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Promoting sustainability of renewable energy technologies and renewable energy service companies in the Fiji Islands

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Abstract

Between 12,000 and 16,000 households in Fiji are potential recipients of rural electrification programmes according to Fiji Department of Energy (DoE) recent assessments. The DoE now has over ten years of experience with small scale simulated Renewable Energy Service Companies (RESCO) operated rural electrification with Solar Home System (SHS) and considers the trials a success. The proposed project to add up to 5,000 homes to the present RESCO programme will be the first full scale implementation with it being considered as the "proof of concept" project. This main objective to provide DoE and all potentially interested parties, sufficient information to allow and plan the development of RESCO based rural electrification that can provide the expected electrical services to rural households in a fully sustainable manner -- which partly means that no further public investment beyond support of the initial investment should be required. This feasibility study has been conceived with that objective foremost. It is to determine the optimal institutional and technical approach by which the electrification of rural households and public facilities can be undertaken through a RESCO based Public Private Partnership.

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Keywords: RESCO; rural electrification; DoE; renewable energy; solar.

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1. Introduction

The Republic of Fiji Islands lies between 177° E and 178° W Longitude and 12° to 22° S Latitude with a land area of 18,333 km^2 and includes 320 islands of which about a third are inhabited. The majority of the land is on continental-like volcanic islands that rise to well over 1,000 metres in elevation. Over 87% of the land is concentrated in the islands of Viti Levu and Vanua Levu, the two main Islands where most of the active population leave. Fiji's climate is tropical, averaging 26°C with annual rainfall ranging from 1,800 to 2,600 mm. Viti Levu has 57% of land area, Vanua Levu and Taveuni islands 33%, the remaining 10% are spread among hundreds of outer islands [1].

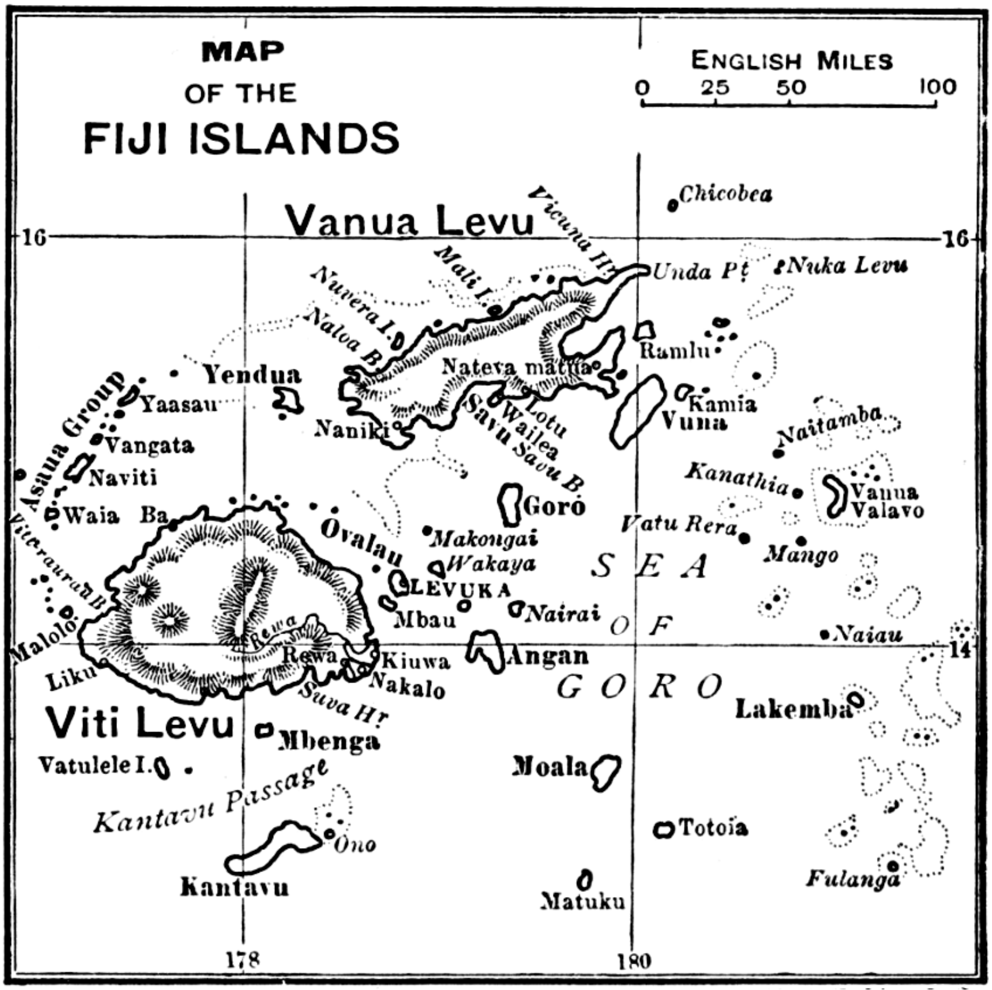

Fig. 1. Main islands of the Republic of Fiji Islands - Source: http://www.probertencyclopaedia.com/photolib/maps/

2. Energy picture of Fiji

More than 70% of energy use comes from domestic sources [1]. Fiji has a major hydroelectric scheme (Monosavu [80 MW] and Nadarivatu [40 MW]) that provides more than 50% of the electrical energy for the population on the main island of Viti levu and biomass contributes both to electricity generation and rural cooking energy. Bagasse, a by-product of sugarcane, is used for power generation in sugar manufacturing, and wood wastes are used for power generation in sawmilling with both sources feeding surplus energy into the Fiji Electricity Authority (FEA) grid. Firewood remains the leading fuel for domestic cooking though LPG and kerosene is commonly used in urban areas [2].

Fossil fuels are used for transport and for nearly all electricity generation on islands other than Viti Levu while on Viti Levu the demand that cannot be met by the hydro scheme is also provided by diesel generators. More than four hundred rural villages have small diesel generators for their local electricity supply. Table 1 below illustrates the main electricity supply by sector in Fiji.

Rural villages that do not have any electrification scheme mostly used standard petrol fuel derivative (diesel, super, LPG, Kerosene, Benzene) for cooking, lighting and operating some small portable generators. Candles and dry cell batteries are also used by more than 30% of not electrified people.

Approximately half of all households designated as rural have access to electricity either from the grid or through independent generators. In Fiji the electricity sector is generally owned and operated by the Government. Except for small private owners especially in the tourism industry (island resorts) and the Vatukoula Emperor Gold Mine, Fiji Sugar Corporation (FSC) and Tropikwoods, the provision of electricity both for urban and rural consumers has been undertaken by three Government institutions: DoE through its Rural Electrification Unit (REU), The Public Works Department (PWD) and FEA.

Under the Ministry of Work and Energy, DoE is responsible for energy policy and off-grid rural electrification, mostly focused on diesel schemes and SHS, although some mini hydro and hybrid electrification has been tried [3]. In general, the budget allocated to preliminary studies, capital investment, operating and maintaining of rural electrification projects has been inadequate to carry out their designated tasks.

Table 1. Main electricity supply by sector

H5. Main Electricity Supply	Sector					
	Total	Percent	Rural	Percent	Urban	Percent
Total	174,423	100.0	85,697	100.0	88,726	100.0
Fiji Electricity Authority	130,055	74.6	47,172	55.0	82,883	93.4
Fiji Sugar Corporation	514	0.3	186	0.2	328	0.4
Vatukoula Goldmine	537	0.3	63	0.1	474	0.5
Public Works Dept	1,967	1.1	1,082	1.3	885	1.0
Village grid	12,059	6.9	12,009	14.0	50	0.1
Home solar	1,561	0.9	1,360	1.6	201	0.2
Own plant	8,397	4.8	7,929	9.3	468	0.5
none	19,333	11.1	15,896	18.5	3,437	3.9

Source: census 2007, Bureau of Statistics

FEA, the government-owned power utility with about 661 staff, is responsible for electricity supply nationally "where financially and economically viable" and operates on the islands of Viti Levu, Vanua Levu and Ovalau. Although FEA is considered as an example of good utility practice in the Pacific Region, the utility is not much concerned by rural electrification and generally extends its grid only when financial and economical viability have been shown either directly or through government subsidy. FEA has an extensive grid system on Viti Levu and three smaller grids on Vanua Levu and Ovalau [4]. Over half of Viti Levu's power comes from hydro with numerous diesel generators and some energy generated from burning bagasse and wood mill waste. Except for a small hydro system on Vanua Levu, all other FEA generation off of Viti Levu is diesel based. The overall energy sector goal of the national plan is efficient, cost effective and environmentally sustainable energy development. Specific objectives include formulation of a comprehensive national energy policy, power sector reform, establishing Renewable Energy Service Companies (RESCOs) and increased funding for the Rural Electrification Programme (REP) [3]. The heavily-subsidised REP provides rural connections to the FEA grid, diesel gensets with a mini-grid system operated at the village level, small hydro powered mini-grids where practical and solar photovoltaic systems for lighting and basic appliances.

3. Experiences with RESCO in Fiji

In a RESCO electrification scheme, government and/or a private company, designed as the RESCO, owns and services the solar PV equipments. The RESCO charges the user an amount intended to pay the operating and maintenance costs plus RESCO administrative costs and RESCO profits. This type of RESCO scheme, based on earlier experience in Kiribati, was first considered by Fijian authorities when DoE started to work on developing a Vanua Levu RESCO pilot project in the 1990s [5]. This was carried out with the help of the Pacific International Center for High Technology Research (PICHTR) that led to first trial SHS installations in 2000 [6]. Prior to this project, several trials with Operation and Maintenance (O&M) scheme supported by local cooperatives, village communities or the DoE itself were implemented in Namara (1983 to present) and Naroi (1999 to present). These first solar projects have similarities to the present RESCO approach and many relevant technical and institutional lessons have come from those projects.

3.1. First technical design – Vunivau Project

In 1996 the residents of Vunivau settlement on Western Vanua Levu expressed interest for the installation of solar Photovoltaic (PV) systems in each household in the area. The DoE working with the Hawaii based renewable energy development organization PICHTR, determined that the minimal system size, for a nominal load of 40W of fluorescent lights and a power point for a small radio or appliance is 75 Wp to 100 Wp of PV; 100 Ah, 12 V deep cycle battery with an 8 A charge controller [6]. A general design was developed by PICHTR for installation in Vunivau. The site selected by DoE, is typical of many rural farming communities and is populated by ethnic Indians. In Vunivau each family of farmers lives in a home on or near their farm. The homes are widely separated and the electricity supply through grid-distribution for the low household loads is much more costly than PV systems offering similar services.

In 1999, PICHTR secured funding from the Government of Japan for the implementation of 60 PV systems for the Vunivau settlement [6]. The DoE was the local executing agency for the project with PICHTR acting as the technical adviser. PICHTR officials proceeded with the Hawaii testing of various PV components to determine the ideal for the Vunivau project. Surprisingly, no prior Pacific system design or component proven for use in the Pacific Islands was tested or used in the final project. Tests performed in 2000 by PICHTR in Hawaii led to the selection of the newly designed “Powerhouse” units – including Conlog pre-payment meters and charge controllers – available from Shell Renewables. The computerised pre-payment meters require the insertion of a magnetic striped card purchased with encoding for a timed period of system operation. In essence, only the Powerhouse housing, control unit and card reader were used. Because of the high cost of imported batteries, automobile type flooded lead-acid batteries manufactured by Pacific Batteries Ltd. (in Suva) were selected for the Vunivau project and replaced the batteries used by the South African manufacturer of the “Powerhouse”. For Vunivau it was necessary to specify 100 Wp of PV to guarantee service during the low insolation hurricane season replacing the 50 Wp panels used in the South African project. Three 11 Watt and one 7 Watt CFL lights were provided. Specific components installed were:

- 2 - Shell Solar RSM 50S polycrystalline panels (US$490);
- 1 - Pacific Battery (Fiji) open cell, 110Ah at C_{20} model SSDC-100-12. 3mm plate automotive type battery (US$79);
- 1 - CONLOG microprocessor controller and pre-payment card reader. (US$98);
- 3 - STECA Solsum CFL lights 11 W (US$39.90);
- 1 -STECA Solsum CFL light 7 W (US$13.30);
- 1 - STECA ¼ Watt LED night light.

3.2. From 60 to 1500 SHS in Vanua Levu

Ninety-six additional systems have been purchased with funding from the Government of Japan for installation during 2002. Vunivau received 84 of those which were installed July, 2002. Twelve went to Nasuva near to Vunivau in Bua province. In January 2002, the Government of Japan provided PICHTR with funding for another ninety SHSs. In December of 2002, Forty-four of these were used to increase the installation base in Nasuva, fifty two went to settlements in the Cakaudrove province. All projects are managed by DoE and maintained by a contractor, operating as a RESCO. Therefore, in early 2003 there are about 252 SHSs installed in Western Vanua Levu and maintained by contractors providing energy services simulating a RESCO type contract while the systems are owned and managed by the Fiji Government. Since 2003, the SHS installation rhythm was almost 100 SHS/year, following similar investment and management schemes with the financial and technical assistance of PICHTR Japan Government and UNDP, to reach over 1500 solar systems by mid 2013, with another 250 planned by 2014 [7].

The SHS are spread among a dozen of Fijian Villages and Indian settlements, mostly based in the eastern and western part of the island. The technical design has been slightly improved thanks to a rigorous technical monitoring of the DoE and PICHTR [2], with the strong collaboration of the more and more involved RESCO (RES Limited). The latest installed systems are made with: 2x55 Wp Shell solar Panels, 100Ah open cell lead acid plate automotive type batteries, Enercash controller with prepayment meter, STECA Solsum bulbs and Renewable Energy Service (RES) limited designed LED night light, and a DC plug for radio. The Enercash prepayment meter/controller is progressively replacing all the Conlog prepayment meters/controllers from the previously installed SHS, as the Conlog units are no longer manufactured and also the Enercash units are considered to be more reliable as they have not created any technical problem in the slightly more than one year that they have been in operation [2]. The institutional RESCO based scheme settled for managing the Vunivau project in 2000 is still effective with most of the solar projects developed in Vanua Levu though the cost of O&M is clearly greater than the fees being charged customers. The replacement of the Conlog prepayment meters by the Enerash units alone cost nearly two years of fees per customer served. The company operating scheme is not an actual RESCO, since the operating and maintenance contractor is not responsible for paying for replacement components, but rather is contracted by DoE to provide maintenance services. However, the institutional aspect of the project has provided relevant results and has provided a good basis for the further development of sustainable RESCO structures.

3.2.1. Operation scheme:

Once solar systems have been properly commissioned and the management contract agreed between the RESCO and the DoE, the operating scheme is also consistent among projects: Theoretically, each of the concerned actors has a specific role to play in order to maintain the stability of the operation outline:

- SHS user DoEs not own any component of the system and has to fulfill the recommendations provided by the installer and/or the RESCO† when using his system. Among other, he cannot replace or bypass any component or add appliances that are not provided by the RESCO. By its own means, the user has to pay a monthly fee of F$14 at the closest post office to receive a one month activation code to be entered in the prepayment meter • The contracted RESCO has to perform all the tasks described in his contract with DoE. He organizes monthly visits in each village with systematic control of all PV installations, following the maintenance procedure agreed in his contract. The RESCO reports monthly to DoE all maintenance performed, payment defaults, possible tampering and users' level of satisfaction. This monthly report is annexed with payment inquiries for the corresponding maintenance tasks, on the basis of a scheduled budget beforehand agreed by the DoE and indicated in the management contract. The RESCO provides the link between the resident and DoE, and can be involved in disconnection or relocating if so requested by DoE.
- The DoE is responsible for collecting the F$50 refundable deposit prior to installation and the F$14.5 monthly fee paid by users at dedicated post offices. A specific fund is thus created and managed by DoE, dedicated to monthly payment to the RESCO, providing funds for components replacements and, provides available and trained human resources for project monitoring. DoE is generally supported by external assistance (PICHTR, development agency).

3.2.2. General outcomes

Although this operational scheme seems technically effective and has contributed to successful development of solar PV in Vanua Levu, detailed analysis and relevant meetings have highlighted some serious weaknesses at all levels. This operational method has been relatively efficient when only a few hundred SHS were to be maintained, but it suffers now from the lack of reinforcement of technical and human resources required to properly manage more than half a thousand SHSs [8]. This also shows that the current RESCO concept has to be significantly improved to suit to a large scale program (4000 and more SHSs), for which recommendations are drawn up in the next sections.

3.3. Weakness of the current RESCO concept

Through the stakeholder meetings and subsequent analysis carried out in June 2006, positive results and vulnerabilities of the current RESCO process in Vanua Levu have been brought to light:

3.3.1. From the SHS' users side:

- The comprehensive level of satisfaction is high. The F$14 DoEs not seem to be an obstacle for the major part of surveyed households [9]. This is confirmed by the RESCO manager who is directly concerned by customer complaints. The notion of service is largely accepted and the package provided by DoE (high quality equipment) and the RESCO (high quality maintenance service) is assumed to be consistent with the monthly financial contribution. The solar electric service is now considered as reliable, comfortable and economically competitive with traditional energy sources (kerosene, dry cell batteries or portable gensets).

- The main requests were concerning the inflexibility of the service and the necessity to reach a post office to get the activation code. A significant part of customers claim to be ready to pay higher fee for having a larger system. Some villages that are especially isolated (eastern part) complain about difficulties in going regularly to the post office, which can take a full day and increase the actual fee by adding substantial transportation costs.

3.3.2. From the RESCO side:

- Since the RESCO contracted for the maintenance has not systematically been involved in the equipment selection, purchasing and installation, several issues have been pointed out. First, the RESCO has the risk of higher maintenance costs resulting from inadequacies in the design or installation stages. Second, the RESCO has to get familiar with the equipment provided under the DoE designs which are not necessarily the components best adapted to the situation according to the RESCO's field experience [10].
- Because of insufficient technical assistance and training provided to the RESCO, the company suffers from weaknesses in its inner management and generally cannot afford new investments to improve its internal performances. This issue is made worse by the small number of customers and the short duration of maintenance contracts [9]. As a result, actual expenses involved to properly perform the maintenance tasks are higher than expected. The RESCO activities are not profitable for the company and it needs to keep on diversifying its business [10]. Therefore, the specific RESCO activities are blended with others and there is no full operational entity specifically dedicated to the RESCO's tasks.
- The RESCO is also subjected to the fragility of the institutional overall management of the project. Irregularity of payment by DoE, poor communications and absence of feedback from project management, too long a reaction time when repairs or replacements are urgently required, uncertainty on contract extensions, etc. These problems are a logical consequence of the weakness experienced by the DoE (detailed below) and the absence of legal framework for RESCO's activities as well as the "demonstration" nature of the projects being serviced.

3.3.3. From the DoE side:

- As unfortunately observed in many other countries, to introduce an efficient and sustainable rural electrification institution empowered with sufficient financial and human resources to be operational is a tricky challenge not yet met in Fiji. DoE does not have the sufficient human and financial resources to properly manage the solar electrification projects. As in every governmental institution, DoE is subjected to political instability and demagogy, processes that are not consistent with rural electrification development that can only be sustainable within a long term continuous management process.
- In the actual case of Vanua Levu, DoE has not enough inner financial and human resources to properly organize the RESCO project [10]. Field missions are rare and the monthly reports provided by the RESCO are barely considered. There is no specific software to store the detailed data on each SHS whereas that could be a very useful tool, therefore DoE does not have the capacity to establish a beneficial and constructive relationship with the RESCO in order to improve its efficiency, something that should be one of the main roles of a supervisor. Some external timely assistance from PICHTR is provided to DoE, but this seems to be insufficient to overcome the day to day problems of management.

- Concerning the financial management of the current RESCO program in Vanua Levu, DoE admits that the fund collected from the users' fees is not sufficient to provide maintenance contract and component replacement, despite a fee collection rate above 85%. At the moment, the entire fund is allocated to RESCO and component replacements, whereas theoretically, one part should be used for internal DoE operations and another to enlarge PV electrification. Since previous SHS project were 100% granted (no contribution from beneficiaries or the Government), the DoE has to admit that the current F$14 monthly fee is even not sufficient to cover the actual cost of the PV energy unit, particularly with the relatively high frequency of component replacements that has been required.

In spite of the numerous weaknesses highlighted beforehand as a part of the study, the nearly 10 years of experience of Fiji in simulated RESCO based solar electrification has been of great value in pointing out those weaknesses and in helping determine processes for their elimination and remains today as an outstanding background for large scale project design.

4. Principal conclusions on RESCO project sustainability

Based on the background and review work conducted by Wade H in 2003 on RESCO experiences spread over four continents, several aspects observed throughout several countries bear directly on the design of RESCO projects for Fiji. Most project difficulties result from institutional issues, not technical failures. The use of institutional models that have had a good rate of success is even more important than using components that have been well tested under local field conditions. Policies are useless unless enforced. Sufficient institutional will to carry out the policies and adequate resources for enforcement must accompany policy decisions.

The rate of collection of fees strongly correlates with system reliability, customer service and the disconnect policy for non-payment. There DoEs does not appear to be a correlation between the rate of fee collection and the method used to collect fees. External supervision of local technicians is necessary for quality maintenance, as well an adequate local spare parts stock for customer satisfaction and service continuity. Fiscal operations for projects should not be controlled at the village level. When controlled externally, they need to be transparent so users know how their money is being used. There appears to be a direct correlation between long term project success and the level of input of the private sector in operation and maintenance of SHS.

Government has not been generally successful in providing quality aftermarket support of PV rural electrification. System abuse correlates closely but inversely with customer satisfaction. That is: with lowered satisfaction, abuse increases. Fees need to be regularly reviewed and adjusted to meet changing conditions. There often is a high turnover of field technicians and a continuing recruitment and training program is necessary where there is large scale implementation of SHS. The use of components that cannot be comprehensively field tested for proper operation increases repair time and maintenance costs substantially while lowering customer satisfaction. The use of prepayment meters for solar implementation has not, by themselves, resulted in high rates of collection but has increased initial cost, lowered system reliability and increased maintenance costs. There is an inverse correlation between system complexity and system reliability. The more complex the system, the lower its' overall reliability and the higher the maintenance cost. Locally manufactured electronic components (lights, controllers and DC/DC converters) can provide high reliability service if the design is attuned to local conditions and quality control is maintained.

It is clear that the RESCO concept is one that can work well and can allow solar energy to be successfully used for large scale rural electrification. The most successful long term projects have been ones where O&M is provided commercially with no government input of either subsidies or direct staff supports [2]. The difficulty the Fijian private sector has to access capital needed for capital investment in PV systems and considering the standard of service level needed by rural customers, the self-financed RESCO scheme observed in some countries is not practical for Fiji. Therefore the model that best fits the Fiji situation is that of Kiribati where Government provides the capitalization of the systems and fully turns them over to a commercial enterprise for operation and maintenance.

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