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Renewable energy in the Pacific Island countries: resources, policies and issues

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Abstract

Purpose – The aim of this paper is to identify the factors that are responsible for the slow development of the renewable energy sector in the Pacific Island countries (PICs), and suggest ways of overcoming them.

Design/methodology/approach – The paper compares the energy situation in Australia and Germany to that in the PICs, and the state of energy development in the PICs to its African, Caribbean and Pacific (ACP) counterparts.

Findings – The paper finds that policy frameworks are important pre-requisites to the development of renewable energy. In addition, the absence of a science and technology base in the PICs is a serious impediment to the development of the renewable energy sector in these countries. It is found that the PICs are lagging behind in policy frameworks and institutional capacity building requirements as compared to other ACP countries.

Practical implications – Policy frameworks must be established as an essential pre-requisite to the development of renewable energy in the PICs. In addition, ways and means must be found to address the lack of proper attitudes amongst decision-makers to the value of a science base in development.

Originality/value – The paper identifies the underlying impediments to the rapid development of the renewable energy sector in the PICs, and suggests what could contribute to the lack of an appropriate science base that is considered as a requirement to development.

Keywords Renewable energy, Pacific Island countries, Energy policy frameworks, FAESP, Science and technology, Renewable energy technology, Sustainable development

Paper type Conceptual paper

1. Introduction

Pacific Island countries (PICs) are faced with a diversity of energy supply challenges. Their lack of indigenous fossil fuel resources means they are heavily dependent on imported fuels for their transportation and power generation needs. Their remoteness from fuel sources leads to supply chain issues and an escalation of landed fuel costs. Renewable energy (RE) is usually touted as part of the solution, if not the only part. However, the success of this solution is hindered by lack of institutional mechanisms, inadequate policy and regulatory frameworks, and a general lack of human capacity.

While significant progress has been made in the planning and implementation of RE programmes in recent years, much remains to be done. Issues remain with the resource assessments as well as the developmental apparatus required to see the successful utilization of these resources. It is also not made generally clear how cost-effective renewable energy technologies (RETs) are in comparison to conventional energy technologies, and which technologies are the most appropriate for the needs of the region.

The development of the RE sector in the PICs has been slow. There are obvious reasons for this, but there are also underlying factors not so easy to discern. What are

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the issues that act as continuing barriers to the successful use of RE in the alleviation the region's energy problems?

PICs are not alone in their predication. Other small island developing states (SIDS) share similar problems, and it is informative to see how the Pacific region fares in comparison with its African, Caribbean and Pacific (ACP) counterparts in these issues.

This paper addresses these issues in an effort to gain insight into the factors that determine the state of development of the RE sector in the PICs. It reveals that one of the major barriers to the implementation of RE programmes is the near absence of the required science and technology base. It suggests that the establishment of this infrastructure may be hampered by the prevailing attitudes of the decision makers towards the importance of such a pre-requisite for the development of the energy sector of the region, and the sparcity of the appropriate scientific intelligentsia to advise the decision makers.

2. The relevance of renewables to the PICs

Why do the PICs need RE? To answer this question, one first has to consider what use energy is put to any nation. It is instructive to start by examining the developed neighbours to see how they use their energy. Table I shows how Australia apportions its energy supply amongst its various energy requirements.

As seen in the table, power generation, transportation and manufacturing generate the main demand for energy. We next consider how Australia generates its power. Table II compares energy sources used for the generation of electricity in Australia and two PICs.

The primary energy source for Australia's power generation needs mostly comprises of coal (76 per cent) and natural gas (16 per cent). The balance of 8 per cent comes from other sources, including RE.

	Electricity generation	Transportation	Manufacturing	Mining	Residential	Commercial
Energy (PJ)	1,760	1,388	1,301	436	426	268
Total (%)	30.5	24.0	22.5	9.6	7.4	4.6

Source: Australian Government Department of Energy and Tourism (2010)

Table I. Energy consumption by industry – Australia 2007-2008

	Australia (%)	Fiji	Kiribati
Coal (black and brown)	76	Nil	Nil
Natural gas	16	Nil	Nil
Oil	1	Nil (imported)	Nil (imported)
Hydro	4.5	Yes (30-70%)	Nil
Wind	1.5	1%	Yes ?
Biomass	0.5	Yes	Yes (CNO)
Biogas	0.4	Yes	?
Solar	0.1	Yes	Yes

Note: ? means not sure
Sources: Australian Government Department of Energy and Tourism 2010, Fiji Electricity Authority (2009), Fiji Bureau of Statistics (2010), Singh (2009), JICA (2009), USP Energy Summit (2010)

Table II. Energy sources for electricity production in developed and developing Pacific countries

When the Australian situation is compared with the PICs, the absence of indigenous fossil fuel sources within the latter countries stands out as an obvious difference. The examples of Fiji (a relatively developed PIC) and Kiribati (a relatively undeveloped PIC) typify two extreme cases of the situation in the PICs. We see however that both depend entirely on imported fossil fuel for their transportation needs, and at least partly for their power generation requirements. Indeed, most PICs rely totally on imported fossil fuels for power generation, as demonstrated in Figure 1.

The result is a heavy burden on their import bills. In the case of Fiji, for instance, fuel import constitutes one-third of the total import bill.

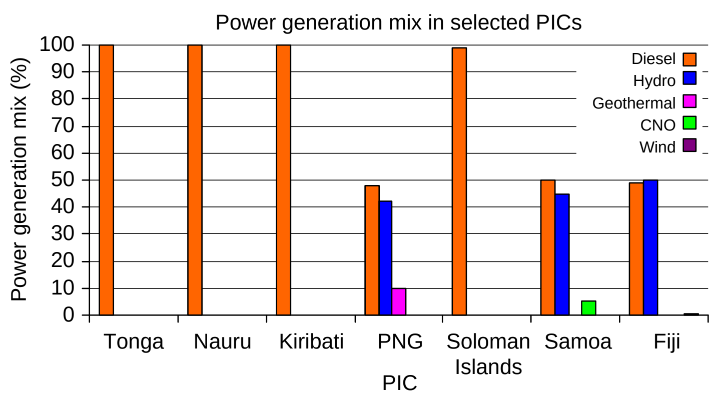
These examples serve to illustrate the need for the PICs to find alternative indigenous sources of energy to meet their energy needs and to alleviate the heavy burden that imported fuel places on their import bills. Because of the unavailability of local sources of fossil fuels, PICs have to develop their RE sector as the only effective means (aside from energy efficiency (EE) and conservation) available to them to alleviate their energy problems.

3. Requirements for the successful development of the RE sector

There are commonly held beliefs amongst many energy experts about what the requirements are for the successful development of a country's RE sector. Amongst these perceived requirements are:

- the availability of indigenous RE resources;
- policy frameworks and facilitating legislations;
- the availability of appropriately trained human resources;
- institutional mechanisms; and
- the availability of the appropriate technology.

Before adopting these largely hypothetical and untested criteria in a working model, it is highly instructive to consider an actual example of how effective some of these perceived requirements have been in the development of the RE sector of a specific country.



Source: Fiji Electricity Authority (2009), JICA (2009), TERM (2010)

Figure 1. Fraction of imported fossil fuel to other primary energy sources used for power generation in selected PICs

We take the case of Germany (Schulte, 2010). This country has, up till recently, depended mainly on coal, oil and natural gas for its energy supply. It used these for heating, transportation and power generation. Like the PICs, however, Germany does not possess indigenous supplies of these fuel sources, and has to import these commodities from its neighbours.

To overcome this dependence on imported fuel, Germany in 1991 passed the Renewable Energy Sources Act (EEG) whose prime aim was to facilitate the development of a sustainable energy supply. In particular, it aimed to increase the RE share of the power generation mix to at least 12.5 per cent by 2010 and 20 per cent by 2020. The Renewable Energy Heating Act (EE WarmeG) made it compulsory for home-owners to use RE for domestic heating. A National Biomass Action Plan was put in place towards significantly increasing the bioenergy share in Germany's energy supply.

In addition to its own legislations, Germany had to abide by those set in place by the EU. In particular, EU's Climate Change Package of 2009 set the following goals for 2020: a reduction of GHGs by 20 per cent, increase in the RE share in the energy mix by 20 per cent and an increase of EE measures by 20 per cent. The EU Energy Efficiency Action Plan covers a host of requirements, including performance standards, product labelling, EE in power generation, transportation to name a few.

Europe also has a European research area concept, established in 2000, that considers the effective coordination of all national and regional research activities under the Strategic Energy Technology Plan (SET Plan).

As indicated in Table III, the result of these measures has been dramatic, resulting in a tripling of the RE contribution to the energy sector in Germany in ten years.

This is a true testament to the importance and efficacy of policy frameworks, strategic planning and goal setting.

4. What the PICs have and what they need

The German example is very pertinent to the PICs. Unlike Australia, Germany has been dependent on imported fossil fuels for its energy needs. Like the PICs, it has been faced with the problem of the lack of indigenous fossil fuels. To solve its problem, Germany embarked upon a comprehensive and concerted plan to increase the share of RE in the country's energy mix. It enacted policies, imposed mandatory legislations and set targets. The results are unequivocal evidence that such measures, if applied properly, can work.

So how does the German example compare with the list of requirements perceived by energy experts for the development of the RE sector? What else can we learn from this example? To begin with, we note that Germany does have the RE resources mentioned in the expert list (it has wind, biomass, hydropower and solar) as well as the human resources. In addition, it has put in place the relevant policies

Energy sector	%RE (1998)	%RE (2008)
Heat	3.5	7.4
Electricity	4.8	15.1
Total	3.1	9.5

Source: Schulte (2010)

Table III. RE share in various energy sectors in Germany – 1998 and 2008 and legislations. Indeed, the German success seem in large part to be due to the application of these legislations, which appear to have been the main driver for the change towards RE.

But the German example reveals additional required criteria that are less frequently aired. In particular, as a highly developed nation, Germany possesses the science and technology infrastructure that is necessary for the development of a RE sector. This base is in turn supported by a stable and robust economic infrastructure that ensures the rapid development of the appropriate technologies and human resources.

Considering the case of PICs, we first note that they have made considerable headway with the required energy policy frameworks. These have been under active development, both at the regional and national scales, in the Pacific from as early as 2004 under the guardianship of the Pacific Island Forum (PIF), Pacific Energy Ministers Meetings (PEMMs) and regional agencies such as the Secretariat of the Pacific Community (SPC), South Pacific Regional and Environmental Program (SPREP) and the South Pacific Applied Geoscience Commission (SOPAC – now incorporated into SPC and SPREP (Singh, 2010)).

The first regional energy policy was introduced in 2002/2004. Called the Pacific Islands Energy Policy (PIEP), this was to act as a guideline document for national energy policy (NEP) developments and initiatives in the Pacific Island countries and territories (PICTs). In addition, NEPs specific to several of the forum member countries (that include the PICTs) were formulated as part of the Pacific Island Energy Policy Strategic Action Plan (PIEPSAP) project (Zieroth, 2008).

By 2009, it was felt that the PIEP needed to be replaced by a new regional energy framework that assured greater energy security in the Pacific. At the 40th PIF meeting in Cairns, Australia (April 2009), the leaders gave the directive that eventually led to the formation of the Framework for Action on Energy Security in the Pacific (FAESP). This new framework utilizes a whole-of-sector approach to energy security, and recognizes the need for continued dependency on fossil fuel in the near future.

The FAESP acknowledges the primacy of NEPs and plans as the principle means of achieving energy security in the Pacific, and focuses on the following seven themes: leadership and governance, capacity development, policy and regulatory frameworks, energy production, energy conversion, end-use energy consumption, energy data and information, and financing, monitoring and evaluation.

Associated with the Framework for Action is the Implementation Plan for Energy Security in the Pacific (IPESP 2010-2015), which outlines how FAESP is to be implemented (Pacific Regional Energy Meeting, 2011).

National Energy Plans and/or Strategic Action Plans were developed with the help of the PIEPSAP project for 11 PICs by the end of this Danish and UNDP-funded project in August 2008. Countries that benefited were the Cook Islands, Federated States of Micronesia (FSM), Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, PNG, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.

The NEPs of the PICs generally have similar structures. They provide broad policy frameworks for the country and support large (national) grids that supply urban areas. In addition to the NEPs, most PICs have rural electrification policies/Programmes (REPs). These cater specifically for small-grid or stand-alone (small home system) electrification schemes for rural communities.

The RE resources available in the PICs vary widely. This is due largely to their geography and geology. While their tropical location assures an abundant supply of solar radiation, the same cannot be said of other RE resources. The geography of the islands varies from low-lying coral atolls to mountainous terrains. Hydropower is only available on some of the latter. Wind energy is likewise not available region-wide, the problem seemingly being more with the ability to harness this resource rather than with its availability. Table IV provides a broad overview of the availability of various RE resources in the PICs.

The human resources required for the development and utilization of RE in the PICs are generally lacking. This has been the subject of much discussion, and the deficiency is being addressed through various national and regional programmes and projects, including the FAESP and its implementation plan, the Pacific Island Greenhouse Gas Abatement through Renewable Energy Programme (PIGGAREP) administered by SPREP, and various country programmes administered by the International Union for the Conservation of Nature (IUCN).

5. What is appropriate RE technology?

Because of their small-scale economic infrastructures and the lack of supporting industries normally available to larger economies, the Pacific Island governments are unable to develop and/or manufacture the RETs appropriate for the harnessing of their RE resources. This means that they all have to import the required RETs from developed countries.

One must ensure that the technology used in the utilization of RE in a country is the appropriate one, both from the resources and economic points of views. This requirement is not as easy to satisfy as it would seem at first. To begin with, the presence of stakeholders in various technologies, who are eager to promote their own choices, means that the true worth of the technology is often masked by promotional campaigns and individual salesmanship. Even academics (with vested interest in one technology or another) are not averse to such excesses!

Yardsticks to assess the merits of RE technologies must obviously include the avoided cost (i.e. how much savings accrue from replacing other forms of energy with RE). They must also include the capital costs of installation, and maintenance costs of the RETs. All this is conveniently measured in terms of the payback period.

Country	Geography	Solar (kWh/m^2/day)	Wind	Hydro	Biomass/biofuel	Geothermal
Nauru	21 km^2	Yes (5.8)	?	No	No	No
Kiribati	32 atolls	Yes (5.7)	No – atolls	No	Coconut oil	No
PNG	Mountaineous	Yes (6)	Yes – 19 sites	Yes (1,400 MW)	Timber, palm oil	Yes (1 location)
Solomon Islands	6 volcanic islands	Yes	No data	Yes (JICA 330 MW)	CNO	?
Samoa	2 volcanic islands	Yes (6.0)	$\sim$3 m/s	Yes (issues)	5% CNO blend	No
Fiji	2 large volcanic islands	Yes	Yes – Butoni	Yes	Timber, CNO	?

Notes: The figures in the solar and wind columns refer to average solar irradiance and wind speeds, respectively; ? means not sure
Sources: Fiji Electricity Authority (2009), Singh (2009), JICA (2009)

Table IV. Availability of renewable resources in the PICs

Technology does not last forever. To ensure economic viability therefore, one must ensure that the equipment lifetime exceeds payback period. The expected lifetime of a technology is thus an important criterion to consider.

The inherent efficiency of the technology in converting the RE resource to a useful form of energy (usually electricity) is also important, though this becomes a matter of secondary concern where the RE resources are in abundant supply. A more important consideration is the capacity factor of the technology. This compares the actual energy production of the RET to its rated (or installed) capacity, and depends on the actual availability of the RE resource at the location of the RET. The capacity factor associated with hydropower is usually high, while wind energy tends to have low values.

Perhaps the most important measure of the efficacy of a technology is whether it has been actually developed to the stage where it is commercially viable. An important indicator of this viability is whether it has actually been market-tested.

Table V attempts to rate the various commercially available technologies according to these parameters.

6. Science base – the weakest link in the development chain

Unlike Germany and other developed nations, PICs generally do not have the science and technology base and the required economic infrastructure necessary for a speedy development of the RE sector.

The required technology may be developed by the government itself through a concerted plan. Alternatively, the private sector can provide an important input, ensuring that technologies and skills specific to their own business strategies are in place in a timely manner. In the case of Australia, for example, government input into scientific research and development comes through institutions such as the CSIRO. Various private sector entities, however, are also very active in their own research and development, particularly in the energy sector.

When it comes to scientific research and development, the PICs find themselves with a debilitating disadvantage. The near-complete absence of a science and technology base in the country means it is extremely difficult to develop this sector further. One also finds that the multi-national corporate entities that are capable of doing their own research and development are usually not present in these countries.

RET	Technology efficiency	Capacity factor	Lifetime	Cost/kW (FJD)	Payback period	Commercial availability
Wind	~40%	10-25%	>25 y	\$5,000-\$15,000	<25 y	Yes
PV	12-15%	~50%	25-30 y	\$20,000-\$30,000	25-35 y	Yes
Microhydro	90%	~100%	>25 y Low maintenance	\$2,000-5,000	5-10 y	Yes
Biomass	<60%	Biomass availability	~25 y	–	<25 y	Yes
Biofuel	<60%	Biofuel availability	~25 y	–	<25 y	Yes/no

Source: Various

Table V.
Technical assessment of the appropriateness of RETs for power generation

It is interesting to see how the PICs compare with their ACP peers with regard to science and technology policy frameworks and infrastructure. Table VI compares the *status quo* in one of the most developed PICs (Fiji) with that in Mauritius and Trinidad and Tobago.

The comparison clearly reveals that Fiji (and the PICs) are far behind their ACP counterparts in providing the required science and technology base for the development of RE.

7. Barriers to the development of a science and technology base

Apart from the lack of financial capacity and supporting structures, the biggest barrier to the development of a science and technology base for RE seems to be a general lack of awareness of the relevance of these disciplines for such development. This is probably due both to the absence of the appropriate value system, and to lack of vision amongst the politicians and their advisors. While governments are keen to grow their economies and much discussion takes place about how this is to be done, neither the politicians nor the economists ever place much emphasis on the relevance of science and technology to development.

There is a need for a knowledge core within the Pacific Island nations that spawns the appropriate decisions. In developed nations, this is usually provided by the scientific intelligentsia, who may come from universities, research institutions, professional societies and large private institutions. Unfortunately, developing countries cannot always boast the existence of such institutions in significant numbers, with the result that the usual group of advisors who help develop standards and proffer scientific advice to the political decision makers is virtually non-existent in these countries. The barriers also include the negative attitudes towards the science and technology sector often found amongst some decision makers, who regard it as expensive and unproductive.

Comparing the PICs to their ACP peers, we have noted that both Mauritius and Trinidad and Tobago place a greater emphasis on research and development in science and technology than Fiji, one of the most developed Pacific Island states. They also have in place the government institutional frameworks that facilitate and support such research and developmental activities. It is interesting to speculate on what caused such structures to evolve in these ACP countries but not in the Pacific.

In the case of Trinidad and Tobago, one may conjecture that the proximity to more developed states, allowing greater interaction, had something to do with it. The case of Mauritius is more difficult to analyze, but a similar reason may exist. Continuing with this argument therefore, a likely factor that could have impeded the development of an adequate science and technology base in the PICs could be their relative isolation from the rest of the developed world.

8. Conclusions

This paper investigates the possible reasons behind the slow progress made by the PICs in developing their RE resources to meet their energy needs and to alleviate the heavy burden that imported fuel places on their import bills.

Amongst the perceived requirements for the development of the RE sector are the availability of indigenous RE resources, the appropriate policy frameworks, facilitating legislations and institutional and human capacity. The paper notes that the PICs have made considerable progress with the energy policy frameworks required for the development of their RE sectors at both the regional level in the FAESP and in the form

Table VI.
Comparison of the science and technology base amongst ACP countries

Trinidad and region	Fiji and region	Mauritius and region
Trinidad has Ministry of Science, Technology and Education. The National Institute of Higher Education, Research, Science and Technology (NIHERST) within the Ministry promotes science and research and makes policies. There is also a Ministry of Energy and Energy Industries, and this looks after a National Energy Policy which incorporates RE, and is developing the country's RE resources (solar, wind, biomass), research in wind turbines, waste to energy, solar PV and hot water systems considered viable.	No scientific research policies exist in Fiji to determine and guide scientific research. There are no institutional mechanisms such as ministries or departments of science and technology. Energy research being undertaken are resource assessments, feasibility studies, usually carried out by regional organizations funded by development partners, who consist of international organizations (EU, ACP, UNDP, GEF) or individual countries through their aid programmes. Examples of the latter are AUSAid, NZAid, JICA, KIOCA and GTZ. The Fiji Department of Energy also carries out RE surveys and monitoring.	It has a Ministry of Industry, Science and Research. Future plans for RE include Waste to energy generation. A 20 MW waste-to-energy plant at La Chaumiere, in the West of the island, will be implemented as a BOO scheme. A 3 MW gas-to-energy unit with an annual electricity generation of 20 GWh will be installed at the landfill site at Mare Chicose.

Source: Surroop *et al.* (2010)

of individual NEPs. Indigenous RE resources vary widely amongst the different countries, and depend on the geography and geology of the islands.

Comparison with Germany, which also has a strong RE programme, reveals that policy frameworks are indeed important tools in the achievement of RE targets. However, the comparison also brings to light the importance of a science and technology base, which is a vital pre-requisite to any technological development.

PICs generally do not have the science and technology base and the required economic infrastructure necessary for a speedy development of the RE sector. The scientific intelligentsia, who are the usual group of advisors who help develop standards and proffer scientific advice to the political decision makers in a country is virtually non-existent in the PICs. The relative isolation of the PICs could also be a contributing factor to the absence of an adequate science and technology base.

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