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Solar PV program in Fiji-Is it a RESCO Approach?

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ABSTRACT

Rural SHS electrification programs have been implemented in most countries in the Asia-Pacific region using a range of delivery and financial mechanisms. Most of these programs, however, have not managed to keep pace with population increases. In Fiji the Program is implemented by the Department of Energy (DoEF) and has been developed to provide electricity for lighting for remote households located in rural areas where supplying electricity via the grid is not an economic option. This research aimed to provide a better understanding on the Fijian SHS program. A survey was carried out to measure the program success and to understand the issues related to program development.

The approaches used in implementation of the Fijian program are similar to those adopted in other countries of the region. The reported lack of success of the Fijian program therefore cannot be readily attributed to substantive differences from other programs in terms of the approach being used. Survey results shows that the impacts of the program on social issues are positive. The concept of RESCO did not support the Fiji program. The program is relies on donor-supplied capital equipment to get started therefore not commercially replicable. All components under the program are owned by the Government and the tariff was designed only to cover the monitoring cost. It was found that the implementation of the program suffers from a lack of well developed support infrastructure. This manifests itself in weak monitoring and maintenance program that gives rise to significant technical problem. The program also suffers from lack of planning and policy. It is not a full RESCO program as the program is totally run by the Government and there is no service company who is responsible for the program. Government has not been generally successful in providing quality after sales support of the program. Overall, the program concept was good but it needs proper planning and implementation mechanism to make this program successful. There is a need to develop proper monitoring systems available under the program mechanism and ensuring quality service, quality components and implementation of the policy.

1. Introduction

One component of the rural electrification program in Fiji that is implemented by the Department of Energy of Fiji (DoEF) involves the now standard approach of installing solar home systems (SHS) on houses in rural villages that are remote from the grid. Although the approaches used in the implementation of the Fijian SHS program are similar to those adopted in most of the other SHS programs that are being implemented in other countries in the region, many of which are relatively successful, the Fijian program has been reported to have experienced several problems that have impacted on its success (Gonelevu, 2006). This study followed on from a previous survey of program implementers in the Asia Pacific region (Urmee *et al.*, 2008, Urmee *et al.*, 2009) and was undertaken in order to better understand the reasons behind the reported limited success of the Fijian SHS program. It involved a comprehensive survey of all stakeholder groups associated with the design and implementation of the Fijian SHS program, as well as users of the solar systems installed through the program.

2. Background

Under the Rural Electrification Policy, endorsed by the Fijian cabinet in 1993, rural villages are able to request Government assistance for electrification. The rural electrification program is administered by the Rural Electrification Unit (REU) within the DoEF (Johnston *et al.*, 2004; Johnston, 2008). Under this program, the government provides 90% of the capital cost of remote area electricity supply systems and the community provides the other 10%. The Policy also includes a uniform tariff policy and regardless of the type of electricity generation system used to supply electricity to those in remote areas, or of the actual cost of electricity production, all customers are charged the same rate tariff that those on the grid on the main island of Vitu Levu.

The Fijian Energy Authority (FEA) has responsibility for supplying electricity to those on the main grid and another key element of the rural electrification policy is for the FEA to have a clear delimitation between the areas that will be connected in the future to the main grid and those areas that will not be connected at any stage, with the latter being eligible for support under the rural electrification policy.

Funding is provided to the REU from the FEA's budget and the limited amount of funding that is made available, combined with the cross-subsidisation policy, restricts the number of households that can be provided with access to electricity in remote rural villages to approximately 2,000 new households per year. As this is of a similar order to the rate of population growth, the rural electrification program is not currently resulting in a long-term reduction in the number of households in Fiji without access to electricity in the country.

Under the rural electrification program, rural villages have the choice of being connected to the main electricity grid, where this is technically and economically feasible, or having a village mini-grid supplied by a standalone diesel generator or renewable energy system, such as a small hydro-electric scheme (DoEF, 2006). A third option of having solar home systems (SHS) installed on houses is offered to a relatively small number of villages on second largest island, Vanua Levu.

The first SHS trial program was initiated in 2000 with assistance from the Pacific International Centre for High Technology Research (PICHTR) based in Hawaii (Saturaga *et al.*, 2004). That pilot project involved the installation of 60 systems using a Renewable Energy Service Company (RESCO) model, with the government retaining ownership of the solar PV systems, and the RESCO having responsibility for installing and maintaining the systems. Households that had systems installed were charged a fee that was set to cover RESCO's costs of maintaining the systems and to provide a profit margin for the RESCO.

A further 96 additional systems were installed in 2002 using funding provided by the Governments of Japan and Fiji. Between 2003 and 2007, approximately 100 systems were installed per year, with a total of approximately 700 PV systems being installed under the program by 2008. The most recently installed systems comprise two 55 Wp solar panels, a 100 Ah open cell lead acid plate automotive type battery, an Enercash charge controller with a prepayment meter, three 11 W CFLs, a LED night light and a DC plug that can be used to operate a radio. Householders pay F\$14 (AUS\$9.70) for a card, purchased through local post offices, with a code that is used to activate the charge controller for a period of one-month.

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3. Survey

The purpose of the survey was to better understand the reasons for the reported lack of success of the program. It was considered that by surveying all stakeholders, including government policy makers, program implementers, system users and service providers responsible for installing and maintaining the systems, the extent of any lack of success and the reasons for that lack of could be better understood. The survey used a combination of socio-economic analysis and program evaluation techniques, including structured, semi-structured and open-ended interviews, focus groups, household surveys, and participant observation. This information was used to comment on the program's success and its strengths and weaknesses, the extent to which it has been successful or unsuccessful, the primary reasons behind this success or lack of success and the factors that constrain its potential to expand and to become more sustainable without ongoing funding support from government or from international donors.

The number of those in each category interviewed during the survey is as follows:

- Policymakers: 4
- Implementing agency : 1(as there is only one agency, 4 staff involved in the program implementation were interviewed)
- Private company providing the maintenance and monitoring service: 2
- Donor agency: 1
- Households/System Users: 100 (using a questionnaire survey schedule)

The survey results were categorised into one of four broad criteria [implementation mechanism, financial mechanism, social, policy], which were coded into sub-criteria and further coded into concepts (Table 1). This was done in order to aid an understanding and evaluation of the program. Using these categories, the survey results were analysed using the NVivo qualitative software program (Richard 1999; NVivo, 2008), with each criteria illustrated by a model imported from the NVivo program.

Table 1: Criteria, sub-criteria and concepts used

Criteria	Sub-criteria	Concepts
Implementation mechanism	Institutional approach	Objective of the program
		Institutional framework
		Supply Chain
		Market demand assessment
		Range of system offered
		System size determination
		Program Actor Selection
		Awareness development to users
	Technical performance and training	Users training
		Technician training
		Technical performance evaluation
		Training manual
	Maintenance & Monitoring	Reliable customer service
		Component selection process
		Regular monitoring

Table 1 Continued.

Financial Mechanism	Funding	Criteria for funding	
		Funding Sources	
		Financing through bank	
	Cost Recovery	Loan repayment	
		Monthly Fee	
		Revenue Collection	
		Tariff	
	Economical perspective	Affordability of the users	
		System price	
		Income generation	
		Affordability of the users	
	Social	User's Behaviour	Cultural difference
Attitude towards system			
Satisfaction level		Customer satisfaction	
		Social impact	
		Decision making	
		Relationships with service providers	
		Requirements	
		Gender issues	
Policy		Lack of policy	Lack of policy
			Implementation of policy
	Rural electrification policy		
	Government requirement		
	RE Policy	Government Policy	
		Country specific need	
		Conflict between grid and RE	
		Future plan for electricity access	
	Policy advocacy		
	Bureaucracy		

4. Survey results

Institutional criteria

A survey of system users found approximately 20% of installed systems to be faulty fail. This corroborated the findings of the earlier study that the Fijian SHS program was experiencing problems. The private maintenance company reported that when it took on the contract for installing and maintaining systems in July 2007, it had found 30% of existing systems, and over 50% of systems in some of the more remote villages, to be faulty. Most of the faults in the installed systems resulted from a lack of maintenance, and particularly from a failure to top the batteries up with distilled water at least once every three months and to clean and check the battery terminals.

One of the reasons for this lack of maintenance stems from a decision by the DoEF not to provide training to users on how to use and to maintain their systems or to provide manuals with the basic DOs and DON'Ts to system users. The reason for this decision on the part of the DoEF has been a preference for any maintenance work to be undertaken by trained maintenance staff employed by the contracted maintenance company rather than by untrained users.

A second reason for the high number of systems that were found to be faulty is that the maintenance company advises the DoEF of any faulty components, such as batteries or lights, but no maintenance is undertaken on the system until the DoEF advises on whether the faulty component is to be replaced or not. This makes the maintenance process both protracted and expensive.

The current limited private sector involvement in the program was put forward by some as primary cause of the program's limited success and some stakeholders expressed a view that the maintenance program would be improved if the program was implemented on a RESCO model to the greatest degree possible rather than the government retaining both the ownership of the solar systems and the responsibility for monitoring and maintaining of the systems. The DoEF held a diametrically opposed view that while its intention is to hand over responsibility for the program to the private sector at some stage, that has not been possible to date as local businesses have not yet developed the necessary technical, financial and managerial capacity and the experience to effectively take on this responsibility and that neither of two companies that currently offer this service possesses the necessary resources required. Neither, for example, has a portable battery charger in either the field in remote sites or in their local offices. Recharging batteries can therefore take users several days due to the need to take their batteries to the company's head office, leave them to be charged and to then return with the charged batteries. This is required even to top up their batteries with distilled water, making the task of maintaining the systems onerous and time consuming for both customers and the private service provider.

The lack of resources and of capacity within the private sector appears to be to some extent the result of a chicken and egg impasse, with local businesses unwilling to invest in developing capacity and expertise while the number of solar systems installed

through the program remains too low for a private company to be able to operate a successful maintenance business. Government stakeholders indicated that they had recognised this problem and the need to facilitate the development of businesses that could be involved in the program.

The lack of resources and capacity is reflected in the system for supplying replacement spare parts. Spare parts, including batteries, are not stocked by the company contracted to provide the maintenance service and if replacement parts are required, the company sends a list to DoEF head office in Suva, which dispatches the required equipment. The time between a fault being diagnosed and the equipment being replaced can be up to three days if the DoEF has the spare parts in stock. If not, and the DoEF has to call for tenders for the supply of the parts, it can take over a month. During this period, the user is using the monthly credit card that has been paid for to operate the system although the system is not operating.

The government provides customers with new lamps when their lamps burn out. Under a service type of mechanism, lamps would be the property of the customer rather than property of the service providers, as is the case with grid connected systems. The DoEF also needs to purchase new batteries every three to five years, depending on the status of the battery. Because the DoEF needs to source funds to purchase new systems as well as provide new parts for existing systems, this puts strain on its resources and makes the program vulnerable. The limited funding made available to DoEF therefore places a serious constraint impacting on the program's successfulness as it is the primary reason for the low numbers of systems installed to date. Furthermore, the resources currently allocated to the program are insufficient to enable the DoEF to have field offices or outlets in remote areas where the systems have been installed. This results in a situation in which DoEF staff require a minimum of two days in some cases to reach an area in which systems have been installed.

A major weakness of the program from the perspective of some stakeholders was the lack of choice over system size offered through the program, with only one size being offered. While recognising that users differ in both their needs for electricity and in their ability to pay, stakeholders from the DoEF expressed a reluctance to modify the program to offer different sized systems. The reasons for this reluctance included wanting to avoid overstressing the limited resources available to the DoEF to implement the program, not wanting to increase the DoEF's workload, and not wanting to compromise or complicate system quality compliance. DoEF stakeholders however reported that the single strongest reason for not offering a range of systems sizes to users stemmed directly from the Fijian culture of not differentiating government services on the basis of household income or ability to pay.

5. Financial criteria

The DoEF undertook a survey prior to program implementation to determine the type and amount of kerosene, benzine and other fuels used for lighting, and the amount spent

on these fuels, in the target rural communities. Based on this information, the DoEF calculated the amount of kerosene that a SHS would displace and how much the household would save by avoiding the need to buy kerosene. The monthly charge for a SHS was then set at a fixed amount to make the SHS a more attractive financial option than buying kerosene. That is, the cost of the card that householders pay each month to activate their systems was not calculated on the basis of the cost of operating and maintaining the systems, but on the typical monthly amount that a household paid for kerosene for lighting. The cost of kerosene and benzine, however, has increased significantly since the survey was undertaken and those without access to electricity that are still using kerosene and benzene for lighting are paying significantly more for their lighting than are those that have had SHS installed. The monthly charge for a SHS, however, had not been changed at the time the survey was undertaken.

The monthly amount that householders are charged, A\$9.70, does not cover system replacement costs, but only the costs to the post office of administering the sale of the activation cards and the costs of the contract for the maintenance service provider, which includes a portion of the costs of spare parts. The DoEF stakeholders interviewed estimated that if monthly charge was set at a level that reflected the actual full cost of the program, the charge would need to be at least doubled. While some of the policy and program implementer stakeholders interviewed expressed a view that the high level of subsidisation has had a detrimental impact on the successfulness of the program, most regarded the cross-subsidisation to be a political rather than an administrative decision and something over which they therefore had no control or say.

The low level at which the monthly fee has been set is compounded by the fact that a portion of householders with SHS do not purchase a card to reactivate their systems each month. The communal nature of the Fijian culture makes it easier for a household to not purchase a card as the SHS are commonly treated as communal property. Those that have not paid for a card to reactivate their solar system are able to go to other houses in the village and use their electric lighting for studying, etc. The portion of households that do not purchase a card is as high as 30% in some villages. In theory, if this occurs for three consecutive months the household's system is removed. In practice, however, a time-lag of a couple of months in information on the number of cards that have been purchased in a village being received by the DoEF means that this policy is not effectively implemented. And even once the DoEF becomes aware that a portion of households with systems have not purchased cards to activate their systems, it is difficult for the DoEF to identify which households have failed to do so. It was reported by some stakeholders that in some cases, although no one had lived in a house for a long period and the DoEF had not been collecting fees for the system, the system had not been removed.

Another problem with the fee collection system occurs in cases where the village is distant from a post office. In these cases, the DoEF appoints the village headman to sell the codes and to collect the money paid by households. The arrangement between the

DoEF and the village headman is informal and the money is sometimes not collected by the DoEF for several months.

The Fijian culture also influences the SHS program in another important way. The primary driver behind the SHS programs implemented in some countries is to provide householders and businesses with a means of increasing their incomes. The electric lighting is used enable household members to work after sunlight or the electricity is used to offer a service such as mobile phone charging. A part of the additional income generated is then used to repay for the SHS. In the case of these Fijian village communities, however, not only are there limited business opportunities available in these remote rural areas, but the survey of households indicated that those living in these communities tend to be happy with what they have and that their goal is not to increase their work hours in order to become wealthier. The primary value of the SHS to those living in these communities is to increase their comfort. Even this, however, is not a straightforward driver for the SHS program as the culture in these communities is to place more importance on the afterlife than on comfort in this life.

6. Social and environmental criteria

User satisfaction with the systems installed through the program is high. The SHS are considered to be reliable and to be financially attractive option compared to kerosene, benzine, dry cell batteries or small petrol generators. Users reported several benefits apart from increased comfort, including improved capacity for children to study at home, a cleaner indoor environment, the facilitation of social gatherings and an ability to undertake activities during the evening that they were could not be undertaken using kerosene or benzine lamps.

The low number of complaints about the adequacy or performance systems reported through the survey may have been due in part to the Fijian culture of not complaining about government services. The main dissatisfaction expressed over the program concerned the inflexibility of the service and the necessity for users to go to a post office to purchase an activation code. This was an issue for those in the more isolated villages for whom a return trip to the post office could take up to a full day. A number of users interviewed expressed a willingness to pay a higher fee if a larger system was installed.

7. Policy criteria

Those interviewed that had responsibility for implementing the SHS program maintained that the clear policy demarcation between the areas that will be at some stage connected to the grid and those areas where the grid will not be extend to greatly assists in achieving the program's goals. Many of those interviewed also expressed the view that the SHS program needed to be customised to suit the cultural and other needs of those in the communities, with community lighting being particularly important.

Several respondents mentioned the lack of a specific Fijian renewable energy policy to be a problem for the SHS program. Political instability and changes to government policies that supported the renewable energy program were regarded by many to be a major contributor to the limited success of the current SHS program. A negative change in policy that was cited was the reversal of the former government's decision to waive the import excise on solar systems in order to encourage the use of solar energy.

Several of those from private companies that were interviewed raised the difficulty in dealing with government processes, with the two years that had been taken by government to select maintenance and monitoring contractor cited as an example. This was given as one of the primary reason for private companies not being enthusiastic about participating in the program.

8. Stakeholders' views on barriers to program success and possible improvements

Stakeholders were asked what barriers they had encountered during the design, implementation and post-operation stages. Some respondent mentioned data management as the main barrier as without this is would be difficult to increase revenue to be increased. It was recognised that until the DoEF has accurate monthly reports of the number of households that have purchased a card, it would remain difficult for the DoEF to obtain a clear picture of the revenue shortfall and to take action to reduce future revenue shortfalls.

The lack of an adequate monitoring and maintenance program was a major cause of concern for many stakeholders. The cause for this, however, tended to be attributed to the lack of funding provided to the DoEF to implement the program as is accepted that finding a company capable and willing to do the work within the budget offered by the DoEF is not easy. Some recognised that a part of the solution was the need to increase the cost to households for the cards used to reactivate their systems as the revenue collected from the sale of the cards does match the actual maintenance and replacement costs.

Policy makers, implementers (DoEF) and the maintenance service provider were asked how successful they considered the program to be. Many were of the view that the program could be improved. Many saw a need for DoEF staff to have more regular contact with users, for users to be better informed on what their systems were and were not able to provide, and for training of users to maintain their systems.

9. Discussion

The Fijian SHS program is successful to the extent that those that are provided with access to electricity through the program report improvements in their quality of life, a general satisfaction with the performance and reliability of systems, and a financial gain

from paying a lower amount in monthly SHS charges than they would for an equivalent amount of lighting from kerosene or benzine. The program is also successful in terms of achieving its objective of using solar home systems to provide electricity for lighting to rural households. The real question is whether that objective can be achieved more effectively and more efficiently so that the numbers of those that are provided with access to electricity in this way can be increased and in a way that results in improved system performance.

All stakeholders, however, recognise that the program has several major weaknesses, all of which impact to varying degrees on the success of the program in terms of the numbers of systems installed each year, the proportion of installed systems that are faulty, and in the inefficiencies in the revenue collection system. Not all stakeholders perceive the same weakness and there is disagreement among the different stakeholder groups on how readily some of these weaknesses can be remedied. In reality, some of these weaknesses are likely to be more intractable than others, with those that stem from the Fijian culture likely to be the most intractable. Those cultural issues will continue to have a major influence on the overall nature of the program and its objectives. The lack of interest on the part of those living in remote rural communities in using their SHS to increase their income levels, for example, means that it would be difficult to radically change the program from that of a government program based on subsidies to one based on micro-credit provided by private financial institutions as the latter requires system owners to use their systems to generate income to repay the loans. Similarly, the strong cultural ethic of not differentiating government services based on ability to pay or household income is likely to cause resistance to any proposals to have a range of system sizes offered through the program.

Those weaknesses that result directly from Government policy are unlikely to be as intractable, but are nonetheless likely to be difficult to change. It is completely understandable, for example, for a government to regard the provision of access to electricity as a service and to be willing to subsidise programs aimed at achieving this. The governments of many developed countries in the early Twentieth Century had rural electrification programs in place and some continue to use uniform tariff policies that was funded using a cross subsidy by inflating electricity prices paid by urban electricity customers in order to reduce the price for rural electricity customers. The subsidisation of SHS, however, is not a cross subsidy but a direct government subsidy and is a double edged sword as the funding provided to the government agency vested with the responsibility for implementing the program is limited and this severely constrains the degree to which the Fijian Government's rural electrification policy can be achieved.

Other weaknesses in the program arise because of the small scale of the program. Implementing a SHS program in which less than a thousand households participate, for example, requires a very different approach to a program in which there are hundreds of thousands of participating households, such as the program implemented in Bangladesh. The major constraint associated with a small program is the limited ability to attract the

involvement of the private sector as the scale of the business activities and the profitability will be low. Given that only two companies have been established to date and only one of these is operating and therefore has a virtual monopoly status suggests that the slow and steady approach being pursued by the government to development of business capacity and the facilitation of private business involvement is perhaps a cautious but prudent one.

The critical question for the Fijian program are which weaknesses can be most readily addressed given the constraints imposed on the nature of the program by virtue of the cultural and policy framework in which it is implemented.

The single largest improvement in the program that appears to be most readily achievable relates to training for system users. It was apparent from the survey results that the high number of faulty systems was due to a lack of maintenance and that training of system users would be one option for reducing this problem. Providing users with a manual that indicated the Do's and Don'ts would also assist in minimizing maintenance cost of the program. It may also have the effect of increasing users' sense of ownership and, therefore, their willingness to take on greater responsibility for system maintenance. Preparing and providing users with such a manual, however, requires a budget and is therefore a policy issue.

Another problem that has limited the success of the program to date and which may be more readily remedied than some of the other problems is the current lack of availability of spare parts. The development of local business capable of building and supplying spare parts would greatly assist in reducing the time required for replacing spare parts and would also assist in managing the increase in costs of spare parts where these are imported. Locally manufactured electronic components (lights, controllers and DC/DC converters) could provide reliable components if their design suited the local needs and if quality control is maintained.

Improved collection of payments for the cards for activating systems would also greatly improve the strained finances of the program. Another factor impacting on the success of the program is the frequency of the fee collection. This issue is closely connected to user satisfaction, which is likely to be strongly correlated to system reliability, and therefore, to the training of users to maintain their systems. Improved data systems for recording which households have purchased cards to activate their systems and which have not would also increase revenue by making an effective disconnect policy possible.

While the Fijian Government may be unwilling to increase the funding for the program, it would appear to be possible to increase the funding available by increasing the monthly charges that users pay. The current charge is not only heavily subsidised but was calculated on the basis of the amount that households paid for kerosene several years ago, and the price of kerosene is likely to have increased over the interim period. An increase in the monthly charge, while still keeping the costs of a solar system the

cost of using kerosene for lighting should therefore be possible. If the charge was increased, however, it would be important to first address the system maintenance issues to increase system reliability. .

In summary, the solar program in Fiji suffers from the limited funding that is made available to those implementing the program. The problems that this creates are compounded by low revenue collection, limited maintenance capacity and the small scale nature of the program. The success of the program could be increased through several relatively simple measures, none of which would involve large costs.

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