

Study on Pacific Clean Energy Financing Potential

Annex 1: Survey Report



This report was prepared by external consultants, Sergio Ugarte (SQ Consult B.V.) and Apisake Soakai, with the support of the Pacific Region Infrastructure Facility (PRIF). PRIF is a multiagency coordination mechanism aimed at improving the delivery of development assistance from donors and development partners to the infrastructure sector in the Pacific region. The PRIF partners are the Asian Development Bank, Australia’s Department of Foreign Affairs and Trade, the European Investment Bank, the European Union, the Japan International Cooperation Agency, New Zealand’s Ministry of Foreign Affairs and Trade, the United States Department of State, and the World Bank Group.

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Published August 2022.

Photos courtesy of Apisake Soakai and the Asian Development Bank.

Note: In this publication, “\$” refers to United States dollars unless otherwise stated.



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ABBREVIATIONS

A\$	Australian dollar
COVID-19	coronavirus disease 2019
GDP	gross domestic product
LED	light-emitting diode
LFL	linear fluorescent lamp
PIC	Pacific island country
PRC	People's Republic of China
PRIF	Pacific Region Infrastructure Facility
T\$	pa'anga (Tongan national currency)
WTP	willingness to pay

SUMMARY OF FINDINGS

This section highlights the key findings derived from the results of the survey conducted in Kiribati and Tonga. The survey explicitly differentiated the economic profile, behavior, and needs of households in urban grid-connected areas and households in rural off-grid areas. The supporting information is contained in the main sections of the report; therefore, this section should be considered in conjunction with the relevant chapters of the report for a full appreciation of the context and issues.

SURVEY SAMPLE

The survey and market inventory were carried out in Kiribati and in Tonga between 20 October and 5 November 2021. The survey sample represented about 3% of the households in selected locations for both countries. The specific areas within the locations where the survey was carried out were chosen for ease of access and communications. The respondents were chosen through random selection. The approach was kept simple, with minimal processing to avoid the complications caused by too many constraints affecting the project, such as COVID travel restrictions and the smallness of the markets. The target sample was 201 households in Kiribati and 270 households in Tonga. The actual sample slightly exceeded these targets, reaching 204 households surveyed in Kiribati and 283 households surveyed in Tonga (Table A1.1).

Table A1.1: Number of Surveyed Households in Kiribati and Tonga

Grid Status	Survey Location/Size	Kiribati	Tonga
Grid-connected	Locations and total number of households	South Tarawa 5,584 households	Tongatapu and Ha'apai 6,240 households
	Survey sample	168 households (3%)	168 households (2.7%) 123 in Tongatapu and 45 in Ha'apai
Off-grid	Locations and total number of households	North Tarawa 1,128 households	Vava'u and Ha'apai 2,745 households
	Survey sample	36 households (3.2%)	115 households (4.2%) 91 in Vava'u and 24 in Ha'apai
Total households		204 households	283 households

Source: Survey carried out by the Pacific Clean Energy Financial Potential project team.

DEMOGRAPHIC INFORMATION

The population captured through the survey's household count was approximately 2,700, of which 57% were Tongans and 43% were I-Kiribati. The overall gender ratio was almost proportionate. Male respondents accounted for 51%, and they were predominantly in rural off-grid households in Kiribati (86%). About 49% of the survey respondents were female, and they were predominant in urban grid-connected households in both countries (52% for both) (Table A1.2).

The age profile of the respondents showed differences between respondents from urban grid-connected and rural off-grid households. More than half of the respondents from grid-connected households in Kiribati and Tonga were under 40 years old. For the off-grid group, 50% of Kiribati's respondents and only 33% of Tonga's respondents were under 40. The

survey did not collect per capita energy consumption information; therefore, a profile of age vs energy consumption could not be estimated. However, it was well noted that, for a range or reasons, different age groups use energy for different purposes, at different times and in different seasons. These aspects influence the households' decisions regarding their willingness to pay for energy products and services.

Table A1.2: Comparative Gender Profile of Survey Respondents in Kiribati and Tonga

Sector	Gender	Kiribati ^a	Tonga ^a	Total ^a	Share
Grid-connected	Male	80	80	160	48%
	Female	88	88	176	52%
Off-grid	Male	31	57	88	58%
	Female	5	58	63	42%
Total	Male	111	137	248	51%
	Female	93	146	239	49%

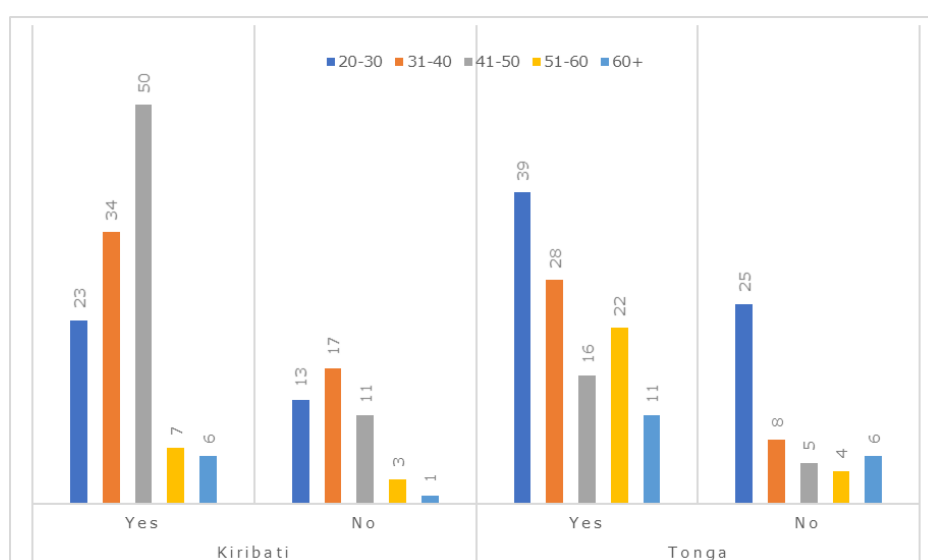
^a The values represent numbers of individuals.

Source: Survey carried out by the Pacific Clean Energy Financial Potential project team.

The survey found that in Kiribati's urban areas, the age group ranging from 31 to 50 years old (51%) responded more positively when asked about their willingness to pay for renewable-energy products and energy-efficient appliances. In Tonga's urban areas, the age group that was more positive about willingness to pay was the group ranging from 20 to 40 years old (58%). These results reflect cultural differences affecting energy consumption behavior, as well as maturity and confidence (Figure A1.1).

The household sizes for Kiribati and Tonga were equivalent; both countries have an average of five to six members per household. Energy consumption varies between households, and often energy costs will impact a household's willingness to pay for energy-efficient appliances and services. The survey revealed that the energy sources that are available and the purpose of consumption vary significantly between urban grid-connected and rural off-grid households. Also, while large households generally pay higher energy bills compared with smaller ones, this situation is not always the case within urban households.

Figure A1.1: Comparison of Willingness to Pay of Different Age Groups in Urban Grid-Connected Areas



Source: Survey carried out by the Pacific Clean Energy Financial Potential project team.

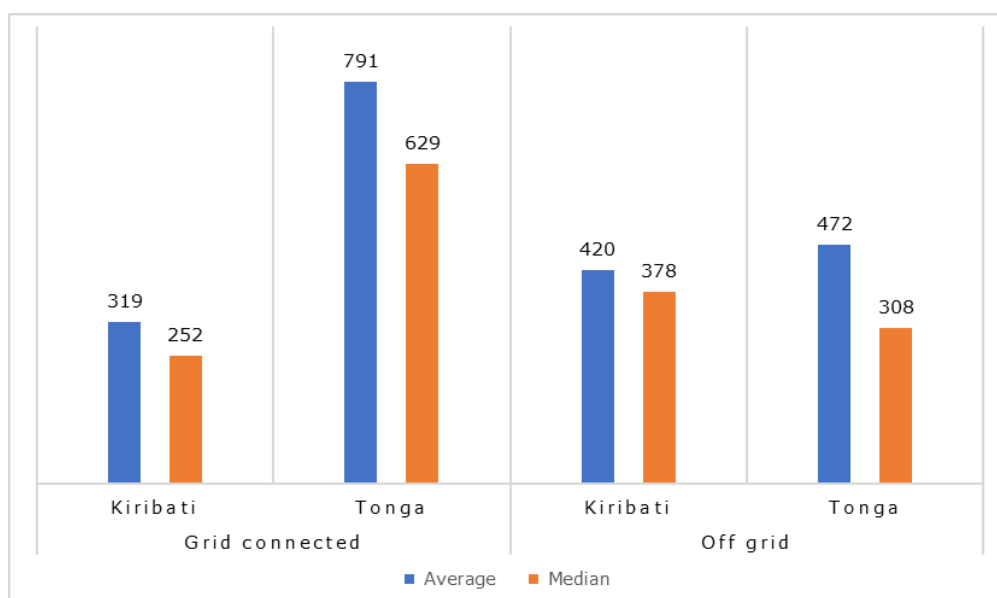
HOUSEHOLD INCOME

A regular monthly income is an indicator of a household's wealth and ability to buy goods and services. A low and irregular income means that households have limited ability to meet its basic needs for food, shelter, and other services. The survey found that most households surveyed in both countries, and in particular, those in rural areas, rely on more than one source of income to sustain themselves. Incomes in surveyed households vary seasonally, and are prone to be impacted by various types of events. For example, during the Christmas season, and around the dates of special events (such as weddings, funerals, birthdays, and anniversaries), many households receive more money in the form of gifts or remittances from family living abroad. This causes spikes in the monthly income of households. However, the impact of these events is difficult to capture in a survey.

The income distribution between urban grid-connected households and rural off-grid households varies considerably in Tonga, apparently reflecting the better economic conditions in urban areas. The situation is different in Kiribati, where incomes in the urban grid-connected areas are lower than in the outer islands. The possible reasons for this disparity include the following: the survey was carried out during the day and respondents, who were not breadwinners, do not have full knowledge of the household's monthly earnings; most respondents were unemployed, and had limited means of earning income (the unemployed and elderly receive \$36 to \$144 per month, depending on the household's circumstances). However, the income in South Tarawa was as low as the income in the rural areas, which leads to the conclusion of an impoverished population in South Tarawa.

In all four cases (urban and rural in both countries), the average income was higher than the median income due to the existence of a considerable number of high incomes at the top range, indicating severe inequalities (Figure A1.2).

Figure A1.2: Comparative Income Profile of Kiribati and Tonga (\$)



Source: Survey carried out by the Pacific Clean Energy Financial Potential project team.

In Kiribati, the survey found a low rate of formal employment (28% in urban areas, 10% in rural areas). The revealed main source of income in surveyed locations was the government's Support Fund for unemployed citizens (56% in urban areas, 72% in rural areas), ranging between \$44 and \$144 a month. Adults between the ages of 18 and 59 receive unemployment support from this Fund. The specific amount received is determined by the circumstances of each individual. Most households depend on more than one source of income. Other important

sources of income for I-Kiribati are the monetary gifts and remittances they receive from friends and family abroad. The survey revealed that about 18% of urban households receive gifts and remittances. The remittances from seafarers (members of the households who work on foreign vessels) and other transactions also contribute to the economy. The World Bank estimated that Kiribati received \$19 million in remittances in 2020, which amounted to 9% of its gross domestic product (GDP).¹ Copra production is also an important source of income, particularly for 64% of rural off-grid households. Other sources of income for both urban and rural households come from fishing, agricultural, and handicraft production.

In contrast to Kiribati, the survey found a much higher rate of formal employment in Tonga: 69% in urban areas and 23% in rural areas. The respondents indicated that salaries and wages are an important source of income for 74% of urban grid-connected households and for 35% of rural off-grid households. Monetary gifts and remittances from abroad are also an important source of income for 32% of urban households and for 70% of rural households, with 14% of rural households relying entirely on remittances. The National Reserve Bank of Tonga reported \$205 million (T\$465.5 million) in remittance receipts in July 2021.² Handicrafts were found to be the secondary source of income in the outer island households. Handicraft exports to Tongan communities in America, New Zealand, and Australia provide significant earnings for rural women in Tonga. The sale of a single 15 square-foot mat can easily fetch \$500, and households often sell three or four items. Handicraft trading between Tongan women's groups and Tongan women's communities abroad occurs annually, during the Christmas season.

Despite the better income levels and employment rates compared with those in Kiribati, the survey found an income disparity between the urban and rural households in Tonga, with the median income in urban households double that of rural households.³ The incomes for 36% of surveyed grid-connected households and for 69% of surveyed off-grid households were below the poverty line.⁴ These findings exceeded the rate of 27% indicated in the national statistics⁵. As in the case of the low-income urban households in Kiribati, there are possible reasons for the disparity found by the survey in Tonga, including the respondents' lack of information and knowledge on household income and expenditure.

HOUSEHOLD EXPENDITURES AND SAVINGS

Household expenditure reveals a lot about how much households consume and, most importantly, what they choose to spend their limited resources on. Monthly expenditure in surveyed households is distributed across many items, mainly food, cooking fuel, spirits, utility bills, school activities, transport, and mobile phone costs. The collection of precise expenditure data per item was difficult, apparently due to the lack of knowledge or inability of respondents to calculate their monthly expenditures per item requested. Therefore, while the results reported here are derived from the analysis of the data collected, they should be taken only as indicative.

Average urban households in Kiribati and Tonga spend a lot on food (46% in Kiribati and 34% in Tonga). Average rural households spend their family cash on a combination of activities, such as food, cooking fuel, fishing boat maintenance, boat hiring, energy costs (batteries, diesel), loan payments, and school and church activities. Food plus energy accounted for 54% of expenses in Kiribati's rural households. Expenditure on kava was also reported to be very high in Kiribati, representing 22% of total monthly expenses. In Tonga, the overall costs associated with fishing and interisland travel amounted to 43% of monthly expenditure.

¹ From [Inward remittance flows May, 2021.xlsx \(live.com\)](#).

² From [Remittances - National Reserve Bank of Tonga](#).

³ Tonga is a hierarchical society, and its social structure is reflected in the distribution of wealth, in which the top echelon of society earns a much higher income than the rest of the population.

⁴ The poverty threshold income in Tonga is set at \$427 (T\$970) per month for adults and \$415 (T\$944) for children.

⁵ [Poverty in Tonga](#). Government of Tonga, Statistics Department.

In Kiribati, the estimated *average* monthly expenditure for urban households was \$189, and the estimated *median* expenditure was \$167; for rural households, the estimated average monthly expenditure was \$54, and the estimated median monthly expenditure was \$37. The lack of knowledge on the part of many respondents regarding household expenditures on several basic items led the authors to conclude that estimated average/median expenditure values are substantially underestimated. Another conclusion was that the average/median low-income levels make it practically impossible for the majority of Kiribati's population to save a meaningful amount of money. The lack of savings will diminish a household's ability to purchase new appliances (such as a refrigerator, freezer, or air conditioner), as well as the household's willingness to pay for energy-efficient appliances and renewable-energy equipment.

The situation was different in Tonga. The average monthly expenditure was estimated at \$347 for urban households and the median monthly expenditure was estimated at \$299; for rural households, the average monthly expenditure was estimated at \$282 and the median monthly expenditure was estimated at \$314. Considering that the average income is double the average expenditure in urban households and is 65% larger in rural households, it can be concluded that some part of the population (especially in the urban areas) have some savings.

AWARENESS, APPLIANCES, AND REPAIR SERVICES

Adequate lighting in households is considered by the large majority of respondents in urban and rural households as very important for families, particularly because it allows more hours for reading and study, and enables more comfortable dining, entertainment, and socializing. About half of the urban households in Kiribati own solar lanterns. Rural households in both countries ranked solar lanterns as their number-one priority, compared with other equipment and appliances.

A variety of appliances and equipment being used in urban households across Tonga and Kiribati were recorded in the survey. These appliances ranged from white goods (refrigerators, freezers, washing machines, and air conditioners) to general household appliances (fans, radios, televisions [TVs], hot water systems, etc.). The most popular appliances in urban Kiribati are fans (78%), radios (70%), TVs (62%), and freezers (58%). The most popular appliances in urban Tonga are TVs (79%), radios (78%), refrigerators (76%), freezers (64%), and fans (61%). The survey also revealed that most off-grid households in both countries owned at least one mobile phone.

Two-thirds of all major appliances in urban Kiribati and Tonga had been purchased during the past five years, with a few of the appliances having been bought as early as 20 years before.

The large majority of surveyed households indicated that they were considering future purchases, but only a small percentage were able to estimate the date of purchase. A common answer was that the new appliances would be bought when the current ones no longer worked and could no longer be repaired. The appliances that were most frequently mentioned as possible future purchase were refrigerators, freezers, TVs, and washing machines.

The salient issue regarding appliance use is the question of repair vs replacement. The survey responses revealed how limited local repair services are in both countries. An inadequate number of operators in a market may result in a monopoly, which would lead to higher service costs. Repairs of household appliances and equipment such as fans, TVs, and lighting fixtures were found to be done mostly by registered electricians; but appliances such as refrigerators and freezers require specialized skills, as well as spare parts, both of which are lacking or are in extremely limited supply in Kiribati and Tonga. The lack of local service providers will diminish the households' willingness to pay, since consumers would prefer to invest in appliances that can be technically serviced to last longer.

Awareness of energy-efficiency appliances was found to be high: 75% in Kiribati and 67% in Tonga. However, more than 80% of the surveyed population in both countries do not know how to correctly interpret energy-efficiency labels; nor are they able to calculate the running cost of equipment. Community awareness regarding labelled appliances and training in the basic operation and maintenance of equipment are both important for increasing the uptake of renewable-energy products and energy-efficient appliances. It is also important to build consumer confidence, as it will have a positive impact on households' willingness-to-pay decisions.

WILLINGNESS TO PAY

Household income and energy consumption have a strong correlation. When income rises, the ability to pay for the use and maintenance of energy services improves. Respondents from rural households were asked if they were willing to pay more for renewable-energy equipment. Respondents from urban households were asked the same question, but for energy-efficient appliances. The levels of positive responses given by the urban households were high in both countries: 73% for Kiribati and 71% for Tonga.

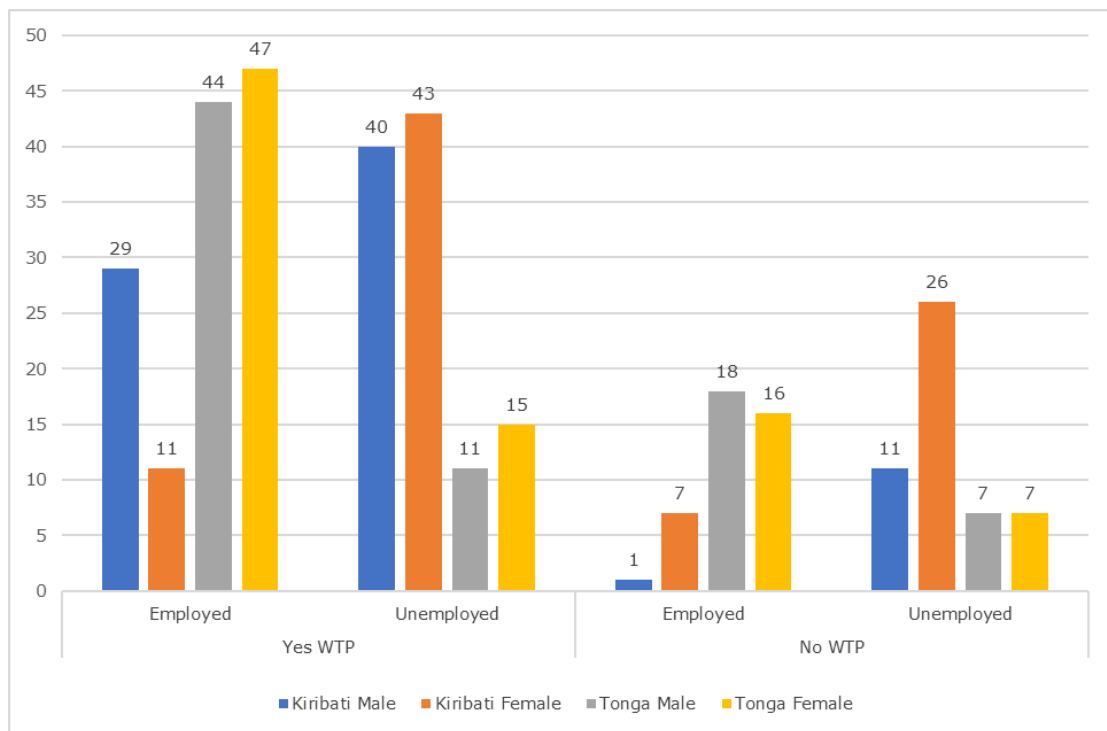
In Kiribati, off-grid households frequently expressed their intention to pay more for renewable-energy products and energy-efficient appliances. Perhaps the desire for better-quality lighting and other services was the driving force behind the Kiribati off-grid sector. Respondents who were willing to pay more for renewable-energy products and energy-efficient appliances also stated that 10% to 20% was their most preferred price increase. In terms of willingness to purchase a solar home system through a loan, Tonga's response was significantly negative. This reaction could be impacted by factors such as low incomes, ongoing donor provision of solar home systems, and an unwillingness to take on risks.

In terms of the correlation between the willingness to pay (WTP) and gender and employment, the survey found that the differences between the employed and unemployed and between male and female respondents were small. The overall WTP for both countries was 72%, and of the total for both countries, 39% were employed and 33% were unemployed, 35% were female and 37% were male. This is an interesting result because it demonstrated that, while employment is a determinant factor in the capacity to pay more, unemployed and poor consumers tend to have a strong desire to buy better (energy efficient) appliances. Among the remaining 28%, which responded negatively regarding WTP, 17% were female and 11% were male, 13% were employed and 15% were unemployed (Figure A1.3).

Despite the fact that the responses to the questions on WTP were positive, the evidence that small savings capacity and limited ability to pay are constraints must be fully noted when planning financing initiatives for these countries. Furthermore, given the inherent weakness of the contingent survey method (i.e., a statement of intention does not always translate into action), these results should be treated with caution. These observations are reinforced with the responses received regarding the willingness to take out a loan for the purchases. The willingness to take out a loan was much lower (Figure A1.4). The non-existent to very low savings levels in Kiribati, and the low saving levels in Tonga, contribute to this lack of willingness to take on more debt. Furthermore, the lack of local businesses supplying spare parts and repair services (as in the case of the Ha'apai islands) limits household confidence in investing in higher-priced energy-efficient appliances.

Households with higher incomes responded positively to the questions on both WTP and the willingness to take out a loan to purchase energy-efficient appliances. This was the case for 38% of households in Tonga with an average income of \$858 per month and for 41% of households in Kiribati with an average income of \$349 per month (Table A1.3).

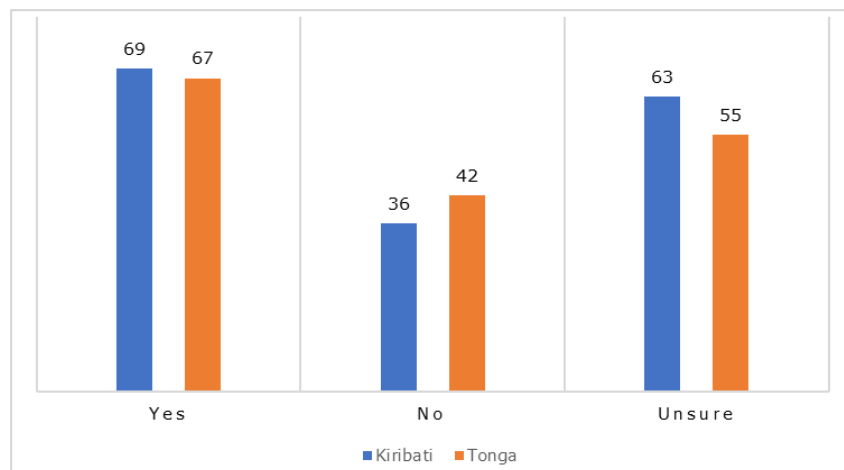
Figure A1.3: Correlation between Willingness to Pay and Employment Status and Gender
(number of people)



WTP = willingness to pay.

Source: Survey carried out by the Pacific Clean Energy Financial Potential project team.

Figure A1.4: Comparative Profile of Willingness to Take Out Loans in Kiribati and Tonga



Source: Survey carried out by the Pacific Clean Energy Financial Potential project team.

Table A1.3: Relationship between Income and Willingness to Pay in Kiribati and Tonga

Willingness to Pay/Take Out Loan	Kiribati			Tonga		
	Number/ Percentage of Respondents	Average Monthly Income (\$)	Extent of Acceptable Extra Cost (%)	Number/ Percentage of Respondents	Average Monthly Income (\$)	Extent of Acceptable Extra Cost (%)
Yes/Yes	69/41%	349	5–80	56/38%	858	1–100
Yes/No	11/7%	324	5–50	13/9%	667	10–80
Yes/Unsure	43/26%	376	5–80	29/20%	827	1–100
No/No	25/15%	257	...	27/18%	570	10–15
No/Unsure	20/12%	169	10	13/9%	592	10–30
No/Yes	0/0%	9/6%	625	5–30
Total	168/100%			147/100%		

... = no data available.

Notes:

1. A blank cell indicates that the column head does not apply.

2. Percentages may not total 100% due to rounding.

Source: Survey carried out by the Pacific Clean Energy Financial Potential project team.

PRODUCT AND SERVICE AVAILABILITY

Many products are sold in local stores in Tarawa and in Nuku'alofa. These products include white goods, general household appliances, solar equipment, lighting, and wiring materials, among many others. Seven suppliers are operating in Tarawa, and eight companies in Tonga, all selling a range of renewable-energy products and energy-efficient appliances from Australia, Fiji, Malaysia, New Zealand, and the People's Republic of China (PRC). The efficiency standards of these products are unknown. However, the implementation and effective enforcement of the governments' energy efficiency policies will ensure that the products sold in the market satisfy the required standards. The survey also found that not all stores (e.g., retail shops) offer repair services; however, a few suppliers do offer both installation and repair services.

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 their products. However, they are often unaware of policy requirements regarding product standards, and this includes the lending facilities that promote their products. Educating these suppliers will improve the uptake of renewable-energy products and energy-efficient appliances.

FINANCIAL SERVICE SUPPORT

The availability of financing services in Kiribati and Tonga is very limited. There are three types of institutions lending to customers: national development banks, public service facilities, and commercial banks (Table A1.4).

The lending services of the national development banks and commercial banks are available to anyone, as long as the collateral requirements are met. However, loans from the retirement fund facility are available only to members, who benefit from low interest rates. All these financial institutions are centrally managed from the main island of each country, with limited facilities and services in the outer islands. The survey found that many respondents (particularly from rural households) do not use banking services; this could be due to a lack of confidence in banking services when interest fees are extremely high, especially for personal loans. Also, the high level of remittance transactions partly eliminates the households' need to use the banks' financial services.

Table A1.4: Lending Institutions in Kiribati and Tonga

Institution Type	Kiribati	Tonga
National development bank	Development Bank of Kiribati	Tonga Development Bank
Public service facility	National Provident Fund	Tonga Retirement Fund Board
Commercial Bank	ANZ Bank	BSP, MBf Bank, ANZ Bank

ANZ = Australia and New Zealand Banking Group, BSP = Bank South Pacific.

Source: Survey carried out by the Pacific Clean Energy Financial Potential project team.

1 INTRODUCTION

Energy demand in the Pacific region has grown vigorously, along with energy access rates, poverty reduction, and the levels of energy use demanded by a modern lifestyle. However, there is limited information on the number and type of appliances used by households, their energy ratings, and the level of residents' awareness of the economic benefits they could get by using energy-efficient appliances, as well as a lack of information on their willingness to purchase them. To date, there have been limited initiatives to identify and measure trends in the demand for renewable-energy products and energy-efficient appliances. In particular, it has been difficult to get insights into these trends disaggregated according to type of area (urban or rural, grid-connected or off-grid). As result, the demand for renewable-energy products and energy-efficient appliances in the 14 Pacific island countries (PICs) analyzed in this study remains largely unknown.

Kiribati and Tonga were selected as target sites for the contingent valuation of renewable-energy products and energy-efficient appliances. The survey sought to gauge the demand for these products and to gain insights into the population's willingness to pay (WTP) for them in grid-connected and off-grid areas. It looked at the income-expenditure profile of the surveyed households, considering their energy consumption, energy-related behavior, and preferences. The survey also looked into the context of the local markets and trade in solar products and energy-efficient appliances.

This survey report describes the methodology used and survey findings for both countries.

2 OBJECTIVES

The objective of the market and WTP survey was to provide an overview of the following:

- **The current situation.** The households' existing solar products and energy-efficient appliances, and how these are repaired, maintained, and replaced.
- **Size of the market.** The surveyed households that are willing to pay for solar products and energy-efficient appliances, given the products and appliances' environmentally cleaner use of energy and lower energy costs.
- **Market preferences and clean energy awareness.** The surveyed households' stated preferences regarding which solar products and energy-efficient appliances they are willing to pay for in order to benefit from the products and appliances' additional value as conduits to good-quality energy services, and to reduce their electricity and/or fossil fuel expenses.
- **Willingness to pay.** Analysis of incomes and expenses at the household level (disaggregated into urban and rural areas), and the 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.** Estimation of the willingness of households to take out loans, and on what conditions.
- **Market overview.** The inventory of solar products and energy-efficient appliances on the market, of suppliers, and of local lending institutions that are willing to support (via loans to households) purchases of solar products and energy-efficient appliances.
- **Other barriers and challenges.** Opportunities and constraints in the marketing of solar products and energy-efficient appliances.

3 METHODOLOGY USED

The contingent valuation approach was selected as the methodology for this study. This method estimates the value consumers place on a particular product by asking them directly about their WTP to obtain that product or willingness to forgo possession of that product.⁶ This method is an alternative to inferring the WTP 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 observation. The questions asked in a contingent valuation-based survey are hypothetical, so the answers are hypothetical as well. Moreover, biases are likely to occur when respondents overlook their budget constraints and overestimate their stated WTP.⁷ In an attempt to understand the context of the consumer behavior and preferences, the survey carried out in Kiribati and Tonga was underpinned by the following assumptions:

- The price of a product will affect WTP decisions. A price that is higher than the household's ability to pay may have a negative impact on WTP.
- A higher income will have a positive impact on WTP decisions. The availability of extra cash will strengthen the household's ability to pay for quality products and services that meet their energy needs.
- Age and gender influence a household's decision to purchase higher-quality products and services. A younger person may be inclined to take on more risks than an older person when taking out a loan. Furthermore, women and men approach the purchase of energy products and services differently. WTP is likely to have a positive impact on women when the purpose of the investment is to reduce their workload.
- The distance to market and availability of repair services also play a role in WTP responses.

The survey activities consisted of two components, which ran parallel to each other:

- Component 1: Market and WTP survey
- Component 2: Inventory of the market and of credit availability.

3.1 Component 1: Market and Willingness-to-Pay Survey

The market and WTP survey was carried out in late October and early November in 2021. It aimed to measure the households' willingness to pay an additional price and take out a loan to purchase solar products and energy-efficient appliances.

Two national energy experts, one for each country, were recruited to perform the following tasks:

- oversee and coordinate the implementation of all survey activities;
- hire a team of local interviewers to carry out the data collection in the selected survey locations;
- administer the project funds and ensure that expenditure is within the allocated budget;
- train the local field survey team in household energy demands, data collection methods, and data collation for reporting purposes;
- liaise with the project team on all matters relating to the project; and
- submit an end-of-project report that contains all the results of the survey, including lessons learnt from the project.

⁶ 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). pp. 5–17. <https://www.fao.org/3/x8955e/x8955e03.htm#TopOfPage>.

⁷ Science Direct. Contingent Valuation. <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/contingent-valuation>.

A sample of 3% of the households in selected locations was chosen. Kiribati's selected locations were: North Tarawa (rural off-grid), and Betio and South Tarawa (urban grid-connected). Tonga's selected locations were: Vava'u and Ha'apai (rural off-grid), and Tongatapu (urban grid-connected). Separate questionnaires were developed for both rural off-grid and urban grid-connected areas. The specific areas within the locations where surveys were carried out were chosen for ease of access and communications. The respondents were chosen through random selection. The number of surveyed households is given in Table A1.5. The major topics covered in the survey are found in Table A1.6. The full questionnaires are presented in Appendix 1.

Table A1.5: Proposed Number of Surveyed Households per Country

Population Measurements	Kiribati	Tonga
Total population (number) ^a	110,136	100,651
Access to electricity (%) ^b	91%	98%
Households (number)	17,772	18,198
Urban households in selected locations (number)	5,584	6,240
Rural households in selected locations (number)	1,128	2,745
Total households in selected locations (number)	6,712	8,985
Proposed sample, comprising 3% of the total (number)	201	270

^a These figures are taken from the 2016 census in both countries.

^b These figures are from 2018.

Source: 2016 Census.

Table A1.6: Topics Covered in the Survey

Urban Grid-Connected	Rural Off-Grid
<ul style="list-style-type: none"> • 18 questions • Socioeconomic data: name^a, gender, household size, employment status, cash income, and expenditure • Appliance inventory, appliance purchases, and WTP (including preferred payment type) • Repair and maintenance services • Awareness of benefits of energy-efficient appliances 	<ul style="list-style-type: none"> • 23 questions • Socioeconomic data: name^a, gender, household size, employment status, cash income, and expenditure • WTP and appliance and equipment rankings. • Mobile phone use and services. • Inventory of solar equipment and energy-efficient appliances • Repair and maintenance services. • Financial services and willingness to use available services.

WTP = willingness to pay.

^a The names of the respondents were recorded to identify the origin of the data and to follow up if there were any problems with the data provided.

Source: Survey carried out by the Pacific Clean Energy Financial Potential project team.

3.2 Component 2: Inventory of the Market and of Credit Availability

Component 2 focused on the elaboration of the market inventory of available solar products and energy-efficient appliances in the local markets of the areas surveyed, their costs, and the suppliers. This component also included an inventory of local lending agencies and services offering loans designed for purchases of solar products and energy-efficient appliances. The lending institutions considered included agencies of the national development banks and of other financial institutions. The templates used to collect the inventory data are presented in Appendix 2.

3.3 Data Processing and Analysis

The data-collection process was challenging in both countries, since the national energy experts and their teams of interviewers were managed remotely due to the travel restrictions resulting from the coronavirus disease 2019 (COVID-19) pandemic. Various factors impacted the process, including time constraints, time differences between the countries, a reliance on a range of communication platforms, and connectivity issues.

Data sets were submitted from both countries in Excel format on two separate dates, as per the project schedule. The survey data was processed starting with a check on inconsistencies and further clarifications wherever needed to ensure the quality of the data. The data sets on demographic information, especially age, gender, employment status, and household size, were consistently filled out. However, the data sets on income and, most notably, on expenditure were not consistently recorded.

During the data processing, the following observations were made:

- The respondents were not always willing to share sensitive information, such as household income and financial commitments (e.g., bank loans, church contributions).
- Many respondents were not fully aware of their household expenditures.
- Many respondents lacked an understanding of energy consumption and electricity demand.
- The survey was carried out during the day. The respondents were mainly unemployed, and mostly women (as in the case of South Tarawa, Kiribati).
- Some respondents shared annual data on their income, so an adjustment was made in these data sets.

4 ANALYSIS OF RESULTS - KIRIBATI

4.1 Demographic Analysis

A total of 204 households were surveyed in Kiribati, of which 82% were selected from 11 grid-connected districts in South Tarawa and the remaining 18% were off-grid households from 4 locations in North Tarawa. The survey collected information regarding each respondent's age, gender, household size, income, and employment status. Table A1.7 lists the number of off-grid and grid-connected households surveyed per location.

Table A1.7: Number of Households Surveyed in Kiribati, by Location

Grid-Connected Locations	Households Surveyed	Off-Grid Locations	Households Surveyed
Betio	40	Buariki	18
Bairiki	7	Tebwangaroi	4
Nanikai	9	Tearinibai	5
Teaoraereke	22	Nuatabu	9
Banraeaba	26		
Ambo	3		
Eita	13		
Bikenibeu	6		
Temaiku	5		
Bonriki	28		
Buota	9		
Total	168 (82%)		36 (18%)

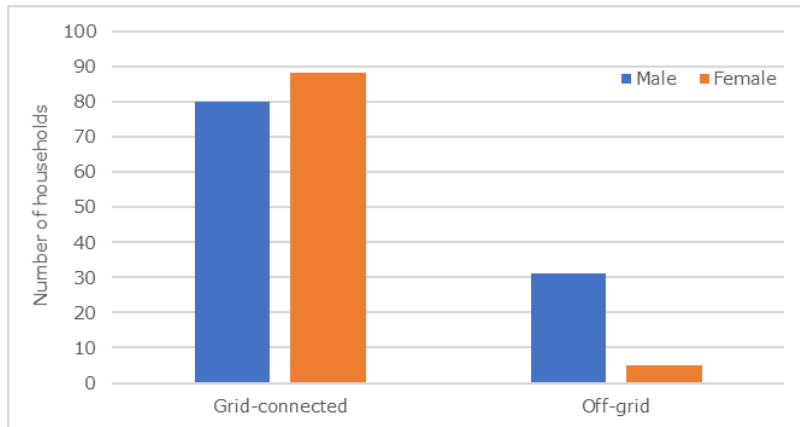
Source: Survey by the Pacific Clean Energy Financial Potential project team.

The gender ratio of respondents in the surveyed households was nearly even in the grid-connected households (48% male and 52% female), but predominantly male in the off-grid households (86% male and 14% female). The low participation of women in the rural areas was possibly due to the following reasons: (i) the survey was carried out during the weekend, when women typically went to market to sell their crafts; and (ii) the women who participated in the survey often submitted their husband's name, rather than their own, as this is a cultural practice in North Tarawa⁸ and perhaps in rural areas generally. However, women are the main energy consumers in the households, mainly for cooking, washing, handicraft production, cleaning, and reading. About 30% of women in the surveyed grid-connected households were willing to pay for energy-efficient appliances (Figure A1.5).

The overall age profile for the survey sample was relatively young, as most respondents were under 50 years old. The average age for the grid-connected households was 39, with the youngest being 19 years and the oldest a retired citizen who was 71. The off-grid household age distribution varied between 24 to 64, with the median age of 40 (Figure A1.6).

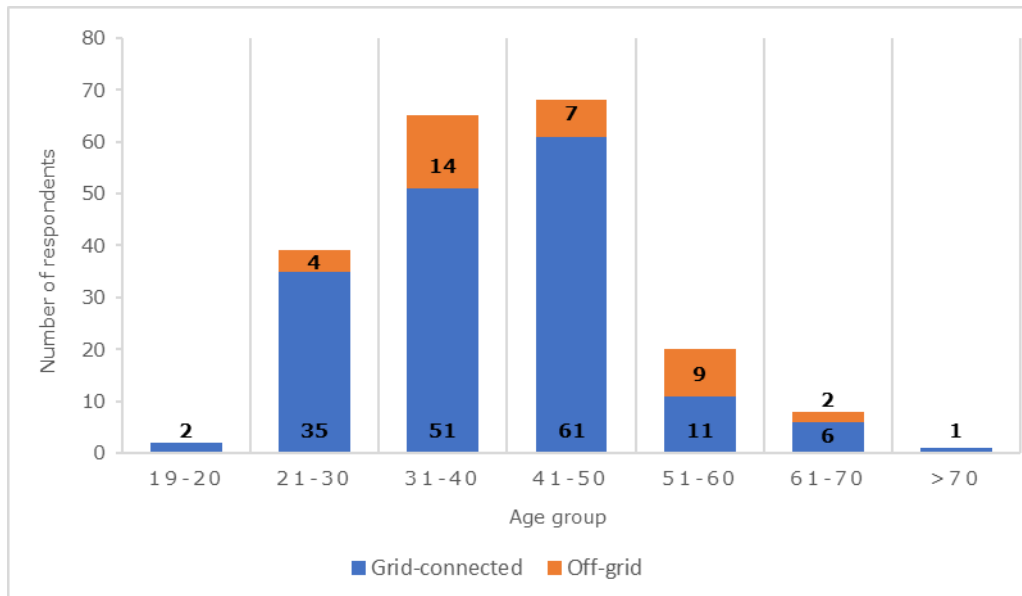
⁸ The surveyed islands in North Tarawa included: Buariki, Buota, Nuatabu, Tearinibai, and Tebwangaroi.

Figure A1.5: Gender Distribution of Survey Respondents in Grid-Connected Households in Kiribati



Source: Survey by the Pacific Clean Energy Financial Potential project team.

Figure A1.6: Age Distribution of Survey Respondents in Kiribati

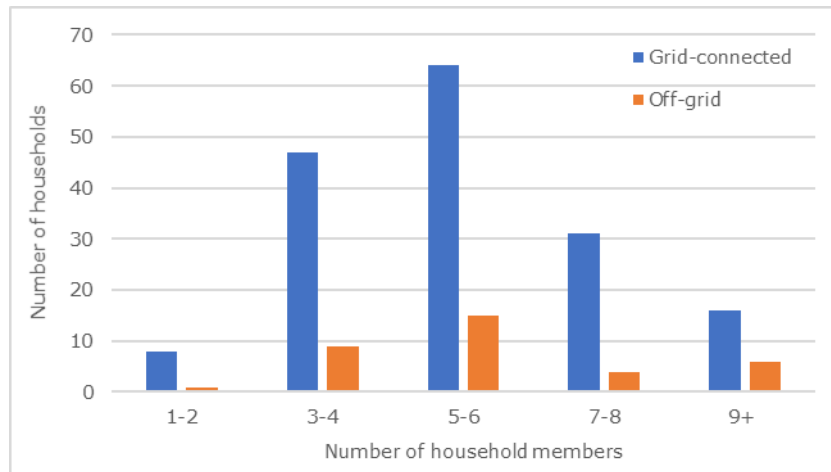


Source: Survey by the Pacific Clean Energy Financial Potential project team.

The total population captured in the survey was 1,151 individuals, of which 82% were grid-connected. The sizes of the grid-connected households varied from 2 to 14 members, with an average household size of 5 members. The remaining 18% surveyed households were in the off-grid areas. The sizes of these households also varied considerably, from 2 members to as many as 24. The average household size was 6.5 members, slightly higher than in the grid-connected sample (Figure A1.7).

Household size and energy consumption are closely linked. A large household (5 members and above) using many appliances for long hours will likely incur in a higher energy bill. The survey found that 12 households were high energy users, with a monthly electricity bill of at least \$72, or 100 Australian dollars (A\$). About 67% of these households had a minimum size of 7 members. However, not all large households have higher energy consumption. The survey found 4 smaller households (average 4 members) paying a monthly electricity bill that was higher than \$72 (A\$100) per month.

Figure A1.7: Sizes of Surveyed Households in Kiribati



Source: Survey by the Pacific Clean Energy Financial Potential project team.

4.2 Household Incomes

4.2.1 Grid-connected households

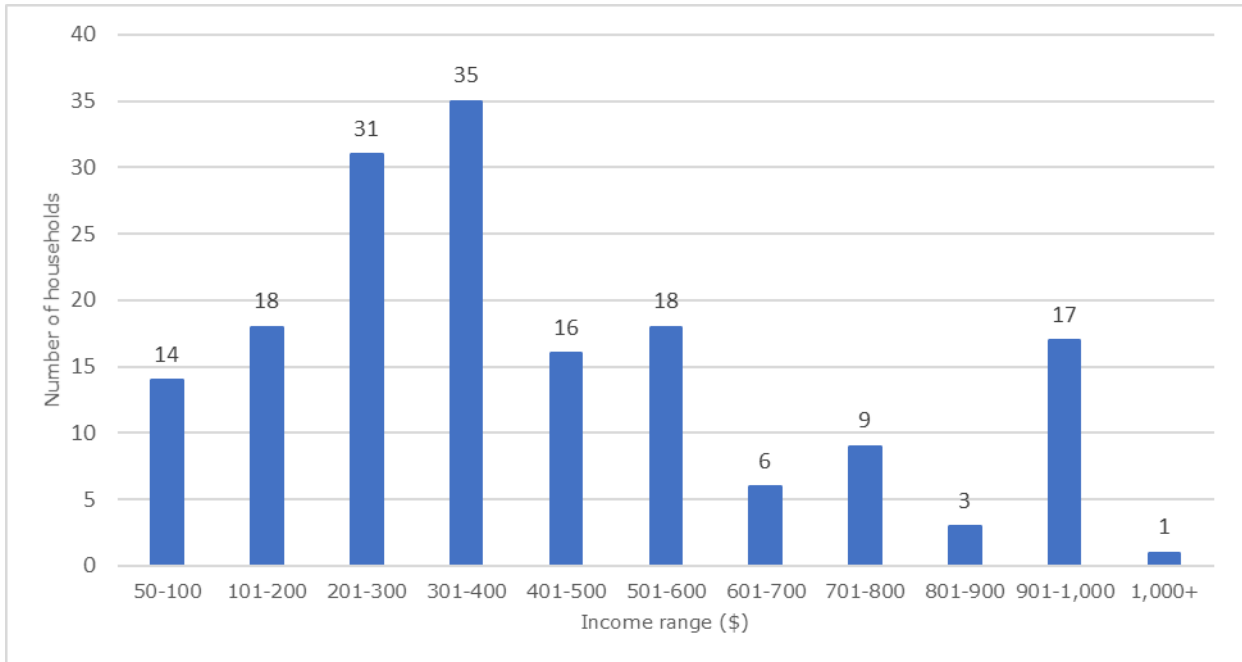
The sum of all the monthly incomes recorded from the grid-connected surveyed households in Kiribati was \$53,636. The incomes ranged considerably, between \$36 and \$792, with an average income of \$319, which was much higher than the median income of \$252 (i.e., 27% higher). The median income is the exact midpoint of incomes or, in other words, the most typical income earned by a grid-connected household in Kiribati. The average income is the mathematical mean of all incomes reported in the survey for each country. The existence of a considerable number of high or low incomes causes the average to be higher or lower than the median income, indicating inequality. The distribution of monthly household incomes in Kiribati is shown in Figure A1.8. The considerable number of monthly incomes at the top range (i.e., higher than \$900) caused the average income to be higher than the median (typical) household income.

Employment is the main income source for urban households. However, the survey revealed a very high unemployment rate of 70% (Figure A1.9). Despite the unemployment rate, the majority of households (88% of employed and 64% of unemployed) stated their willingness to pay for energy-efficient appliances.

About 34% of surveyed households identified wages and salaries as one of their sources of income. About 56% of surveyed households stated that they rely on the government's Support Fund to meet their family needs. The Support Fund is a government allowance to unemployed adults to help them buy food and other much-needed goods and services. Monetary gifts from family and friends living abroad were also stated as a source of income by 18% of surveyed households.

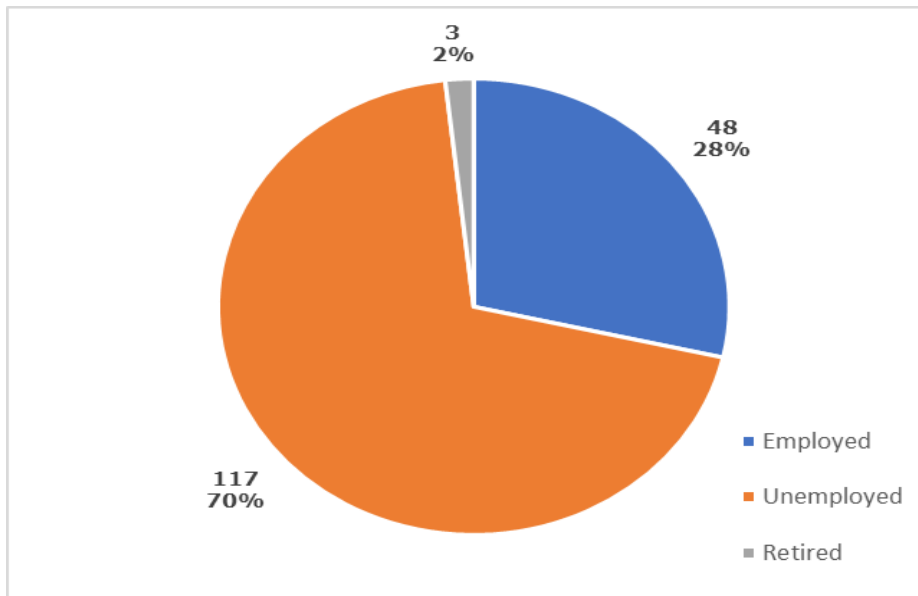
There were various other sources of income. About 17% of households make some money by selling their catch of the day. Also, the same proportion of households generated income from agricultural activities, 14% from private businesses, and 10% from handicraft production (Figure A1.10).

Figure A1.8: Monthly Cash Incomes of Grid-Connected Households in Kiribati



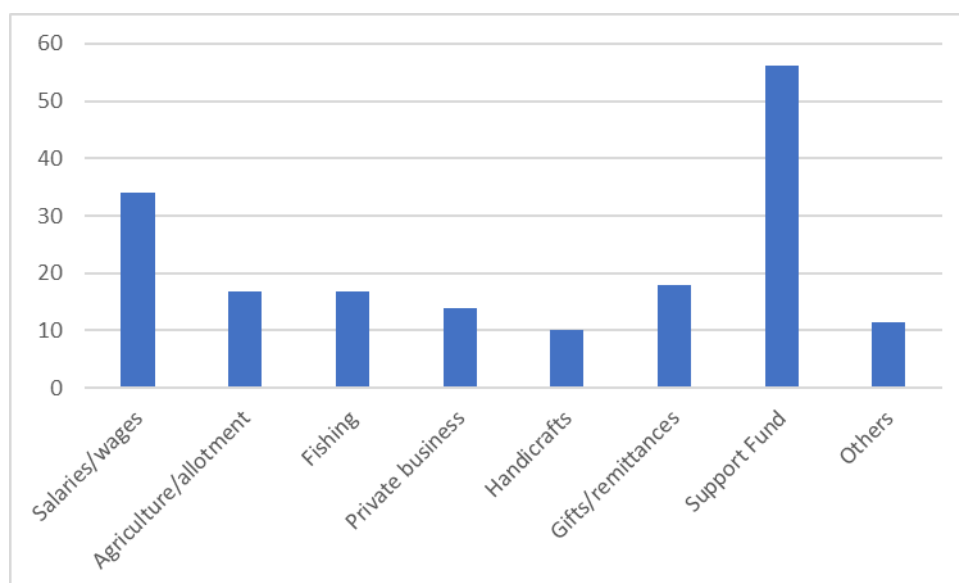
Source: Survey by the Pacific Clean Energy Financial Potential project team.

Figure A1.9: Employment Profile of Grid-Connected Households in Kiribati



Note: The first value in each section represents the actual number of respondents, and the second represents the percentage of all respondents from grid-connected households in Kiribati.
 Source: Survey by the Pacific Clean Energy Financial Potential project team.

Figure A1.10: Sources of Income for Grid-Connected Households in Kiribati (%)



Note: Each bar in this graph indicates the percentage of grid-connected households that claimed the associated category as one of their sources of income or as their only income. Source: Survey by the Pacific Clean Energy Financial Potential project team.

4.2.2 Off-grid households

The sum of all monthly incomes recorded for the sample of rural off-grid households in Kiribati was approximately \$15,106. Monthly household incomes ranged between \$144 and \$1,296. The average monthly income was \$420, which was 11% higher than the median income of \$378 (Figure A1.11). This result showed that the surveyed households in rural North Tarawa were faring better than their counterparts in urban South Tarawa. As noted above, the median income is the most typical income earned by a household. An average income that is higher than the median income indicates at least some level of inequality, though not as much as that revealed by the survey in Kiribati's urban areas.

Residents of rural and remote locations tend to have irregular incomes due to the limited extent of economic activity there, so they depend mostly on handicraft production, agriculture, and fishing. The monthly incomes of the surveyed households were said to come from a variety of sources (Figure A1.12). Copra production is a main source of income for remote and rural villages in Kiribati. North Tarawa produced 330 tons of copra in 2017.⁹ About 64% of the households surveyed in off-grid areas earned cash from copra processing and production. Fishing for subsistence and commercial sale is also very common in Kiribati's remote islands and rural locations. Approximately 56% of respondents stated that they earned an income from fishing. Another common activity is handicraft production, which was identified as an income source by 42% of the surveyed off-grid households.

The survey revealed an unemployment rate of 90% among the off-grid surveyed households (Figure A1.13). Unemployment in North Tarawa is largely due to the absence of a robust economy, which limits opportunities for formal employment. Due to the high unemployment rate, 72% of surveyed households were receiving unemployment support from the government.

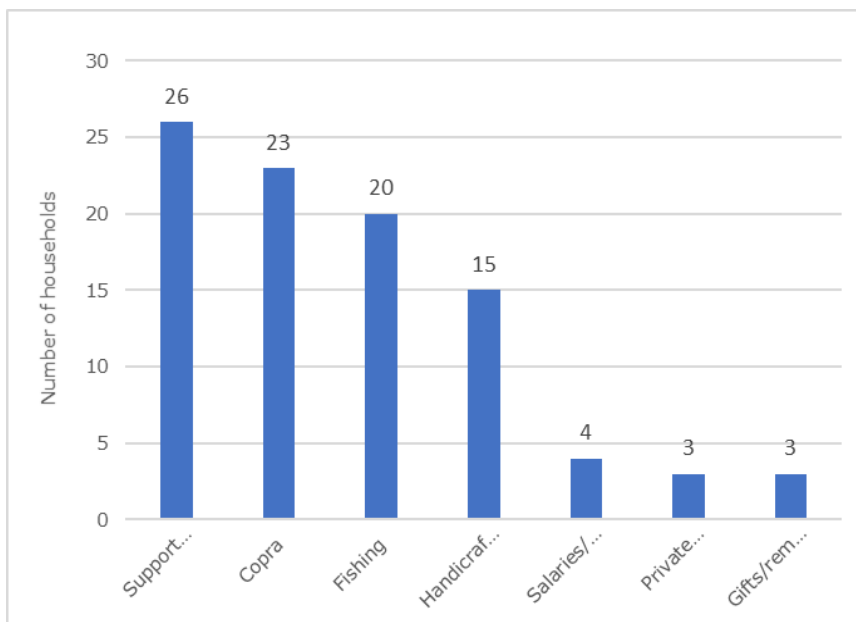
⁹ Government of Kiribati, National Statistics Office. "Production." <https://nso.gov.ki/statistics/economy/copra-production/>.

Figure A1.11: Distribution of Monthly Incomes in Off-Grid Households in Kiribati



Source: Survey by Pacific Clean Energy Financial Potential project team.

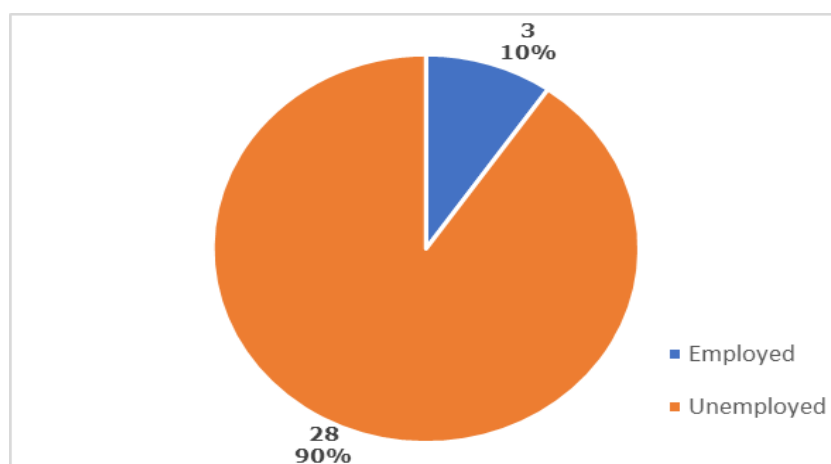
Figure A1.12: Sources of Income for Off-Grid Households in Kiribati



Note: Each bar in this graph indicates the number of off-grid households that claimed the associated category as one of their sources of income or as their only income.

Source: Survey by the Pacific Clean Energy Financial Potential project team.

Figure A1.13: Employment Profile of Off-Grid Households in Kiribati



Note: The first value in each section represents the actual number of respondents, and the second represents the percentage of all respondents from off-grid households in Kiribati.

Source: Survey by the Pacific Clean Energy Financial Potential project team.

4.3 Expenditure and Savings

The collection of precise expenditure data per item was difficult, due to the respondents' lack of knowledge or their inability to calculate their monthly expenditures per item requested. Therefore, while the results reported here are derived from the analysis of the collected data, they should be considered only as indicative.

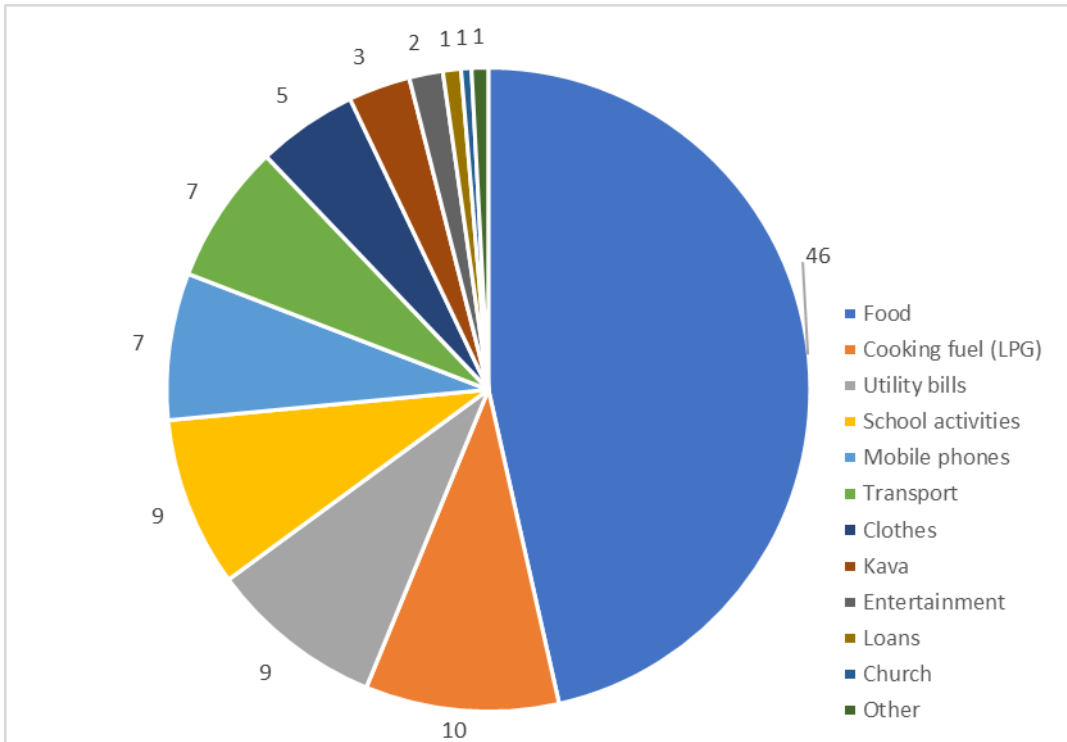
4.3.1 Grid-connected households

The average monthly expenditure for urban grid-connected households was estimated at \$189 based on the survey data, and the median monthly expenditure was estimated at \$167. The lack of knowledge on the part of many respondents regarding their household expenditures on several basic items led the authors to conclude that the estimated average and median expenditure values were substantially underestimated. Another conclusion was that the low average and median incomes make it practically impossible for the majority of Kiribati's urban population to save a meaningful amount of money. A lack of savings will affect a household's ability and willingness to pay (WTP) for energy-efficient appliances.

The overall expenditure on food represented 46% of total monthly spending, followed by cooking fuel, at 10%; utility bills and school activities, both at 9%; and mobile and transport costs, both at 7% (Figure A1.14).

The minimum value recorded for a monthly electricity bill was \$4, and the maximum was \$144. The median electricity bill was \$15 (Figure A1.15).

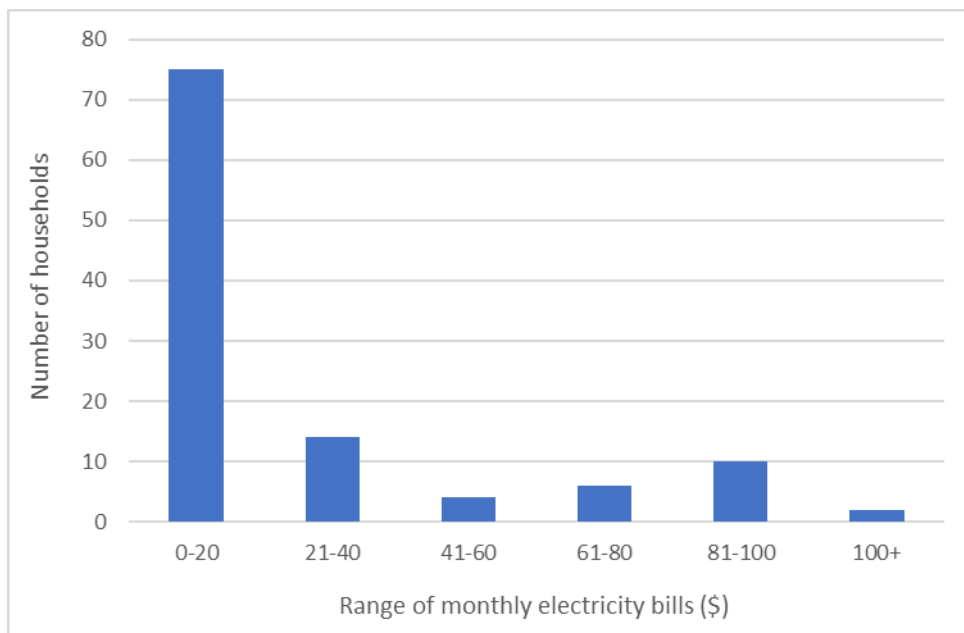
Figure A1.14: Monthly Expenditures of Grid-Connected Households in Kiribati (%)



LPG = liquefied petroleum gas.

Source: Survey by the Pacific Clean Energy Financial Potential project team.

Figure A1.15: Monthly Electricity Bills of Grid-Connected Households in Kiribati



Source: Survey by the Pacific Clean Energy Financial Potential project team.

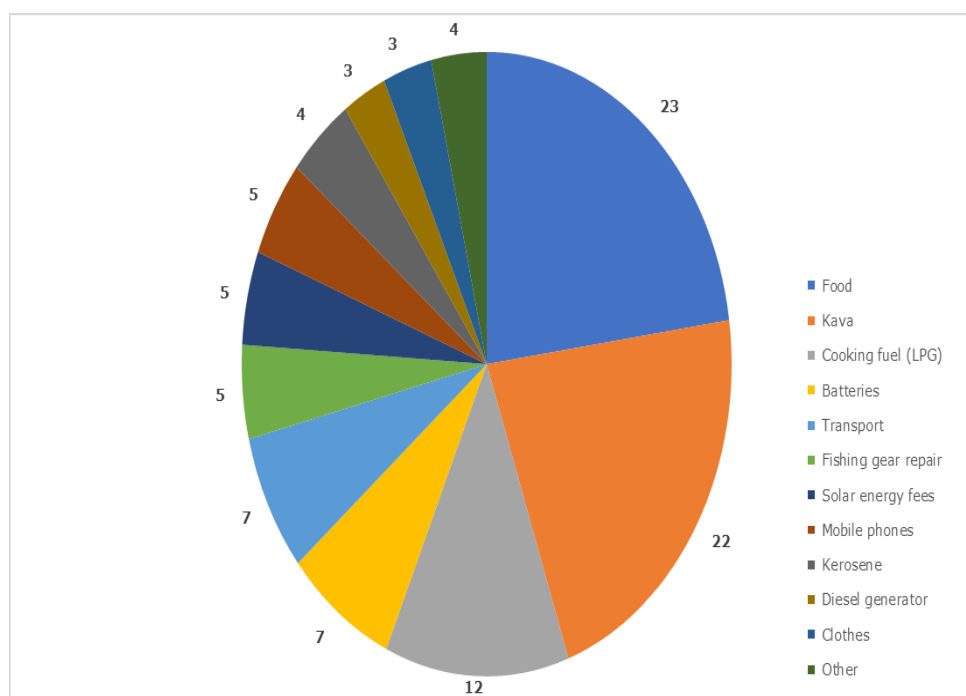
4.3.2 Off-grid households

The average monthly expenditure for rural off-grid households was estimated at \$54 based on the survey data, and the median monthly expenditure was estimated at \$37. The lack of knowledge on the part of many respondents regarding their household expenditures on

several basic items led the authors to conclude that the estimated average and median expenditure values were substantially underestimated. Another conclusion was that the low average and median incomes make it practically impossible for the majority of Kiribati’s rural population to save a meaningful amount of money; at best, they can manage some modest savings.

The combined expenditure on food and cooking fuel accounted for 35% of all expenses. Expenditure on energy-related items, except cooking fuel, accounted for 19%. Food plus energy comprised 54% of the overall household monthly expenses. Spending on Kava in this sample was high, with an average of 22% of the total monthly expenses (Figure A1.16).

Figure A1.16: Monthly Expenditures of Off-Grid Households in Kiribati (%)



LPG = liquefied petroleum gas.

Source: Survey by the Pacific Clean Energy Financial Potential project team.

4.4 Appliance and Solar-Product Inventory

4.4.1 Grid-connected households

The rate of appliance ownership in the surveyed grid-connected households in Kiribati is shown in Table A1.8. A total of 835 appliances for cooking, cooling, heating, and other activities were recorded in all 168 households surveyed. Many households owned more than one appliance, particularly freezers, fans, and televisions (TVs). About 78% of households owned fans, 70% owned radios, 62% owned TVs, and 58% owned freezers, but only 14% owned refrigerators.

A total of 120 grid-connected households were able to respond to questioning about their purchases of major appliances over the past couple of years. Of these households, 64% had bought a major appliance during 2019-2021 (Figure A1.17). The preferences for next appliance purchases in grid-connected households is shown in Figure A1.18. Washing machines, refrigerators, freezers, and TVs were the most preferred next purchases.

Repair and maintenance of electrical appliances was considered very important. However, only 38% of households stated that there were repair and maintenance services available to them (Figure A1.19). The total monthly cost of repairs and maintenance was recorded at \$2,716, with the minimum cost per household at \$7 and the maximum cost per household at \$72; the median cost was recorded at \$36.

Regarding lighting equipment, 393 lighting units were found in the surveyed grid-connected households in Kiribati. Light-emitting diode (LED) long fluorescent light (LFL) tubes are common, with 157 units currently in operation (accounting for 40% of all lighting units). LED lighting accounted for 28% of all lighting units in use, with compact fluorescent lights accounting for 21% (Figure A1.20). The popularity of LFLs may be due to the need for better lighting; product availability; and possibly, the cost.

Table A1.8: Ownership of Appliances in Grid-Connected Households in Kiribati

Appliance	Number in Operation	Households Owning Appliance (%)
Fans	214	78
Radios	121	70
TVs	114	62
Freezers	112	58
Refrigerators	31	14
Solar lighting	93	49
Rechargeable lights	22	2
Kettles for hot water	67	40
Cooking tops	29	15
Air conditioners	10	3
Microwave ovens	11	33
Hot water systems	6	1
Irons, blenders, solar pumps	5	1
Total	835	

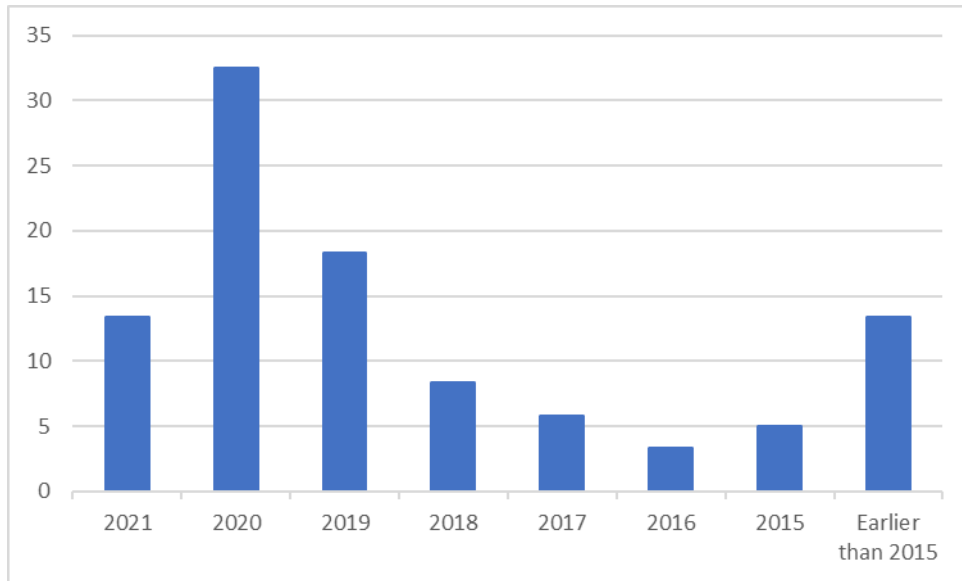
Notes:

1. The values in this table are based on 168 surveyed households.

2. A blank cell indicates that a column head does not apply.

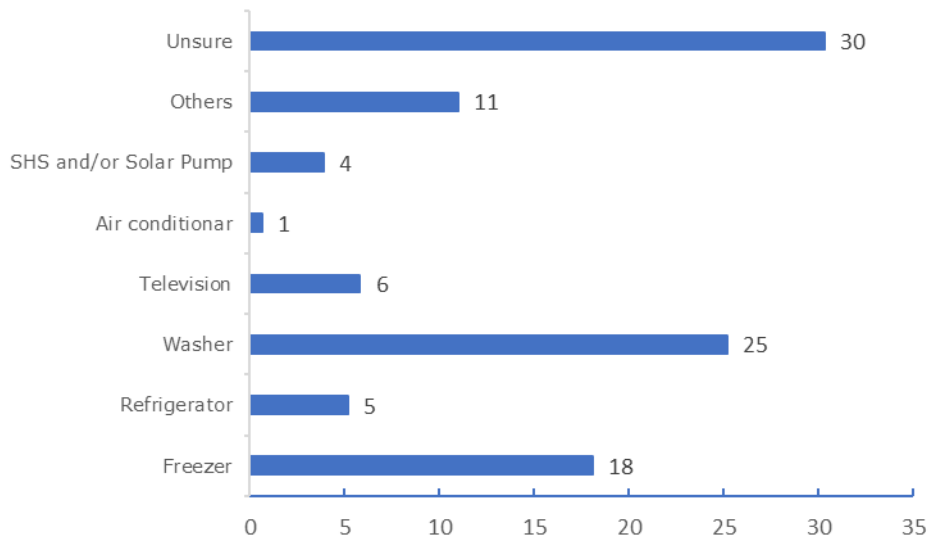
Source: Survey by the Pacific Clean Energy Financial Potential project team.

Figure A1.17: History of Major Appliance Purchases in Grid-Connected Households in Kiribati (%)



Source: Survey by the Pacific Clean Energy Financial Potential project team.

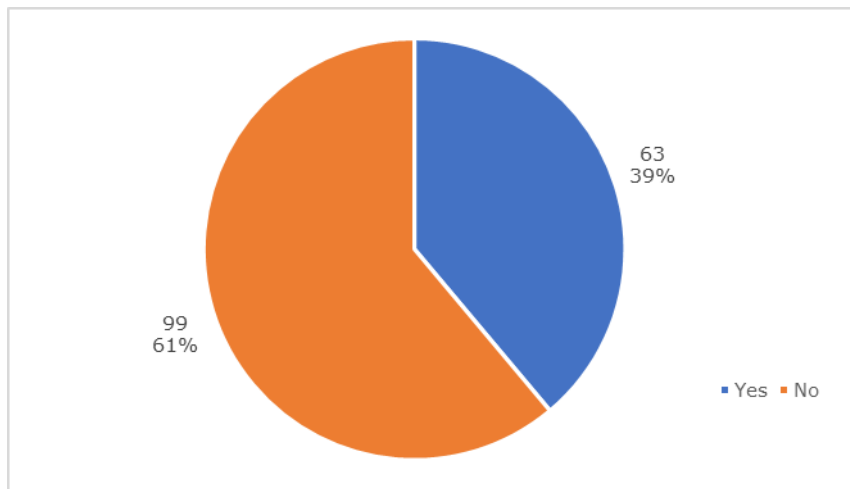
Figure A1.18: Preferences for Next Appliance Purchases in Grid-Connected Households in Kiribati (%)



SHS = solar heating system.

Source: Survey by the Pacific Clean Energy Financial Potential project team.

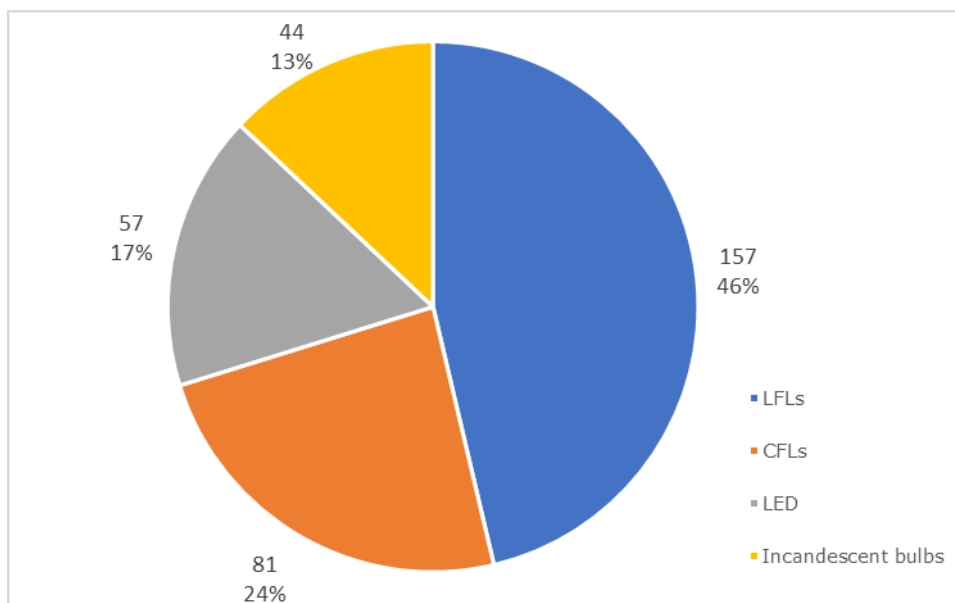
Figure A1.19: Availability of Repair and Maintenance Services for Grid-Connected Households in Kiribati (%)



Note: The first value in each section represents the actual number of respondents and the second represents the percentage of all respondents from grid-connected households in Kiribati.

Source: Survey by the Pacific Clean Energy Financial Potential project team.

Figure A1.20: Types of Lighting Equipment in Grid-Connected Households in Kiribati (%)



CFL = compact fluorescent lamp, LED = light-emitting diode, LFL = long fluorescent light.

Note: The first value in each section represents the actual number of respondents, and the second represents the percentage of all respondents from grid-connected households in Kiribati.

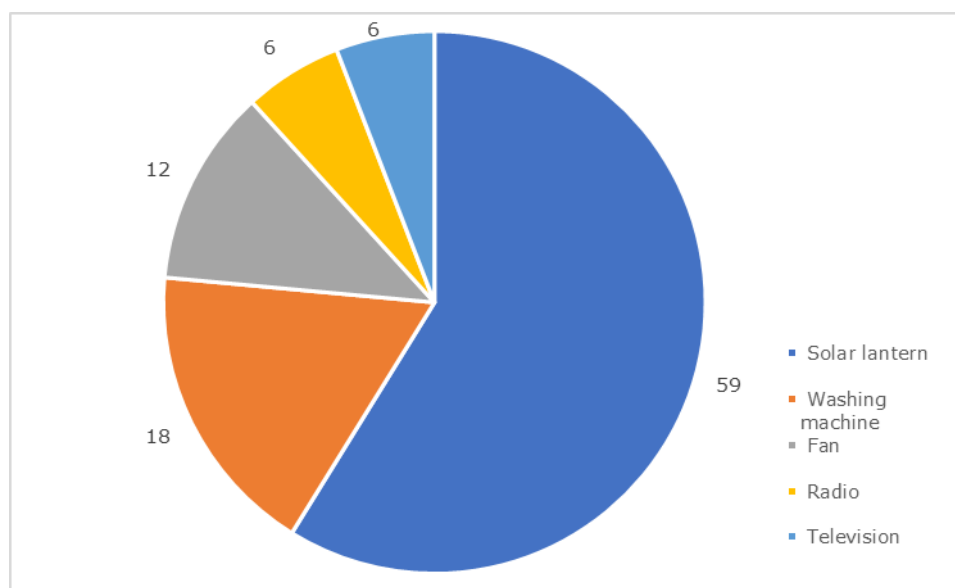
Source: Survey by the Pacific Clean Energy Financial Potential project team.

4.4.2 Off-grid households

Respondents to the survey were asked to rank seven types of appliances commonly used in rural communities for lighting, communication, cooling, and washing. They were asked to give a score of 1 for the most important item and 5 for the least. Only five types of equipment and appliances received a score of 1. Mobile phones and refrigerators did not receive an

importance ranking at all. The results of this ranking showed that lighting remains an essential service for rural households with limited energy access (Figure A1.21).

Figure A1.21: Ranking of Importance of Solar Products in Off-Grid Households in Kiribati (%)



Source: Survey by the Pacific Clean Energy Financial Potential project team.

Mobile phone ownership was 83%, and almost all units were charged through solar chargers. Only two respondents used mobile money services.

In terms of lighting devices, all the off-grid households except two had lighting units, though the number of units owned varied from household to household. A total of 49 units were recorded as being in operation, with the households owning one, two, or six units. Families were using lighting mainly for reading, studying, cooking, and socializing. Each time a lighting device was used, the duration of such use varied among households, ranging from three hours to overnight. A total of 17 solar products were found in operation, and they are recorded in Table A1.9. Respondents stated that the repair of solar equipment was a service mostly provided by the community council (33%), was done by the respondents on their own (21%), or done by a household member (15%), or that there was no repair service available (30%). Only one respondent mentioned he had paid \$7 for repair service.

Table A1.9: Recorded Solar Products in Off-Grid Households in Kiribati

	Fan	Television	Radio	Laptop	Solar pump
Number of units	7	5	3	1	1
Number of households	6	5	3	1	1

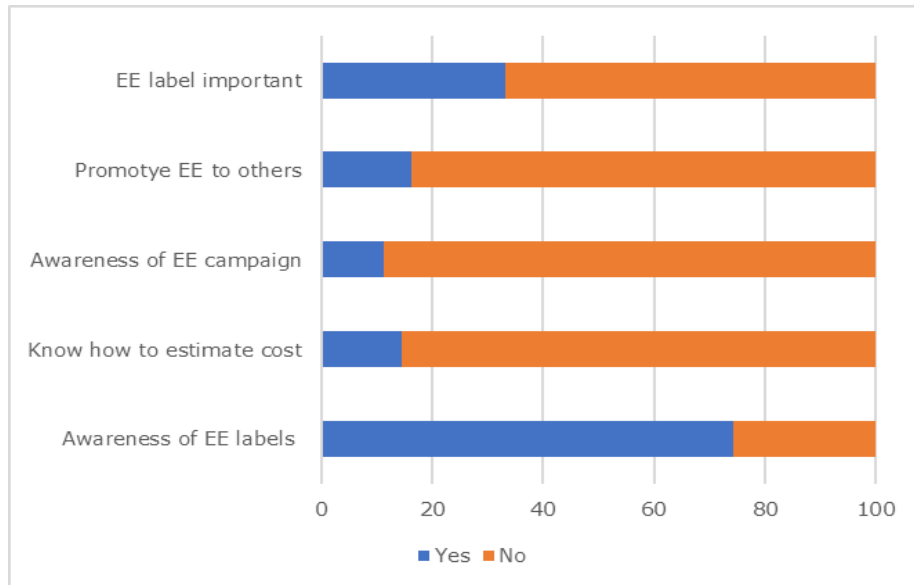
Source: Survey by the Pacific Clean Energy Financial Potential project team.

4.5 Awareness of Energy Efficiency

The awareness of energy efficiency labelling is very low in Kiribati (Figure A1.22). For instance, approximately 14% of respondents in grid-connected households confirmed that they knew how to read labels and estimate energy consumption and costs; 33% of respondents stated that labelling was an important element in their decision to purchase their next appliance. Their reasons included paying lower bills and saving money. Awareness of

the promotion of energy-efficient appliances is also very low. Only about 11% of respondents (19) were aware of energy-efficient appliances, and only 16% stated that they would recommend energy-efficient household appliances to other people.

Figure A1.22: Awareness of Energy Efficiency and Labels in Grid-Connected Households in Kiribati (%)



EE = energy efficiency.

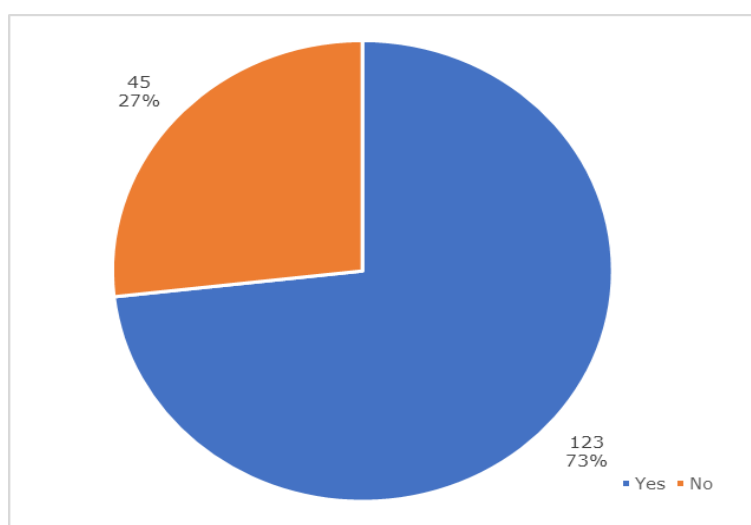
Source: Survey by the Pacific Clean Energy Financial Potential project team.

4.6 Willingness to Pay

4.6.1 Grid-connected households

The survey revealed that 73% of surveyed grid-connected households were willing to pay a higher price for energy-efficient appliances (Figure A1.23). This is encouraging, given the generally low awareness of energy-efficiency issues.

Figure A1.23: Willingness to Pay in Grid-Connected Households in Kiribati (%)



Notes:

1. This figure refers to the willingness to pay a higher price for an energy-efficient appliance.
2. The first value in each section represents the actual number of respondents and the second represents the percentage of all respondents from grid-connected households in Kiribati.

Source: Survey by the Pacific Clean Energy Financial Potential project team.

About 19% of respondents from grid-connected households stated that they would be willing to pay up to 5% more for energy-efficient appliances. This preference appeared to be strongly linked to the respondents' monthly incomes. As many as 36% households stated their willingness to pay up to 10% more for energy-efficient appliances, while 20% were willing to pay 20% more. Of the grid-connected households surveyed, 2% placed their willingness to pay (WTP) threshold at 80%, although this preference did not have a strong link with above-average incomes (Table A1.10).

Table A1.10: Willingness of Grid-Connected Households in Kiribati to Pay More for Energy-Efficient Appliances

Extra cost (%)	≤5	10	12	15	20	30	40	50	>50	Total
Households (number)	23	44	1	1	24	11	4	11	2	121
Households (%)	19	36	1	1	20	9	3	9	2	100

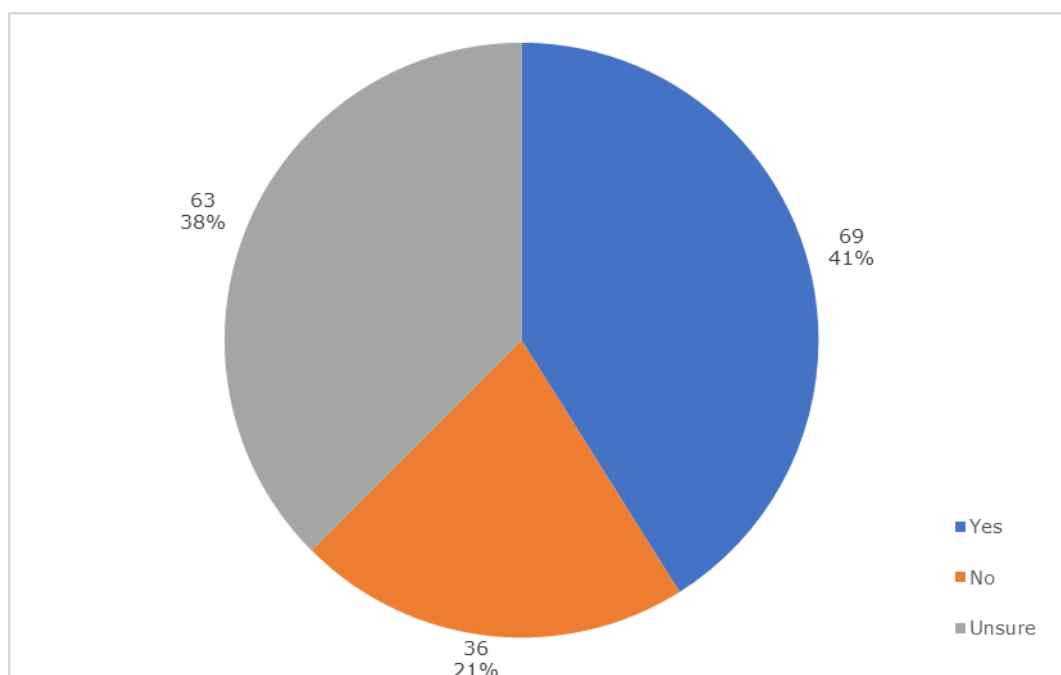
Source: Survey by the Pacific Clean Energy Financial Potential project team.

The survey also revealed that 41% (69 households) of the respondents were willing to take out a loan to purchase energy-efficient appliances, 38% (63 households) were unsure, and 21% (36 households) stated that they were not willing to take out a loan (Figure A1.24).

Further analysis on the correlation between WTP with other factors, such as income, employment, gender, and household size was carried out to establish if these factors impacted on WTP preferences and decisions. According to the survey results, the correlation between WTP and income was not as clear-cut as expected. The largest group of respondents (41%) stated that they were willing to pay more money, take out a loan, or resort to a purchasing facility to buy energy-efficient appliances at prices that were 5%–80% higher. However, the average monthly income (\$349) of this group was the second highest of the overall survey sample. The second group of respondents (26%) reacted positively when asked if they would be willing to pay more money for energy-efficient appliances, but they were not sure about

taking out a loan to do so; their average monthly income was \$376, and they were willing to pay up to 80% extra. The third group (7%) stated they were willing to pay extra for energy-efficient appliances, but they would not be willing to take out a loan or engage a facility to do so; their average monthly income was \$324. The two remaining groups, comprising 12% and 15% of the respondents, were not willing to pay extra, or were unsure, or would not take out a loan to buy energy-efficient appliances (Table A1.11).

Figure A1.24: Willingness of Grid-Connected Households in Kiribati to Take Out a Loan to Buy Energy-Efficient Appliances (%)



Note: The first value in each section represents the actual number of respondents, and the second represents the percentage of all respondents from grid-connected households in Kiribati. Source: Survey by the Pacific Clean Energy Financial Potential project team.

Table A1.11: Comparison of Income, Willingness to Pay More, and Willingness to Borrow to Buy Energy-Efficient Appliances in Urban Kiribati

Willingness to Pay More / Borrow	Number of Respondents/ Percentage of Sample	Average Monthly Income (\$)	Extent of Acceptable Extra Cost (%)
No/No	25/15%	257	
Yes/No	11/7%	324	5-50
Yes/Unsure	43/26%	376	5-80
No/Unsure	20/12%	169	10
No/Yes	0/0%		
Yes/Yes	69/41%	349	5-80
Total respondents	168/100%^a		

Note: A blank cell indicates that the column head does not apply.

^a Percentages may not total 100% due to rounding.

Source: Survey by the Pacific Clean Energy Financial Potential project team.

Regarding the linkage between WTP and employment, the survey results showed that 88% of the employed group (48 respondents) and 64% of the unemployed group (117) responded positively. This result demonstrates a positive relationship between income and WTP for the

employed cohort. However, the unemployed group appears to be an exception to the rule, as their budget constraints did not overrule their strong desire to enjoy the benefits of energy-efficient appliances. This group may have been unaware of the financial implications for their household financial situation if they were to pay higher prices for energy-efficient appliances. Alternatively, they may have answered positively to the WTP question because they thought it was expected of them.

In terms of the relationship between WTP and gender, it is commonly assumed that women are likely to respond positively to WTP because they are the biggest users of energy at home; thus, they would prefer to use energy-efficient appliances for reasons of cost and overall efficiency. Among the respondents, approximately 42% of men and 30% of women stated that they were willing to pay a higher price for energy-efficient appliances. All the males who responded positively were employed. The remaining 28% did not respond.

4.6.2 Off-grid households

The survey revealed that the WTP for enough electricity for better lighting, radio, phone charging, cooling, etc. was very high among the surveyed off-grid households. About 94% respondents said “yes,” and the remaining 6% did not respond. Of the group that agreed, 81% of them were unemployed, with monthly incomes ranging from \$144 (A\$200) to \$1,296 (A\$1,800). It appears that there was a weak correlation between income and WTP for the surveyed off-grid sample.

The willingness for take out loans to purchase renewable-energy products and energy-efficient appliances was also very high, with as many as 83% responding positively. This result may be affected by the very low participation of women as respondents in the sample of off-grid households. One of the weaknesses of stated preference surveys is that the respondents often fail to follow their stated preferences, so caution must be exercised when interpreting this result.

4.7 Supplier and Market Inventory

Suppliers are essential to the Kiribati energy market, as they play an important role in the provision, installation, repair, and maintenance of appliances and energy-related equipment. The survey found seven local companies selling and distributing renewable-energy products from Australia, Fiji, Malaysia, New Zealand, and the People’s Republic of China (PRC). About five of these local companies provide installation, repair, and training services. The presence of these suppliers encourages competition and provides employment opportunities. The survey also found seven local companies importing and selling a range of household electrical appliances (e.g., refrigerators, freezers, and washing machines) and equipment from Australia and the PRC. However, only limited information on repair and maintenance services was available for inclusion in the survey results (Tables A1.12 and A1.13).

Table A1.12: Suppliers and Distributors of Renewable-Energy Products in Kiribati

Supplier	Products	Services / Customers	Charges/Fees	Countries of Origin
Kiribati Green Energy Solution	SHSs (pre-wired), solar kits, mini-grids (5 kW and 10 kW), solar pumps, solar panels, solar streetlights, solar air conditioners, batteries, solar charge controllers, inverters, solar freezers, fans, LED lights, wind turbines	Sales, installations, repairs and maintenance, customers training Households, businesses, and communities	\$50–\$108 (A\$70–A\$150) for SHS, and \$7/watt (A\$10/watt) for a mini-grid system	Australia, PRC
Taotin Trading Company	Stand-alone systems customizations, solar panels, controllers, batteries, switches, solar kits, streetlights, freezers, DC breakers, arresters, DC cables, solar pumps, TVs, hi-fi, DC outboard motors	Sales, installations, repairs and maintenance, customers training Households, businesses, and communities	10% of the system cost	Australia, Malaysia, PRC
Slim Price Trading	SHSs, solar panels, batteries, controllers, solar lights	Sales, and warranty and customers training, but no installations,	No fees or charges	New Zealand, PRC
Sunrise Enterprises	Batteries, controllers, rechargeable solar lights, TV screens, home theaters	Sales, installations, repairs and maintenance, but no warranties	Installation charges (depending on cost)	Australia, PRC
JMR Group	Solar lighting, solar panels, batteries, controllers	Sales, installations, repairs and maintenance, 6-month warranties	Installation fee (depending on cost)	Australia, PRC
Darling Enterprises	Solar lighting, solar panels, controllers	Sales, installations, repairs and maintenance, 6-month warranties	installation charges (depending on system cost)	Australia
Betty Trading	SHSs, solar panels, solar lighting, solar freezers, batteries, TV screens, solar pumps, solar water heaters	Sales, installations, repairs and maintenance, 12-month warranties	Installation charges (depending on cost)	Australia, Fiji, New Zealand, PRC

A\$ = Australian dollars, DC = direct current, kW = kilowatt, LED = light-emitting diode, SHS = solar home system, PRC = People's Republic of China, TV = television.

Source: Survey by the Pacific Clean Energy Financial Potential project team.

Table A1.13: Suppliers and Distributors of Electrical Appliances and Equipment in Kiribati

Supplier	Products	Customers	Countries of Origin
Angiriin Hardware	Refrigerators, freezers, washing machines, air conditioners, LED lighting, rice cookers, microwave ovens, etc.	Households, businesses, communities, NGOs	No data
Slim Price Trading	Refrigerators, freezers, washing machines, LED lighting, TV screens, water pump	Households, businesses, communities, NGOs	Australia, PRC
Sunrise Enterprises	LED lighting, washing machines, TV screens, water pumps	Households, businesses, communities, NGOs	PRC
JMR Group	Refrigerators, freezers, washing machines, air conditioners, LED lighting, TV screens, fans, cooking appliances	Households, businesses, communities, NGOs	PRC
Darling Enterprises	Refrigerators, freezers, air conditioners, cooking appliances, electric tools	Households, businesses, communities, NGOs	Australia
Betty Trading	Refrigerators, freezers, washing machines, air conditioners, LED lighting, TV screens, electric tools, fans, water pumps	Households, businesses, communities, NGOs	Australia, PRC
Fair Price Hardware	Refrigerators, freezers, washing machines, LED lighting	Households, businesses, communities, NGOs	PRC

LED = light-emitting diode, NGO = nongovernment organization, PRC = People's Republic of China, TV = television.

Source: Survey by the Pacific Clean Energy Financial Potential project team.

4.8 Lending Agency Inventory

The financial possibilities in Kiribati are limited and more accessible to South Tarawa residents. North Tarawa residents must travel up to two hours to reach the nearest bank. Only one surveyed household uses banking services to support a family activity. This strong evidence showed that banking services are not essential for the North Tarawa community. The results of the inventory of lending agencies are shown in Table A1.14.

Table A1.14: Inventory of Lending Agencies and Services in Kiribati

<p>Development Bank of Kiribati</p> <ul style="list-style-type: none"> • DBK provides business and personal loans, and it provides support for the rural population in the outer islands through social loans and “energy efficiency loans.” DBK now has 19 agencies in the outer islands. • Various solar products and appliances are funded through energy efficiency loans, including solar lighting kits, solar refrigerators, and water solar pumps. The list of financeable products and their prices is provided by the Green Energy Solutions Company. Customers are not required to have a bank account. Loan repayments can be made in cash at the agency or branch. However, customers in outer islands have not shown much interest in these loans yet, since they cannot afford most of the listed products. • All loans require collateral, and the value of the collateral 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 if the Provident Fund assets are insufficient. For physical assets, real estate is preferred. • Target customers: households, businesses, schools, communities, churches, etc.
<p>Kiribati Provident Fund</p> <ul style="list-style-type: none"> • The Provident Fund lends to members to improve their living standards, including such activities as installing solar-energy systems, starting a new business, and refinancing other loans. • Target customers: households and businesses.
<p>Australia and New Zealand Banking Group</p> <ul style="list-style-type: none"> • The ANZ Bank provides personal and businesses loans. • Target customers: households, businesses, schools, and communities.

ANZ = Australia and New Zealand, DBK = Development Bank of Kiribati.

Source: Survey by the Pacific Clean Energy Financial Potential project team.

5 ANALYSIS OF RESULTS - TONGA

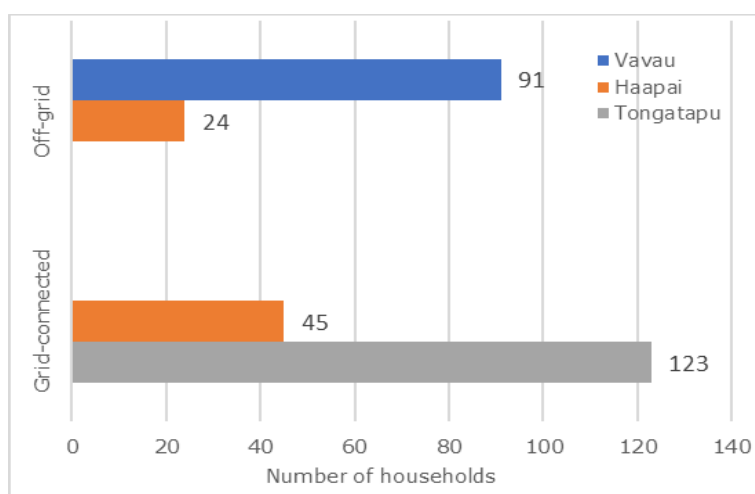
The survey in Tonga was carried out from 20 October to 5 November 2021, across three island groups: Tongatapu (main island), Vava'u, and Ha'apai.

The Ha'apai and Vava'u island groups are considered remote outer islands and are classified in the census as rural areas. To reach these islands requires an hour of air travel or two days via the local ferry to the main islands, and from there another boat trip to reach the final outer island destination. The cost of travel to these outer islands is considered expensive by local standards. The specific areas where the survey was carried out were chosen based on ease of access and communication.

5.1 Demographic Analysis

A total of 283 households were surveyed in Tonga. These households accounted for 2% of the total number of households in the three island groups. Of the surveyed households, 168 were grid-connected (representing 59% of the survey sample), and they were located in 7 districts on Tongatapu and in 7 villages in the Ha'apai island group. The remaining 115 households surveyed (41% of the survey sample) were off-grid, and located in 11 outer island villages in the Vava'u group and in 7 island villages in the Ha'apai group (Figure A1.25).

Figure A1.25: Households Surveyed by Island Group in Tonga



Source: Survey carried out by the Pacific Clean Energy Financial Potential project team.

Table A1.15 shows the number of grid-connected households surveyed by location. Over half of the grid-connected households were in the two districts of Tongatapu, where 35% of Tonga's population resides: Kolomotuá (29% of the sample) and Kolofoóu (22%).¹⁰ In Ha'apai, a total of 45 households participated, of which, 16 were from the district of Pangai.

Table A1.16 shows the number of off-grid households surveyed by location. A total of 115 households in 18 off-grid villages in the Vava'u and Ha'apai island groups participated in the survey.

The overall gender ratio for the respondents in Tonga was 49% male and 51% female. The ratio for the grid-connected sample was 48% male and 52% female, while that for the off-grid sample was 50% for each gender. Women are high users of energy appliances, so purchasing decisions often rely on the women's experience and knowledge. The age distribution of the Tongan respondents ranged from 20 to 84, with an average of 46 (Figure A1.26).

¹⁰ Government of Tonga, Statistics Department. 2017. *Tonga 2016 Census of Population and Housing*. Nuku'alofa, Tonga. The census included 6,240 households.

Household size matters in terms of energy demand, supply, and costs. The household sizes in the Tonga sample ranged from 1 dweller to 15 family members. The average number of members in a household was 5 for the off-grid and 6 for the grid-connected households (Figure A1.27), with 5 family members being the national average.¹¹ The sum of all the household members recorded was 1,545 individuals: 931 grid-connected and 614 off-grid.

Table A1.15: Number of Urban Grid-Connected Households Surveyed in Tonga by Location

Tongatapu	Number of Households Surveyed	Ha'apai Island Group	Number of Households Surveyed
Kolomotuá	48	Pangai	16
Kolofoóu	37	Koulo	10
Tatakamotonga	11	Holopeka	7
Nukunuku	9	Foa	5
Vaini	9	Nomuka ^a	3
Kolovai	5	'Uiha ^a	3
Lapaha	4	Ha'ano ^a	1
Total	123 (73%)		45 (27%)

^a These communities are connected to a mini-grid.

Source: Survey by the Pacific Clean Energy Financial Potential project team.

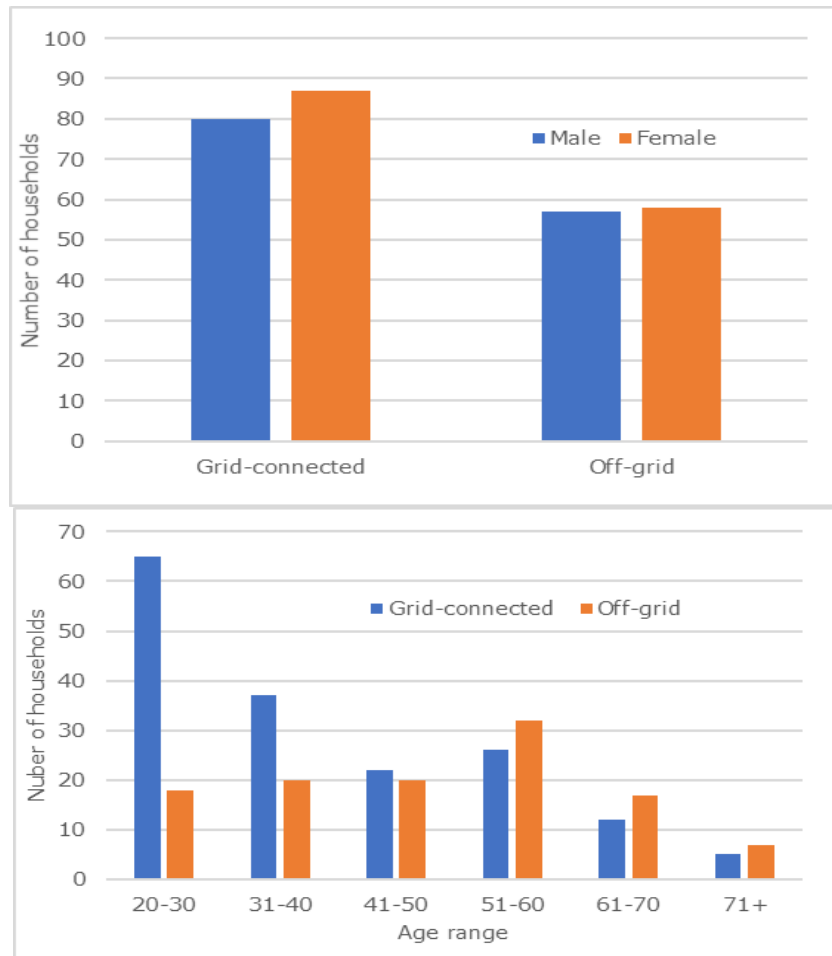
Table A1.16: Number of Rural Off-Grid Households Surveyed in Tonga by Location

Location	Island Group	Number of Households Surveyed
'Otea	Vava'u	9
Matamaka	Vava'u	5
Hunga	Vava'u	12
Ofu	Vava'u	11
Falevai	Vava'u	7
Ovaka	Vava'u	12
Nuapapu	Vava'u	10
Taunga	Vava'u	7
Kapa	Vava'u	6
'Olo'ua	Vava'u	10
Lape	Vava'u	2
Fotuha'a	Ha'apai	1
Matuku	Ha'apai	1
Mo'unga'one	Ha'apai	11
Kotu	Ha'apai	1
Lofanga	Ha'apai	8
'O'ua	Ha'apai	1
Mango	Ha'apai	1
Total		115

Source: Survey by the Pacific Clean Energy Financial Potential project team.

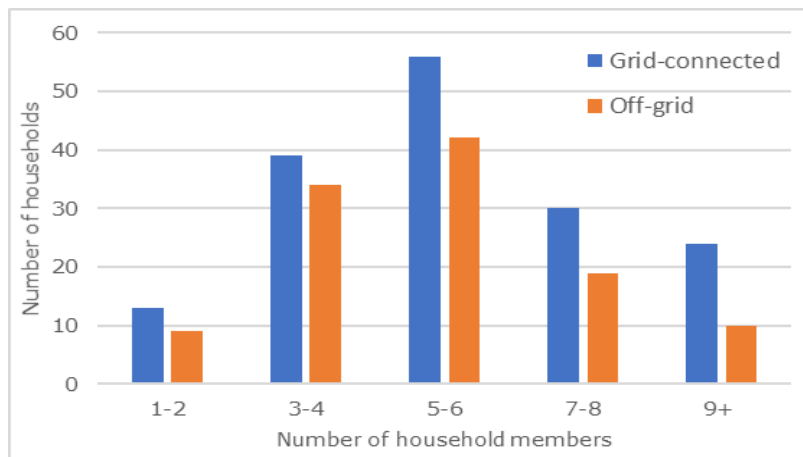
¹¹ Ibid.

Figure A1.26: Gender and Age Distribution of Survey Respondents in Tonga



Source: Survey by the Pacific Clean Energy Financial Potential project team.

Figure A1.27: Sizes of Surveyed Households in Tonga



Source: Survey by the Pacific Clean Energy Financial Potential project team.

5.2 Household Incomes

5.2.1 Grid-connected households

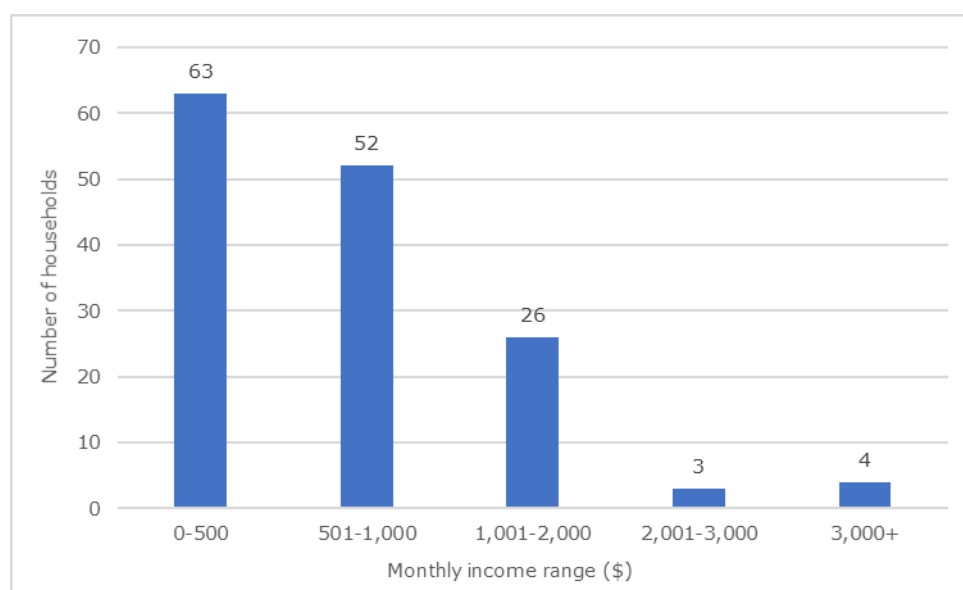
The sum of all the monthly incomes for the 148 grid-connected households that shared their earnings information was \$117,113. The monthly income per household ranged between \$13 and \$8,800. The average income was estimated at \$791, which was 26% higher than the median income, estimated at \$629 (Figure A1.28). As noted above, the median income is the most typical income earned by a household. An average income that is higher than the median income indicates a high level of inequality. About 36% of the surveyed households (54 households) were considered poor by definition¹² as their monthly incomes were below the poverty line. This limitation severely affected their ability to purchase solar-energy products and energy-efficient appliances.

According to the employment profile of the entire group of surveyed households, 69% of the respondents were employed full-time, and 21% were unemployed. Among the employed people, 63% worked for the government and 32% work for the private sector.

Six key sources of income were identified by the surveyed households: salary and wages, gifts and remittances, agricultural activities, handicrafts, fishing, and other private businesses. About 74% of the respondents indicated that salaries and wages were one of their sources of income, while 32% said that monetary gifts and remittances contributed to their household takings for the month (Figure A1.29).

About 67% of households indicated that they relied on one source of income. About 21% said that they relied on two income sources, while the rest indicated that they relied on three (9%) or four or more (2%) income sources to sustain their well-being. The collected data strongly suggests that having incomes from two or more sources increases a household's total financial resources. The evidence in this survey has shown that, in most households with three or four income sources, the monthly income is higher than average; however, this is not the case for all houses with multiple sources of income.

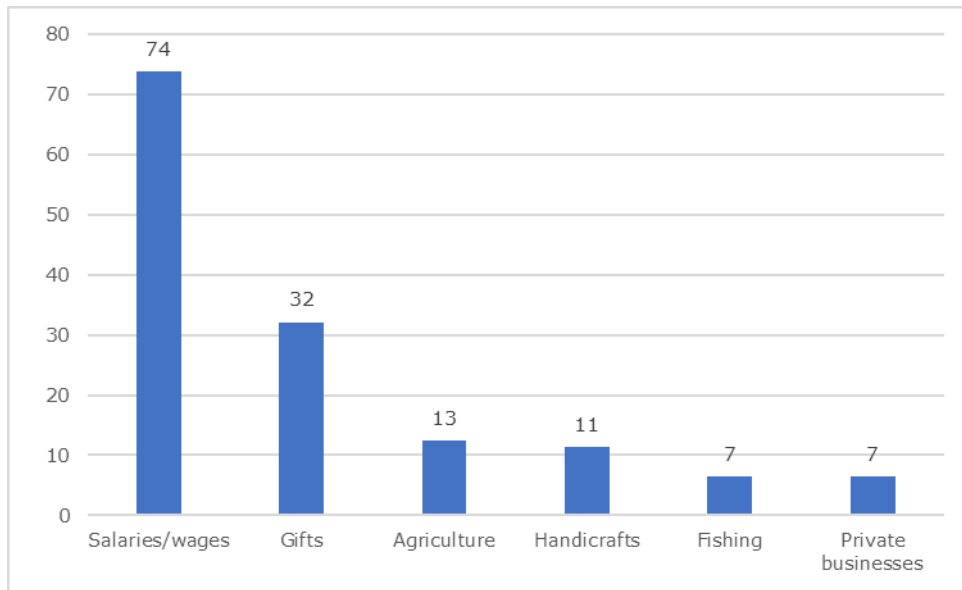
Figure A1.28: Monthly Cash Income in Grid-Connected Households in Tonga



Source: Survey by the Pacific Clean Energy Financial Potential project team.

¹² The poverty threshold in Tonga is defined at \$427 per month for each adult.

Figure A1.29: Sources of Income for Grid-Connected Households in Tonga (%)

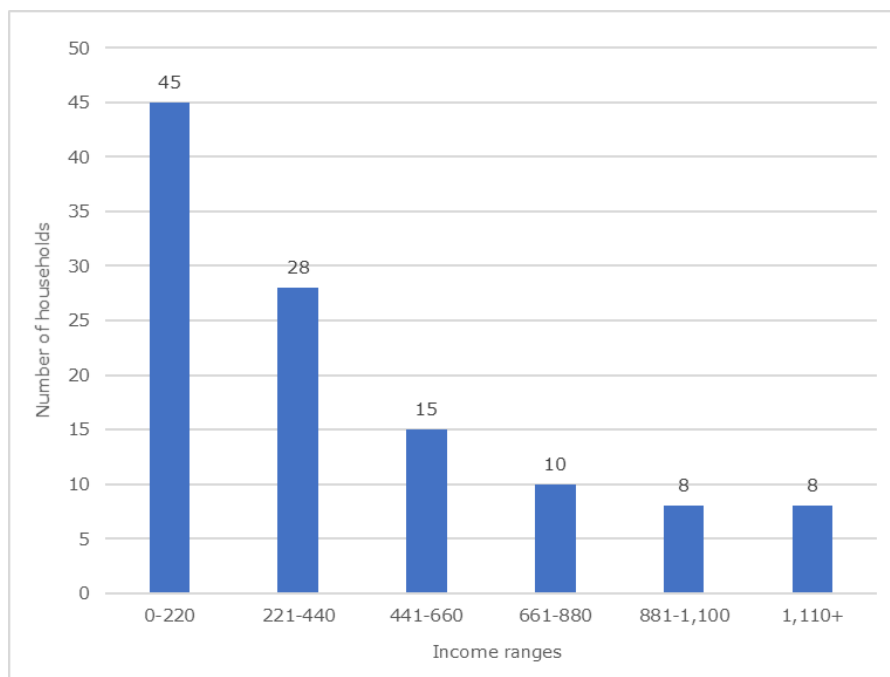


Note: Each bar in this graph indicates the percentage of grid-connected households that claimed the associated category as one of their sources of income or as their only income. Source: Survey by the Pacific Clean Energy Financial Potential project team.

5.2.2 Off-grid households

The sum of the monthly incomes recorded for the surveyed off-grid households was \$542,296. The recorded incomes ranged from \$31 to \$3,586, with the average income estimated at \$472, 53% higher than the median income of \$308. The large difference between the average and median incomes points out the country's severe level of socioeconomic inequality, as illustrated in Figure A1.30.

Figure A1.30: Distribution of Monthly Incomes in Off-Grid Households in Tonga

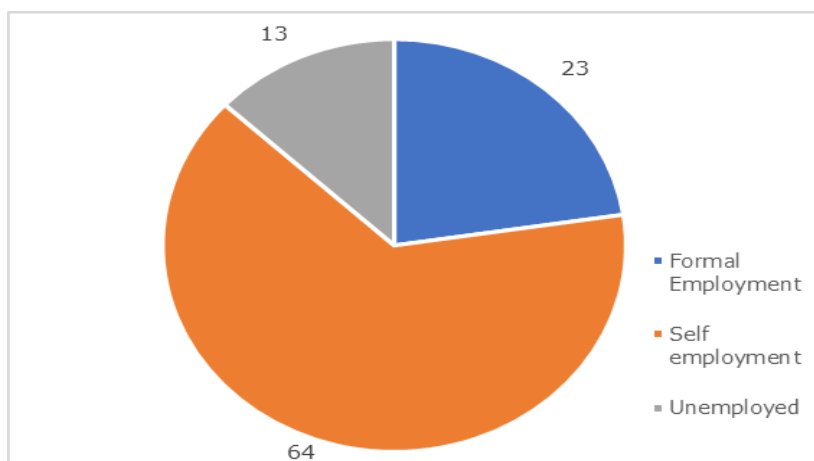


Source: Survey by the Pacific Clean Energy Financial Potential project team.

The most common source of income was gifts and remittances from family, friends, and relatives living on the main island of Tongatapu and abroad (mainly in New Zealand, Australia, and the United States). About 70% of respondents identified monetary gifts as one of their sources of income, with 14% of households relying on monetary gifts and remittances as their only source of income.

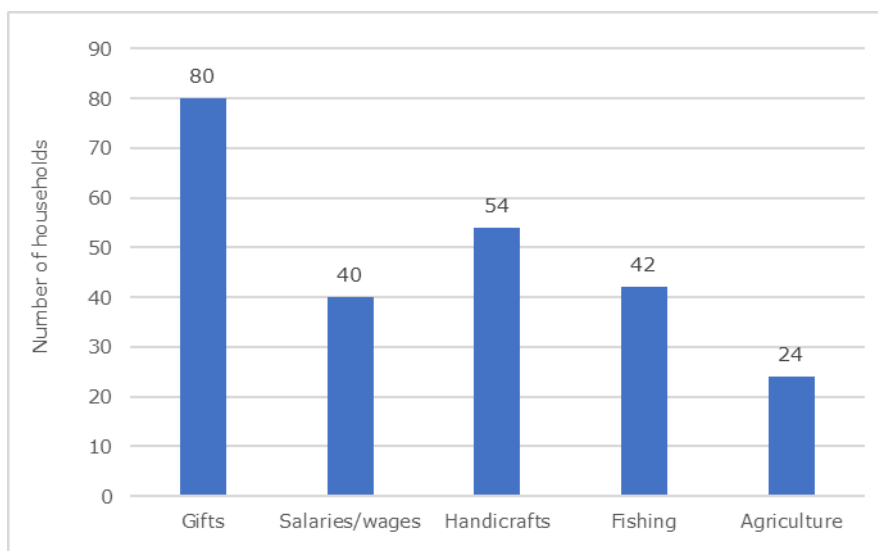
Only 35% of households received income in the form of salaries and wages. A significant number of the households were actively engaged in the informal sector, with 64% of households engaging in handicraft production, fishing, and agricultural activities (Figure A1.31). Approximately 47% of the households generated income from selling handicrafts, 37% from fishing activities, and 21% from agricultural activities (Figure A1.32).

Figure A1.31: Employment Profile of Off-Grid Households in Tonga (%)



Source: Survey by the Pacific Clean Energy Financial Potential project team.

Figure A1.32: Sources of Income for Off-Grid Households in Tonga



Note: Each bar in this graph indicates the number of off-grid households that claimed the associated category as one of their sources of income or as their only income.
 Source: Survey by the Pacific Clean Energy Financial Potential project team.

5.3 Expenditure and Savings

The collection of precise expenditure data per item was difficult, apparently due to the lack of knowledge of the respondents or to their inability to calculate their monthly expenditures per item requested. Therefore, while the results reported here are derived from the analysis of the collected data, they should be taken only as indicative.

5.3.1 Grid-connected households

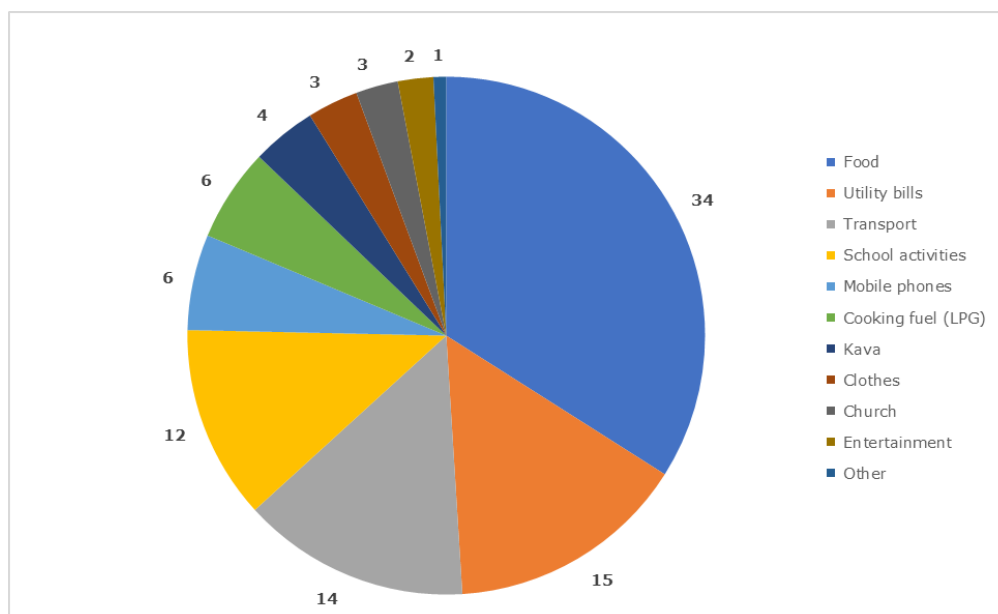
The average monthly expenditure for urban grid-connected households was estimated at \$347 based on the survey data, and the median monthly expenditure was estimated at \$299. About 21% of households (31 households) spent all their earnings during the month and were not able to save any money. These households were typically larger in size (at least five members), with monthly electricity bills exceeding \$44 (T\$100). Households with higher incomes spent as much as \$1,474 per month but were still able to save money.

The comparison of monthly incomes versus monthly expenditure provided the potential savings that could be expected of any household. It can also highlight the purchasing ability of the surveyed households, and thus inform policies to target the most vulnerable groups in the community. The average monthly savings per household were estimated at \$392, based on the survey data, and the maximum monthly savings per household were estimated at \$8,246. The large difference between them reflects the disproportionate distribution of wealth across the urban communities.

Over a third of household expenditure was on food, followed by utility bills (15%), transport (14%), and school activities (12%) (Figure A1.33).

The minimum household monthly expenditure on electricity was \$9, and the highest was \$260. The average monthly electricity bill was \$83, and the median \$88. The households with higher electricity bills were mostly larger and tended to have three major appliances, usually a refrigerator, freezer, and washing machine, in addition to numerous lighting units, including some with incandescent light bulbs.

Figure A1.33: Monthly Expenditures of Grid-Connected Households in Tonga (%)



Source: Survey by the Pacific Clean Energy Financial Potential project team.

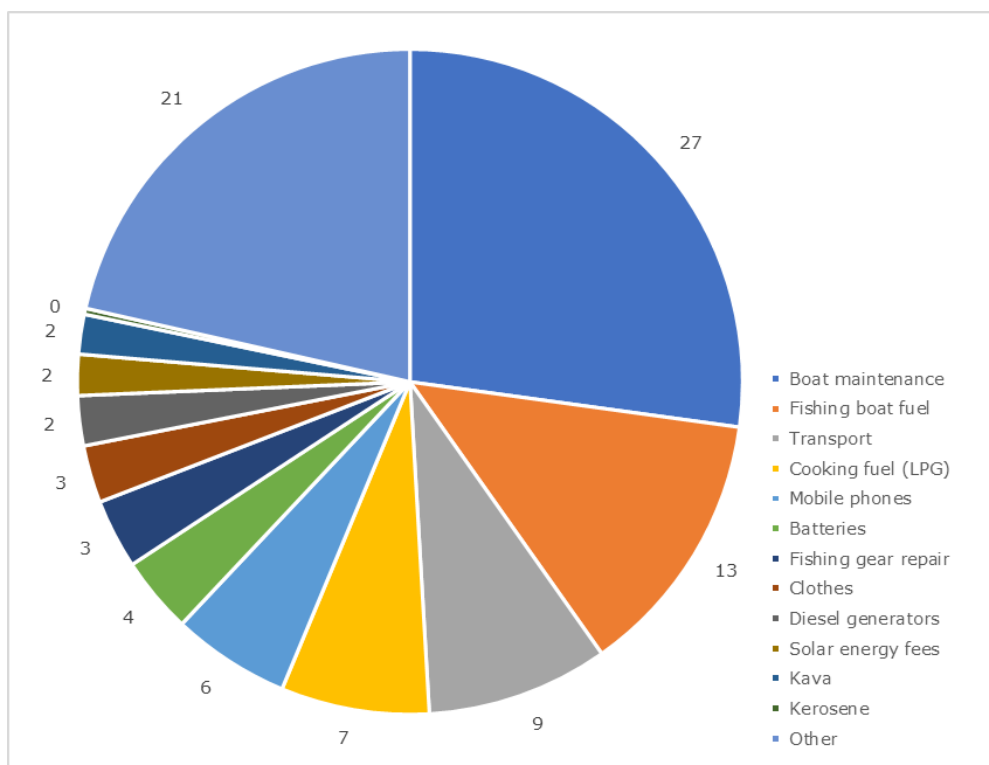
5.3.2 Off-grid households

The average monthly expenditure for rural off-grid households was estimated at \$282 based on the survey data, and the median monthly expenditure was estimated at \$134. In terms of savings, the estimated median monthly savings was \$30, and the maximum was \$1,919. A few households were not able to save at all. This large disparity reflects the unequal distribution of wealth in the outer islands of Tonga.

Travel between islands and fishing are key activities for the Ha’apai and Vava’u outer island communities. The cost of these activities is reflected in off-grid household spending: Boat maintenance and repair accounted for approximately 27% of total monthly expenses, and fuel for fishing boats accounted for 13%. When fishing gear repair (3%) is added, the overall costs associated with fishing and inter-island travel amounts to 43% of monthly household spending.

Food, church contributions, boat rentals, and bank loans amounted to 21% of total monthly spending in the outer islands. The costs of transport, cooking fuel, and solar-energy fees accounted for another 18% (Figure A1.34). It is important to note that the distance and cost of travel to the main island have an economic impact on all outer-island residents, especially on the employed population. The respondents who were employed at the time of the survey usually commuted to the main island for work (e.g., commuting from Kapa Island to Neiafu), and then remained at home with their families over the weekend. This is a very common practice for residents in the outer islands of the Vava’u and Ha’apai island groups.

Figure A1.34: Monthly Expenditures of Off-Grid Households in Tonga (%)



LPG = liquefied petroleum gas

Source: Survey by the Pacific Clean Energy Financial Potential project team.

5.4 Appliance and Solar-Product inventory

5.4.1 Grid-connected households

A wide range of household appliances for heating and cooling were found to be used in grid-connected households. The pattern of appliance ownership in all 168 surveyed households is shown in Table A1.17. A total of 1,384 equipment units and appliances were recorded. Many households owned more than one appliance, particularly freezers, fans, and TVs. About 76% of households owned a refrigerator, while 64% owned a freezer; ownership of TVs and radio was high, with 78% owning a TV and 79% owning a radio.

Table A1.17: Ownership of Appliances in Grid-Connected Households in Tonga

Appliance	Number in Operation	Households Owning Appliance (%)
Fans	207	61
Radio	154	79
TVs	158	78
Freezers	117	64
Refrigerators	136	76
Solar lighting	32	7
Kettles for hot water	135	74
Cooking tops	108	45
Air conditioners	23	8
Microwave ovens	83	45
Hot water systems	57	30
Irons, blenders, solar pumps	50	18
Total	1,260	

Notes:

1. The values in this table are based on 168 surveyed households.

2. A blank cell indicates that a column head does not apply.

Source: Survey by the Pacific Clean Energy Financial Potential project team.

Lighting in households is considered very important for families, particularly for allowing more hours for reading and study, and for more comfortable dining, entertainment, and socializing. A total of 1,594 lighting units in operation were recorded. The distribution of lighting units is shown in Table A1.18.

Table A1.18: Lighting Equipment in Use in Grid-Connected Households in Tonga

Type of Lighting	Number in Operation	Household Ownership (%)
Incandescent	545	95
CFLs	304	39
LFLs	432	51
LED	313	15
Total	1,594	

Notes:

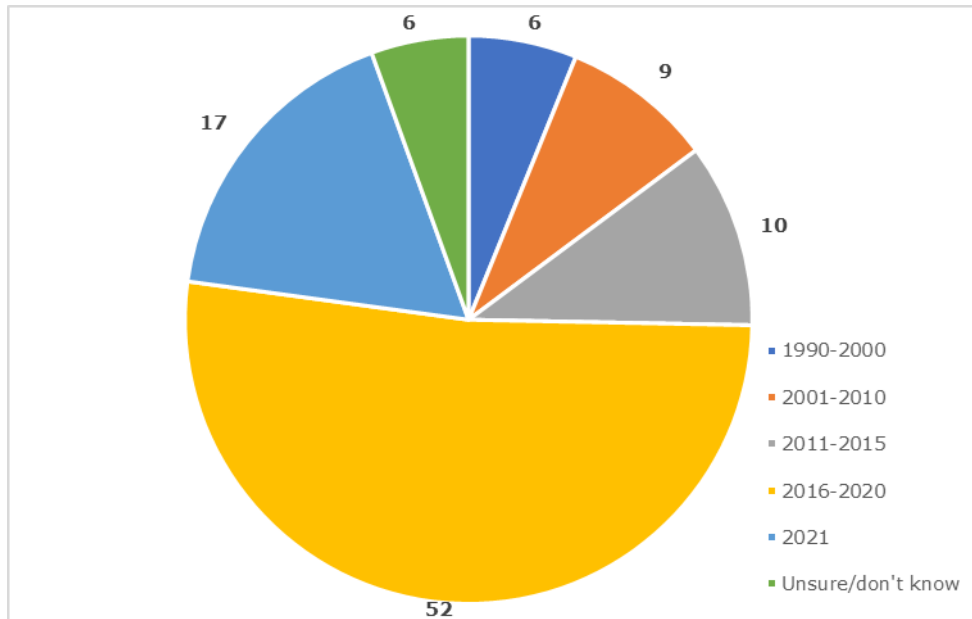
1. The values in this table are based on 168 surveyed households.

2. A blank cell indicates that a column head does not apply.

Source: Survey by the Pacific Clean Energy Financial Potential project team.

Appliance purchase history provided information on household preferences for various types of electrical appliances and revealed the periods of operation of these appliances. A total of 162 respondents were able to recall the year when they had last purchased a major appliance. Of these households, 69% had bought a major appliance during the past five years. It was interesting to note that appliances purchased 20 years ago were still operational at the time of the survey (Figure A1.35).

Figure A1.35: Purchase History of Major Appliances in Grid-Connected Households in Tonga (%)



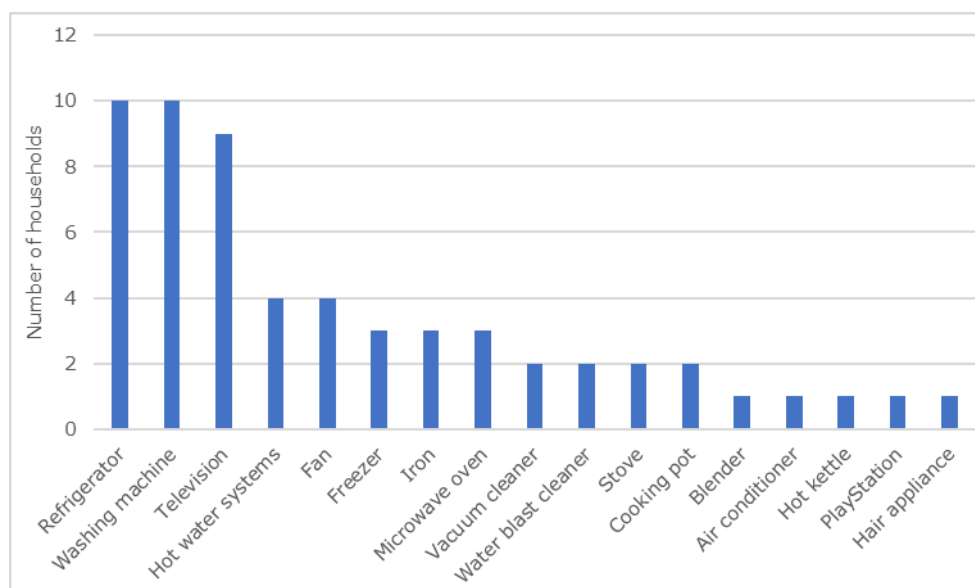
Note: The values in this figure represent the time when surveyed grid-connected households had bought their last major appliance.

Source: Survey by the Pacific Clean Energy Financial Potential project team.

About 77% of surveyed households (130 households) indicated they would consider future purchases. However, only 13% of these respondents (17 households) were able to estimate a date of purchase. Three households planned to make their next purchase before the end of 2021, four households in 2022, two households in 2023, and eight households in 2025 or later. A common answer was that new appliances would be bought when the current ones no longer worked and could no longer be repaired. The most frequently mentioned appliances for future purchase were refrigerators, washing machines, and TVs (Figure A1.36).

The survey also revealed that repair and maintenance services are severely limited. Approximately 48% of the respondents stated that there were no available repair and maintenance services. Eighty surveyed households reported on their average estimated monthly cost of repair and maintenance of appliances. These costs varied between \$22 and \$220 per month, with an average value of \$72 and a median of \$66 per month.

Figure A1.36: Next Planned Appliance Purchase for Grid-Connected Households in Tonga



Source: Survey by the Pacific Clean Energy Financial Potential project team.

5.4.2 Off-grid households

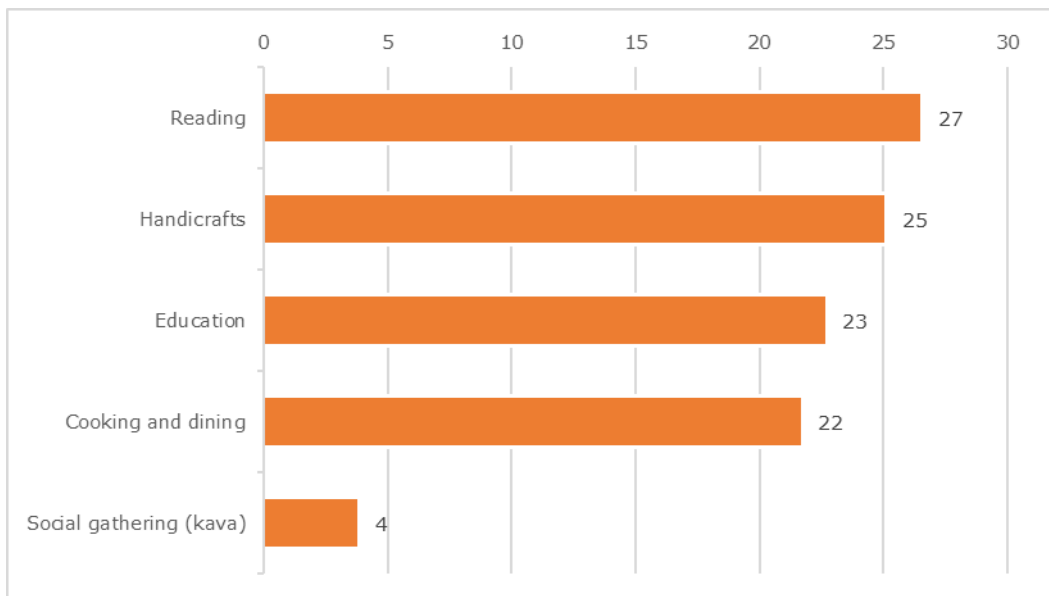
Surveyed off-grid households were asked to rank their energy requirements. They ranked solar lanterns as their number-one priority, compared with other equipment such as radios, fans, TVs, refrigerators, and washing machines.

The survey revealed that all off-grid households owned lighting units, and a total of 478 units were recorded. About 27% of these households stated they used lighting for reading, 25% for weaving and handicraft production, 23% for studying, 22% for cooking and family dinners, and 4% for social activities such as kava drinking (Figure A1.37). About 42% of the households were using lighting units for seven to nine hours a day, although lighting use ranged from 1 to 12 hours (Figure A1.38).

The survey also revealed that all off-grid households owned a mobile phone. All respondents stated their mobile phones were charged through a solar energy source, except for one respondent who claimed that he charged his mobile when his diesel genset was running. None of the respondents used a mobile money service.

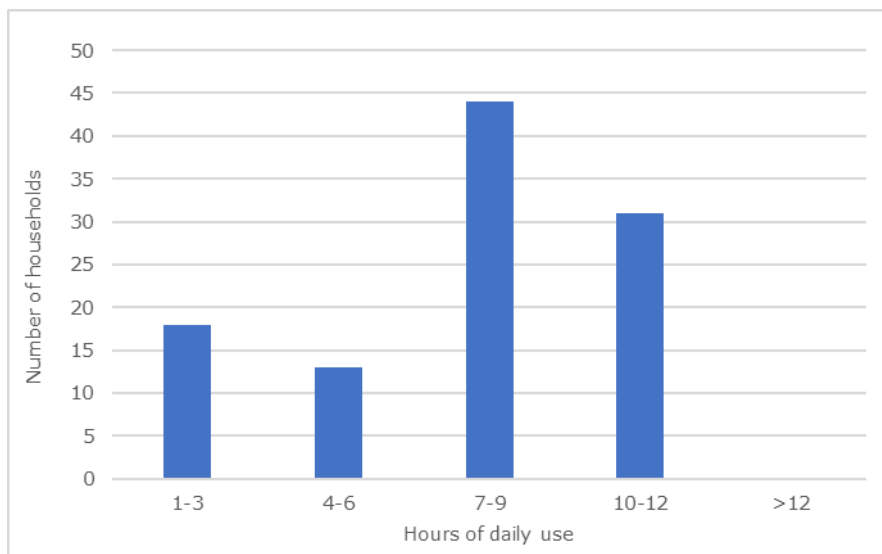
In terms of equipment repair and maintenance in off-grid households, all solar-energy systems were being serviced by an island-based technician, thanks to the support received from the Department of Energy. The cost of maintenance cost was said to be \$3 per month.

Figure A1.37: Uses of Lighting Equipment in Off-Grid Households in Tonga (%)



Source: Survey by the Pacific Clean Energy Financial Potential project team.

Figure A1.38: Hours of Lighting-Equipment Use in Off-Grid Households in Tonga



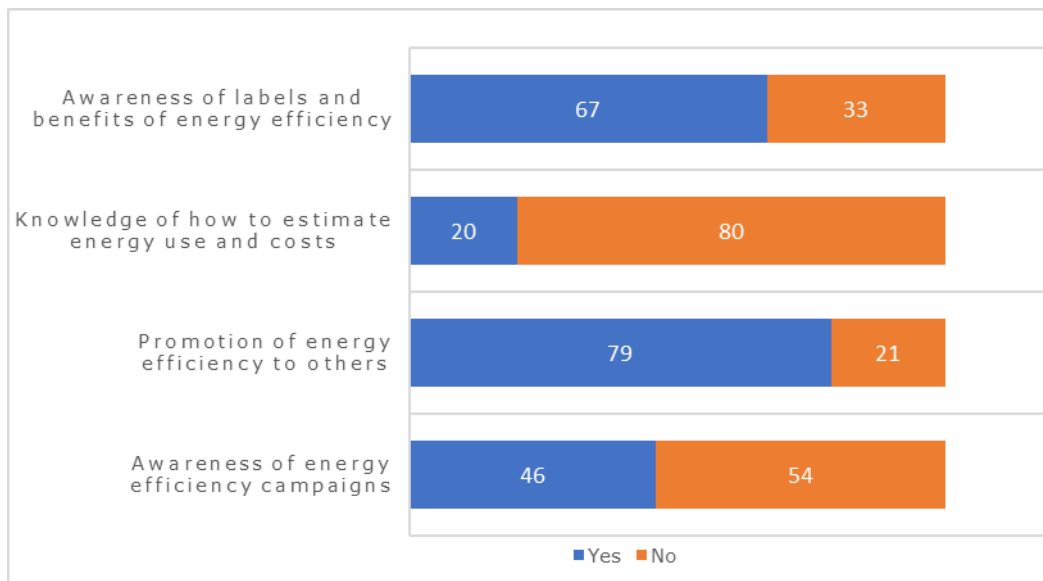
Source: Survey by the Pacific Clean Energy Financial Potential project team.

5.5 Awareness of Energy Efficiency

Awareness of the benefits of energy-efficient appliances in grid-connected households was 67%. About 64% of grid-connected households perceived energy efficiency labels to be very important when purchasing a new appliance. Most respondents had seen star-rating labels on white goods such as refrigerators, freezers, and washing machines. However, only 20% of grid-connected households stated that they were able to interpret those labels and estimate the appliances' running costs.

A large majority of households (79%) was willing to promote energy efficiency to others. However, only 46% were aware of energy-efficiency awareness campaigns. Figure A1.39 illustrates the range of factors impacting the grid-connected households' awareness and understanding of energy efficiency.

Figure A1.39: Awareness of Energy Efficiency in Grid-Connected Households in Tonga (%)



Source: Survey by the Pacific Clean Energy Financial Potential project team.

Respondents in grid-connected households also provided various reasons why it is important to promote energy efficiency labelling, including:

- reducing electricity use,
- conserving energy sources,
- saving on electricity bills, and
- helping others know more about energy efficiency.

Contrary to the situation in grid-connected areas, awareness of the benefits of energy-efficient appliances in off-grid households was found to be extremely low. A nationwide energy campaign seems necessary to educate and raise household awareness about the economic and environmental benefits of using energy-efficient appliances. The suppliers and distributors of solar products and appliances will be essential for such an initiative and should be given a marketing role.

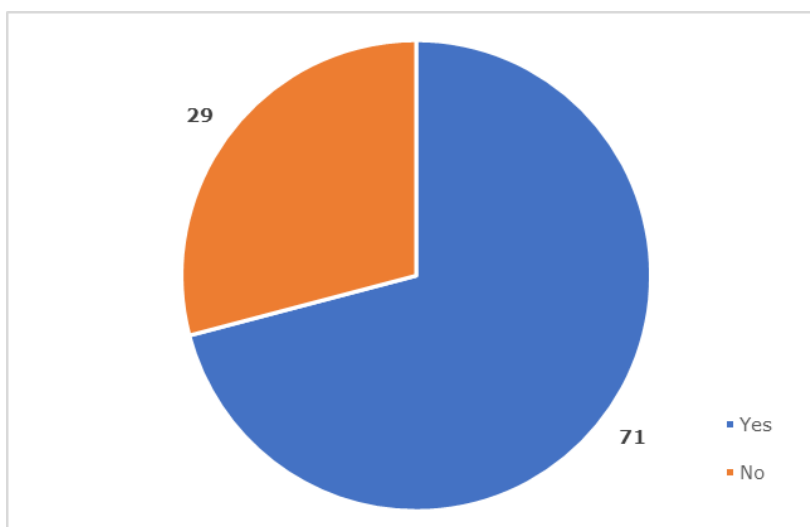
5.6 Willingness to Pay

5.6.1 Grid-connected households

The survey revealed that 71% of all respondents from grid-connected households were willing to pay higher prices for energy-efficient appliances (Figure A1.40).

When asked how much more they were willing to pay (WTP), in terms of percentages, 125 respondents indicated a value, whether or not that had earlier indicated willingness. About 19% of the respondents said that they would pay up to 10% more for an energy-efficient appliance, 22% of the respondents said they would pay 11%-20% more, and another 22% would pay up to 30% more (Table A1.19).

Figure A1.40: Willingness to Pay in Grid-Connected Households in Tonga (%)



Source: Survey by the Pacific Clean Energy Financial Potential project team.

Table A1.19: Extent of Higher Costs Grid-Connected Households were Willing to Pay for Energy-Efficient Appliances

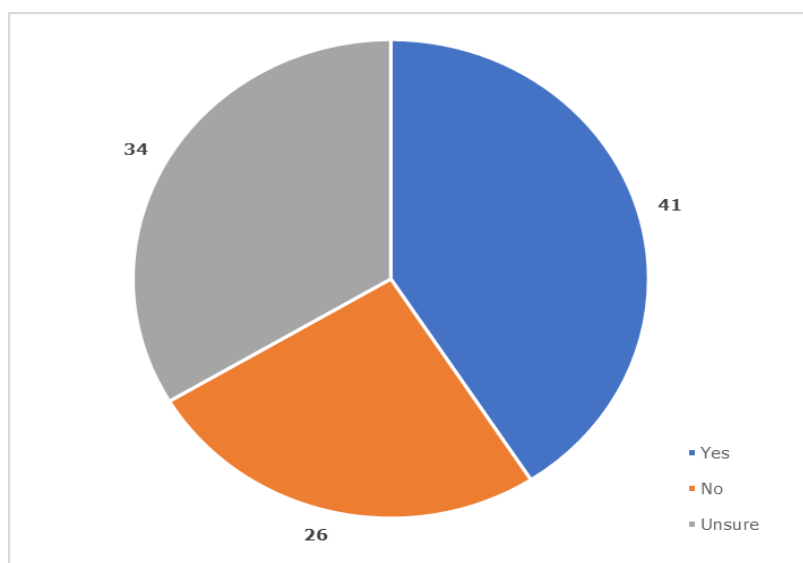
Quantity of Households	1% to 10%	11% to 20%	21% to 30%	31% to 50%	51% to 100%	Total
Number	24	28	28	24	21	125
Percentage	19	22	22	19	17	100^a

^a The percentages in this row do not actually add up to 100 due to rounding.

Source: Survey out by the Pacific Clean Energy Financial Potential project team.

Regarding the willingness to take out a loan to finance the purchase of renewable-energy products or energy-efficient appliances, 41% responded positively, 33% responded negatively, and 33% were unsure (Figure A1.41). This low positive response may have been due to the low incomes and higher expenditures of households with more than six members.

Figure A1.41: Willingness of Grid-Connected Households in Tonga to Take Out a Loan to Purchase Energy-Efficient Appliances (%)



Source: Survey by the Pacific Clean Energy Financial Potential project team.

The survey results showed that 38% of the respondents from grid-connected households were willing to pay more for energy-efficient appliances and would take out a loan to buy them. These respondents were willing to pay prices up to 100% higher than the prices for non-energy-efficient appliances. Note that their average income was approximately \$858 per month. Another 20% were willing to pay higher prices (up to 100%) for energy-efficient appliances, but they were not sure about taking out a loan or using a purchasing facility. Their average income per month was as high as \$827. About 9% stated that they were willing to pay higher prices (up to 80%) but would not take out a loan or use a purchasing facility. A few respondents (6%) declared that they would not be willing to pay extra but would consider taking out a loan. The remaining 27% did not respond positively to the WTP question, and their incomes ranged from \$570 to \$592 per month (Table A1.20).

Table A1.20: Respondent’s Incomes, Willingness to Pay More and/or Borrow to Buy Energy-Efficient Appliances in Tonga

Willingness to Pay More/Borrow	Number/Percentage of Respondents	Average Monthly Income (\$)	Extent of Acceptable Extra Cost (%)
No/No	27/18%	570	10%–15%
Yes/No	13/9%	667	10%–80%
Yes/Unsure	29/20%	827	1%–100%
No/Unsure	13/9%	592	10%–30%
No/Yes	9/6%	625	5%–30%
Yes/Yes	56/38%	858	1%–100%
Total	147/100%		

Source: Survey by the Pacific Clean Energy Financial Potential project team.

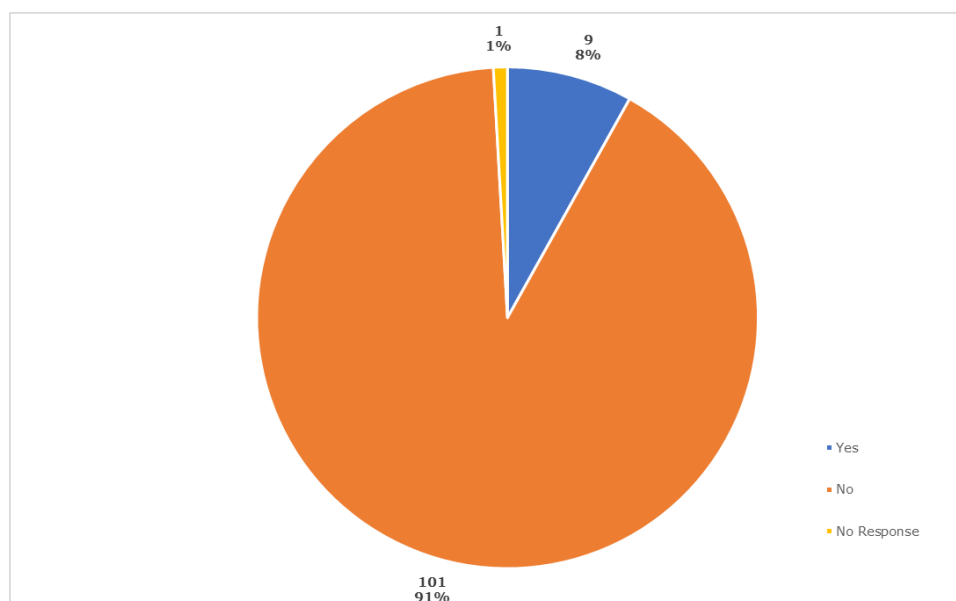
The survey results showed that 62 females (38%) and 55 males (33%) were willing to pay more money for energy-efficient appliances. Of those who were willing to pay more, 28% of the females and 27% of the males were employed.

5.6.2 Off-grid households

The WTP of the surveyed off-grid households was very low. Only 10% of the households said that they were willing to pay additional costs for improved services such as higher-quality lighting, radios, and cooling appliances.

Furthermore, only 8% of the off-grid households were willing to take out loans to purchase solar products (Figure A1.42). This lack of willingness may be largely due to the longtime dependency on grant aid for the electrification of Tonga’s outer islands. Existing solar home systems in Tonga’s outer islands, and the recently established mini-grids, were funded by development partners such as the European Union (EU), Japan International Cooperation Agency (JICA), Australia’s Department of Foreign Affairs and Trade (DFAT), and New Zealand’s Ministry of Foreign Affairs and Trade (MFAT), among others. While this assistance was important for increasing energy access, it may have had the unintended outcome of fostering dependency.

Figure A1.42: Willingness of Off-Grid Households in Tonga to Take Out a Loan to Purchase Solar Products



Note: The first value in each section represents the actual number of respondents, and the second represents the percentage of all respondents from off-grid households in Tonga.

Source: Survey by the Pacific Clean Energy Financial Potential project team.

5.7 Supplier and Market Inventory

Suppliers of goods and services are critical actors in the energy market, as they facilitate trade, encourage competition (e.g., lower prices, higher quality), and offer consumers a variety of products and services (e.g., repair, replacement).

The number of outlets and distributors of electrical appliances and equipment in Tonga is very limited. The survey identified six local companies importing (from Australia, Europe, Fiji, Japan, New Zealand, the PRC, and the United States) solar home systems and other renewable-energy products; four of these local companies provided installation and repair services. The survey also identified nine suppliers and distributors of energy-efficient appliances, including white goods (e.g., refrigerators, freezers, washing machines) and lighting products. Limited information is available on repair and maintenance services, except for one service provider.

Tonga's Electricity Commission requires all electrical contractors to be registered. Only a few of the currently 31 registered contractors sell electrical products and appliances. Prices and countries of origin of white goods and other electrical products and equipment available in the local stores vary, depending on the origin of the foreign business partners of the local suppliers (Tables A1.21 and A1.22).

Table A1.21: Suppliers and Distributors of Renewable-Energy Products in Tonga

Supplier	Products	Support Services	Product/Service Costs	Countries of Origin
E.M. Jones	Mini-solar home systems	Not available. Distribution only.	\$220 (T\$500) per system	No data
Kingdom Energy & Electrical Services	DC 12V/15A charge and discharge controllers, and DC light bulbs in stock	Registered electrical contractor offering all types of electrical work, including solar installations (mostly small scale to mini-grids), electrical maintenance of solar-energy systems, and general electrical work on both AC and DC systems	No Data	Mostly New Zealand and PRC
JH Electrical	Lights, fittings, wires, tools, switches, switchboards, etc. Also installations, upgrades, house wiring, appliance repair, solar home systems	System installations, upgrades.	Varied pricing, depending on product quality; service price quotations available	Australia, New Zealand, PRC
Vaitohi Enterprises	Solar batteries	By customer order	Prices and charges depending on product and service type	New Zealand
'Ofa Construction Limited	No renewable-energy products, only contractors working for donors, with renewable-energy products supplied by the donors	Registered electrical contractors who can install whole solar-energy systems, from panels to storage installations	Pricing depending on the type of work	Japan (mainly)
Vete Electronics	Customer orders only: solar-energy systems	Capable of installing solar-energy systems	Pricing subject to the type of work.	Australia, Fiji, Europe, New Zealand, PRC, US

A = ampere, AC = alternating current, DC = direct current, PRC = People's Republic of China, T\$ = pa'anga (Tongan national currency), US = United States, V = volts.

Source: Survey by the Pacific Clean Energy Financial Potential project team.

Table A1.22: Suppliers and Distributors of Electrical Appliances and Equipment in Tonga

Supplier	Products/ Services	Customer Types	Pricing	Countries of Origin
Lords Mobile	White goods (freezers, refrigerators, air conditioners), LED lights, microwave ovens, dryers, irons, etc.	Households, businesses, communities, churches, schools	Price range: \$44–\$1,320 (T\$100–T\$3,000)	Hong Kong, China; Singapore; PRC
Pacific Timber & Hardware	Lighting and electrical equipment (wires, switches, plugs)	Households, businesses (electrical contractors, etc.)	Price range for LED lighting: \$3–\$35 (T\$7–T\$80)	Australia, Fiji, New Zealand, PRC, US
Top Tile Company	LED lighting, wires, switches, plugs, electric water heaters	Households, electrical contractors, businesses	Price range for LED lighting: \$8–\$11 (T\$18–T\$24)	PRC
W&D Electrical	LED lighting, fans	Households, businesses	Price range for LED bulbs: \$2–\$5 (T\$5–T\$12); price range for LED floodlights: \$35–\$308 (T\$80–T\$700)	Australia, Fiji, New Zealand, PRC
Vete Electronics	Four types of white goods; also security systems, sound systems, TVs, radios	Households, businesses, communities	Prices varying with the product ranges; products directly ordered by customers	Australia, Fiji, New Zealand, PRC, US
Luna'Eva and Sons Hardware Store	LED lighting, air conditioners, refrigerators, freezers, fans, electrical tools and equipment	Households, businesses, communities	LED downlights: \$9 (T\$20); freezers: \$660 (T\$1,500)	New Zealand, PRC
E.M. Jones	All types of white goods, LED lights, fans, stoves, TVs, generators, electrical tools and equipment	Households, businesses	LED lights: \$18–\$24 (T\$40–T\$55); other home appliances: \$440–\$1,760 (T\$1,000–T\$4,000)	Australia, New Zealand, PRC
Dexing Hardware	LED lights, fans	Households, businesses	LED tubes: \$7 and \$20 (T\$15 and T\$45); bulbs: \$4 (T\$10)	PRC
JH Electrical	Lights, fittings, wires, tools, switches, switchboards etc.; installations, upgrades, house	Households, businesses, electrical contractors, communities, schools	Prices varying according to product quality; service price quotations available.	Australia, New Zealand, PRC

	wiring, appliance repairs.			
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LED = light-emitting diode, PRC = People's Republic of China, T\$ = pa'anga (Tongan national currency), TV = television, US = United States.

Source: Survey by the Pacific Clean Energy Financial Potential project team.

5.8 Lending Agency Inventory

The survey revealed that members of households were using financial services to deposit savings and to take out loans. Visits to the banks occurred fortnightly and/or monthly. Respondents in the outer islands stated that they had to travel by boat to the nearest commercial center, mainly in Neiafu (Vava'u) or Pangai (Ha'apai). Travel time could take up to two hours by boat.

Lending agencies vary in sizes and functions. Commercial banks have larger portfolios and manage many customers. Smaller agencies operate in micro lending markets, where the risks are much higher, but the requirements are much more flexible. The survey identified five lending institutions in Tonga, including three commercial banks, the national development bank, and the public retirement service. The result of the inventory is shown in Table A1.23.

Table A1.23: Inventory of Lending Agencies and Services in Tonga

Tonga Development Bank
<ul style="list-style-type: none"> • Term loans are available to both homeowners and businesses that require financing for the installation of energy-efficient appliances and renewable-energy systems with energy star ratings (NZ Standard), such as washing machines, refrigerators, freezers, air conditioners, solar-energy systems, electric light fittings, and flat-screen TVs. The only suppliers of these appliances working with the Tonga Development Bank are Courts and E.M. Jones, where customers can get their invoices to submit to the bank. The loan officers ensure that the appliances to be purchased rate three stars and that they satisfy the energy-efficiency rating requirements (NZ Standard). • Under the EESL program, financing is available through personal and business loans for the purchase and installation of energy-efficient installations and home appliances, along with a subsidy amounting to 30% of the cost of the product. Since 22 December 2014, the program's funding has been provided by the IUCN. • Personal loans: Salary Deduction to be within 60% of borrowers.
Tonga Retirement Fund Board
<ul style="list-style-type: none"> • The Retirement Fund Board offers personal loans for various purchases, such as electrical appliances, solar hot-water units, and vehicles. The size of a loan is usually determined by the borrower's income; for instance, some borrowers have received up to \$30,000, with a payback period of 4 years (maximum) and interest rates ranging from 6% to 16%. • The Retirement Fund Board serves mostly civil servants and public utilities employees.
Bank of South Pacific
<p>Bank South Pacific's services include:</p> <ul style="list-style-type: none"> • Unsecured personal loans for immediate short-term needs, for a fixed interest rate of 18.5% per year. • Secured personal loans, for a fixed interest rate of 14% per year. • Small business loans, for a fixed interest rate of 15% per year.
Australia and New Zealand Banking Group
<ul style="list-style-type: none"> • Personal loans are available.
Bank Negara Malaysia
<ul style="list-style-type: none"> • Personal loans are available.

EESL = Energy Efficiency Subsidy Loan, IUCN = International Union for Conservation of Nature.

Source: Survey by the Pacific Clean Energy Financial Potential project team.

6 APPENDICES

6.1 Appendix 1: Survey Template

Target Group: Off-Grid Customers

PREAMBLE

Thank you for your willingness to participate in this survey.

This project is an initiative of the Pacific Region Infrastructure Facility (PRIF) and its partners.¹³ It consists of a study to identify financing potential in the Pacific islands for distributed energy resources (DER) and energy efficiency (EE) through retail lending via national development banks. The outcome the study will provide the basis for support by PRIF development partners for households and small business enterprises that need financing.

The project involves a stocktaking of household (HH) energy consumption and a detailed analysis of future energy demand, including households' willingness to pay (WTP) for DER and EE goods and services. Evidence and data on household WTP is lacking in the Pacific region, so data collection will be essential for the success of this study and for future projects.

Kiribati and Tonga have been selected as the target sites for a detailed WTP study of grid-connected and off-grid energy consumer behavior, including the context of the local market and DER and EE businesses. The activities will involve interviewing electricity customers in urban and rural areas, including a compilation of products and services in the local markets, as well as lists of the financial institutions and agencies currently lending to households and small business enterprises.

All the information and data gathered in this survey will be kept confidential, and will be used for analytical purposes only. If you do not wish to record your name, you may wish to declare anonymity.

Thank you for your time and support.

¹³ Asian Development Bank (ADB), the Australian Agency for International Development (AusAID), European Investment Bank (EIB), European Union (EU), Japan International Cooperation Agency (JICA), New Zealand Agency for International Development (NZAID), United States Agency for International Development (USAID), and the World Bank (WB).

Section 1 Socioeconomic Information.

Name: _____

Age: _____

Gender:

Male

Female

Location: _____

1. Employment status:

Employed

Full-time

Part-time

Self-employed

Type of employment: _____

Unemployed

2. Number of members in your household: _____

(Please do not include members who are staying temporarily.)

3. What is your source of cash income?

Wages / salaries	\$ _____	Private business	\$ _____
Gifts	\$ _____	Other	\$ _____
Agriculture	\$ _____	Other	\$ _____
Fishing	\$ _____	Other	\$ _____
Handicrafts	\$ _____	Other	\$ _____

4. How much do you spend per month?

Kerosene	\$ _____	Boat maintenance	\$ _____
Batteries	\$ _____	Cooking fuel (LPG)	\$ _____
Solar-energy fees	\$ _____	Diesel generator	\$ _____
Mobiles	\$ _____	Repair of fishing gear	\$ _____
Clothes	\$ _____	Fuel for fishing boat	\$ _____
Transport	\$ _____	Other	\$ _____
Kava	\$ _____	Other	\$ _____

5. How much is the household willing to pay in cash to have access to enough electricity for good-quality lighting, radio use, phone charging, and cooling appliances (e.g., freezer)?

6. Please rank each appliance in the order of its importance to you.

Solar lantern	_____	TV	_____
Radio	_____	Mobile	_____
Fan	_____	Fridge	_____
Washing machine	_____	Other	_____

Section 2 Mobile Phone

7. Do you or a household member have a mobile phone?

Yes No

8. How is it charged?

9. Does mobile service include money transactions (MPAiSA)?

If yes, how often does your household use the service?

Section 3 Lighting

10. Does your household have a solar-powered portable lantern or other solar lighting unit?

Quantity: _____

11. What activities does your household use electric lighting for?

12. How many hours per day does your household use electric lighting?

13. Which household member uses electric lighting most often?

Section 4 Solar Equipment and Appliance Inventory

14. Inventory

Fans

Quantity:

TVs

Quantity:

Radios

Quantity:

Laptops

Quantity:

Tablets / iPads

Quantity:

Other equipment

Quantity:

Section 5 Repair and Maintenance Services

15. Who repairs the solar equipment when it is broken?

16. Is there a fee for that you pay for the repair service?

\$

17. Who is trained in the community to provide repair and maintenance services to customers?

18. Are there monitoring visits by the village solar technician?

Section 6 Financial Services

19. How far away is the nearest bank and/or financial services? (e.g., for money transfers, loans) _____

How long does it take to travel there? (hours, days, weeks) _____

20. Do you or another household member use the bank and/or financial services (e.g., for money transfers, loans)?

Yes No

21. For what purposes do you or your household use the bank or financial services?

22. How often do you visit the bank and/or financial services?

23. Are you willing to borrow money from a bank, private lender, or higher purchase facility to purchase a better solar home system?

Yes No

If yes, how much money would you be willing to borrow to purchase an additional system?
\$ _____

This is the end of the survey. In case we need clarifications or additional information, we may contact you directly. May I have your contact number.

Name of Participant	Telephone contact (Mobile, landline, etc.)

THANK YOU FOR YOUR PARTICIPATION.

Interviewer Declaration

NAME	SIGNATURE	DATE
Interviewer _____		____/____/2021
Supervisor _____		____/____/2021

Target group: Grid-Connected Customers

PREAMBLE

Thank you for your willingness to participate in this survey.

This project is an initiative by the Pacific Regional Infrastructure Facility (PRIF) and its partners.¹⁴ It consists of a study to identify financing potential in the Pacific islands for distributed energy resources (DER) and energy efficiency (EE) through retail lending via national development banks. The outcome the study will provide the basis for support by PRIF development partners for households and small business enterprises that need financing.

The project involves a stocktaking of household (HH) energy consumption and a detailed analysis of future energy demand, including households' willingness to pay (WTP) for DER and EE goods and services. Evidence and data on household WTP is lacking in the Pacific region, so data collection will be essential for the success of this study and for future projects.

Kiribati and Tonga have been selected as the target sites for a detailed WTP study of grid-connected and off-grid energy consumer behavior, including the context of the local market and DER and EE businesses. The activities will involve interviewing electricity customers in urban and rural areas, including a compilation of products and services in the local markets, as well as lists of the financial institutions and agencies currently lending to households and small business enterprises.

All the information and data gathered in this survey will be kept confidential, and will be used for analytical purposes only. If you do not wish to record your name, you may wish to declare anonymity.

Thank you for your time and support.

¹⁴ Asian Development Bank (ADB), the Australian Agency for International Development (AusAID), European Investment Bank (EIB), European Union (EU), Japan International Cooperation Agency (JICA), New Zealand Agency for International Development (NZAID), United States Agency for International Development (USAID), and the World Bank (WB).

Section 1 Socioeconomic Information.

Name: _____

Age: _____

Gender:

Male

Female

Location: _____

1. Employment status:

Employed

Unemployed

Retired

If employed:

Full-time

Part-time

2. Type of employment: _____

3. How many members are in your household? _____
(Please do not include members who are staying temporarily.)

4. What is your source of cash income?

Wages/salaries \$ _____
 Gifts \$ _____
 Agriculture \$ _____
 Fishing \$ _____
 Handicrafts \$ _____

Private business \$ _____
 Other \$ _____
 Other \$ _____
 Other \$ _____
 Other \$ _____

5. How much do you spend a month?

Food \$ _____
 Mobiles \$ _____
 Clothes \$ _____
 Transport \$ _____
 Kava \$ _____
 Utility bill \$ _____
 Cooking fuel (LPG) \$ _____

School activities \$ _____
 Entertainment \$ _____
 Other \$ _____
 Other \$ _____
 Other \$ _____
 Other \$ _____
 Other \$ _____

6. How much do you spend on electricity per month? \$ _____

Section 2: Appliance Inventory

7. List electrical appliances in the home.

Refrigerators Qty _____
 Freezers Qty _____
 Air conditioners Qty _____
 Fans Qty _____
 TVs Qty _____

Microwaves Qty _____
 Hot kettles Qty _____
 Cooking tops Qty _____
 Incandescent bulbs Qty _____
 Compact fluorescent lights Qty _____

Radios	Qty _____	LFLs	Qty _____
Hot water systems	Qty _____	Other	Qty _____
Solar home system lighting	Qty _____	Other	Qty _____

8. When was your last appliance (refrigerator, freezer, etc.) purchase?

9. What is your next appliance purchase?

10. Are you willing to pay more money for a more efficient appliance? Yes No

How much more are you willing to pay, by percentage? % _____

11. Will you borrow, pay hire purchase, or pay cash to replace your current appliances (refrigerator, freezer, or solar water heaters) with more efficient ones?

Yes No Unsure

Section 3: Repair and Maintenance of Appliances

12. Is there a local repair and maintenance service for your appliances? Yes No

13. How much do you spend on services? \$ _____

Section 4: Awareness of Energy-Efficient (EE) Appliances

14. Have you seen any kind of EE appliance label before? Yes No

If yes, where have you seen it? _____

15. Do you know how to estimate your running cost based on label data? Yes No

16. How important is the label to your decision whether to purchase your next appliance?

Important Not important

Why? _____

17. Are you aware of public-awareness campaigns or promotions of EE appliances?

Yes No

18. Would you recommend an EE household appliance to others?

Yes No

Why? _____

This is the end of the survey. THANK YOU FOR YOUR PARTICIPATION.

Interviewer Declaration

NAME	SIGNATURE	DATE
Interviewer _____		____/____/2021
Supervisor _____		____/____/2021

6.2 Appendix 2: Market and Lending Facility Inventory Templates

Section 1: Inventory of Renewable Energy (RE) Suppliers in the Local Market				
Question 1 Please list the local suppliers of RE products.				
Name of the RE Product Supplier	Type of Products (Solar home system, solar water heater, panel, battery, controllers etc)	Types of Services, Customers, Services, and Guarantees (Installation, repair and maintenance, training, etc)	Charges and Fees for Services	Sources of Imported Products (e.g., Australia, Germany, India, New Zealand, People's Republic of China)
1.				
2.				
3.				
4.				
5.				
6.				
7.				

Section 2: Inventory of Energy-Efficient (EE) Appliance Suppliers in the Local Market

Question 1 Please list the local suppliers of EE products.

Name of the Renewable-Energy (RE) Product Supplier	Types of Products Sold – Please Tick the Appropriate Ones Key: Refrigerator (RFG), freezer (FRZ), air conditioner (AC), light-emitting diode (LED), washing machine (WM)						Types of Customers (households, businesses, communities, others)	Cost/Price per unit	Sources of Imported Products (e.g., Australia, Germany, India, New Zealand, and the People’s Republic of China)
	RFG	FRZ	AC	LED	WM	Other			
1.									
2.									
3.									
4.									
5.									
6.									
7.									
8.									
9.									
10.									
11.									
12.									
13.									
14.									
15.									
16.									

Section 3: Financing Facilities for Distributed Renewable Energy (DRE) and Energy-Efficient (EE) Products and Services.

Question 1. Please list the local financing institutions and/or agencies that lend money or allow customers to pay hire purchase for RE and EE household items (e.g., development banks, commercial banks, financing agents, hardware stores, and retail stores)

Name of Institution/Agency/Company	Type of Lending Service and Product, Typical Amounts of Loans, and Payback Fees. (e.g., loans for RE solar home systems, solar water heaters, and electric vehicles)	Target Customers. (e.g., households, businesses, schools, communities, and churches)
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		

Note: Please use additional sheets if needed.

Section 4 Surveyor's Contact Inventory List

Please list all the names of people consulted in this survey for future reference and clarification if needed.

Name, Title	Company	Phone Number	Email
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Name, Title	Company	Phone Number	Email
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