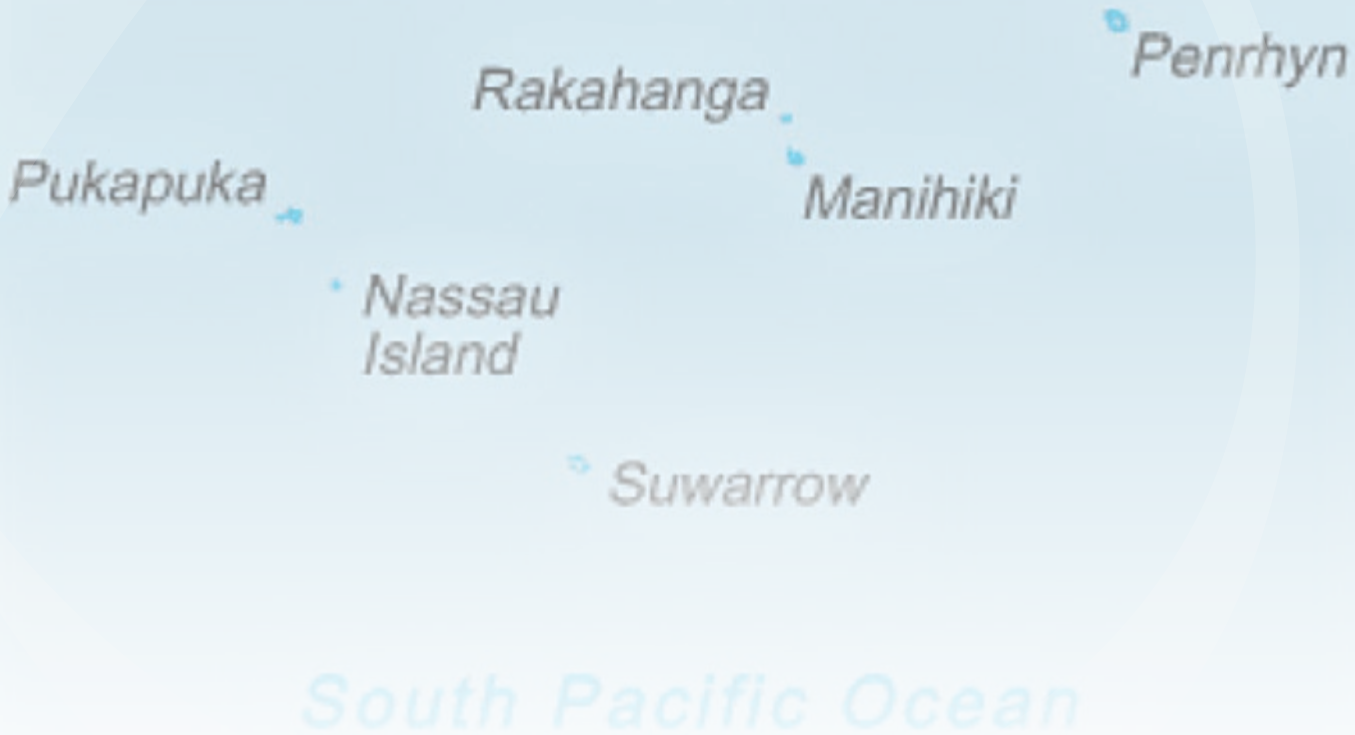
Report

IRENA
International Renewable Energy Agency

Pacific Lighthouses

Renewable energy opportunities and challenges in the Pacific Islands region

Cook Islands



About IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international cooperation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.
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TABLE OF CONTENTS

Note on currency:
On October 23, 2012, the exchange rate was New Zealand Dollars (NZD) 1.223 per United States dollar (USD).

Preface

In the Abu Dhabi Communiqué on accelerating renewable energy uptake for the Pacific Islands (of 13 January 2012), leaders from the Pacific Island Countries and Territories (PICTs) called on the International Renewable Energy Agency (IRENA) to "...map the Renewable Energy Readiness of the Pacific Islands Countries and Territories to ascertain the status of renewable energy opportunities and identify pathways to close gaps" and to integrate all IRENA activities in the region "...into a coherent roadmap for the Pacific Islands". In response, IRENA has carried out a wide range of activities of specific relevance and application to the PICTs as well as other Small Island Developing States (SIDS). This work has now been integrated into the IRENA report: ***Pacific Lighthouses: Renewable Energy Roadmapping for Islands***.

The report consists of an overview roadmap framework and 15 island-specific studies on the respective energy situations, and the challenges and opportunities for renewable energy deployment, around the region. These studies are available for the Cook Islands, the Federated States of Micronesia, the Republic of Fiji, Kiribati, the Republic of the Marshall Islands, the Republic of Nauru, Niue, the Republic of Palau, Papua New Guinea, Samoa, the Solomon Islands, the Kingdom of Tonga, Tokelau, Tuvalu and the Republic of Vanuatu. The IRENA Pacific Lighthouses report draws on those studies, as well as an additional study on a diesel-renewable energy hybrid power system, intended as a transition measure to a renewables-based energy future for the PICTs, which is also part of the series.

IRENA, in collaboration with its members and other key development partners, will continue to support the development national roadmaps and strategies aimed at enhanced deployment of renewables in the Pacific and other island states and territories.

Acronyms

ADO	Automotive Diesel Fuel
BP	British Petroleum
CCOP/SOPAC	Committee for Offshore Prospecting/South Pacific)
GDP	Gross Domestic Product
GoCI	Government of the Cook Islands
GWh	Gigawatt hours (thousands of millions of watt hours)
kW	Kilowatt (thousands of Watts)
kW/m	Kilowatts per metre (wave energy measure)
kWh	Kilowatt hours (thousands of Watt hours)
kWh/m2	Kilowatt hours per square metre (solar radiation)
m/s	Metres per second (wind speed)
MFAT	New Zealand Ministry of Foreign Affairs and Trade
MW	Megawatt (Thousands of kilowatts)
NEP	National Energy Policy
NZD	New Zealand Dollar (Currency)
OTEC	Ocean Thermal Energy Conversion
PIC	Pacific Island Country
PV	Photovoltaic
REDD	Renewable Energy Development Division
SOPAC	South Pacific Applied Geoscience Commission
SPC	Secretariat of the Pacific Commission
TAU	Te Aponga Uira (the Rarotonga Electricity Authority)
Wp	Watts peak (rating of solar panels at standard conditions)

1. Country context

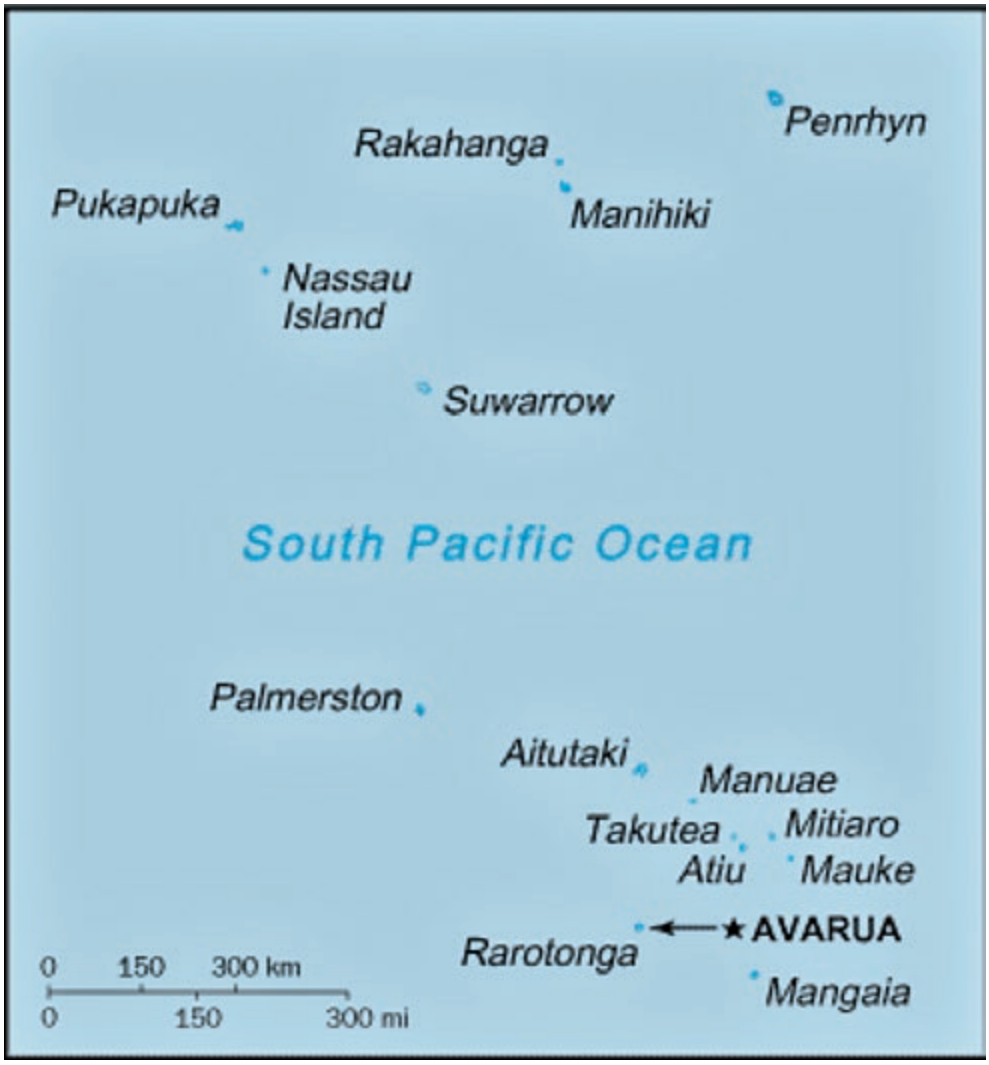

Figure 1. Map of the Cook Islands

Source: CIA Factbook 2011

The boundaries and names shown on this map do not imply official acceptance or endorsement by the International Renewable Energy Agency

Physical description. The Cook Islands consist of 15 islands totalling 240 km^2 of land, located in the South Pacific Ocean half-way between Tonga and Tahiti. Approximately 90% of the land and population are in the southern group of the eight mostly elevated, fertile islands. The northern islands are low-lying, sparsely populated coral atolls. About 17% of all land is arable, with 13% under permanent cultivation.

Population. The population of the Cook Islands has been declining for a long time owing mainly to emigration, mostly to New Zealand and Australia. In the

December 2002 the population was 18 027 with over 70% of the people living in Rarotonga. Provisional figures from the 2011 census indicate a total population of 17,800. The Ministry of Finance and Economic Management has projected a population growth of 1.6% (medium growth scenario) through to 2022.

Environment. The climate of the Cook Islands is maritime tropical with a small temperature difference between day and night, and modest seasonal changes. The annual rainfall is 2 000 mm with two-thirds of the rainfall occurring between the months of November and April. On average, three cyclones occur every two years, usually between November and April. Biodiversity is not high anywhere in the country, with the northern atolls being very low in land-based biodiversity. The Government of the Cook Islands (GoCI) has signed various treaties and conventions related to environmental protection, including the United Nations Framework Convention on Climate Change and the Kyoto Protocol.

Economic overview. Tourism provides the economic base for the Cook Islands, contributing up to approximately 70% of the country's GDP. Agriculture, fishing, fruit processing, clothing and handicrafts are the ramaing economic actvities. About 75% of outer island households engage in fishing, mostly for their own use, compared to 29% in Rarotonga. The northern group of islands has shifted from land-based agriculture as their principal economic activity to sea-related activities, notably pearl and seaweed farming. The southern group of islands continues to grow bananas, taro and cassava. Agriculture provided about 15% of GDP in 2000 but only 2.7% in 2010. The economy of Rarotonga is largely based on trade and service, with tourism being the economic mainstay.

Trade deficits are offset by remittances from emigrants and by aid from New Zealand. The GDP growth at the turn of the century was good at 2.7% (1999), 13.9% (2000), 4.9% (2001) and 3.9% (2002) but has been generally lower in recent years (Table 1).

Table 1. – GDP 2008–2010

Component	Annual GDP			% Change over Previous Year		
Calendar Year	2008	2009	2010(*)	2008	2009	2010(*)
Total	**332 119**	**330 486**	**334 825**	**7.1**	**-0.5**	**1.3**
Agriculture	8 773	9 290	9 120	-2.0	5.9	-1.8
Fishing & Pearl	8 158	7 567	7 994	-12.3	-7.2	5.6
Mining & Manufacturing	11 845	12 556	11 929	10.0	6.0	-5.0
Electricity & Water Supply	7 350	7 425	8 429	20.1	1.0	13.5
Construction	11 984	14 667	11 771	8.5	22.4	-19.7
Wholesale & Retail Trade	85 464	66 204	80 795	18.6	-22.5	22.0
Restaurants & Accommodation	48 066	52 602	49 419	7.7	9.4	-6.0
Transport & Communication	52 210	59 034	44 241	3.9	13.1	-25.1
Finance & Business Services	35 208	41 586	44 209	9.5	18.1	6.3
Community & Personal Services	9 517	9 767	8 275	-7.4	2.6	-15.3
Public Administrator	29 188	28 841	34 592	0.8	-1.2	19.9
Education and Health Services	18 163	18 268	18 510	5.9	0.6	1.3
Ownership of Dwellings	19 352	20 128	22 916	2.2	4.0	13.8
less Financial Intermediation Services Indirectly Measured	13 161	17 451	17 374	25.8	32.6	-0.4

Source: Provided through communication by Cook Islands Statistics Office (2012).

** For 2010, the numbers were not available for the entire year and are projected.*

2. Energy landscape

Institutional and regulatory arrangements for energy

Acts of Parliament. Several Acts of Parliament deal directly with energy or related issues:

The Energy Act specifies and assigns the energy responsibilities within the Government for planning, renewable energy, standards, legislative review, energy efficiency, energy research, monitoring of electricity tariffs, and monitoring and approving the quality of petroleum products and their compliance with fuel standards.

- The Te Aponga Uira (TAU) Act established a government-owned utility to generate and distribute electricity for Rarotonga.
- The Environment Act is applicable to Rarotonga, Aitutaki and Atiu, with no energy-specific provisions, although biomass use for energy is effectively restricted.
- The Dangerous Goods Act addresses safe storage and handling of petroleum fuels but there are no specific standards or inspection procedures.
- The Building Controls and Standards Act requires building permits for storage of 22730 litres of fuel or more.

National Energy Policy (NEP). In 2003, the Cook Islands' Cabinet endorsed a National Energy Policy, which aims to "to facilitate reliable, safe, environmentally acceptable, and cost-effective sustainable energy services...". The NEP includes a strategic plan with activities, lead agencies, indicators of success, assumptions and risks, and timeframes. The policies and activities are well thought-out, clear and consistent, although until recently there was neither a budget allocation for implementing activities nor indications of priority. The new Renewable Energy Development Division (REDD) that reports directly to the office of the Prime Minister has now, under the new Energy Act, assumed all responsibility for implementing the energy policy and strategic plan and has absorbed all functions of the old Energy Division, including responsibility for the inspectors. This action clearly shows the Government's commitment to reducing the use of fossil fuels and improving efficiency in the use of available energy.

Renewable Energy Chart and Implementation Plan. The Cook Islands Renewable Chart is the country's renewable energy "roadmap". Published in 2012, the chart aims to achieve the Government's target of 50% of the Cook Island's electricity to be provided by renewable energy in 2015, and 100% in 2020 (i.e. the 50/15 – 100/20 renewable electricity policy goals). The chart is accompanied by an implementation plan that aims to use proven technologies for achieving the renewable energy goals.

Renewable Energy Development Division ("REDD"). Based within the Prime Minister's Office, REDD is charged with promoting awareness of the country's renewable energy policy drive and targets, planning of the Renewable Electricity Chart and its implementation plan, and coordinating the Renewable Energy Committee.

National Renewable Energy Committee (NREC). The National Renewable Energy Committee, chaired by the Prime Minister, has the role of leading and directing project initiatives arising from the Renewable Energy Chart as well as vetting the deployment of various renewable energy technologies in the country.

Te Aponga Uira (TAU). The TAU Act of 1991 (amended 1999) established it as a commercially-operated government-owned utility. It is charged with generating and distributing electricity for Rarotonga. TAu's operation is governed by this act and the Cook Islands Investment Corporation (CIIC) Act of 1998 which allow TAU to operate with private sector participation from diesel and renewable (solar PV and wind) power generators.

Energy supply and demand

Petroleum. The Cook Islands are overwhelmingly dependent on imported refined petroleum fuels, which probably account for 90% of gross energy supply (Table 2). Biomass provides most of the remaining 10%, which is mainly used for cooking. Petroleum fuels are supplied by Mobil and British Petroleum (BP), with the local distributor, Triad, purchasing fuel from BP. Wholesale prices of gasoline and automotive diesel oil (ADO), excluding taxes and duties are considerably higher than average for Pacific Islands region overall and about double those of nearby French Polynesia.

Table 2. Liquid Fuel Imports (in Tonnes of oil equivalent)

Fuel	2002	2003	2004	2005	2006	2007
Gasoline	3621	3751	3765	4239	4725	4528
Aviation gasoline (Avgas)	0	3	0	0	1	2
Kerosene & jet fuel	2024	158	16	7271	10377	7244
Automotive diesel (ADO)	4448	5398	11997	13752	11596	10892
Total imports	10093	9310	15779	25262	26698	22665

Source: Cook Island Energy Indicators 2009

Electricity generation and demand. In 2003, TAU had 6.8 MW (continuous rated capacity) of diesel generation, which grew to just over 11 MW in 2013. In 2002, maximum demand was 4.4 MW (growing 5% per year since 1985) and generation was 25 GWh (growing 9.4% per year since 1997). In 2011 the total generation exceeded 27 GWh and the peak power demand of just under 5 MW. Table 3 shows the energy use in the Cook Islands between 2006 and 2010, while Table 4 shows the installed gensets across the islands. Rarotonga accounts for the bulk of electricity generation by TAU, the Government-owned power utility for Rarotonga (Tables 3 and 4).

By 2001, nearly 99% of all households had electricity, with 94% of them connected to an island grid; 8% had solar photovoltaic (PV) systems and 3% used small diesel generators (with some households having access to more than one source of power). In the northern islands, 60% of households were connected to an island grid and 43% had PV systems.

Outer island electrification has been problematic since the 1970s. Excluding the largest island, Aitutaki, outer island systems suffer from irregular fuel supply, poor fuel handling, inadequate maintenance and poor facilities. Each local government is responsible for its power system (Table 5). General subsidies continue to be provided from the national government for island operations, some of which are used for electricity supply. The charge to consumers varies by island but is typically substantially higher than Rarotonga, with most suppliers not able to fully recover costs.

The goal is to convert all outer island generation to renewables by 2020. The first island to receive funding for the conversion is Rakahanga with Japan committing to a project that started in 2011. Solar mini-grids (solar with batteries and inverters) sized to handle 80%–90% of the required grid energy are planned, with shortfalls covered by diesel. With recent price reductions for solar panels, generation cost is no greater than existing diesel generation costs with the added advantages of silent operation, no air pollution and lower maintenance requirements. One problem that has to be addressed is that for donor-funded schemes, each donor will often designate the source of components, and the result is a different set of components and a different design for otherwise similar installations. This causes many problems with maintenance, since technicians need to

Table 3. Electricity use in the Cook Islands 2006–2010

Period	Rarotonga	Aitutaki	Atiu	Mauke	Mangaia	Mitiaro	Penrhyn	Rakahanga	Manihiki
YEAR	(kWh'000)								
2006	29 390	2345	316	218	465	115	121	30	154
2007	29592	2384	443	273	464	130	124	54	231
2008	28471	3201	469	241	460	118	124	72	293
2009	27751	3285	332	222	450	119	124	74	300
2010	43155	4936	497	331	663	179	186	113	450

Source: Provided through communication by GoCI (2012).

Table 4. Gensets Installed on Rarotonga

No.	Make and Model	Year Installed	Rated MW	De-rated MW
1	Duvant Crepelle 12V26N	1991	2.0	1.5
2	Duvant Crepelle 12V26N	1991	2.0	1.5
3	Mirrlees Blackstone MB 275-8	1989	1.6	1.2
4	Lister Blackstone ETSL	1971	0.6	0.4
5	Lister Blackstone ETSL	1985	0.6	0.4
6	Lister Blackstone ETSL 16	1985	1.2	0.9
7	MAN B&W L9-27/38	2006	2.7	2.0
8	Cummins KTA 50-G3	2004	0.8	0.8
9	Cummins KTA 50-G3	2004	0.8	0.8

Source: ADB (2011)

be trained on several different types of systems and different sets of spare parts must be stocked.

Aitutaki has too large a load to make the mini-grid approach financially viability. The most cost-effective approach for adding renewables to the grid in Aitutaki and Rarotonga are grid-connected solar installations. In Aitutaki, the ANZ Bank has installed a 7.9 kWp grid-connected system to offset the cost of air-conditioning. In Rarotonga, the TAU has a net-metering policy and has shown considerable interest in connecting both small wind and solar to the grid.

Electricity tariffs. The tariffs for Rarotonga are given in Table 6.

Table 5. Peak load, capacity in kW and hours per day (Outer islands)

Island	Peak (kW)	Hours per Day	Available Capacity (kW)	MWh (2010)
Rakahanga	18	24	40	76
Manihiki	30	18	290*	300
Pukapuka	35	0	21	na
Nassau	10	18	14	na
Penrhyn	50	18	290*	124
Palmerston	8	12	21	na
Mitiaro	39	21	77	120
Mauke	90	24	168	220
Atiu	100	24	242	332
Mangaia	120	24	330	441
Aitutaki	620	24	880	3 291

Source: Provided through communication by REDD (2012).

** Three gensets totalling this amount on different islets of each atoll.*

Table 6. Tariff structure for Rarotonga (Outer islands each have their own tariffs)

Domestic	Rate (NZD)	Commercial	Rate	Demand	Rate	Dual Tariff	Rate
First 60 kWh/month	0.57	Service Charge	5.00	Service charge	20.00	Service Charge	10.00
		kWh used	0.81	kWh used	0.72	First 60 kWh/month	0.57
61 to 300 kWh per month	0.80			Peak/kW	30.00	61 to 240 kWh/month	0.80
>300 kWh/month	0.84			Shoulder/kW	26.00	Balance	0.84

Source: Provided through communication by TAU (2012). The NZD was 1.223 per USD in October, 2012

3. Renewable Energy Opportunities

Biomass. No surveys of biomass energy resources in the Cook Islands have taken place since the 1980s. Approximately 65% of the land has tree cover, ranging from sparse to dense, with biomass energy potential. However, it is unlikely that any of this will be, or should be, used for energy purposes, other than meeting existing demand for fuelwood. Biomass-based energy generation in the Pacific utilises waste products agricultural or wood-processing industries. None of these sectors are likely to be developed in the Cook Islands. According to the 2000 agricultural census, there are about 43 000 easily accessible coconut trees considered by households as useful nut producers, with over 97% of production used for household purposes. In some PICTs, there is considerable potential for coconut oil produced from copra as a fuel. However, in the Cook Islands, despite the fact that there are still a large number of "wild" coconut trees of bearing age, copra no longer has significant economic importance and, with relatively high labour costs compared to other Pacific Islands, the cost of re-establishing a copra production capability appears to be prohibitively high.

Biogas. Pigs and chickens represent a modest resource for biogas production through anaerobic digestion of their wastes, though they must be penned and the manure manually collected.

Solar energy. Solar energy is an excellent resource in the Cook Islands, particularly for the northern atolls. The Pacific Islands Forum Secretariat collected two years (1995–1996) of horizontal, global solar radiation data through the Southern Pacific Wind and Solar Monitoring Project. The data showed that insolation, corrected for a tilted collector, has an average of over 5.5 kWh/m^2 per day. Satellite data indicate that solar radiation in the northern group is somewhat higher than in Rarotonga, but there are no surface measurements to confirm this.

Wind power. The Pacific Islands Forum Secretariat's wind and solar monitoring project is the main long-term data source for Rarotonga wind energy and is used to estimate wind regimes of other islands. At Ngatangila Point, Rarotonga, wind data recovery was 100% during two years of monitoring. The annual average wind speed was 5.5 m/s. The highest hourly and daily averages were 17.7 m/s and 14.0 m/s respectively. Correlations with a six-year average for Rarotonga airport indicate that long-term wind speeds could be about 5% higher than those measured, with a calculated annual average wind energy at 10 m of 180 W/m^2. A study in May 1999, using data from Ngatangila, estimated a wind speed of 6.1 m/s at 30 m. A subsequent Danish feasibility study in 1997 estimated annual average wind speeds in the range of 6.1–7.5 m/s (at 30 m), suitable for economic power generation.

Additional wind energy measurement masts have been installed on Rarotonga and on the outer islands, on Atiu in 2010, for example.

Hydropower. The Ministry of Works has monitored water flows at a number of sites on Rarotonga. There were some rough estimates in 1990 of hydro potential at several sites of possibly several hundred kilowatts, but implementation costs were too high for economic development.

Wave energy. In 1987, a Norwegian/ South Pacific Applied Geoscience Commission (SOPAC) regional wave energy resource assessment programme included the Cook Islands. Ocean swells and wave conditions were measured with Waverider buoys at Rarotonga and three years of satellite data were assessed for ocean waves. The southern islands were found to have the highest wave energy resource of all countries included in the study (23–28 kW/m). In the northern Cook Islands, the resource was also high for such low latitude. Close to the coast of Rarotonga, the buoy measured a long-term average of 24.5 kW/m. This is a large potential resource but all installed wave energy systems globally are still experimental or prototypes and cannot be considered for commercial use in the PICTs at present.

Ocean thermal energy conversion (OTEC). The temperature difference between deep-ocean and surface waters can be exploited for energy production. Experimental units have been tested in the Pacific but these were for short periods of time. The OTEC potential is not known for the Cook Islands but is conceivably much larger than the total electrical energy requirements of the country. At this point in time no commercially viable OTEC generation plants have been constructed for the type of environment and conditions and, with the considerable development required to make the concept viable for small utilities, it is unlikely that OTEC will be in use in the Cook Islands in the very near future.

Geothermal energy. The geothermal energy resource in the Cook Islands is unknown.

4. Experiences with renewable energy technologies

Largely through the personal efforts of the late Stuart Kingan, a scientist for the GoCI, his associates and the energy office staff, numerous trials of small wind, solar PV, electric transport and biogas generation were conducted from the late 1970s through to the early 1990s. The projects yielded valuable technical and social information for later projects.

Solar PV. All outer islands have had, or still have, some household PV systems for lighting and radio operation. Most of these were small government pilot projects, but none of the projects included mechanisms for proper maintenance or financial sustainability. Some solar pumps, a fish freezer and refrigerators have been installed on outer islands, also with minimal post-installation support. No information could be found on performance, cost, ownership or outcome. The telecom company has installed many PV generators, ranging from 600–7 800 watts peak (Wp) with excellent performance and high reliability due to the quality of installations and good maintenance from the use of well-trained staff.

The largest stand-alone PV project was the electrification of Pukapuka in 1992 with finance from France. Over 46 kWp of solar panels to electrify more than 160 household and public systems, including communal refrigerators and streetlights were installed. The installations worked well for more than 10 years before the high-quality industrial grade batteries began to fail. Then, a cyclone in 2005 damaged many systems and put most of the installations that were still working out of service. After considering a diesel grid, the Government decided that the best option was a solar mini-grid (actually two mini-grids since there are two population centres separated by over a kilometre).

Given the goal of 100% renewables, conversion of outer island electricity systems to solar generation has commenced with the conversion of the existing power system on Rakahanga to solar through Japanese funding.

TAU itself is installing solar panels on the roof of its Atiu power house and many private investors are applying for connection under the utility's net metering policy. As of mid-2012 over 90 private grid-connected PV systems have been installed or were planned for immediate installation. About 60% of these are residential and the rest are commercial, with the average installation being about 7 kWp. The largest is 85.2 kWp, on a commercial building, and the smallest is 800 Wp on residences. The total private installations completed by April 2012 was 367.12 kWp with another 300.56 kWp expected to be installed by the end of 2012. The installations are distributed all around Rarotonga, but in terms of the Wp amount installed, it is concentrated in the Avarua area.

Solar thermal. Solar water heaters were used as early as the 1950s in the Cook Islands. Today about half of existing housing, and nearly all the new housing and commercial buildings, have solar water heaters, mainly imported from Australia. One estimate suggests that over 70% of residences in Rarotonga have solar water heaters. The high percentage is largely the result of financial incentives.

Wind power. Multi-bladed windmills were used for water pumping prior to the 1970s but suffered damage from salt, humidity and cyclonic winds and are no longer used. Wind turbines for battery charging were used from the late 1930s until about 1955. In 1975, a small French wind generator was installed to power a marine beacon at Penrhyn, Rarotonga. Stuart Kingan installed several very small (less than 1 kW) locally made wind turbines on Rarotonga and elsewhere in the 1970s, but no serious effort was made to develop wind power until the late 1990s.

Wind power could provide substantial direct input into the Rarotonga electricity grid at current wind power costs although the costs could be higher in the outer islands, where generation costs tend to be higher. A Danish feasibility study in the late 1990s found three sites on Rarotonga with an average resource estimated at 7 m/s or higher. Under the present net-metering system of TAU, four small wind turbines have been installed for a total of 11.2 kW of rated capacity.

The Secretariat of the Pacific Community (SPC) evaluated sites in Rarotonga, Atiu and Mangaia in 1999, concluding that a 600 kW installation could be accommodated by the Rarotonga grid. However, the study proposed a smaller pilot project for Mangaia, which was later funded under SPC's Pacific Rural Renewable Energy France-Australia Common Endeavour project. Two 20 kW turbines were installed in 2003 and were operational periodically for about five years. There were many technical problems with the turbines and the project was not considered a good model for replication.

In late 2001, a UN team proposed a 1.8 MW wind farm (eight 225 kW turbines) for Rarotonga and a German/local group proposed a 3.75 MW wind farm (five 750 kW turbines). An independent assessment concluded that the UN proposal was sound, but that the wind resource at the site must be monitored for 18–24 months prior to implementation of so large a project.

Biofuels and biomass. Before 1980, biomass was the primary household energy source used for cooking and drying of copra. It is now a minor energy source, although still significant on the outer islands. In the mid-1980s, the GoCI considered developing a 1.7 MW biomass-fuelled steam generation system for Rarotonga. This proposal was rejected by the government mainly for land use and logistics reasons, factors that continue to prevent large-scale biomass-based generation. In 1983 the utility operated a small sawdust-fuelled gasifier but there were technical problems and tests were abandoned. Coconut oil has been used in very small trials as a diesel fuel replacement but so far has not been used as a significant energy source for the Cook Islands.

Hydropower. No hydro systems have been installed or seriously considered.

Biogas. Eleven biogas units were built at piggeries in Rarotonga in the late 1980s and early 1990s, of which two were operating as late as 2005. Their purpose was primarily environmentally appropriate waste disposal and the gas was vented and not used for energy.

Ocean energy. In 1976, water flow through reef channels was considered for power generation. The Economic and Social Commission for Asia and the Pacific Coordinating Committee for Offshore Prospecting, South Pacific (CCOP/SOPAC, the forerunner of SOPAC) was asked to arrange a feasibility study, but the resource was not considered suitable for development.

OTEC. In 2003, Xenesys, a Japanese company, proposed carrying out a feasibility study for OTEC with a 3 MW Uehara cycle, a 3 MW plant for Aitutaki and two 3 MW plants for Rarotonga. Although the Cook Islands Cabinet approved the proposal no study resulted.

Wave energy. No wave energy generation has occurred in the Cook Islands and none is currently planned, although if the planned wave energy installations for Kosrae Island in the Federated States of Micronesia (FSM) are installed and work well, they may be considered for installation in the Cook Islands.

Geothermal energy. No geothermal surveys have yet been carried out on Rarotonga, the only island likely to have an economically viable resource.

5. Challenges for renewable energy deployment

Challenges to be overcome for effective renewable energy deployment include the following:

- Large-scale solar development requires recycling of spent batteries; otherwise toxic chemicals may be released into the environment and groundwater.
- Donor-funded energy projects have tended not to be consistent with one another, resulting in a variety of different types of installations that present difficulties with maintenance and spare parts. It is important, particularly for solar in the outer islands, that all the systems have a consistent and standardised design approach, with as many components as possible standardised for all islands.
- Limited technical capacity of those living on the outer islands requires installations that are simple to maintain and can be monitored externally through the Internet if they are to be sustainable and reliable.
- Access to the northern island group is limited and expensive, making it necessary to have in place locally the necessary maintenance capability, in terms of both human capacity and spare part stocks.
- Integration of higher shares of solar or wind to the grid without sufficient planning and controls can result in instability and reduced quality of power. Dynamic modelling of the grid will be an important aid to maximising renewable energy input without compromising overall power quality.

IRENA can suggest pathways to overcome these challenges through its Global Renewable Energy Islands Network (GREIN) and believes that regional and national roadmaps should reflect these pathways. IRENA will continue to work with existing regional and national stakeholders to achieve the transition to renewable energy for a secure and sustainable energy supply.

References

In the preparation of this report, primary sources were used as much as possible. Personnel from the REDD and the TAU spent considerable time in locating and providing much of the requested information, as well as in helping to find additional sources. Where primary sources were not available, the following secondary and tertiary sources were used.

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