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Policy Approaches and Tariff Structures to Maximise Renewable Energy Uptake in Pacific Island Grids

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Abstract

Pacific Islands are at the forefront of the trend towards high or even 100% renewable energy penetration of their electricity grids. Many have been highly or totally reliant on imported diesel fuel, with associated price uncertainties and GDP impacts. Countries like Fiji are highly reliant on hydro power and become vulnerable in periods of low rainfall, such as during El Nino events, when diesel use increases. All Pacific Islands are prone to cyclones, making technology choice and installation requirements harder. In addition, transport of equipment, installation and maintenance can be extremely challenging, and further limit feasible options.

Renewable energy-based electricity has the potential to improve the quality of life in many remote islands and also to stabilise power costs across the region. Many Pacific Island countries have introduced renewable energy targets or support policies and some, such as Tokelau, have successfully moved to 100% renewable supply, with a PV/battery system. Policy approaches across the region vary and are often complicated by reliance on aid funding, which in turn has its own drivers.

In this paper we propose criteria for assessing the viability of renewable energy support programs, discuss some options suitable for use in Pacific Islands and examine the implications for electricity tariff setting.

1. Introduction

Renewable energy-based electricity has the potential to improve the quality of life in many remote Pacific islands and also to stabilise power costs which are currently heavily reliant on imported diesel fuel (Dornan and Jotzo, 2011). Many Pacific Island countries have introduced renewable energy targets or support policies (IRENA 2013)[1] and some, such as Tokelau, have successfully moved to 100% renewable supply, with a PV/battery system (3News, 2012). Nevertheless, implementation of renewable energy programs brings its own problems: countries like Fiji are highly reliant on hydro power and becomes vulnerable in periods of low rainfall, such as during El Nino events (ABC, 2012); all Pacific Islands are prone to cyclones, making technology choice and installation requirements harder and more expensive; transport of equipment, installation and maintenance can be extremely challenging due to distances as

[1] For our purposes, the following definitions are used: ***policies*** represent government objectives (eg. encouraging the construction of renewable energy), ***policy mechanisms*** are types of approaches to carry out such policies (eg. feed-in tariffs) while ***policy programs*** are actual implementations (eg. feed-in tariff design for distributed generation).

well as restricted and infrequent transport services – with many islands only accessible by small boats.

Policy approaches across the Pacific region vary and are often complicated by reliance on aid funding. The latter can be tied to specific technologies, which may be costly to integrate into existing systems: or available for capital equipment only, leaving the burden of ongoing operation, maintenance and replacement costs to the local utility. For utilities aiming to achieve financial sustainability, adding donated equipment to their asset bases may also increase rather than decrease electricity tariffs, thus creating social - and political - problems.

Given this context, there is a need for a rigorous set of criteria to assess the viability of different types of renewable energy support programs, and their impacts on electricity tariffs.

2. Criteria for Assessing Renewable Energy Programs

Processes used to drive the uptake of renewable energy can be divided into those which are primarily concerned with program design, those focussing on implementation and those concerned with eventual evaluation in order to test how well policy objectives have been met. Combined, these should form an ongoing process, where further program design and implementation follow on from the initial evaluation process, and so on, so that the mechanisms and programs can be refined and adapted to changing circumstances.

In this process, separation of powers between the ‘designer’, ‘implementer’ and ‘evaluator’ is important, firstly to reduce perceived or real conflicts of interest, especially where the evaluator is publicly reporting on outcomes that are relevant to public welfare, and secondly to inform revision of the program design. Managing the interface between each stage is very challenging for complex programs, while the need for program revision must be balanced with the need for investor certainty and the reduction of sovereign risk.

Figure 1 below illustrates one possible decision-making framework suitable for renewable energy support programs. A program is designed at the ‘Governance’ level, implemented by the ‘Scheme Administrator’, and evaluated by the ‘Regulator’. For each policy mechanism or program implemented, the roles and potential conflicts of interest of these various parties are important, as is independent evaluation - not only to ensure they do in fact operate well, but that they are *seen* to operate well and fairly.

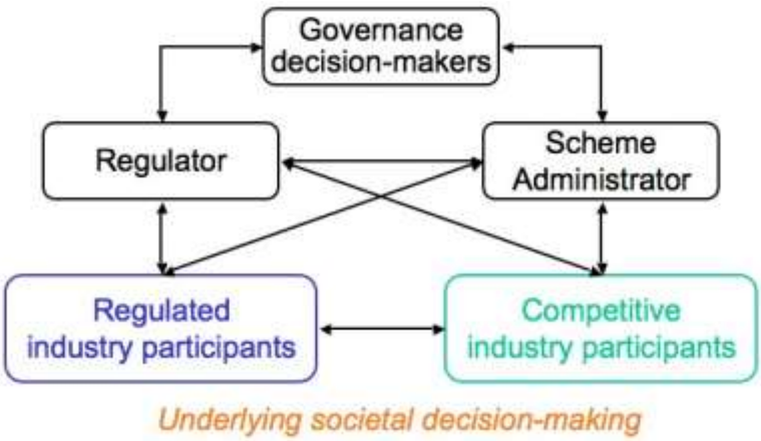

Figure 1. Decision-making framework for a competitive electricity industry (Passey et al., 2008). Note: All arrows are bidirectional to indicate the two-way flow of influence between the various participants.

In small jurisdictions such as Pacific Islands, complete separation of powers between the above participants is not always possible. The most likely compromises are where the Governance and Administration bodies are combined, but it is even possible for there to be overlap between the Governance body and the Regulated industry participant. It is therefore even more important for transparent processes to be in place so that, for instance, critical issues or poorly operating programs can be identified early and rectified, equipment suppliers and installers can be held accountable for warranties, and local customers feel their concerns will be dealt with fairly.

2.1. Program Evaluation

Program evaluation by an independent 'Regulator' is critical to successful delivery and should be ongoing (ITP, 2014). It needs to be built into the program design from the start, not left until the final program review, to ensure the criteria for evaluation are understood from the start and also that relevant data are being collected for a proper evaluation to be undertaken. The relevant steps could be:

1. **Monitoring** of uptake, issues and outcomes to facilitate evaluation: Benchmarking before the program goes ahead would be useful, while processes to record details of uptake and issues arising will need to be in place from the start.
2. **Assessment** of monitored results to assess trends, costs and other aspects: This can be done monthly or quarterly, with an annual progress report also recommended. In this way, issues can potentially be resolved while the program is underway, thus enhancing the chance of success, while end of program reviews should be easier to manage, with no surprises for the government or the funding agency.
3. **Recommendations for revision** and adaptation of programs: These should be based on the assessments, to ensure they remain relevant, that lessons learned are acted upon, and to respond to changing circumstances, including prices, new technologies or information. These recommendations are passed on to the 'Governance' level where adjustments can be made to the program design and also taken on board for new programs.

The following assessment criteria[2] can be used to evaluate programs once they have been operating for some time, as well as at program completion.

- **Effectiveness:** For instance, how effective is the program at deploying plant that generate the expected amount of renewable electricity over a given timeframe?
- **Efficiency:** Is the program able to deliver renewable energy at low cost, and are there any other cost impacts?
- **Equity:** Are the costs and benefits of the scheme distributed fairly?
- **Administration:** Is the program easy or difficult to administer, including any relevant data collection, auditing and compliance requirements and costs?

3. Examples of Governance Arrangements and Evaluation of Support Options for Renewable Energy in the Pacific

There are many different ways that renewable energy uptake can be supported. The most appropriate way or ways will depend on the local circumstances, but often it is the design,

[2] They are almost identical to those proposed by IRENA (2014) – Effectiveness, Efficiency, Equity and Institutional Feasibility.

implementation and evaluation arrangements that determine success. The following illustrates how these arrangements could be set up to increase the likelihood of successful outcomes for three types of policies implemented in Pacific Islands.

3.1. Competitive Bidding Programs

Table 1 shows the possible split of responsibilities for a competitive bidding or reverse auction process to solicit bids from independent power producers (IPPs) for the construction of renewable energy generation plant. It also highlights the issues that need to be considered to help ensure success.

Table 1: Possible Regulatory Responsibilities for Competitive Bidding Process for New Central or Mini-Grid Electricity Supplies

Role	Responsible party	Comment
Governance (design)	Regulator designs the auction process With input from the utility and government energy agency or department	There may be overlap between the Governance body, Administrator and Regulated industry participant
Administrator (implementation)	Regulator or government agency runs the auction	Transparent process needed with clear guidance on technical and financial requirements, plus capacity sought and timelines. Reasons for selections / rejections provided to all bidders.
Regulator (evaluation)	Regulator or government agency evaluates outcomes	Needs to be independent so it can effectively evaluate both scheme design and outcomes
Regulated industry participant	Utility	Sets the volume, locational preferences and connection requirements
Independent industry participant	Independent parties bidding in projects	Need to know the process is fair. Participation costs need to be minimised by provision of as much relevant information as possible. Need to provide financial credentials and be held to bid prices and timelines.

Table 2 summarises possible monitoring and evaluation criteria for such a competitive bidding process. The design should of course be assessed both before and after implementation, with the 'design evaluation' being *ex ante* (ie. of the expected outcomes) and the 'outcome evaluation' being *ex post* (ie. of the actual outcomes). The details of any subsequent revision would of course depend on the outcomes of the evaluation, but should follow the process described above, that is, the outcomes of the evaluation would be passed on to the Governance body, who would then alter the process for future auctions.

It can be seen that clearly defined program aims are important, as are data on pre-existing costs of energy supply and administrative processes (such as how to run an auction). Note that the administrative costs are likely to be higher for the first set of auctions as the relevant organisations familiarise themselves with the processes.

Table 2: Possible Monitoring & Evaluation Criteria for a Competitive Bidding Program

Role	Criteria
Effectiveness	Against target amount of generation capacity or output.
Efficiency	Electricity generation cost ($/MWh) compared to generators currently operating locally and regionally. Separately evaluate program administration costs and compare to other programs or processes. Can be converted to a per kWh administration cost for the electricity to be generated.
Equity	Type of impact on electricity prices, such as impact on electricity prices for end users and impacts on utility costs.
Administration	Cost of designing and implementing the auction and selecting the successful IPP(s).

3.2. Feed-in Tariff Programs for Distributed Energy

Feed-in tariffs have been one of the most common support mechanisms used world-wide to encourage customers to install their own distributed grid-connected renewable energy systems. Table 3 illustrates the possible allocation of responsibilities for a feed-in tariff program.

Table 3: Possible Responsibilities for a Distributed Energy Feed-in Tariff Program

Role	Responsible party	Comment
Governance (design)	Regulator Input from the utility and relevant government agency	Ensure all parties are in agreement on processes, target quantities and sizes
Administrator (implementation)	Utility	Overlap between Administrator and Regulated industry participant
Regulator (evaluation)	Regulator, government agency or 3rd Party overseen by these	o Uptake levels, system sizes, locations and customer categories o Net or gross; timing of any change from net to gross o Demographics o Administrative costs o Grid impacts o Impacts on FEA costs and subsidies

Regulated industry participant	Utility	Ensure standardised and straightforward processes are in place for grid connection approvals
Independent industry participant	Installers	Need to be provided with standardised processes for connection. Need to provide warranties and O&M schedules

Table 4 summarises the monitoring and evaluation criteria which might be used to assess a feed-in tariff program. It can be seen that a significant amount of data need to be collected in order to manage such programs over time, and to be able to provide useful information about their impacts. Note that not all customers will take up the option, yet it will be important to demonstrate that the benefits are shared – for instance, that electricity tariffs are reduced for everyone because of the avoided cost (of mostly diesel generation) being provided by renewable sources.

Table 4: Possible Monitoring & Evaluation Criteria for a Feed-in Tariff program

Role	Criteria
Effectiveness	Number, types, capacity, location and generation from RE systems connected to the distribution network. Assessment of any technical impacts, both positive and negative, location specific or otherwise.
Efficiency	Electricity generation costs achieved. Reduction in costs of central supply achieved. Administration costs, including managing the grid connection process, which could be converted into a per kWh cost. Administration costs may be higher initially as the necessary procedures are put in place. The implementation of standard procedures, processes and paperwork should decrease such costs over time.
Equity	o Survey residential recipients for income, housing type, system type, cost, size and reasons for installing. o Does the feed-in tariff rate represent the avoided costs of generation o Are the benefits distributed fairly amongst the population? o Depending on the program goals, are installations spread across income groups / customer types? o Is access to finance an issue?
Administration	Administration costs per MW installed, and per kWh, if different types of generators are deployed. Ensure administration processes involved in meeting technical connection and billing requirements are not onerous for installers. Procedures may need to vary for different technologies.

3.3. Off-Grid Solar Home System Support Programs

Pacific Island countries often include dozens of small islands, and in these situations, there is no form of grid and so Solar Home Systems are widely used. Table 5 illustrates the possible allocation of responsibilities for a Solar Home System program.

Table 5: Possible Responsibilities for Off-grid Solar Home System Programs

Role	Responsible party	Comment
Governance (design)	Government agency	
Administrator (implementation)	Government agency	Overlap between Governance and Administration which makes it even more important to have an independent regulator
Regulator (evaluation)	Government agency, Regulator or 3rd Party overseen by these	○ System numbers and sizes ○ Annual generation ○ % of people with access to 4 hrs electricity per day ○ End-user satisfaction ○ LCOE
Industry participant	Utility or Independent Installers	Need to be provided with standardised requirements for operation of SHSs. Need to provide warranties and O&M schedules

Table 6 summarises possible monitoring and evaluation criteria which could be used for off-grid solar home system programs. Again it can be seen that the more information that can be collected about the systems being deployed and the customers using them, the more useful the evaluation process can be. It is important therefore to establishing a process for monitoring and data collection at the program outset.

Table 6: Possible Monitoring & Evaluation Criteria for Off-grid Solar Home System Programs

Role	Criteria
Effectiveness	○ Number of renewable energy systems deployed. ○ Capacity of renewable energy systems deployed. ○ Annual generation. ○ Percentage of people with access to electricity for at least 4 hours a day. ○ Number of customers who pay their monthly fee. ○ Assessment of end-user satisfaction with the systems.
Efficiency	LCOE of systems compared to diesel or to costs of kerosene lamps displaced. Assessment of administration costs against effectiveness metrics

	identified above.
Equity	Number of systems installed, LCOE compared to the tariff paid by grid customers, quality of electricity services, including reliability and number of hours available.
Administration	Administration costs per kW installed, and possibly per kWh. These programs can be complex to administer, as reflected in the efficiency assessment above. As experience is gained and streamlined processes are put in place, administration costs should decline. If, over time, the sector develops to the extent where installers supply SHSs that they own and operate themselves, government administration requirements would be reduced to the development of standardised processes and occasional evaluation of the operations of the installers.

4. Impact of Renewables on Electricity Tariffs

Electricity tariffs in Pacific Islands are rarely cost-reflective. While this is common in other jurisdictions also, Pacific Islands have the added issues of very small customer bases, large sections of the population at or under the poverty line, high exposure to diesel and gas fuel price volatility, utilities and/or policies heavily influenced by political issues and influential stakeholders, and a heavy reliance on aid funds for infrastructure development (IRENA, 2013). This makes it difficult, even for the most efficient utilities, to establish cost-reflective tariffs and transparent processes for regular price adjustment. Nevertheless, many Pacific Island utilities are expected to operate sustainably, and even to provide dividends to government.

Social, and hence political, pressures to maintain low tariffs extend across all jurisdictions, not only in Pacific Islands. However, the relatively low average income of most Islanders, combined with the relatively high cost of electricity supply, means that cross subsidies between customer classes and via direct budget allocations under community service provisions or low income support payments are common.

Understandably, aid funding for increased renewable energy generation is proactively sought, as it promises to improve self-reliance, reduce price volatility and lower electricity prices. However, when renewable energy systems are donated by well-meaning aid agencies, the impact such systems have on the electricity cost structure of the incumbent utility is often overlooked. The problems arise largely because aid funds are typically attached to capital grants and not to ongoing operation, maintenance or equipment replacement. Utilities, while grateful for the new infrastructure, must nevertheless account for its operation, maintenance and replacement by adding it to their asset base. This means that, while energy costs may be reduced as renewable energy systems displace diesel fuel, regulated returns on asset value may increase and the electricity tariff may not be reduced as anticipated – it may even rise. This is difficult to explain either to the public or to the politicians who may have worked hard to secure renewable energy equipment donations. A related problem is caused by the need for utilities to maintain N-1 or N-2 reliability criteria. As renewable energy generators are added, more back-up or standby generation is needed, with diesel gensets often being the cheapest option. Asset values are increased even more, compounding the tariff impact. These issues need to be considered when assessing the long term sustainability of adding donated renewable energy systems to small grids, with allocation of aid funds to the operation, maintenance and future replacement of assets strongly recommended.

Other avenues to reduce tariffs should be considered alongside utility-owned renewable energy deployment, including support for the use of demand management and storage as options to achieve reliability goals; funding to ensure the ready availability and affordability of energy efficient appliances to maximise the benefits of all energy supplied; and examining options for supporting onsite, distributed energy options, such as solar water heaters and rooftop PV systems, to minimise grid power requirements.

5. Conclusions

Increased use of renewable energy in Pacific Islands will improve self-reliance and access to electricity, whilst also reducing exposure to international fuel price changes and the difficulties of fuel delivery to remote locations. Experiences with renewable energy deployment have had mixed results to date, with problems arising from a range of issues, including unclear aims, non-transparent processes for supply and connection, conflicting responsibilities and poor monitoring and evaluation procedures.

We have proposed some straightforward ways of separating the various responsibilities for renewable energy program delivery, indicating which party is most appropriate to fulfil each role and defining the sorts of actions each party should undertake. We have also suggested evaluation criteria which can be used as part of any program to ensure appropriate information is collected. Such data can be used to make adjustments as the program is rolled out, to evaluate outcomes after the program ends and to better design future programs. Three examples have been provided to illustrate how the governance arrangements can be made and the sorts of evaluation criteria which might apply.

Funding from the World Bank, the Asian Development Bank, other multinational aid organisations, as well as EU and country-based aid agencies, provide support services for governance. It is recommended that project/program-specific funding be accompanied by funds or direct assistance to cover the establishment of appropriate processes. As with ongoing operation, maintenance and replacement cost allocations post installation, ensuring proper processes are followed in the first place will assist in achieving better outcomes for energy programs than have occurred to date.

It is hoped that all renewable energy support programs in the Pacific, whether aid funded or otherwise, will benefit from the processes proposed in this paper.

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