SPREP

Pacific Islands Renewable Energy Project

A climate change partnership of GEF, UNDP, SPREP and the Pacific Islands

GEF

UNDP

The Secretariat of the Pacific Regional Environment Programme

DEMONSTRATION PROJECTS TO SHOWCASE THE BUSINESS ANGLE OF RENEWABLE ENERGY SERVICE DELIVERY IN THE PACIFIC ISLANDS

PIREP

our islands, our lives...

Erratum: the printed report shows the wrong CiP data; the correct version is shown below as a replacement.

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Acronyms

ACP	African, Caribbean and Pacific Countries
ADB	Asian Development Bank
AusAID	Australian Aid
COOP	Producer owned and managed economic cooperative group
CROP	Council of Regional organizations in the Pacific
DME	Department of Minerals and Energy (South Africa)
DOE	Department of Energy (Fiji)
EDF	Electricité de France
ESCAP	Economic and Social Commission of Asia and the Pacific
EWG	Energy Working Group of CROP
EU	European Union
EUEI	EU Energy Initiative For Poverty Eradication and Sustainable Development
FSM	Federated States of Micronesia
FSP	Foundation for the Peoples of the South Pacific
GEF	Global Environmental Facility
IBRD	International Bank for Reconstruction and Development (World Bank)
JICA	Japanese International Cooperation Agency
KZN	Kwazulu Energy Services
MAEC	Marshall's Alternative Energy Company
MEC	Marshall Energy Company
NZAID	New Zealand Aid, previously NZODA
O&M	Operation and Maintenance
ONE	Office National de l'Electricité
OPRET	Office for the Promotion of Renewable Energy Technologies (Fiji DOE)
PIC	Pacific Island Country
PNG	Papua New Guinea
PPA	Pacific Power Association
PV	Photovoltaics
PIESD	Pacific Islands Energy for Sustainable Development
PIEPP	Pacific Islands Energy Policy and Plan
PIEPSAP	Pacific Island Energy Policies And Strategic Action Planning
PIREP	Pacific Islands Renewable Energy Project
PIFS	Pacific Island Forum Secretariat
POS	Point of Sale
PWD	Public Works Department
PREFACE	Pacific rural Renewable Energy France-Australia Common Endeavour
RESCO	Renewable Energy Service Company
RE	Renewable Energy
REEP	Renewable Energy and Efficiency Program for the Pacific (ADB)
RET	Renewable Energy Technology
RMI	Republic of the Marshall Islands
RSC	Regional Support Company

SIDS	Small Island Developing States
SEC	Solar Energy Company (Kiribati)
SHS	Solar Home Systems
SIEA	Solomon Islands Electricity Authority
SOPAC	South Pacific Applied Geoscience Commission
SPC	Secretariat of the Pacific Community
SPREP	Secretariat of the Pacific Regional Environmental Programme
SWH	Solar Water Heater
TOISEP	Tonga Outer Islands Solar Electrification Programme (Tonga)
TSECS	Tuvalu Solar Electric Co-operative Society
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization
USP	University of the South Pacific
WSSD	World Summit on Sustainable Development

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1 INTRODUCTION

This report is an outcome of a series of studies conducted under the framework of the Pacific Islands Renewable Energy Project (PIREP) – a climate change mitigation partnership of the Global Environment Facility (GEF), the United Nations Development Programme (UNDP), the Secretariat of the Pacific Regional Environmental Programme (SPREP) and Pacific Islands countries (PICs).

The PICs are currently heavily dependent on fossil fuels. Renewable energy (RE), mostly hydro, is estimated to contribute less than 10 percent of each PIC's commercial energy use and the region is characterized by scattered and fragmented efforts to promote RE technologies that are based on unreliable and unsubstantiated data on RE resource potentials. The PIREP aims to facilitate the promotion within the PICs of the widespread implementation and ultimately, commercialisation of RE technologies (RETs) through the establishment of a suitable enabling environment. The establishment of an environment conducive to the region-wide adoption and commercialisation of RETs would involve the design, development and implementation of appropriate policies, strategies and interventions addressing the fiscal, financial, regulatory, market, technical and information barriers to RE development and utilization. It also involves the development of interventions for strengthening of the relevant institutional structures and national capacity for the coordination and the sustainable management (design, implementation, monitoring, maintenance, evaluation and the marketing) of RE initiatives in each country..

A RE assessment study[1] conducted by the PIREP in 15 PICs identified, among others, the absence of projects to demonstrate the business angle of RE service delivery as a major market barrier to the RE development in the PICs.

This report identifies three sub-regional demonstration projects to be further considered by the PICs and authorities concerned and discuss regional and global experiences with business approaches to RE dissemination.

1.1 Concept

When discussing business aspects of renewable energy development, the first consideration must be the markets for the technologies. There are three distinct classes of Pacific Island Countries (PICs) when considering renewable energy development. By far the largest class is that dominated by Papua New Guinea. This group includes the Melanesian countries of Fiji, Papua New Guinea, the Solomon Islands and Vanuatu. Those countries have large and diverse renewable energy resources and large unelectrified populations in rural areas where there is little participation in the money economy.

The second group includes FSM, Kiribati, and the Marshall Islands and FSM and is characterised by small populations, large numbers of often difficult to access islands and relatively small land areas for most islands and therefore limited renewable energy resources. A high percentage of the population is unelectrified, rural, and most still have subsistence based economies though there generally is participation in the money

[1] **This study produced 15 Country Reports and a Regional Synthesis.**

economy through the organised production and sale of copra, fish and agricultural products.

The third group of PICs includes the Cook Islands, Nauru, Niue, Palau, Samoa, Tokelau, Tonga and Tuvalu. These countries have a high rate of electrification, approaching 100% for Nauru, Tokelau and Niue with over 85% for the rest. These countries can benefit relatively little from additional off-grid electrification programmes. Most of the population of these countries is engaged in the money economy and though subsistence agriculture and fishing is still present it is declining in importance.

The region as a whole is dominated by Melanesia simply because of the sheer size of the countries relative to the rest of the PICs. The Melanesian countries represent 98.8% of the total land area and 85.8% of the population of the 15 PICs being considered by PIREP. Thus any regional effort to be carried out has to focus a high percentage of its resources on Melanesia to show the maximum regional effect in terms of gross GHG growth rate reduction. Further, the Melanesian countries all have relatively low per-capita energy use when compared with the other PICs and therefore there is greater potential for energy growth for the future and also greater opportunity, even on a per-capita basis, for lowering the rate of growth of greenhouse gas production. Yet the other 11 PICs are in the political majority and must be included in regional programmes even though the end effect of GHG reduction cannot be anywhere near as large as the long term GHG reduction potential of the combined Melanesian countries. For these reasons, several types of demonstration projects that focus on the business of renewable energy utilisation need to be developed since all three market classes of countries must be addressed. The relative size of the demonstration projects should, however, relate to the relative size of the type of market being served with the dominant focus on the market types found in the Melanesian countries, in particular off-grid electrical service provision.

Table 1 – Compilation of RET Market Characteristics for the PIREP PICs.

Market Group	Countries	Market character	Character of the economy	RET Market suitable for private development	Primary Market Barriers for private RET development
Group I	Melanesian (PNG, Solomon Islands, Vanuatu and Fiji)	Large unelectrified rural population. High percentage of population is classed as rural. Little prior exposure to renewable energy technologies other than traditional biomass use for cooking.	Rural areas include both commercial and subsistence agriculture or fishing. "Hot Spots" exist where concentrated development of mineral resources or large commercial plantations occur. Donor support or foreign investment is significant to the economy. Tourism is important for Fiji and to some extent for PNG and Vanuatu.	Biofuels (notably coconut oil and palm oil based fuels) Off grid electrification with solar and hydro Biomass where agricultural processing takes place Grid power from hydro, biofuel, biomass, geothermal and wind Solar water heating in urban areas	Limited participation in the cash economy making payment a problem Poor rural infrastructure making access difficult and maintenance a problem Little prior experience with renewable technologies Weak rural institutions make it difficult to assure compliance with agreements, collection of payments, etc.
Group II	Kiribati, RMI, FSM	Numerous isolated islands, large unelectrified rural population, high percentage of population classed as rural. Rural areas familiar with solar technology for lighting and basic electrification.	Rural areas combine money economy and subsistence economy. Donor support significant to the national economy. Narrow based economy with agriculture and fisheries dominant.	Off grid electrification with solar energy Coconut oil based biofuels Grid power from biofuel and solar Solar water heating in urban areas	Many small, remote islands make installation and maintenance expensive and difficult Small populations making it difficult to maintain a large enough market for private business development Few technical resources outside of urban areas.

					Poor communication and financial infrastructure in rural areas.
Group III	Palau, Nauru, Tuvalu, Tonga, Samoa, Niue, Tokelau	Most of the population is urban or semi-urban. Rural electrification complete or nearly so. Rural areas familiar with solar energy for basic electrification through long term projects	Largely focused on money economy though subsistence fishing and agriculture remains important. Donor support represents a significant part of the national economy for most. Agricultural or fisheries based economy with significant tourism income for Palau, Tonga and Samoa.	Grid power from biofuel, solar and wind Solar water heating	Small populations limit opportunity for business development Tonga and Tuvalu have high cost of access to rural areas with numerous isolated islands. Tokelau also has a high access cost. Utilities are small and integration of renewable energy at an economic scale is relatively difficult.

Source: Information from PIREP Country Reports and PIREP Regional Synthesis Report

It is clear that development of private sector involvement in renewable energy development faces substantial finance and technical support barriers as well as other barriers relating to taxation, access to markets, public awareness, etc. Since other reports in this series are focused on the reduction of finance and technical support barriers, this report will focus mainly on the development of projects to demonstrate business structures, incentive programmes and marketing approaches that have the potential for major renewable energy development activity in the PICs.

This report considers the problems of each of the three RET market classes of PICs and develops a regional project proposal to demonstrate the "business angle" of RE development for each class. To do this, the report will:

- for each of the three PIC groups, identify and evaluate the key RET markets and their associated barriers;
- review existing initiatives and activities relating to RE market development in the region; and
- review and assess the experience of different delivery mechanisms for off-grid RE service which is the largest RET market opportunity for the region.

2 Group I – The Melanesian Countries of Fiji, Papua New Guinea, Solomon Islands, and Vanuatu.

2.1 Market Characteristics

2.1.1 Utility market for RET

The power utilities of the Melanesian countries primarily serve the urban and peri-urban areas. Of the four countries, only the Fiji Electricity Authority (FEA) has electrified a significant percentage of rural households. The mountainous terrain and the large land areas of the Melanesian countries offer opportunities for hydro development for utility generation and PNG and Fiji include large hydro components in their generation mix with diesel power the other main power source. Substantially more hydro development is possible. The low rural labour cost of the Melanesian countries is expected to allow the development of biofuels for power generation and trials of coconut oil as a diesel replacement have yielded favourable technical results. Larger scale use of biofuels can be expected as the cost of diesel fuel rises in relation to locally made biofuels.

The primary business opportunity for this market is the development of renewable energy based power generation for the sale of power to the utilities. Biomass, hydro, geothermal and wind power all are possible for development by businesses as Independent Power Producers (IPPs). The end effect of development of renewable based IPPs would be reducing the percentage of electricity generation by diesel power since all Pacific utilities utilise high marginal cost diesel generation to fill the gap between hydro and other renewable sources and the demand for electricity. Though the opportunity for greenhouse reductions through IPPs using RETs is significant, the primary problem is one of capital access for the purchase and installation of the equipment and that cannot be directly addressed by GEF. The non financial barriers relate mainly to policy development to encourage IPPs through easing licensing requirements and requiring utilities to pay a price for purchased power that relates to their marginal cost of generation, not to their often subsidised tariff or to their average cost of generation which typically includes a large block of low cost hydro generation. These issues can be the subject of GEF interventions for policy development but do not constitute a stand-alone project suitable for *"demonstrating the business angle"* of RET development.

2.1.2 Industrial market for RET

Biomass is available in large quantities as residues from forest product processing and waste from agricultural processing (notably sugar cane milling and rice milling). Substantial generating capacity using these biomass residues has evolved in those industries both to provide local heat and power for the processing facility and to provide supplementary income through the sale of surplus power to the national utilities.

The mining industry requires large amounts of electrical power in typically remote sites. In PNG, substantial hydro and geothermal developments have been made by the mining industry and more are planned.

The primary business opportunity is the promotion, sale and after-market support of the equipment used by industry to develop their renewables based power generation. This market in the PICs is small, highly technical and insufficient to support a business limited to sales in the region..

2.1.3 Commercial market for RET

The primary use of renewable energy in the commercial sector is the widespread use of solar water heating in hotels, offices and resorts. The market is large and well developed in Fiji, less so in PNG and Vanuatu and hardly tapped in the Solomon Islands. Some eco-tourism facilities are also using solar PV for electrical power but that market will remain limited to these specialized facilities as long as the cost of PV remains at current levels relative to diesel power.

The main business opportunity consists of import or local manufacture of suitable solar water heaters and their sale, installation and after-market support. Experienced businesses exist already and there could be an increase in market penetration. The Group III demonstration project addresses this barrier and can be used as a model for increasing the penetration of solar water heaters into the commercial market and opening up the largely untapped household market in Melanesia.

2.1.4 Household market for RET

The primary undeveloped market for RET in Melanesia is for off-grid electrification systems sufficient to provide lighting and basic entertainment power for rural households. Through over two decades of experience in the Pacific, solar photovoltaics have been shown to be economically and technically reasonable for this application.

The very low per-capita energy use of rural dwellers in Melanesia can be expected to rise rapidly as rural areas are electrified and the rural economy strengthened. Whether that new energy supply is renewables based or fossil fuel based will largely be determined by the type of initial electrification technology used. Therefore it is argued that although installing solar PV for rural electrification does not impact on existing fossil fuel use – and therefore does not lead to an immediate greenhouse gas reduction – it can impact dramatically on the rate of growth of fossil fuel use if early electrification is renewables based and as a result the expansion of diesel electrification for off-grid power that has been seen elsewhere in the Pacific does not take place in Melanesia.

2.2 Demonstration project focus

Because of the large potential for reducing the rate of increase of GHG production through development of renewable based rural electrification, the demonstration project that is proposed for Group I application is the dissemination of solar home systems to rural areas through a partnership of government and the private sector in the form of RESCOs as developed by the GEF project of 2000-2003 in Fiji with the demonstration project located in Fiji.

This demonstration project has strong relevance for both Group I and Group II PICs. Since there is little additional rural electrification possible in Group III countries, its relevance for those countries is not great.

3 Group II – Kiribati, the Marshall Islands and the Federated States of Micronesia

3.1 Market characteristics

3.1.1 Utility Market

With the exception of a small, seasonal hydro resource on Pohnpei, all electrical generation in the Group II countries is through diesel power. There is no known wind resource that can economically supplement utility generation and the economics of using solar PV for grid supplementation is unsatisfactory unless diesel fuel costs rise dramatically beyond the present level. Since the Group II countries have large, typically underutilized coconut resources, the use of biofuels as a diesel replacement for power generation represents the only realizable use of renewable energy for utilities.

3.1.2 Industrial Market

There is almost no industrial development in the Group II countries and energy used for industrial activity is a very small percentage of national energy use. Overall, the largest industry is the manufacture of coconut oil from copra that is the major "industrial" activity of both the Marshall Islands and Kiribati. Those facilities are already using renewable energy for the production of process heat and in the case of the Marshall Islands, coconut oil is also being used in the diesel powered vehicles owned by Tobolar, the producer of coconut oil on Majuro.

3.1.3 Commercial Market

Imported solar water heaters are used in hotels and resorts and a few households. But the tourist industry is small and the present commercial market for solar water heaters is not considered large enough to warrant direct intervention through external programmes structured toward increasing solar water heater market penetration.

The major commercial use of energy is for shipping. The Group III countries include large numbers of widely dispersed islands and a large volume of diesel fuel is used to support inter-island shipping. The potential market for a technically satisfactory biofuel based diesel substitute or for a blend of diesel fuel and biofuel is large if the supply can be developed at a price that is acceptable.

3.1.4 Household Market

Few households have piped hot water of any kind and the present market for solar water heaters is small, though long term growth is likely as economic development allows family incomes to increase causing an increased demand for luxury services in households. At the present time it does not appear to be cost effective to implement programmes to increase market penetration of solar water heaters in households though that may change over the next few decades.

The large unelectrified rural population does represent a significant demand for solar photovoltaics. Kiribati has had a programme for PV based rural electrification for over 20 years with nearly 20% of rural households now electrified by PV (following the completion of the EU funded outer island electrification project in 2005). The Marshall Islands has not implemented such large-scale PV projects but has plans for rapid deployment of large numbers of PV systems for rural electrification over the next several years using local budgets and EU donor funds. FSM has no national programmes for rural energy development though Pohnpei and Yap both have state level rural electrification projects that utilize solar photovoltaics with plans for expansion if money becomes available.

FSM will be the recipient of €4.08 million in renewable energy development programmes under the EU ACP country project that commences in 2005. However, the actual content of the programme for FSM will not be known until 2006 though it is known that the project will use the Kosrae, Pohnpei, Chuuk and Yap utilities for implementation of renewable energy and energy efficiency activities. Given the resources available to FSM, rural electrification through PV and the development of biofuels are the only likely RETs for utility development in Federated States of Micronesia.

3.2 Demonstration Project Focus

Although PV based rural electrification is a major market for renewable energy products and can support businesses acting as Renewable Energy Service Companies, both the Kiribati and the Marshall Islands already have competent businesses in place that can handle the few thousand installations that are possible in these countries. The Solar Energy Company of Kiribati has been functioning as a RESCO since 1989 and the Marshall's Energy Company (the Majuro utility company) has agreed to act as a RESCO for all the outer island PV electrification in the Marshall's. The Pohnpei and Yap utility companies have acted as operators of PV electrification pilot projects and are to be the focus of renewable energy activities under the EU renewable energy and energy efficiency initiatives expected to be formulated in 2005. Thus local and donor resources are already to be focused strongly on the development of competent RESCO type operations for PV based rural electrification in the Group II countries and the value of an additional RESCO demonstration project for those countries will be marginal though GEF support for the EU projects in capacity building could provide complementary benefits.

Since the Group II countries' utilities are effectively diesel powered and since these countries have substantial coconut resources and a well developed coconut oil industry, the proposed demonstration project for Group II countries is the development of coconut oil as a biofuel substitute for diesel fuel for power generation and both land and marine commercial transport. The demonstration project is proposed for RMI since 1) the RMI coconut oil company (Tobolar Coconut Processing Industry) has shown a strong interest in biofuels and is currently operating its vehicles on pure coconut oil; 2) the utility, MEC, has expressed an interest in renewable energy both PV for outer island electrification as well as biofuels for diesel fuel replacement; and 3) RMI is to receive major funding for RET development from the EU starting in 2005. This demonstration also has value for most of the other PICs and especially for the Melanesian countries where rural labour costs are quite low.

4 Group III – Countries with a High Level of Electrification: Cook Islands, Nauru, Niue, Palau, Samoa, Tokelau, Tonga and Tuvalu

4.1 Market characteristics

4.1.1 Utility Market

With the exception of Samoa where there is some hydro resource, all the Group III utilities rely on diesel generation. Resource assessments indicate that Niue and the Cook Islands can supplement their generation with wind power and there may be sufficient wind resource in Tonga as well, but wind power cannot provide base load power nor can it be introduced into the grid at levels much higher than about 20% of existing demand without technical requirements that would be difficult to manage in the PICs.

Coconut oil processed as a diesel fuel substitute therefore has the largest potential for GHG reduction through renewable energy use by utilities in the Group III countries. However, the Group III countries tend to have higher rural labour costs than the rest of the Pacific and it will be more difficult for coconut oil to compete with diesel fuel than in Group I or Group II countries.

The ADB REEP programme is presently examining the feasibility of large scale use of coconut oil for power generation on Upolu, Samoa. SOPAC is also examining the Samoa coconut resource as a possible large -scale source of biofuel for EPC and looking at the practicality of converting some existing diesel generation to coconut oil use. The results of both programmes will be available in 2005 or early in 2006.

4.1.2 Industrial Market

Samoa has a significant industrial energy use as does Tonga. Most of the industrial energy use is electricity provided from the national utility and there is little opportunity for direct replacement of fossil fuels by renewable energy in Group III industry except where process heat is required and diesel fuel is burned for its provision. In those few cases, biofuel or possibly biomass could replace the diesel fuel used for process heat.

4.1.3 Commercial Market

The Group III countries, with the exception of Nauru, Tokelau and Niue, have a well developed tourism industry and numerous hotels, resorts and tourist facilities. Solar water heating is widely used in these commercial buildings and the market is well served already.

4.1.4 Household Market

Solar water heating is widely used on homes in the Cook Islands and often installed on homes in the other Group III countries but market penetration is generally low at the household level. Given the relatively high family incomes found in the Group III countries, a much higher level of penetration of the household market appears possible.

4.2 Demonstration Project Focus

A demonstration project focusing on local manufacture or assembly of solar water heaters, their marketing, proper installation and proper maintenance is proposed for the

Group III countries with Tonga as the site of the demo project. Tonga is chosen since the household market is large but weakly penetrated and because there is local assembly of solar water heating units as well as the import of Australian made systems.

5 Market Barrier Reduction Strategies

5.1 Group 1 Barriers to the Proposed PV Rural Electrification Demonstration Project

Though there is a considerable difference in the level of economic development among the Group 1 countries, there are many common barriers to the large scale implementation of renewable energy for rural electrification. The important barriers and the processes proposed for their reduction are:

Barrier:

The rural economy is mainly subsistence based with limited cash availability

Reduction strategy.

Introduce productive uses of renewable energy that can increase the level of interaction by the rural populace with the money economy. Integrate rural energy development using RETs with other rural economic development projects.

Barrier:

Communications with and access to rural villages is difficult or expensive

Reduction strategy.

As part of the business development process, assist rural focused RET businesses in understanding the structural requirements and financial benefits of using local agents for sales, operation and maintenance of RETs. As part of incentive programmes include support for local maintenance capacity development.

Barrier:

There is no national energy policy or energy development plan

Reduction strategy.

This barrier is being addressed by the PIEPSAP project.

Barrier:

There is little knowledge in rural areas relating to renewable energy development

Reduction strategy.

Provide selected households in what appear to be good market areas with RET installations for a limited time as demonstrations of the technology. Disseminate information about RETs through meetings, demonstrations at agricultural fairs, information provided through local cooperatives and other communications mediums available in rural areas.

Barrier:

There are inadequate financial mechanisms available in rural areas, and to rural people, for the private development of renewable energy technologies for household and productive use.

Reduction strategy.

Work with micro-finance agencies and commercial banks that have a rural presence to understand RET finance, provide them with RET loan incentives through loan guarantees, term extension funds and concessionary finance and provide information to the rural populace regarding the availability of credit for the purchase of RETs.

Barrier:

There is no sustainable institutional framework to develop and operate rural electrification on a commercial basis.

Reduction strategy.

Work with private businesses and government to develop rural technical and financial facilities that can support the development of RET use in rural areas. These could provide micro-finance for RET purchase, increase the quality and quantity of RET maintenance capacity in rural areas through training and business development incentives, develop RESCO institutional structures as has been done in Fiji.

Barrier:

Energy office funding is inadequate to provide for the capacity improvements that are needed particularly with regards to project development, economic analysis, project management, project monitoring and project data analysis.

Reduction strategy.

Provide funding and expertise for capacity development of energy offices in those areas that are weak.

Barrier:

Secure access to land over the long term can be a serious barrier for both community scale and large-scale grid-connected renewable energy.

Reduction strategy.

Use RETs that do not require access to land not controlled by the user, such as solar PV for household electrification.

Barrier:

There are no national standards or certifications to assure that RET components are suitable for local conditions.

Reduction strategy.

Work with energy offices and standards authorities to develop end enforce technical standards and certification requirements for equipment and certification or licensing arrangements for technicians.

Barrier:

Past project failures suggest to potential investors and recipients that renewable energy development is risky, making involvement difficult to obtain without the inclusion of risk abatement incentives.

Reduction strategy.

Provide risk abatement incentives including extended warranties, loan guarantees, use of RESCO model for operations.

Barrier:

There is limited understanding of the rural market for energy, making it difficult to determine the appropriate marketing approach for rural areas.

Reduction strategy.

Demonstrations of appropriate RET use strategically placed in rural areas were the RET market is to be developed to provide familiarity with the technology to be used.

Barrier:

There is limited expertise in business management and marketing strategies.

Reduction strategy.

Capacity building activities for local educational facilities to provide training in rural marketing strategies and business management with a focus on rural markets.

Barrier:

Technical training is not readily available for local maintenance and operation of technologies used in rural areas.

Reduction strategy.

Work with local technical training facilities to introduce curriculum modules and short courses for the training of rural technicians and businesses in RET operation and maintenance.

5.2 Group II Barriers to the Project Proposed for Demonstration of Biofuels

Barrier

The price that biofuel needs to be sold for exceeds the market price of diesel fuel.

Reduction Strategy

Examination of alternative production approaches such as purchasing whole nuts from growers and doing all processing at a centralised, highly mechanised facility; eliminating subsidies for the import of diesel fuel (duty free entry for utilities, subsidised government shipping to outer islands, etc.), providing subsidies for biofuel production to lower the cost to match that of diesel fuel; provide duty free diesel fuel imports for diesel fuel that is to be blended with coconut oil; reduce or eliminate taxes on the sale of biofuels.

Barrier

The coconut resource has lost substantial productivity due to long neglect resulting from low market prices for copra

Reduction Strategy

Provide incentives to replace senile coconut trees; use cut trees for coconut wood products or if in very large numbers develop a biomass facility for power production.

Barrier

Concerns by users regarding long term effects on equipment of using biofuel as a diesel fuel replacement.

Reduction Strategy

Provide an insurance fund to pay for repairs needed that are specfically due to the use of biofuels; implement fuel production quality control inspections by an independent body; for each installation provide expert advice on the type of engine used with the project paying for any modifications that need to be made to the engines to use biofuel without problem.

Barrier

Lack of local expertise in the manufacture of biofuels

Reduction Strategy

Develop regional and local training facilities for biofuel production and use; retain expertise in biofuel technology at the regional level for provision to PIC biofuel projects as needed.

Barrier

Quality control of copra delivered from the outer islands is poor and makes maintaining the quality of biofuel manufacture difficult

Reduction Strategy

Develop small scale oil production facilities on outer islands to help guarantee the quality of oil and to reduce shipping costs; provide copra dryers to island producers that deliver higher quality copra for shipping to the central mill.

Barrier

Natural disasters such as cyclones or drought can suppress coconut production for six months or more.

Reduction Strategy

Develop storage facilities for oil sufficient to cover production variations; provide a higher percentage of diesel fuel in the diesel/coconut oil blend that is being produced; shift users to diesel fuel during the shortage.

Barrier

Rising rural income expectations has made it increasingly difficult to maintain an interest in copra production as it is labour intensive and fewer and fewer persons are willing to perform the necessary manual labour for the amount of money that is received for copra shipped to Majuro.

Reduction Strategy

Develop small -scale oil production facilities on the outer islands so the oil can be used for fuel without shipping cost and the cost of shipping of copra to the Majuro mill can be reduced to the much lower cost of shipping oil to Majuro. Develop copra production facilities on outer islands that allows labour sensitive producers to provide whole nuts (which have low labour input) and pay lower cost labourers to process the nuts into copra. Obtain mechanised copra production facilities to allow provision of whole nuts by growers and use mechanical systems to reduce the labour requirements.

Barrier

Insufficient oil can be produced to fully offset diesel fuel use making it necessary to use both.

Reduction Strategy

Produce a blend of diesel and coconut oil rather than a pure oil product for high use applications (e.g. marine transport, utility use); use pure oil fuels in applications where the use requirement is less than production capability (e.g. on outer islands); produce chemically modified oil biofuels that allow shifting of fuel from biofuel to diesel and back with no change in engine components or performance.

Barrier

The PICs have no standards or certification processes in place for biofuel production or storage

Reduction Strategy

Using existing international standards, assist the PICs to develop needed standards and establish the procedures for enforcement.

5.3 Group III Barriers to the Project Proposed for Solar Water Heater Manufacturing and Market Development

Barrier

Lack of finance for household purchase of SWH

Reduction Strategy

Assistance to finance agencies with loan guarantees, technical support for understanding the technology and its risks, interest reduction programmes, loan term extension programmes. (Covered by the proposed Pacific Regional Renewable Energy Finance Mechanism).

Barrier

High initial cost of SWH relative to cost of electric or gas water heaters

Reduction Strategy

Loan term extension programmes to reduce initial cash outlay requirements. Information programmes to inform households of the life cycle cost advantages. Special metering of electric water heaters to charge a higher tariff due to the added demand cost for these high wattage appliances. (Partially addressed by the proposed Pacific Regional Renewable Energy Finance Mechanism).

Barrier

Lack of design and manufacturing expertise in local businesses

Reduction Strategy

Technical and business capacity building programmes for local businesses to continue or to enter the manufacturing business. Exchange programmes for businessmen from the PICs to visit well established water heater manufacturers in Australia, New Zealand and China. (To be covered by the proposed Technical Support Mechanism for the Pacific)

Barrier

Lack of information for decision making by households

Reduction Strategy

Information preparation and delivery programmes through local media; assistance to local sellers of SWH to prepare information brochures and other informational materials.

Barrier

Lack of finance for companies to increase capitalisation for manufacture and sale of SWH

Reduction Strategy

Loan guarantees, interest reduction and term extension programmes. Development of special loan funding for manufacturer finance. (To be covered by the proposed Pacific Regional Renewable Energy Financial Support Mechanism).

Barrier

Lack of capacity to administer SWH incentive programmes

Reduction Strategy

Capacity development programme for the agency administering incentive programmes. Keeping incentive programmes simple in application to reduce administrative problems.

Barrier

Lack of capacity in businesses for SWH marketing, management, record keeping and financial analysis

Reduction Strategy

Capacity building programmes for RET businesses. Development of local capacity for training in RET business development. (Covered under the proposed Pacific Regional Technical Support Mechanism).

Barrier

PICs have no standards or certification processes in place for manufacturing or importing SWH.

Reduction Strategy

Assist the PICs develop appropriate standards and certification schemes for SWH that are based on existing international standards. Assist in the development of appropriate enforcement mechanisms.

Barrier

Lack of capacity for inspection and maintenance of SWH.

Reduction Strategy

Training for local plumbing companies and SWH companies in the inspection, troubleshooting and maintenance of SWH. Development of SWH training modules and their integration within local training institutions both as short courses and as part of the regular plumbing trades training programme. (Covered under the proposed Pacific Regional Technical Support Mechanism).

6 Regional Demonstration Project Proposals

6.1 General objectives

The goals of the demonstration projects are to support the sustainable development of RE rural electrification businesses in the PICs and capitalise on relevant know how and expertise at the national and regional level. Given the need do develop several technologies and to meet the needs of each of the three country groups of the Pacific, three markedly different projects are proposed, each emphasising a different technology and market group but all intended to result in increased private sector delivery of RETs.

6.2 Demonstration project for RESCO based Off-Grid Electrification using Solar Energy

6.2.1 Scope

The Demonstration project would be appropriate for development of further off-grid electrification in the Federated States of Micronesia, Fiji, Kiribati, the Marshall Islands Papua New Guinea, Solomon Islands and Vanuatu. , . Since Fiji has participated in an earlier GEF project do develop the institutional systems needed for RESCO type solar powered rural electrification, Fiji is proposed as the site of the demonstration project. Since this application has the largest market potential, the scale of the proposed demonstration project is the largest of the three.

The project would be a “proof of concept” project intended to demonstrate the sustainability of the RESCO concept through the implementation of approximately 2000 SHS that are installed and operated by RESCOs under regulatory structures provided by government. The project would electrify two rural areas, one on Vanua Levu and one on Viti Levu. A different RESCO operator would be competitively chosen for each site. The size of the project is the minimum that is likely to provide sustainability and to achieve that with only 1000 SHS per project site, it will be important that each of the two components be established in a geographically compact area to minimise the cost of maintenance service.

6.2.2 Overview of project characteristics

The project characteristics would be those established under the 2000-2003 GEF project for Fiji RESCO development. The Fiji Department of Energy (DOE) would designate the two rural electrification target areas (one on Vanua Levu and one on Viti Levu) and through surveys and analysis of the solar resource determine the appropriate SHS characteristics to be provided in each region. The DOE would specify and purchase the necessary components for the 2000 SHS and lease them at a subsidised rate to two RESCOs selected through a competitive process. The RESCOs would market the SHS, install them and maintain them for a fee negotiated with the users and DOE. The fee would include a component to pay the DOE lease, a component to be placed in a Component Replacement Fund audited by the DOE, a component to be used for maintenance and administration and a component for company profit. Based on rural surveys and operational trials in Vanua Levu that have operated for approximately five years, a fee of FJ$15 to $20 per month appears to be acceptable to users and is an amount that can sustain the RESCO operations.

Funding has been sought by DOE for a "Proof of Concept" project as a component of a larger rural electrification project developed for ADB funding in 2004. The project finance is presently stalled due to negotiations between the Government of Fiji and the ADB regarding the mode of finance for power sector loans but appears to remain as a feasible component for 2005-2006 power sector development through ADB. Funding from France and Japan has also been sought and the Government of France has indicated an interest in co-financing the project.

The Government of Japan under its community development programme is presently funding the small scale pilot RESCO project on Vanua Levu where approximately 300 SHS have been installed using RESCO operational principles though the small scale of the project and its dispersed geographic implementation does not allow sustainable operation based solely on fee collections. Further funding from Japan to increase the number of installations by around 100 SHS per year appears likely and this can be integrated into the larger scale "Proof of Concept" project that is proposed. Co-finance from Japan for the "Proof of Concept" project has been proposed but there is no indication that co-finance from Japan is likely.

Project components for GEF funding

As this will be the first large scale RESCO project in Fiji, there will be a need to develop standards, component certifications, personnel certifications, component specifications, SHS design specifications and procedures, installation standards and guidelines, maintenance standards, maintenance procedures and guidelines, RESCO auditing procedures, monitoring procedures, financial analysis procedures for tariff determination, criteria for the selection of rural electrification target areas, criteria and procedures for the selection of RESCOs to service rural electrification target areas plus DOE and RESCO capacity building efforts. These capacity building efforts can be a part of the Pacific Regional Technical Support Mechanism with some special components specifically for RESCO development.

Additionally, it is proposed that incentives be provided to financial institutions (through risk abatement programmes, loan extension programmes, interest reduction programmes, etc.) to make available loans especially structured for RESCO business development to help capitalise the facilities needed to establish the rural maintenance presence required of RESCO operators. The capitalisation required for full development of a RESCO business is estimated to be approximately US$75,000 and it is proposed that up to half that be available through special loan structures for RESCO businesses.

Capacity building for RESCO businesses will need to include training in RESCO business practices (fee establishment, fee collection processes, accounting requirements for RESCOs, methodology for meeting record keeping and monitoring requirements, spare parts management) plus development of training processes that are continuously available to RESCOs for field technicians and supervisory technicians (for system installation, troubleshooting and maintenance).

Funding for long term (5-10 year) monitoring, results analysis and the international dissemination of project results should also be included.

Proposed budget for support of the Group I project

The overall budget that has been established for the "Proof of Concept" project is approximately US$4m dollars. To provide the capacity building and capital loan support services needed to ensure sustainability of the project, an amount of US$450,000 appears adequate. This could largely be integrated into any Pacific Regional RET Technology Support Programme and Regional RE Financing Mechanism that is put into place.

6.3 Demonstration project for Coconut Oil Use for Transport and Power Generation

6.3.1 Scope

Coconut oil has long been used as a satisfactory diesel fuel substitute but until recently the economics of its use has not been favourable. The PICs generally have a coconut surplus since the price that the copra market can provide is too low to encourage large scale production and much of the available coconut resource is not used. Additionally, in the Group III countries the income expectations of the rural population has become too high to permit cost effective, large scale production of copra even with substantial increases in copra prices and in those countries copra exports have fallen to essentially zero with coconuts being harvested only for "drinking" coconuts, for use in cooking or for animal feed. Countries in Group I and II still have rural economies that allow the production of copra at a cost that can result in oil production with a sale cost comparable to that of present-day diesel fuel. A demonstration project for the commercial provision of coconut oil as a substitute for diesel fuel for transport and electric power generation is proposed to be established in the Marshall Islands where initial trials have been underway for several years and the PIREP team found a generally favourable technical and economic climate for further development.

Not only are there carbon reduction advantages to the use of coconut oil as a diesel substitute, there are substantial economic development advantages for most PICs. These include:

- revitalisation of the coconut industry to make use of now idle resources in rural areas for sustainable economic development;
- reduce the requirements for foreign reserves to pay for fuel imports;
- transfer more money from high income urban areas to low income rural areas through market mechanisms rather than the use of subsidies and remittances to sustain the rural economy; and
- increase the economic ties between the rural economy and the urban economy resulting in more consolidation of the national economy and increased rural investment by local financial sources.

6.3.2 Overview of project characteristics

The project is intended to shift the market of coconut oil from export oriented to the provision of oil for local sale as an offset for imported diesel fuel. Since the coconut oil production facility is currently operating at about half capacity (5,000 tonnes of copra processed per year with 10,000 tonnes per year of processing capacity), there is substantial room for expansion of oil production though even at maximum capacity the production will fall far short of allowing replacement of all diesel fuel use (about 63 million litres imported in 2003) by biofuels. Therefore the project will focus on blending of coconut oil with diesel fuel for use by shipping or for utility generation and for the direct replacement of the small quantities of diesel fuel used on outer islands.

As noted earlier, a major barrier to the use of coconut oil as a diesel replacement is that the export market value of coconut oil has been higher than the import cost of diesel fuel. Another barrier is that the cost of labour in rural areas has been slowly rising as a result of economic development. Therefore the project needs to simultaneously lower the overall cost of oil production while providing a higher price for coconut grower labour. A third barrier is that the quality of copra received at the Majuro mill is very variable and the quality control of biofuel that results is difficult. These three barriers can be reduced through the production of oil on the rural islands with the processing facility accepting whole nuts, using mechanical systems and controlled drying processes. This will produce high quality copra and oil to be shipped to Majuro instead of grower produced copra. This will benefit the project by:

- replacing some of the high cost of handling and shipping of copra by much lower handling and shipping costs for oil;
- allowing greatly reduced labour inputs by growers through their provision of whole nuts instead of copra; and
- improving quality control of the end product though centralised processing using mechanised systems and controlled copra drying processes.

An additional advantage of local oil production is that the oil can be used locally to reduce the need for shipping of diesel fuel from Majuro to the outer islands, a costly process and one that does not result in reliable fuel availability as shipping delays are common and there is little storage capacity for fuel on the islands.

Copra produced and stored under the quality controlled conditions of the centralised outer island producer can also be shipped to Majuro for oil production when the capacity of the outer island oil production facility is smaller than the coconut production. It is proposed that the goal for local oil production on the outer islands be set at approximately double the outer island requirement for diesel fuel with the surplus oil and high quality copra shipped to Majuro for further processing and ultimate sale as biofuel.

As a demonstration project, it is proposed that two outer islands participate in the programme as local oil producers and that assistance be provided to Tobolar to convert at least 50% of its oil production into biofuel – either a blend of diesel fuel and coconut oil for general use or a coconut oil product that is to be used for a specific application (e.g. power generation by MEC in one of its smaller plants such as Jaluit, fuel for diesel powered fishing boats, fuel for one or more inter-island shipping vessels).

The capital investment that would be required would be primarily for development of the outer island facilities and any processing equipment needed for the conversion of coconut oil to the appropriate biofuel product. It is anticipated that most of not all the capital investment can be provided by Tobolar and the Republic of the Marshahll Islands government using rural development funds. Additionally, the EU funds allocated for RMI under the 2005 ACP project for the Pacific may include some component for biofuel development though the actual allocation of country funds will not be known until 2006.

Project components for GEF funding

Components of the demonstration project for GEF funding include:

- survey of the condition of the coconut resource to determine the existing resource and the extent that the resource can be expanded through replacement of senile trees by new growth and/or more productive species;
- determine the best approach for the use of coconut oil for fuel on Majuro – whether the production of pure coconut oil biofuel products for specialised use or a blend of coconut oil and diesel fuel for general use;
- review the worldwide use of coconut oil for biofuel production and the processes used for smaller scale, local production of coconut oil from whole nuts. The African, Central American and South American experience should be included as well as the Asia-Pacific experience;
- locate, and if necessary fund the further development of, mechanical systems for converting whole nuts to coconut oil with minimal labour input with a focus on the scale of production to be found on an outer island. Sri Lanka, Indonesia, Malaysia, Philippines, Thailand, Australia and India should be investigated as sources of such equipment;
- assist outer island users of diesel fuel convert to coconut oil based biofuel substitute through technical assistance for engine and fuel system modification;
- provide loan guarantees and other financial risk abatement processes to develop finance for the modification of outer island diesel engines and fuel systems for the use of coconut oil as their primary fuel;
- assist in the determination of the most cost effective approach for the development of outer island production of oil (e.g. several small facilities on several islets of an atoll, delivery of nuts to a central location on the atoll for larger scale production);
- provide technical assistance during the establishment of the project and provide for project monitoring and results analysis for at least a five year period;
- assist in the development of standards and certification processes for the production and storage of biofuels in the Marshall Islands with the expectation of transferring them to all the PICs; and
- disseminate the results of the project internationally.

Proposed budget for support of the Group II project

The proposed budget for the project is US$375,000 assuming the need to provide up to US$200,000 for the technical development of the mechanical systems for outer island conversion of whole nuts to oil, a development that would be of both regional and international value if adequate equipment is not found to be already available.

6.4 Demonstration project for Solar Water Heating business development

6.4.1 Scope

Solar water heating is a renewable energy application that is fully mature technically and in most urban environments is the source of a viable business in the manufacture, sale, installation and maintenance of the systems. Expansion of the use of solar water heaters is appropriate for all urban areas of the Pacific and for all areas of the Group III countries including the Cook Islands, Nauru, Niue, Samoa, Tokelau, Tonga, and

Tuvalu The regional demonstration project for SWH business development is proposed for Tonga since there is a company presently assembling solar water heaters but struggling to survive in the face of what seems to be a declining market when in fact the market should be expanding as the Tonga economy expands.

6.4.2 Overview of project characteristics

The project would have as its goal the increased penetration of the market for water heating, the development of local capacity to train technicians in the installation and maintenance of SWH, the development of local capacity to design and manufacture SWH fitted to the local economic and environmental conditions, assistance in developing the market for SWH in households and commercial users of hot water such as hospitals, tourist accommodations, laundries as well as industries requiring heated water; the development of risk abatement schemes for the finance of SWH manufacturers and sales businesses and the provision of incentives for SWH purchase by end users.

Actions included in the project, all of which could be funded by GEF, would be:

- technical assistance to manufacturers and prospective manufacturers in the design, manufacture and after sales support of SWH suitable for the Pacific environment;
- visits of manufacturers and prospective manufacturers to well established SWH manufacturers in Australia, New Zealand or China;
- a three or four day regional workshop on SWH manufacturing and marketing held in Tonga;
- loan terms improvement activities for manufacturing development (purchase of tools, manufacturing equipment, materials stocks);
- business capacity development for record keeping and analysis, marketing of SWH, manufacturing process and work flow design, cost control in manufacturing, financial management;
- capacity building for local training institutions to incorporate short courses and curriculum modules for SWH into plumbing trades training programmes;
- support of training for plumbing businesses to enhance skills in SWH installation, troubleshooting and maintenance;
- survey of SWH installations to determine problem areas and maintenance requirements;
- assistance in the preparation of marketing materials such as product brochures, video presentations, media releases;
- capacity building for financial institutions to enhance awareness of SWH and processes for risk analysis and reduction;
- develop terms improvement activities for the finance of household SWH;
- assist government develop and implement incentives for SWH installation (e.g. tax incentives, direct grants to SWH purchasers, duty free entry for components and SWH units);
- assist in the development of public awareness programmes for SWH (e.g. flyers to be inserted in power bills, public service announcements on television and radio, posters for display in public places); and

- assist in the development of standards and certification processes for SWH. Assist local manufacturers obtain international certification for their products.

Proposed budget for support of the Group1 project

Presently there is no funding source identified as a probable co-financier of this project. UNDP and UNESCO should be contacted as possible co-financers along with NZAID, AUSAID and the European Union. Government would co-finance through the incentive programmes that are developed under the project. Also, part of the capacity building component would come under the companion Pacific Regional Renewable Energy Technical Support Mechanism project and part of the terms improvement for finance would also come under the same.

The proposed budget for the Group III demonstration project is US$190,000 of which $45,000 is for the regional workshop and visits to foreign manufacturers, $60,000 for capacity building activities (including public information programmes) and the remaining $75,000 for financial terms improvement programmes. The sum of $10,000 is budgeted for the SWH survey and analysis. A three-year programme is proposed.

7 ANNEX 1 - REVIEW OF REGIONAL AND GLOBAL EXPERIENCE WITH BUSINESS APPROACHES TO RENEWABLE ENERGY DISSEMINATION

7.1 Evaluation of PIC off-grid renewable energy delivery models

7.1.1 Pacific islands business context

Energy market framework

Energy has a vital role in achieving economic growth in the Pacific region. Responding to this issue within the context of sustainable development, PICs face a unique and challenging situation in respect to energy for sustainable development. Demographics vary widely between countries but usually feature many small, isolated population centres. A significant share of the total population does not have access to electricity in most of the PICs. Energy markets are therefore fragmented, small and difficult to serve with little potential for achieving economies of scale. Another characteristics of this market is the lack of experience installing and maintaining technical systems.

PICs are motivated to develop renewable energies due to climate change concerns, the volatility of imported fuel prices and the fear that the fuel supply could be interrupted should there be serious problems in the Middle East. The development of renewable energy resources has thus far been limited by the difficulty of installing suitable systems and providing on-going maintenance in small, remote markets at an acceptable cost. The PICs have limited human and institutional capacity to overcome these problems and often must depend on foreign aid and technical support. For the PICs, the main challenge remains in: i) the provision of sufficient and affordable energy to promote the population's economic and social development; ii) the development of sustainable indigenous energy production; iii) the reduction of the negative environmental effects of energy use in countries; and iv) the improvement of the performance of the overall energy sector through efficiency and conservation, private sector participation, and development of indigenous resources and capacity.

Pacific Islands Energy Policy and Plan (PIEPP)

The *Pacific Islands Energy Policy and Plan* (PIEPP) was developed by the Council of Regional Organisations of the Pacific (CROP) Energy Working Group (EWG) and affirmed by Pacific Island Countries (PICs) in 2002 as a guideline for PIC national energy polices (to be adapted to the circumstances of each country) and as a mean of coordinating the energy programmes of the regional organisations and development partners. The PIEPP is presently being reviewed by the CROP EWG and the PICs and the document has been split into a Pacific Islands Energy Policy (PIEP) and a Pacific Islands Energy and Strategic Action Plan (PIESAP). From the perspective of PIREP, the document is very supportive since it describes the energy issues over six themes, one of them being renewable energy, and four cross cutting issues including energy for rural areas and outer islands. For the rural and remote islands, the specific goal is to provide reliable, affordable, and sustainable energy for social and economic development of rural areas and remote islands, while an increased share of RE in the region's energy supply is recommended.

Pacific Islands Regional Climate Change Framework

In April 2000, a conference on the Pacific Islands Climate Change, Climate Variability and Sea Level Rise, adopted a draft "Pacific Islands' Framework for Action on Climate Change, Climate Variability and Sea-Level Rise (PIFRACs). The objective of the PIFRACs is to catalyse actions and strengthen partnerships at all levels to enable the Pacific Islands' region to understand and effectively respond to climate change, climate variability and sea level rise. As with the Regional Energy Policy, this Framework is currently being reviewed in accordance with a direction from the Pacific Islands Forum. A number of activities have been identified as priority actions including capacity building, understanding climate change, climate change impacts and vulnerability and response measures. The document has identified renewable energy as a priority activity under Climate Change Mitigation. The document makes explicit references to the promotion and use of biomass energy, hydropower, solar water heaters, wind power, PV systems, and coconut oil for use in remote areas.

7.1.2 Review of possible models, with advantages and disadvantages

PICs have experienced three main models for off-grid RE electrification, including government-managed and subsidized, community-managed but government subsidized, and utility-managed but government subsidized models.

The UTILITY model

The utility approach is based on the concept that a single company owns and operates electrification systems such as solar home systems (SHS) or hybrid mini grids with the collection of a fee for the service provided. Therefore the equipment is purchased on the international and local market directly by the utility. Each customer contracts with the utility for services, while the utility itself operates within a concession contract with the government. The "customer" contract defines the role and the duty of both parties, including a guarantee of the level of service to be supplied and the fees to be charged by the company for those services. In case the fees are not paid in due time, the services will be disconnected. All the maintenance, repairs, commercial operation and fee collection costs are the responsibility of the utility. The customer does not take part in the maintenance of the system. Field services such as installation, maintenance and fee collection may be subcontracted to local suppliers. Initial project finance is generally structured around: i) a commercial investment of the utility; ii) connection and monthly fee charges to the end users and iii) a subsidy that covers a major fraction of the capital costs, either from the government or other donors. According to the level of subsidy provided and other factors, the concession period may range from five to thirty years in the Pacific.

The RESCO model

Renewable Energy Service Companies (RESCO) are generally smaller companies than utilities and are contracted for undertaking the implementation and the follow-up of a project in a specific (limited) area. In the case of a RESCO, the contractual arrangements with the end users are similar to the utility model in the sense that it is still a fee-for-service activity. The main difference is that the equipment is purchased and owned by the government (or, eventually one of its representatives). The RESCO operates the systems on behalf of the government, possibly paying a fee for the use of the systems that is calculated to cover the non-subsidised fraction of the capital cost. The RESCO is in charge of the market development, the installation and the maintenance and fee collections. The fees are typically expected to cover the full cost of the RESCO operation, including a reasonable commercial margin. The investment of the RESCO itself is limited to a modest investment in vehicles and tools since the system capital comes from government. As a result, the return on investment may be significantly faster than for a utility and the duration of the contract may be reduced to five or ten years.

Solar Co-operative (COOP)

The COOP scheme is very much different than the two other schemes in the sense that the status of the operator is an association of end users, the coop members, that gather together to form their own operating structure.

This arrangement places the end user in the position of both owner and customer which can cause problems with management and the proper setting of fees. The co-operative may receive government or donor support for capitalising the RE equipment but rarely will the government have any further input other than a role as regulator of co-operatives in general.

The co-operative is usually a not-for-profit entity that owns and operates the equipment, and receives contributions from its members that are supposed to cover the operational costs.

Advantages and disadvantages of different models

Models	Characteristics	Advantages	Disadvantages
UTILITY	Institutional framework	Very strong institutional set-up, including a balanced partnership among the players, and long term visibility	Difficult and long preparation since the interest of involved players needs to be harmonised. Lot of legal and regulatory work needs to be carried out.
	Capital financing	Financing risks is shared between public and private bodies. Higher confidence of donors.	Private sector financing needs long term contracts and large market size, which reduces competition.
	O&M sustainability	Long-term sustainability strengthened by the financial assets of the utility, and the long-term concession contracts.	
	End user service	Level of service is guaranteed under a clear agreement with the utility in the long run.	Little involvement of the end users in the whole process.
RESCO	Institutional framework	Strongest institutional framework, including an actual partnership among the public and private players, as well as strong commitment of the government.	Relatively long preparation process since legal and regulatory work need to be carried out.
	Capital financing	Financing risk is in the hands of the government, which increases the confidence of donors, and facilitates the participation of private sector.	Government must allocate sufficient funds to meet co-finance requirements of donors.
	O&M sustainability	O&M carried out by specialists in a professional way with strong commitment on results from the operator.	Medium term contract only, that does not ensure long company experience. RESCOs may be small companies that have insufficient capacity to develop without outside assistance.
	End user service	Level of service are guaranteed under a clear agreement with the RESCO	Little involvement of the end users in the whole process.
COOP	Institutional framework	Relatively short preparation processes since little legal and regulatory work needs to be carried out.	Weak institutional framework, with few commitments from either the private sector or the government.
	Capital financing	Donors or government may provide funds directly to the COOP, and preparation may be relatively fast.	Limited confidence from financing institutions, making implementation of large-scale projects difficult.
	O&M sustainability	O&M carried out with the participation of the members, including a strong field representation.	No actual long-term sustainability is ensured because of small size of the activity. COOPs usually have insufficient technical or management skills to handle major problems.

	End user service	End users are members of the COOP and participate actively in the whole process.	Level of service is not guaranteed because responsibilities are shared among the members.

7.2 REVIEW OF PICs EXPERIENCES WITH DIFFERENT MODELS

7.2.1 Fiji RESCO model

Prior solar electrification experience in Fiji

Fiji has developed considerable experience and understanding of the use of PV for rural electrification. Most recent PV projects in Fiji include 63 SHS in the village of Namara, installed in 1994 and undergoing technical evaluation for 10 years, 170 SHS in the village of Naroi, installed in 1999 and over 300 SHS in Vanua Levu installed between 2000 and 2003.

Namara project (1994)

Project goal

The project originally started over 20 years ago, as one of the first solar electrification pilot projects in Fiji the Pacific. Initially it was based on a village cooperative structure. Despite the rapid failure of the cooperative, and a number of problems with the quality of the electronic controllers, households continued to show a strong interest in PV systems, and Namara was selected in 1992 by the Fiji Department of Energy (DOE) as the site for a new rural electrification pilot project. The installed systems were to be operated as a technical pilot project with DOE maintenance support and were to be turned over to the users after 10 years of operation.

Project description

The equipment was purchased by the EU who also contracted for the overall supervision of the project[2] in cooperation with the DOE who carried on with the project after installation. During the years of project operation, the DOE regularly visited the site for technical supervision and control as well as for management of the local technician who was hired by DOE. Equipment was to be handed over to the end users at the end of the 10 years supervision period. A connection fee of FJ$20 was paid by the users after commissioning and a monthly fee of FJ$2 is collected by the local technician, during the monthly service visits.

Project achievements

The project has allowed the electrification of over 60 households as well as a community hall, a school room, the dispensary, a store and the church. Systems provided included 110 Wp of panels that were combined with the existing panels from earlier installations. The systems installed have proven to have a very high reliability over 10 years with only one failed battery, which is a testimony to the quality of the design and the installation as well as the preventive maintenance provided on site by the local technician The money collected is managed by the DOE and is intended for the partial financing of maintenance, the local technician's salary and replacement parts. These funds also will be used for financing new batteries when the systems are turned over to the village.

[2] **Five countries were included in the Lomé II PV Follow-Up programme, Fiji, Kiribati, Tuvalu, Tonga and PNG.**

Lessons Learned

SHS can provide a high level of reliability if high quality components that are well adapted to Pacific conditions are used and if good quality preventive maintenance is supplied. A satisfactory level of maintenance can be provided by local technicians if they have been sufficiently trained and managed for undertaking specific field services. It has been proven that experienced installers can ensure both a good quality installation and a good training to end-users in a quick and efficient manner. The F$2 monthly fee, is certainly much below the minimum threshold that is required for ensuring the long term financial viability of the project but since the DOE accepts the cost of maintenance for the first 10 years this has been sufficient for the project to date. After turnover, if no other subsidies are injected, it is anticipated that the tariffs will need to be substantially increased to ensure continuance of good quality service.

Naroi village solar electrification (1999)

Project goal

The project was integrated into a larger development project that included a village water supply, a seawall and storm water drainage. The goal was to provide 24-hour electrification to individual and public facilities. The design was based on the Namara experience regarding acceptable panel size and battery type and included the testing of an innovative prepayment metering system,that was supposed to facilitate the collection of fees through the local post office.

Project description

The initial design included the testing of an innovative 16-digit code keypad activated prepayment meter for increasing the fee collection rates, simplifying the collection process and speeding up the payments. The users were required to pay an installation fee of F$100 and a monthly tariff of F$4.50 cents. Credit codes are issued in Suva by the DOE and sold at the Post Office in the village. If the code is not entered before the end of the month, the prepayment meter is supposed to automatically disconnect the service. The Fiji Post keeps a five percent commission on all collected fees. The balance is managed by the DOE in a specific account and is intended to cover project costs. Abuse or tampering of the system is supposed to lead to the removal of the PV equipment. Maintenance is by an island technician trained by the DOE during the installation of the systems. The technicians are paid by DOE following submission of monthly reports by the technicians. The island technicians provide quarterly preventive maintenance service visits and liaises with the customers.

Project achievements

The project has supplied approximately 170 houses with 100Wp SHS. After about 5 years of operation, overall technical performance remains satisfactory, despite the many prepayment meter failures. A reliable fee collection scheme, involving the local post office, has been established but unfortunately in 2003, 50% of fees remained unpaid each month because many of the pre-payment meters allow power to continue without payment. The fee was increased from FJ$4.50 up to FJ$7.50, which still does not cover the full operation and maintenance (O&M) costs even if all fees are collected.

Lessons learned

Most of the problems encountered were caused by the pre-payment meters (because of failures and the absence of skills to repair the complicated units). This shows that the use of prepayment to improve system functionality has to be considered only when proof of reliability is provided and other means of collection are clearly unsatisfactory. There can be substantial costs due to the use of pre-payment meters in case of failure. In addition, tampering of prepayment meters and a low rate of collection is not prevented by pre-payment technology when the quality of service is not perceived by the users to be satisfactory. The current tariffs structure, as for Namara, is still below the minimum level for ensuring long-term sustainability including battery replacement. Therefore, the project still requires a substantial operating subsidy from the government. In theory the DOE was supposed to withdraw from the project after three years but failure of the project is feared since sustainability would only be possible if: i) preventive and repair maintenance services are undertaken by a professional operator, and ii) the level of fees is increased significantly, in order to cover the full cost of such an operator.

Vanua Levu pilot project (2000)

Project goal

In 1996, the community of Vunivau (Western Vanua Levu) expressed interest for the installation of PV systems for domestic electrification. The DOE carried out a feasibility study, and decided to develop another pilot operation on this settlement to test the RESCO approach.

Project description

A first lot of "Powerhouse" SHS were implemented on the Vunivau village, which were to be owned permanently by DOE. The systems include magnetic card pre-payment meters. The project implementation began in August 2000 and local technicians were trained and supervised by DOE for the installation phase of the project. The initial total capital cost for this project was approximately FJ$130,000 representing a cost of FJ$2200 per household. Fees are collected through the sale of prepayment cards valid for 30 days of operation. The "charged" cards are purchased from the Post Office at a cost of FJ$14.50, and the Post Office keeps FJ$0.50 as a collection fee. Fees were supposed to cover O&M costs. The money collected is managed in a DOE account. O&M services are provided by a local private sector contractor acting as a RESCO.

Project achievements

During the first two years with 60 SHS operating, approximately 20% encountered control unit failures and five percent had card reader problems. These initial technical problems have caused much higher maintenance (labour and travel) costs than anticipated. However, during the last year of operation, problems have been reduced and the failure rate is much lower. Assuming that no other major technical failures occur, the current level of service fee, FJ$14, seems to be sufficient to cover the full O&M costs.

Lessons learned

Installing innovative equipment that has never been tested in a similar environmental context can result in higher failure rates and higher maintenance costs than expected. Long-term sustainability should not require any additional subsidies beyond those capital subsidies already provided. Nevertheless, the current tariffs will need to be regularly adjusted in order to follow the change in the part of the private operator cost that is linked to inflation.

7.2.2 Kiribati Solar Utility model

Project goal

Kiribati experience with off-grid electrification started in the mid-80's with the creation of the Solar Energy Company (SEC), a local public owned company, specialising in the supply of PV systems. The systems were sold to users who did their own installation and maintenance which proved to be unsatisfactory. The poor performance of these systems resulted in a loss of market confidence and the SEC became effectively bankrupt in 1989. In 1990, the SEC was transformed into a "solar utility" (a RESCO) providing customers not only with the installation of systems but also long term maintenance and field services. But the small number of systems, 325 in 2003, and the level of tariffs A$9.50, were not sufficient to cover the full cost of the company's operation. In 2000, the European Union (EU) financed a larger project of 1700 SHS. This quantity was judged sufficient to allow the SEC to reach its financial breakeven point, and to ensure sustainability in the long term. Those installations will be completed in 2005.

Project description

Individual system capacity is 100Wp, and includes three lights, as well as a 12V socket for a radio. There are also systems for public buildings. The SEC owns the equipment and ensures full service under a utility agreement. In total, it employs 30 people, including field staff, half of them working full time. Installation, maintenance and fee collections are carried out by local technicians, locally recruited and trained by SEC. Most of the hardware is purchased on the international market. Key components like modules and batteries have to comply with very high quality specifications in order to face the tough local operation conditions (salty atmosphere, heat and humidity). The SEC manufactures its own controllers which have proven their reliability with over 15 years of PIC experience.

Achievements

By end of year 2004, the total power installed will reach 215kW, representing 1700 households, and 100 public facilities. Individual customers pay an AUD 10 monthly fee, which is intended to cover the full SEC service operational costs, including local technician salaries and replacement parts. However, estimates of costs for the future indicate that this will have to be raised. This level of fee seems acceptable if compared to the mean family income on the outer islands, in the order of AUD $175 - $350 per month. Since the capital costs have been entirely subsidized, the project should be sustainable for the long term.

Lessons learned

Reliability of the systems is achieved when proper maintenance programmes are in place and managed at a professional level by a specialised company. An appropriate level of tariff can be established in least developed countries that can cover the full cost of operation and maintenance for the long run. O&M sustainability may be achieved as long as enough systems are installed, in the range of 1000 – 2000 per RESCO. Local technicians living close to the site are necessary to ensure maintenance at a reasonable cost. Also, local technicians can achieve a high fee collection rate during maintenance visits. All together, the characteristics of this model, providing the required conditions are present (significant capital subsidy, minimum size of the market, level of tariffs, political support, etc.), seem to be well suited to ensure viability of local PV businesses, in the long run.

7.2.3 Tuvalu Solar Energy Co-operative model

Project goal

The Tuvalu Solar Electric Co-operative Society (TSECS) was established in 1984 in order to provide solar lighting for outer island households.

Project description

The co-operative included full time professional staff. During the first ten years of its operation, the TSECS expanded its business with systems provided by international donors including the US, France and the EU. Because of the regular presence of qualified staff on the field, despite early technical problems these arrangements provided the necessary environment for ensuring customer satisfaction. In a first stage, TSECS implemented a total of 170 lighting systems on eight islands using USAID funding. A second phase was financed by an EU grant, allowing the purchase of additional 150 kits. Unfortunately the specifications provided were poor and the results were disappointing since the project did not meet customer needs. A grant provided by the French Government helped in upgrading the systems installed in phase 1 and allowed the TCECS to keep them in operation. The EU also agreed to replace the failed components and to double the system capacities of the SHS installed during phase 2. This upgrading was completed in 1991 and system performances reached an acceptable level. This was due not only to the supply of additional good quality components, but also by a significant effort made on improving the quality of the service, including the training of local technicians and a stronger institutional support by the TSECS.

Project achievements

At the end of 1994, following a further input of equipment by the EU, the co-operative had more than 400 members, and another 200 had joined the co-operative on a waiting list. Unfortunately major management problems occurred in 1994 and 1995, due to a lack of fiscal oversight, that resulted in the effective dismantlement of the co-operative by 1998 and its final legal dissolution in 2004. With almost no support to local technicians and few spare parts available for repairs the result from 1996-2004 was a very low level of end-user satisfaction. This situation led the government to implement diesel schemes in all outer islands and solar activity in Tuvalu fell to limited use for pumping, telecommunications and isolated households.

Lessons Learned

Long-term sustainability is not only a matter of technical performance, but is directly dependent of the institutional support. It appears that a co-operative structure is much too weak in terms of management quality and fiscal discipline for ensuring the long-term professional service required for the viability of PV projects.

7.2.4 Marshall Island Utility model

Project goal

A project was implemented on the atoll of Namdrik in 1996, with the goal of establishing an off-grid electrification utility, named Marshall's Islands Alternative Energy Company (MAEC). This structure was never properly operational, and left the islands with no maintenance service and no spare parts causing failure of most systems within two years. In 2002, the Pacific rural Renewable Energy France-Australia Common Endeavour (PREFACE) programme rehabilitated the project with new batteries and lights as well as integrating the Marshall Energy Company (MEC) into the project for operation and maintenance.

Description

The PREFACE project included the refurbishment of the 130 previously installed PV systems, and the removal of the first project's pre-payment meters in favour of direct cash collection on the island. The management of the project was transferred to the local electricity utility, the Marshall's Energy Company (MEC), under a RESCO agreement (systems ownership is kept by the government and O&M is done by the MEC).

Local technicians are employees of the MEC. An island agent collects the fees and keeps the accounts. The MEC can provide technical backup to local technicians. Should operating and maintenance costs exceed the fees collected, the government has agreed to cover the balance.

Achievements

130 households now have reliable electrical services. Connection fees have been raised to US$100 and the monthly fee up to US$12 dollars. These fees are expected to fully cover MEC's O&M costs. A strict disconnection policy has been introduced for non-payment of fees. It is expected that no other subsidy than the one required for financing the initial capital costs will be needed. The MEC is in the process of integrating PV into its business profile, and is expected to be able to deliver the service with no government subsidy.

Lessons Learned

A solar utility cannot properly operate until appropriate project components, including strong institutional support, continuous training, and spare parts supplies are in place. It can only operate well if it has a sufficient and qualified staff for managing all aspects of the project. In the case of many PICs, this level of management quality may only be found within the electricity utilities. At the same time, utilities will be extremely reluctant to enter the business unless the government will provide a sufficient level of subsidies to cover capital costs and operating losses.

7.2.5 The PREFACE programme

Project goals

PREFACE is the most recent programme undertaken at the regional level, with the objective of demonstrating the long-term sustainability of RE electrification. PREFACE includes both hardware demonstration at a significant scale and the provision of local/regional capacity building activities in order to strengthen the local stakeholders in the field of project development, project finance and operation and maintenance management. Given the regional dimension of the project, its focus on RE electrification, long-term sustainability issues and the extensive and informative literature available, it should be considered as a good example for development of a PIREP demonstration. Most of the information hereafter is extracted from the executive summary of the final review report prepared in 2003.

Project overview

PREFACE was a joint French-Australian initiative which aimed at promoting the use of renewable energy technology in the PICs. It was a three-year and approximately US$2 million programme that ended in 2003. Emphasis was put on PV and wind technologies for off-grid and mini-grid application purposes. PREFACE provided support for better identification of the priorities and characteristics of RE electrification opportunities among the PICs, for strengthening local technical and financial management structures as well as being a regional demonstration of the process for developing rural renewable energy projects using small wind and PV technologies.

The bulk of the budget was used for demonstration projects in several PICs based on various concepts, with the objective of replicating them throughout the region. The demonstration projects were implemented in Vanuatu (public facilities), Marshall Islands (project rehabilitation), Tonga (rural electrification) and the Cook Islands (grid tied wind).

In Vanuatu, the project provided electrification for health and education facilities as well as for a few houses on a remote island in order to demonstrate the use of RE for community services. In Tonga PREFACE provided additional PV systems for the islands electrification in the Ha'apai group. The project aimed at reaching a "critical mass" of PV systems in the country in order to improve sustainability. The Marshall's Namdrik electrification project had as its goal to demonstrate the rehabilitation of failed PV electrification projects through improved technical and institutional systems. Finally, the Cook Islands wind demonstration plant on Mangaia aimed to demonstrate the feasibility of integrating wind power into small island grids.

Project achievements

Operation and maintenance financing

In Vanuatu, tariffs are paid by the relevant agencies in charge of the public facilities and by the households. However, the level of fees will have to be raised in order to cover the whole O&M costs or government will have to subsidise the project. In Tonga, fees are also not high enough to cover all O&M costs, especially spare parts and batteries. Additional subsidies from the government will be needed unless fees can be raised soon. In the Republic of the Marshall Islands (RMI), the fees are calculated to cover the full costs for MEC to operate the systems in the long run, including battery replacement. This should be a sustainable project, provided that the fee collection rate remains at a high level. In the Cook Islands, finance for O&M is provided by selling the electricity to the end users, assuming that the wind plant performance is as predicted and that maintenance is properly carried out so that the system provides the design output.

Local Private Sector Participation and Economical development

PREFACE extended participation to local companies in the target PICs for installation and later maintenance. It helped create local capabilities for installation, maintenance and after sale services. Off-grid electrification by itself is not likely to promote much economic development of the communities involved unless all the other factors of production are also present at the time of electrification. Nevertheless, a few local merchants will be able to attract more customers to their brightly lit shops and work hours for fish net mending or handicraft manufacture can be extended. Local agents and technicians will also benefit from the cash flow generated by the project.

Regional dimension

Apart from being implemented in four PICs, the regional dimension of this initiative has been mainly based on dissemination and information components. Email communication via a distribution list was established with over 150 contacts all over the region. Nevertheless, this was not sufficient for establishing a proper regional network including both way information flows as the list was rarely used for anything but information dissemination by PREFACE.

Lessons learned

From a technical point of view, PREFACE showed that PV and wind technologies could achieve a high degree of performance, as long as the design and installation are carried out in a professional manner. From the institutional point of view, the project has ended with some uncertainties concerning the capabilities of the local players to maintain the project. This situation justifies monitoring and external advisory support over the next few years.

7.3 Review of other international experiences

7.3.1 Morocco / ONE-TEMASOL RESCO model

Project goal

The project is managed by the national electricity utility Office National de l'Electricité (ONE), which has provided off-grid electrification (mainly PV) since 1998. This approach targets those remote settlements that are not connectable to the national grid and are intended to provide electricity at an economically reasonable cost. PV has been selected because of the simplicity of implementation, the modularity, the reliability of photovoltaic modules and the high level of performance made possible by a high level of solar irradiation. Intending to develop this scheme on a large scale, ONE has tested several models with the objective of providing remote populations with a level of service equivalent to what is delivered in urban areas. The concept includes both government and the private sector, with the largest fraction of the equipment cost being covered by a national subsidy and the private sector being involved in operation, maintenance and after-sale service. A total of 150,000 households representing seven percent of the rural population and spread over 5000 villages are affected by this photovoltaic scheme.

Project description

ONE's project is a fee-for-service scheme, targeting the supply of PV-based full service to its off-grid customers including a warranty of service quality. Under this scheme, ONE owns the equipment, the private sector competes for the supply of the systems and the users become ONE customers. The private company provides installation services, including in-house electrical wiring. The company also provides a full operation and maintenance service, including the collection of fees and the replacement of failed parts, including batteries, over a 10-year contract period. At the end of the contract, the end user is offered ownership of the equipment. The total duration of the project is 14 years. Under this scheme, ONE in September 2002 contracted the Moroccan company TEMASOL for the electrification of 16,000 off-grid households in the centre of the country. Three different levels of services are offered: S1 (50Wp) with four lamps and a 12V socket, S2 (75Wp) with six lamps and a 12V socket and S3 (100Wp) with eight lamps and a 12V socket. ONE provides a subsidy on the capital cost of MAD 5375 (US$600) per household. The remaining cost is financed by the operator who gets the money back by charging the customers a connection fee and a monthly tariff. The connection cost to the end user level ranges from MAD 704 (US$78) up to MAD 3113 (US$350), and the monthly fee is from MAD 65 (US$7.22) up to MAD 130 (US$14.44). The financing of the project includes a grant of EUR 5 million (US$6 million) from Kreditanstalt für Wiederaufbau (KfW) the German

Banking Syndicate to ONE, against the EUR 12 million (US$14.4) total project cost for serving 16,000 families.

Project achievements

At the end of year 2003, approximately 8,000 new customers were supplied by TEMASOL. The collection rate, from the latest statistics, exceeds 90%. The subsidy provided by ONE represents 63% of the capital costs, while the loan from the operator represents 22 percent. The remaining 7 percent corresponds to the connection fee paid by the customers. While it is still under examination, initial results appear fully in line with financial forecasts. The implementation pace (50% of the total project realized within a year and a half) is even exceeding the forecasts. Since then, two other "fee-for-service" contracts have been awarded totalling 37,000 new customers.

Lessons learned

Having the national grid power utility directly managing the implementation of an off-grid component can be a strong and efficient institutional scheme. It avoids any competition between grid and off-grid service providers and provides the project with the resources of one of the most powerful companies in the country. Having the private sector simultaneously in charge of developing the off-grid market and, supplying and servicing the equipment provided by the utility is an efficient and competitive scheme. It improves the overall profitability of the operator relative to an operator-financed scheme and thus improves its own sustainability. All together this model has proven to be one of the most successful ones considering its capacity to (i) attract large amounts of funds for PV electrification and (ii) rapidly achieve a very high penetration rate.

7.3.2 South Africa - KZN RESCO experience

Project goals

Kwazulu Energy Services (KZN) is a company of decentralised services owned by Electricité de France (EDF) (65%) and TOTAL (35%). The Department of Minerals and Energy (DME) have contracted it as one of five off-grid electrification concessionaires, which in total aims at supplying 300,000 households with PV electrification. The concession contracts were supposed to be valid for a 15 years period, but due to uncertainties in the sustainability of the subsidisation scheme, the project has been divided into two phases, the first one being already launched under an interim 18-month contract limited to 3,000 installations

Project description

There are two Points of Sale (POS) located 20 km from each other. Each POS is allowed to provide its services to households located within a 30-km radius. The list of potential customers is growing rapidly and the project cannot cover all expressed needs in Phase 1. At the end of Phase 1, an assessment will determine whether the program will continue and deliver additional 12,000 installations expected for 2006. The systems have been designed to support four lamps, a radio and a black and White TV for approximately three hours per day. Each customer pays an installation fee of 100 Rand(US$15.90) and benefits from the use of the basic equipment package providing they prepay a monthly fee of 18 Rand (US$2.87). The government provides a subsidy of 40 Rand (US$5.370 per month per customer. To prepay the monthly fees, the customer comes to the POS desk to "recharge" a magnetic key. Once at home, the customer places his magnetic key in the meter box to reset the power for another payment period. The meter box automatically cuts the battery power when the time runs out if a new key is not purchased.

Project achievements

Almost 3000 households have been equipped to date. Satisfaction and expectation levels are high and these are encouraging signs for launching the phase 2 implementation. The main issues and concerns encountered to date are related to security and poverty (thefts, payment delays). Thefts are not always reported and can lead to conflict between villagers. A few systems were dismantled and the equipment recovered by the operator because of non-payment of monthly fees.

Lessons learned

Adequate training is essential in insuring proper maintenance of the equipment (especially the battery). Capital costs, if sufficiently subsidised, are low enough for generating sufficient returns for private investors, even in risky places like Kwazulu Natal. Major technical risks are related to non-optimal use of batteries and abuse of systems. User training is essential to proper system use and sustainability of the market. Off-grid electrification, especially PV, appears to provide a sustainable model for rural development in areas that do not and will not have access to the grid in the near future. If the service offered corresponds to both the needs of the population and its financial capabilities, then quick implementation and sustainable operations can be achieved.

8 Annex 2 – Preliminary business plan for a typical PIC off-grid electrification operator

The purpose of this section is to provide indicative figures concerning PICs off-grid electrification businesses financial sustainability. Results have been extracted from a preliminary study carried out in Fiji (2003, DOE), whose goal was to assess the local companies and their financial viability as off-grid operators. Economic data and technical concepts are based on previous experiences in Fiji, as well as other PICs and elsewhere around the world.

Capital cost financing assumptions

Past experience with PV electrification in the Pacific has proven the necessity of a substantial subsidy component in the financial structure of this type of project. The subsidy, however, should only be for capital investment, not for operations and maintenance. The amount of capital subsidy typically varies between 65% and 100% of the total investment cost depending on the size of the project as well as on the capacity and willingness to pay of the targeted populations. In the present case, it is assumed that 90% of the initial investment will be covered by an external subsidy (the current case in Fiji), channelled through the government. The remaining 10% of capital costs would be repaid by the end users through their monthly fee effectively requiring the end users to finance this portion of capital investment but over a long-term period. The end users should retain ownership of the appliances and internal house wiring but an external agency retain ownership of the solar equipment. The cost of installing those components can be collected as a connection fee. Collecting a connection fee is considered as being the preferred approach because: i) it would reduce the risk of connecting households which do not have insufficient funds to pay the continuing service fee and ii) such connection and wiring fees are currently being charged for grid connections making the SHS installation process consistent with existing grid connection policy.

RESCO structures financial assessment

Average installed SHS cost (75Wp) US$960

Annual O&M costs:US$102

Annual Discount rate:6%

Annual Inflation rate:1.5%

Payback time on private investments:5 years

Schedule of implementation:

- Year 1: 20%
- Year 2: 70%
- Year 3: 10%

Number of system installed: 2000

Government subsidy on initial capital costs: 90%

Operator initial investment on capital costs: ~5%

Monthly fee: US$8.40

Connection fee (on initial capital costs):10%

Operation and Maintenance characteristics

Fee recovery rate: 95%

Fee collection (per system) costUS$0.50- / month

Breakdown rate: 3% per annum

Private operators activity assessment

Starting from zero, by the end of the implementation phase (three years) the annual gross income of the company will reach over US$192,000. The 2000 systems installed will represent a total investment of US$2,496,000 and the company will itself have to invest about US$96,000 dollars. The payback period for covering this private sector investment is estimated to be about 4.5 years.

Fig 4 : [Typical off-grid RE operator turnover forecasts]

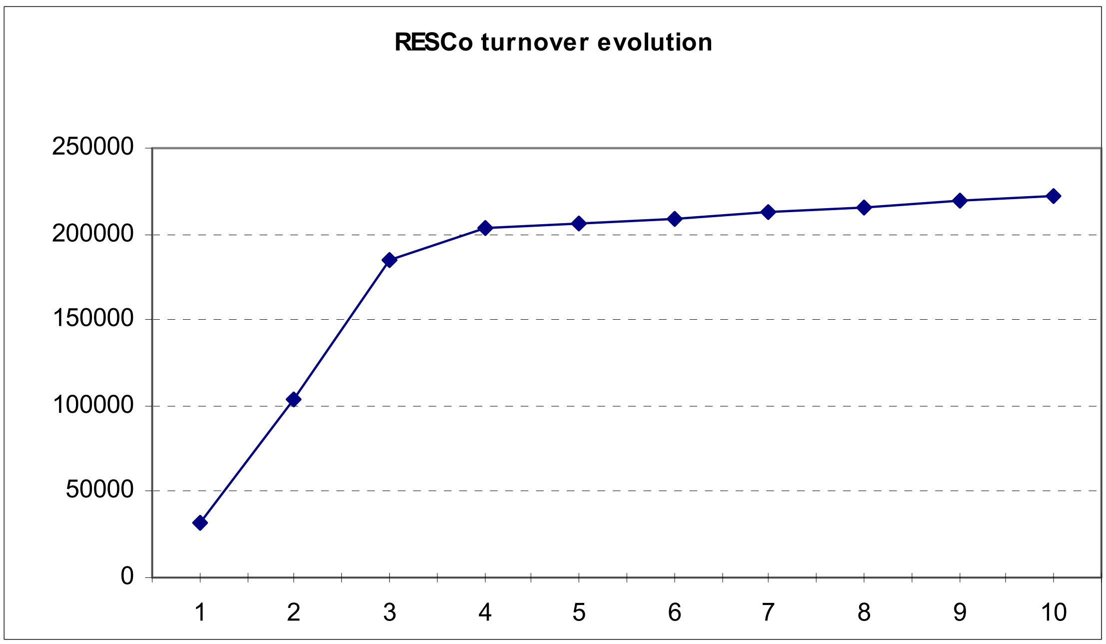
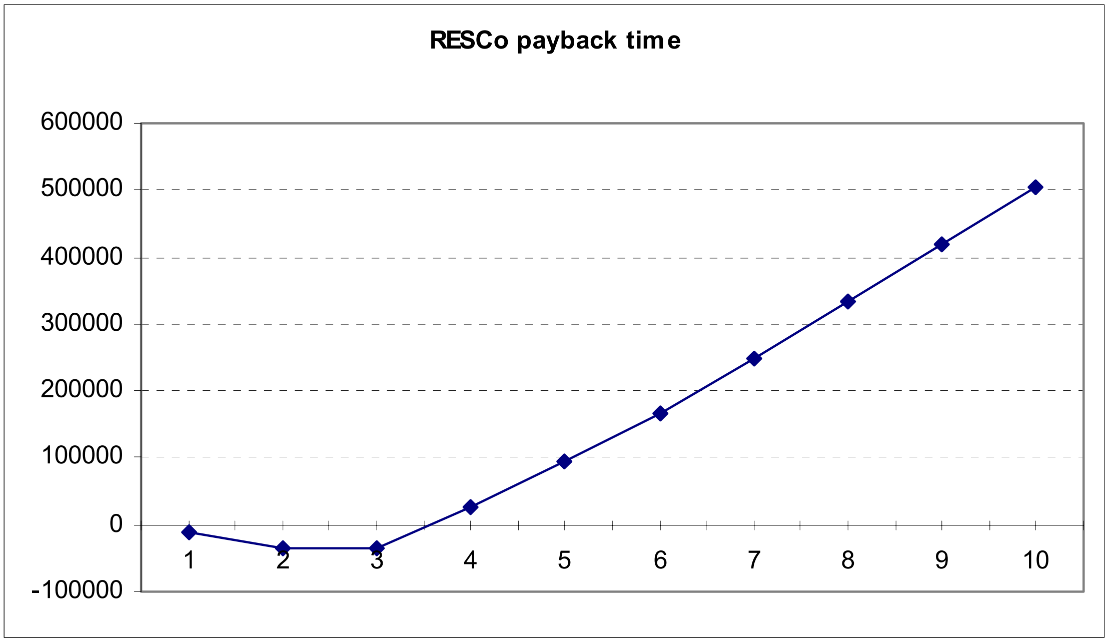


Fig 5 : [Typical off-grid RE operator payback period]



8.1 Lessons learned on the business experience

The various experiences in the PICs and abroad presented above have shown that off-grid RE electrification may offer a significant potential for local businesses. Whatever is the chosen model (e.g. utility, RESCO or professionally managed COOP), installation, maintenance and commercial operation depends on the full participation of local operators that are identified and trained for that purpose. Nonetheless, these field activities represent a relatively high level of business risk, given the nature of this dispersed and low-income market. To attract local business participation the level of risk has to be offset by a sufficient level of subsidies or warranties, and the establishment of an institutional framework that provides the companies with some assurance of the long-term viability of the business. Another critical issue is, given the small size of RE businesses, the necessity to implement affordable, permanent training facilities, sufficiently flexible to match the individual needs.

Developing projects for rural electrification using any technology usually needs a substantial level of government or donor support in financing the capital costs. As the market is still in an early stage, a high level of external finance will be required in order to reduce the level of the perceived risk seen by the local businesses. The preliminary business plan presented above shows that 90% capital subsidy is an acceptable level although in some situations where higher fees may be charged and still maintain adequate user acceptance it may be lower.

Once capital cost financing is secured, an immediate issue that needs to be solved is the long-term viability of O&M activities. Little grant or subsidy money will generally be available for this type of service, which means that O&M costs will have to be entirely sustained by the project recipients. Whatever the proposed model, the only reliable and sustainable source of money for covering the O&M costs will be service fees collected from the end user.

Pacific and international experience has shown that several fee collection techniques have proven to be sustainable but need to vary according to the cultural and physical situation. Direct cash collection in the field by the local technician, the use of pre-payment metering, payment to a government agency, collection by the electricity utility or collection by a village committee have all been tried with varying levels of success. But whatever the fee collection method, the operator's financial viability will be determined by the reliable collection of an adequate level of tariff that is acceptable to the end user for the given level of service, and covers all the costs of the company incurred for the services provided.

Under these circumstances, the sustainability of a local business as an off-grid RE delivery service company will depend to a large extent on the political support they obtain, i) for implementing a tariff structure that is based on their true O&M costs as well as ii) for applying clear rules in case of non-payment such as disconnecting the appliances from the PV systems or removing the systems entirely.

Should the above conditions be met, RE electrification in the PICs can offer significant business opportunities in those countries with many off-grid households. It is expected that 10 full time positions may be created for each 2000 systems installed. As noted earlier, the same volume of customers may generate a turnover of €160,000 (US$192,000), with O&M activities only. Given the level of investment required (O&M structure, tools…etc), estimated to 5-10% of the project capital cost, the payback period for a local operator’s investment would about four years. The above figures neither include the cost for training the operator staff, nor any extra project costs that may only occur during the first couple of years of operation as initial problems with the systems and the company structure arise and are solved.