Report

IRENA
International Renewable Energy Agency

Pacific Lighthouses

Renewable energy opportunities and challenges in the Pacific Islands region

Samoa

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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Note on currency:
On 23 October 2012, one United States dollar (USD) exchanged for Samoa tala (WST) 2.269.

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

ADB	Asian Development Bank
AusAID	Australian Agency for International Development
EPC	Electric Power Corporation
GDP	Gross Domestic Product
JICA	Japan International Cooperation Agency
kt	Kilotonne (one thousand metric tons)
ktoe	Kilotonnes of oil equivalent
kWh	Kilowatt hours (thousands of Watt hours)
kWp	Kilowatts peak (solar output rating)
LED	Light Emitting Diode
LPG	Liquefied Petroleum Gas
m^2	Square meters
m3	Cubic meters
MNRE	Ministry of Natural Resources and Environment
MoF	Ministry of Finance
MPPT	Maximum Power Point Tracking (solar controller)
MW	Megawatts (millions of Watts)
NGO	Non-Governmental Organisation
PSEP	Power Sector Expansion Project
PV	Photovoltaics
SROS	Scientific Research Organization of Samoa
V	Volts
WST	Tala (Samoa currency)

1. Country context

Figure 1. Map of Samoa and its location in the Pacific

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. Samoa, located north-east of Fiji, has 2 934 km^2 of land area, mostly on the islands of Savai'i (58% of land) and Upolu (38%). The climate is warm, humid and tropical with distinct wet and dry seasons. The annual rainfall is 2880 millimetres (mm), with considerable variation by location. Mean annual temperatures vary from a low of 20°C to a high of 30°C with limited seasonal variation. Sunshine averages 2 500 hours annually.

Population. In the 2011 census, Samoa counted a population of 187 820, with an average national growth of 0.8% per year and an urban growth of 1.5% per year since 1991. Around 22% of the population resided in the Apia urban area, 30% in northwest Upolu, 24% elsewhere in Upolu, and most of the remaining 24% in Savai'i. There is a high rate of migration to New Zealand, Australia and the United States as well as considerable internal migration into Apia and the northwest of Upolu from the rest of the country.

Environment. Samoa is party to a number of international and regional treaties and conventions, including several with energy implications, particularly the United

Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. Environmental issues related to energy use include air pollution from incineration of rubbish and cooking in outdoor kitchens. About 70% of Samoa's population and infrastructure are located in the environmentally vulnerable coastal zone. Only 4% of the coastline is resilient to coastal hazards. The disastrous Tsunami of 2009 painfully confirmed the vulnerability of the coastal areas.

Economic overview. The economy of Samoa is narrowly based agriculture, fishing, tourism, remittances and development aid. It is highly vulnerable to climate, weather-related and other external shocks. However, until recently Samoa's economic growth has been steady with gross domestic product (GDP) per capita growing some 3.3% per year in real terms in the last decade until the recent global economic crisis and natural disasters impacted the economy of the country. The World Bank estimates Samoa's GDP at about USD 640.9 million for 2011. The economy is heavily dependent on private remittances and investment through official transfers, with as much as 25% of GDP coming from overseas remittances, mostly from Samoans living in Australia, New Zealand and the USA.

Tourism is becoming an increasingly important part of the economy providing up to 25% of GDP. Other industry is limited. Manufacturing of automobile wiring harnesses for the Australian market employs about 3 000 thousand people and the Vailima Brewery produces around 8 600 litres of soft drinks and 16 400 litres of beer per day. Agricultural products provide about 90% of all exports and about 65% of the labour force is involved in agricultural sector.

In 2009 a devastating tsunami struck the southern coast of Upolu, causing death and major damage to infrastructure. Recovery required unexpected large expenditures, disrupting not only those directly affected, but the entire Samoan economy. Growth for 2009 was estimated at -5.1%. Samoa is also in the cyclone belt of the South Pacific and the aftermath of storms includes loss of crops and costly repairs to buildings and facilities.

2. Energy landscape

Institutional and regulatory arrangements for energy

Energy Policy and Coordination Division. The Energy Policy and Coordination Division of the Ministry of Finance (MoF) is responsible for energy planning and policy, development of the Samoa Energy Sector Plan (energy roadmap), and a programme of activities to implement these policies. The Energy Policy and Coordination Division is also responsible for overall monitoring and evaluation of the energy sector, including coordinating national and regional level energy projects and publishing annual energy reviews. Arranging petroleum supply is also part of the MoF's responsibilities and it negotiates the five-year contract for supply and distribution of fuel from government-owned storage.

Electric Power Corporation. The state-owned Electric Power Corporation (EPC) reports to the Minister of Works, Transport and Infrastructure (MWTI). Due to Samoa's growing dependence on fossil fuels and the need for external assistance for planning and investing at EPC, the Asian Development Bank (ADB) has instituted a series of technical assistance programmes directed at capacity building and investment support.

Ministry of Natural Resources and Environment (MNRE). The MNRE is responsible for environmental aspects of energy use including greenhouse gas emissions and climate change matters.

Samoa National Energy Policy. The Government has developed a comprehensive Samoa National Energy Policy, which came into effect in 2007 along with an associated Strategic Action Plan. All aspects of energy policy are included in the plan with renewable energy and energy efficiency well supported. The Strategic Action Plan includes a goal of 20% of all energy services to be supplied from renewable energy by 2030. In 2012, the policy and its associated plan were reviewed as the first step towards the development of the Samoa Energy Sector Plan 2012–2016 and its Programme of Activities, which was launched in December 2012.

Samoa has had a consistent and successful petroleum policy for the past 20 years. By assuring access to, and ownership of, petroleum storage it leverages its bargaining strength when negotiating petroleum supply arrangements. As a result, Samoa has consistently had relatively low landed prices for petroleum products in the Pacific.

Samoa Energy Sector Plan 2012-2016. The Energy Sector Plan is aimed at supporting delivery of the Strategy for the Development of Samoa (SDS) 2012-2016 which has the vision to improve the quality of life of all citizens of Samo. Renewable energy and energy efficiency are the main components of the energy sector plan where the MoF plays a coordinating role. Various ministries and agencies such as MNRE, the Scientific Research Organisation of Samoa (SROS) and EPC as well as NGOs and the private sector carry out implementation of the plan. Renewable energy projects are sometimes coordinated by these agencies in relation to their own particular mandates and roles but they are all linked to the Energy Sector Plan, policy and programme of activities coordinated by the MoF. EPC is usually the interface for electricity-based renewable energy systems.

The Acts that deal directly or indirectly with energy issues include:

- The Price Control Act (1982) includes procedures for controlling prices of petroleum fuels and other commodities.
- The EPC Act (1980 and amended in 2010) governs activities of the electric power utility.
- The Foreign Investment Act (2000 and amended in 2012) reserves some businesses for Samoans.
- The Petroleum Act (1984 and amended in 2003) covers supply, transport and storage of petroleum and tendering for its supply.
- The PUMA Act (2004) regulates the development, regulation, sustainable use, and management of land, requiring environmental impact assessments and management plans for a range of activities.
- The Public Bodies (Performance and Accountability) Act (2001) requires state-owned enterprises to meet community service obligations, including universal access to a necessary good or service.
- The Samoa Forestry Act regulates management of forest resources.
- The Electricity Act (2010) created an independent regulator to oversee the electricity sector.

Energy supply and demand.

Only limited data are available on household energy use. In 2011, 65% of households reported fuelwood as their main cooking fuel, ranging from 28% in Apia to 87% in Savai'i. Kerosene, LPG, electricity and charcoal were the main cooking energy sources for 4.5%, 19%, 6.5% and 4.3% of households respectively. 97% of households use electricity for lighting, the rest mostly use kerosene. Biomass use for the traditional underground oven (Umu) remains common even in central urban areas, especially on weekends and for special events. Total biomass usage for residential cooking and crop drying was estimated at 36.7 kilotonnes of oil equivalent (ktoe) for 2010.

Petroleum. Estimates for commercial energy end use by sector in 2003 indicate that 36% of distillate was used for electricity generation, 25% for heavy machinery, 15% for fishing and 24% for ground transport. For petrol 80% was used for transport and 20% for fishing. The figures for kerosene (including jet fuel) were 90% for transport and 10% for household cooking and lighting. About two-thirds of LPG use was by households and the rest for commerce. Overall, about 45% of the 73 ktoe consumed was for transport, 30% for electricity production, 16% for commerce and industry, and 2% for households. In the Energy Review Report 2010, prepared by the Energy Policy and Coordination Division, the Ministry of Finance estimated that biomass used for cooking and crop drying supplied about 42% of the total energy used in Samoa.

Electricity generation and demand. Up to 50% of Upolu's electricity is generated from hydro, while other energy needs are met primarily from petroleum fuels. In 2011, 98% of Samoa's households were considered electrified. The remainder are mostly located too far from distribution lines for grid extension to be economical. Those areas are therefore being considered for solar home systems.

In 2011 EPC had 36 785 meters in operation, of which 86% were in domestic households accounting for an average of around 100 kWh per month and over 40% of all sales. Of the residential meters, 11 294 were standard units read monthly and 20 497 were pre-paid meters. Commercial users had 4 267 standard meters and 543 pre-paid meters. Government facilities had 176 standard meters and eight pre-paid meters. Samoa's public streetlights, the majority of which are 80 watt LED lights, are not metered.

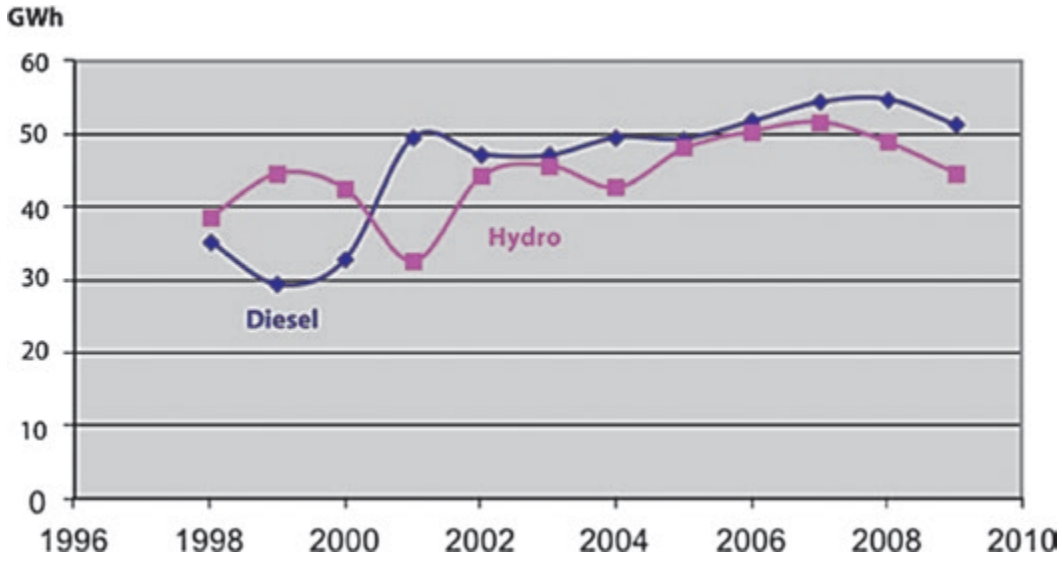
EPC is continuing implementation of its USD 100 million Power Sector Expansion Project (PSEP) – funded by ADB, the Australian Agency for International Development (AusAID) and the Japan International Cooperation Agency (JICA) – through its Project Management Unit. Sub-projects being carried out as part of PSEP include building a new 20 MW diesel power station, burying transmission lines underground in the town area, and installing pre-payment meters.

EPC has eight small hydroelectric plants (950–2 000 kW, mostly run-of-river) at five locations on Upolu totalling 9.71 MW of effective capacity. The Utility also has about 18.5 MW of diesel de-rated to 16.9 MW. Dry season hydro capacity is about 4.2 MW. Overall, the de-rated dry season capacity of all systems is about 21 MW of which 81% is diesel and 19% hydro.

The peak Upolu load in 2011 was around 16.2 MW (Figure 2). The Savai'i peak was 2.8 MW with 6.6 MW of nameplate capacity de-rated to 5.8 MW. Generation on Upolu is a mixture of hydro and diesel (Figure 3). All generation on Savai'i is diesel.

Figure 2. Upolu load curves for weekday, Saturday and Sunday

Source Provided through communication by EPC (2012).



Hydro installations operational in 2011 – all on Upolu – totalled 9.71 MW capacity:

1. **Alaoa** – 1.050 MW
2. **Fale-O-Fale (FOF)** – 1.740 MW
3. **Afulilo/Taelefaga** – 4.120 MW
4. **Samasoni** – 0.950 MW
5. **Sauniatu/Lalomauga** – 1.850 MW

Figure 3. Hydro and diesel power delivery from 1996 – 2010 (EPC)

Source: Provided through communication by EPC (2012).

A 2003 Japan International Cooperation Agency (JICA) study estimated that Samoa's generation would grow at 6.5% per year over the next few years.

The Savai'i and Upolu grids are not connected. Table 1 shows Savai'i sales in kWh up to 2011 and Table 2 shows the corresponding figures for Upolu. Sales data by sector are currently difficult to obtain due to the conversion to pre-paid meters, particularly in the residential sector.

The multi-year PSEP is underway and so increases investments in virtually all aspects of EPC's operations, including renewable energy.

Electricity tariffs. The EPC tariff has not changed much in five years and there is an increasing gap between real costs and revenue. The tariffs from August 2013 were as given in Table 3.

Table 1. Savai'i Sales (kWh)

Year	Sector	Sales
2010	Residential	4 324 848
	Commercial	4 152 750
	Government	878 039
	TOTAL	9 355 637
2011	Residential	3 402 424
	Commercial	4 518 807
	Government	932 037
	TOTAL	8 853 268

Source: Provided through communication by EPC (2012).

Table 2. Upolu sales in MWh 2005–2009

Year	Sector	Sales in MWh	Year	Sector	Sales in MWh
2005	Residential	27179	2006	Residential	23181
	Commercial/Industrial	46279		Commercial/Industrial	44490
	Government	8701		Government	9030
2007	Residential	28771	2008	Residential	24149
	Commercial/Industrial	46587		Commercial/Industrial	46685
	Government	8328		Government	9142
2009	Residential	21281			
	Commercial/Industrial	40783			
	Government	8018			

Source: Provided through communication by EPC (2012).

Note: EPC uses a different sector classification than the above. Sectors that are not government or residential such as churches are combined into the Commercial/Industrial classification above.

Note: Due to the conversion from the post-payment meters to pre-payment meters, 2010 usage data by sector have not been available.

Table 3. Electricity tariffs in Samoa

Consumer type		Tariff (WST/kWh)	Pre-paid tariff (WST/kWh)
Residential	0–50 kWh/month	0.85	0.84
	> 50 kWh/month	1.01	0.99
Commercial	All usage	1.01	0.99

3. Renewable energy opportunities

In the Samoa National Energy Policy adopted in 2007, Samoa set a goal of increasing the contribution of renewable energy (over that already produced by hydro) by 20% by 2030.

Geothermal energy. There may be potential for 4–5 MW of geothermal power plant in Savai'i, where there have been active lava flows within historical record, but this is based on a very limited study. Given the small population on Savai'i and the high cost of undersea transmission lines to the main load centre on Upolu, geothermal is unlikely to be a cost-effective development at this time.

Hydropower. About 12 MW of hydroelectric capacity has been developed on Upolu. Several studies of Savai'i's hydro potential suggest that sites with capacities of 1.5–5.0 MW could be developed. Although hydro development on Savai'i has been proposed in the past, a lack of local support has prevented any installations actually being constructed.

Ocean energy. There is very little knowledge of Samoa's ocean-based energy potential, whether ocean temperature gradients, tidal or wave. In the early 1990s Norwegians mapped the wave resource through data buoys moored off Upolu and other islands. In the open sea, annual mean wave power levels were 20–25 kW/m but only 16 kW/m on the coast, where it is of more practical significance. Estimates based on satellite measurements suggest that the northern shores average 8–9 kW/m.

Wind energy. EPC is conducting an ongoing assessment of Samoa's wind energy potential. Masts for 10 metre and 30 metre measurements were installed at the Afuilo hydro site and at Aleipata on the coast. In 2009 an assessment of the wind regime at the two sites was commissioned but since there were many gaps in the records, it was decided that any estimates would be inaccurate and more continuous data were needed for a proper analysis of the wind energy potential. The data collected from both sites need further analysis to determine their actual potential. However, the mast at Aleipata was damaged during construction of a new wharf and is no longer functioning. The mast at Afulilo is still operating and collecting up-to-date data. The consultants on the project suggested other sites with higher potential for survey. There may be a sufficient wind resource on Upolu for electricity generation, but there are issues of access to land with the potential to slow or halt development.

Solar Energy. Most parts of Samoa appear to receive a daily average insolation of over 5.0 kWh/m^2 with relatively small seasonal variation. This offers good potential for off-grid electrification and grid-connected solar generation.

Bioenergy. Samoa's forests are mainly humid tropical rainforests and 75% are on Savai'i. Estimates of coverage range from about 35% to 45% but data collection has been poor and recent work suggests that the lower estimates may be more accurate. More than 80% of forests are not commercially exploitable and most of the remainder has already been cleared for timber or agriculture or damaged by cyclones. Logging productivity has fallen from a peak of 16 000 m^3 to 9 000 m^3 in 2003 and continues to decline while commercial logging has now almost ceased due to overexploitation. Although there has been replanting of the cut forests, the new plantation resources will not be ready for harvesting until around 2020, limiting the practical energy potential of woody biomass waste until that date.

About 22 000 hectares of land are filled with coconut trees, many of which have been damaged by cyclones although most are still within their economically productive age. Of particular interest is a government-owned 2 500 ha coconut plantation near the airport. This site, although presently partially overgrown and with limited collection and processing facilities, could become a major producer of biofuels for Samoa if rehabilitated. A 2006 ADB report (RETA 6102) recommended that EPC should consider establishing a power plant and an oil mill within the plantation to process fuel harvested from the coconuts. This approach would eliminate costly transport of coconuts to a processing site, locate production close to Samoa's growing load centres, and eliminate the problem of noise from the diesel generators annoying residents.

Although Samoa no longer exports copra, in the late 1990s it exported 4 800 tonnes of copra and 3 900 tonnes of coconut oil annually, an amount sufficient to produce the equivalent in energy terms of nine million litres of diesel fuel. Production today could be substantially higher with improved use of the available coconut resource.

Biogas generation relies on anaerobic digestion, which occurs naturally in landfills and in specially designed digesters. There may be opportunities for biogas generation at piggeries and chicken farms in Samoa where the digesters could generate burnable gas and, at the same time, convert animal waste into sterile, high-quality fertiliser.

Existing landfills should also be tested for gas production that could be used for energy. This arrangement would also assist with greenhouse gas emissions since the methane produced through anaerobic digestion is many times more harmful, when released into the atmosphere, than carbon dioxide.

4. Experience with renewable energy technologies

Geothermal energy. Samoa has no experience with geothermal energy. No boreholes have been drilled to assess the country's geothermal resource and no serious surface studies have been undertaken.

Hydropower. The only hydroelectric power generation in Samoa has been on Upolu with six run-off-river systems ranging from 950–1750 kW plus a 4 MW system with water storage at Afulilo. Actual peak output is 11.5 MW, dropping to 4.2 MW in the dry season. In 2010, a dry year, hydro produced 35.9% of the country's electricity – about 40 GWh. There is hydro potential on Savai'i but various local factors have prevented its development.

Wind power. Small-scale wind energy trials seem to have taken place in Samoa in the 1980s but they have not survived. A wind assessment project is currently underway with four masts on Upolu and another on Savai'i. NZAid is supporting data analysis and initial findings suggest that there is an adequate wind energy resource.

Solar energy. Hotels in Samoa typically have solar water heaters but there is little demand for them by homeowners, who traditionally bath with cold water. In 1986, EPC electrified Safotu (on Savai'i) with solar photovoltaics (PV) through a United States Agency for International Development (USAID) grant. The project installed 30 household systems, each with three 13 watt fluorescent lights. Families paid WST 200 (USD 88) for installation and were to pay WST 10 (USD 4.40) weekly for the service. For various reasons, including lack of EPC support, lack of spare parts, insufficient training and low user payments, the systems were not sustained and the community is now grid-connected.

In 2006, 10 households and a village church on Apolima island (a small caldera island between Upolu and Savai'i) were electrified using the first independent solar mini-grid in the Pacific. The system has 13.76 kWp of panels with battery storage which provides uninterrupted AC power supply to the island. The system has worked very well and, despite some minor problems with the controllers' cooling fans and the settings on one inverter, no power outages have occurred since it was commissioned.

Approximately 1600 Samoa homes (5%) are not connected to the grid, and in 2008 a feasibility study was conducted for their electrification with various sizes of solar home systems. So far 46 systems donated by a Chinese company after the 2009 tsunami, have been installed in these homes. That project also provided two off-grid solar installations for government facilities and one for an NGO.

To date EPC has had no experience with grid-connected solar although a 400 kWp grid-connected solar installation has been approved by Japan under the Pacific Environment Community (PEC) Fund. A feasibility study for the project, funded by Pacific Islands Greenhouse Gas Abatement through the Renewable Energy Project (PIGGAREP), has been completed and a tender has been prepared for materials. The installation will be split across three sites around the country on EPC properties at Tanugamanono, Vaitele and Saleologa in order to reduce variation in solar output caused by passing clouds.

A Power Purchase Agreement has been signed between EPC and Solar Samoa, Ltd., a local company operating as an IPP for solar PV. A total of 4 MWp of solar installations are planned with 1 MW at the airport and the rest distributed around Upolu. However, as of October 2012, construction had not begun.

Bioenergy. Fuelwood remains a large, though declining, source of household energy for cooking. Twenty or so years ago, Samoa used biomass for copra drying (about 38 kilotonnes of coconut residue), for producing steam for coconut oil production (11 kT), for electricity production from wood product manufacturing waste (1 kT) along with steam production for timber drying (11 kT) at Asau, and for soap and coconut cream manufacture (0.5 kT). However, Samoa no longer has a significant coconut export market and the natural timber resource is now mostly gone or protected against logging. Biomass is no longer used for power generation and its use for agricultural drying is believed to be small. Cooking is the only significant use.

EPC has experimented with blends of coconut oil and diesel fuel for power generation on both Savai'i and Upolu. On Savai'i the results with blends of up to 20% coconut oil were generally positive giving no problems with the engines although fuel filters tended to clog more rapidly. Unfortunately the coconut oil supplier went out of business and EPC has, at least temporarily, ceased using biofuel on Savai'i. EPC did consider constructing its own oil mill but found no clear economic benefit since the cost of coconut oil and diesel fuel was

about the same. Diesel blended with 5% coconut oil has been used at the power plant on Upolu but the blend was lowered to 2% and finally stopped in 2011 because of concerns about fuel quality and the limited availability of good quality coconut oil. EPC is now installing its own high-grade oil filtering and mixing unit at the plant to assure oil quality rather than relying on suppliers. It seems that EPC will soon resume operating the power plant's small Cummins engine with a mix of coconut oil and diesel. As of 2010, coconut oil's contribution to Samoa generation was only about 1% although it is clear that much higher usage can be attained once the necessary infrastructure is in place.

In 2009 the SROS engaged in developing biodiesel technology using coconut oil as the primary feedstock. Instead of using straight coconut oil to blend with diesel to run vehicles, SROS has successfully converted coconut oil into biodiesel using the transesterification process. In late 2009 three of the organisation's diesel vehicles were using B100 (100% biodiesel) produced at the SROS complex using a 200 litres biodiesel pilot plant. After months of trials to measure the efficiency of the coconut biodiesel as a fuel the blend changed to B50 (50% biodiesel) in order to test the relative energy output from these two blends. In early 2012 the blend changed to B10 (10% biodiesel) with the initiative to introduce the fuel to other government and non-government organisations. By the end of 2012, five other vehicles were fuelled using the SROS B10 (two from SPREP and three from Samoa Trust Estates Corporation). In early 2013 the MNRE joined in by fuelling four of its diesel vehicles with SROS coconut-based biodiesel. The biodiesel produced at SROS is tested for its quality based on ASTM standards while engine performance when using the fuel is being studied by the engine performance research group at the University of New South Wales' School of Mechanical Engineering in Sydney.

In collaboration with STEC and MNRE further research is being put into place and there are plans for planting *Jatropha curcas* to use its oil as an alternative feedstock to coconut oil.

A few biogas plants using piggery waste were built in the 1980s but none of them sustained operations. In 2005–2006 there were attempts at large-scale biogas production with equipment installed at the Tafai'gata landfill on Upolu. Unfortunately trials did meet expectations and no further attempts have been made to develop biogas.

5. Challenges to renewable energy deployment

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

- Financing institutions require complex project proposals and project management arrangements.
- The low cost of electricity, due to Samoa's hydro resources, reduces the competitiveness of other renewables.
- Renewable energy development is not the specific responsibility of any government department.
- Lack of clear roles for different agencies and weak institutional structure for energy within government.

Other challenges to developing renewables in Samoa include the following:

- Land tenure issues.
- Difficult environment for electrical and mechanical equipment with salt corrosion, high moisture levels and high ambient temperatures.
- Lack of adequate technical capacity for complex energy technologies.
- Limited knowledge of renewable energy with key decision makers.
- Lack of clear roles for different agencies and weak institutional structure for energy within government.
- Lack of a realistic and well-defined action plan to implement fuel import reduction targets.

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 EPC and others 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.

Publication References

ADB (2006) Pacific Subregional: Renewable Energy and Energy Efficiency Programme (REEP) Final Report.

ADB (2007), Independent State of Samoa: Technical Assistance Cluster for Implementing the Samoa National Energy Policy.

ADB (2011), TA 6485-REG: Promoting Energy Efficiency in the Pacific – Appendix C-Samoa.

ADB-Castalia (2010) Electricity and Water Regulation in Pacific Islands – Country Case Studies.

ADB (2006), Final report of RETA-6102 Renewable Energy and Energy Efficiency Project (REEP).

ADB (2011), Finding Balance: Benchmarking Performance of State-Owned Enterprises in Fiji, Marshall Islands, Samoa, Solomon Islands and Tonga.

ADB (2012), Newsletter: Pacific Economic Monitor.

AusAID (2009), Pacific Economic Survey, engaging with the world.

Cloin, Jan-South Pacific Applied Geoscience Commission (2007), Liquid Biofuels in Pacific Island Countries.

Electric Power Corporation (2007) Corporate Plan 2008-2010.

Forum Secretariat – SMEC/Barnes & McKenzie (2007), Baseline Study on Opportunities under the Clean Development Mechanism (CDM).

Government of Samoa (2008), Samoa National Energy Policy Strategic Action Plan.

Hassett, Timothy (2007) Final Report: Renewable Energy and Carbon Financing Penetration in Papua New Guinea, Samoa and Vanuatu.

IT Power (2012) Electric Power Corporation Samoa's 400 kWp Solar Project System Design Documentation.

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

Mario, rUpeni SOPAC (2005), Demand-Side Management in Samoa.

McCoy-West, A.J. (2009) Geothermal Power Potential of Selected Pacific Nations.

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

Pacific Power Association-KEMA (2012), Quantification of the Power System Energy Losses in Southern Pacific Utilities.

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

PRIF (2011) Samoa National Infrastructure Strategic Plan.

Promotion of Renewable Energy, Energy Efficiency and Greenhouse Gas Abatemenet (PREGA) (2006), Sava'i Hydro: Overcoming Social Barriers to Implementation.

Samoa Bureau of Statistics (2012), Population and Housing Census 2011.

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

SOPAC (2010) Energy Review Report.

SOPAC (2005), CocoGen – Feasibility Study into the use of Coconut Oil Fuel in EPC Power Generation.

SOPAC-International Institute for Energy Conservation (2003), Demand-Said Management Project, South Pacific Island States.

SOPAC-Risø (2005), Final Wind Energy Capacity Building Mission and Workshop.

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

TEPCO/JICA (2009), Preparatory Survey on the Programme for Climate Change In the Pacific Islands (Renewable Energy).

Theodore Levantis, et. al.-AusAID (2006), Are Pacific countries coping with surging oil prices?

UNDP Samoa/GHD (2009), Upolu (Samoa) Wind Resource Assessment.

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

Wade, Herbert et. Al. (2008) Preparatory Phase of the Samoa Photovoltaic Electrification Programme – Survey Report Final Draft.

Wade, Herbert-Secretariat of the Pacific Regional Environment Programme/Pacific Islands Renewable Energy Project (2005), Pacific Regional Energy Assessment 2004, Volume 11 – Samoa.

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?

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