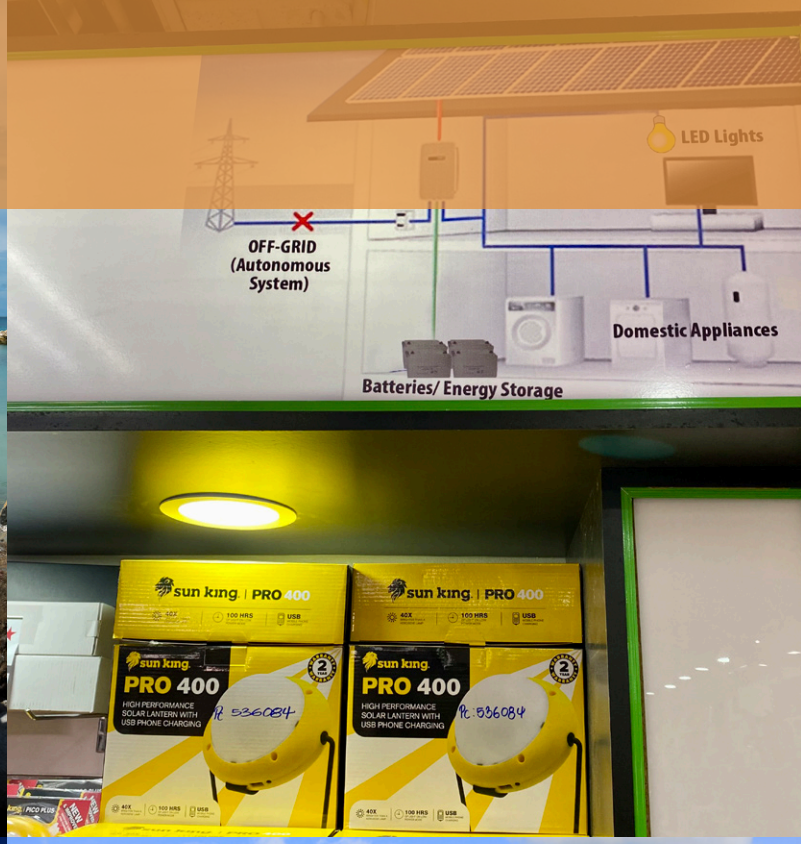
Pacific Region Infrastructure Facility



Study on Pacific Clean Energy Financing Potential

Main Report

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TABLE OF CONTENTS

EXECUTIVE SUMMARY VI
1 OBJECTIVES 1
2 BACKGROUND OF THE STUDY 2
3 METHODOLOGY USED 4
3.1 Data Collection and Filling in Gaps 4
3.2 Analysis of Case Countries 6
3.3 Demand Analysis and Willingness-to-Pay Assessment 8
3.4 Discussion and Recommendations 9
4 REGIONAL MARKET ASSESSMENT 10
4.1 Macroeconomic Overview 10
4.2 Characteristics of the Energy Sector 12
4.3 Energy Poverty 14
4.4 Product Inventory 15
4.5 Demand Forecasting 17
4.6 Purchasing Power and Willingness to Pay 19
4.7 Community Awareness 20
4.8 Product Supply and Cost of Ownership 22
4.9 Availability and Access to Finance 25
5 DISCUSSION AND RECOMMENDATIONS 32
5.1 Enabling the Regulatory and Institutional Environment 32
5.2 Overcoming Challenges in Accessing Finance Products 34
5.3 Opportunities for Job Creation in Operations and Maintenance Services 36

REFERENCES 38
ANNEXES 43

FIGURE/TABLE LIST

Figure: Key Elements of the Methodology Used 4

Table 1: Classification of Pacific Island Countries according to Economic Indicators 4
Table 2: Selected Indicators for Demand Comparison 6
Table 3: Selected Countries for Energy Profiles 6
Table 4: Topics Covered in Surveys 7
Table 5: Overview of Economics and Energy Access in Lower-Income Countries 10
Table 6: Overview of Economics and Energy Access in Higher-Income Countries 11
Table 7: Energy Sector Characteristics in Lower-Income Countries 12
Table 8: Energy Sector Characteristics in Higher-Income Countries 13
Table 9: Income Situation in Lower-Income Countries 15
Table 10: Income Situation in Higher-Income Countries 15
Table 11: Grid-Connected Households Using Appliances in Lower-Income Countries 16
Table 12: Grid-Connected Households Using Appliances in Higher-Income Countries 16
Table 13: Types of Lighting Used in Households in Lower-Income Countries 17
Table 14: Types of Lighting Used in Households Using in Higher-Income Countries 17
Table 15: Timing of Next Purchase for Grid-Connected Households in Lower-Income Countries 18
Table 16: Timing of Next Purchase for Grid-Connected Households in Higher-Income Countries 18
Table 17: Next Purchase for Grid-Connected Households in Lower-Income Countries 18
Table 18: Next Purchase for Grid-Connected Households in Higher-Income Countries 19
Table 19: Awareness and Understanding of Energy Labels in Lower-Income Countries 21
Table 20: Awareness and Understanding of Energy Labels in Higher-Income Countries 21
Table 21: Estimated Costs of Energy-Efficient Appliances in Lower-Income Countries 23
Table 22: Estimated Costs of Energy-Efficient Appliances in Higher-Income Countries 23
Table 23: Estimated Costs of Solar Products in Lower-Income Countries 24
Table 24: Estimated Cost of Solar Products in Higher-Income Countries 24

ABBREVIATIONS

ADB	Asian Development Bank
ANZ	Australia and New Zealand Banking Group
BSP	Bank South Pacific
COVID-19	coronavirus disease 2019
DBK	Development Bank of Kiribati
DBS	Development Bank of Samoa
DBSI	Development Bank of Solomon Islands
DBT	Development Bank of Tuvalu
FSMDB	Federated States of Micronesia Development Bank
GDP	gross domestic product
GEF	Global Environment Fund
HIES	Household Income and Expenditure Surveys
IPP	independent power producer
IUCN	International Union for Conservation of Nature
MEC	Marshalls Energy Company
MIDB	Marshall Islands Development Bank
NBV	National Bank of Vanuatu
NDBP	National Development Bank of Palau
NDC	nationally determined contribution
NGEF	National Green Energy Fund
O&M	operations and maintenance
PAD	Pacific Appliance Database
PIC	Pacific Island Country
PPA	Pacific Power Association
PRIF	Pacific Region Infrastructure Facility
PV	photovoltaic
SMEs	small and medium-sized enterprises
SPC	Secretariat of the Pacific Community
TDB	Tonga Development Bank
UNDP	United Nations Development Programme
VREP	Vanuatu Rural Electrification Project

EXECUTIVE SUMMARY

The overall objective of this study is to shed light on the market potential for distributed energy equipment (mostly solar products) and energy-efficient appliances in 14 Pacific Island countries (Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Nauru, Niue, Palau, Papua New Guinea, Republic of the Marshall Islands, Samoa, Solomon Islands, Tonga, Tuvalu, and Vanuatu). The study takes stock of the energy landscape and market potential, and assesses the prospects for clean energy retail lending through national development banks and other intermediary financial institutions. The study also identifies challenges and makes recommendations for developing a more enabling environment for investments, removing bottlenecks for households trying to access to finance products, and for realizing opportunities for job creation by developing local services in the clean energy sector.

The methodology used in this study is largely based on an extensive literature review, including sources with secondary data, the elaboration of in-depth country energy profiles for five countries, and the implementation of validation surveys in two of those countries. The study explicitly separated the economic profiles from the data on the behavior and needs of households in urban grid-connected areas and households in rural off-grid areas. The main findings are discussed next.

Income and energy poverty

Chronic energy poverty in the Pacific is not only due to insufficient power supply, high tariffs, and the lack of new investments. It is also affected by the low and irregular income of a large part of the population in the Pacific; in particular the population in rural areas where formal employment is very low, and households are forced to rely on more than one sources of income. A lower income means a larger risk of energy poverty since alternatives for self-production of energy cannot be realized. Upper-income countries show an important income difference between their urban and rural populations, with the rural population at a greater risk of energy poverty. This income difference between urban and rural households almost vanishes in lower-income countries, suggesting extended impoverishment.

Product inventory and demand forecast

Most popular appliances in urban households are televisions (TVs) and radios (mostly found in about 70% to 80% of homes), as well as fans and refrigerators (60% to 80%). The use of washing machines is increasing, but has not yet been fully mainstreamed. The use of air conditioners is greater in countries with a higher gross domestic product (GDP), and almost nonexistent in countries with lower GDPs. Two-thirds of all major appliances in urban areas were purchased during the past 5 years. There is a strong sentiment in the majority of households against replacing appliances until they can no longer be fixed.

In various surveys, a large majority of households indicated that they did expect to purchase appliances in the future, but only a small percentage were able to estimate any dates of purchase. A common answer was that new appliances would be bought when the current ones no longer worked and could not be repaired. An average of 20% to 40% of the surveyed households were thinking about their next purchases, and expected to make those purchases within the next 6 months; and 15% to 30% expected to make a purchase within the next 12 months.

Freezers/refrigerators, washing machines, and TVs are the most preferred appliances for next purchases among urban households connected to the grid. However, a large number of urban households that have purchased their cooling/freezing appliances made their choices based

on the lowest price, rather than on energy performance or other technological benefits. Strengthening energy labelling and, where possible, restricting imports of low-energy performance equipment (as is done in Vanuatu) would help to develop the market for energy-efficient appliances.

Cheaper and longer-lasting solar lamps are the most preferred technology in the Pacific by both urban and rural households. Mini solar home systems, of less than100 Watt peak, and other solar home products, such as 150-Wp solar kits for basic lighting and charging, are the type of products preferred by rural households. The next most popular technologies are medium-sized solar heating systems of up to 1,000 Wp for households or for establishing microgrids, and direct-current (DC) appliances such as small fans and TV screens. Finally, fishing cooperatives, community centers, and some large higher-income households have demand for solar freezers with capacities larger than 300 liters, as well as small and medium-sized solar water pumps. These investments are usually linked to business or community activities.

Purchasing power and willingness to pay

The low average and median income levels make it practically impossible for the majority of the populations in lower-income countries to accumulate sufficient savings. The lack of savings severely affects a household's ability to purchase new appliances and the household's willingness to pay. These are constraint factors that must be fully noted when planning financing facilities. Despite low or no savings, many households in urban areas (grid-connected) expressed in the surveys their willingness to pay for energy-efficient appliances, particularly younger households in upper-income countries.

Most people aged 20 to 40 who lived in urban areas in upper-income countries were willing to pay more, compared with only a slight majority observed in the 31-to-50 age group in lower-income countries. This observation seems to reveal more cautiousness and distrust in lower-income countries regarding the economic benefits of energy-efficient appliances. The survey in Kiribati revealed that about 73% of grid-connected households were willing to pay a higher price for energy-efficient appliances. About 19% of the respondents stated that they would be willing to pay up to 5% more, and as many as 36% stated their willingness to pay up to 10% extra, while 20% were willing to pay 20% extra. It was observed that their preferences were strongly linked to their monthly incomes. The survey also revealed that up to 41% of household would consider taking out a loan to purchase energy-efficient appliances.

Rural households were more reluctant to take out loans. This may be explained by the many challenges they face in getting loan approvals and by their reluctance to become indebted. Young employed energy consumers were more inclined to risk taking out a loan, compared with the older generation.

Community awareness

Different surveys found that awareness about energy-efficient appliances was generally moderate to high across the region, but that awareness declines with age. Awareness of specific energy labels grows with per capita GDP. People in Kiribati, Papua New Guinea, and Tuvalu are moderately aware of star energy labelling in appliances, with about 30% of them mistakenly thinking that more stars mean more energy consumption. The exception among the countries with lower per capita GDPs is Vanuatu, where 94% of the population are aware of energy labelling. This is due to Vanuatu's Energy Efficiency Act of 2017, which established technical standards for refrigeration, air conditioning, and lighting products. However, the large majority of people in Vanuatu do not know how to read energy efficiency labels and cannot calculate the running cost of equipment.

Product supply and cost of ownership

There is only a limited number of local operators in the region; this often results in monopolies and, consequently, in higher costs of services. The lack of sufficient and adequate local service providers affects the willingness to pay, since consumers would prefer to invest in appliances that can be technically serviced and thus last longer.

As noted above, consumers are likely to compare prices, rather than technological features and benefits. Educating consumers about the different types of technology and the benefits of higher energy performance would help to change the culture, decision-making, and evaluation process that influence consumer choices. The costs of energy-efficient appliances (more than three stars on the energy label) and of solar products differ widely among countries, and among retailers within countries. Costs also vary at different times of the year, as they also reflect retailing opportunities found by vendors. An indicative estimation of initial cost, based on real prices as offered by vendors, and proxies for translating prices to other countries, has been elaborated.

Availability and access to finance

Most of the 14 countries have formally recognized national development banks by means of national legislation. The exception is Vanuatu, where the National Bank of Vanuatu (NBV), a registered state-owned commercial bank, has identified economic development as one of its objectives. There are also some non-state-owned commercial banks in these countries, but they tend to be much more risk averse when it comes to clean energy products, and are less likely to extend their services outside of the main island. While all the national development banks are explicitly committed to promoting economic development, they need to improve accessibility to finance for vulnerable groups.

In the Pacific region, formal full-time employment is the main eligibility criterion for access to the financial products offered by national development banks. However, the rate of formal employment in the rural areas may be only one-third of that in urban areas. This puts the rural population at a big disadvantage, particularly lower-income households and women. The eligibility problem is clearly worse in the lower-income countries, where formal employment levels can be half of those in upper-income countries. Again, as noted above, rural households are more resistant to the idea of loans, possibly due to the many challenges they face when trying to obtain a loan and their reluctance to become indebted.

Recommendations

The energy landscape of the Pacific region has some success stories, as well as evidence of a gradual transition from fossil fuel dependency to a renewable-energy and clean-energy future, in which improved energy-efficient practices and installations are the top priorities. Access to energy has improved markedly over the last decade. However, there are still many challenges to overcome before the 14 countries can develop a more enabling environment for investment, remove bottlenecks for households seeking to access to finance products, and for realizing opportunities for job creation by developing local services in the clean energy sector. These challenges and recommendations to overcome them are discussed just below.

1. **Enabling the regulatory and institutional environment**

a) **Integrate utilities into program design.** Governments and development partners should work closely with utilities to achieve a better design and implementation of clean energy programs. For example, utilities could serve as technical advisors to the institutions that are implementing lending programs, such as national development banks. Utilities are also necessary partners in the preparation of training and educational programs delivering technical courses. And they are potential financial partners in energy-efficiency programs.

Joint business opportunities could be explored with utilities for offering LED lighting and energy-efficient appliances, partly financed by the utilities against saved energy costs.

b) **Establish clear and enabling guidelines for the grid connection of photovoltaic (PV) systems.** Discretionary connection permits should be avoided. National governments should work with the utilities to revise the existing guidelines to ensure that compensation mechanisms are clear and promote the connection of PV systems to the grid. These guidelines should establish the technical conditions for such connections, as well as the rights of the parties and fair costs, without hampering the process of decarbonizing the electricity system. This would require a national consensus and the protection of the financial health of the utilities, but it would also have to include fair economic compensation for the owners of PV systems.
c) **Adopt energy performance standards and registration systems.** Fiji and Vanuatu have mandatory standards and registration systems in place, under which inefficient appliances and low-standard equipment are not allowed to enter the national market. Other Pacific Island countries have yet to adopt and effectively implement energy-efficient standards and targets. They must be encouraged to register with the Pacific Appliance Database (PAD), as good practice, and to establish their own monitoring measures through specific regulations.
d) **Strengthen consumers' education in energy efficiency and energy labels.** National governments and utilities need to increase their efforts to improve public-information and general education strategies for consumers, to help them understand what energy labels are and how they must be read, so they can make informed purchasing decisions.
e) **Consider reductions of import tariffs.** National governments should seriously consider the reduction of import duties and taxes on solar equipment and energy-efficient appliances as the first measure to reduce the cost of ownership.

2. Overcoming challenges in accessing finance products

a) **Strengthen the preparation and early phase of project implementation.** Higher output and above-average impacts on energy access can be reached by a project's midterm if adequate financing is made available during the project's preparatory phase and early phase of implementation. Development partners should strongly consider how they could redesign their preparatory work to ensure that they systematically include: (i) financing for preparatory activities (i.e., technical studies, social surveys, etc.); (ii) the provision of long-term international technical assistance in the field to support program/project implementation; and (iii) strengthened monitoring tools, reporting, and verification of requirement fulfillment for the support programs.
b) **Support the design of flexible and inclusive eligibility conditions.** Development partners could more actively support and promote the establishment of more flexible and inclusive loan eligibility conditions by the national development banks, to increase credit access for the populations most at risk of energy poverty. Alternatives to explore include: (i) less rigidity when validating sources of income, for instance, accepting proofs of income based on self-employment and partial employment, including earnings from small-scale productive and trading activities (e.g., invoices for farming, fishing, and handicrafts), activities in the informal sector, and/or remittances from abroad; (ii) broadening loan guarantors from formal employers to also include family members, island councils (as in Kiribati), and the relevant community associations; and (iii) facilitating loans through cooperative arrangements (e.g., cooperatives with financial support from the government).
c) **Accept financed energy equipment as collateral.** Development banks could explore other types of collateral, in addition to salaries, money from provident funds, or real estate. Financed energy equipment—such as solar home-heating systems, solar freezers, or large energy-efficient appliances—could become collateral themselves.
d) **Design tailor-made lending terms and conditions for groups at risk of exclusion, particularly women.** Lending terms and conditions should be tailor-made for specific target groups, such as women entrepreneurs, female heads of households, and other groups at a larger risk of exclusion or poverty. The lending terms and conditions currently

offered by most development banks are designed to promote the uptake of specific technologies, rather than to ease credit access for groups at risk of exclusion. Lending terms and conditions must look beyond technologies; they should also seek to diversify bank portfolios to include women-led projects that could generate income and create jobs. Key performance indicators and specific targets in terms of the number and size of the loans should be adopted by development banks to measure the credit access of groups at risk of exclusion.

e) **Proactively search for and promote synergies with direct aid programs.** Banks offering financial products for energy equipment should strongly consider joining forces with aid programs that provide direct subsidies to help the most vulnerable populations gain access to that equipment.

3. Opportunities for job creation by developing operations-and-maintenance services

a) **Promote and support technical training in all programs and facilities.** Development partners and national development banks should actively promote training and technical education for local suppliers and service providers. This could be done by including training and education requirements in the design of all financing programs and facilities. Measures to strengthen the local operations-and-maintenance (O&M) market should involve incentives for community colleges, national universities, and technical institutes to create suitable educational and vocational programs in electrical and mechanical engineering, project management, and related disciplines. These programs could be delivered in collaboration with more recognized educational institutions. These efforts would result in an increased availability of local skills, more employment opportunities, a growing community of heads of small and medium-sized enterprises (SMEs), and both new and revived services—all of which would encourage competition.

b) **Support the establishment of local service businesses.** Skilled young entrepreneurs should receive loans to help them set up service businesses such as repair shops; these loans could also be combined with subsidies targeting the young. Both training programs and subsidies for business founders should have specific quotas for female entrepreneurs and technicians, as there is evidence across the Pacific that women are generally more committed to maintaining their local businesses, instead of seeking job opportunities abroad.

1 OBJECTIVES

The overall objective of this study is to shed light on the market potential for distributed energy equipment and energy-efficient appliances in 14 Pacific Island Countries (PICs).[1] Distributed energy equipment mainly entails solar photovoltaic (PV) systems of different sizes, for home use or for microgrids, and direct current (DC) appliances fed with solar energy.

The specific objectives of this study are:

- Taking stock of the energy landscape and market potential for distributed energy and energy efficiency, primarily in households. Other consumer segments are also considered to the extent information is available.
- Identifying and assessing the prospects for clean-energy retail lending through national development banks and other intermediary financial institutions. The assessment would include the identification of barriers and challenges that households face when trying to access retail lending, and the identification of opportunities for local job creation and for the development of local O&M services. Special attention would be given during the assessment to the prospects for targeting financial products for poor and female-headed households.
- Provide recommendations to the country members of the Pacific Region Infrastructure Facility (PRIF) for their future interventions involving clean energy financing.

To achieve these objectives, a regional demand analysis covering all 14 countries has been carried out. The findings and recommendations of the study will help develop a consensus among PRIF partners on the way forward toward supporting retail financing for clean energy products.

1 The PICs covered by this study are: Cook Islands, Fiji, Federated States of Micronesia, Kiribati, Nauru, Niue, Palau, Papua New Guinea, Republic of the Marshall Islands, Samoa, Solomon Islands, Tonga, Tuvalu, and Vanuatu.

2 BACKGROUND OF THE STUDY

The PICs share similar challenges in development, human resources, markets, and climate change. They generally have small populations dispersed over numerous islands and atolls, and struggle with limited natural resources, including clean drinking water and arable land.

Energy demand in the Pacific region has grown vigorously, along with poverty reduction and higher rates of access to energy. The countries' populations are growing, although some at very slow rates of less than 1% per year, but a significant outmigration of young people is leading to increases in the median ages. Additionally, internal migration—primarily from "outer" islands and rural areas to the urban areas—is causing significant urbanization, high population densities, and overcrowding in the national capitals and secondary urban centers. In the Federated States of Micronesia, Samoa, Solomon Islands, and Vanuatu, the urban areas are now home to approximately 20% of population; the rate is lower in Papua New Guinea (12%), but significantly higher in Kiribati (55%), Fiji (57%), Tuvalu (64%), Tonga (64%), Marshall Islands (78%), and Palau (81%).[2]

Urban growth is placing an immense strain on land and water resources, as well as on key services such as electricity and sanitation, especially affecting low-income households. Furthermore, the remoteness of all these countries means that significant levels of self-sustainability are required, and this results in high costs of imported necessities, especially food and fuel. Energy supply chains remain dependent on petroleum fuels despite the relative abundance of renewable energy resources. All the Pacific Island countries covered in this study are directly threatened with displacement due to climate change, and accelerated sea level rise it is causing. Climate change and variable weather patterns are also impacting their energy infrastructure, as well as primary industries such as agriculture and fishing.

Energy efficiency and renewable energies provide opportunities to increase the resilience of the energy sector, and of the more vulnerable customers, especially the poor and those living on the outer islands, by facilitating a continuity of access to energy and speeding up disaster recovery. All 14 countries have submitted their nationally determined contributions (NDCs) to the United Nations Framework Convention on Climate Change (UNFCCC), and most have developed national strategies and road maps with ambitious targets for reducing their dependency on fossil fuels and increasing their resilience to climate change. However, the implementation of these strategies and road maps are hampered by various factors, including the lack of financing and lack of private sector participation in projects required to meet the growing demand. Consequently, the achievement of national targets is constantly delayed.

Development partners have kept their commitment to engage with Pacific Island countries, but the engagement is usually conducted on a project-by-project basis, which entails lengthy learning curves and high transaction costs relative to the scale of the financial assistance. To date, there has been limited progress toward identifying and developing programs that aggregate project financing to create economies of scale that reduce transaction costs.

A major bottleneck development partners face is the large data gaps on household energy consumption, and on the opportunities and challenges these households have to improve their quality of life in a sustainable manner. There is limited information on the numbers and types of appliances households used, their energy rating, and on the levels of the residents' awareness of the economic benefits energy-efficient appliances.

[2] World Bank Data. https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=KI-TV-MH-FM-VU-WS-SB-PW-PG-FJ-TO-NR (Accessed 25 February 2022).

Finally, the purchasing capacity of households is also largely unknown, as is their willingness to pay extra for improved energy services and more energy-efficient appliances. In particular, it has been difficult to get insights into demand trends disaggregated according to urban and mostly off-grid rural areas, where a large part of the Pacific population lives.

During the inception phase of this study, a presentation and discussion with PRIF's Energy Working Group were conducted to align expectations regarding the outcomes of the study and to fine-tune its final scope. The inception phase was also used to identify the challenges to be addressed in the methodology of the study. The following challenges in determining the current and future demand of energy products were identified:

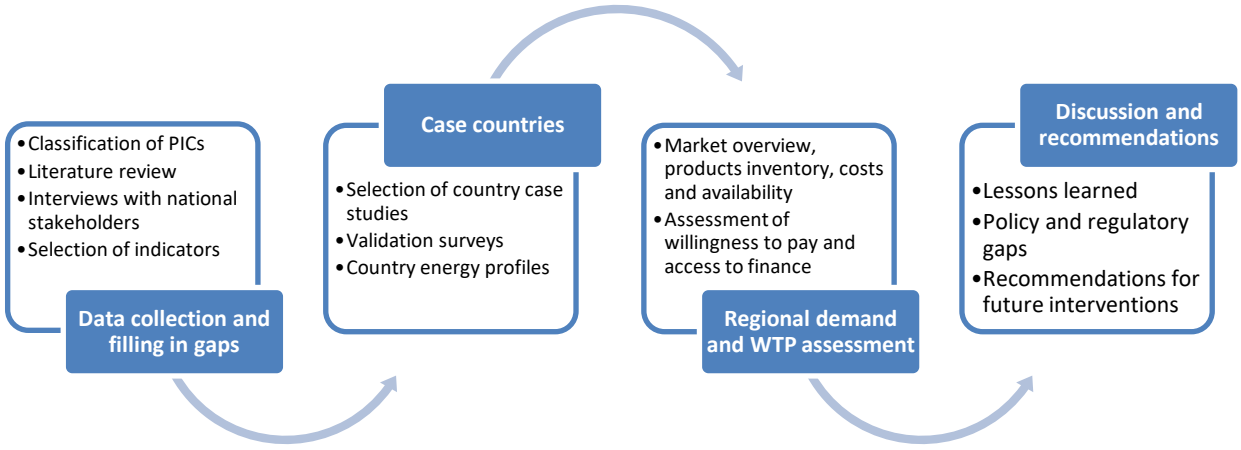
- **Lack of purposeful data.** The data available in most countries refer mostly to overall renewable energy targets and energy efficient goals (i.e., NDCs, national strategies, and road maps).
- **Limited country experience.** There is limited country experience and achievement, particularly with upscaling distributed energy and energy efficiency at the household/building level, often due to lack of funding.
- **Insufficient retailers in the local markets.** Only few options are available in most of these countries, and mostly serve the capital city and few of the larger cities. And in many cases, the products offered are the cheapest retailers can import, so they may be of low quality or lack good energy performance.
- **Limited local technical skills.** Similar to the insufficient number of retailers, there is a widespread lack of installation, maintenance, and repair services for energy-related equipment, mostly due to the limited local technical skills.
- **Lack of experience of commercial banks in clean-energy lending.** Local commercial banks are inexperienced in clean-energy retail lending channeled through development assistance, and they are reluctant to service low-income families.

This study aims to shed light on the potential demand of households for distributed energy equipment and energy-efficient appliances in 14 PICs. The results and recommendations of the study will help PRIF partners to develop a consensus on retail financing, and will provide them with a basis for designing their own support initiatives.

3 METHODOLOGY USED

The methodology used incorporated four key elements as represented in the figure below. A team of two senior consultants with expertise in the energy sector (Sergio Ugarte) and in energy economics (Apisake Soakai), both with a long track record in the Pacific region, carried out the demand analysis. The two experts worked complementarily, assisting each other in their respective tasks.

Figure: Key Elements of the Methodology Used



PIC = Pacific Island Country, WTP = willingness to pay.
Source: Pacific Clean Energy Financial Potential project team.

3.1 Data Collection and Filling in Gaps

Classification of countries for data analysis

For an adequate organization of data, the first activity of the study was the classification of the 14 countries according to the subregion they are located in and according to basic economic indicators characterizing the purchasing capacity of their populations (Table 1).

Table 1: Classification of Pacific Island Countries according to Economic Indicators

Region	GDP per Capita in 2019 < $5,000		GDP per Capita in 2019 > $5,000	
	Low	Medium-Low	Medium-High	High
Micronesia	Kiribati	Federated States of Micronesia, Republic of the Marshall Islands		Nauru, Palau
Melanesia	Papua New Guinea, Solomon Islands	Vanuatu	Fiji	
Polynesia		Samoa, Tuvalu	Tonga	Cook Islands, Niue

GDP = gross domestic product.
Note: A blank cell indicates that the column head does not apply.
Source: Pacific Clean Energy Financial Potential project team.

Targeted data

The data targeted for the regional demand analysis of clean energy products included:

- macroeconomic and demographic information at the national level and disaggregated according to urban and rural population segments;
- the regulatory framework that is promoting or creating barriers to energy efficiency and to self-production of energy at home;
- household income and expenditure at the national level disaggregated according to urban and rural population segments;
- information about access to grid and off-grid power, and to other sources of energy;
- characteristics and performance of the grid power supply;
- energy tariffs and energy consumption per consumer sector;
- inventory of lighting units, renewable energy equipment, and electrical appliances in households, disaggregated according to urban and rural population segments;
- energy needs, habits, and purchasing preferences of households, disaggregated according to urban and rural population segments;
- frequency of solar product purchases, electrical appliance purchases, and stated willingness to pay, disaggregated according to urban and rural population segments;
- the available vendors and the types and prices of the products offered;
- the conditions for financial products offered by development banks and private entities; and
- access of the residents to financial products and their willingness to use them.

Literature review

The process of data collection and of filling in data gaps was based on an extensive review of relevant studies and available secondary data. The extensive literature review included:

- national energy strategies, energy policies, electricity acts, road maps, and NDCs;
- reports on the national population census and household income and expenditure census;
- the PRIF's *Pacific Infrastructure Performance Indicators 2021 Report*;
- Pacific Power Association (PPA) surveys and benchmarking reports;
- energy and household energy surveys conducted by the United Nations Development Programme (UNDP), Secretariat of the Pacific Community (SPC), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), and PRIF;
- utilities' strategies and reports;
- specific literature prepared by PRIF members addressing the demand for energy services and equipment, including design and evaluation reports of programs and interventions addressing the deployment of solar home systems, energy efficiency, and energy retail on-lending programs;
- reports and information issued by national development banks;
- websites of government departments (e.g., for financial planning, tourism, labor, and industry) and financial entities;
- websites and documentation of dedicated programs supporting energy access and the installation of solar home systems and solar products;
- websites of local vendors and retailers of solar products and electrical appliances;
- relevant non-energy assessments, such as for poverty, gender, and disaster resilience;
- reports on policy initiatives to improve market entry and ease of doing business; and
- a bibliography of secondary data referred to in any of the above sources.

Interviews with regional and national stakeholders

A large number of consultations were carried out through phone calls, video calls, and e-mails with regional and national stakeholders, targeting policymakers from the relevant government offices, utilities, national development banks, private commercial banks, and regional institutions such as the SPC and the PPA. Interviews and consultations aimed at filling in data gaps and at improving the understanding the key constraints and opportunities that should be considered in the demand analysis.

Selection of indicators

Finally, a common set of indicators to facilitate comparison was defined. These indicators are shown in Table 2.

Table 2: Selected Indicators for Demand Comparison

Area of Analysis	Indicators
Demographics/economics	Population, per capita GDP, average income, employment, population under the poverty line
Quality of energy service	Access to electricity, tariffs, interruptions in grid supply
Use of energy in the household	Main type of lighting used, inventory of appliances owned
Demand forecast	Willingness to pay extra for energy-efficient appliances or for better energy service, preferences for the next purchase, timeline for the next purchase, prices of equipment

GDP = gross domestic product.
Source: Pacific Clean Energy Financial Potential project team.

3.2 Analysis of Case Countries

Selection of case countries

Five countries were selected to represent the three Pacific subregions and the different economic levels. The criterion for selection was availability of data and contacts for further consultation. The selected countries are: Cook Islands, Kiribati, Solomon Islands, Tonga, and Vanuatu (Table 3).

Table 3: Selected Countries for Energy Profiles

Region	GDP per Capita in 2019 < $5,000		GDP per Capita in 2019 > $5,000	
	Low	Medium-Low	Medium-High	High
Micronesia	**Kiribati**[a]	Federated States of Micronesia, Republic of Marshall Islands		Nauru, Palau
Melanesia	Papua New Guinea, **Solomon Islands**	**Vanuatu**	Fiji	
Polynesia		Samoa, Tuvalu	**Tonga**[a]	**Cook Islands**, Niue

GDP = gross domestic product.
Note: The selected countries are in bold.
[a] These countries were selected for the validation survey and country energy profile.
Source: Pacific Clean Energy Financial Potential project team.

Validation surveys

Validation surveys were conducted in two countries of different economic levels: Kiribati and Tonga. The contingent valuation approach was selected as the methodology for the survey. This method estimates the value that people place on a particular product through a survey question asking them directly about their willingness to pay for that product.[3] The method is an alternative to inferring the willingness to pay from the behavior of customers observed in more developed markets. However, contingent valuation has its limitations. Some argue that the quality of stated-preference data is inferior to data inferred from market observations. The questions asked in a contingent valuation-based survey are hypothetical, so the answers are hypothetical, as well. Biases are likely to occur when respondents overlook their budget constraints and overstate their willingness to pay for something.[4] In an attempt to better understand the context of consumer behavior and preferences, the surveys carried out in Kiribati and Tonga were underpinned by the following assumptions:

1. The price of a product will impact willingness-to-pay decisions. A price that is higher than a household can afford may have a negative impact on its willingness to pay for the product. The opposite will occur if the price is right for the household.
2. A higher income will have a positive impact on the willingness to pay. The availability of extra cash will strengthen the household's capacity to pay for quality products and services that better meet their energy needs.
3. Age and gender will influence a person's decision to purchase higher-quality products and services. A younger person may be inclined to accept more risk when taking out a loan. Furthermore, women and men have different attitudes towards purchases of energy products and services. Women will be more willing to pay for a new appliance if it will reduce their workload.
4. The distance to markets and availability of repair services also play a role in willingness-to-pay responses.

The validation surveys consisted of two components, which ran parallel to each other:

Component 1: A market and willingness-to-pay survey to measure household preferences regarding the payment of higher prices and the taking out of loans to purchase solar products and energy-efficient appliances. A sample of 3% of all households in selected locations was chosen. The specific areas within the survey locations were chosen on the basis of ease of access and communication. The respondents were chosen through random selection to reduce bias. Specific questionnaire surveys were developed for both rural (off-grid) and urban (grid-connected) areas (Table 4).

Table 4: Topics Covered in Surveys

Urban Grid-Connected (18 Questions)	Rural Off-Grid (23 Questions)
• Socioeconomic data: name,[a] gender, household size, employment, cash income, and expenditure • Appliance inventory; appliance purchases and WTP, including payment type • WTP for repair and maintenance services • Awareness of energy efficiency	• Socioeconomic data: name,[a] gender, household size, income, expenditure • WTP and appliance/equipment ranking • Mobile phone usage and services • Inventory of solar equipment • WTP for repair and maintenance services • Willingness to use financial services

WTP = willingness to pay.
[a] The names of respondents were recorded to identify the origin of data and to be able to follow up if needed.
Source: Pacific Clean Energy Financial Potential project team.

[3] A. Alberini and J Cooper. 2000. Applications of the Contingent Valuation Method in Developing Countries: A Survey. *FAO Economic and Social Development Paper*. No. 146. Rome: Food and Agriculture Organization of the United Nations (FAO).
[4] Science Direct. Contingent Valuation. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/contingent-valuation.

Component 2: Inventory of market and lending services. This includes solar products and energy-efficient appliances that are available in the local market, as well as their costs and suppliers. It also includes the locally available lending agencies and services tailored to solar products and energy-efficient appliances.

Country energy profiles

As is the case for validation surveys, country energy profiles seek to provide a deeper understanding of the market drivers and market barriers that affect the upscale of renewable energy products and energy-efficient appliances. The profiles focus particularly on the following:

- **Stock of household products.** The stock of existing solar products and energy-efficient appliances in surveyed households, and how they are repaired, maintained, and replaced.

- **Size of market.** The number of customers that are willing to purchase solar products and energy-efficient appliances.

- **Market preferences and clean energy awareness.** Households' stated preferences regarding which solar products and energy-efficient appliances they are willing to pay for, in order to enjoy their additional value as a way to improve the households' access to good-quality energy services and to reduce their electricity and/or fossil-fuel expenses.

- **Willingness to pay.** Analysis of income and expenses at the household level (disaggregated according to urban and rural areas), and an estimation of how much households are willing to spend on new or enhanced-quality solar products and energy-efficient appliances.

- **Willingness to take out a loan.** Estimations of the willingness of households to take out loans, and on what conditions.

- **Market overview.** Review of the inventory of solar products and energy-efficient appliances on the market, of available suppliers, and of accessible local lending institutions supporting the penetration of solar products and energy-efficient appliances.

- **Other barriers and challenges.** Specific opportunities for the marketing of solar products and energy-efficient appliances.

Country energy profiles look in detail at the learning experiences and lessons of relevant past and ongoing support programs, and at the challenges households face when trying to obtain adequate clean-energy financing. Special attention was given to those barriers that prevent poor and women-led households from escaping the high levels of energy poverty suffered by most PICs.

3.3 Demand Analysis and Willingness-to-Pay Assessment

Market overview and ownership cost

The regional demand analysis and forecasting are conducted using the same set of indicators identified in the validation surveys and country energy profiles, this time for five selected country case studies, with extrapolations from relevant data and estimations when there was

insufficient national data. The results regarding ownership costs will be extrapolated in order to estimate the costs in the rest of countries. The costs of ownership will be indicative to the extent possible, given the variations in market size and in the market forces influencing consumer behavior.

Assessment of willingness to pay and access to finance

The assessment of willingness to pay and access to finance ranks the preferences for future purchases and the capacity of the population to actually pay for those purchases. The capacity to purchase is assessed against the level of income and accessibility to financial products. Financing requirements and modalities, in particular those for poor households and for female-headed households, are also assessed.

3.4 Discussion and Recommendations

Lessons learned are identified and discussed. Policy and regulatory gaps often affect the possibility of success for interventions promoting off-grid energy solutions and energy efficiency. Those gaps are identified and discussed, as well. Finally, a set of recommendations for future interventions is proposed for discussion with PRIF's Energy Working Group.

4 REGIONAL MARKET ASSESSMENT

4.1 Macroeconomic Overview

Economics and energy access

All 14 countries are characterized by limited income-generation activities, increasing urbanization, dispersed small populations, large households, food insecurity, high impacts of climate change, increasing social inequality, limited access to financial services, and by significant gender inequality. The Federated States of Micronesia, Kiribati, Papua New Guinea, Samoa, Solomon Islands, and Vanuatu are classified as lower middle-income countries; while the Marshall Islands, Tonga, and Tuvalu are classified as upper middle-income; and Fiji, Nauru, and Palau as high-income countries.[5] Most of the 14 national GDPs are small compared with the global average, with Tuvalu's GDP estimated to be the world's smallest.

The Pacific has gone through a second year of economic contraction. The forecast of 1.4% growth estimated by the Asian Development Outlook for 2021 was revised down to –0.6% in the Asian Development Outlook Update. The regional outlook reflects the adverse impact of continuing coronavirus disease (COVID-19) containment measures, particularly border restrictions, on business activities and tourism in the Cook Islands, Fiji, Palau, Samoa, Tonga, and Vanuatu. Economic prospects in Papua New Guinea are weighted down by weak mining and petroleum output, and by a worsening pandemic situation. Exports are small in both value and quantity (primary exports are fish, copra, coconut oil, timber, and kava). Imports, on the other hand, are significant, with all 14 countries relying heavily on imported goods for food, transport, and construction. The region is forecast to rebound once the broader vaccination coverage permits progressive border reopening.

Diesel fuel is the largest and most expensive import and is used widely for energy generation on inner islands and in urban areas. High dependence on imported petroleum fuels and high electricity costs are the main challenges for all 14 countries, restraining economic development. The high cost of electricity suppresses demand; impedes business growth; and contributes to energy poverty in households, which disproportionately affects women. In addition, remittances sent by Pacific workers in Australia and New Zealand have dropped dramatically, particularly for I-Kiribati and Samoan people.

A general overview of the economics and energy access in all 14 countries is presented in Table 5 and 6. The demographic distributions in all the countries show a large share of each country's population living in rural off-grid areas. This makes it pretty clear that distributed energy (micro-grids and mini-grids) and home solar products will continue to play a central role in the Pacific region's electrification strategy. A higher share of renewable electricity production, especially from photovoltaic (PV) cells, is a key goal in all 14 national policies.

Table 5: Overview of Economics and Energy Access in Lower-Income Countries

Item	Low GDP PC			Medium-Low GDP PC				
	KIR	PNG	SOL	FSM	RMI	SAM	TUV	VAN
Population	119,940	7,275,324	712,071	115,021	54,590	198,646	10,580	300,019
GDP PC ($)	1,671	2,636	2,295	3583	4,073	4,284	4,223	3,260
Access to electricity (%)	91	47	57	68	99	98	100	64

[5] World Bank. The World by Income and Region. https://datatopics.worldbank.org/world-development-indicators/the-world-by-income-and-region.html (accessed 25 February 2022).

Access to grid electricity (%)	38	15	14	55	69	98	98	30
Access to off-grid electricity (%)	53	32	43	12	29	0	1	98
Urban								
Population	66,405	…	…	26,378	40,943	37,567	…	66,753
Number of Households	9,576	…	…	38,02	…	5,849	…	14,702
Access to grid electricity (%)	88	73	70	85	99	10	99	
Rural								
Population	53,535	…	…	88,643	13,648	161,860	…	233,266
Number of Households	12,283	…	…	…	…	23,380	…	48,663
Access to off-grid electricity (%)	94	45	54	63	…	98	100	…

… = no data available, FSM = Federated States of Micronesia, GDP PC = gross domestic product per capita, KIR = Kiribati, PNG = Papua New Guinea, RMI = Republic of the Marshall Islands, SAM = Samoa, SOL = Solomon Islands, TUV = Tuvalu, VAN = Vanuatu.

Sources: Country censuses; Pacific Region Infrastructure Facility (PRIF) and Pacific Community. 2021. *Pacific Infrastructure Performance Indicators 2021*. Sydney: PRIF Coordination Office; Secretariat of the Pacific Community; World Bank.

Table 6: Overview of Economics and Energy Access in Higher-Income Countries

Item	Medium-High GDP PC		High GDP PC			
	FIJ	TON	COO	NAU	NIU	PAL
Population	864,132	100,651	17,434	10,764	1,695	21,516
GDP PC ($)	4,881	5,081	10,649	10,983	16,551	17,280
Access to electricity (%)	96	98	99	99	100	99
Access to grid electricity (%)	80	93	96	99	98	98
Access to off-grid electricity (%)	16	6	3	0	1	0
Urban						
Population	477,500	23,221	13,007	…	…	14,334
Households	109,828	4,184	3,386	…	…	4,961
Access to grid electricity (%)	98	99	96	…	…	…
Rural				…	…	
Population	386,682	77,430	4,427	…	…	3,247
Households	89,860	14,041	1,257	…	…	985
Access to off-grid electricity (%)	…	98	3	…	…	…

… = no data available, COO = Cook Islands, FIJ = Fiji, GDP PC = gross domestic product per capita, NAU = Nauru, NIU = Niue, PAL= Palau, TON = Tonga.

Sources: Country censuses; Pacific Region Infrastructure Facility (PRIF) and Pacific Community. 2021. *Pacific Infrastructure Performance Indicators 2021*. Sydney: PRIF Coordination Office; Secretariat of the Pacific Community; World Bank.

4.2 Characteristics of the Energy Sector

Electricity generation, transmission, and distribution are for most of the Pacific region not unbundled. Urban areas are grid-connected and served by utilities, most of them public. Those utilities maintain and operate the distribution and transmission grids, and they own most of the power-generation units within their areas of concession.

The high generation costs for most utilities are mainly a result of system inefficiency and the high costs of diesel imports. The size and general characteristics of the grids in the Pacific region vary widely, as illustrated in Tables 7 and 8. Despite these differences, they all have in common high retail electricity tariffs. Technical losses in all the distribution grids are relevant, revealing suboptimal maintenance and poor expansion and upgrade planning, mostly due to a lack of economic resources. The Marshall Islands has the highest distribution losses in the region in terms of the percentage of electricity delivered to the distribution system. Grid-electricity tariffs in all 14 countries, with the exception of Fiji, are among the highest in the world. This is largely due to the high share of diesel generation and low economies of scale. Solar potential is good or excellent throughout the Pacific region.

Rural areas and outer islands are served by off-grid solutions, including solar lamps and chargers, solar home systems, small diesel and petrol generators, and solar micro-grids and mini-grids.

The combination of high dependance on fossil fuels, high costs of power generation, and poor-quality power supply makes the case for decisive efforts to achieve more renewable energy on the supply side, and energy efficiency on the demand side, as a pathway toward sustainable growth. All else being equal, such as regional and regulatory risk, the potential for renewable energy investments should look attractive when grids are prepared to handle renewables intermittency. The technology uptake in the region has accelerated since 2010, thus facilitating the transition from fossil fuel technologies to a renewable and energy-efficient future. A host of clean technologies - such as hydro, solar, wind, and biomass - are currently being deployed across the region. Fiji, Papua New Guinea, Samoa, and the Solomon Islands have good hydro resources, while wind technology is being harnessed in the Cook Islands and Vanuatu. Solar energy is the most abundant resource in the region, and is harnessed by all the Pacific countries for grid and off-grid electricity generation. The capacity of grid-connected PV solar systems has grown significantly, and wind farms are not far behind. In particular, the commercial potential of PV systems is especially good in all 14 countries because PV solar energy could displace diesel to supply daytime peak loads.

Table 7: Energy Sector Characteristics in Lower-Income Countries

	Low GDP PC			Medium-Low GDP PC				
Item	KIR	PNG	SOL	FSM	RMI	SAM	TUV	VAN
Peak demand (MW)	4.9	…	…	12.23	9	…	…	…
Installed capacity (kW per capita)	0.07	0.07	0.04	0.36	0.39	0.26	0.31	0.09
Electricity production (GWh/year)	32.99	1,500	98.95	71.95	80.1	192.41	9.65	59.74
Share of renewable energy in produced electricity (%)	7	45	2	7	3	44	16	15

SAIFI (number of interruptions/ customer/year)	2.2	…	8.5	31.4	13.1	11.7	1.5	246
SAIDI (minutes/ customer/year)	0.4	…	1,146.9	2,287.1	1,146.9	1,439.5	5.9	0.03
Average tariff ($/kWh)	…	…	…	…	…	…	…	…
Residential	0.25	0.20	0.72	0.44	0.34	0.26	0.29	0.72
Commercial	0.39	0.28	0.79	0.48	0.41	0.29	0.39	0.41
Industrial	0.49	0.28	0.79	0.49	0.41	0.29	0.39	0.41
Government	0.39	0.28	0.79	…	0.42	0.29	0.39	0.41

… = no data available, FSM = Federated States of Micronesia, GDP PC = gross domestic product per capita, GWh = gigawatt-hour, KIR = Kiribati, kW = kilowatt, kWh = kilowatt-hour, MW = megawatt, PNG = Papua New Guinea, RMI = Republic of the Marshall Islands, SAIDI = system average interruption duration index, SAIFI = system average interruption frequency index, SAM = Samoa, SOL = Solomon Islands, TUV = Tuvalu, VAN = Vanuatu.
Sources: Pacific Power Association (PPA). 2019. *Pacific Power Utilities Benchmarking Report: Fiscal Year 2019*. Suva, Fiji: PPA; Pacific Regional Infrastructure Facility (PRIF) and the Pacific Community. 2017. *Pacific Infrastructure Performance Indicators 2017*. Sydney: PRIF Coordination Office; utilities reports.

Table 8: Energy Sector Characteristics in Higher-Income Countries

Item	Medium-High GDP PC		High GDP PC			
	FIJ	TON	COO	NAU	NIU	PAL
Peak demand (MW)	123.23	11.03	5.13	5.3	…	…
Installed capacity (kW/capita)	0.35	0.18	0.88	0.61	…	1.67
Electricity production (GWh/year)	977	73.2	31.2	39.2	…	82.6
Share of renewable energy in produced electricity (%)	64	13	14	8	2	2
SAIFI (number of interruptions/ customer/year)	4.5	6.8	1.2	42	…	
SAIDI (minutes/ customer/year)	1,921	625.4	31.5	5.1	…	0.1
Av. tariff ($/kWh)	…	…	…	…	…	…
Residential	0.16	0.33	0.47	0.26	0.40	0.26
Commercial	0.19	0.33	0.52	0.49	0.40	0.31
Industrial	0.19	0.33	0.52	0.49	0.40	0.31
Government	0.19	0.33	0.52	0.49	0.40	0.31

… = data not available, COO = Cook Islands, FIJ = Fiji, GDP PC = gross domestic product per capita, kW = kilowatt, kWh = kilowatt-hour, MW = megawatt, NAU = Nauru, NIU = Niue, PAL= Palau, SAIDI = system average interruption duration index, SAIFI = system average interruption frequency index, TON = Tonga.
Sources: Pacific Power Association (PPA). 2019. *Pacific Power Utilities Benchmarking Report: Fiscal Year 2019*. Suva, Fiji: Pacific Regional Infrastructure Facility (PRIF) and the Pacific Community. 2021. *Pacific Infrastructure Performance Indicators 2017*. Sydney: PRIF Coordination Office; utilities reports

4.3 Energy Poverty

Despite the important progress since 2000 in improving energy access in the Pacific region, the PICs still suffer from chronic energy poverty. Throughout the region, chronic energy poverty is not only due to insufficient power supplies, high tariffs, and the lack of new investments. It is also the result of the low, irregular incomes of a large part of the population. Household expenditure data reveals what households choose to spend their limited resources on, and how much they choose to spend. The review of survey results and secondary data done for this study showed that urban households in the Pacific spend an average of about 40% of their income on food. Spending is also high for transportation and utility bills.

A regular monthly income (e.g., income from formal full-time employment) is an indicator of a household's wealth and ability to buy goods and services, including energy services. However, the rate of formal employment among rural households is low to very low across all 14 countries.

The rural population across the Pacific region is operating in a subsistence economy, with most people having informal employment, being self-employed, or simply being fully unemployed. Most rural households in the region, where formal employment is very low, rely on more than one source of income to sustain their needs. These sources usually include frequent remittances from family members working abroad (mostly in Australia and New Zealand) and informal economic activities such as micro-farming, selling the fish catch of the day, and producing handicrafts. This irregularity of these incomes also makes it very difficult for households to plan and prepare a household budget, and spend money effectively. A World Bank report from 2020[6] analyzed the income effects of COVID-19 across the Pacific region. Among the nationalities surveyed, Samoan and I-Kiribati workers in Australia and New Zealand had the highest number of reported reductions in their earnings, at 86% and 77%, respectively. Unsurprisingly, about 75% of I-Kiribati workers reported sending home lower remittances.

In the Pacific region, low incomes make it practically impossible for most households to accumulate any relevant savings. The lack of savings affects the household's ability to purchase new appliances (such as energy-efficient refrigerators, freezers, air conditioners, etc.) and the willingness to pay for energy-efficient appliances and renewable-energy equipment. A low and irregular income means that households have limited ability to meet its basic needs for food and shelter, and larger risk of suffering energy poverty. The irregularity in income makes it very difficult for households to plan and prepare a household budget, and spend money effectively. Female-headed households are common, representing around one in five households across the Pacific and are more affected by lower income, primarily due to men having more opportunities to work overseas. Lower and irregular income means larger risk of suffering energy poverty since alternatives for self-production of energy to overcome energy poverty cannot be realized.

Tables 9 and 10 show the income situation in all 14 countries. Literature reviewed and surveys analyzed indicate that there is a large difference between the incomes of urban and rural populations in high-income and upper-middle-income countries, where urban households tend to be affluent and have access to broader energy services. The income difference almost vanishes in countries with lower GDPs per capita, as revealed in the survey carried out in Kiribati under this study. This situation reflects the greater risk of energy poverty among the urban populations in lower-GDP countries, compared with the urban populations in the wealthier countries.

[6] World Bank. 2020. *Pacific Labor Mobility, Migration and Remittances in times of COVID-19: Interim Report.* https://documents1.worldbank.org/curated/en/430961606712129708/pdf/Pacific-Labor-Mobility-Migration-and-Remittances-in-Times-of-COVID-19-Interim-Report.pdf.

Table 9: Income Situation in Lower-Income Countries

Item	Low GDP PC			Medium-Low GDP PC				
	KIR	PNG	SOL	FSM	RMI	SAM	TUV[a]	VAN
Household income ($/year)	6,264	1,790	2,370	2,408	5,010	4,070	1,924	8,364
Population under the poverty line (%)	…	37.5	…	41.2	7.9	…	…	…
Urban								
Population under the poverty line (%)	…	…	…	34	…	…	…	…
Household income ($/year)	8,827	…	…	13,090	…	…	14,897	10,260
Rural								
Population under the poverty line (%)	…	…	…	66	…	…	…	…

… = data not available, FSM = Federated States of Micronesia, GDP PC = gross domestic product per capita, KIR = Kiribati, PNG = Papua New Guinea, RMI = Republic of the Marshall Islands, SAM = Samoa, SOL = Solomon Islands, TUV = Tuvalu, VAN = Vanuatu.

[a] Tuvalu data on household income was taken from the Tuvalu Household Income and Expenditure Survey (HIES) report. The average income per capita is AUD$2,700, and the household income average is AUD$16,080.

Table 10: Income Situation in Higher-Income Countries

Item	Medium-High GDP PC		High GDP PC			
	FIJ	TON	COO	NAU	NIU	PAL
Household income ($/year)	12,159	2,592	34,422	9,554	22,068	25,600
Population under the poverty line (%)	29.9	27.0		24.0	15.0	…
Urban						
Population under the poverty line (%)	37.8	…	…	…	…	…
Household income ($/year)	14,128	16,386	37,502	…	…	26,290
Rural						
Population under the poverty line (%)	62.2	…	…	…	…	…

… = no data available, COO = Cook Islands, FIJ = Fiji, GDP PC = gross domestic product per capita, NAU = Nauru, NIU = Niue, PAL= Palau, TON = Tonga.
Note: A blank cell indicates that the column head does not apply.
Sources: World Bank. *Household Income and Expenditure Survey (HIES)* (2 years: 2020–2021).

4.4 Product Inventory

Not every household in the grid-connected urban areas have a refrigerator, a freezer, a television (TV), or a washing machine. Tables 11 and 12 show the inventory of appliances for households in all 14 countries. Most of the purchased and used appliances were fans, TVs, refrigerators, and freezers. Operating these appliances contributes to enhancing household well-being in terms of reducing the stresses of daily demands.

Table 11: Grid-Connected Households Using Appliances in Lower-Income Countries (%)

Appliance	Low GDP PC			Medium-Low GDP PC				
	KIR	PNG	SOL	FSM	RMI	SAM	TUV	VAN
Fan	82	89	82			90	91	80
Refrigerator	36	68	78			76	45	80
Freezer	68	35	28			36	53	55
Washing machine	48	62	23			65	67	51
Air conditioner	7	35	11			68	3	31
Television	56	82	67			94	44	80
Desktop/laptop computer	41							
Solar water heater	2		13					
Solar water pump								

FSM = Federated States of Micronesia, GDP PC = gross domestic product per capita, KIR = Kiribati, PNG = Papua New Guinea, RMI = Republic of the Marshall Islands, SAM = Samoa, SOL = Solomon Islands, TUV = Tuvalu, VAN = Vanuatu.
Note: A blank cell indicates that the column head does not apply.
Sources: National censuses for 2020–2021; Secretariat of the Pacific Community. 2017. *Minimum Energy Performance Standards and Labelling Study.* Suva, Fiji; United Nations Development Program (UNDP) 2016. *Energy Survey*. New York.

Table 12: Grid-Connected Households Using Appliances in Higher-Income Countries (%)

Item	Medium-High GDP PC		High GDP PC			
	FIJ	TON	COO	NAU	NIU	PAL
Fan	81	57	84	96	84	98
Refrigerator	93	55	89	67	98	85
Freezer	24	40	78	66	82	NA
Washing machine	88	89	90	71	92	92
Air conditioner	20	15	8	64	10	45
Television	95	76	93	85	85	80
Desktop/laptop computer		67	81	54	49	20
Solar water heater	16		37	11		
Solar water pump						

COO = Cook Islands, FIJ = Fiji, GDP PC = gross domestic product per capita, NAU = Nauru, NIU = Niue, PAL= Palau, TON = Tonga.
Note: A blank cell indicates that the column head does not apply.
Sources: National censuses for 2020–2021; Secretariat of the Pacific Community. 2017. *Minimum Energy Performance Standards and Labelling Study.* Suva, Fiji; United Nations Development Program (UNDP) 2016. *Energy Survey*. New York.

The stock of appliances in countries with lower GDPs include fans (82% to 91%), refrigerators and freezers (53% to 80%), televisions (44% to 94%), and washing machines (23% to 67%). Very few of them have air conditioners, with the exception of Samoa. The appliances used more in countries with higher GDPs include fans (57%-98%), refrigerators and freezers (55% to 98%), TVs (76% to 95%), and washing machines (71% to 92%). In this group of countries, air conditioners are more popular, and are used in 8% to 64% of households. Two-thirds of all major appliances in urban areas were purchased within the prior five years. A large number

of old appliances are still running. There is a strong sentiment in the majority of households against replacing appliances until they can no longer be fixed.

Linear fluorescent lights have long been considered in the Pacific region as offering the best quality lighting. According to surveys by the Pacific Community, and two surveys conducted under this study, linear fluorescent lights are still more popular in countries with lower GDPs, while the use of LEDs is slowly increasing in countries with higher GDPs (Tables 13 and 14).

Table 13: Types of Lighting Used in Households in Lower-Income Countries (%)

Type	Low GDP PC			Medium-Low GDP PC				
	KIR	PNG	SOL	FSM	RMI	SAM	TUV	VAN
LED Flat Light (LFL)	89	96	69			80	59	69
Compact Fluorescent Lamp (CFL)	68	10	78			59	65	78
Light Emitting Diode (LED)	15	5	25			13	14	15

FSM = Federated States of Micronesia, GDP PC = gross domestic product per capita, KIR = Kiribati, PNG = Papua New Guinea, RMI = Republic of the Marshall Islands, SAM = Samoa, SOL = Solomon Islands, TUV = Tuvalu, VAN = Vanuatu.
Note: A blank cell indicates that the column head does not apply.
Sources: National censuses for 2020–2021; Secretariat of the Pacific Community. 2017. *Minimum Energy Performance Standards and Labelling Study.* Suva, Fiji; United Nations Development Program (UNDP) 2016. *Energy Survey*. New York.

Table 14: Types of Lighting Used in Households Using in Higher-Income Countries (%)

Type	Medium-High GDP PC		High GDP PC			
	FIJ	TON	COO	NAU	NIU	PAL
LED Flat Light (LFL)	77	86	64	56	66	
Compact Fluorescent Lamp (CFL)	75	57	89	40	96	
Light Emitting Diode (LED)	30	6	16	…	16	

… = no data available, CFL = compact fluorescent lamp, COO = Cook Islands, FIJ = Fiji, GDP PC = gross domestic product per capita, NAU = Nauru, NIU = Niue, PAL= Palau, TON = Tonga.
Note: A blank cell indicates that the column head does not apply.
Sources: National censuses for 2020–2021; Secretariat of the Pacific Community. 2017. *Minimum Energy Performance Standards and Labelling Study.* Suva, Fiji; United Nations Development Program (UNDP) 2016. *Energy Survey*. New York.

There is no available data on the solar equipment stock in rural areas. However, and despite the lack of savings, most rural off-grid households own at least one mobile phone and aspire to purchase energy-efficient appliances and renewable-energy products, as revealed by the surveys carried out in Kiribati and Tonga households.

4.5 Demand Forecasting

Energy-efficient appliances

According to different surveys, the large majority of households indicated that they considered future purchases. However, only a small percentage were able to estimate a date of purchase. A common answer was that new appliances will be bought when the current ones no longer work and cannot be repaired. On average, 20% to 40% of households thinking about their

next purchase want to make that purchase within the next 6 months, and 15% to 30% within the next 12 months (Tables 15 and 16).

Table 15: Timing of Next Purchase for Grid-Connected Households in Lower-Income Countries (%)

Timing	Low GDP PC			Medium-Low GDP PC				
	KIR	PNG	SOL	FSM	RMI	SAM	TUV	VAN
<6 months	32	40	29			44	35	38
Within 1 year	22	22	26			12	15	29
Do not know	46	38	45			44	50	33

FSM = Federated States of Micronesia, GDP PC = gross domestic product per capita, KIR = Kiribati, PNG = Papua New Guinea, RMI = Republic of the Marshall Islands, SAM = Samoa, SOL = Solomon Islands, TUV = Tuvalu, VAN = Vanuatu.
Note: A blank cell indicates that the column head does not apply.
Sources: Secretariat of the Pacific Community. 2017. *Minimum Energy Performance Standards and Labelling Study.* Suva, Fiji; Kiribati data source from WTP and Markey Survey 2021.

Table 16: Timing of Next Purchase for Grid-Connected Households of Higher-Income Countries (%)

Timing	Medium-High GDP PC		High GDP PC			
	FIJ	TON	COO	NAU	NIU	PAL
<6 months	58	35	22		23	
Within 1 year	34	24	26		46	
Don't know	8	41	52		31	

COO = Cook Islands, FIJ = Fiji, GDP PC = gross domestic product per capita, NAU = Nauru, NIU = Niue, PAL= Palau, TON = Tonga.
Note: A blank cell indicates that the column head does not apply.
Sources: Secretariat of the Pacific Community. 2017. *Minimum Energy Performance Standards and Labelling Study.* Suva, Fiji; Tonga data source from WTP and Market Survey 2021.

Freezers and refrigerators, washing machines and televisions are the most preferred appliances for next purchase among urban households (Tables 17 and 18). However, a large number of their past purchases have been based on the lowest price, rather than on the energy performance of the appliance or on other technology benefits. Strengthening energy labelling and, where possible, restricting imports of low-energy-performance equipment would help to develop the market for energy-efficient appliances.

Table 17: Next Purchase for Grid-Connected Households in Lower-Income Countries(%)

Appliance	Low GDP PC			Medium-Low GDP PC				
	KIR	PNG	SOL	FSM	RMI	SAM	TUV	VAN
Television	6	8	19			5	20	10
Refrigerator	5	11	15			8	3	5
Freezer	18	11	16			12	18	7
Washing machine	25	14	11			18	18	8
Air conditioner	1	4	2			18	6	5

FSM = Federated States of Micronesia, GDP PC = gross domestic product per capita, KIR = Kiribati, PNG = Papua New Guinea, RMI = Republic of the Marshall Islands, SAM = Samoa, SOL = Solomon Islands, TUV = Tuvalu, VAN = Vanuatu.
Note: A blank cell indicates that the column head does not apply.
Sources: Secretariat of the Pacific Community. 2017. *Minimum Energy Performance Standards and Labelling Study.* Suva, Fiji; Kiribati Data source from WTP and Market Survey 2021.

Table 18: Next Purchase for Grid-Connected Households of Higher-Income Countries (%)

Appliance	Medium-High GDP PC		High GDP PC			
	FIJ	TON	COO	NAU	NIU	PAL
Television	6	10	8		12	
Refrigerator	7	8	13		10	
Freezer	8	7	11		6	
Washing machine	7	5	12		22	
Air conditioner	5	2	7		8	

COO = Cook Islands, FIJ = Fiji, GDP PC = gross domestic product per capita, NAU = Nauru, NIU = Niue, PAL= Palau, TON = Tonga.
Note: A blank cell indicates that the column head does not apply.
Sources: Secretariat of the Pacific Community. 2017. *Minimum Energy Performance Standards and Labelling Study.* Suva, Fiji; Tonga data source from WTP and Market Survey 2021.

Solar equipment

Cheaper and more long-lasting solar lamps are the most preferred technology in the Pacific region, by both urban and rural households. Adequate lighting is considered to be very important by households in both urban and rural areas. In particular, rural households rank solar lighting units as their number-one priority, compared with other equipment and appliances. Almost every rural household owns one or more solar lanterns, as they allow more hours for reading and studying, and enable more comfortable dining, entertainment, and socialization. Urban households use solar-lighting kits to light the exterior of their houses, and portable ones to walk in nearby streets, as lighting is inadequate or nonexistent in many places.

Regarding solar home systems and DC-current appliances, mini-solar home systems, with less than 100 Wp, and solar home systems with 150 Wp for basic lighting and charging are the most preferred by the rural population. This equipment is becoming more affordable for rural households, and it is taking over the rural markets in the Melanesian countries,[7] where the rural population is significantly high. The next most popular technologies are medium-sized solar systems with up to 1,000 Wp (for households or micro-grids) and DC-current appliances such as small fans and TV screens. These systems are also commonly used for micro business ventures by rural and remote island women.

Finally, fishing cooperatives, community centers and, in some cases, large higher-income households demand solar freezers with capacities of more than 300 liters, as well as small and medium-sized solar water pumps. These investments are usually linked to economic or community activities.

4.6 Purchasing Power and Willingness to Pay

The average and median low-income levels make it practically impossible for the majority of population in most of the 14 countries to accumulate any relevant savings. The lack of savings severely affects a household's ability to purchase new appliances and the household's willingness to pay. These are constraints that must be fully noted when planning financing facilities.

[7] Specifically, these countries are Papua New Guinea, Solomon islands, and Vanuatu.

Willingness to pay is a positive experience for energy consumers and households with access to resources. Despite low or no savings, many households in urban areas (grid-connected) have expressed in the surveys their willingness to pay for energy-efficient appliances: in particular, the younger population of upper-income countries. The majority of people in the 20–40 age range living in urban areas of upper-income countries are willing to pay more, compared with only a slight majority observed in the 31-50 age range in lower-income countries. This observation seems to reveal more cautiousness and distrust in lower-income countries regarding the economic benefits of energy-efficient appliances.

The survey in Kiribati revealed that about 73% of grid-connected households are willing to pay an additional price for energy-efficient appliances. About 19% of respondents stated that they would be willing to pay up to 5% more. As many as 36% households stated their willingness to pay up to 10% extra, while 20% were willing to pay 20% extra. It was observed that their preferences had a strong link to their monthly incomes.

The survey also revealed that up to 41% of urban households would consider taking out a loan for purchasing energy-efficient appliances. However, rural households are more reluctant to take out loans. This may be explained by the many challenges they face in getting their loans approved, and their reluctance to become indebted.

4.7 Community Awareness

The analysis of different surveys conducted in urban grid-connected areas, including the surveys conducted under this study in Kiribati and Tonga, concluded that awareness about energy efficiency in appliances is medium to high across the region (Tables 19 and 20), though it was observed that awareness declines with age. Specific awareness of energy labels grows with GDP per capita. People in Kiribati, Papua New Guinea, and Tuvalu have a moderate awareness of star energy labelling in appliances. The exception in the group of countries with low GDPs per capita is Vanuatu, where 94% of the population is aware of energy labelling. This is explained by Vanuatu's Energy Efficiency Act of 2017, which established technical standards for refrigeration, air conditioning, and lighting products. These standards are based on the minimum energy performance standards in Australia and New Zealand and were developed with assistance from the Pacific Community. Only compliant products and equipment can be imported into the country. Compliant equipment and products are registered online in the Pacific Appliance Database (PAD). Awareness of energy labelling is very high in most countries with higher GDP per capita. Almost universal awareness exists in the Cook Islands, Fiji, and Niue. The exception is Tonga, which shows a similar awareness level to those of Kiribati and Papua New Guinea.

Simply being aware of energy efficiency and energy labelling is not sufficient. More than 30% of the population of Kiribati, Papua New Guinea, Samoa, and Tuvalu (all belonging to the low GDP per capita group) incorrectly understood the messages on the labels. They wrongly thought that more stars meant more energy consumption. Less than 20% of the population in Vanuatu and in countries with higher GDP per capita have this distorted perception of energy labelling.

Table 19: Awareness and Understanding of Energy Labels in Lower-Income Countries (%)

Item	Low GDP PC			Medium-Low GDP PC				
	KIR	PNG	SOL	FSM	RMI	SAM	TUV	VAN
Aware of labels	66	65	77			87	57	94
Get info right	65	65	75			53	67	73
Misunderstand message	33	30[a]	21			41	31	16
Know how to use labels	14	Low [b]	Low[b]			Low[b]	22	Low[b]
Read labels when purchasing	55	Low[b]	77			Low[b]	47	61

FSM = Federated States of Micronesia, GDP PC = gross domestic product per capita, KIR = Kiribati, PNG = Papua New Guinea, RMI = Republic of the Marshall Islands, SAM = Samoa, SOL = Solomon Islands, TUV = Tuvalu, VAN = Vanuatu.
Note: A blank cell indicates that the column head does not apply.
[a] This value is an approximation.
[b] There was insufficient data for determining the actual values.
Sources: National censuses for 2020–2021; Secretariat of the Pacific Community. 2017. *Minimum Energy Performance Standards and Labelling Study.* Suva, Fiji; United Nations Development Program (UNDP) 2016. *Energy Survey*. New York.

Table 20: Awareness and Understanding of Energy Labels in Higher-Income Countries (%)

Item	Medium-High GDP PC		High GDP PC			
	FIJ	TON	COO	NAU	NIU	PAL
Aware of labels	99	67	91		100	
Get info right	82	80	79		88	
Misunderstand message	18	20	17		12	
Know how to use labels	20	Low[a]	51		Low[a]	
Read labels when purchasing	70[b]	Low[a]	43		Low[a]	

COO = Cook Islands, FIJ = Fiji, GDP PC = gross domestic product per capita, NAU = Nauru, NIU = Niue, PAL= Palau, TON = Tonga.
Note: A blank cell indicates that the column head does not apply.
[a] There was insufficient data for determining the actual values.
[b] This value is an approximation.
Sources: National censuses for 2020–2021; Secretariat of the Pacific Community. 2017. *Minimum Energy Performance Standards and Labelling Study.* Suva, Fiji; United Nations Development Program (UNDP) 2016. *Energy Survey*. New York.

The vast majority of people (>80%) in most Pacific region countries do not know how to use the information communicated by energy labels to calculate their energy consumption. The exception is the Cook Islands, where 51% of the surveyed residents stated that they knew how to use this information. Awareness and education initiatives will have a positive impact on these households, especially if they are supported by a rebate scheme for the very poor ones.

The use of labels as decision factor for next purchases is not homogeneous across the region. More than 50% of the urban population in Fiji, Kiribati, the Solomon Islands, and Vanuatu believe that labels will be a decision factor in their next purchases. In the Cook Islands, 41% considered price to be the most important consideration, so price incentives for energy-efficient appliances may be attractive to those households.

For the rest of countries in the region, labels seem not to be a decision factor. In surveys, respondents from the other countries said that they could only buy what they could afford, thus indicating that budget constraints were the most significant barrier when making a purchase.

4.8 Product Supply and Cost of Ownership

Vendors and repair services

There are a limited number of operators in the region, so monopolies are common, leading to higher costs of services. All 14 countries have private local retailers, installers, and maintenance services available for clean energy products, mostly in the capital cities and largest cities. Most of the products offered have been procured from Australia, Fiji, Malaysia, New Zealand, and the People's Republic of China. These vendors eventually sell their products to outer islands on demand.

There are also in all 14 countries private electricians providing installation, repair, and maintenance services to households and private businesses, including community facilities. Some retailers also provide installation and repair services. However, in general these services are not sufficient to meet the demand, particularly the demand in outer islands.

With the exception of Fiji and Vanuatu, there is limited control over the quality of imported renewable-energy products and appliances. Imported equipment and appliances do not have to meet energy label or similar standards. Therefore, the market offers a mix of efficient and cheaper inefficient appliances. Import licenses for refrigerators, air conditioners, and lighting equipment imported into Vanuatu are issued only to importers of products that comply with Australian and New Zealand minimum energy performance standards.

Cost of ownership

The costs of energy-efficient appliances (over three stars on energy labels) and of solar products differ widely among countries and among retailers within a country. The cost of spare parts can make repairs not only expensive, but also time-consuming due to the long delays until they arrive from abroad. Costs also vary during the year, as they also respond to retailing opportunities found by vendors. With these uncertainties, it is a challenge to determine the cost of ownership. Several factors contribute to forming the overall cost of ownership of solar equipment or an electrical appliance. These include the:

- purchase price, which reflects the product value, taxes, and profit margin;
- cost of delivery and installation;
- cost of operation, repairs, and maintenance over the appliance's life-span;
- cost of insurance; and
- the cost of disposal of certain appliances and equipment.

The cost of owning a refrigerator includes its purchase price, the cost of delivery and installation, insurance, and repairs during its 10-year lifetime. An energy-efficient appliance will have a lower cost of ownership value compared with that of an inefficient one. Most consumers seem to understand this concept, but their purchasing decisions are often affected by the appearance of appliances with low initial costs (that may have low energy performance and/or higher operation costs and shorter life cycles). Different types of technology will incur different costs of ownership, so more attention should be given to improving the process and experience of ownership for all energy consumers.

Consumers are likely to compare prices based on the cost of ownership as an initial decision, rather than comparing technology features and benefits. Educating consumers about different types of technologies, and the benefits of higher energy performance, will help to change the culture, decision-making, and evaluation process that influence consumer choices.

As noted above, it is difficult to determine the costs of energy-efficient appliances and of solar products because they are affected by several factors. Nevertheless, indicative estimations of the initial costs of energy-efficient appliances, based on the real prices offered by vendors and on proxies to translate those prices to other countries, have been calculated and presented in Tables 21 and 22. In the same way, indicative estimations of the initial costs of solar products are presented in Tables 23 and 24. These estimations are also based on the real prices offered by vendors and on proxies to translate the costs into prices in other countries.

Table 21: Estimated Costs of Energy-Efficient Appliances in Lower-Income Countries (US$)

Appliance	Low GDP PC			Medium-Low GDP PC				
	KIR	PNG	SOL	FSM	RMI	SAM	TUV	VAN
Refrigerator	1,349	1,798	1,124	1,495	1,517	838	1,292	1,180
Freezer	328	474	296	394	400	409	340	311
Washing machine	443	590	369	491	498	461	424	387
Air conditioner	611	814	509	677	687	559	585	534
Fan	78	104	65	86	88	81	75	68
Television	511	629	393	523	531	491	452	413
Laptop/desktop	611	814	509	677	636	703	585	534

FSM = Federated States of Micronesia, GDP PC = gross domestic product per capita, KIR = Kiribati, PNG = Papua New Guinea, RMI = Republic of the Marshall Islands, SAM = Samoa, SOL = Solomon Islands, TUV = Tuvalu, VAN = Vanuatu.
Note: “Energy-efficient” is defined as having more than three stars on the appliance label.
Sources: Compilation of prices from local suppliers and estimates by consultants.

Table 22: Estimated Costs of Energy-Efficient Appliances in Higher-Income Countries (US$)

Appliance	Medium-High GDP PC		High GDP PC			
	FIJ	TON	COO	NAU	NIU	PAL
Refrigerator	1,124	1,461	1,083	1,383	1,191	1,472
Freezer	296	385	1,070	337	1,265	388
Washing machine	369	480	961	454	1,057	738
Air conditioner	509	662	1,564	626	1,720	667
Fan	65	85	101	80	111	85
Television	393	511	1,022	483	1,124	515
Laptop/desktop computer	509	662	1,401	626	1,541	667

COOK = Cook Islands, FIJ = Fiji, GDP PC = gross domestic product per capita, NAU = Nauru, NIU = Niue, PAL= Palau, TON = Tonga.
Note: “Energy-efficient” is defined as having more than three stars on the appliance label.
Sources: Observations at stores and estimates by consultants.

Table 23: Estimated Costs of Solar Products in Lower-Income Countries (US$)

Solar Product	Low GDP PC			Medium-Low GDP PC				
	KIR	PNG	SOL	FSM	RMI	SAM	TUV	VAN
Mini-solar home system (<100 Wp)	352	210	261	322	256	379[a]	247	455
Solar kit for basic lighting/ charging (150 Wp)			800			170		740
Prewired solar set (500W, 12V)	1,835	1,,841	1,845					1,146[b]
Solar water heater	1,768	1,783	1,796	1,541	1,902		1,204	
Solar lighting kit	126	108						175
Solar water pump (32 LPM)	280							
Small solar water pumping kit	720	850	1,249	767				
Medium solar water pump	902		2,889					2,466
Hybrid air conditioner	1,750							
Solar freezer (vaccine)				906				
Solar freezer (170 liter)		1,490[c]	2,670					2,152[d]
Solar freezer (340 liter)	2,585	3,159[e]						3,167[f]
Solar freezer (433 liter)			4,650		5,311	5,215	5,263	5,260
Solar washing machine (300 liter)	3,310							

FSM = Federated States of Micronesia, GDP PC = gross domestic product per capita, KIR = Kiribati, LPM = liters per minute, PNG = Papua New Guinea, RMI = Republic of the Marshall Islands, SAM = Samoa, SOL = Solomon Islands, TUV = Tuvalu, V = volt, VAN = Vanuatu, W = watt, Wp =Watt peak, V = volt.

[a] 100 Wp system.
[b] 400 Wp solar set.
[c] 158-liter freezer capacity.
[d] 166-liter freezer capacity, available in local markets.
[e] 358-liter freezer capacity.
[f] 240-liter freezer capacity.

Sources: Compilations from various suppliers' and retailers' websites, Facebook pages, and observations at stores.

Table 24: Estimated Cost of Solar Products in Higher-Income Countries (US$)

Solar Product	Medium-High GDP PC		High GDP PC			
	FIJ	TON	COO	NAU	NIU	PAL
Mini-solar home system	211	235			253	220
Solar kit basic lighting/ charging (150 Wp)	184					
Prewired solar set (500W, 12V)	2,000[a]					
Solar water heater	1,304	1,848	1,430	1,799	1,644	1,540
Solar lighting kit	65–193					

Solar water pump (32 LPM)						
Small solar water pump	601	739	720	724	761	
Medium solar water pump	877	1,829	987			982
Hybrid air conditioner	1,601[b]					
Solar freezer (vaccine)	845		960			
Solar freezer (170 liter)	1,627					
Solar freezer (340 liter)	2,139[c]					
Solar freezer (433 liter)	2,605	5,588				
Solar washing machine (300 liter)	2,255					

COO = Cook Islands, FIJ = Fiji, GDP PC = gross domestic product per capita, LPM = liters per minute, NAU = Nauru, NIU = Niue, PAL= Palau, TON = Tonga, V = volt, W = watt, Wp = Watt peak

[a] Price for a 1,000 Wp system.

[b] Based on Australian price for 3.5 kilowatt unit.

[c] Price for 303-liter solar freezer.

Sources: Observations at stores, suppliers' websites, and consultant's estimates.

4.9 Availability and Access to Finance

Most of the 14 countries have formally recognized national development banks under their national legislation. The exception is Vanuatu, where the National Bank of Vanuatu (NBV), a registered state-owned commercial bank, has identified economic development as one of its objectives. There are also some non-state-owned commercial banks present in these countries. However, they tend to be much more risk-averse with clean energy products, and are less likely to extend their services outside the main island.

Most of the development banks usually serve both the business and household segments in terms of lending services, and they offer loans addressed to energy efficiency or renewable energies (and to other environmental concerns), even if in most cases the loans have been granted in small volumes and were directed towards specific consumer segments, such as the integration of clean energy into the construction of new homes (Federated States of Micronesia, Vanuatu). The banks of Palau, Republic of the Marshall Islands, and Tuvalu offer energy-efficiency loan products to purchase appliances and equipment, although demand for these products has been low, with only few disbursals. The banks generally offer small loans for solar lighting or energy-efficient appliances under their standard retail loan products, with the potential to develop specialized products in the future. However, there is limited control over the quality of imported distributed renewable energy technologies and appliances. Appliances and equipment imported to most countries (except Fiji and Vanuatu) do not have the obligation to meet energy label or similar standards. Therefore, the market offers a mix of efficient and cheaper inefficient appliances. Most development banks do not enforce energy labelling, or any sort of quality guarantee, as required for the appliances to be purchased by borrowers.

While all of national development banks are explicitly committed to promoting economic development, and exert some effort to work with disadvantaged clients, such as low-income households, female-headed households, and people on outer islands, they all need to improve the access to financing for these vulnerable groups.

Formal full-time employment is the main eligibility criterion for having access to financial products offered by national development banks in the Pacific region. However, formal employment in the rural areas may be only one-third of that in urban areas. This puts the rural population at a big disadvantage, particularly lower-income households and women. This

eligibility-related grievance is distinctly worse for the lower-income countries, where the rates of formal employment can be as little as half those recorded in the upper-income countries.

Rural households are more resistant to the idea of loans. This hesitance may be explained by the many challenges they face when trying to obtain a loan, and by their reluctance to become indebted. Working with national development banks to make their eligibility conditions more inclusive and flexible would make their financial products more accessible to vulnerable households, including rural and female-headed households. Considering synergies with other mechanisms that provide direct economic assistance to the most vulnerable households for the purchase of clean-energy products may accelerate market uptake.

Examples of the type of financing products offered in eight of the fourteen targeted countries are given in the next several paragraphs.

Federated States of Micronesia

The Federated States of Micronesia Development Bank (FSMDB) offers home energy loans of up to $100,000 at an interest rate of 9%, with up to 20 years for repayment, a three-month grace period and, until recently, a subsidy of $6,000 (no longer available, as that grant is now depleted). About 100 applications, mostly for new homes and some renovation projects, were received in since 2020. Most of the applications have been granted. Eligibility criteria include home design requirements (construction materials, size and position of windows, etc.). Appliances to be purchased must be energy efficient and have an energy label. Inspectors visit the homes and check work progress to ensure that there are no deviations from the technical specifications. However, there are no specific guidelines regarding the number of label stars appliances should have. Most preferred appliances are refrigerators and stoves (gas and electric), followed by TVs and washing machines. No loans have been requested for rooftop solar panels yet. There are no clear guidelines on how homeowners should deal with utilities in cases where they install their own.

In addition to home energy loans, consumer loans are also used for purchasing appliances. Consumer loans are popular because not everyone can get home energy loans. However, with consumer loans there are no energy-efficiency requirements, and consumers may purchase what they wish, though energy billing statements are checked to compare energy savings. About 600 consumer loans are processed per year. The minimum loan amount is $1,000, and the maximum is $30,000, The interest rate for consumer loans is 15%, with terms of up to 5 years. Eligible applicants must be citizens of the Federated States of Micronesia or residents there for at least 5 years, be permanently employed, have a good credit record, and be at least 18 years of age.

The eligibility conditions of the FSMDB include formal employment and a steady income. Most borrowers are located in Pohnpei, followed by Chuuk. There are only few borrowers from the outer islands of Tonoas, Fefan, Uman and Tol, which are locations identified by utilities for future electrification. There are no borrowers from more remote islands in Chuuk, Yap, and Pohnpei. In addition to economic eligibility conditions for loan applicants, transportation is a major issue for potential borrowers in the outer islands. This situation results in practically no access to markets for this population.

Kiribati

The Development Bank of Kiribati (KDB) offers different kinds of loans for purchasing solar products and electrical appliances. The loans include a targeted energy-efficiency loan addressed mostly to the outer islands, as well as generic loans that could be used to buy appliances (home, social development, and business loans). Different solar products and appliances are eligible for the energy-efficiency loans, including solar lighting kits, solar

refrigerators, and solar water pumps. The list of financeable products and their prices is defined by the Kiribati Green Energy Solution (KGES) Company. The bank pays the vendor, the product is delivered to the customer, and KGES monitors the energy bills to collect data on energy efficiency. Examples of appliances offered are solar lighting kits, solar pumps, and solar refrigerators. Customers in the outer islands have not yet shown interest in energy-efficiency loans. Most of products are too expensive, given their incomes. Loan repayments can be made in cash at DBK agencies, and DBK now has 19 agencies in the outer islands. Banaba is the only important inhabited island without a DBK agency or branch. The main responsibilities of DBK agents in the outer islands are to support the loan application process and pass the applications to the head office for further processing and decision-making. The agents also collect cash payments and communicate with past-due borrowers. Other lending institutions include the Kiribati Provident Fund; the commercial ANZ Bank; and the Ministry of Women, Youth and Social Affairs, jointly with the Ministry of Commerce, Industry and Cooperatives, and the Kiribati Chamber of Commerce and Industry. There are also some private lending agencies servicing microloans. The Provident Fund lends to its members to improve their living standards, help them start new businesses, and refinance other loans. Purchases of small solar energy systems, solar products, and electrical appliances are eligible for these loans. The commercial ANZ Bank provides both personal and businesses loans.

The employed population are the most likely potential customers of DBK. People with no official income and/or already indebted are hardly eligible for DBK loans. However, unemployment, informal employment, and self-employment are common, particularly in the outer islands, and many people have no bank account. Applicants for DBK loans are not required to have a bank account. However, not having a bank account or a mobile phone is considered a drawback by DBK when considering loan approvals. Further, all loans approved by DBK require applicants to present collateral, and the collateral value must be at least 150% of the loan amount. DBK prefers to use the customer's Provident Fund assets as collateral, but will accept physical assets as collateral if the Provident Fund assets are insufficient. For physical assets, real estate is preferred.

Another source of financial support is the Promoting Outer Island Development through the Integrated Energy Roadmap (POIDIER) project, funded by the Global Environment Fund (GEF). Officially launched on 28 January 2021, the project aims to enhance outer island development through the achievement of Kiribati’s renewable-energy and energy-efficiency targets. POIDIER is organized in four components: (i) capacity building, (ii) the strengthening of institutional framework and planning, (iii) a financial support mechanism through grants to households purchasing solar products and energy-efficient appliances, and (iv) the development of mini-grids in the outer islands. For phase one of the project, $3 million has been allocated by UNDP for interventions in nine outer islands in the Gilbert Islands group (Abaiang, Arorae, Butaritari, Makin, Marakei, Nikunau, Nonouti, Tabiteuea North, and Tamana) and in two outer islands in the Line Islands group (Tabuaeran and Teraina). The first actions of the project have aimed at improving capacity building at the institutional level and working on training and awareness with the population. Capacity building and public awareness are developed on the islands through a series of visits and community awareness events and training. The aim of community awareness is to have people in each village categorize their own energy needs. The training offered to people in the outer islands includes the basic operation and maintenance of mini-grids and solar products. Usually two people, one male and one female, are trained on each island. For 2022, the POIDIER project is installing 15 hybrid solar photovoltaic (PV) diesel mini-grids of 50 kilowatts (kW) to 200 kW in size, and offering grants to people in the outer islands to subsidize part of the purchasing cost of solar products and energy-efficient appliances.

Palau

The National Development Bank of Palau (NDBP) started offering loans related to energy efficiency and renewable energy in 2009. The first financial product was the “energy efficiency subsidy loan,” aimed at improving energy efficiency in the housing sector. This program was funded by the International Union for Conservation of Nature (IUCN) with grants from Austria, Italy, etc. To make the program a success, NDBP decided to add this product to its already well established “housing loan” (for building new houses). NDBP decided to make energy efficiency a requirement for housing loans, so borrowers would end up taking both loans together. With the energy-efficiency subsidy loan, measures like radiant barriers, white colored roof painting, etc. were implemented. The program effected a big change in the cooling needs of new houses. New home owners realized the improvement very quickly, and this contributed to the success of the program. Within 2 years, NDBP dispensed all the available funding ($500K) in loans for more than 70 houses.

The current loan program, with support from the Asian Development Bank (ADB), aims to install 800 on-grid modular solar home systems with a 1.7 kilowatts peak (kWp). NDBP is offering a loan for purchasing a solar-home-system module at an interest rate of 4.5%, with no co-payment, to be paid in 10 years, for a maximum of $10,000. This program requires a strong technical training component (for installers), since at the time there was no one on the island with the requisite technical knowledge. An important challenge to the program is that many installers are no longer available (leaving the business, among other reasons) after 2 or 3 years. Palau Community College has been engaged in a “train the trainer” program to support technical capacity needs. Such a central approach and NDBP’s strong involvement were needed to start the market.

Applicants for this loan must be over 21 years old and must own the house in which the solar system will be installed. NDBP will check on the applicant’s repayment ability, but the bank is flexible. It does not tie loan approvals to proof of formal employment. The sources of income of self-employed people are also considered valid in an application. NDBP does check records for the prior 12 months (e.g., invoices issued by a self-employed applicant), and it checks if the power bills have been paid diligently or not. It checks the savings that the solar home system would generate, and counts these savings as valid source for repayment of the loan. However, the amount of energy consumption by the applicant must make sense. A too small energy consumption would mean that a 1.7 kWp solar home system would not be economically viable. People from rural areas can also apply for loans. In their case, if they cannot provide 12 months of invoices, they are asked to record their income (with invoices) over the next 3 months and then come back for an evaluation. NDBP may also ask for a guarantor before approving a loan.

Republic of the Marshall Islands

The Marshall Islands Development Bank (MIDB) offers three types of loans for solar streetlights and solar appliances: solar energy loans, housing loans, and consumer loans. The solar energy loans are funded with $4 million from the Government of Taipei,China (with the first $1 million already disbursed to MIDB). These loans are offered at an interest rate of 5%, with a repayment period of a maximum 5 years (no grace period). The loans are for purchasing energy-efficient appliances and for “solarizing homes” (solar home systems plus batteries). In the case of loans for purchasing energy-efficient appliances, MIDB issues purchasing orders directly to the vendors, who need to provide proof or certification that the equipment they offer to clients and install are energy efficient. Energy efficiency is proven with energy star labels. Loans for solarizing homes require that at least 50% of the energy consumed by the household come from solar energy, which is challenging, as it entails not only a number of solar panels, but also energy storage capacity. This requirement makes the projects expensive. The house in question must also undergo a free audit by the Marshalls Energy Company (MEC) to confirm

that the required level of solarization has been met. As of the end of 2021, no application had been approved for solarizing homes, and only nine loans had been approved for purchases of energy-efficient appliances. Consumer loans are a more popular alternative, and they are used to purchase appliances. The interest rate of consumer loans is higher than that for solar energy loans, as solar energy loans entail less risk. (The requirements are stricter for solar energy loans, including two guarantors, verification of employer, and a credit check). In contrast to the very few solar energy loans awarded, more than 6,000 consumer loans have been awarded by MIDB. Clients need to provide quotations with reasonable prices of the goods they intend to purchase, but there is no energy-efficiency requirement for the appliances to be purchased with this type of loan.

The employed population are the most likely potential customers of MIDB, since employment is the main eligibility criterion for access to finance. Most customers with consumer loans live in urban areas (estimated in 80% of borrowers by MIDB), with the remainder in rural areas. There is low uptake of all types of loans in the outer islands. The reason given by MIDB is that this population segment has lower incomes and often does not meet the eligibility criteria. Eligibility for the solar-energy and consumer loans offered by MIDB requires that applicants be residents or citizens of the Marshall Islands, have been employed for a minimum of 6 months at the current workplace, and have a good credit history with other lending institutions (for loans already taken out whose gross value exceeds the borrower's annual salary, at least 50% must have already been repaid). MIDB also requires verification of the employer and proof that the applicant meets the minimum requirements for the net weekly salary if repayment is to be through paychecks ($50 for Majuro and Ebeye residents, and $25 for outer island residents). However, unemployment and self-employment are common, particularly in the outer islands. People with no official income in the outer islands are hardly eligible for MIDB loans. Many of them do not even have a bank account. According to MIDB, many of the potential applicants for solar energy loans are already indebted with consumer loans, and cannot easily take on more loans to purchase more expensive energy-efficient appliances or to solarize their homes.

Samoa

The Development Bank of Samoa (DBS) is currently working on economic and social loans, but not yet on environmental loans. DBS has not yet offered loans focused on energy efficiency or renewable energy. It currently lends exclusively to business customers. However, small and medium-sized enterprises (SMEs) and even microenterprises dedicated to fishing and interested in cost savings can use their loans to finance solar freezers and coolers.

Solomon Islands

The Development Bank of Solomon Islands (DBSI) offers Livelihood and Investment Facility (LAIF) loans to households. These loans are meant to enable working islanders to venture into productive activities that could improve their livelihoods. They can be used for purchasing small solar systems; solar lighting units; and other solar products, such as solar refrigerators, that serve the loan’s general purpose. LAIF loans can range from $600 to $9,000, and are lent at an annual interest rate of 13%, with a maximum 5-year term. DBSI is also interested in lending money to the tourism sector for the purchase of solar energy systems, solar refrigerators, solar lighting units, etc. At the moment, the funds are dispensed directly to the approved applicants, not to the vendors. DBSI started its operations in June 2020, and still does not have enough expertise to evaluate the technical aspects or energy-performance characteristics of the equipment its customers purchase. DBSI’s predecessor was the Agriculture and Industrial Loans Board, established by the Agriculture and Industrial Loans Board Ordinance in 1955. There are also two commercial banks operating in the Solomon Islands. These are the Bank South Pacific (BSP) and the Australia and New Zealand Banking Group (ANZ), Solomon Islands. BSP started operations after acquiring the National Bank of

Solomon Islands in 2007. BSP took over Westpac's operations in the Solomon Islands in 2015. It operates the largest banking network in the Solomon Islands. Currently, these banks do not offer clean-energy loan products.

Most applicants for LAIF loans are from Honiara, the capital. People in the outer islands are generally not aware of these loans, and would probably not fulfill the eligibility conditions. DBSI usually requires that loan repayments be made directly from the borrower's paychecks or Provident Fund requirement account. For this reason, unemployed, informally employed, self-employed, and partially employed people are generally not eligible for DBSI loans. Yet this is the situation of a majority of population in the outer islands. Further, all loans approved by DBSI require that applicants present collateral with the value of at least 90% of the loan amount. Eligibility conditions for an LAIF loan also include being a citizen, of legal age, and employed full time for at least 2 years. All these eligibility conditions effectively bar those people who are at the greatest risk of energy poverty.

Tonga

The Tonga Development Bank (TDB) had an energy efficiency loan program about 5 years ago, supported by IUCN funding. TDB loan products included housing loans ($5,000 minimum for construction, and all activities for building, renovations, etc.), with the purchase of solar water systems included in the package. TDB also offered personal loans, for a maximum of $15,000, with a 2-year term and an interest rate of 10%.

Tuvalu

The Development Bank of Tuvalu (DBT) offers two sources of loans: the Energy Efficient Revolving Fund (interest rate of 7% and repayment terms of 1–10 years) and the Low Carbon Fund (interest rate of 3% and repayment terms of 1–3 years). The purpose of the Energy Efficient Revolving Fund is to replace low-energy-performance lighting systems and appliances, and to enable purchases of small solar-energy systems (not connected to the grid) and solar water pumps (without batteries) with an overhead water-tank system to allow for gravity feed. The Low Carbon Fund is available to licensed businesses and eligible households for the acquisition of energy-efficient appliances and lighting systems. Both types of loans rely on Australia's and New Zealand's energy-labelling schemes. In addition, there are personal loans available for buying any asset the customer wants (with an interest rate of 8%).

Vanuatu

To assist the achievement of renewable energy penetration targets, Vanuatu's Parliament created the National Green Energy Fund (NGEF) in 2018 as a state-owned entity under the Department of Energy. The main purpose of the NGEF is to mobilize and channel revolving financial resources through loans to households, communities, and businesses, so they can access renewable energy and energy-efficient products. Funded by the state, the NGEF's capital budget is about Vt500 million for 2020–2025, of which the Council of Ministers has already approved the allocation of Vt230 million. In addition, the revenues derived from the NGEF's financial activities are expected to bring in additional funds. The initial focus of the NGEF will be on access to electricity (mainly in off-grid areas), renewable energy, and energy-efficient appliances. The NGEF supports all its projects with concessional loans covering 50% of project cost at 6% annual interest. The loan term is 1 to 5 years (5 years for larger projects), but 7–8 years in exceptional cases. For eligible projects under the Vanuatu Rural Electrification Project II (VREP II), this concessional loan provides additional support to the 33% grant received under VREP I. The beneficiary pays up front only 17% of the purchasing cost. The cost of the solar-energy system is usually 70% of the total project cost (which includes wiring, installation, LED lighting, and appliances). According to the NGEF, however,

the subsidy of 33% is still low for the population of the outer islands of Vanuatu. Since the beginning of its operations, the NGEF has funded about 70 projects, most of them during 2020–2021. However, this number is still far below the ambitious targets set for VREP II.

All loans approved by the NGEF require the applicants to offer collateral. The NGEF prefers to use the applicant's Provident Fund assets as collateral, but will accept physical assets such as real estate if the Provident Fund assets are insufficient. The unemployed, people with informal employment, and the self-employed cannot enjoy of the benefits of the Provident Fund. Consequently, most of them are ineligible for NGEF loans. To partially address this problem, the NGEF has signed a memorandum of understanding with the Department of Cooperatives to guarantee loans made to cooperative societies. In Vanuatu, any society of at least seven persons can register as a cooperative. Fishermen cooperatives and even household cooperatives have applied successfully for NGEF loans. As the regulatory regime is already established for cooperatives, their loan preparation and approval process is relatively short. However, the low incomes of many other residents and community institutions remain a large obstacle to their obtaining clean-energy loan products. A large number of households, schools, and cooperatives do not apply for NGEF loans because their incomes would not allow them to pay for the already subsidized cost of solar equipment. The NGEF considers that subsidies for solar products should probably be between 50% and 60% to make the clean energy loans attractive to the population and achieve sufficient market penetration of these products.

Another active lending institution is the National Bank of Vanuatu (NBV). NBV is the largest bank in Vanuatu. It has 29 branches and agencies across the country, and is the only commercial bank with branches outside the largest cities. Clean energy lending is integrated into current NBV programs for building or renovating houses. The "IsiHaos" project lends money for building houses based on any one of its six models, all resilient to extreme weather and cyclones. Each IsiHaos model includes a 3,000-liter fiberglass water tank, an underground water well, and a solar-power system. IsiHaos funding is available through very low-interest housing loans from NBV. All construction and renovation works are done by individuals or companies registered with NBV. And the engineers usually follow technical standards from Australia and New Zealand for the solar home systems.

5 DISCUSSION AND RECOMMENDATIONS

The energy landscape in the Pacific region has some successful stories, as well as evidence of a gradual transition from fossil fuel dependency to a renewable-energy and clean-energy future, in which improved energy-efficient practices and installations are the top priorities. Access to energy has improved markedly since 2010. The proportion of the population with access to electricity varies among the Pacific Island Countries (PICs), from 47% in Papua New Guinea and 57% in the Solomon Islands to 100% for Niue and Tuvalu, and eight other countries achieving nearly full energy access. Access to some level of off-grid electricity in the rural areas has also shown significant improvement, mainly in Vanuatu (98%), the Cook Islands (96%), and Tonga (93%). However, there are still many challenges to overcome on the way to developing a more enabling environment for investments, removing bottlenecks for households seeking to access finance products, and realizing opportunities for job creation by developing local services in the clean energy sector. These challenges, and recommendations to overcome them, are discussed in this chapter.

5.1 Enabling the Regulatory and Institutional Environment

Many PICs have instituted governance models, including regulatory and policy frameworks, to provide a conducive environment for sustainable energy development. Ambitious renewable-energy targets and energy-efficiency goals were set, together with strategic road maps for achieving them. When setting their nationally determined contributions (NDCs), five PICs (Cook Islands, Fiji, Samoa, Tuvalu, and Vanuatu) established 100% renewable-energy targets to help mitigate against climate change impacts.

In terms of the regulatory environment, new energy laws were enacted to facilitate the establishment of energy departments (e.g., the Palau Energy Administration) and renewable energy functions (e.g., for the Tonga Renewable Energy Board). Various energy regulations were also adopted to clearly define the roles and responsibilities of various government and energy actors, facilitate market entry and foreign investment, remove tariff barriers affecting clean energy trade and business, and continue strengthening local capacity.

Sector-wide project coordination and collaboration have also increased through government intervention and leadership. Development partners have been collaborating with the national governments and with each other to maximize project synergy. Public and private partnerships have been forged between public entities and private operators—specifically, with independent power producers (IPPs)—through net metering and similar arrangements. Fiji, Samoa, Tonga, and others have IPP agreements in place with private operators. The Cook Islands successfully ran a net metering campaign, as well. These are some examples of how the PICs have begun their transition to clear energy and how they remain committed to their goals.

An adequate enabling regulatory and institutional environment is the catalyst for economic development and social advancement. Setting appropriate polices and regulatory frameworks, clearly defining and coordinating the roles and responsibilities of institutions, and building local capacity are all actions that encourage robust economic activity. Nevertheless, there are identified challenges that have been impeding the development of a more enabling environment. They include the following:

Insufficient integration of utilities into national efforts and program design. Utilities are the sole suppliers of grid electricity in all the PICs, and they play a pivotal role in meeting ambitious national renewable-energy and energy-efficiency goals and targets. Such targets will not be reached if utilities are not fully integrated into, and aligned with, national efforts.

Lack of rules and guidelines for connecting photovoltaic systems to the grid. The solar PV market has grown rapidly in both grid-connected systems for urban power supply and off-grid rural and remote island applications. Grid-connected solar-energy systems have grown in recent years through an ad hoc process that has led to bottlenecks where the issuance of permits is discretionary, rather than based on clearly defined timelines and acceptable connection costs. Although net metering and IPP policy measures have been adopted in some countries, and utilities have signed IPP contracts with net metering arrangements in some others, gaps in the roles and responsibilities of public and private stakeholders persist widely across the Pacific. Rights, responsibilities, and compensation mechanisms remain unclear, creating uncertainty for household and larger private investors.

Absence of energy performance standards. Across the Pacific region, the energy technology market is externally driven, leading to a lack of consistent energy performance standards, as countries continue to exercise limited control over the quality of imported equipment. However, many of the imported equipment comes from Australia, New Zealand, People's Republic of China, and the United States, as well as the East Asian market, where energy performance standards exist.

Misunderstood energy labels. Energy efficiency awareness and campaigns have increased over recent years through initiatives by the Pacific Region Infrastructure Facility (PRIF) and development partners. The PICs have set energy-efficiency goals and targets, but awareness raising about energy labels has been inadequate in most cases. Labeled appliances are sold in local stores, but the surveys conducted under this study in Kiribati and Tonga revealed that an important part of the population does not know how to interpret them.

High costs of ownership. The costs of ownership differ widely among countries, but they are generally high. Energy equipment and electrical appliances are costly in most PICs, with the exception of Fiji due to its high import duties and taxes.

Recommendations

1. **Integrate utilities into program design.** Governments and development partners should work closely with utilities to enable the better design and implementation of clean energy programs. For example, utilities can play a technical advisory role as a counterpart to the lending program's implementing institutions (such as national development banks). Utilities are also necessary partners in the preparation of technical training and educational programs. And they are potential financial partners in energy-efficiency programs. Joint business opportunities could be explored with utilities for offering LED lighting and energy-efficient appliances that would be partly financed by the utilities against saved energy costs.

2. **Establish clear and enabling guidelines for the grid connection of PV systems.** Discretionary connection permits should be avoided. National governments, together with utilities, should work on revising the existing guidelines, and updating them where necessary, to ensure that compensation mechanisms are clear and that they promote the connection of PV systems to the grid when appropriate. These guidelines should establish the technical conditions for such connections, as well as the rights of the parties and fair costs, without hampering the process of decarbonizing the electricity system. This will require a national consensus, in order to protect the financial health of the utilities, while financially compensating PV-system owners in a just way.

3. **Adopt energy performance standards and registration systems.** Fiji and Vanuatu have mandatory standards and registration systems in place, under which inefficient appliances and low-standard equipment are not allowed to enter the national market. Other Pacific Island countries have yet to adopt and effectively implement energy-

efficient standards and targets. They must be encouraged to register with the Pacific Appliance Database (PAD) as good practice, and to establish their own monitoring measures through specific regulations.

4. **Strengthen consumer education on energy efficiency and energy labels.** National governments and utilities need to improve their communication and general-education strategies to explain to the public what energy labels are and how they must be read, so consumers can make informed purchasing decisions.

5. **Consider a reduction of import tariffs.** National governments should give serious thought to reducing import duties and taxes on solar equipment and energy-efficient appliances, as the first set of measures to reduce the cost of ownership for households and businesses.

5.2 Overcoming Challenges in Accessing Finance Products

Energy financing via bilateral and multilateral arrangements has grown exponentially in the recent decades in the Pacific region. Energy financing is channelized through grants, loans, and cofinancing mechanisms. Development partners have now recognized that households need access to clean-energy financial products that target energy technologies and services. Resource allocations to lending programs via national development banks are currently expanding from Palau to several other countries. However, important challenges remain.

The lending services offered by national development banks and commercial banks are available to anyone meeting the eligibility requirements and duly registering the collateral required for their loans. However, these two conditions are very difficult for the residents of rural areas, particularly the poor. Specific identified challenges in accessing finance include the following:

Slow start of support programs. Many renewable-energy and energy-efficiency programs are funded by development programs, and are thus subject to various vetting processes to ensure the fulfillment of policy and regulatory requirements. As a consequence, these programs tend to get a slow start, with the resulting energy access achieved by the midpoint in many cases reaching only 10% of the target. Experience has shown that projects are frequently hindered by time-consuming pre-feasibility studies, a lack of local experts with the necessary technical and engineering skills, and poor monitoring, among other challenges.

Eligibility conditions. The extent of formal full-time employment is low to medium in all 14 countries. As noted above, people with no formal employment usually do not even have a bank account. However, employment is the main eligibility criterion for access to financial products, including those offered by national development banks. Development banks usually require that repayment be done directly from the customer's paychecks or Provident Fund retirement account. Further, all loan applications require collateral ranging from 90% to 150% of the value of the loan in order to secure approval. These eligibility conditions effectively bar those people who are at the greatest risk of energy poverty. The rate of formal employment in the rural areas may be only one-third the rate in urban areas. This puts the rural population at a big disadvantage, particularly lower income households and women. Consequently, people who are unemployed, informally employed, self-employed, or partially employed are usually not eligible for loans from development banks or commercial banks. This is the situation for the majority of rural population and for the majority of women, and particularly for female-headed households. This eligibility-related grievance is distinctly worse for the lower-income countries, where the rates of formal employment can be as little as half those recorded in upper-income countries.

Restricted lending to women. Access to finance remains difficult for women in the Pacific region, especially for those seeking to start a new business. There are far fewer women in formal full-time employment than men, and women usually have less property than men to offer as collateral. In a 2014–2015 survey conducted among 120 businesswomen in Fiji, Papua New Guinea, Samoa, Solomon Islands, Tonga, and Vanuatu, between 17% and 56% of them said that interest rates were too high; and up to 33% did not have the collateral required by the banks to obtain a loan.[8] Another 11% said that the loan amounts offered by the banks were inadequate. Gaining credit from formal finance institutions is thus a major challenge for potential women entrepreneurs, especially for rural women who have less knowledge about how to access financial services from formal banks.

Indebted population. The employed population are the most likely potential customers of development banks. However, according to some development banks that were interviewed for this study, many employed people are already so indebted, they cannot easily take out more loans to buy solar products or replace inefficient appliances.

Recommendations

1. **Strengthen the preparation and early phase of project implementation.** Higher output and above-average impact on energy access can be achieved by the midpoint of project implementation if adequate financing is available during the project's preparatory phase and early phase of implementation. Development partners should strongly reconsider how they design and assess their own preparatory work, to make sure that they systematically include: (i) financing for preparatory activities (i.e., technical studies, social surveys, etc.); (ii) the provision of long-term international technical assistance in the field to support program/project implementation; and (iii) the strengthening of tools for monitoring, reporting, and verifying the fulfillment of requirements established by the support programs.

2. **Support the design of flexible and inclusive eligibility conditions.** Development partners could actively support and promote the design of more flexible and inclusive eligibility conditions at national development banks, so as to provide lending access to populations most at risk of energy poverty. Alternatives to explore would include: (i) less rigidity when validating the sources of income, which could mean accepting proofs of income from self-employed and partially employed applicants, including proofs of income earned from small production and trading activities (e.g., invoices related to farming, fishing, handicraft production, and trading), as well as other proofs of income from activities in the informal sector and/or proof of regular remittances from abroad; (ii) a broadening of accepted loan guarantors from formal employers to family members and island councils (as in Kiribati), as well as relevant community associations; and (iii) a facilitation of loans through cooperative arrangements such as government-backed cooperatives (as in Vanuatu, where cooperatives can register at the Department of Cooperatives, deposit money, register their collateral, and receive financial backing from the government when applying for loans).

3. **Accept financed energy equipment as collateral.** Development banks could explore other types of collateral, in addition to job salaries, Provident Fund retirement accounts, and real estate. Financed energy equipment, including solar home systems, solar freezers, or large energy-efficient appliances (e.g., refrigerators and washing machines) could become collateral in themselves.

[8] ADB. 2018. *Women and Business in the Pacific*. Manila. https://www.adb.org/publications/women-business-pacific.

4. **Design tailor-made lending terms and conditions for groups at risk of exclusion, particularly women.** Lending terms and conditions should be tailor-made for specific target groups such as women entrepreneurs, female-headed households, and other groups at a greater risk of exclusion or poverty. Lending terms and conditions currently offered by most development banks are designed to promote the uptake of specific technologies, but not designed to ease financial access and conduct of business for groups at risk of exclusion. Lending terms and conditions must look beyond technologies, and instead diversify portfolios by focusing on local women-led projects that generate income and create jobs. Key performance indicators and specific targets in terms of number of loans and borrowed amounts of money should be adopted by development banks to measure the finance access of these vulnerable groups. Such a change would encourage and strengthen women entrepreneurs, both in urban and rural communities.

5. **Proactively search for and promote synergies with direct aid programs.** Banks offering financial products for energy equipment should strongly consider working with aid programs that provide direct subsidies to help the most vulnerable people afford that equipment.

5.3 Opportunities for Job Creation in Operations and Maintenance Services

Assessing the opportunities to develop local operations and maintenance (O&M) companies in the PICs, and thus generate more jobs in the region, is challenging due to the poor documentation of O&M capacities and energy sector employment. In general, the countries have limited information available regarding energy-related jobs and have done little analysis of growth opportunities.

Insufficient operations and management skills and services. Many government-donated solar PV systems have been installed in outer islands to provide lighting, vaccine storage, water pumping, phone charging, and other services. The ongoing maintenance of these systems fall under the mandate of the governments. However, maintenance and repair services are usually delayed and inadequate, especially in outer islands and rural communities. Local retailers and service providers play a key role in the quick uptake of renewable-energy products and energy-efficient appliances and services because it is in their interest to sell these products. However, there is a general shortage of skilled technicians who can repair solar-energy products and modern energy-efficient appliances. The relevant skills are industry specific, so the local retailers and suppliers of these appliances would need assistance in establishing a twinning arrangement with the manufacturers (e.g., Fisher & Paykel) to upskill local technicians when new technologies entered the market. Otherwise, the limited repair services in the region may result in a monopoly, leading to higher prices for services. Furthermore, retailers are often unaware of the government requirements regarding product standards, and that is also the case for the lending facilities that promote their products.

This situation has mostly stemmed from the PICs' high dependency on external expertise in clean energy. The number of local engineers and technicians has increased, especially the recruitment of women into the workforce. Although the PICs have exerted a lot of effort in improving their ongoing capacity-building and training programs, access to education through regional institutions such as the University of the South Pacific, and the operations of programs such as the European Union Pacific Technical and Vocational Education and Training (EU PACTVET), more needs to be done.

Recommendations

1. **Promote and support technical training in all programs and facilities.** Development partners and national development banks should actively promote and support technical education and training for local suppliers and service providers. This could be done by including mandatory training and education elements in the design of all finance programs and facilities. Engaging a critical mass of local suppliers and service providers in a scheme of continuous learning and training would likely dramatically improve the uptake of renewable-energy products and energy-efficient appliances. Efforts to strengthen the local O&M market should involve the provision of incentives to community colleges, national universities, and technical institutes to create suitable educational and vocational programs in electrical and mechanical engineering, project management, and related disciplines. These programs could be delivered in collaboration with more recognized educational institutions, such as the University of the South Pacific and universities in Australia and New Zealand. Academic institutions will need financial support for the hiring of technical experts to deliver the courses, and for the provision of equipment and training infrastructure. These efforts would result in an increased availability of local skills, employment opportunities, a growing community of entrepreneurs, and new and revived services, all of which would encourage competition.

2. **Support the establishment of local service businesses.** Actively help young skilled entrepreneurs to set up service business such as repair shops via specific loans, possibly in combination with subsidies targeting the young. Both training programs and subsidies for new enterprises should have quotas for female entrepreneurs and technicians, as there is evidence across the Pacific region that female technicians are generally more committed to maintaining their local businesses, rather than emigrating to search for job opportunities abroad.

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ANNEXES

This report is accompanied by two annexes:

Annex 1: Survey results
Annex 2: Country energy profiles

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