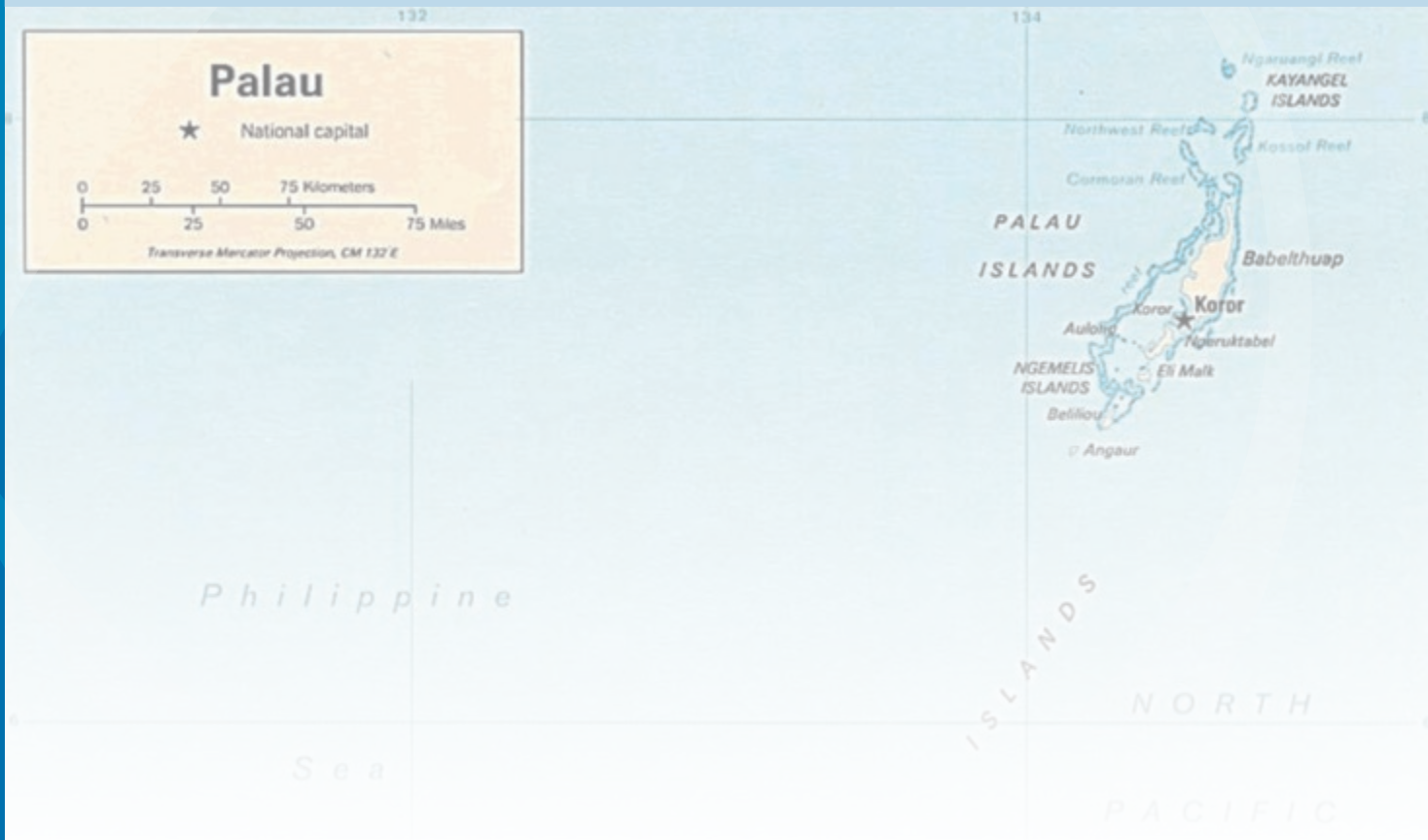
Report

IRENA
International Renewable Energy Agency

Pacific Lighthouses

Renewable energy opportunities and challenges in the Pacific Islands region

Palau



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.
www.irena.org

Acknowledgements

The work and data for the preparation of this paper was carried out by Herb Wade (Consultant). The kind assistance and support provided by Greg Decherong (Palau Energy Office), Nyk Kolulubak (Palau Energy Office), Anare Makaiviti (International Union for Conservation of Nature), Apisake Soakai (Consultant), Ken Sugiyama (Palau Public Utilities Corporation) and Kaleb Udui (Consultant) are gratefully acknowledged. This report could not have been completed without their generous assistance.

Authors: Mirei Isaka (IRENA), Linus Mofor (IRENA) and Herb Wade (Consultant)

For further information or to provide feedback, please contact: Linus Mofor, IRENA Innovation and Technology Centre. E-mail: LMofor@irena.org or secretariat@irena.org.

Disclaimer

Pacific Lighthouses

Renewable energy opportunities and challenges in the Pacific Islands region

Palau

August 2013

TABLE OF CONTENTS

Note on currency:
The currency for Palau is the 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

COFA	Compact of Free Association
CTF	Compact Trust Fund
GDP	Gross Domestic Product
GWh	Gigawatt hours (thousands of millions of watt hours)
kt	Kilotonnes (thousands of tonnes)
kVA	Kilovolt Amperes (Voltage times amperes measure of power)
kW	Kilowatts (thousands of Watts)
kW/m	Kilowatt per metre (measure of wave energy)
kWh/gal	Kilowatt hours per US gallon (engine fuel efficiency)
kWh/m^2	Kilowatt hours per square meter (Solar measurement)
kWh/m^2/day	Kilowatt hours per square meter per day (solar energy measurement)
kWp	Kilowatts Peak (kilowatts of solar PV rated power)
LPG	Liquefied Petroleum Gas
ML	Megalitres (millions of litres)
MW	Megawatt (millions of Watts)
MWh	Megawatt hours (thousands of kilowatt hours)
NDBP	National Development Bank of Palau
OTEC	Ocean Thermal Energy Conversion
PPUC	Palau Public Utilities Corporation
PV	Photovoltaic
UNDP	United Nations Development Programme
Wp	Watts peak (measure of rated power for solar panels)

1. Country context

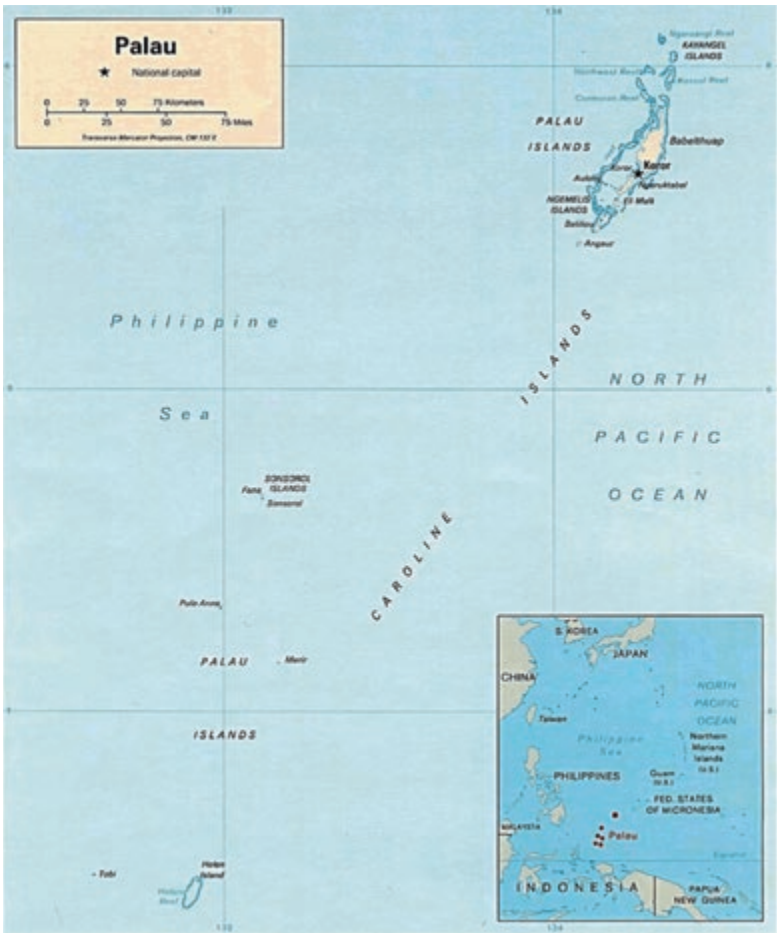


Figure 1. Map of Palau

Source: http://www.lib.utexas.edu/maps/

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

Physical description. Palau is located about 660 km north of Papua New Guinea and 1300 km west of Guam. The country consists of 458 km^2 of land area spread over more than 200 islands, although over 95% of that area lies within a single reef structure that includes the islands of Babeldaob, Peleliu and Koror where over 90% of the population resides. Babeldaob is the largest island and accounts for about 75% of Palau's total land area. Outlying populated islands include Sonsorol, about 300 km to the south-east of the main island group, with Tobi and Helen's Reef around 300 km further to the south-east. Angaur lies 20 km to the south-west of the main island group and Kayangel about 30 km to the north-east.

Babeldaob and Koror are mountainous and volcanic in origin, although Palau also includes raised coral islands and atolls. Koror and Babeldaob, the two most populous islands, are connected by a suspension bridge.

Population. The 2005 census showed 19 907 persons residing in Palau, 69.9% of whom were ethnic Palauan. The rest are largely migrant workers from the Philip-

pines and other neighbouring Asian countries. Over 70% of Palau's population lives on Koror, and another 20% on Babeldaob and Peleliu. Koror is densely populated although with the recent establishment of the national Capitol Complex on Babeldaob, a slow population shift to that much larger island is expected.

Environment. Palau has an equatorial marine environment. No cyclones have been recorded in decades, though near passages are not unusual. Palau has a strong environmental preservation programme, particularly for the major tourist attractions including the Rock Islands and the reefs where some of the best diving in the world is found. Marine biodiversity is high and land biodiversity moderate. Strict U.S. regulations for water and air pollution have been adopted and despite the dense population, environmental quality is generally good, although waste management is a problem with some 6 500 tonnes of urban waste generated annually.

Economic overview. Of the USD 500 million scheduled for payment under the Compact of Free Association (COFA), USD 70 million was set aside in a Compact Trust Fund (CTF) which has now grown to around USD 140 million. COFA grants ceased in 2009 and the CTF helps fund government activities. Palau's gross domestic product (GDP) is around USD 120 million per year representing a per-capita GDP of about USD 6 200, one of the highest in the Pacific Island Countries and Territories (PICTs). Salaries are relatively high with the mean annual income for employed workers at over USD 8 000. The economy is over 80% service-oriented, primarily the public sector and tourism. The public sector accounts for about 25% of GDP and is the main employer and primary supplier of services. Tourism services have grown rapidly in recent years and account for the majority of GDP. Tourism numbers dropped recently as a result of world economic problems, but in 2011 there was a strong recovery and Palau's economy expanded 5.8%, much better than the 0.3% recorded in 2010.Fisheries accounted for less than 3% of GDP but aquaculture, particularly of the giant clam, is hoped to boost exports in the future.

Large capital projects – building the Capitol Complex, the Koror/Babeldaob bridge and massive road construction on Babeldaob – contributed around 10% of GDP in the early 2000s.

Although COFA payments have ended, the U.S. remains Palau's largest donor, with the EU and Japan being other major donors. Institutions in Chinese Taipei have also made sizable financial contributions.

2. Energy landscape

Institutional and regulatory arrangements for energy

Palau National Energy Policy. The National Energy Policy was approved in 2010. It includes the requirement to prepare an Energy Act that clearly spells out the institutional arrangements for energy within the government. However, a bill to create this legislation has yet to be proposed. Until it is, the Palau Energy Office remains the primary energy focal point for the Government. The Energy Office operates under the Public Works Department although the Director of Energy reports directly to the Minister of Public Infrastructure, Industries and Commerce. Only the Director is established in the Energy Office; all other personnel are hired as needed, either as un-established staff or contract workers. The *de facto* role of the office is policy, renewable energy, energy efficiency and acting as the Government's focal point for energy when dealing with outside agencies. In the past the Energy Office took responsibility for outer island electrification and renewable energy development.

Palau Public Utilities Corporation (PPUC). Electricity is supplied by the PPUC, which is government-owned but operated as a commercial enterprise and required to break even on operating and maintenance costs. Capital costs are not included in determining the profit figures. Although the legislation forming the PPUC states that it should consider renewable energy, it gives no guidelines or priorities.

Energy supply and demand

Petroleum. Blue Bay and IP&E, subsidiaries of international companies supply Palau's fuel from Guam. Liquefied petroleum gas (LPG) is imported by Palau Equipment and NECO Gas, both local companies. The Government tenders for its own petroleum purchases and large energy users often make their own purchase arrangements. Pricing of petroleum products is not regulated and the oil companies set their own prices based on cost of supply plus profit.

Fuel is stored in bulk totalling nearly 40 million litres representing about nine months of supply. The storage is owned by the oil companies, who both use U.S. regulations and safety standards for storage and distribution operations.

Petroleum use in 2010 totalled about 53.8 ML (Table 2). The volume of diesel imported was about 27.7 ML, of which 25.0 ML were used for electricity generation, 2.6 ML for land transport and 43 394 litres for sea transport. The fuel import of 14 ML of gasoline in 2010 was split between land and marine transport and about 4 ML of aviation gasoline was imported for the small sightseeing planes servicing the tourist industry. There were around 4 800 vehicles on Palau's roads in 2001 almost all of which use petrol. Some kerosene is used for cooking but is being slowly replaced by LPG.

Gasoline use for boats is closely linked to tourism since high horsepower outboard engines are typically used for tourist transport to the Rock Islands and to dive sites. The use of automotive has increased since most employees need to commute around 50 km each way from homes on Koror. Inter-island flights between Babeldaob, Angaur and Peleliu are possible and small aircraft operate for sight-seeing tours and charters.

Electricity generation and demand. Palau has two power stations (Table 1). In 2011, the Malakal power plant generated about 43 375 400 kWh using 2 650 504 US gallons (10 033 249 litres) of diesel fuel giving an energy conversion of 14.2 kWh/gal (4.2 kWh/litre). The Aimeliik Power Station, with its much older engines, generated 45 375 400 kWh using 3 640 389 US gallons (13 780 371 litres) of diesel fuel for an efficiency of 12.5 kWh/gal (3.3 kWh/litre). PPUC's system reliability and power quality has been good, even on the rural islands.

Of the app roximately 600 kWp of grid-connected solar PV installed capacity about 540 kWp is owned by Palau Government, about 17 kWp by private operators, and 42.4 kWp U.S. Government. The rest of the electricity generation is powered by diesel engines. About 23 MW of useable capacity is presently split about half and half between Babeldaob and Koror and capacity is transmitted through a 34.5 kV intertie. Around 2 MW of capacity is present on Peleliu with 500 kW on Angaur and 200 kW on Kayangel. These outer island generators are seriously oversized and operate at low efficiency. There are plans to add solar with battery storage to the outer island grids to cater for all loads, except peak loads.

Table 1. Fuel imports 2007–2010

Fuel Type	2007 (litres)	2008 (litres)	2009 (litres)	2010 (litres)
Diesel	46 203 708	29 138 265	25 554 655	27 694 394
Gasoline	16 031 954	14 936 466	14 338 294	14 338 294
Jet Fuel	1 907 612	17 417 793	11 718 919	11 718 919
TOTAL	64 145 280	61 492 523	51 611 867	53 751 606

Source: Estimated from Palau Customs Authority Records.

Table 2. Installed Gensets (2011)

Location	Engine	Rating	RPM	Volts	Installed
Malakal	Mitsibushi 12	3.4 MW	720	13.8kV	1997
	Mitsibushi 13	3.4 MW	720	13.8kV	1997
	Wartsilla 1	2.0 MW	1200	13.8kV	1996
	Caterpillar 1	1.825 MW	1800	480V	2006
	Caterpillar 2	1.825 MW	1800	480V	2006
	ALCO	1.25 MW	720	4.16kV	1982
	Nigata 1	5 MW	450	6,6kV	2005
	Nigata 2	5 MW	450	6.6kV	2005
Aimeliik	Unit 2	3.27 MW	450	13.8kV	1984
	Unit 3	3.27 MW	450	13.8kV	1984
	Unit 4	3.27 MW	450	13.8kV	1984
	Unit 5	3.27 MW	450	13.8kV	1984

Source: Provided through communication by PPUC (2012).

On 5 November 2011, a fuel leak spraying on a hot exhaust pipe caused a major fire at the Aimeliik power plant on Babeldoab. The fire spread quickly and put the facility out of operation for several months, requiring the PPUC to establish rolling blackouts. By mid-2012 enough capacity was restored to return to full 24-hour power throughout the PPUC system but it will take quite some time for the system to fully recover from the accident.

Electricity demand grew rapidly in the 1990s as tourism increased but has slowed and even declined in recent years (Table 3). The typical daily load curve is shown in Figure 2. The energy delivery in 2005 was 88 GWh which declined to 62.66 GWh in 2010. Since there have been no aggressive load reduction efforts, it is assumed

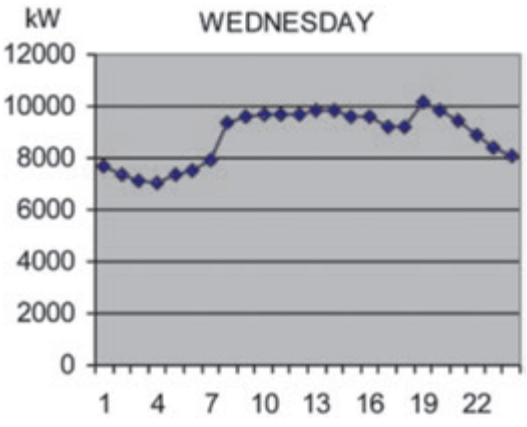


Figure 2. PPUC Load Curve (weekday)

Source: Provided through communication by PPUC (2012).

Table 3. Electricity sales in kWh

Year	Sector	Sales in kWh
2005	Residential	24 189 435
	Commercial/Industrial	41 046 510
	Government	22 774 168
2006	Residential	17 610 999
	Commercial/Industrial	33 849 116
	Government	22 057 130
2007	Residential	26 805 751
	Commercial/Industrial	32 976 727
	Government	22 911 597
2008	Residential	22 583 686
	Commercial/Industrial	32 393 194
	Government	21 719 186
2009	Residential	18 963 528
	Commercial/Industrial	22 567 002
	Government	20 650 847
2010	Residential	18 040 852
	Commercial/Industrial	24 729 437
	Government	19 890 650

Source: Provided through communication by Palau Energy Office (2012).

that the imported fuel price and corresponding electricity price hikes in 2008 caused users to use less energy. In the future, the load growth will probably be no higher than the population growth rate of about 2% per year. Commercial use in 2010 was about 24.7 GWh, government about 19.9 GWh and domestic about 18 GWh. Non-technical and technical losses were high for PPUC, partly because public lighting is not metered, although there also appears to be considerable room for supply-side efficiency improvements. Energy efficiency improvement through demand-side management in all sectors can further reduce energy use in all sectors.

Electricity tariffs. The electricity tariffs for Palau Public Utilities Corporation as reported to the PPA for 2013 are as given in Table 4.

Table 4. PPUB electricity tariffs (2013)

Consumer type		Tariff (USD/kWh)
Residential	0–150 kWh/month	0.282
	151–500 kWh/month	0.356
	over 500 kWh/month	0.405
Commercial/ Government/ Rest of Palau		0.405

3. Renewable energy opportunities

Solar energy. Although precise, ground-based solar radiation measurements are not available, satellite measurements show Palau's solar input to be about 5.5 kWh/m^2/day. There is a small market for solar PV to provide lighting for second residences located in off-grid areas but virtually all primary residences are connected to the grid or already have had PV installed. Therefore the market for solar PV is primarily for grid-connected installations and eventual phase-out of the diesel generators. Solar water heating is clearly cost-effective and a number of systems are installed in houses and tourist facilities.

Wind power. No systematic wind resource measurements have been carried out in Palau over the years, though they are now planned. Based on measurements made for climate records, it appears unlikely that wind energy can be a significant resource for power generation. However, since wind power is very site-specific, proper assessment is needed. Wind energy measurements using well instrumented 30-metre masts are planned to commence in 2013 and a proper wind map of the main islands should be available by 2015.

Biomass. Although biomass was once the primary source of cooking energy, it has been almost completely replaced by LPG, kerosene and electricity. Palau has about 75% general forest coverage with 15% coastal mangroves and 6% swamps. About 60% of the land is classed as densely forested, essentially tropical jungle. However harvesting this resource as biomass or planting large plantations of fuel crops is unlikely due to environmental, economic and land tenure reasons. There are no large coconut plantations in Palau and the production of biofuels would require extensive planting and a long wait before production could begin. At current fuel prices, locally produced biofuels are not likely to be a practical or reliable source of energy.

Biogas. There may be a good opportunity for biogas production using animal waste, since there are piggeries with 20–50 animals and chicken farms with 5 000–9 000 birds. Biogas makes good sense for this type of facility since it generates combustible gas and also properly disposes of waste products by converting them into high-quality fertiliser. Gas from the Koror sewage plant could also be used. If Koror's sewer system added a digester to its treatment system, sufficient biogas could be generated to at least operate the plant's various pumps and controls. Methane generation should also be considered at the various landfills being developed on Palau to reduce greenhouse gas production and provide energy as a useful by-product.

Hydropower. Economically viable hydro resource in Palau are very limited. A study by the Filipino consulting firm Vergel Consult in 2005 indicated that some electricity generation was possible on the permanent streams of Babeldoab including the Diongradid, Ngermeskand and Ngrikill streams. Since this resource is seasonal and large land areas would need to be set aside for reservoirs, the economics are poor. However, the consultants did not consider run-of-river hydro for supplementary power only. As run-of-river hydro would be much less costly and requires little land use, now that there are transmissions lines in the area, this approach may be cost-effective and should be considered.

Ocean Thermal Energy Conversion (OTEC). Although Palau is known to have good OTEC resources, the technology has been under development for over 30 years and still remains at the research development and demonstration stage. It appears unlikely that a cost-effective OTEC facility for Palau can be provided in the near future.

Geothermal energy. There is no known geothermal resource in Palau.

Wave energy. Palau's wave energy resource is considered to be modest though wave energy surveys have yet to be carried out. Since there are no commercially available wave energy conversion machines that have been properly tested for the conditions in Palau, it is unlikely that wave energy will be a significant energy source in the near term.

4. Experiences with renewable energy technologies

Solar PV off-grid. Solar lighting systems were installed in the 1980s on Kayangel, Sonsorol, Tobi and parts of Babeldaob. There were institutional problems that prevented their long-term operation although a few systems have been maintained by individual households. The main problems were that services were too limited, the cost was high for the services that could be provided, and the structures for maintenance and repairs were inadequate.

In recent years, much larger solar PV systems have been installed on Sonsorol and Tobi – two distant islands that do not yet have diesel generation. The systems were large enough to operate refrigerators, washers and video players as well as lights and other entertainment appliances. Unfortunately their institutional design did not include adequate technical support structures to suit the environment. All the inverters and batteries have failed, and the systems have now been abandoned.

Communications on outer islands are powered by PV, which has proved reliable and cost-effective for that purpose.

Grid-connected solar PV. There has been a rapid increase in the amount of solar PV connected to the PPUC grid since 2007. The installations worked at different levels of success determined by proper components and connection to the grids. There was no net-metering law in Palau until 2012, so each installation had to be individually approved for connection to the grid by the PPUC who also had to operate and maintain the government-owned installations.

Other grid-connected solar. The first grid-connected solar in Palau was installed on Koror in 2008 when Japan funded a 6.5 kWp grid-connected installation on the roof of the island's solid waste segregation facility using an SMA inverter for connection to the grid. The installation has functioned without problems since its installation.

In 2010 the National Development Bank of Palau (NDBP) initiated a programme for the subsidised financing of private (residential or commercial) grid-connected solar. The project was supported by the United Nations Development Programme (UNDP), the Italian Fund, and the European Investment Bank. NDBP installed 8.5 kW on their own premises and as of early 2012 had installed 6.8 kW on residences. The solar panels, AC inverter, monitoring equipment, wiring and all hardware are provided by the NDBP at cost as a 1.7 kW kit. Two kits can be combined using a single inverter to make a 3.4 kWp installation, which is the option that most residences have accepted. The financing subsidy is set at a level where the cost of the solar energy is about the same as the cost of PPUC energy so that the payments equal the savings on the purchaser's electric bill. This means that household cash flow remains unchanged at the time of purchase, although the solar owner begins to make money when the cost of PPUC power increases.

The NDBP programme also stocks and finances off-grid solar for those few Palau residences that are off-grid. This programme uses a modular system so that installation can range from basic lighting up to the use of urban-style domestic appliances.

After several years of deliberations, the US Military Community Service Camp on Babeldoab installed 42.3 kW of grid-connected solar in 2011 to help offset energy costs at the facility. The installation is on the roof of a large workshop building and uses SMA inverters.

The total of all grid-connected solar on the PPUC grid is around 600 kWp. With a mid-day peak of 9–10 MW, PPUC has few problems absorbing this level of solar input and can probably accept another 1 MW without stability problems, particularly if the solar is geographically

Table 5. Government-owned, PPUC-managed grid-connection solar installations

Location	kWp capacity	Year
Capitol	100	2008
Hospital	150	2008
Airport	225	2011
Dept. of Education	51.06	2010
National Archives	13.7	2010
Public Works	6.5	2012
Total	**546.26**	

Source: Provided through communication by PPUC (2012).

dispersed on the grid. However, when more variable renewable energy is integrated into grids, maintaining grid stability becomes more challenging. In 2012, IRENA used a dynamic model of the Palau grid to carry out a grid stability assessment, which aimed to determine the level of solar that could be integrated before special grid-stabilising controls and/or storage needed to be considered. The study showed that the island could expand its PV penetration to 30 percent of current maximum demand without any special control requirement in grid operations, owing to the high availability of spinning reserve from existing diesel units.

Solar Thermal. Most tourist facilities include solar water heating as do a number of private homes. Systems are imported but locally installed.

Wind power. A 1.5 kW wind generator was installed in 1982 on Koror. It never provided its rated power and was disassembled a few years later. No other wind power systems have been installed although they have been considered.

Biofuels and biomass. Biomass gasification was tried with funding from U.S. Department of Energy in 1984 with a small-scale (15 kW) gasifier at the Nekken forestry site using wood chips as fuel. The unit worked poorly and was not considered suitable for further trials. As there are no significant forestry or agricultural industries in Palau, the lack of biomass industrial waste products as feedstock makes it unlikely that biomass energy development will be significant in the near term.

5. Challenges and opportunities for renewable energy deployment

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

- Palau's wind potential has not been fully assessed.
- Palau's high labour costs and income expectations limit biomass and biofuel development.
- Achieving a high level of renewable energy input solely from variable sources, such as solar and wind, requires significant investment in storage and complex control systems to maintain grid stability.
- Renewable energy projects have no single focal point for implementation, and implementation is therefore often fragmented and uncoordinated.
- Tariffs for electricity do not include capital costs.
- The market is small, making additional new renewable energy capacity and energy-efficiency products and services difficult to introduce profitably without well designed market support. However, there are over 13 MW of diesel systems at Aimeliik (about 35% of Palau's current installed capacity) that are nearly 30 years old and will need replacement, thus offering opportunities for a high share of renewable in the Palaun energy mix.
- Energy development is a low priority for private investment. Palau's economy offers other, more profitable, opportunities.
- Conditions are difficult for electrical and mechanical equipment because of the tropical marine environment, including high humidity, high levels of airborne salt, and high ambient temperatures.

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 for Palau.

References

In the preparation of this report, primary sources were used as much as possible. Some information was obtained through written questionnaires, some through interviews and some through email correspondence. Where primary sources were not available, the following secondary and tertiary sources were used.

Publication References

Asian Development Bank (2012), Newsletter: Pacific Economic Monitor.

Castalia/Asian Development Bank (2010), Enhancing Effective Regulation of Water and Energy Infrastructure and Utility Services (Small Island Country Component) Interim Pacific Report.

Government of Palau and World Bank (2011), Palau Petroleum Chain.

Johnston, Peter – Secretariat of the Pacific Regional Environment Programme/Pacific Islands Renewable Energy Project (2005), Pacific Regional Energy Assessment 2004 Volume 10 – Palau.

Johnston, Peter (2008), Expanding and Updating the Pacific Islands Renewable Energy Project (UNDP/GEF/SPREP/PIREP) Reports and Data.

McCracken, Philippe et al. (2007), Palau Energy Conservation Strategy (PECS).

Ministry of Finance Office of Planning and Statistics (2006), Republic of Palau Household Incomes and Expenditures Survey (HIES).

Pacific Power Association (2011), Performance Benchmarking for Pacific Power Utilities.

Pacific Power Association-KEMA (2010), Quantification of Energy Efficiency in the Utilities of the U.S. Affiliate States (excluding US Virgin Islands).

Pacific Regional Infrastructure Facility (2011), Pacific Infrastructure Performance Indicators.

Palau Energy Policy Development Working Group (2009), Republic of Palau Strategic Action Plan Energy Sector.

Palau Energy Policy Development Working Group, (2009), Republic of Palau Draft National Energy Policy.

Palau Office of Planning and Statistics (2006), 2005 Census Tables.

Pool, Frank GEF/UNDP (2012), Mid-Term Review, Palau Sustainable Economic Development Through Renewable Energy Applications (SEDREA).

Resources and Logistics-EU (2011), Support to the Energy Sector in 5 Pacific Island States, REP-5. Final Evaluation Report Vol 1 – Main Report.

Secretariat of the Pacific Community (2011), Towards an energy secure Pacific, Framework for Action on Energy Security in the Pacific.

Syngellakis, Katerina IT Power (2011), UNIDO-SPC Assessment of Renewable Energy (RE) and Energy Efficiency (EE) Potential in Selected Pacific States.

United States Central Intelligence Agency, (2012), The World Fact Book 2012–2013.

World Bank, East Asia and Pacific Region, Pacific Islands Country Management Unit (2006), A review of obstacles and opportunities for improving performance in the Pacific Islands.

Internet Reference Sources

Secretariat of the Pacific Community, Pacific Regional Information System, Statistics for Development Programme (2012), http://www.spc.int/nmdi/MdiHome.aspx

Secretariat of the Pacific Regional Environment Programme, Pacific Regional Energy Assessment: Country Reports (PIREP) (2012), http://www.sprep.org/Pacific-Environment-Information-Network/country-profiles-directory

The World Bank, Indicators (2012), http://data.worldbank.org/indicator/all

United States National Aeronautics and Space Administration (2012), solar and wind data website URL: http://eosweb.larc.nasa.gov/cgi-bin/sse/sse.cgi?

IRENA
International Renewable Energy Agency

IRENA
C67 Office Building, Khalidiyah (32nd) Street
P.O. Box 236, Abu Dhabi,
United Arab Emirates
www.irena.org