barriers in the energy sector of PICs is that of the desire for improved energy security rather than reducing GHG emissions, which are negligible in the PICTs. A number of driving forces are summarised below. These are not listed according to barriers of Chapter II, as most address a number of barriers, not just one:

- Serious concern within PIC governments, among their people, and within development agencies of the significant harmful economic and financial impacts of the extreme dependency on petroleum imports on PIC economies.
- The existence of the *Pacific Plan*, a broad framework for Pacific subregional cooperation for more sustainable development.
- The existence of a broad twenty-year energy path (the FAESP) and an associated implementation plan that has been strongly endorsed by Pacific leaders.
- The reduction in the initial costs of RE technologies that are appropriate for the Pacific over the past decade, particularly solar photovoltaic systems.
- Significant levels of recent donor interest in, and support for, supporting PIC energy policies, implementation plans and investments compared to a relatively quiet period from roughly 1990-2000.
- Significant amounts of external funding recently available to the Pacific for adapting to (and to a lesser extent) mitigating the effects of climate change.
- A significant increase in recent years of Pacific Islanders with tertiary qualifications in various aspects of energy studies.
- Growing experience within the region of the types of energy technologies that are appropriate for Pacific conditions.
- A significant recent increase within governments, the private sector and development agencies in improving energy efficiency within PICs, including increased skills in EE implementation.
- The existence of sufficient private sector involvement in sustainable energy initiatives to result in the establishment of a 'Sustainable Energy Industries Association of the Pacific Islands' with members throughout the region, and its cooperation with members of the Council of Regional Organisations of the Pacific (CROP) to begin developing standards for renewable energy design, installation and operations appropriate for the Pacific.
- The existence of a mechanism for cooperation among CROP agencies, NGOs, governments and others dealing with energy issues in the Pacific.
- Increased interest within PIC power utilities in implementing renewable energy and energy efficiency, including a number of training programmes.

2. Existing National Initiatives[55]

- The development of 'national energy roadmaps'in Tonga and Cook Islands (complete), Vanuatu and Kiribati (underway), Nauru (beginning in November 2012) and the Solomon Islands (planned) with several other countries in the process of developing action plans for renewable energy projects and energy efficiency activities intended for reducing imported fuels: Samoa (solar, hydro and wind); Tuvalu (solar) Palau (solar); FSM (solar, hydro and wind); RMI (solar and biofuel); Niue (solar); Fiji (hydro and biofuel); Solomon Islands (hydro and PV). These tend to be less comprehensive than the titles suggest[56] but are nonetheless positive developments.
- Development of, and Cabinet or Parliamentary approval of, national energy policy frameworks by most PICs since 2008.
- Investment in grid-connected RE generation from solar PV in Yap state, Federated States of Micronesia based in part on loans rather than (as historically the case) grants.
- Planned or proposed private (or private/public partnership) investments in RE: Kosrae, FSM (seawave), Samoa (solar PV) and Fiji (biomass to energy).
- Establishment by the National Development Bank of Palau of a programme specifically targeting loans to residents and businesses for sustainable energy, including energy efficient home construction, energy efficiency home and business renovations and RE investments. At least four other PIC Development Banks are seriously considering similar programmes.
- Establishment by one central bank (the Reserve Bank of Fiji) of rules requiring commercial banks to allocate a specified minimum percentage of all loans (2%) for RE investments. This with the previous example suggests a growing awareness of practical roles of Pacific financial institutions in promoting sustainable energy.
- Development and implementation of legal tools or regulations allowing RE connection with the grid:
  - Feed-In tariffs. Fiji has a maximum feed-in tariff, set by the Commerce Commission. which is to be reviewed in early 2013. The Cook Islands utility will purchase power on a contractual basis but there apparently no set formula or rate. In both cases, the price paid is below the normal retail tariff so they are not FITs in the sense of providing incentives for RE.
  - Net-metering: The Cook Islands, Palau, and Tonga have formal net metering arrangements, it is being prepared in Yap, FSM, and under consideration in Fiji.
- Growing private sector interest in investing in non-hydro RE in several PICs (e.g. Cook Islands, Fiji, Nauru, Samoa) for sale to the power utility although none of the proposals have yet been finalised, perhaps in part because there are no contract templates specifically designed for Pacific utilities to use as a guide for preparing a Purchase Power Agreement. However there are plans to develop such a standard.

[55] Information listed in this section is from Herbert Wade (personal communications), Thomas Jensen, UNDP Pacific Center, March 2012) and discussions with PIC governments.

[56] In principle these were envisioned to be comprehensive whole-of-sector policies and implementation plans. However, some are primarily power sector (Cook Islands, Vanuatu) whereas others are broader. In general transport energy use and energy efficiency tend to be neglected.

3. Analysis of Existing Activities of Development Partners

For some years, there was considerable discussion among development agencies and financial institutes active within the energy sector in the Pacific regarding ways to improve coordination and cooperation among themselves, and with regional agencies and PICs. Although cooperation/coordination remain less than ideal, this has improved considerably in recent years.

- The Pacific Energy Donor/International Financial Institutions Working Group (EDWG),[57] chaired by the World Bank, was established in 2008. It initially met quarterly, alternating between Sydney and various PICs, to coordinate energy sector activities and currently meets less frequently, once or twice annually.
- The Pacific Region Infrastructure Facility (PRIF; http://www.theprif.org/) is a multi-partner infrastructure coordination and financing mechanism, also established in 2008 for the Pacific region which covers key economic infrastructure sub-sectors, with a range of energy sector initiatives funded by PRIF partners.[58] There is an advisory / coordination mechanism under PRIF, the Pacific Infrastructure Advisory Centre (PIAC), based at ADB in Sydney.

There are numerous programmes of multilateral and bilateral energy sector assistance to PICTs. The most recent publicly-available overview was prepared in early 2010 and is attached as Annex 3. The data are out of date, indicative and incomplete but nonetheless show the substantial volume of energy sector grant assistance to the region, particularly on a per capita basis. The initiatives listed are typically spread over a 4-5 year period. There is nearly US$30m from the GEF, over $70m committed from Japan for solar PV, about $46m from the EC, nearly $49m from ADB (including bilateral input), about $23m from AusAID (excluding some support through development banks), about $50m from US sources to its Pacific territories, and over $15m from other sources. Information on energy assistance to the French Pacific was unavailable.

4. Gaps that Could Be Addressed Through Regional Cooperation

Although differing in many respects, and spread over a huge area of ocean, the PICs share a number of concerns that can most effectively be addressed through regional cooperation. These include:

- Improved energy sector training at tertiary level. The University of the South Pacific (USP) recently initiated a postgraduate programme in energy studies and the University of Technology in PNG has long had an active energy interest. The demand in a subregion of only 10 million people for training in energy at a postgraduate level is too small to

[57] Participants include the Asian Development Bank (ADB), the Australian Agency for International Development (AusAID), the European Commission (EC), the European Investment Bank (EIB), Deutsche Gesellschaft für Internationale Zusammenarbeit (German GIZ), International Finance Corporation (IFC), International Renewable Energy Association (IRENA), International Union for Conservation of Nature (IUCN Oceania), Japanese International Cooperation Agency (JICA), New Zealand Ministry for Foreign Affairs and Trade (NZMFAT), Pacific Power Association (PPA), Renewable Energy and Energy Efficiency Partnership (REEEP), SPC, SPREP, UNDP and the World Bank (WB).

[58] These are ADB, AusAID, the EC, the EIB, NZMFAT and the World Bank Group (WBG, or IFC and WB).

justify national efforts. There have been discussions regarding a Pacific Energy Training Association, possibly linked to a proposed EU programme (co-financed by GIZ) on Sustainable Energy Technical and Vocational Education and Training.

- Improved energy sector training at technician level. There is a considerable demand for ongoing training at national or island level for installing, operating, and managing small-sale RE systems and for energy auditing and efficiency implementation. It is cost-effective to develop separate subregional programmes for the North Pacific and South Pacific (where power standards differ) with training of trainers at local training institutes.
- Technical standards for RE and EE. There is a range of standards that could, and should, be developed as regional standards (with some North-South differences) for sustainable energy system design, installation, operations and maintenance, and common fuel standards. These include:
  - Technical and contractual standards for IPPs and PPAs. There should be standard regional templates for Independent Power Producers and Power Purchase Agreements including clear rules for grid access, standard contract forms, standard legal tools, etc.
  - Petroleum contracting and advisory Services, including publication of a regular petroleum price newsletter similar to the old quarterly PIFS *Pacific Fuel Price Monitor*, but including details of taxes and duties (ad valorum, fixed or combination) clearly specified for all key fuels.[59] Improved sharing and networking among PICTs of petroleum contracting and pricing practices could benefit the Pacific subregion considerably.
  - Fuel and fuel storage and distribution standards. Common standards for fuel which can be imported (petroleum products) or produced in the region (biofuels) should be regional. This is also true of fuel storage standards and fuel distribution.
  - Practical energy policies and implementation plans. Although policies and plans must be adapted to local requirements, there is sufficient commonality to warrant a regional programme of support for policies, plans and their monitoring and evaluation.
  - Improved project investment analysis. Develop practical methodologies for use by CROP agencies, PICTs and others for assessing the technical, economic and financial viability of proposed PIC energy sector projects and investments, with mechanisms for assessing the extent and type of additional investment justified to improve resilience to uncertainty, including climate change and disaster management. This might reduce the disconnect sometimes alleged between the 'soft' assistance of regional organisations and the hardware efforts of PRIF partners.
  - Improved measures for Pacific energy security. Development of a common methodology to determine trends in the energy security of individual PICTs, with a simple annual quantitative measure if practical.
  - Improved energy access. Development of standard, practical approaches for sustainable access to modern energy for low-income and off-grid Pacific islanders.

[59] The PIFS, SOPAC and now SPC have long provided elements of this sort of service.

- Effective life-line tariffs. Development of a common recommended approach to Pacific utility life-line tariffs that effectively subsidise low-income consumers without excessive burdens on utility finance and other consumers.
- Development of a regional programme to define key energy resources.
- Improved energy data. Establishment of a long-term programme for regular collection and analysis of energy supply and demand data using a consistent approach.[60] (With the exception of Papua New Guinea, the PICs do not have access to APEC support for energy databanks and energy balances, and little has been done outside of Melanesia).
- Improved balance between power generation and efficiency improvements. PIC power utility investment plans are focussed entirely on generation. Develop a practical regional approach for recommended incentives and regulations that would result in the inclusion of EE investments where these are more cost effective than adding either conventional or RE based new generation.
- More emphasis in energy action plans on transport, which is the biggest single user of petroleum fuels in almost all PICs.

5. Mechanisms for Coordination and Integration of Energy Initiatives in the Pacific

The *Pacific Plan* is a master strategy, managed through a Pacific Plan Action Committee for regional integration and coordination in the Pacific, that guides the work of national governments, regional agencies and development partners in support of the aspirations of Forum island countries and our people. Building on the Leaders' Vision, it is a high-level framework that guides the work of national governments, regional agencies and development partners in support of the aspirations of Forum Island Countries and Pacific people. The Plan was endorsed by the region's leaders in Port Moresby, Papua New Guinea, in October 2005. It is meant to be a living document that adapts to changing priorities of Pacific regionalism. Implementation of the Plan is guided by five themes and related priorities linked to the Pacific Plan pillars[61] which were endorsed by Leaders at their meeting in Cairns in August 2009 and cover a 3-year period from 2009 to 2012. The Pacific Plan will be externally reviewed in early 2013.

Sectoral plans are linked to the Pacific Plan. For energy, the previously mentioned *Framework for Action on Energy Security in the Pacific* (FAESP)[62] for 2010-2020 guides the energy sector work of the Pacific agencies which are members of the Council of Regional Organisations of the Pacific (CROP).[63] The FAESP was developed in close consultation with PICTs, development agencies, the electric power utilities and the private sector. It was endorsed by energy ministers and subsequently by the region's leaders at the Forty-First Pacific Islands Forum held in Vanuatu in 2010. Subsequently, an *Implementation Plan for*

[60] This should include electricity use by sector and separation of petroleum fuel used for commercial sea transport, private sea transport, commercial land transport and private land transport.
[61] The *Pacific Plan* themes and priorities are available from http://www.forumsec.org/resources/uploads/attachments/documents/Pacific_Plan_Nov_2007_version.pdf.
[62] *Towards an Energy Secure Pacific: A Framework for Action on Energy Security in the Pacific (FAESP): 2010-2020* http://www.spc.int/edd/en/download/finish/11-reports/360-energy-framework-final
[63] For energy, the key CROP agencies are SPC, PPA, PIFS, SPREP and USP.

Energy Security in the Pacific (IPESP) was developed and was endorsed by the region's energy ministers in 2011. The implementation plan is reviewed and updated annually.

The Secretariat of the Pacific Community (SPC) is the CROP Lead Coordinating Agency for energy sector matters[64] operating under a CROP charter.[65] There is a Pacific Energy Oversight Group (PEOG) chaired by SPC that meets regularly. PEOG membership consists of CROP agencies and IUCN Oceania which has an active PIC energy programme. The Pacific Energy Advisory Group (PEAG) consists of the PEOG, selected country representatives and development partners, meeting annually.[66]

Regional meetings of Pacific Island Ministers of Energy have been held, typically every two or three years, for several decades. In 2009 the PIFS with SPC hosted the Pacific Energy Ministers' Meeting (PEMM) in Tonga. In 2010 there was a Special Forum Energy Ministers Meeting (FEnMM) hosted by the Australian Government. Most recently, in 2011, SPC organised a regional 'Meeting of Ministers for Energy, Information and Communication Technology and Transport' in New Caledonia. The government of New Zealand has offered to host a ministerial-level Pacific Energy Conference in 2013.

The other CROP agency with a specific regional energy mandate is the Pacific Power Association (PPA) which has about 25 member utilities and numerous private sector associate members. PPA's Annual General Meeting rotates among members and coordinates regional power sector activities. The *PPA Strategic Plan: 2011-2016* which guides its activities is currently being reviewed. the plan has a strong focus on support to members for sustainable energy, specifically renewables, supply side energy efficiency and demand side energy efficiency.

At the level of individual national and subregional energy sector technical assistance projects, there are nearly always project steering committees with varying membership, typically including government agencies and other stakeholders.

[64] SPC's lead role includes: coordination of CROP regional energy services including resource mobilization and allocation, development partner interaction and monitoring and evaluation; issues and trends analysis; policy analysis; policy advice to PICTs; establishment of a common approach to data collection, analysis and dissemination including a Pacific wide energy data and information system.

[65] There is no agreed definition of CROP 'lead (coordinating) agency' in the CROP Charter, which is currently being reviewed. It would be useful if the updated charter included an explicit definition of lead or coordinating agency for specific sectors.

[66] Members are ADB, AusAID, EU, GIZ, IRENA, NZAID, PRIF, REEEP SIDS Dock, UNDP & WB.

Chapter IV: Political Commitments in the Pacific

As noted in Chapter III, the leaders of the PICs have made strong and regular commitments to shift toward more sustainable use of energy and improved energy security in the region. In summary, leaders have formally endorsed the *Pacific Plan* as the overall framework for Pacific subregional cooperation. The leaders have made specific commitments regarding energy at many of their annual summits and these commitments are included in their formal communiqués. Leaders have endorsed the 2010-2020 *Framework for Action on Energy Security in the Pacific* and in 2011, Energy (and other) Ministers endorsed the *Implementation Plan for Energy Security in the Pacific*. Excerpts from relevant documents and communiqués are attached as Annex 5. The political commitments by the Governments of PICs to improve energy security in the region and shift PICs toward a more sustainable energy development path are briefly summarised below. These are from the above documents or entirely consistent with the political commitments therein.

1. **Critical Elements that the Subregion Would Like to See Reflected in Ministerial Declaration**

- a steady reduction over time on dependence on imported petroleum fuels, with renewable energy developed wherever it is socially, economically and environmentally preferable to petroleum.
- a balanced approach relying on the two pillars of sustainable energy, more efficient use of existing sources of energy and increased use of indigenous renewable energy resources.
- rapid expansion of affordable modern energy services to those who currently lack such access.
- developing and implementing practical mechanisms to secure petroleum fuel supplies at the best available prices.
- building climate change resilience into energy sector investments.
- support the development of new international development goals to replace the MDGs from 2015, with a stronger focus on sustainable energy and energy security.

2. **Justification**[67]

The Pacific subregion faces serious development challenges due to small remote populations, with limited human and physical resources, spread over a third of the world's surface area. These challenges are expected to be exacerbated by the impacts of climate change, to which the Pacific is arguably the most vulnerable on the planet. Compared to other regions, and even other small island states, dependence on imported petroleum for commercial energy needs is extreme at over 95%, and energy intensity (energy demand / GDP) may be increasing over time, opposite the Asia-Pacific trend. Although challenges differ substantially by country, overall only about 20% of the population of 10 million have access to electricity.

By any reasonable definition, energy security in the Pacific is low and a substantial commitment is required for an appreciable improvement.

[67] The TOR specify a brief 'Overview of Existing Political Commitments at the National, Subregional and Regional Levels', but this has been covered elsewhere in the report and its annexes.

Chapter V: Proposed Actions in the Pacific

Actions that could be achieved through regional/subregional cooperation listed in Chapter III, Section 4 - 'Gaps that Could Be Addressed Through Regional Cooperation' - are all consistent with the commitments already made by Pacific leaders as summarised in Chapter IV, Annex 5 and other sections of this document. In the Pacific context, 'regional' generally refers to cooperation within the subregion but some actions are appropriate for wider Asia/Pacific cooperation.

During the 8-9 October 2012 *High Level Dialogue*, PIC representatives felt that no new commitments can or should be entertained due in part to time constraints but primarily because the existing commitments are fairly comprehensive and already have wide endorsement at the highest national political levels. Some PICs felt that all of the actions below are appropriate and should not be prioritised as they are each components of an overall consistent approach, rather than stand-alone actions.

Five of the 14 PICs did suggest priorities and these are summarised below, ranked as follows: **H** = high, **M** = medium, **L** = lower and **none** (i.e. delete the action.) The results are summarised in Table 5.1, ranked from 1 through 4.

Table 5.1:
Proposed Energy Sector Actions Through Regional Cooperation **Priority**
(The expected outcome is indicated in parentheses below)

1. *Improved balance between power generation and efficiency improvements*. Develop practical regional approach for incentives and regulations which would result in inclusion of EE investments where these are more cost effective than new generation. 1. *Improved energy sector training at technician level* (national or island level for installing, operating and managing small-sale RE systems and for energy auditing and efficiency implementation). Separate programmes for North and South Pacific (where power standards differ) with training-of-trainers at local training institutes.	These were ranked **H** by all who responded
2. *Improved energy sector training at tertiary level*. Develop cooperative training programme in energy studies at Pacific universities and other tertiary institutions. 2. *Effective life-line tariff*s. Develop a common Pacific approach so utility life-line tariffs effectively subsidise low-income consumers without excessive burdens on utility finance. 2. *Improved energy access*. Develop standard, practical approaches for sustainable access to modern energy for low-income and remote Pacific islanders.	4 of 5 rated these as **H**

Table 5.1 (continued):
Proposed Energy Sector Actions Through Regional Cooperation **Priority**
(The expected outcome is indicated in parentheses below)

3. *Technical standards for RE and EE*. Develop a range of regional standards (with some North-South differences) for sustainable energy system design, installation, operations and maintenance, and common fuel standards, including biofuels 3. *Improved petroleum contracting and pricing capacity within PICs*. Develop petroleum contracting and advisory services, including publication of a regular regional fuel price monitor (c.i.f., wholesale & retail prices for key fuels, with and without duties and taxes. 3. *Improved energy policies and practical implementation plans*. Develop practical energy policies and implementation plans with a subregional programme of support for policies, plans and their monitoring and evaluation, similar to the flexible, but now defunct, UNDP/SOPAC Pacific Islands Energy Strategies and Action Planning (PIESAP) initiative. 3. *Common regional IPP/PPA standards.* Develop regional technical and contractual standards for Independent Power Producers and Power Purchase Agreements including clear rules for grid access, standard contract forms, standard legal tools, etc. 3. *Improved energy data*. Establish a long-term programme for regular collection and analysis of energy supply and demand data using a consistent approach.	These received 3 **H**s and 2 **M**s
4. *Common fuel and fuel storage and distribution standards*. Develop Pacific regional standards, , including for biofuels. 4. *Improved project investment analysis*. Develop practical Pacific methodologies for assessing the economic and financial viability of proposed PIC energy sector projects and investments, with mechanisms for assessing the extent and type of additional investment justified to improve resilience to uncertainty, including climate change. 4. *Improved measures of Pacific energy security*. Develop a common methodology to determine trends in the both short-term and longer-term energy security of individual PICTs, with a simple annual quantitative measure if practical. 4. *Improved energy efficiency of road transport*. Develop a regional initiative for energy action plans on road transport, which is the biggest single user of petroleum fuels in almost all PICs. 4. *Improved knowledge of Pacific energy resources*. Develop a cost-effective regional programme to define key indigenous energy resources	Mostly ranked as **M** with some **H** & **L** scores

It was felt that all of the above actions were appropriate, manageable, and of sufficiently high priority to warrant regional / subregional attention. The priorities are only indicative (as they have not been formally endorsed by PICT governments) and there are other activities within the FAESP implementation plan that could be included. In general, the expected results would be improved capacity within the PICs to manage their energy sectors in a manner which would improve sustainability and energy security. There was no discussion (or time for discussion) regarding measurable impacts.

Annex 1: Terms of References

***Purpose*. Explain the terms of reference for the service required, their relation to the Unit's work programme, (and in particular what special skills or knowledge are required to perform those responsibilities. (see Section 3 of ST/AI/1999/7)**

The Commission at its 67th session adopted resolution 67/2, aimed at promoting regional cooperation for enhanced energy security and the sustainable use of energy in Asia and the Pacific. With this resolution, ESCAP is mandated to organize the Asian and Pacific Energy Forum (APEF) at a ministerial level. Subsequently the Russian Federation has offered to host this event in May 2013. In order to capture the differences and commonality of the region, it was agreed to develop subregional perspectives on energy security and the sustainable use of energy for each subregion in the Asia-Pacific. The subregional perspectives will contribute to the development of the Ministerial Declaration and the Regional Action Programme to be adopted by the Ministers attending the APEF. This analysis will provide Pacific sub-regional input into the APEF process. It is also expected that the study will provide a valuable resource for Pacific island countries, sub-regional organisations and development partners, by providing an overview of current energy issues in the Pacific as part of efforts to support sustainable development.

Objective .The main objective of this assignment is to develop the Pacific perspectives on the challenges to energy security and the sustainable use of energy. The report should consist of 30-40 pages, and the following outline should be adopted in the study:

Executive Summary (2 pages)
Chapter I: **Introduction** (10 pages)
Description of the Subregion (basic indicators, such as population, GDP, economic growth, etc.)
Energy Situation (resources, supply, demand, trade, dependency on oil, etc.)
Chapter II: **Major challenges relevant to enhancing energy security and the sustainable use of energy** (15-20 pages)
Major sustainable development challenges (5 pages)
Major energy challenges (10 pages)
Access to energy services
Energy Efficiency
Renewable Energy
Energy Trade
Energy pricing, subsidies and taxation
Linkages between sustainable development and energy challenges (3 pages)
Chapter III: **Opportunities for the subregion to enhancing energy security and the sustainable use of energy** (7-10 pages)
Driving forces that could remove the barriers
Existing national initiatives
Analysis of existing activities of development partners (e.g. UN, ADB, World Bank etc)
Gaps that could be addressed through regional cooperation
Mechanisms for coordination and integration of energy initiatives in the Pacific
Chapter IV: **Political Commitments** (no more than 1 page)
Critical elements that the subregion would like to see reflected in Ministerial Declaration
Overview of existing political commitments at the national, sub-regional and regional levels
Justification (highlights based on chapters I-III)
Chapter V: **Proposed Actions** (about 3-5 pages)
Prioritizing challenges and opportunities (Criteria: Regional Cooperation as a modality; Niche area; Manageable)
Expected Results and Measurable Impacts

Outputs / Work Assignments *(must be tangible and/or measurable)*

Outputs	Deliverables	Delivery Date
First draft of the document including the preliminary key messages and supportive arguments clearly stated in the documents.	Draft report	30 September 2012
Presentation at subregional consultation meeting	Presentation (including any background materials and PPT)	8-9 October
Revise the subregional perspectives following the recommendations of the Subregional Consultation Meeting.	Final document with associated statistics, graphs and charts to be submitted to EDD through EPO.	10 working days after Subregional consultation meeting.

How are the outputs to be delivered? MS Word 2003

Performance indicators for evaluation of outputs.

Timely submission of documents;

Clarity in the methodology applied and arguments used;

Thoroughness and accuracy of the analysis;

Incorporation of feedback from reviewers;

Acceptance/Endorsement of the study by the Subregional Consultation Meeting.

Annex 2: Documentation

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	Energy Security Challenges for Asia and the Pacific (Discussion note 1; KV Ramani) http://www.unescap.org/esd/Energy-Security-and-Water-Resources/energy/security/eForum/documents/Discussion-Note-1-Energy-security-

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- Papua New Guinea (Aug draft)
- Regional Overview (Aug draft)
- Republic of Marshall Isl (Sept draft)
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PIFS, 2012	Forum Communiqué (43rd Pacific Islands Forum; Cook Islands; August) http://www.forumsec.org/resources/uploads/attachments/documents/43rd%20Pacific%20Islands%20Forum%20Communique%20-%20FINAL1.pdf
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Annex 3: Matrix of Energy Sector Grant Support to PICTs (March 2010; Indicative Only)

These tables are based on consultations in early 2010 with donors and development partners and information from reports available on-line. It was prepared as part of the background information during the development of the *Framework for Action on Energy Security in the Pacific* and was widely distributed in 2010. The annex excludes the French Pacific, for which information was unavailable.

Table 1: Global Environment Facility Energy Support to Pacific Island Countries

Project / Programme	PICs included	Execution	US$m *	Comments
Promoting Energy Efficiency in the Pacific	Cook Islands, Samoa, Tonga, PNG, Vanuatu	ADB	6.0	Excludes $1m ADB grant. Being developed during 2010. (See *Promoting Energy Efficiency in the Pacific* in Table 2)
Action for Development of Marshall Islands Renewable Energy (ADMIRE)s	Marshall Islands	UNDP	1.1	March 2009 – March 2014. Status review planned for March 2010. No substantive activities begun.
Sustainable Economic Development through Renewable Energy Applications (SEDREA)	Palau	UNDP	1.1	Preparatory work for renewable energy fund at national development bank; reports include RE technologies appropriate for Palau & electricity tariff review.
Energizing the Pacific Regional Project	PNG, Solomon Islands and Vanuatu	World Bank	4.0	From April 2011 – April 2018; possibly to include Kiribati
Fiji Renewable Energy Power Project (FREPP)	Fiji	UNDP	1.1	Medium sized project to be developed during 2010; Co-financing estimated as $1.5m
Pacific Islands Greenhouse Gas Abatement through Renewable Energy Project (PIGGAREP)	Eleven PICs (excludes Palau & RMI)	UNDP/ SPREP	5.2	Effectively 2008-2011. Over $3.5m remains for 2010-2011.
Accelerating the Use of Renewable Energy Technologies	Nauru, Niue and Tuvalu	UNEP/ IUCN	1.5	Being implemented by IUCN Oceania, with project development underway in February 2010
Sustainable Energy Financing Project (SEFP)	Marshall Islands, Vanuatu	IFC	9.5	Missions in 2009 but no (?) activities
	Fiji, PNG, Solomon Islands	World Bank		WB components underway
Total GEF-			29.5	

* Budget indicated is for GEF input only

Table 2: Other Energy Sector Grant Assistance in Energy to Pacific Island Territories and Countries

Project / Programme	PICs included	Execution	US$m *	Comments
Grid-connected Photovoltaics and desalination in Pacific Island Countries (Govt of Japan)	Forum Island Countries	Forum Sec./ Govt of Japan	≈75 **	From 2001 or 2011 About 6.8 billion yen for grid-connected and stand alone PV for power and sea water desalination. **
Follow-up assistance for upgrading electrical power system and power supply adviser	Palau	JICA	0.6 +	Overhaul of Mitsubishi engine in Malakel Power Plant and capacity building
Hydro Power Energy Study	PNG	JICA	?	April 2010
Advisor for Renewable Energy Development	Tonga	JICA	?	Assist PM's office in developing RE policy
Improvement of Sarakata Hydroelectric Power Station	Vanuatu	JICA	14.4	Rehabilitation of Sarakata Hydro Power Plant
Advisers for power sector expansion	Samoa	JICA	?	TA to EPC including generation, system planning & SCADA. Also senior volunteer (civil engineer)
Study for maximum and effective use of renewable energies in electric power supply	Fiji	JICA	?	Covers hydro and solar
Promoting Energy Efficiency in the Pacific	Cook Islands, PNG, Samoa, Tonga, Vanuatu	ADB	1.7	Support for energy efficiency pilot projects (audits, CFLs, appliance labelling, retrofits, etc.)
Promoting Renewable Energy in the Pacific	PNG, Solomon Isl, Vanuatu	ADB	3.0	Hydro (PNG), biofuel (SI) & PV (Vanuatu)
Strengthening Capacity of Pacific Developing Member Countries to Respond to Climate Change	Pacific Developing Member Countries	ADB	1.5	$1m for upscaling RE; $0.5m for promoting Clean Development Mechanism. Awaits approval from Japanese Asia Clean Energy Fund

Table 2: Other Energy Sector Grant Assistance in Energy to Pacific Island Territories and Countries (continued)

Project / Programme	PICs included	Execution	US$m *	Comments
ADB energy grant pipeline for Pacific Member Developing Countries in 2010 (RMI support from Japanese Fund for Poverty Reduction)	Marshall Islands	ADB	3.0	Improved Energy Supply to Poor Households
	Papua New Guinea		3.0	Improved Power Supply to Poor Communities
	Samoa		1.0	Support for Power Sector Regulator
	Tonga		3.0	Support to Energy Sector Roadmap ($1m in 2010 + $2m for 2011)
Other ADB energy sector grants (linked to loan finance)	Samoa	ADB	27.4	Power sector expansion. $15.4 m ADF, $12m AusAID
	Samoa		1.9	Implementing National Energy Policy
	Samoa		1.2	Afululo hydro environmental impact
	PNG		0.5	National power sector development plan
	PNG		1.2	Off-grid provincial centre hydropower
Italy/Austria Pacific Energy Programme	Palau, RMI, Samoa, Tonga Tuvalu & Vanuatu	IUCN Oceania	10.0	Of total, €4m (over US$5m) is managed by IUCN for 2008-2011. From 2010 IUCN initiatives include increased ecosystem focus.
	Cook Islands, Kiribati FSM, Fiji, Nauru, PNG	The PIC governments		
Energy Efficiency Assessment Program for the Northern Pacific Utilities	FSM, Marshall Islands, Palau, Guam, Northern Marianas	PPA	≈0.4	2010 – 201. Power sector supply-side energy efficiency assessment funded by US Department of the Interior, Office of Insular Affairs (USDOI OIA)
Capacity Support for Sustainable Management of Energy Resources in the Pacific Region	ACP Pacific Island states	PPA	≈1.6	Mid 2008-2011; effectively 2010-2011. EC EDF9 grant of €1.2m for assistance in integration of RE to grid, identification of supply side losses and training
Northern Utilities Support	Northern Pacific PIC utilities	PPA	0.4	2009-201 supported by USDOI OIA. Engineering services for northern utilities

* Values converted to US$ at early Feb 2010 exchange rates from ExchangeRate.com (US$1.00 = A$ 1.14 = €0.73 = yen 89)

** Apparently includes US$17.3m from JICA to FSM, Palau & RMI for grid-connected PV approved in 2009 and US$6.6m for stand-alone solar home systems for Tonga.

Table 2: Other Energy Sector Grant Assistance in Energy to Pacific Island Territories and Countries (continued)

Project / Programme	PICs included	Execution	US$m *	Comments
Capacity Support for Solar PV Stand Alone & Grid Connected Systems and Demand-side Management;	PICs	PPA	0.6	2009-2010. Workshops on PV systems and energy efficiency (demand-side) for PIC utilities supported by the e8 utility network.
Energy Efficiency Assessment Program for the Southern Utilities (not finalised)	Cook Islands, Tonga, Kiribati, Niue, Solomon Islands, PNG, Samoa, Fiji, Tuvalu	PPA	≈0.3	2010 – 2011 Power sector supply-side energy efficiency assessment funded by EC & NZAid
Feasibility study for Tina River Hydropower	Solomon Islands	EIB	≈0.7	€0.5m; 2010
International Partnership for Energy Development in Island Nations (EDIN)	PICs & island countries globally?	USA, NZ & Iceland ?	**?**	Established late 2008 for pilot projects. Inactive ?
Strengthening of the Energy Sector in Pacific ACP countries (EC EDF-10)	All Pacific ACP states	SPC	≈12	2010-2014. €9 m from EC regional programme. Identification fiche accepted; detailed proposal to be submitted by mid 2010.
North Pacific/ACP Renewable Energy and Energy Efficiency Programme (North REP)	FSM, Palau & Marshall Islands (RMI)	SPC	≈20	€14.4 m 2010-2014 from EDF10 national allocation as follows: FSM €7.47m, RMI € 4.5m & Palau €.2.47m.
Other European Commission EDF-10 national energy assistance.	Nauru	Nauru govt	≈3.2	€2.3m for supply-side EE and also RE
	Niue	Niue govt	≈3.5	€2.55m for supply-side EE and also RE
	Kiribati	Kiribati govt	≈5.6	€4.1m for outer island solar photovoltaic energy
	Tonga	Tonga govt	≈6.9	€5.0 m for Tonga Energy Programme
Strengthening of the Energy Sector in Pacific ACP countries (EC EDF-10)	All Pacific ACP states	SPC	≈12	2010-2014. €9 m from EC regional programme. Identification fiche accepted; detailed proposal to be submitted by mid 2010.
Clean and Affordable Energy for the Pacific Islands	All Forum Island Countries	AusAID (mainly thru PRIF)	≈22	A$25 m from AusAID. FY 2009/10 - 2012/13 mainly through PIAC/PRIF to expand access to reliable and affordable energy services, while reducing reliance on imported fuel

Table 2: Other Energy Sector Grant Assistance in Energy to Pacific Island Territories and Countries (continued)

Project / Programme	PICs included	Execution	US$m	Comments
Renewable Energy & Energy Efficiency Partnership (REEEP) Pacific programme	Regional	AusAID/ REEEP	≈1.3	A$1.5m from AusAID. Activities include green tourism study (Fiji)), energy audits & training through SOPAC (RMI, Palau), microfinance (Fiji, Samoa), support for 'Roadmap' (Tonga), kerosene replacement (SI, Vanuatu, PNG)
Miscellaneous AusAID	All Pacific Island Countries	Support to dev partners	See comments	Over US$15m (over A$17m) but not included in table to avoid double-counting. See note below this table.
Renewable Energy & Energy Efficiency Partnership (REEEP) Pacific programme	Regional	REEEP	≈$1.3	A$1.5m from AusAID. Activities include green tourism study (Fiji)), energy audits & training w. SOPAC (RMI, Palau), microfinance (Fiji, Samoa), support for 'Roadmap' (Tonga), kerosene replacement (SI, Vanuatu, PNG)
American Recovery & Reinvestment Act (ARRA) funds for energy improvements. **	Guam	Guam	≈20	2010-2013? Improved efficiency, reduced reliance on imported energy, improved reliability of electricity & fuel supply, reduced environmental impacts energy
	American Samoa	A Samoa	18.5	
	Northern Marianas	N Marianas	10 +	

Note on AusAID. AusAID provides support for other energy activities, including supporting energy projects led by other development partners. These include in Australian dollars):

- Samoa Power Sector Expansion program (ADB-led): AusAID has provided grant funding of $8 million with future support envisaged. (This is in addition to ADB grant financing and loans, and grant financing from Finland and Japan. ADB will know the total project values.)
- Contribution to WB SEFP in Solomon Islands – approximately $1m over 3years (2007/08- 2009/10).
- Vanuatu Power Access Program – through PRIF, approx $7 million for an initial 3 year period from 2009/10.
- Nauru Infrastructure reform (in partnership with ADB): Support for utility management (power and water) over an initial 7 year period (from 2004/05). Funding totals unavailable at the present time but can provide additional information if necessary.
- Energizing the Pacific: $1.05 million provided in 2008/09 to support its development.
- Through Energizing the Pacific/World Bank, providing support for the Tonga Energy Road Map (actual figures not yet available).
- Solomon Islands Hydropower: World Bank's Tina River Hydro program (though PRIF): Not yet commenced – support for preparation currently being provided through the PRIF.

** The ARRA data are approximate as reporting sites are confusing. There are many other US programmes from which they (and FSM, RMI & Palau) can receive energy funding.

Annex 4: The Concept of Energy Security

Energy security is a cornerstone of energy policies but there are numerous understandings of the concept, as illustrated below. The text has been abridged and sometimes slightly paraphrased from the original sources.

International Energy Agency. Energy Security can be described as "the uninterrupted physical availability at a price which is affordable, while respecting environment concerns":

- Long-term energy security is mainly linked to timely investments to supply energy in line with economic developments and environmental needs.
- Short-term energy security is the ability of the energy system to react promptly to sudden changes in supply and demand.

Another way to look at energy security is to study the different energy sources (coal, oil, gas, renewables), intermediate means (electricity, refineries) and transportation modes (grids, pipelines, ports, ships). All of these have risks of supply interruptions or failures, challenging the security of undisturbed energy supply.

The IEA works towards improving energy security by:

- promoting diversity, efficiency and flexibility within the energy sectors of member countries
- remaining prepared collectively to respond to energy emergencies
- expanding international co-operation with all global players in the energy markets

Source: http://www.iea.org/subjectqueries/keyresult.asp?KEYWORD_ID=4103 (accessed 3 Oct 2012)

In a speech at APEC's 2012 Ministerial Forum , IEA Executive Director Maria van der Hoeven stressed the need for improved energy efficiency, diversity of supply and enhanced cooperation with partners as keys for ensuring energy security.

Source: http://www.iea.org/newsroomandevents/news/2012/june/name,28136,en.html 29 June 2012

Long term energy security must tackle root causes, which include four broad types:

- Energy system disruptions linked to extreme weather conditions or accidents: Policies are generally precautionary in nature. Governments have an important role in preparing contingency arrangements for the management of, and recovery from, such incidents after they happen.
- Short-term balancing of demand and supply in electricity markets: To ensure the security of electricity systems, governments establish independent transmission system operators responsible for the short-term balancing of demand and supply.
- Regulatory failures: Government. action aims to monitor the effectiveness of regulations and to adjust regulatory structures when inefficiencies are detected.
- Concentration of fossil fuel resources: Government action aims to minimise the exposure to resource concentration risks in fossil fuel markets and includes moving away from fossil fuels, or diversifying supply routes and means.

Source: Energy Security and Climate Policy: Assessing Interactions (IEA, 2007)
http://www.iea.org/publications/freepublications/publication/energy_security_climate_policy-1.pdf

ESCAP Electronic Forum on Energy Security in Asia and the Pacific. Energy security is elusive to define, depending on who is asking the question. Policymakers striving to strike the 'right balance' between economic, social and environmental goals look for compromises consistent with the development status of their countries. Developing countries with low levels of energy consumption and problems of poverty tend to stress the need for raising energy consumption, for which fossil fuels are the most ready solutions. Developed countries that have achieved high levels of energy consumption tend to look for technological solutions to improve energy efficiency and diversify away from fossil fuels without eroding their development status. The preferences of the one do not easily resonate with the preferences of the other. Few countries are willing to do away with fossil fuels altogether so long as they can access available supplies in spite of the many uncertainties clouding the future of these fuels.

Source: *Energy Security Challenges for Asia and the Pacific* (Discussion note 1; KV Ramani)
http://www.unescap.org/esd/Energy-Security-and-Water-Resources/energy/security/eForum/documents/Discussion-Note-1-Energy-security-challenges.pdf

Brookings Institute. There is no consensus on a definition of "energy security" because the concept depends on where in society one sits. At the most basic level, energy security means having access to the requisite volumes of energy at affordable prices. There is also an implicit assumption that access to the required energy should be impervious to disruptions—that alternative supplies should be readily available at affordable prices and sufficient with respect to both available volume and time required for distribution.

- From the perspective of a government …, energy security implies energy policies and standby measures that can be implemented in the event of a supply disruption—and at a cost that its citizens consider reasonable. Such measures include energy supply diversification and a certain volume of energy stock. Governments must be able to manage the macroeconomic effects of a major supply disruption, including price shocks, inflation, and loss of jobs.
- From the vantage point of a private citizen, energy security … hinges on access to readily available resources in sufficient volume at affordable prices. The concept is now applied to individuals and small enterprises.
- To the growing urban communities, energy security simply means keeping the lights on. For many developing countries, brownouts and blackouts are commonplace, sometimes fomenting political demonstrations.
- For the poorest populations, energy security has profound implications on daily lives. A basic supply of commercial energy sources and electricity can empower women and girls, ensure better education for children, and improve health and healthcare. Energy security is … about guaranteeing access.

Source*: The Meaning of Energy Security Depends on Who You Are* (Brookings Institute, 10 Oct 2011)
http://www.brookings.edu/research/opinions/2011/10/10-energy-security-ebinger

Electricity Policy Research Group, Cambridge University. Energy security is one of the main targets of energy policy but the term has not been clearly defined, which makes it hard to measure and difficult to balance against other policy objectives. The multitude of definitions … can be characterized according to the sources of risk, the scope of the impacts, and the severity filters in the form of the speed, size, sustention, spread, singularity and sureness of impacts. The selection of conceptual boundaries along these dimensions determines the outcome, which can be avoided by more clearly separating between security of supply and other policy objectives. This leads us to the definition of energy security as the continuity of energy supplies relative to demand. If security is defined from the perspective of private utilities, end consumers or public servants, the concept could further be reduced to the continuity of specific commodity or service supplies, or the impact of supply discontinuities on the continuity of the economy.

Source: *Conceptualizing Energy Security* (Electricity Policy Research Group, Cambridge University, Paper 1123 by Christian Winzer July 2011) http://www.dspace.cam.ac.uk/bitstream/1810/242060/1/cwpe1151.pdf

Oil expert Daniel Yergin. Diversification will remain the fundamental starting principle of energy security for oil and gas. It will likely also require … encouraging a growing role for a variety of renewable energy sources as they become more competitive. … In a world of increasing interdependence, it will depend much on how countries manage their relations with one another, whether bilaterally or within multilateral frameworks. … Part of the challenge will be anticipating and assessing the "what ifs" which requires looking not only around the corner, but also beyond the ups and downs of cycles to both the reality of an ever more complex and integrated global energy system and the relations among the countries that participate in it.

Source: *Ensuring Energy Security* (Daniel Yergin, Foreign Policy, April 2006)
http://www.un.org/ga/61/second/daniel_yergin_energysecurity.pdf

Climate Change and sustainability study, R Craig. Discussing sustainability (and implicitly security): ' So, what *should* we pursue, if not sustainability? *Adaptability*, for one—that is, the ability to change (foods, jobs, health regimes, industries, *etc*.) in response to, and preferably in tandem with, climate change impacts. Nostalgic conservatism will be, sometimes literally, a dead end. *Resilience*, for two—that is, the ability to absorb change without losing overall functionality, such as food production, water supply and sanitation, law and order, individual and cultural self-expression. … As Charles Darwin emphasized, "It's not the strongest of the species that survives, nor the most intelligent, but the one most responsive to change." '

Climate Change Means the Death of Sustainability (Robin Craig, University of Utah, August 2012)
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2139605

Annex 5: Political Commitments to Improve Energy Security in the Pacific

The following excerpts indicate the commitments by the Pacific political leaders to improve energy sustainability and security. This is not complete but clearly shows the commitments made.

Communique of the 43rd Pacific Islands Forum, 2012:

[Leaders supported] "increased investment in basic infrastructure to improve access to water and sanitation and energy."…"

"Leaders welcomed the offer from New Zealand to host a Pacific Energy Conference in April 2013. This Conference will showcase progress in the region towards the goal of improving access to clean affordable energy and will mobilise additional support to further reduce the Pacific's dependence on fossil fuels.

Forum Economic Ministers' Meeting, 2012:

"Ministers acknowledged the need to work with development partners and the private sector to improve energy efficiency and significantly increase investment in alternative forms of energy so as to reduce reliance on fossil fuels."

Communique of the 42nd Pacific Islands Forum, 2011:

"Leaders agreed on the value of energy audits and of developing credible whole of sector plans such as "energy road maps" and structures to improve energy security, reduce dependency on fossil fuel for electricity generation and improve access to electricity."

Waiheke Declaration on Sustainable Economic Development, 2011

Leaders committed themselves specifically to: "Improve energy security through greater efficiency measures and the promotion of clean and affordable energy, including renewable energy."

Pacific Plan 2011 Annual Progress Report:

"Energy remained a key priority under the Pacific Plan in 2010 an 2011. The 2011 inaugural meeting of the Ministers of Energy, Information and Communications Technology and Transport gave its support to the Framework for Energy Security in the Pacific, the related implementation plan and energy security indicators for monitoring implementation. The implementation plan provides a common platform for greater coordination and collaboration by CROP and other agencies working in the energy sector under the 'many partners, one team' approach. The implementation plan will guide resource mobilisation to implement priorities agreed to by the ministerial meeting and coordinated by the Pacific Energy Oversight Group. …

Leaders at the 2010 Pacific Islands Forum reaffirmed their commitment to renewable energy ad an energy efficient future based on achievable, practical and voluntary targets. This was reflected in the outcomes of the inaugural meeting of Ministers of Energy, Information and Communications Technology and Transport which urged Pacific Island Countries to set time-bound targets for the sustainable development of renewable-based electricity. In August 2010, the Green Energy Initiative (GEM) was launched…. [It] aims to reduce the dependence of Micronesian states on fossil fuels by achieving 20 per cent of power generation through renewable energy by 2020 and improving the efficiency of energy generation and supply. At the national level, Tonga continued to successfully coordinate development partner support for its energy sector through the Tonga Energy Road Map. The Government of the Cook Islands adopted a Renewable Energy Charter with the goal of generating 50 per cent of its electricity from renewable sources by 2015 and 100 per cent by 20120."

Special Forum Energy Ministers' Meeting: Brisbane Communiqué 2010:

The 2009 Forum Leaders' meeting expressed strong concern on the region's energy security and directed that a Special Forum Energy Ministers' Meeting be convened to consider progress on relevant resource mobilisation and activity identification, with a report to be provided to the 2010 Forum. At their special meeting in Brisbane, Australia in June 2010, Forum Energy Ministers: recognised that energy security is fundamental to achieving the social and economic aspirations of the Pacific; recalled**:**

- the 2007 and 2008 Forum meetings which accorded urgent priority to providing available, reliable, affordable, and environmentally sound energy for the sustainable development of all Pacific Island communities;
- the decisions of the Forum Economic Ministers, and Pacific Ministers for Energy for effective and appropriate 'Pacific approaches and solutions' to addressing energy challenges in the region, including the call to review the 2004 Pacific Islands Energy Policy;
- the 2009 Cairns Forum Communiqué, which called for action to "… identify options for scaled-up, better coordinated financing for clean and affordable energy in the region; …

Forum Energy Ministers therefore:

- welcomed the progress to date on the implementation of decisions by Forum Leaders on the energy sector;
- recognised that petroleum will continue to play a key role in meeting the energy needs of Forum Island Countries, especially in the transport sector, and efficient management of petroleum products should underpin energy policy decisions;
- recognised that while renewable energy can offer many benefits, its development should be pursued in conjunction with a conducive regulatory environment and energy efficiency and conservation measures that can deliver early significant gains toward energy security in the Pacific
- endorsed the Framework for Action on Energy Security in the Pacific
- encouraged the adoption of a whole-of-sector approach to effectively address energy challenges on the basis of "many partners, one team, one plan" as outlined in the Framework.
- noted that the regional Implementation Plan for Energy Security in the Pacific, which will focus on a prioritised list of regional interventions to support national activities, will be presented to the 2011 Pacific Energy Ministers' Meeting for their consideration and approval; and
- recommended the Framework for Action on Energy Security in the Pacific to Forum Leaders for consideration and endorsement at their 2010 meeting in Port Vila, noting that similar endorsement will be sought from non-Forum Island Countries and Territories at the next Pacific Energy Ministers Meeting in 2011.