DRAFT

# Pacific Renewable Energy and Microfinance (PREM) Project

## Possibilities in renewable energy lending for microfinance institutions in the Pacific

**THE FOUNDATION FOR DEVELOPMENT COOPERATION**

**SEPTEMBER 2009**

A baseline study on Vanuatu, Fiji and Samoa's potential renewable energy and energy efficiency lending market.

**Acknowledgements**
This information is based on information gathered by staff of the Foundation for Development Cooperation for the development of the "PREM" project, funded by Renewable Energy and Energy Efficiency Partnership (REEEP). Contributing staff members include Prashant Murthy, Jessica Hasker, Melanie Aube – Senior Operations Officer and Craig Wilson – Executive Director. FDC would like to thank the UNDP Pacific Centre, SOPAC, World Bank, Fiji Department of Energy, CBS Power Solution, Clay Engineering and Hybrid Power for providing information regarding this study.

Warm regards,

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## Acronyms

*General*

| | |
|---|---|
| ACP | Africa-Caribbean-Pacific EU Partner Countries |
| ADB | Asian Development Bank |
| ADO | Automotive Diesel Oil |
| AGO | Australian Greenhouse Office |
| CATD | Centre for Appropriate Technology Development |
| CEO | Chief Executive Officer |
| CFL | Compact Fluorescent Light |
| CIDA | Coconut Industries Development Authority (Fiji) |
| $CO_2$ | Carbon Dioxide (greenhouse gas) |
| CTA | Technical Centre for Agricultural and Rural Co-operation |
| CROP | Council of Regional Organizations of the Pacific |
| DOE | Department of Energy (Fiji) |
| DSM | Demand Side Management |
| EE | Energy Efficiency |
| EESCO | Energy Efficiency Service Company |
| EET | Energy Efficiency Technology |
| EPC | Electric Power Corporation (Samoa) |
| ESCAP | Economic and Social Commission for Asian and the Pacific |
| EU | European Union |
| EUEI | European Union Energy Initiative |
| EWG | Energy Working Group of CROP |
| FEA | Fiji Electricity Authority |
| FIT | Fiji Institute of Technology |
| PIFS | Pacific Islands Forum Secretariat |
| FSC | Fiji Sugar Corporation |
| GEF | Global Environment Facility |
| GHG | Green-House Gas |
| GoF | Government of Fiji |
| ha | hectare |
| HECEC | Australia's Hydro-Electric Commission Enterprises Corporation |
| IIEC | International Institute for Energy Conservation |
| IPP | Independent Power Producer |
| JICA | Japan International Cooperation Agency |
| JV | Joint Venture |
| LPG | Liquid Petroleum Gas |
| MFI | Microfinance Institution |
| MoU | Memorandum of Understanding |
| MOF | Ministry of Finance (Samoa) |
| MOFP | Ministry of Finance and Planning (Fiji) |
| NCSMED | National Centre for Small and Micro-Enterprise Development (Fiji) |
| NEP | National Energy Policy |
| NGO | Non-Government Organization |
| NMFU | National Micro Finance Unit (Fiji) |
| NUS | National University of Samoa |
| O&M | Operation and Maintenance |
| OTEC | Ocean Thermal Energy Conversion |
| PDMCs | Pacific Developing Member Countries (of ADB) |
| PIC | Pacific Island Countries |
| PIEPSAP | Pacific Islands Energy Policies and strategic Action Planning |
| PIGGAREP | Pacific Islands Greenhouse Gas Abatement and Renewable Energy Project |

| | |
|---|---|
| PIREP | Pacific Island Renewable Energy Project |
| PIRGADI | Pacific Islands Regional Geothermal and Development Initiative |
| PPA | Pacific Power Association (also "Power Purchase Agreement") |
| PV | Solar Photovoltaics |
| PWD | Public Works Department |
| RE | Renewable Energy |
| REEP | Renewable Energy and Energy Efficiency Program |
| REM | Regional Energy Meeting |
| REP-PoR | UN Asia-Pacific Renewable Energy Programme for Poverty Reduction |
| RET | Renewable Energy Technology |
| RESCO | Renewable Energy Service Company |
| RMI | Republic of the Marshall Islands |
| SHS | Solar Home System |
| SOPAC | Pacific Islands Applied Geoscience Commission |
| SPREP | Secretariat of the Pacific Regional Environment Programme |
| SPBD | South Pacific Business Development Foundation |
| SPC | Secretariat of the Pacific Community |
| STEC | Samoa Trust Estates Corporation |
| TA | Technical Assistance |
| ToR | Terms of Reference |
| TPAF | Training and Productivity Authority of Fiji |
| UNDP | United Nations Development Programme |
| UNDESA | United Nations Department of Economic and Social Affairs |
| UNESCO | United Nations Education, Scientific and Cultural Organization |
| USP | University of the South Pacific |
| yr | year |

*Energy and power units*

| | |
|---|---|
| AC | Alternating Current |
| DC | Direct Current |
| KGOE | Kilograms of Oil Equivalent |
| kV | Kilo-Volts (thousands of volts) |
| kVA | Kilo-Volt-Amperes (Thousands of Volt Amperes of power) |
| kW | Kilo-Watt (Thousands of Watts of power) |
| kWh | Kilo-Watt-Hour (Thousands of Watt Hours of energy) |
| kWp | Kilo-Watts peak power (at standard conditions) from PV panels |
| MW | Mega-Watt (millions of watts of power) |
| toe | Tonnes of Oil Equivalent |
| V | Volts |
| W | Watts |
| Wh | Watt hours (of energy) |

# Preface

70% of the Pacific Island Countries (PIC) population are "unelectrified" and do not have access to modern energy services. Access to basic modern energy has been defined as essential in the fulfillment of the Millennium Development Goals (MDG's) as it leads to improvements in education, health, gender, communication and income generating prospects. The low population and geographic nature of PICs means that the distribution of electricity is extremely challenging financially and technically.

Past electrification schemes in many PICs have left them highly dependent on imported fossil fuels to meet their electricity demands. The cost of fuel imports is a significant strain on income, reducing available capital for investment and savings. Additionally, due to the small economic scale of PICs, they cannot avoid being "price-takers", increasing their susceptibility to fuel price volatility.

Simple off-grid renewable electricity has the potential to provide isolated areas with modern energy services without the need for imported fuels. This avenue has been explored by a number of donor-funded pilot projects with little long term sustainability and outreach due to institutional, technical and financial constraints. However, progress is being made and these barriers are being reduced.

The Pacific Renewable Energy and Microfinance (PREM) project was instigated with the aim to integrate microfinance institutions (MFI's) with the energy sector to improve the financial availability of RE and EE systems and also increase awareness of their availability. MFI's have outreach to the low-income and rural demographic who are at the greatest disadvantage in regards to modern energy access. Their clients are financially literate, have the ability to pay back a loan and, with the provision of this service, have the possibility to substantially improve their livelihood.

This study aims to introduce the fundamental concepts that will lead to 'Energy Lending' by MFIs in PICs. The material is targeted towards the organizations who are implementing the PREM project. It should be used as an introductory guide to RE and EE and the activities of the target countries - Vanuatu, Fiji and Samoa.

For further reading and in depth analysis of the addressed topics, please refer to references on page 51.

# Executive Summary

The Pacific Renewable Energy and Microfinance (PREM) project, run by The Foundation for Development Cooperation (FDC) and funded by Renewable Energy and Energy Efficiency Partnership (REEEP) has developed this baseline study to assess the prospects for renewable energy (RE) and energy efficiency (EE) lending in Pacific Island Countries (PICs), specifically Vanuatu, Fiji and Samoa. The report is aimed at familiarizing microfinance experts and other consultants with RE and EE fundamentals in the Pacific. The content is derived from a combination of desktop research and interviews with key stakeholders.

This report is divided into two sections, energy concepts and country analysis:

1. **Energy concepts**
   The first section of this study introduces basic energy concepts. It is suggested that a typical rural MFI clients will not require an energy system of more than 1kW and will therefore be only interested in purchasing "pico"[1] energy systems. Systems of relevance include solar photovoltaic (PV), wind, hydro-power and biogas. Also introduced are energy efficiency products that have the ability to significantly reduce fossil fuel or traditional biomass consumption, for instance LED light bulbs and solar cookers.

2. **Country analysis**
   The second section of this study explores the RE and EE market of the three target countries, Vanuatu, Fiji and Samoa. On a micro-level the needs of the population varies considerably between countries:

   - Vanuatu is largely subsistent and only 20% of the population have access to modern energy;
   - In Fiji, 80% of the population has access to modern energy, however those "electrified" are not always satisfied; and,
   - In Samoa, almost 100% of the population has access to electricity.

   On the macro-level, the policies, legislation, financial institutions and private sector supporting the RE and EE development in the three target countries differs:

   - Vanuatu has only recently implemented an active energy policy, has commercial RE lending and a small RE private sector exists;
   - Fiji's energy sector is far more advanced with strong legislation, utilities, financial providers and a growing RE private sector; and,
   - Samoa has strong utility and legislation, but no commercial RE lending or developed RE private sector.

[1] Pico are energy products that produce 1Kw or less energy.

## Recommendations

Pending the results of a needs analysis conducted by MFI's, it is recommended that this project concentrates on income-generating loans. History has shown that when energy systems increase the cost of living to such an extent that the system becomes more a burden then benefit, project failure is high. The tendency to assume that energy will automatically coincide with income generation is false - only 10% of those with energy access use it for income[2]. Targeting only those who will use the system for microenterprise has a number of benefits. Firstly, with extra income generated, the user will more likely afford the extra expense. It also means the system will contribute to increasing the livelihood of the client, rather than placing an unnecessary burden on income. Finally, in only providing micro-enterprise loans, the MFI should experience higher repayment rates than that of consumer loans. Possible avenues for microenterprise are suggested:

- **Energy lending for business development**
  Loans are delivered on the provision that there is evidence the energy system will generate income and/or reduce costs.
- **Retailing energy products**
  Loans are given to small shop-owners to act as retailers for pico-RE and EE products.
- **Pico-utility for energy**
  Loans are delivered to entrepreneurs who will distribute energy to the village on a fee-for-service basis.

The provision of RE & EE loan products should not be conducted in haste. This study has found that the distribution of RE & EE is a complex process. Project failure in this area is high due to incorrect assumptions of client needs, incomplete regional assessments on the RE & EE market and lack of technical skill. Despite this, having identifying appropriate regions, partners and customers, it is possible for microfinance loans for RE & EE to significantly improve the rural PIC population's to access energy and reduce reliance on fossil fuels.

[2] (Jensen, 2007)

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# 1. Introduction

Pacific Island Countries (PICs) face an enormous challenge in supplying rural electricity. The conventional grid-system of supplying power is considered inappropriate for many areas due to the extreme isolation and low population. Off-grid power supplies of diesel generators, household solar photovoltaic (PV) systems, pico /micro-hydro schemes and wind-power projects are often considered expensive, unreliable and difficult to maintain. As a result, 70% of the region's population still lacks access to electricity[3].

Reliable access to energy is fundamental for economic and social development as stated in the Millennium Development Goals (MDG's). Basic lighting provides educational benefits as study can be conducted at night, income benefits whereby shop-owners can extend their opening hours, communication access as mobile phones can be recharged and health benefits with the lowered risk of fires caused by kerosene lanterns or candles. Modern cooking technology addresses gender inequalities whereby women can reduce smoke inhalation and time and energy spent looking for biomass. Energy efficient products are beneficial in significantly reducing the financial strain households spend on energy bills.

The market for renewable energy in PICs has evolved. Costs are now economical when compared to conventional energy forms, institutional structures support RE and EE use and development, reliability has improved and training and maintenance is more adequate. Despite these advances, the upfront cost of renewable energy is too often outside the budget of rural households, even when the lifetime cost is comparable or less than their current energy sources.

This baseline study explores the ability for microfinance institutions (MFIs) in PICs to finance the upfront cost of RE and EE systems. In doing so, the various types of RE and EE systems are introduced. Then, an in-country analysis of the three target countries – Fiji, Vanuatu and Samoa has been conducted to assess the RE and EE macro- and micro- economic climate, thus opportunities and constraints of MFIs offering "energy" lending.

[3] (Urmee, Harries, & Schlapfer, 2009)

# 2. Purpose and scope

## 2.1 Purpose

This study aims to outline the possible applications of RE and EE in PIC's, particularly in off-grid areas. This information will be directly used to develop the training manual required for FDC's PREM project, funded by REEEP. The PREM project will provide training to MFI's so they have the knowledge and technical skills to develop loans for RE and EE products. Equally as important, the PREM project will encourage MFIs to utilize their outreach to increase awareness of RE and EE.

## 2.2 Scope

The scope of this baseline study is limited to the needs of MFI clients. There are four primary requirements for systems discussed in this analysis. Technology must be:

1. Decentralized;
2. Meeting the needs of the user;
3. "Pico" or "micro" in capacity;
4. Less than $US15,000 in upfront capital and installation costs.

### 2.2.1 Scale of energy generation

*Decentralised energy generation* (otherwise known as off-grid energy) is energy produced at the point of use. This form of generation is only economical when the user is isolated and has limited usage. The user pays for the energy system, installation, maintenance and fuel (if required). Due to the isolation and low population of rural PICs, this is often the best option for providing power.

The decentralized energy process – from production to use - is similar across all electricity generating systems. Power is created through the product, for instance photovoltaics or a diesel generator. A regulator will control the amount of energy entering and exiting the system (if it is too large, the system with falter). The energy used can be directly used or stored in a fuel cell or battery. An inverter is required to convert stored energy to useable AC power[4].

[4] Customised SPV appliances have been designed to operate off DC power, meaning no inverter is required.

**FIGURE 1 RENEWABLE ENERGY TIME-LINE**


*Mini-grid electricity generation* utilizes small economies of scale to centralize energy production at a village level. Electricity is generated at a central point and distributed to the user through power lines. This may be appropriate if a number of rural PIC families or a village cooperate to purchase a RE system. However, the ability of a MFI to sponsor this purchase is questionable, as they usually exceed $100,000 in capital costs.

*Centralised energy generation* (otherwise known as grid energy) is large-scale energy produced at a central point and distributed through power lines to the point of use (households, businesses, industry, etc). Centralised energy generation is generally the preferred method of energy distribution as it can effectively utilize economies of scale in production and transmission. Users can generally acquire unlimited electricity[5] and pay a fee based on total energy use. This source of energy is not an option for rural PICs and our target audience.

### 2.2.2 Rural PIC energy needs

Initially, energy requirements for rural PIC communities are expected to be much lower than that of urban centres due to lack of appliances. Consequently, energy systems can be limited in their capacity. To identify the required energy capacity, the user must determine the power and energy required.

a. Power
   Power is the energy required at a point in time. It is usually measured in watts (W) or kilowatts (kW). Total power is calculated by summing the power required by all appliances used at one time.
b. Energy
   Energy is the power used over a period of time. It is generally measured in watt hours (Wh) or kilowatt hours (kWh). Total energy is found by multiplying power by time used.

Below is a table of common appliances and their equivalent energy usage. The table should be used only as a guide. Appliances will differ in their power requirements depending on manufacturer and product.

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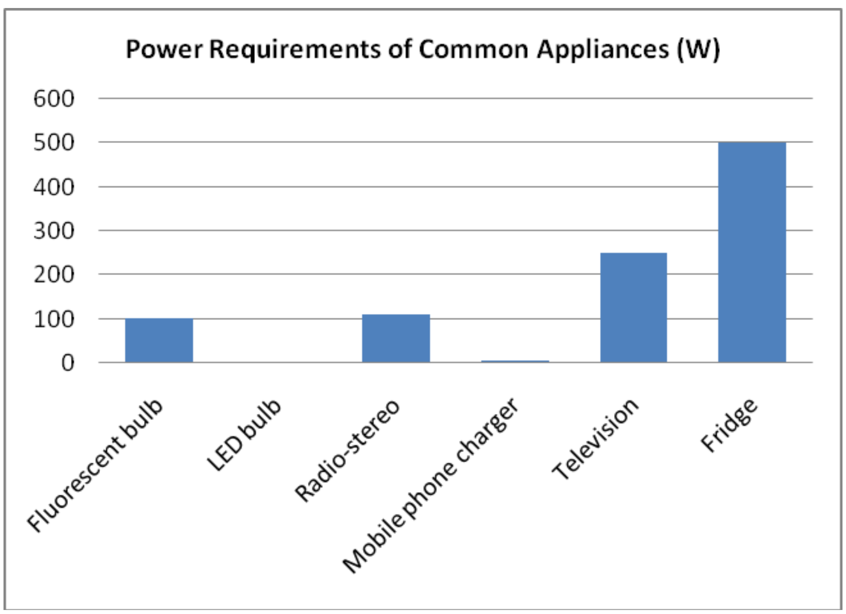
[5] Unless total power use has exceeded capacity whereby a power outage will occur.

**Table 1 Typical power usage of common appliances**[6]

| | Power (W) | Average time used per day (hours) | Daily energy (Wh) *Power x time used* |
|---|---|---|---|
| Fluorescent bulb | 100 | 5 | 500 |
| LED bulb | 1 | 5 | 5 |
| Radio-stereo | 110 | 7 | 770 |
| Mobile phone charger | 3 | 1 | 3 |
| Television | 250 | 2 | 500 |
| Fridge | 500 | 24 | 12000 |

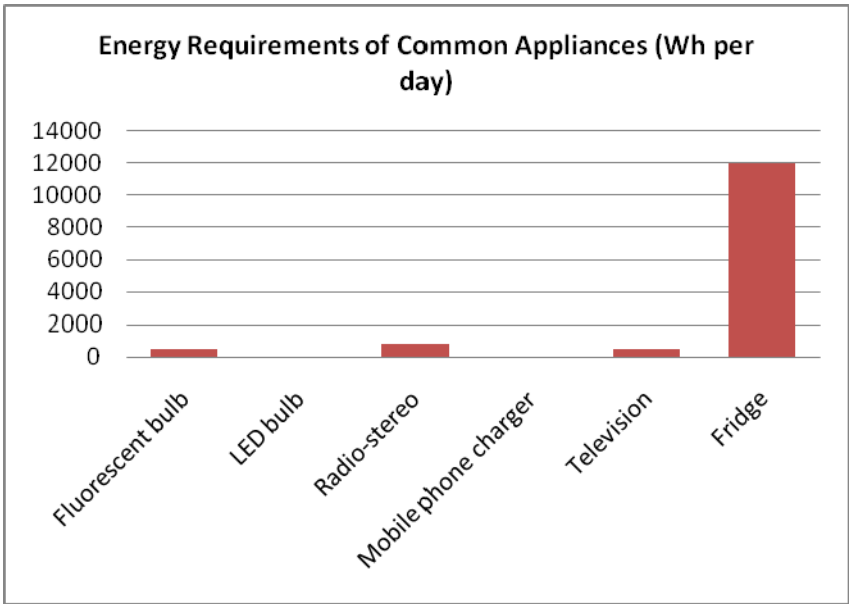
*Application example*: If a household were to have 2 fluorescent lights (2 x 100 W) and a mobile phone charger (3 W) on at the same time, they would require an outlet capable of providing more than 203 W of power. If they were to use these appliances for 4 hours per day, more than 812 Wh (203W x 4 h) of energy are required from their RE technology.

**Figure 2 Typical power requirements of common appliances (W)**




[6] This does not account for start-up power requirements.

**FIGURE 3 TYPICAL ENERGY REQUIREMENTS FOR COMMON APPLIANCES (WH PER DAY)**



### 2.2.3 "Pico" and "Micro" Renewable Energy (RE) Systems

RE systems that are less than 1 kW are discussed in detail in this analysis. It is assumed that systems above this power load will be outside the scope of MFI clients' profiles and incomes. The RE's pertaining to this category are Solar PV, Wind, Hydro, Biogas and Hybrid systems. We have classified RE systems as "pico" (<1 kW), "micro" (1-100 kW), "mini" (100-1000 kW), "small" (1 - 10 MW) "medium" (10 – 100 MW) and "large" (>100 MW) for clarity in understanding the scale of each application. Below is a table summarizing each RE and its system availability.

**TABLE 2 RE SYSTEM AVAILABILITY[7] (BOLD INDICATES SYSTEMS EXPLORED IN THIS REVIEW)**

| | | *Diesel Generator* | Solar PV | Solar thermal | Wind | Hydro | Geothermal | Biomass | Biogas | Hybrid (PV-Wind |
|---|---|---|---|---|---|---|---|---|---|---|
| *Off-grid* | **Pico <1 kW** | ***300 W*** | **50 W**<br>**300 W** | | **300 W** | **300 W** | | | **600 W** | **300 W** |
| | **Micro 1-99 kW** | ***1 kW*** | 25 kW | | | **1 kW** | | | 60 kW | 99 kW |
| *Mini-grid* | Mini 100-999 kW | *100 kW* | | | 100 kW | 100 kW | 200 kW | 100 kW | | |
| | Small 1 - 9 MW | *5 MW* | 5 MW | | | 5 MW | | | | |
| *Grid electrification* | Medium 10 MW – 99 MW | | | 30 MW | 10 MW | | 20 MW | 20 MW | | |
| | Large >100 MW | | | | 100 MW | 100 MW | | | | |

### 2.2.4 Capital Costs

Due to the nature of MFIs, loans greater than US$15,000 are above their capacity. All pico systems are considered suitable for microfinance. The micro-hydro system is the only micro RE system within MFIs scope. All other RE systems listed are too large to be financed through MFIs, despite their low levelised[8] cost. Below is a summary of the international average $US per kW costs of various energy systems.

**TABLE 3 CAPITAL VS LEVELISED COSTS[9] (BOLD INDICATES ABILITY TO BE FINANCED BY MFI)**

| $US / kW | Pico (<1 kW) | | Micro (1-99 kW) | | *Mini (100-999 kW)* | |
|---|---|---|---|---|---|---|
| | Capital | Levelised (/kWh) | Capital | Levelised (/kWh) | *Capital* | *Levelised (/kWh)* |
| *Diesel Generator* | **$ 890** | **$ 0.65** | **$ 680** | **$ 0.51** | *$ 640* | *$ 0.20* |
| Solar PV | **$ 7,480** | **$ 0.56** | **$ 7,510** | **$ 0.51** | | |

[7] (Technical and Economic Assessment of Off-grid, Mini-grid and Grid Electrification Technologies, 2007)
[8] Total cost over the lifetime of the product, including maintenance, repairs and fuel.
[9] (Technical and Economic Assessment of Off-grid, Mini-grid and Grid Electrification Technologies, 2007)

| | | | | | | |
|---|---|---|---|---|---|---|
| Wind | **$ 5,370** | **$ 0.34** | | | *$ 2,780* | *$ 0.41* |
| Hydro | **$ 1,560** | **$ 0.15** | **$ 2,680** | **$ 0.13** | *$ 2,600* | *$ 0.11* |
| Geothermal | | | | | *$ 7,220* | *$ 0.16* |
| Biomass | | | | | *$ 2,880* | *$ 0.09* |
| Biogas | | | **$ 2,490** | **$ 0.07** | | |
| Hybrid (PV-Wind | **$ 6,440** | **$ 0.42** | $ 5,420 | $ 0.30 | | |

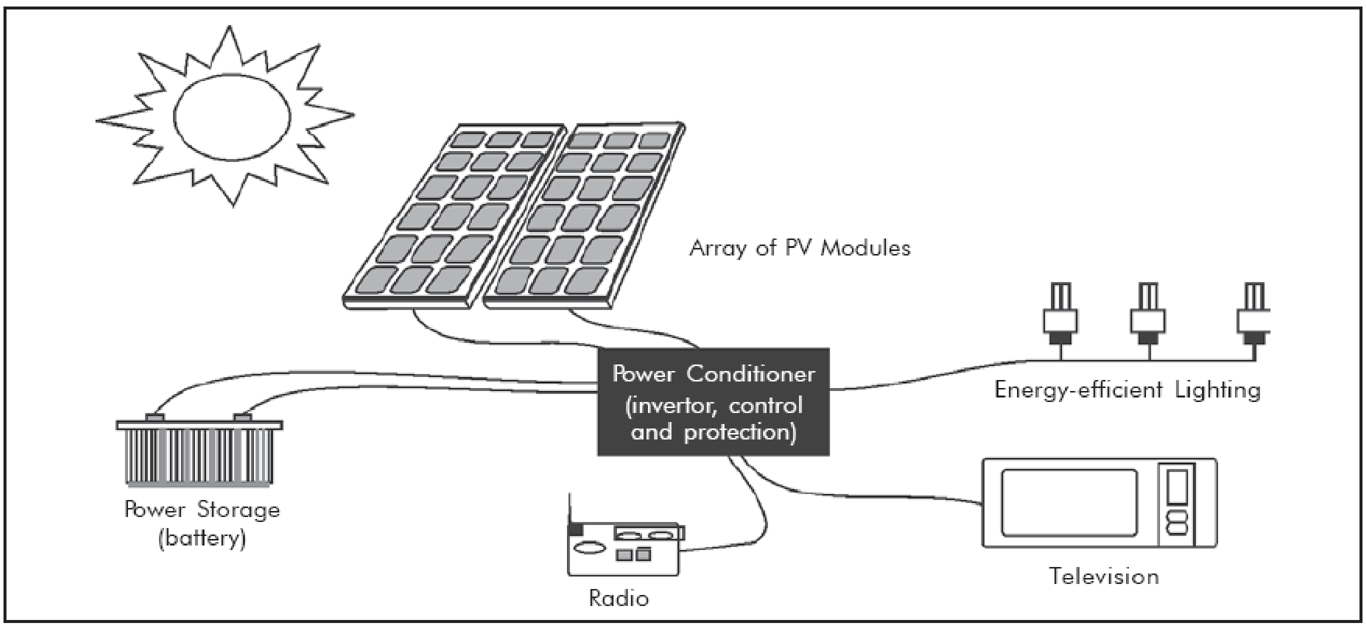
# 3. Renewable Energy (RE) and Energy Efficient (EE) Systems

MFIs capacity to finance a number of RE and EE systems including solar photovoltaic (PV), small scale wind, pico- and micro-hydro and biogas systems. MFIs may also finance energy efficient systems (EE) like efficient woodstoves, biodiesel generators and LPG stoves.

## 3.1 Solar photovoltaic (SPV)[10]

Solar photovoltaic energy systems utilize semiconductor-based materials (solar cells) to convert solar energy into DC electricity[11]. It does not require fuel, has no noise, zero emissions, is modular and does not require a grid connection. However, the cell-module characteristic of SPV means that it does not experience the benefit of economies of scale and is generally considered an expensive technology. However, it is advantageous for niche uses (especially in rural PICs) and may be economical in catering to pico, micro and small energy applications.

**FIGURE 4 DIAGRAM OF A TYPICAL SOLAR HOME SYSTEM[12]**




<u>Pico</u>

a) >50 W
This size PV array is commonly used for specific needs, for instance lighting, telecommunication and water pumps. Appliances are specially designed to connect to a PV array which means a

[10] SPV should not be confused with solar thermal technology that uses the solar heat to generate a difference in temperature to run a turbine.
[11] (Technical and Economic Assessment of Off-grid, Mini-grid and Grid Electrification Technologies, 2007)
[12] (Technical and Economic Assessment of Off-grid, Mini-grid and Grid Electrification Technologies, 2007)

power inverter is not required, saving total energy requirements. The systems are designed to be user-friendly, with minimal technical knowledge and maintenance required. The average international levelised cost is approximately $US 0.56/kWh which is expected to fall by $US 0.05/kWh over the next 10 years[13]. The average lifespan of the PV module is 20 years, the battery and inverter 5 years.

b) ~300 W Solar Home Systems (SHS)
This sized system is usually an array of SPV modules which connect to an DC-AC inverter for common appliance usability. The inverter and controllers also protects the system from power blow-outs. Also required in this system is a battery to store excess energy for later use. The average international levelised cost is approximately $US 0.56/kWh which is also expected to fall by $US 0.05/kWh over the next 10 years[14]. Additionally, the average lifespan of this sized module is 20 years. The batteries and inverter will need replacing every 5 years.

Also available:

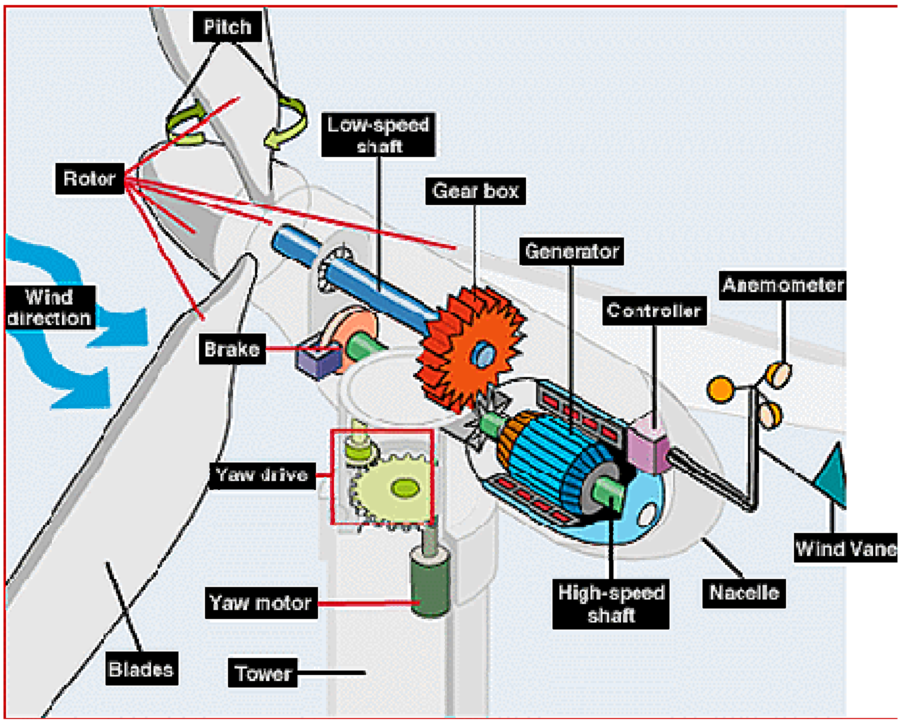
- Mini (25 kW) module systems

[13] (Technical and Economic Assessment of Off-grid, Mini-grid and Grid Electrification Technologies, 2007)
[14] (Technical and Economic Assessment of Off-grid, Mini-grid and Grid Electrification Technologies, 2007)

### 3.2 Wind

Wind turbines convert the kinetic energy in the wind into mechanical energy. The turbine consists of rotor blades, generator, power regulations, aerodynamic mechanisms and the tower. There are two types of turbines – small and large. Small turbines are used in pico applications; large turbines for more industrial, grid-type settings. Wind must be monitored for at preferably 18 months before a site is deemed suitable. Also, turbines require frequent maintenance of between 2 and 4 times per year. Where there is adequate and consistent wind speed to support small turbines, and access to technical assistance is reliable and cost effective, they may be an economical purchase for energy supply.

FIGURE 5 DIAGRAM OF A WIND TURBINE[15]




Pico

a) 300 W

Like SPV home systems, small wind turbines are used to both directly supply power to appliances through a an inverter, controller and store energy in a battery bank. The average international levelised cost of small wind turbines is $US 0.34 /kWh, which is expected to lower by $US 0.03 by 2015. The life span of small turbines is approximately 20 years[16]. The capacity factor depends on the location wind speed and can vary between 20 and 40 percent. To mitigate the risk of

15 http://en.wikipedia.org/wiki/File:EERE_illust_large_turbine.gif

16 (Technical and Economic Assessment of Off-grid, Mini-grid and Grid Electrification Technologies, 2007)

intermittent wind, a hybrid configuration of wind turbines and SPV or diesel generators can be established.

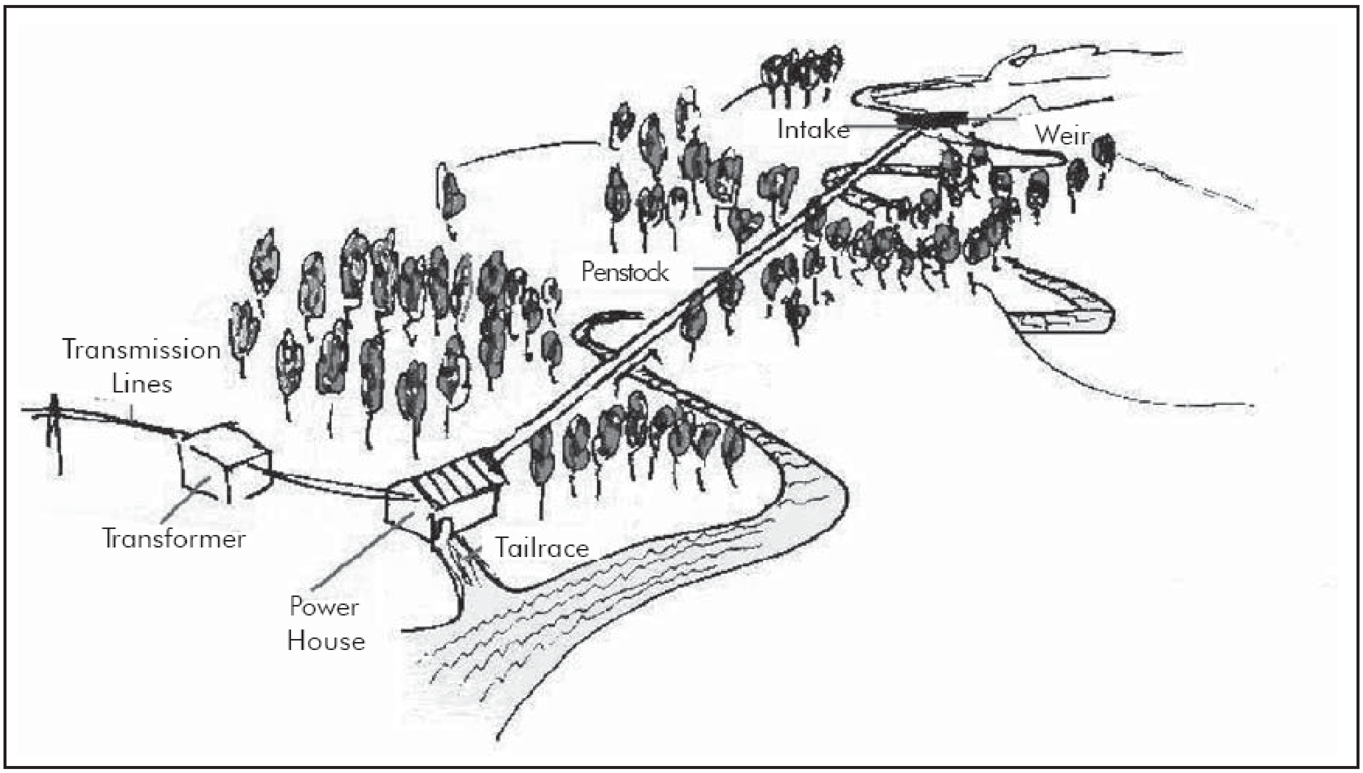
<u>Also available</u>

- Mini (100 kW) mini-grid, village-scale systems
- Medium (10 MW) centralized grid systems
- Large (100 MW) centralized grid systems

### 3.3 Hydro

Hydro power is derived from the force or energy of moving water. Water behind a dam flows through the intake and into a pipe called a penstock. This pressurised water turns a turbine, which then turns a generator to produce electricity. Hydro power can be used to satisfy almost all scales of energy needs – pico, micro, mini, small and large depending on the size of the river and system. It is beneficial as it provides consistent 24 hr supply of energy unlike other RE systems. In rural PICs, pico and micro hydro can be both economical and environmentally sustainable as the construction of a water catchment is not required. However, the technology is site specific and not easy to transfer as it requires the co-operation of a community at a technical and organizational capacity[17]. Additionally, due to the moving parts, regular maintenance is required.

**FIGURE 6 DIAGRAM OF A TYPICAL MICRO HYDRO SYSTEM**




*Source: http://www.microhydropower.net.*

<u>Pico</u>

a) 300 W

Requiring no construction, a portable device has been developed that incorporates all the electro-mechanical elements of a hydroelectric power plant. The unit can be installed by the purchaser

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[17] (Williams & Simpson, 2009)

and only requires river head of 1-2 m. New machines come with embedded power electronics to regulate voltage and balance loads. On average, this system has a lifespan of 5 years. The average international levelised cost of pico hydroelectric plants is $US 0.15 /kWh, which is expected to only lower by $US 0.01 by 2015[18]. The capacity factor depends on the location, but is usually assumed to 30%.

Micro

a) 1 kW

The design is similar to the pico hydroelectric plant, however head requirements are 5-6 metres. As a result, a small amount of construction is required on a river or stream embankment. On average, this system lasts longer, with a lifespan of 15 years. The average international levelised cost of a micro hydroelectric plant is $US 0.13 /kWh, which is also expected to lower by $US 0.01 by 2015[19]. The capacity factor is assumed to 30%.

Also available

- Mini (100 kW) mini-grid, village-scale systems
- Small (5 MW) centralized grid systems
- Large (100 MW) centralized grid systems

18 (Technical and Economic Assessment of Off-grid, Mini-grid and Grid Electrification Technologies, 2007)
19 (Technical and Economic Assessment of Off-grid, Mini-grid and Grid Electrification Technologies, 2007)

### 3.4 Biogas

Biomass feedstock (animal dung, human excreta and leafy plant materials) are digested anaerobically in a dome to produce a highly combustible biogas. The gas can be used as a substitute for LPG in cooking, heating and lighting. Any remaining slurry can be used as fertilizer. This system is useful where livestock are common and animal dung is readily available. The biogas digester is constructed in situ by qualified biogas builders. Different sizes are available depending on need. Pico-sized biogas digesters are still in trial phases in some PICs but are showing promising results.

Also available

- Micro (60 kW) mini-grid, village-scale systems

## 3.5 Other RE Systems

Biomass, biofuel and geothermal energy systems are suitable for mini-grid village applications. These are outside the scope of MFI loans, but will be briefly described for general awareness:

1. Biomass
   a. Biomass-gas
      Using biomass material (woody cellulose or organic material) as fuel, a biomass gasifier will convert this to "producer gas" (a combustible gas mixture). This is then filtered, scrubbed and treated, at which point it can be used in a standard engine-generator. In 15 years, capital costs are expected to be 10% lower than current prices of approximately $US 2,880 /kW for a 100 kW generator[20]. It is possible for this to be a rural PIC energy system if the scale of application is reduced and costs fall.
   b. Biomass-steam
      A biomass-steam electricity generator operates in a similar manner to conventional oil and coal power plants, except the fuel source is woody cellulose or agro waste. It is designed as centralized power supply and will not be suitable for MFI loans.

2. Biofuel (coconut oil)
   Coconut oil can be used in generators as a substitute for diesel. Due to the combustion point of coconut oil and viscosity issues, generators should be adapted for efficiency and better combustion of the coconut oil. However, straight use of [quality] coconut oil can still be entertained with many diesel generators. The use of biofuel in un-adapted generators can lead to engine problems and failure[21] such as the increased need to change filters. The production of biofuel in PICs is currently in experimental phase, but may be a viable micro-enterprise in the future.

3. Geothermal
   Geothermal resources suitable for energy generation are naturally-occurring hydrothermal resources. Hot water and steam are used to run a turbine at a centralized power plant. The process of establishing a geothermal plant is highly technical and requires a number of specialists. Additionally, there are significant costs in exploration, confirmation, construction of the main wells and power plant. The World Bank has estimated capital costs to exceed $US 7,200 /kW for a 200 kW station[22]. It is unlikely this form of energy will be suitable for MFI loans.

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20 (Technical and Economic Assessment of Off-grid, Mini-grid and Grid Electrification Technologies, 2007)
21 (Woodruff, 2007)
22 (Technical and Economic Assessment of Off-grid, Mini-grid and Grid Electrification Technologies, 2007)

### 3.5 Energy efficient (EE) products

Through the use of efficient appliances, it is possible to dramatically reduce total energy consumption. There are a wide range of products that reduce reliance on fossil fuels, discussed below are key technologies that may significantly improve energy consumption of rural PIC populations.

1. LED light bulbs and CFL Bulbs

   Light emitting diodes (LED) and compact fluorescent lights (CFL) use approximately 10% of the energy required by a commonly used fluorescent or incandescent bulb. Additionally, incandescent bulbs last around 1000 hours, whereas CFL bulbs will last for more than 6000 hours and LED bulbs up to 60000 hours. The upfront cost of energy efficient bulbs is the major barrier, with CFLs priced at approximately US$4 and LED bulbs at US$20 compared to US$0.50 for an incandescent bulb.

2. Improved Stoves

   Improved cook stoves require less fuel and direct smoke away from the user. They are simple, low-cost and rapidly deployable. They are particularly advantageous for women and children who require less time searching for fuel wood, and enjoy the health benefits of reduced smoke inhalation.

3. Solar ovens /cookers

   Aluminum cookers direct sunlight to one concentrated point, generating temperatures high enough to cook food. These products are only advantageous in areas that experience long sunshine hour days. Unpredictable weather patterns will affect the performance of such products.

4. Liquefied petroleum gas (LPG)

   LPG is a portable, clean, safe and efficient fuel for cooking as a substitute for electricity. The standard LPG cylinder size is between 11kg and 13kg, which last about 1 month for an average household of 3-5 people. The International Energy Agency (IEA) estimates capital costs for an LPG stove and cylinder are between US$45 and US$60, and fuel costs range from US$0.55 to US$0.70 per kg. A number of interventions to scale up LPG use in rural areas have been identified, such as reducing the cylinder size and improving rural distribution channels, but LPG uptake in rural areas still remains slow.

# 4. Country Profiles

The PREM project will initially be training MFIs in Vanuatu, Fiji and Samoa. The economic climate relevant to RE and EE in these countries are explored below. Also discussed are the outcomes of a number of key pico-projects.

## 4.1 VANUATU

### 4.1.1 Background

Vanuatu lies directly west of Fiji and is known to have an intact Melanesian culture, especially on the island of Tanna. Vanuatu includes 13 larger islands and about 70 smaller ones, with a total land mass of 12,200 square kilometers. Most are mountainous, volcanic in origin (some still active), and covered in lush rain forests. Many are protected by coral reefs. The islands are subject to devastating cyclones (hurricanes). The most destructive cyclone in living memory hit in 1987, damaging or ruining most of the local dwellings.

The local economy still revolves around agriculture and fishing, but tourism is a fast-growing industry and liberal tax laws have made Vanuatu a popular offshore financial center. While most of the outer islands maintain their traditional Melanesian lifestyle, the capital city of Port-Vila is crammed with colonial buildings, expats, duty-free shops, casinos, open-air markets, upscale restaurants and tourists. Vanuatu has a population of about 210,000 where English, French, Pidgin and numerous local dialects are spoken[23].

Vanuatu has one of the fastest growing economies in the Pacific with economic growth averaging about 6% in the last 6 years. It has a gross per capita income of about $3,410. Tourism accounts for about 20% of GDP and has shown rapid growth. The agriculture sector follows, constituting about 20% of GDP. About 60 % of the population is involved in subsistence and cash based agriculture.

Despite steady economic growth and governments economic reforms, there are constraints to a sustained growth. There is high cost of infrastructure and insufficient government investment to encourage private sector development. This leads to limitations in the transportation, telecommunications and power sectors. Other constraints include an ineffective land lease system and access to credit.[24]

### 4.1.2 Energy Use

Of the 73% of Vanuatu population living in rural areas, only 7% have access to electricity. Even in major urban centres, electricity is scarce with 30% of the urban population connected to the grid. Cooking using wood is standard (95% of rural households) as is obtaining light from kerosene

[23] (www.worldatlas.com)
[24] (*ADB Private Sector Assessment Vanuatu: Country Partnership Strategy 2010-2014*, August 2009)

(86% of rural households)[25]. The recent increase in oil prices has seen biomass becoming more prevalent as the main source of fuel[26].

### 4.1.3 Key Energy Stakeholders

a. The Ministry of Lands, Geology, Mines, Energy, Environment and Water Resources (Energy Unit, EU)
   The EU oversees design, installation, finance, operation and maintenance of rural electrification. Its activities are concentrated around donor funded small RE technologies like SPV and micro-hydro. Energy policies are also formulated, implemented and monitored through this Ministry.
   i. Sarakata Special Reserve Fund
      This fund finances EU RE activities. The fund was established from savings of a hydroelectric system installed in 1995 near Luganville, operated by UNELCO.

b. Union Electrique de Vanuatu Ltd (UNELCO)
   The four main urban centres of Port Vila - the capital, Luganville on the island of Santo, Norsup on the island of Malakula and Lenakel on the Island of Tanna are managed by UNELCO. UNELCO is privately owned by GDF – SUEZ and has been operating in Vanuatu for 70 years. The company aims for 33% renewable energy by 2013 though wind, biofuel and hydro. Currently, it is highly reliant on diesel for electricity generation and imports approximately 11 million litres a year.

c. National Advisory Committee on Climate Change
   This committee is responsible for coordinating the VREP-IP project (below) and all other external donor funded RE related energy activities. It collaborates the interests of the Ministry of Agriculture, Livestock, Forestry and Fisheries; Ministry of Internal/Provincial Affairs; Ministry of Lands, Energy, Environment, Geology and Water Resources; Ministry of Foreign Affairs; Ministry of Infrastructure and Public Utility; Ministry of Education; Ministry of Health.

d. Vanuatu Renewable Energy Projects for the Italian-Pacific SIDS Cooperation Programme (VREP-IP)
   VREP-IP aims to strengthen the national energy infrastructure through the development of the available local renewable energy resources and increasing the accessibility of energy services to 80% of the people in outer rural and remote communities by 2017. A number of interventions are currently being implemented[27]:
   - Provision and installation of solar PV hardware equipment (9 schools & 8 health centres in Santo; 11 schools and 5 health centres in Malekula)
   - Review and installation of mini-hydro for rural electrification (review 2002 Talise Hydropower Feasibility Study Report)
   - Wind resource assessment and technical assistance (Tafea Provence – Whitegrass area on Tanna & Ipoto on Erromango; Malampa Provence – Norsup on Malekula; Penama Provence

[25] (Wade, 2005)
[26] (*Vanuatu Renewable Energy Projects for the Italian-Pacific SIDS Cooperation Programme: Project Outline*, 2008)
[27] (*Vanuatu Renewable Energy Projects for the Italian-Pacific SIDS Cooperation Programme: Project Outline*, 2008)

– Ahivo on Pentecost; Torba Province – Sola on Vanua Lava, Gaua Island; Shefa Province – Tongariki)

- Institutional Strengthening for the Energy Unit
- Capacity development to the Energy Unit
- Market development (demonstration projects; develop a rural micro-finance strategy)
- Education and awareness enhancement

e. Japan International Cooperation Agency (JICA)
JICA offers solar and hydro technical assistance to the Energy Unit and rehabilitation of the Sarakata hydro project (1.2 MW plant).

f. Pacific Islands Greenhouse Gas Abatement through Renewable Energy Project (PIGGAREP),
The PIGGAREP, managed by SPREP and the UNDP, funded by the Global Environment Fund (GEF) has broad energy objectives in the Pacific. The project timeframe is 2008 to 2012, focusing on the following areas:

- Renewable Energy educational/awareness
- Capacity development
- Technical assistance
- Feasibility studies
- Institutional strengthening

g. United Nations Development Program (UNDP)
Training is offered in Vanuatu on the installation, commissioning, operation and maintenance of waste-to-energy systems.

h. World Bank
The World Bank is currently implementing the Sustainable Energy Financing Project. The purpose of this project is to reduce the financial constraint of the upfront cost of RE (PV, pico-hydro and pico-wind) purchases. The World Bank has trained ANZ Bank on Renewable Energy lending and offers a 50% guarantee on all energy loans.

i. Council of Regional Organisations of the Pacific (CROP) agencies
Technical assistance, support to capacity development and project management, and institutional strengthening is offered through other CROP agencies such as SOPAC and SPC.

### 4.1.4 Legislation

Vanuatu implemented its new National Energy Policy recently in 2006. Previously, legislation controlling and directing the energy sector was minimal.

i. Vanuatu National Energy Policy
In 2006, the Vanuatu National Energy Policy was developed by the Department of Economic and Sector Planning with assistance from SOPAC and cooperation from UNELCO and the Energy Unit[28]. These documents form the guidelines of energy activities. The renewable energy focus in

[28] (*Vanuatu Energy Policy Framework*, 2007)

this policy is "to ensure the provision of appropriate, reliable and affordable energy services to rural remote areas; encourage the promotion of alternative sources of energy for power generation; and promote the sustainable use of and investments in renewable energy".

ii. Environmental Management and Conservation Act
EIA's are required for all projects and activities that directly impact the environment.

### 4.1.5 Private RE Providers

There are a number of RE companies operating in Vanuatu. Solar products can be supplied by JEM Solar Trading, Vanglobal Industry and other local companies based in Port Vila. Hydro products imported from Vietnam (220V, 50 Hz with capacities of 100-100W) are sold by Hong-Auto Enterprise[29].

Other regional companies readily supply products to Vanuatu, however do not have an office or showroom in the country. Some Suva based companies are CBS Power Solutions, Clay Engineering and Hybrid Power. Products and installation of RE by these companies is usually tailored to the design of the project.

### 4.1.6 Energy Financial Inclusion

ANZ Bank, along with World Bank offer energy loans targeted towards the rural population. This program has been running since 2008 with varied success. Limits to uptake include lack of financial literacy to the target audience and lack of outreach.

The sole MFI in Vanuatu, Vanwods, currently does not offer formal "energy loans". However, they are keen to start and have already made progress contacting renewable energy private companies.

### 4.1.7 Microfinance Institutions

The largest microfinance service provider in Vanuatu and which has been in operation since 1996 is VANWODS, a microfinance institution.

By July 2007 it had outreached to primarily women with more than 2,600 active members, with Vt. 29 million in outstanding loans.

VANWODS provides both loans and savings services. 60% of loans are used for productive purposes (i.e. income generation) and 40% for consumers products. The most common business activities are: retail stores, sewing, selling fruit and vegetables at market, Nakamal (kava bar), selling cigarettes and baking. [30]

[29] (Wade, 2005)
[30] Vanwods Impact Assessment Final Report July 2007

A brief status of the VANWODS microfinance service is outlined below:

- 1648 active loan clients in Efate (the main island in Vanuatu) and 781 in Santo
- 177 care savings members
- 44 MicroPeps members (clients in full time employment)
- Total savings: Vt. 50 million (35 million in compulsory savings + 15 million voluntary)
- Current level of savings mobilization: Vt. 5.6 million per month
- Outstanding loan balance: Vt. 29 million
- Cumulative disbursements: Vt. 225 million over 11 years
- Current level of disbursements: Vt. 9 million per month

The National Bank of Vanuatu is the only other provider of microfinance in Vanuatu. However, the scale of their operations in this department is small.

### 4.1.8 Key Projects

RE rural electrification pilot projects have occurred for over 20 years across Vanuatu. Below are some of the key activities.

a. Solar PV

   In 2000 the PREFACE project, administered by SPC, provided 81 SHS to two villages (however due to non-payment of the monthly fee, 15 systems were removed). A local NGO, Vanuatu Renewable Energy and Power Association (VANREPA), has installed 20 systems at aid posts in Tafea Province and are currently implementing Solar/Wind hybrid systems in Futuna and Aneityum, funded by the EU-ACP. SOPAC is also involved in SPV, powering Coconak Primary School on Tongoariki Island.

   In the private sector, 283 PV systems for telecommunication power have been installed by Telecom. A number of PV based systems have also been installed by Digicel.

b. Wind

   Community-based utilities in the Southern Islands of Aneityum and Futuna have recently been installed with wind power by VANREPA, funded by the EU-ACP energy facility. A number of sites are being monitored by the VREP-IP program.

c. Hydropower

   There are no micro-hydro projects currently underway in Vanuatu. However, 13 sites on six islands have been identified by the EU as having micro-hydro potential[31].

d. Biomass gasifier

   In the 1980s, Onesua Presbyterian College installed a 25kW wood-fuelled biomass gasifier. It is not currently operational; however it was functional for eight years. Currently, the UNDP is funding a “Sustainable Energy Interventions in Vanuatu through Community Biogas Digesters” project.

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[31] (Wade, 2005)

e. Biodiesel
   Coconut oil has been used as a biofuel in Vanuatu since 1990. There are two small producers of coconut biofuel in Efate. Their product was used in about 200 mini-buses with no serious technical difficulties[32]. In 2003, the equivalent of a diesel import duty was imposed on coconut biofuel, raising the price and making it illegal to blend without a license, significantly reducing its used. This duty was removed in 2007 to encourage the sector[33].

f. Training and awareness
   In Vanuatu, there have been a number of ad hoc training and awareness programs. Developed by UNESCO, a "Pacific Island Countries RE Toolbox" is available that provides materials to raise general awareness. At the institutional level, in 2004, ESCAP ran a "Regional RE Training Program", where key stakeholders of Vanuatu's energy sector were trained on planning and management of energy projects.

### 4.1.9 Vanuatu MFI Recommendations

There are a number of renewable energy financing opportunities in Vanuatu, but also numerous constraints. The country has very low levels of electrification, even in urban areas, indicating that services offered by national utilities are not adequate. The increase in biomass consumption is also indicative that kerosene and diesel costs are unaffordable. There appears to be a widespread need for energy services and the health, education and income benefits they provide.

A number of opportunities for MFIs and their clients are available. It may be possible for one owner of electricity in a village to act as a utility, and provide small amounts of power for a fee to the community which in turn pays for the system. Secondly, the lack of retail RE and EE products provides an ideal prospect for small shop owners to act as distributers of small RE and EE products (assuming there is a need and products are affordable). The mainstream use of biomass for cooking and lighting can be mitigated through the use of small biogas digesters. Again, in this instance it may be possible for one village member to sell digesters.

The Sustainable Energy Financing project run by the World Bank provides a unique opportunity for MFIs in energy lending. Currently, this project is having difficulties with outreach to their target audience, a niche area MFIs can satisfy. The possibility for partnership should be explored, with potential benefits of a 50% RE loan guarantee offered by the World Bank.

A major constraint of Vanuatu's widespread ability to purchase RE and EE systems through microfinance loans is the lack of financial capacity. A large proportion of the rural population is not integrated into the cash economy, severely restricting their ability to pay back a loan. Even those that use cash have struggled to pay for kerosene, indicating the repayment of RE loans could be difficult.

[32] (Wade, 2005)
[33] (*Vanuatu Energy Policy Framework*, 2007)

There is also the constraint of suppliers and maintenance. Although there is a developed regional RE and EE private sector, most companies work on a project-tender basis and have limited retail experience. For one-off projects, often the cost of supplying maintenance is not cost effective and avoided.

## 4.2 FIJI

### 4.2.1 Background

Fiji lies in the heart of the Pacific Ocean containing about 330 islands of which about a third is inhabited. Fiji's total land mass is 18,333 square kilometres. The capital, Suva, is located on Viti Levu, one of the two main islands in Fiji. Fiji has a population of 837,271. The two main ethnic groups are the indigenous Fijian population which make up 56.8% of the population and the Indian population accounting for 37.5 % of the population, the rest made up of remaining groups.[34]

Fiji Islands is rich in forest, mineral, and fish resources and its economy is one of the largest and most developed in the South Pacific. Industries centered on agriculture and natural resources account for about 30% of gross domestic product (GDP) and 70% of national exports. 70% of the labor force depend on subsistence agriculture, tourism, sugar, clothing, copra, gold, silver, lumber, and cottage industries.

Sugar cane production and processing utilizes 50% of arable land and accounts for one-third of industrial activity. The sugar industry also employs about 13% of the labor force, contributes directly 9% of GDP, and generates about 30% of exports. Sugar cane production has dropped because of prolonged drought, inefficiencies, and the non-renewal of land leases.

Crops other than sugar contribute only about 8% of GDP and about 11% of agricultural exports. Fisheries and forestry are the other two important natural resource sectors, contributing 4.9% and 2.5% of GDP, respectively.[35]

The political events in Fiji since 1987, expired land leases, the decline in sugar prices and several natural disasters have negatively affected the Fijian economy. This is reflected in declines in economic growth, remittance levels, investment rates, employment and income. In turn, these factors have critically influenced the levels of available private credit. In its latest quarterly report, the RBF reported a 6.6 percent decline in economic output in 2007, with an estimated growth of 1.2% in 2008.[36]

### 4.2.2 Energy Use

Fiji has a diverse energy profile. About 50% of grid-electrification is supplied though hydro and the rest through diesel generators. The country is estimated to import about 350 million litres of petroleum annually. Electrifying rural communities is challenging, with 20% of Fiji's population still without electrification[37]. Of those unelectrified communities, it was found that the monthly average expenditure on lighting fuels and batteries was $F 18.60, with approximately 38% spending more than $F 20 per month[38]. Fluorescent light bulbs are used in over 90%

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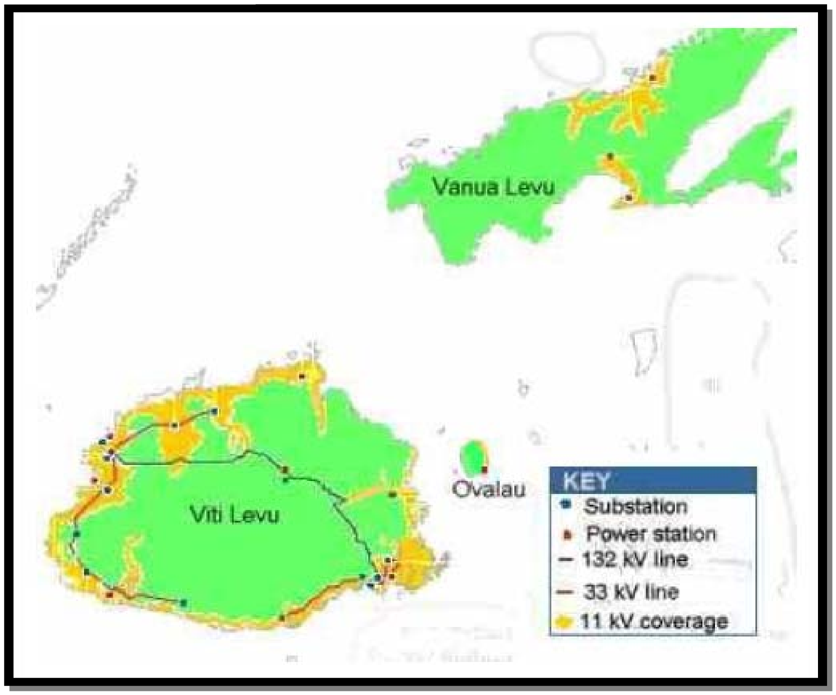
[34] (Bureau of Statistics: Fiji Facts and Figures, July 2008)
[35] (ADB Country Partnership Strategy: Fiji 2006-2008)
[36] (Reserve Bank of Fiji. *Quarterly Review.* December 2008)
[37] (Urmee, et al., 2009)
[38] (Johnston, 2005a)

households[39]. In total, it is estimated that there are approximately 12,000 unelectrified rural households in Fiji who are possible users of RE[40].

**FIGURE 7 FEA GRID SYSTEMS (JOHNSTON, 2005A)**




### 4.2.3 Key Energy Stakeholders

There are a number of government institutions, regional organizations and bilateral organizations who are involved in the RE and EE activities in Fiji.

a. The Department of Energy (DoE)

DoE manages Fiji's energy policy and off-grid rural electrification. Their national plan incorporates efficient, cost effective and environmentally sustainable energy development. They recently formulated the national energy policy, conducted studies and recommended a power sector reform strategy, established a Renewable Energy Service Companies (RESCOs) and increased funding for their Rural Electrification Program (REP).

i. Rural Electrification Program (REP)

The DoE commissions about 15 diesel genset systems and 400 SHS for rural villages per year. Currently 1200 SHS have been installed. The village pays for 5% of the capital costs and operating costs of about $FJ12 per month. Any village without energy can apply, however the waiting time is 2 years. If an installation has occurred post-1995, the village is no longer eligible to apply. Due to poor management, poor operation and maintenance and high fuel costs, some systems are no longer operational[41].

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[39] (*Rural Electrification Survey Report*, 2006)
[40] (Johnston, 2005a)
[41] (Johnston, 2005a)

b. The Fiji Electricity Authority (FEA)
   Owned by the government, FEA is Fiji's power utility responsible for supplying national electricity where it is financially and economically viable. It has a staff of 640 operating on the three main islands, Viti Levu, Vanua Levu and Ovalau. The FEA plans to produce 90% of electricity from RE by 2011.

c. The Fiji Department of Environment (DoEnv)
   DoEnv is responsible for Fiji's national Greenhouse Gas (GHG) inventory. It is also required to manage the national climate change activities.

d. Pacific Islands Greenhouse Gas Abatement through Renewable Energy Project (PIGGAREP)
   The PIGGAREP managed by SPREP and the UNDP, and funded by the Global Environment Fund (GEF) is focusing on two key initiatives in Fiji:
   i. Government of Fiji's REP (see above)
   ii. Pacific Islands Cooperation Programme with the Government of Italy (see below)

e. United Nations Development Program (UNDP)
   In 2008, UNDP completed the Regional Energy Programme for Poverty Reduction Project (REP-PoR). This project targeted the improved access to energy services, promoted efficient use of energy and increased access to financing for sustainable energy. It worked through policy advocacy, capacity development and action research and knowledge management.

f. Pacific Islands Cooperation Programme with the Government of Italy
   Proposals for this project include:
   i. 10 Biogas digesters
   ii. Enactment of Fiji's Energy Bill and review/adoption and re-enactment of relevant policies, frameworks and legislations for RETs
   iii. Detailed designing for hydro projects in the Bua (Navakasali/Naruwai), Cakaudrove areas
   iv. Detailed designing and construction of hybrid (wind/diesel) project on Gau Island (Vadravadra) – to include maintenance, management, etc.

g. World Bank
   The World Bank is currently running the Sustainable Energy Financing Project. The purpose of this project is to reduce the financial constraint of the upfront cost of RE (SPV, pico-hydro and pico-wind) purchases. The World Bank has trained ANZ on Renewable Energy lending and offers a 50% guarantee on all energy loans.

h. Asian Development Bank (ADB)
   Asian Development Bank (ADB) funded by the Danish Government is running "REEP", a technical assistance project intended to provide capacity building assistance to Fiji. The overall goal is to increase the capacity to develop, fund and implement RE and EE projects while emphasizing market driven structures.

i. Council of Regional Organisations of the Pacific (CROP) agencies
Technical assistance, support to capacity development and project management, and institutional strengthening has been on-going activities by other CROP agencies such as SOPAC and SPC.

### 4.2.4 Legislation

The FEA's planning, operations and transactions are appropriately regulated. There is a duty tax concession for all RE systems in Fiji. Parliamentary acts of importance include:

- The Electricity Act;
- The Petroleum Act – for fuel storage and transport;
- The Fuel and Power Emergency Act – for the supply and distribution of fuel during emergencies;
- The Public Enterprise Act – for the restructuring and regulating government commercial companies in the public interest; and
- The Commerce Act – for promoting competition[42].

### 4.2.5 Private RE Providers

There are a number of RE and EE businesses in Fiji. On the whole, they operate on project-tender basis, importing products as required. Retail stores are limited, however several businesses have plans to open shop fronts in the near future. Non-project-tender customers are mostly resorts who hear about the company through word of mouth. Those villages that purchase RE systems usually pay cash up front. The businesses are not involved in marketing, although many have plans in the future.

Some businesses include CBS Power Solutions, Clay Engineering and Hybrid Power.

### 4.2.6 Energy Financial Inclusion

ANZ Bank, along with World Bank offer energy loans targeted to the rural population. This program has been running since 2008 with varied success. Limits to uptake include lack of financial literacy in the target audience and lack of outreach.

None of the MFI's are involved in energy lending. Despite this, at least three of the MFI's show keen interest in starting RE and EE lending for the benefit of their clients.

### 4.2.7 Microfinance Institutions

In 1999, the Fiji government instigated microfinance, using NGO's as platforms to build and operate Fiji MFI's. Today there are 9 MFI's, of which three are urban based and the rest small

[42] (Johnston, 2005a)

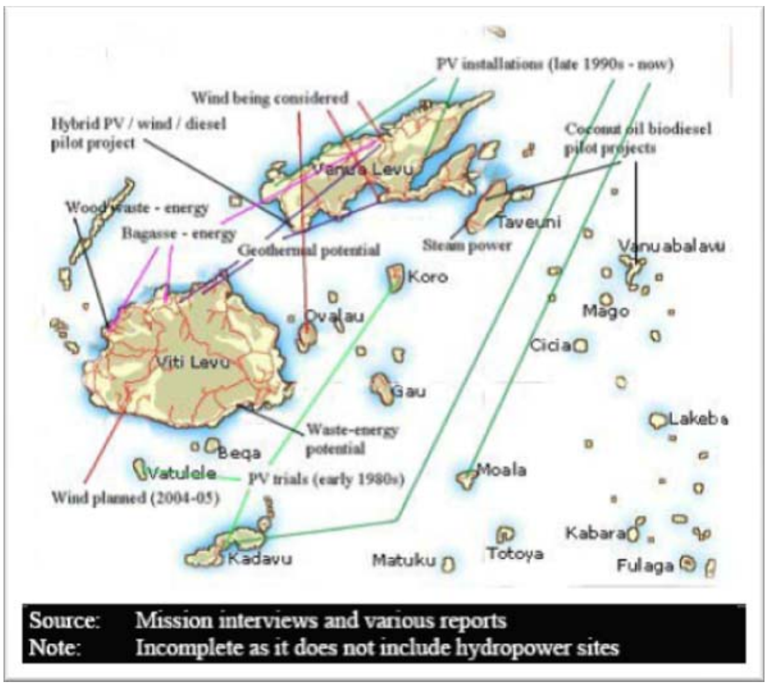
village based programmes. Many of the MFI's have struggled to become viable and sustainable in past 9 years.

In 2009 micro-savings levels were over FJ$1 million with over 22,000 savers. Loans disbursed annually amount to over FJD 1Million. Lending and Savings levels have declined over the past 3 years and the challenge is on the MFIS to diversify into new products that will enable them to bring lending onto a higher and more sustainable level. Also on record are the improvements in socioeconomic status of microfinance clients, including the large number of women who now have access to financial services and the increase in associated enterprise development. [43]

### 4.2.8 Key Projects

Since the 1980's, Fiji has been involved in electrifying rural populations through the use of RE. Outlined below are some examples of pico-RE pilot projects.

**FIGURE 8 FIJI RE PROJECTS - PAST, PRESENT AND PROPOSED (JOHNSTON, 2005A)**




a. Solar PV

There have been a number of solar projects in Fiji. Namara (Kadavu) and Vatuele (Koro) were the first rural areas to be electrified by PV in 1983. Households paid $F 25 upfront and $F 3-4 per month for the system. In Koro, the cooperative spent the accumulated funds after a Peace Corps manager left. In Namara, by 1993 the co-op no longer functioned, but luckily about half the installed systems were still operational. Another project was run in 1987 that installed 100 SHS in Viti Levu with a monthly charge of $F

[43] Microfinance in Fiji, Asaeli Tamanitoakula, Pacific Microfinance Week presentation 2009

4.50. In this instance, customers were dissatisfied with undersized systems and funds intended for maintenance were embezzled by a DoE employee.

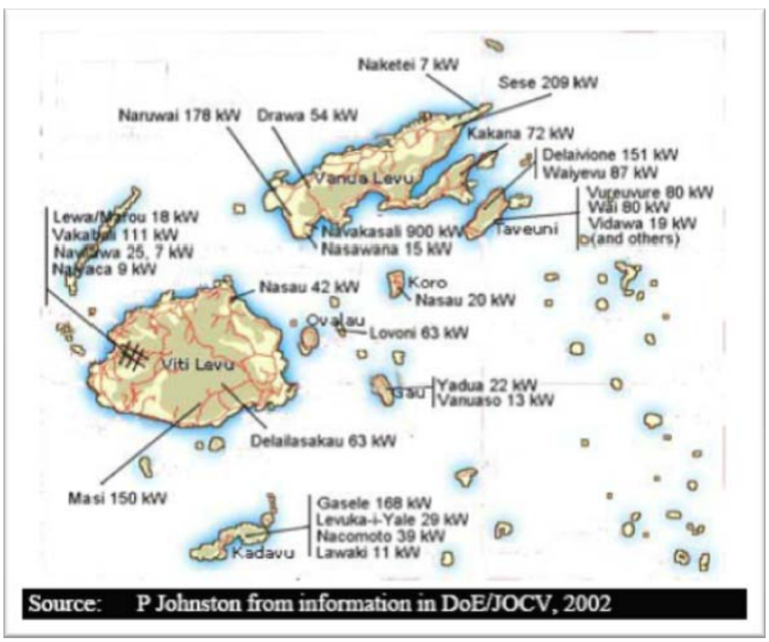
More recently, projects include 100 household PV systems in Vanua Levu funded by JICA and 3,200 trial solar home systems in 75 remote villages funded by ADB and France.

PV is increasing its presence in Fiji. In 2009 the DoE estimated that 1200 SHS were in use. Additionally, all telephone systems in the outer islands are PV powered.

b. Wind
Pico wind power is used in Fiji in a number of resorts with varied success. In Nabouwalu, a 6.7 kW solar/wind/diesel hybrid project was commissioned in the 1990s. Maintenance issues has been an issue and the project currently runs entirely on diesel.

c. Hydropower
Since the 1980s there have been a number of micro-hydro installations. In Viti Levu, a 4 kW system in Nasoqo was installed in 1984, however it is no longer operational due to several difficulties with electrical systems and a lack of technical knowledge) (Johnston, 2005a). In Vanua Levu, Muana holds a 30 kW hydro system installed in 1994. Also in 1994, a 20 kW system was installed in KadavuKoro, Kadavu. Technical support has been a major barrier to the reliability of these systems with electrical component problems common, particularly turbine speed controllers and alternators.

**FIGURE 9 POSSIBLE HYDRO SITES (JOHNSTON, 2005A)**




d. Biodiesel
In Vanuabalavu, Lau, coconut oil was used as an alternative to operate diesel generators. Similarly coconut oil was also being trialed in Taveuni. There were a number operational

and management issues with the in situ production of oil (Johnston, 2005a). These projects are no longer in operation due to the break-down of the production systems.

Currently, DoE with financial and technical assistance form ADB, is exploring the possibility of the production of biofuel in Rotuma. Additionally, SOPAC is implementing a Biofuels (coconut oil) with a Value Adding component at Nadave in Nausori, with coconut soap as well as biodiesel produced.

e. Biogas
FDoE is currently piloting the use of biogas digesters in the "Fiji National Biogas Programme". Digesters are being installed at Queen Victoria School, Ratu Kadavulevu School, Wainiyabiya Settlement and Namatakula village.

f. Efficient stoves
A project occurred in the 1980s whereby several hundred efficient stoves were distributed (Johnston, 2005a). This project was unsuccessful in the long term and stoves are no longer used due to lack of maintenance.

g. Training and awareness
Awareness of RE and EE in Fiji has been conducted through a number of means. The "Pacific Island Countries RE Toolbox" developed by UNESCO is available that provides materials to raise general awareness. SOPAC has also created a number of educational materials, including story books, DVDs and brochures.

At the institutional level, in 2004, ESCAP ran a "Regional RE Training Program", where key stakeholders of Fiji's energy sector were trained on planning and management of energy projects.

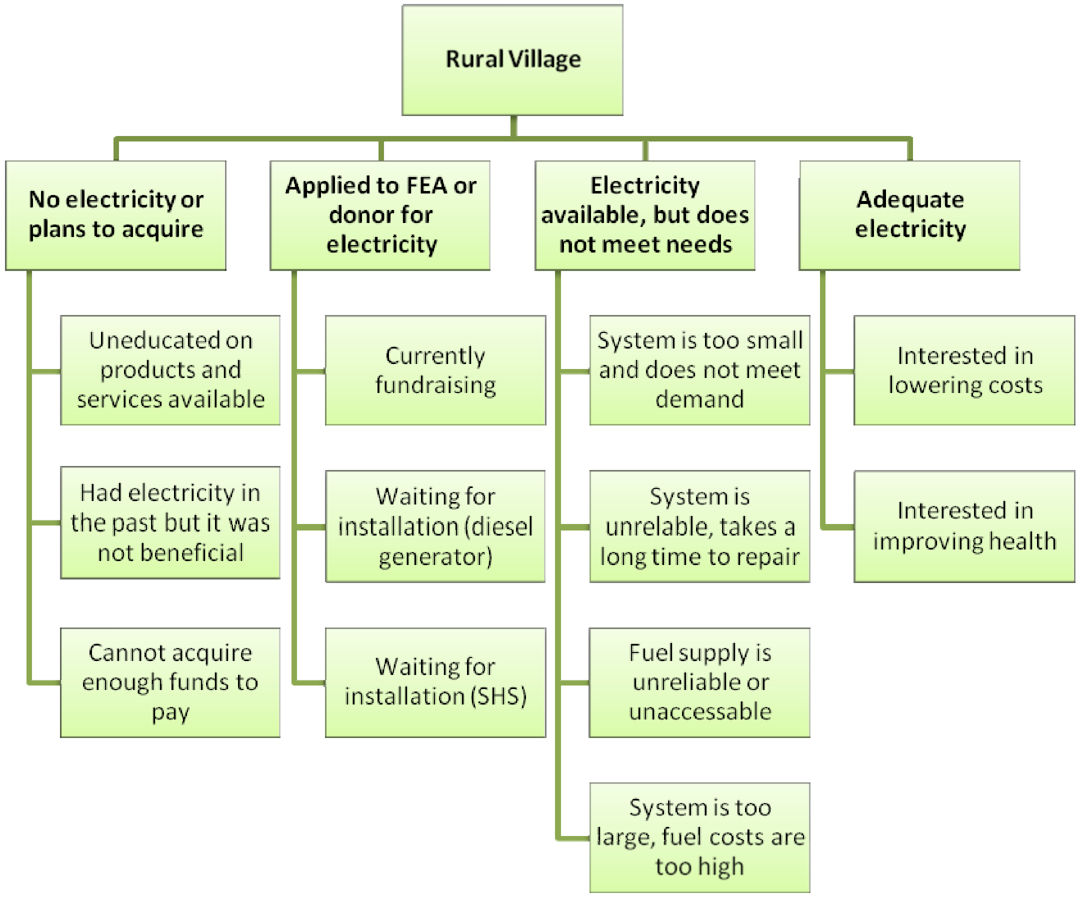
In 2006, UNESCO/ESCAP completed a Fiji rural electrification study identifying the key trends in energy use.

### 4.2.9 Fiji MFI Recommendations

Fiji's energy situation is complex. Where energy is provided by the grid system, it is affordable and reliable. In rural areas whereby energy is supplied by the DoE rural electrification scheme, customer satisfaction varies[44]. Below is a summary of the variety of possible energy conditions in rural Fiji.

[44] (*Rural Electrification Survey Report*, 2006)

**FIGURE 10 FIJI VILLAGE ENERGY CONDITIONS**




Of the situations above, MFI's in Fiji have the ability to fulfill unsatisfied energy clients through education and awareness, loans for additional RE systems and loans for EE retrofitting. Having identified appropriate clients and needs, the environment in Fiji is conducive to energy loans. MFIs have financially literate customers, there are a number of RE businesses based in-country and technicians are readily available.

It is recommended that MFI's originally concentrate on loans for microenterprise development. Businesses can use the additional energy for value-adding, RE and EE retailing or to act as a mini-utility. With the energy system increasing income, the system will pay for itself rather than being a financial burden. Additionally, this will reduce the risk of loan defaults, benefiting both MFI and clients.

As in Vanuatu, the Sustainable Energy Financing project run by the World Bank provides a unique opportunity for MFIs in energy lending. Currently, this project is having difficulties with outreach to their target audience, a niche area MFIs can satisfy. The possibility for partnership should be explored, with potential benefits of a 50% RE loan guarantee offered by the World Bank.

## 4.3 SAMOA

### 4.3.1 Background

Samoa lies slightly north east of Fiji. It has 2 main islands Upolu and Savaii, with the capital Apia located in Upolo. It has a total area of 2,934 square kilometres and approximately 179,000 people. The main languages spoken are English and Samoan. Its economy revolves around agriculture, timber and tourism. The GDP per capita is US?$4,900[45]. Samoa relies on remittance from Australia, New Zealand and USA for balance of payments, and as a result it is susceptible to adverse changes in these external economies.

Samoa appears to be broadening its economic base and building its private sector. It has developed its national energy grid to cater for the energy needs of most of the population. However its heavy reliance on imported fuel is a big burden on Samoa's national expenditure. Plans are underway with multiple stakeholders to convert to renewable sources of energy. Other constraints in development are the inefficient infrastructure industries, inefficient public service and health system, and a weak enabling environment for the public sector.[46]

### 4.3.2 Energy Use

Samoa is highly electrified, with all communities having access to electricity and only 250 households without power. Recently JICA agreed to sponsor the electrification of these remaining houses by SHS and grid extension. Of the electrified households, about 30% of power is supplied through hydro and the rest through petroleum fuels. Average household power use is low at 330W for a small house and 1960W for a large house[47]. More than half of households (62%) use fuel wood as their main cooking fuel[48]. Kerosene and LPG are also common household cooking fuels. Lighting is provided by benzene and kerosene for 7% of households, the remainder use electricity.

### 4.3.3 Key Stakeholders

Government institutions, regional organizations and bilateral organizations are directly involved with Samoan energy production and use.

a. Ministry of Finance (MOF) – Energy Unit

Overall energy sector planning, energy policy and its coordination and project coordination are the responsibilities of the Energy Unit. It aims "to increase the contribution [of renewable energy] for energy services and supply by 20% by the year 2030."

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[45] www.cia.gov/library/publications/the-world-factbook/
[46] ADB Country Partnership Strategy: Samoa 2008 -2012
[47] (Wade, 2009)
[48] (Wade, 2005)

b. The Minister of Works, Transport and Infrastructure – Electric Power Corporation (EPC)
The commercially operated, but government-owned EPC is to provide grid electrification throughout Samoa. The Board of Directors determine policies. Since the reform, the EPC manages contracts, but is not involved in construction or maintenance - these operations are carried out by the private sector. It is involved in reducing diesel dependency through RE and EE. Currently the EPC is investigating the potential of biofuel, solar and wind power and increasing the hydro capacity.

c. Ministry of Finance (MOF) – Ministry of Staff & Tenders Board
Sets and monitors wholesale and retail prices of fuel every month.

d. Pacific Islands Greenhouse Gas Abatement through Renewable Energy Project (PIGGAREP),
The PIGGAREP managed by SPREP and the UNDP funded by the Global Environment Fund (GEF), is working on three key initiatives in Samoa:
    i. Co-operation in developing a strategic energy action plan
    ii. Follow-up in cooperation with UNDP on the Preparatory Phase for the Samoa PV Rural Electrification Programme, including support for the implementation of such a PV program
    iii. Support for EPC wind energy development including comprehensive feasibility studies (including geotechnical analysis) and identification of funding sources, possibly CDM.

These operations will be administered in cooperation with the ADB, UNDP, SOPAC and the Government of Samoa.

e. United Nations Development Program (UNDP)
In 2008, UNDP completed the Regional Energy Programme for Poverty Reduction Project (REP-PoR). This project targeted the improved access to energy services, promoted efficient use of energy and increased access to financing for sustainable energy. It worked through policy advocacy, capacity development and action research and knowledge management. Additionally, the UNDP is working with SOPAC and SPREP on a number of initiatives.

f. Asian Development Bank (ADB)
In Samoa, the ADB Power Sector Expansion Project was instigated to offer the EPC technical assistance in improving the energy sector. It had three major goals:
    i. Develop a comprehensive reform program, including a regulatory framework that would enable private sector participation and enhance the efficiency in the sector;
    ii. Develop a program to reform the EPC's internal and business management procedures to enhance governance and cost efficiency; and
    iii. Prepare an investment road map to diversify the country's energy resources, meet future load growth, and reduce the burden of diesel imports.

The technical assistance offered consists of four components:

    i. Regulatory reform in the power sector
    ii. Establishment of a clean energy fund

iii. Establishment of a designated national authority
iv. Residential financial management advisor to the EPC

This project is currently under implementation and is scheduled to complete in 2015.

g. Council of Regional Organisations of the Pacific (CROP) agencies
Other CROP agencies offer technical assistance, support to capacity development and project management, and institutional strengthening.

### 4.3.4 Legislation

Energy issues are addressed by a number of government acts.

- The Price Control Act – the procedures for controlling fuel prices;
- The EPC Act – the governing activities of the electric power utility;
- The Foreign Investment Act – reserves some businesses for Samoans;
- The Petroleum Act – the supply, transport and storage of petroleum;
- The PUMA Act – the development, regulation, sustainable use and management of land;
- The Public Bodies (Performance and Accountability) Act – regarding state owned enterprises
- The Samoa Forestry Act – the management of forest resources

### 4.3.5 Private RE Providers

Regional businesses operate in Samoa under project tender agreements. The service provided has been tailored towards large grid-scale applications. It is questionable whether service to smaller applications would be deemed cost effective.

### 4.3.6 Energy Financial Inclusion

No financial body in Samoa currently offers “energy loans”. However, SPBD (see below) has a keen interest in renewable energy sources as one of its key development areas.

### 4.3.7 Microfinance Institutions

South Pacific Business Development Foundation (SPBD) is a Grameen Bank style MFI serving those that live in poverty in the Pacific Islands. Established in Samoa in January 2000, it has assisted over 10,000 people with microenterprise loans in over 150 villages all over Upolu. SPBD has a target to reach 48% of the population that the UNDP declared as being food deficient. [49]

Since inception, SPBD reported an outreach to over 11,000 clients and over WS Tala 30 Million. Currently (2009) it has over 6,000 active clients and WS Tala 6 Million disbursed. The portfolio at

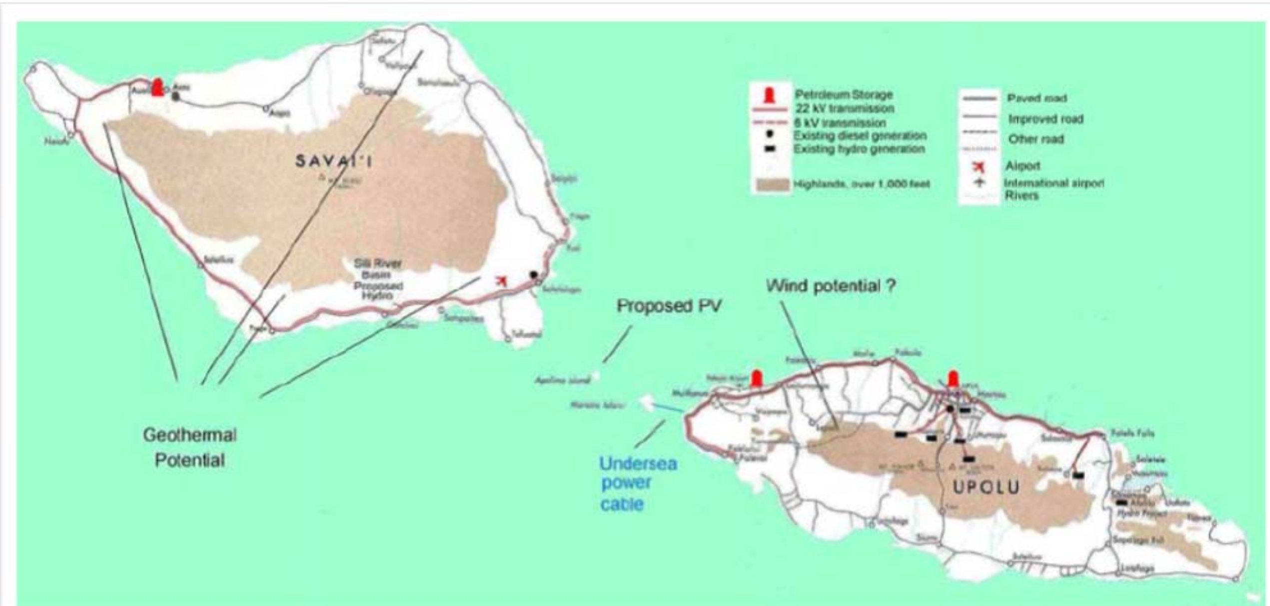
[49] www.spbd.ws

risk is an impressive 1.8%. SPBD also has savings amounting to over WS Tala 600,000 between 3,000 savers.[50]

### 4.3.8 Key projects

Numerous RE electrification projects have been conducted in Samoa, however most of these are large grid-connected scale projects. There have been a few pico-scale RE projects with varied success.

**Figure 11 Potential RE developments in Samoa**




Source: adapted from PREA. 1992: Note: The petroleum tank farm at Asau has since been relocated to Salelologa.

a. Solar PV

In Samoa, there is limited use of PV[51]. In 1986 30 households in Safotu (Savai'i) were supplied with SHS for a WS$200 installation fee and WS$10 weekly service rental. However, the project was unsuccessful due to lack of support, spare parts and insufficient training. Recently, a successful project powering the 100 residents of Apolima Island by PV mini-grid was run by the Government of Samoa, EPC and the UNDP from 2004-2006. SHS with 24 hour power supply are proposed for the remaining 250 households without access to power with funding provided by JICA.

b. Wind

Large, grid-scale wind resource assessment is being undertaken in Upolo by EPC/Government of Samoa/SOPAC/UNDP. These assessments are planned for Savai'i in the near future. If viable, the proposed wind farms will be connected to the grid. No new pico-wind projects have been reported in Samoa.

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[50] SPBD, Key factors in building a successful MFI in the Pacific, Pacific Microfinance Week August 2009.

[51] (Johnston, 2005a, 2005b; Wade, 2005)

c. Hydropower
Samoa is experienced in installing large grid-scale hydro applications in excess of 1MW capacity on the island of Upolu. Currently the total dry season capacity of these hydro plants is 22 MW. The potential for hydro on Savai'i has been explored, but not developed. Additionally, pico- and micro-hydro has not been utilised in Samoa.

d. Biodiesel
SOPAC and UNDP undertook a "CocoGen" project. This project explored the possibility of generating coconut biofuel at a cost competitive to importing diesel oil. Similarly, ADB's REEP project is offering technical assistance in "EPC Hydro and Biofuel Power Development".

e. Improved stoves
A Rural Development Programme promoted the sale of $5 portable concrete charcoal stoves. Its goal was to improve cooking efficiency and reduce heavy fuel wood harvesting. The project experienced short-term success, with 4,000 stove sold within the first year. However, by 2001 less than 1% of households cooked with charcoal.

f. Training and awareness
Awareness for RE and EE in Samoa has been conducted through a number of means. The "Pacific Island Countries RE Toolbox" developed by UNESCO is available that provides materials to raise general awareness. SOPAC has also created a number of educational materials, including story books, DVDs and brochures. On April 25, 2008, SPREP through PIGGAREP funded the Samoa National Energy Awareness Day (SNEAD), an educational program targeted towards school children.

At the institutional level, in 2004, ESCAP ran a "Regional RE Training Program", where key stakeholders of PICs energy sector were trained on planning and management of energy projects.

### 4.3.9 Samoa MFI Recommendations

Samoa is almost fully electrified, but this does not limit the scope for energy loans. The completion of a needs assessment will clearly distinguish the possibilities for MFI's in Samoa. The needs assessment will discover (a) whether Samoans are educated on RE and EE; (b) whether they are satisfied with their energy service and costs; and (c) if there is interest in modifying their cooking methods.

If there appears to be a lack of awareness of RE and EE, the MFI's can use their outreach to educate clients on these products. Increasing awareness on EE may have the benefit of reducing the overall demand for energy, reducing the country's reliance on fossil fuels and reducing the individual or microenterprises electricity bill.

The high use of biomass and kerosene for cooking may introduce another possible niche for MFI's to explore in Samoa. If there is deemed to be interest, MFI's may offer loans to local micro-entrepreneurs to sell the cooking product, or value-added food item.

There are few obstacles to implementation in Samoa. In particular, major barriers of financial literacy and lack of outreach are not present. However, there is a lack of retail outlets and locally qualified technicians which may prove to be a barrier in widespread uptake.

# 5. Recommendations

The next step in the PREM project is conducting a client needs analysis. Using the results of this survey, MFI's will be able to develop appropriate awareness material and loan products.

1. Needs analysis

Before an MFI develops any RE or EE loan product, it is vital that a client needs analysis takes place. This will identify their awareness of RE and EE, energy demand, capacity to pay and interest. Having completed this study, appropriate loan products can be designed.

2. Education and awareness

MFIs have the outreach through their clientele to increase awareness towards RE and EE systems or technologies. This existing outreach is a real opportunity for marketing and expanding the retail market for RE and EE, which will over time reduce costs. Possible partnerships to reduce educational costs may be instigated between MFIs and regional organizations, NGOs or private businesses.

3. Possible loans

There are a number of options for MFI RE and EE loans in PICs. These may not be appropriate for all regions but can be used as a guide. It is important the system will either generate income or reduce costs to ensure the user has the ability to pay for the system.

**Business loans:**

1. Local store
    - Supply of electricity for mobile phone charging; solar battery charging
    - Purchase of freezer/fridge to sell cold drinks, preserve food
    - Act as a retailer for LED lights
    - Act as a retailer for biogas digesters and/or biogas stoves
    - Act as a retailer for solar lamps
2. Fisherman
    - Scaling fish at night
    - Purchase of solar freezer to preserve fish
3. Handicrafts
    - Operations at night

**Personal loans**

1. Purchase solar lamp
    - No ongoing cost of kerosene
2. Purchase SHS
    - No ongoing cost of diesel generator
3. Purchase battery for diesel generator
    - Reduce ongoing fuel costs

4. Purchase LED/CFL light bulbs
    - Reduce fuel requirements & costs
5. Purchase biogas digester & gas stove
    - No ongoing fuel costs

# 6. Conclusion

Determining the most appropriate way to electrify rural PICs through RE is a complex process. National energy policies and legislation must be assessed to identify any limitations. Possible business partners should be recognized and their ability to provide a quality service should be examined. Finally, a comprehensive customer profile needs to take place so the most appropriate technology will be purchased.

Vanuatu, Fiji and Samoa are extremely different countries in their Energy Profile. Vanuatu has very low levels of electrification; Fiji moderate and Samoa high. Additionally, they have different structures in terms of key stakeholders, legislation and financial inclusion. Customized loan products must be developed by each MFI for the needs of *their* clients to ensure the success of this project.

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