REVIEW OF INTERNATIONAL BEST PRACTICE FOR RENEWABLE ENERGY DEPLOYMENT

Final Report

October 2014

Report to the UNDP

Formulation of an Independent Power Producer and Investment Framework for Developers of Renewable Energy Power Generation Projects in Fiji

(RFP/FJI0-007-14)

About IT Power

The IT Power Group, formed in 1981, is a specialist renewable energy, energy efficiency and carbon markets consulting company. The group has offices and projects throughout the world.

IT Power (Australia) was established in 2003 and has undertaken a wide range of projects, including designing grid-connected renewable power systems, providing advice for government policy, feasibility studies for large, off-grid power systems, developing micro-finance models for community-owned power systems in developing countries and modelling large-scale power systems for industrial use.

The staff at IT Power (Australia) have backgrounds in renewable energy and energy efficiency, research, development and implementation, managing and reviewing government incentive programs, high level policy analysis and research, including carbon markets, engineering design and project management.

About this report

This report is part of work commissioned by the UNDP to help Fiji meet its Renewable Energy Power Project (FREPP) goals. This work is intended to contribute to the revitalisation of the renewable energy market in Fiji, especially where IPPs are concerned. Of particular interest is the policy framework regulating both public and the private investments in renewable energy, and the incentives which could be applied to stimulate growth in the sector.

The work is divided into three components, a) the development of standard Power Purchase Agreements, b) the formulation of Investment Promotion Packages, and c) the assessment and development of Renewable Energy Incentive Schemes.

This report contributes to part c) and reviews international best practice regarding subsidy and incentive schemes that may be suitable for Fiji. It will be incorporated into the Final Report.

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1. INTRODUCTION

1.1. Project Background

The UNDP funded Fiji Renewable Energy Power Project (FREPP) addresses 4 categories of barriers to the widespread application of RE-based power generation in the country:

a) Energy Policy & Regulatory Frameworks;

b) RE Resource Assessments & RE-based Project Assessments;

c) RE-based Power Generation Demonstrations; and

d) RE Institutional Strengthening.

This project focuses on the third component — Renewable Energy-based Power Generation Demonstration. This component is intended to contribute to the revitalisation of the renewable energy market in Fiji, especially where IPPs are concerned. This report summarises some of the key policies, mechanisms and strategies used world-wide to support and increase the deployment of renewable energy technologies.

Separate reports as part of this project examine existing subsidies and incentives available in Fiji for renewable energy investment, power purchase agreements and suggested investment strategies.

Section 1.2 summarises best practice policy principles based on international experience.

Section 2 then describes the current state of play regarding international uptake of mechanisms used to drive renewable energy, before describing in detail the five most successful mechanisms. This section also describes four complementary policies that are required to maximise the effectiveness of the five primary mechanisms.

Section 3 then recommends specific support mechanisms for each of the four electricity submarkets in Fiji: centralised generation, distribution grids, mini-grids and off-grid generation. It also explains why some mechanisms, which are successful elsewhere, are unsuitable for Fiji.

Section 4 concludes the report with mention of polices which may not be immediately appropriate for Fiji, as well as key principles for successful deployment of those policies which are implemented. This includes the need for complementary polices and the removal of pre-existing policies which work counter to RE deployment goals, such as restrictive deployment practices and fossil fuel subsides.

1.2. Best Practice Policy Principles:

According to the International Energy Agency, the most successful policies to support the uptake of renewable energy (IEA, 2011):

- Provide a **predictable and transparent RE policy framework**, integrating RE policy into an overall energy strategy, taking **a portfolio approach** by focusing on technologies that will best meet policy needs in the short and long term, and backing the policy package with ambitious and credible **targets**.
- Take a **dynamic approach** to policy implementation, differentiating according to the current maturity of each individual RE technology (rather than using a technology neutral approach), while closely **monitoring national and global market trends and adjusting policies accordingly.**
- Tackle **non-economic barriers** comprehensively, streamlining processes and procedures as far as possible.
- At an early stage, identify and address overall **system integration** issues (such as infrastructure and market design) that may become constraints as deployment levels rise.

Fiji's draft Energy Policy provides a sound foundation for RE implementation. It will be important that programs and projects individually, and as a group, are consistent with the policy aims. This will facilitate infrastructure and capacity development, which will in turn improve the overall outcomes. For instance, development and use of standardised PPA templates will establish a transparent process for projects and provide more certainty in the market. This in turn will facilitate financing, reduce risk and lower costs. Similarly, establishment of standards and training for installation and maintenance of PV systems will facilitate both large and small-scale projects, while improving system performance and reducing long-term costs.

2. POLICIES AND MECHANISMS USED WORLD-WIDE TO SUPPORT RENEWABLE ENERGY

Globally, governments have introduced a multitude of regulatory and fiscal incentive programs that have been instrumental in building both the grid-connect and off-grid renewable energy markets to the point where many technologies, especially solar PV and wind, are now mainstream technologies which will establish themselves in diverse markets over the coming decade. By early 2014, renewable energy support policies were in place at the national or state/provincial level in 138 countries (REN21, 2014) – see Figure 1. Without these government support programs, it would have taken many more decades for the current development of the RE market to have occurred.

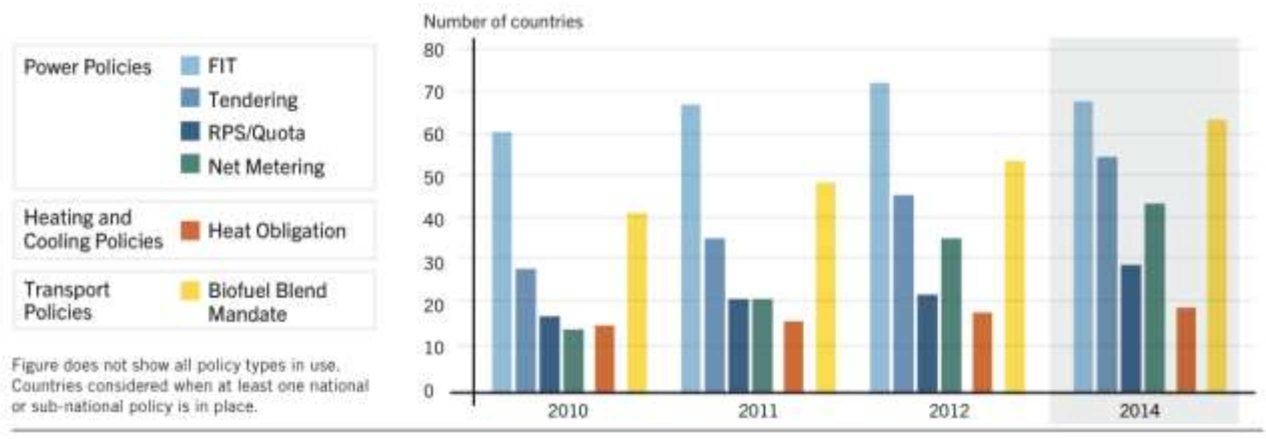

Figure 1. Number of Countries with RE Policies, by Type, 2010 to early 2014 (REN21, 2014)

Developing and emerging economies have led the expansion in recent years, accounting for 95 of the countries with renewable support policies in place by early 2014, up from an estimated 15 in 2005 – see Figure 2 (REN21, 2014).

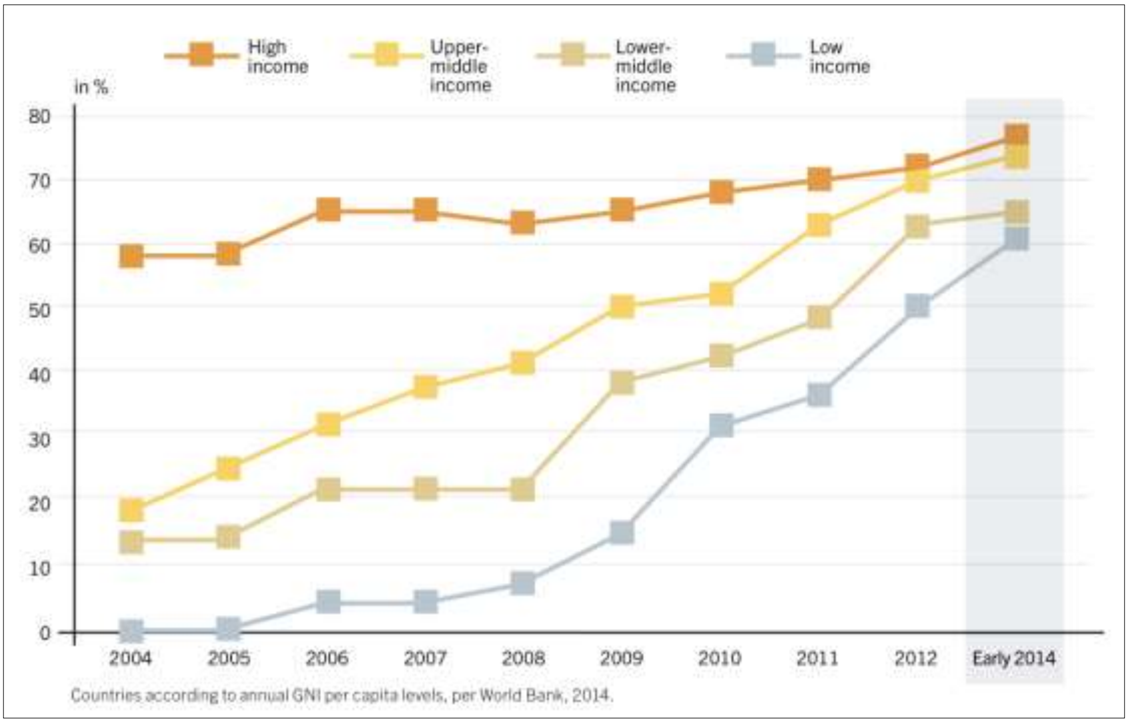

Figure 2. Share of Countries with Renewable Energy Policies by Income Group, 2004 – early 2014 (REN21, 2014)

As shown in Figure 3, the number of Pacific Island Countries with renewable energy and energy efficiency policies and targets has increased significantly over the last four years.

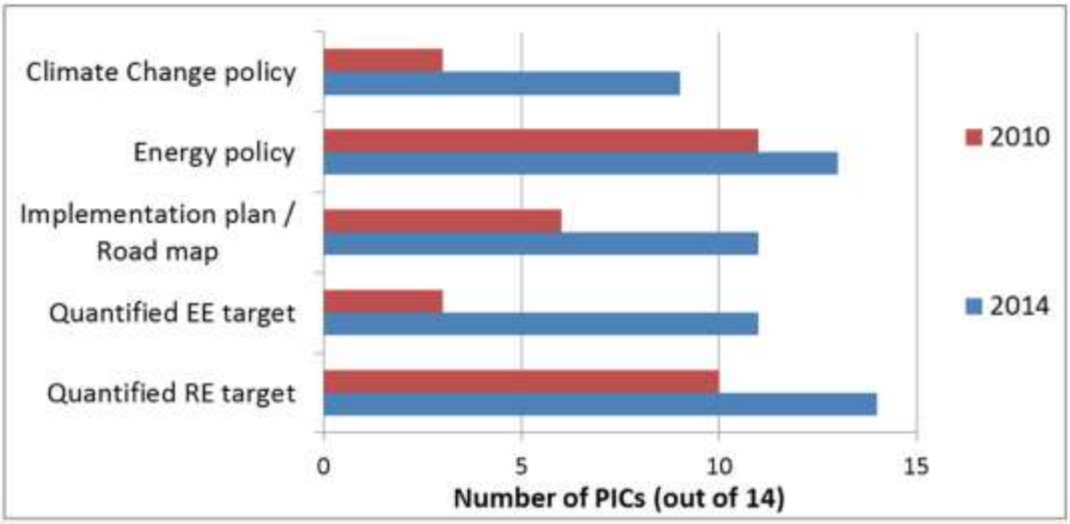

Figure 3. Pacific Island Countries with renewable energy and energy efficiency targets or plans (Syngellakis, 2014)

The most highly successful support mechanisms that have been implemented in numerous jurisdictions globally are (REN21, 2014; KPMG, 2011):

1. Competitive bidding
2. Renewable energy targets and portfolio standards
3. Feed-in tariffs
4. Capital subsidies
5. Tax incentives

Given the importance of each, they are described below. It is noteworthy, however, that generalising about each of these main policy mechanisms is difficult because globally there are a multitude of variations that have been applied to suit local circumstances. The mix of pros and cons also vary, in part according to whether deployment of a particular technology is in the early or advanced stages. No country or state has identical policies while complementary policy approaches are often also required.

This section therefore also describes important complementary policies / strategies:

1. Supportive building and planning codes
2. Supportive grid connection regulations
3. Government procurement / awareness raising
4. Research, development and demonstration
5. Local training and capacity building
6. Energy efficiency
7. Storage

In Section 3, specific policies from each of these types of primary and complementary support mechanisms are discussed for Fiji.

2.1. Competitive Bidding (Auctions or Tenders)

Competitive bidding for a set amount of renewable energy supply or capacity is an increasingly popular procurement mechanism for many Governments (REN21, 2014, IRENA, 2013b). The winning bid is usually that which offers the lowest price, with performance bonds increasingly being used to discourage unrealistically low bids (IEA, 2011). Competitive bidding is especially useful for large-scale technologies with high technological risk because they reveal the true market price and, for these projects the high transaction costs are less significant compared to overall project costs (ibid).

Public competitive bidding, or tendering, continues to gain prominence, with the number of countries turning to public auctions increasing from 9 in 2009 to 55 by early 2014 (IRENA, 2013b). Central and South American countries continue to be global leaders in renewable energy tenders. Brazil, which has held tenders for wind power for several years, included solar power projects for the first time in November 2013. Overall, Brazil's auctions awarded 4.7 GW of new wind capacity, 122 MW of solar PV, 700 MW of small hydropower, and 162 MW of bio-power during 2013. (Bloomberg, 2013). Chile held its first CSP tender in 2013; Ecuador held its first auction for solar PV; Peru allocated USD 3.6 billion for tendering of renewable energy projects designated to come on line by 2016; and Uruguay launched multiple solar power tenders throughout the year. In Central America, El Salvador announced tendering for the allocation of 100 MW of wind and solar PV plants.79 (REN21, 2014).

Case Study; Single Round Reverse Auction for 40MW of PV

The Australian Capital Territory government recently ran a single round reverse auction[1] process for an IPP to install up to 40MW of PV. It was run in a two-stage process with all bids having to pass through a 'pre-qualification' round to ensure that the proposals were realistic and the proponent could deliver. Those bids that met all the pre-qualification requirements, which included having approved grid connections and access to land or rooftops, could go through the fast track process. All others went through the regular longer process.

Out of 40 submissions, 22 bids were shortlisted for the fast track round and represented 148 MW of capacity. The winning bidder was Fotowatio Renewable Ventures (FRV), which won the auction with a bid of $186/MWh to build a 20MW solar farm at Royalla, 23kms south of the Canberra. The tariff is for 20 years and is not indexed to inflation, and would have been roughly 2-3c/kWh lower if it was indexed.

The second round, contested by 15 bidders, was won by two projects – a 13MW plant to be built by China's Zhenfa Solar and a 7MW plant to be built by Australia's Elementus Energy. Zhenfa's project will attract a fixed tariff of $178/MWh. It reflects a cost of less than $150/MWh when indexing is taken into account. The Elementus project, which will combine with a 3MW facility won during bidding for an earlier ACT government program, was bid at $186/MWh.

An independent review of the Auction process was largely positive, concluding that it effectively achieved all of its outcomes, resulting in a competitive process that provided the ACT Government with a number of high quality proposals to select from that offered relatively low FiT rates (thus providing value for money)[2].

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[1] A reverse auction is a type of auction in which the roles of buyer and seller are reversed. In an ordinary auction buyers compete to obtain a good or service by offering increasingly higher prices. In a reverse auction, the sellers (in this case the installers of the PV systems) compete to obtain business from the buyer (the ACT government), which results in the lowest bid winning.

[2] Sinclair Knight Merz, 2013. ACT Solar Auction Review. http://www.environment.act.gov.au/__data/assets/pdf_file/0004/581602/ACT_Solar_Auction_Review_-_Summary_Report.pdf

IRENA (2013b) suggests that, when implementing auctions or competitive bidding processes, the following should be considered:

- Type of auction: the sealed-bid reverse auction is simple, easy to implement, fosters competition and avoids collusion.
- Ceiling prices should not be disclosed to the bidders in order to ensure greater competition.
- Auction volumes must be determined in relation to the capacity of the market to deliver, particularly in markets with a limited number of local renewable energy developers and suppliers. Determining the optimal number of rounds and the volumes that would create greater competition is a challenge that requires learning by doing.
- Streamlined administrative procedures, with communication and transparency provided equally to all bidders, are essential to the success of an auction scheme.
- Strong guarantees and penalties are essential to the success of auction schemes, preventing potential underbidding and minimising the risk of project delays and completion failure.

Advantages

Competitive bidding can be a relatively simple and transparent process, which provides Governments with control of the amount and location of the capacity installed. Assuming that processes are put in place to ensure that bids are realistic, competitive bidding is a very effective way to identify the lowest viable market price for a particular technology.

Disadvantages

Establishing the bidding process may have high administrative costs and thus best suited to an ongoing set of calls. Transaction costs for bidders can also be high, since a great deal of the up-front project development costs would need to be done in order to submit a bid. As above, mechanisms need to be put into place to reduce the risk of unrealistically low bids.

2.2. Renewable Energy Targets or Portfolio Standards

Mandated targets for renewable energy are in place in 25 countries at the national level and 54 states/provinces in the United States, Canada, and India (REN 21, 2014). Such targets are widely used by State and central governments as a means of encouraging energy sector diversification, cleaner generation and as a means of meeting greenhouse gas targets. Such targets differ to those in place in Fiji. The Fijian target is currently 'aspirational', whereas a mandated target includes penalties for non-compliance.[3]

The mechanisms used to achieve the targets vary. They can be set as a MW target, sometimes increasing at a set rate over time, as in Australia (Australian Government, 2013), or as a percentage by a particular year. They can be technology neutral, have separate targets for a specified list of technologies, or provide different levels of support for each technology, depending on cost, stage of development or percentage penetration, for instance (UK Department of Energy and Climate Change, 2013). Many operate by placing an obligation on electricity supply companies to source a specified fraction of their electricity from renewable energy sources. Certified renewable energy generators earn certificates for each MWh of electricity they produce and can sell these along with their electricity to supply companies.

Renewable energy targets expose renewable energy projects to wholesale or retail market signals while providing an additional production incentive for renewable generation. As such they are a potentially strong driver for establishing renewable energy markets where conventional generation is entrenched and market access is otherwise difficult.

In Australia, small-scale (up to 100kW) renewable energy installations (including solar hot water systems) are supported under the Renewable Energy Target via a deeming mechanism which allows small generators to create a set number of certificates, depending on location, for generation over 15 years. This therefore operates as an up-front capital rebate, although certificate prices are set in the market and can vary.

In the US, almost all States have some type of renewable energy target or portfolio standard, with PV included in all programs. Though rules differ between States, trading of certificates is allowed between some jurisdictions (DSIRE, 2013).

Advantages

The primary advantage of renewable energy targets is that they provide a clear investment signal and, if the target is long term, can facilitate the establishment of industry infrastructure and capacity. Depending on their structure, they can promote competition between different types of renewable energy, arguably producing greater efficiency and innovation and delivering renewable energy at the lowest possible cost.

Disadvantages

Renewable energy target programmes are typically major regulatory interventions impacting numerous energy sector stakeholders, and they therefore are complex to establish and operate. Depending on their structure, and that of the underlying electricity market, complexities include that

[3] Aspirational targets do have role to play because they still have value in being a public statement of the government's support for renewable energy, and in allowing that commitment to be assessed against progress.

a separate market for trading renewable energy certificates must be created, the risk that market power may be exercised (where there are few buyers of certificates and so they can control the certificate price, for example in Fiji where the FEA would be the only buyer). There may also be high transaction costs associated with creating, trading and buying certificates, as well as ensuring compliance (MacGill, 2006; MacGill and Passey, 2009).

2.3. Feed-in Tariffs

Renewable energy feed-in tariffs, or buy-back rates for all electricity sent back into the grid (or just the portion in excess of a consumer's load) are a popular support mechanism. They now exist in 98 nations or states, with most of the recent adopters being developing nations.[4] The different types of feed-in tariffs are defined in the box below.

Different types of Feed-in Tariffs and Metering

Gross feed-in tariff: Where the tariff is paid on all generation regardless of how much is exported to the grid. Requires at least a two-channel meter.

Net feed-in tariff: Where the tariff is paid only on the electricity that is exported to the grid. Generated electricity that is not exported is used on-site and so is effectively paid the retail tariff. The feed-in tariff may be greater than or less than the retail tariff. Requires at least a two-channel meter.

Net metering: Where electricity that is exported to the grid is paid the retail tariff. Similarly electricity that is used on-site reduces the amount of electricity imported from the grid and so is effectively \ paid the retail tariff. Requires only a single channel, 'spinning disk' style meter.

Net billing: Can be applied to either gross or net feed-in tariffs and is where the payments for electricity generation and use are netted out over a certain period, normally the billing period.

Feed-in tariffs have been used in Germany in particular as the key mechanism to support increased uptake of a range of renewables, although their origin is probably the US PURPA Act of 1978, which compelled public utilities to purchase power from independent producers, where this would be a lower cost option (Watt and MacGill, 2014). In Austria, and then in Germany, gross feed-in tariffs were introduced in 2000, initially in conjunction with low interest loans, but then on their own, starting at multiples of the prevailing tariff. They have gradually been reduced as renewable energy

[4] REN 21

uptake rose and renewable energy system prices dropped. The tariffs available are set for each technology at the time of installation and paid for a set number of years (ibid).

Feed-in tariffs have been introduced in many other countries and with many variations (REN 21, 2012), but perhaps not as successfully as in Germany. In countries like Spain (a range of renewables) and Australia (PV only), feed-in tariffs were introduced then removed in a very short time, due to high uptake rates and concerns about the long-term payment liability. In Germany, the feed-in tariffs are funded via electricity bills, so that the payments are spread amongst all customers. However, there is often political concern about the impact on electricity prices, and in other countries, government budget allocations are often used to pay the feed-in tariff liabilities. As with any mechanism relying on annual budget allocations, the latter approach is prone to abrupt changes. As renewable energy technology and deployment costs have fallen, price impact is less of a concern, with PV and wind electricity now close to retail tariffs in many jurisdictions, and sometimes wholesale tariffs. In Fiji, depending on the location, PV electricity in particular may be cheaper than the marginal cost of generation from diesel fuel, and so reduce overall electricity costs.

Differentiated feed-in tariffs can be used to promote specific renewable energy types or applications. In France, higher tariffs are paid for building-integrated PV products, as a means of stimulating the local manufacturing industry. In Spain, initial support was also available for large utility-scale systems, and this section of the market boomed. Initial support in Germany also targeted farmers and other commercial enterprises, resulting in many mid-range (50 kW – 5 MW) systems being installed. These larger-scale installations were instrumental in ramping up market volume faster than was possible with smaller residential systems (ibid).

In 2013, new net metering policies were adopted in 5 countries at the national level, bringing the total to 43 countries (REN21, 2014). In Europe, Greece enacted a net metering programme for small-scale solar PV and small-scale wind plants; Latvia enacted a net metering policy that entered into force on 1 January 2014; and Ukraine launched a net metering programme that requires utilities, as of 1 January 2014, to connect residential solar PV systems to the grid within five days of project completion and the filing of an interconnection request. In Central America, Honduras approved net metering for systems smaller than 250 kW. Additionally, the Philippines adopted new interconnection standards, bringing into effect the net metering policy that was legally established in 2008.

In Fiji, current demand for PV is focussed in the mid-range (50 kW – 5 MW), particularly to offset diesel in resorts or agricultural applications, but also on the main grids for commercial businesses of various types. Support for PV has been through a net feed-in tariff of around 15c/kWh, although this may now be increased to the new 33.08c/kWh rate under the new IPP regulations stipulated by the Commerce Commission (note that FEA considers PV and other intermittent renewables as less valuable than power from plants capable of supplying 24 hours a day and so may wish to continue to pay the lower rate). The trial for residential PV is a combination of a gross feed-in tariff and net billing.

Advantages

Feed-in tariffs are a good mechanism for encouraging installation quality and performance, because customers are focused on their system output. They can be targeted to support particular technologies more than others, can be used to encourage generation at different times of the day as well as in particular locations. They can be structured to operate over a given timeframe and can be reduced gradually, or when predetermined installed capacity milestones are achieved, in order to avoid industry boom/bust cycles. The tariff structure may impact on customer load patterns. As shown in Western Australia, net feed-in tariffs set higher than the retail tariff may lead to customers minimising their own use during the times of PV generation, with the potential to increase evening peaks (Jones, 2012). In contrast, a net feed-in tariff that is lower than the retail tariff may encourage electricity use during times of generation, and so is less likely to increase evening peaks.

Disadvantages

The primary limitation is that feed-in tariffs only support grid-connected installations, although these can be any type of grid or power system where a tariff is paid per kWh of use. Where the feed-in tariff is funded through a budget allocation, there is a risk that it could be stopped suddenly, which reduces confidence and so can reduce the rate of installation.

Poor scheme design can produce socially costly system implementation. For utility-scale systems, a major problem with conventional flat rate feed-in tariff arrangements is that they don't expose renewable energy projects to wholesale market signals that reflect the time and location varying value of generation, or associated market signals such as those of ancillary services involved in securely and reliably integrating these renewables. As the renewable energy industry matures, if feed-in tariffs are to be used for large-scale generation, new designs are needed which capture some of this complexity and add to the overall value of renewables in the network.

Country	Feed-in-tariff / Net-metering
Cook islands	Yes
Fiji islands	Yes
Federated States of Micronesia	Yes
Kiribati	No
Nauru	No
Niue	No
Palau	Yes
Papua New Guinea	Yes
Republic of Marshall Islands	No
Samoa	No
Solomon Islands	No
Tonga	Yes
Tuvalu	No
Vanuatu	Yes

Figure 4. Feed-in tariffs operating in the Pacific (Syngellakis, 2014)

2.4. Capital Subsidies

Simple and transparent capital subsidies have been widely used to drive a diverse range of renewable energy commercialisation objectives (particularly off-grid PV applications) for many years.

Capital subsidies are especially useful for renewable energy technologies because of their high upfront capital cost. With many renewable energy systems, fuel and operating costs are low, so that, in effect, the 25 years or so of electricity they will produce is paid for at the outset. This is a challenge for householders in particular because they are used to paying for electricity as they use it, with the capital cost having been raised and amortised by governments and utilities.

Capital subsidies were especially useful when renewables were an expensive investment. They can be paid to the purchaser or to the installer, at a fixed amount or as a percentage of cost. For example in the 1990’s in Japan subsidies were used to drive the on-grid PV market and to assist the local manufacturing industry. Public interest grew rapidly and subsidies were gradually reduced and eventually stopped before starting again recently. Government subsidies not only assisted with the cost, but also appeared to provide a level of public confidence in the technology and its take-up, because uptake continued steadily, even when subsidies were reduced to 10% of costs. Take-up declined rapidly once they were removed altogether in 2005, however. (IEA PVPS, 2012).

Capital grants are still useful in certain, most likely remote or difficult to access, locations where renewables are more expensive – for example in many Fijian islands. In the future, capital grants may also be usefully directed to aspects of grid integration, including the addition of storage, ancillary services, and upgrading grids with the communications and controls systems necessary for the future introduction of a range of intermittent and/or distributed energy options.

Advantages

Capital subsidies are simple to implement and understand, are transparent and boost market confidence.

Disadvantages

Capital cost subsidies contain no reference to system performance. Hence, installers have little incentive to optimise system design and least-cost sub-optimal installations may result. There is also less incentive to maintain systems over time.

Choosing the right level of subsidy is also challenging. Subsides that are too generous (either from the outset or due to a reduction in technology costs) can lead to unsustainable industry booms, which in turn often leads to an unexpected removal of the subsidy, followed by an industry crash. They can also serve to keep costs from falling to levels they might otherwise reach.

2.5. Tax Incentives

Tax incentives can operate at a number of levels, for instance, as exemptions from sales, payroll or import taxes; as tax deductions for individuals or businesses; or as tax credits.

Exemptions from tax have most commonly been used during the industry development phase, although more recently, taxes on imports are being used in Europe and the US to protect local industry against cheaper module imports, which result from industry support programs introduced by other governments. Tax deductions or credits are more focused on the end user and on deployment. The US has used tax credits of 30% for businesses as its key support mechanism for renewables (DSIRE, 2013). The tax credit is deducted directly from tax payable and any unused amount, if tax payable is less than the 30% credit, can be carried forward to the next tax year. For electricity utilities, this has been an important driver for large-scale systems, as it can be used to meet their Renewable Portfolio Standards.

As with any program funded from a government budget, the length the program runs is important. Longer running programs reduce the boom-bust cycles and allow more orderly industry development. Also, a tapered reduction is preferable to a complete stop, as weaning an industry off subsidies is always difficult.

In 2013, India reintroduced the Generation Based Incentive scheme that had expired in April 2012, with payments of USD 0.01/kWh (Sengupta, 2013). China introduced a 50% value-added tax (VAT) rebate for solar power plant operators as well as tax incentives to spur the development of hydropower (Haugwitz, 2013).

2.6. Complementary Policies

Many discussions about renewable energy programs neglect the broader context of facilitating policies. While on their own these policies are not sufficient to drive a rapid increase in renewable energy capacity, they can substantially improve the effectiveness of the primary policy measures.

2.6.1. Planning Codes and Energy Rating Schemes for Buildings

Building codes can provide a useful indirect incentive to install renewables or energy efficiency options. For example, energy rating schemes which provide credits for PV and solar water heaters have been used in Australia to meet standards for new buildings or substantial renovations (Watt and MacGill, 2014). Commercial buildings similarly often use PV or energy efficiency to achieve higher energy ratings, especially as the latter can mean higher rentals (Feurst, 2009). Although renewable energy additions may add to the initial cost of a building, they appear also to add to resale value, especially in jurisdictions which require an energy rating on building sales (Hoen, 2011). The process of broadening the obligations of new buildings and re-developments can often be achieved through building energy codes, and by introducing benefits such as expediting permits and inspections.

Planning codes can also be useful in encouraging optimum orientation for new developments, which is critical to the opportunities then available for PV, passive solar design and solar thermal devices. Solar access regulations are increasingly important to prevent future overshadowing problems as more building owners invest in solar products.

Building codes and rating schemes provide an economically efficient approach because it is often cheaper to build PV, solar thermal, passive solar design and energy efficiency products into buildings than it is to provide ongoing energy supplies over the buildings' life. They can be applied to new buildings and to existing buildings when they are renovated. In that way, the efficiency of the building stock improves over time.

Codes and rating schemes help to reduce energy demand growth, and can even result in an absolute reduction in demand, and therefore reduce the need for public investment in generation and transmission infrastructure. However, they may increase the up-front cost of new buildings. Requires well-developed building planning approval and auditing processes.

2.6.2. Supportive grid connection arrangements

Jurisdictions can have widely varying arrangements for the connection of renewable energy systems. Connection requirements for small distributed generators such as residential PV systems may be regulated and specify a process and charges associated with grid connection. Larger systems will often require more detailed, complex and often expensive connection arrangements that may involve network studies. This is standard practice for utility-scale projects of all generation technologies. In some jurisdictions these processes are not always as transparent as they might be, and can pose significant barriers for small and medium-scale projects, such as commercial and industrial systems, which may be too large to fall within standardised arrangements available for residential systems.

Recently, as renewable energy shares continue to rise, regulations that focus on mandatory grid connection and priority dispatch are becoming increasingly important. In 2013, Chile passed regulations to fast-track the process for renewable energy permitting from 700 to 150 days (REN21, 2014). France revised a number of wind permitting procedures; while Turkey revised electricity licensing procedures (Raizada, 2012). In the United States, two separate pieces of legislation were adopted to streamline the permitting process for renewables, including refining regulatory oversight procedures and raising from 5 MW to 10 MW the maximum capacity for small-scale hydropower plant classification (Leidreiter *et al*, 2013). In addition, the U.S. Federal Energy Regulatory Commission (FERC) approved guidelines to allow for a “fast-track” interconnection process for certain renewable systems up to 5 MW in size, eliminating the need for them to undergo extensive interconnection studies (Wu, 2013).

The advantage of fair and transparent grid connection regulations is that it reduces the uncertainty and risk faced by private sector investors, and should reduce administration costs for the utility. There are no disadvantages.

2.6.3. Public procurement and awareness raising

Procurement policies that create an obligation for government buildings to install renewable energy technologies such as PV, energy storage or smart meters are a good way of building greater public awareness and community support. In particular, the ability of the Government to showcase particular installations and report cost and performance data greatly assists in developing private sector interest and knowledge.

The advantage of renewable energy public procurement policies are that they produce a number of reliable examples of renewable energy installations, while potentially saving the government money over the long term. Provided that benefits are judged to exceed the investment opportunity costs, there are no disadvantages.

2.6.4. Research, Development and Demonstration

Linked to public procurement is the need to support local research, particularly where it is aimed at customizing technologies for local use. Development of local solutions and, most usefully, demonstration of new technologies or approaches is very important in framing public attitudes and gaining acceptance.

It is critical however, that research and development is not over-sold before outcomes are known since, by its nature, research outcomes may differ from those originally anticipated and also new energy technologies take decades to reach commercialization. For demonstration systems, it is critical that sites chosen are accessible to researchers, that sufficient funds are allocated for ongoing monitoring and maintenance and that outcomes are publicly available so they can build local knowledge. Demonstration systems that are perceived to be failures, or which are abandoned with no published data immediately imply a technology failure when the issues may lie elsewhere. Research, development and demonstration also link to local capacity building.

2.6.5. Local training and capacity building

The installation of RE in Fiji is undertaken by a combination of local companies and external experts. Where external expertise is used to bring in the required knowledge, it is important that knowledge transfer occurs to drive capacity building in local expertise and to allow the gradual scaling down of reliance on external expertise in the medium to long-term. The REP-5 Programme (Federated States of Micronesia, Nauru, Niue, Palau and the Republic of the Marshall Islands, 2006-2010) installed over 250 kWp of grid-connected PV and was largely implemented by external experts in the Programme Management Unit and short-term international consultants and companies. However, more than 15 renewable energy training sessions were conducted for in-country utility, government and private sector staff, while hired local staff worked alongside overseas contractors and assisted the governments of the target countries to develop appropriate policies for renewable energy technologies. Recent training programs funded by USAid have been useful in developing local capacity for small-scale RE installations (Periera, 2014).

Of most relevance to centralised and grid-connected RE is FEA's expertise in RE technologies and the impacts of different types of RE technologies on the networks. In large part this can be driven by requirements laid down by the Fijian government, such as mandatory rights to connection, subject to safety and technical criteria being met at the site. Such requirements will drive the development of the expertise required to meet them. At present, Australian standards are routinely used, and local companies are training their own and FEA staff on the relevant requirements (Clay, 2014).

What has been found to be critical for DG is ongoing maintenance. For central generators, this aspect is routinely included in project development. However, for smaller systems, particularly if aid funded, consideration of ongoing O&M is often deferred, or unfunded. For distributed PV systems, for instance, appropriate mechanisms need to be in place to ensure that inverters and any other enabling technologies (eg. batteries) are maintained on an ongoing basis and that other problems with wiring, switches, module damage or failure can be readily dealt with. An inventory of spare parts should also be available. This can be a difficult issue if project finance is based on up-front capital cost only, with separate provision needed for ongoing maintenance. However it is less likely to be a problem where the per kWh return is sufficient to justify investment and the owner of the system is paid on a per kWh basis.

A post-installation assistance programme should be put in place to monitor the performance of any installed system. Capacity to monitor renewable energy installations or to deal with manufacturers to replace broken down components, takes time to build, despite the local operators having been trained in the operation and maintenance of the installations during the project. Many past and present aid-based projects have not taken this into account, resulting in failure of the installed energy generation system or even worse, damage to equipment connected to the DG energy supply.

Ultimately, the ability to apply best practice design, installation and maintenance of grid-connected renewables in the long-term will depend on the local expertise available. This means that energy professionals in the public and private sector need to be trained on an on-going basis, so that as technologies, products, installation methods, standards, regulations and best practices evolve, knowledge in the national industry also evolves.

2.6.6. Energy Efficiency Programs

Reducing the energy required to provide a given end use service reduces the overall investment required in energy infrastructure, as well as the ongoing costs of energy delivery. Where energy services are high cost and cross-subsidised, as they are for many customers in Fiji, energy efficiency benefits the customer as well as the government.

Energy efficiency can be delivered via building energy standards, minimum energy performance standards for appliances and energy awareness programs. Several programs are already established in Fiji, including minimum performance standards for selected appliances and energy efficiency standards for buildings, as detailed in the review of existing incentives and subsidy schemes, but there is scope for expansion and compliance.

2.6.7. Storage

Policies to promote energy storage have gained prominence internationally since 2013. Japan introduced subsidies to cover two-thirds of the capital costs of lithium ion batteries installed with solar PV systems (REN21, 2014). In Canada, the provisions of Ontario's Long-Term Energy Plan were amended to include 50 MW of energy storage in the province's competitive procurement process (ibid). Puerto Rico's energy regulator revised its existing minimum technical requirements to mandate the incorporation of energy storage in new renewable energy projects, and the U.S. state of California introduced a mandate on investor-owned utilities to begin buying 200 MW of energy storage capacity by 2014, with a statewide goal to acquire 1.3 GW of storage capacity by 2020 Dalenbäck, 2013). In addition, Massachusetts introduced requirements on utilities to develop plans to introduce smart meters and increase investments in smart-grid technology over the next decade (Euroheat & Power, 2013).

Fiji has a large hydro capacity, coupled with diesel generation and so has a relatively flexible generation base. Nevertheless, as more intermittent generation is added to the portfolio, battery storage located at substations or load centres may become cost effective. Storage may be used as an alternative to transportable diesel use to cope with local peaks, as well as to smooth the output from intermittent generation.

3. RENEWABLE ENERGY SUPPORT MEASURES RECOMMENDED FOR FIJI

This section recommends policies for Fiji based on the discussion above, as well as the earlier report 'Review of Existing Subsidy and Incentive Scheme – Fiji', according to the four categories of electricity supply:

1. Central grid: large-scale centralised generators connected to the transmission network (MW in size)
2. Distribution grids: any generation connected to the distribution network (from kW to MW)
3. Mini-grids: Isolated minigrids, that in Fiji are currently generally powered by a diesel generator (kW)
4. Off-grid: Small isolated systems, that in Fiji currently generally consist of PV and possibly batteries (kW)

Fiji's current policies and our recommendations for each of these categories are summarised in Table I and discussed below.

Table I. Current and Proposed Policies for Fiji

Electricity Supply Type	Current policies	Proposed policies
Central Grid	• Confidential PPAs offered by FEA to IPPs who offer to build systems and pass FEA's due diligence assessment.	• Reverse auction where generation and network services, such as storage or voltage support, are called for, based on needs of electricity system. • Supportive grid-connection arrangements. • Training on O&M of new technologies. • Resource monitoring
Distribution grids	• Net metering (commercial) with conditions individually negotiated • Gross Feed-in tariff/net billing trial (residential)	• Net metering (commercial) with standards, published conditions • Gross Feed-in tariff/net billing generally available (residential). • Solar Schools program. • Building and planning codes. • Supportive grid-connection arrangements. • Government procurement. • Standards, Training, Accreditation, Information.
Mini-grids	• SEFP	• Feed-in tariffs.

	• Community PV trial • PV/diesel hybrid systems	• Capital subsidies. • Supportive grid-connection arrangements. • Training • Demonstration systems • System performance monitoring.
Off-grid	• SEFP • Solar Home Systems (RESCOs)	• Capital subsidies. • Government procurement. • Standards, Training, Accreditation and information.

3.1. Support Mechanisms for Renewables on Central Grids

Most of the current generating capacity connected to the transmission system (central grid) is owned by FEA. It has been acknowledged that the Government will not be in a position to finance significant amounts of new capacity and that private investment should be sought. FEA has developed an in-house PPA process and contracts. Although two non-disclosure agreements have been signed, there have been no recent PPAs finalised by FEA for generators connected to the central grid, indicating that the current process is not effective. Several agreements have been signed for smaller, distributed generators for the small amounts of exported power and FEA is negotiating on several new or expanded biomass and hydro plants.

It is difficult to determine what, if any, additional generation capacity is required in the short term. FEA's current generation capacity connected to the Viti Levu grid is about 223MW plus about 6MW of bioenergy for about six months of the year. According to the 'Draft SE4All Rapid Assessment and Gap Analysis Report, May 2013', the peak demand on the Viti Levu grid is expected to be 181.6MW in 2014. Given that their spinning reserve requirement is 42MW, new generation capacity may be required shortly. However, according to a recent presentation by the FEA, Viti Levu's peak demand is only 144MW, in which case new generation capacity is not required in the short to medium term.

The FEA have been unable to provide us with the information that would allow us to assess how accurate this is, and the degree to which any potential new generation will meet any shortfall over the medium term.[5]

[5] FEA were asked for the actual annual demand peak for Viti Levu in 2013, as well as the current peak generation capacity and the types of generators that make up that capacity. They were also asked for the generation capacity of the IPPs that they are hoping will provide generation capacity in the near future, and the year they hope they will come online.

Recommendation 1: Initiate a competitive bidding process

The Commerce Commission has recently ruled that all IPPs should be paid 33.08c/kWh. While this rate is certainly the minimum that should be paid for distributed generation, some type of competitive bidding process (using 33.08c/kWh as the ceiling) could be used to identify the lowest market price for larger-scale centralised generation (and potentially also off-grid projects, as discussed below). Competitive bidding will offer a more transparent and equitable outcome than current processes. Such a process could also facilitate access to finance, via the SEFP or other sources. The main characteristics of such a process are outlined below and will be discussed in more detail in the report on the Design of Subsidy and Incentive Schemes.

- Use a single round sealed bid reverse auction process, possibly with a 'pre-qualification' round.
- Aim to keep the process as simple as possible, avoiding collusion and ensuring transparency and equal access to information by all interested parties.
- Indicate early on the number and timing of rounds to be called, the capacity required, any locational preferences and conditions of connection.
- To avoid spurious or under-priced bids, penalties should apply if projects do not proceed within a set time period.
- Responsibilities for monitoring and system performance should be defined in the call, as well as penalties for under-performance.

Recommendation 2: Complementary policies

There is a range of complementary policies that would help to identify and connect the most suitable and lowest cost generation options:

- Publicly available and consistent grid connection requirements for large-scale power plant
- Network maps or processes to assist larger scale IPPs to undertake relevant network studies
- Training and accreditation of FEA personnel, and staff of IPPs, on new technologies, interconnection equipment, monitoring systems.
- Continuation and perhaps expansion of monitoring of renewable energy resources, with publicly available data made available through a single web portal: wind, solar, biomass, hydro and as technology develops, geothermal, wave and tidal.
- Exemptions from import taxes should remain for Renewable energy equipment.
- The 5 year tax holiday for RE infrastructure investment should also remain.

3.2. Support Mechanisms for Renewables in Distribution Grids

Medium-scale grid-connected PV systems have recently been privately installed on FEA's grid at Viti Levu. They are connected under a net feed-in tariff where generation used onsite displaces the prevailing retail tariff and potentially reduces demand charges, while exported electricity currently receives up to 15c/kWh. Hence, they are sized to offset onsite demand and minimise export. Several PV systems up to 250kW have been installed, with at least one 700kW PV system planned for an international hotel.

A residential grid-connect PV trial is currently being conducted by the FDOE. It involves the installation of up to sixty 1.2kW or 2.4kW PV systems at no cost to the household, with PV output gross metered and net billed.

Recommendation 1: Net then gross feed-in tariff for all distributed generation

According to the Commerce Commission's ruling, medium-scale PV systems connected to the grid should now be paid 33.08c/kWh for all exported electricity. We recommend that this should be adhered to by the FEA.

However, on a net feed-in tariff, as distributed generation reaches higher levels of penetration, it can reduce income to FEA. This is because the retail tariff consists of TDR costs as well as generation costs – and the on-site use of PV electricity means the customer avoids paying the TDR costs. Having a gross feed-in tariff based on the avoided cost of generation means that the system owner will pay for electricity use just like any other customer, and so will still pay all the TDR costs associated with that use. Therefore, as PV penetration reaches higher levels,[6] the FEA could consider moving to a gross feed-in tariff set at the avoided cost of generation.

A net feed-in tariff should not be seen as a mechanism to limit system size and so avoid potential technical impacts on the network. Financially-based mechanisms are a very blunt instrument to achieve technical outcomes. For example, as system costs decrease, a net feed-in tariff will become less effective in limiting system size, and such a tariff is much harder to make location-specific to target areas of high penetration. Technical issues should be addressed with technical measures – for example, inverters now commonly provide higher quality power than on many networks and ramp-rate controls can readily be used to minimise the impacts of changing output.

Customers will need to be confident that their investment will be able to be paid off at a reasonable rate, so the length of time over which tariffs will be paid must be clear and not able to be changed retrospectively (this also means that any gross feed-in tariff should not be imposed on systems installed under the net feed-in tariff). If the value of the feed-in tariff needs to be changed (for example because the avoided cost of generation changes), the new rate should only apply to

[6] For example, when PV system generation reaches 10% of electricity sales.

systems installed after the date the change is introduced. To facilitate changeover to the new tariffs over time, a set period of time (say 10 years) can be specified in the feed-in tariff contract.

If particular milestones are set (for example, MW installed, price decreases, or other measurable parameters), automatic yet gradual reductions in support should be built in from the start, and made known to the public. Similarly, information on PV systems and details of the tariffs, application requirements, standards and approval processes will still need to be made publicly available if the market is to be stimulated.

A higher feed-in tariff could potentially be offered for generation during peak demand periods or in grid constrained areas – with the level determined according to the additional value distributed generation may provide. Higher tariffs could also be offered in order to promote a particular technology (for instance, mini-hydro, PV, small wind, small biogas generators), or a particular sector (commercial, residential, or community).

Recommendation 2: Residential feed-in tariff trial

As discussed earlier, this trial is being conducted by the FDOE. It involves the installation of either 1.2kW or 2.4kW PV systems at no cost to the household. The effectiveness of such trials relates to more than just the number of systems successfully deployed. The desirable outcomes also include:

1. Information for the households taking part, and then extending to the wider community, so they know what to expect, how the technology works, general maintenance aspects, and who to call in case of concerns,
2. The development of a streamlined grid-connection application process and agreement with the FEA,
3. The development of a streamlined installation process, that is shared with other installers, follows agreed standards and can significantly decrease installation costs,
4. The collection of data that lead to a better understanding of the financial and technical impacts of distributed small-scale PV systems, by the FEA, the FDOE, installers and householders, and
5. A public information dissemination phase as the trail begins and at regular intervals, to inform all potential customers (both those interested in PV and those sharing the grid) of performance, costs, lifetimes, and other issues likely to be of interest.

Recommendation 3: Solar Schools

A separate Solar Schools program should be considered, and funding sought. Solar systems at schools are installed with a descriptive interface that allows school children to understand how and when electricity is being produced. This can be combined with relevant curricula material from kindergarten through high school and serve as a valuable means of increasing familiarity, knowledge and acceptance of the technologies, which can be carried into later life.

Installations at Solar Schools can be funded through a capital grant in combination with the feed-in tariff described above. The income from the feed-in tariff can be split: with some going to the school and some being rolled back into the Solar Schools program to support more PV installations.

Recommendation 4: Complementary policies

The amount of distributed generation that local grids can readily accept will remain a site-specific issue. Nevertheless, the potential is increasing fast as technology and costs improve, so mechanisms should be in place to encourage appropriate installations and ensure they meet safety and quality standards. In addition to the complementary policies recommended for centralised generation, options include:

- Supportive grid connection arrangements and streamlined approval processes. Approval processes should include cost and time limits for connections of different sizes.
- Training and accreditation of installers of distributed generation systems.
- Building and planning codes could include targets for renewable energy contributions (this can be solar water heaters, PV and passive solar design)
- Government procurement, for public buildings and facilities. The aim should be to demonstrate a range of technologies, showcase different examples of applications, and publish cost and performance data.
- General provision of reliable, easy to understand information about renewable energy technologies, principles of operation, site selection, installation requirements, accredited installers, approved components and cost-effectiveness.

3.3. Support Mechanisms for Renewables in Mini-Grids

About 600 community diesel power systems operate around the smaller islands, and have been installed between 1978 and 2013. In general, these diesel systems are working well, but access to fuel is a problem. The DOE is to trial the addition of PV to a small number of existing diesel systems, while the United Arab Emirates is supporting three PV/diesel hybrid systems for Government facilities on Vunisea, Lakeba and Rotuma. Following on from the trials, and incorporating lessons learned, there are several options to encourage other communities to add PV to their power systems, to reduce diesel requirements and/or to increase electricity hours.

Recommendation 1: Payment through capital subsidies and feed-in tariffs

The PV systems could be paid for through a combination of capital subsidies and feed-in tariffs.

<u>Capital subsidies</u>: These are already provided for the diesel power systems, so could also be offered to private investors (including installers), again where this would reduce cross subsidies. The capital subsidies for the PV systems will have to cover PV's higher upfront costs. This is of

course counter-balanced by having zero fuel costs. Aid funding may continue to be needed to fund such subsidies although SEFP loans could also be used.

Feed-in tariffs: These can be used as proposed for the grid-connected systems described above, to encourage private investment in RE generation, where this would be cost effective and reduce the cross subsidies currently needed for operating diesel systems. However, because the communities are currently responsible for paying for the diesel (that will be saved by the PV system), they should also be responsible for paying the feed-in tariff. The owner of the PV system would need some guarantee that they would be paid, and this would most likely be through some sort of pre-paid metering system. Pre-paid meters were used for the Solar Home Systems but, for various reasons, they have now been abandoned. Alternative payment systems are needed, such as those used for mobile phones (which appear to be used widely, even on remote islands). The owner of the PV system would also need to be provided with the option of removing the PV system after a specified period, if it is not being used or paid for to a specified extent. The level of the feed-in tariff would need to be calculated on a system-by-system basis, after taking into account the level of the capital subsidy. Nevertheless, for reasons of equity, common rates are most likely to be preferred.

The feed-in tariff could be set to cover the avoided fuel costs and the maintenance costs, with the capital subsidy set at such a level that the feed-in tariff results in, for example, a 5 year payback period. A system that was used only to reduce diesel use, and so had no batteries, would have lower up-front costs and maintenance costs, and so would likely require a lower capital subsidy and feed-in tariff. Of course, larger PV systems could require batteries to control their impact on the diesel generator ramp rate, however they would generally have a much lower capacity than the batteries needed for the system to operate for extended periods of time without any diesel backup.

Recommendation 2: Solar Schools

If there are schools connected to mini-grids, they could be provided with a PV/battery system through the Solar Schools program discussed above.

Recommendation 3: Complementary policies

The complementary policies are the same as for the renewable energy on distribution grids. In addition, the effectiveness of this approach should be monitored and evaluated at regular intervals to ascertain performance, long-term costs and issues arising.

3.4. Support Mechanisms for Renewables in Off-Grid Power Systems

The current program for deployment of stand-alone Solar Home Systems, which is delivered via Renewable Energy Service Companies (RESCOs), seems to be working reasonably well. RESCO contracts are awarded after a competitive bidding process every two years and thus are considered to provide an efficient service. The requirement for a customer contribution to the capital cost of the system encourages ‘buy-in’ by the people who benefit from the system, as does the monthly payment for maintenance.

Recommendation 1: Payment options

Feedback from stakeholders indicated that the $18/month maintenance fees are not enough to cover long term costs of routine inspection, repair and battery replacement, so they may need to be increased. Another issue raised was the need for better payment systems which, as discussed for mini-grids, could be based on a pre-paid model accessed via mobile phone apps, or linked to other government service provision.

Recommendation 2: Larger system sizes

It seems that some people would like larger systems and so these should be made available, possibly simply as multiples of the current 270W systems, to facilitate component standardisation and bulk purchase. Whether or not existing cross-subsidies should be extended to larger systems will need to be considered by the Government.

Recommendation 3: Solar Schools

If there are schools that are not connected to any grid, they could be provided with a PV/battery system through the Solar Schools program discussed above.

Recommendation 4: Complementary policies

The complementary policies are the same as for renewable energy on mini-grids. More local capacity development for routine system maintenance could be a cost effective means of overcoming current issues of long lead times for servicing and component replacement, which in turn impacts customers’ willingness to pay.

4. CONCLUSIONS

The only policy not considered suitable for implementation in Fiji in the short term is Renewable Energy Portfolio Standards. Even though this would guarantee that Fiji achieves its stated renewable energy target, this type of policy (particularly the creation and trading of Renewable Energy Certificates) is complex, difficult to get right, and expensive to administer in a small jurisdiction. A Pacific wide approach, similar to the Caribbean Community approach could be considered in the longer term.

Most other polices could be implemented in Fiji, albeit with careful consideration of the local conditions and goals. For those polices which are implemented, key elements to success include:

- Long term focus, so that industry can plan ahead and establish suitable infrastructure and supply channels, while customers can familiarise themselves with the options without having to make rapid decisions. This also prevents the boom-bust cycle so common internationally with short-term, stop-start programs.
- Built-in processes, timelines or targets for reduction of support and final termination of the programs, again so that industry and customers can plan ahead.
- Procedures for regular program monitoring, evaluation and adjustment as necessary.
- Allocation of sufficient funds for on-going system maintenance, as well as the establishment of suitable facilities and services for spare parts.
- Public information and local capacity development to ensure programs are understood and systems well maintained.
- Public consultation to ensure that programs and systems meet the local needs and expectations, and hence are well accepted and understood.
- Environmental impact assessment to ensure projects and technologies do not cause unexpected environmental impacts (such as those caused by land clearing, changes to water courses, disposal of batteries etc), which will have detrimental local effects.

Complementary policies, including energy efficiency, demand management and capacity development can significantly increase the effectiveness and efficiency of RE deployment programs and should be considered essential elements of the policy mix.

A diversified set of renewables, complemented by energy efficiency, demand management and storage, will provide Fiji with a resilient and cost effective electricity system in the long term. Nevertheless, as the penetration of new energy technologies, especially intermittent renewables and distributed energy solutions increases, there will be a need to change the way grids are operated. This may include the installation of new types of metering, of different set points and control strategies for voltage on distribution lines and for increased use of two way communication between the supply and demand. It will be important that these changes are discussed and prepared for, and that they are not used as a means of limiting or stopping the deployment of renewables.

A final, key consideration when deploying a comprehensive set of renewable energy policies is to ensure that any pre-existing policies which support fossil fuel use, or otherwise work against RE uptake, should be clearly identified and gradually reduced. This will remove conflicting messages and facilitate success of the RE programs.

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