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# Renewable Energy Development in Small Island Developing States of the Pacific

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**Abstract:** Small Island Developing States (SIDS) of the Pacific over the last decade have established some of the most ambitious renewable energy targets in the world. The promotion of renewable energy has been motivated by a desire to lessen dependence on fossil fuels, given the adverse economic impacts of high oil prices on these countries. Efforts to attract development assistance and to strengthen the position of Pacific SIDS in climate change negotiations have likely also played a role. This paper explores the development of renewable energy resources in the Pacific through a public policy lens. The ambitious renewable energy targets established by Pacific SIDS are argued to be appropriate in some cases, but in other cases are criticised on economic grounds. A potential trade-off is identified between the risk mitigation benefits and poverty alleviation benefits of different renewable technology investments, with questions raised about whether support for the former rather than the latter by development partners is appropriate. A number of institutional and financial challenges to the development of renewable energy resources in Pacific SIDS are also discussed.

**Keywords:** Small Island Developing States (SIDS); energy policy; renewable energy; risk mitigation; development assistance

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## 1. Introduction

Small Island Developing States of the Pacific over the last decade have established some of the most ambitious renewable energy targets in the world. These countries, which currently rely on fossil fuels

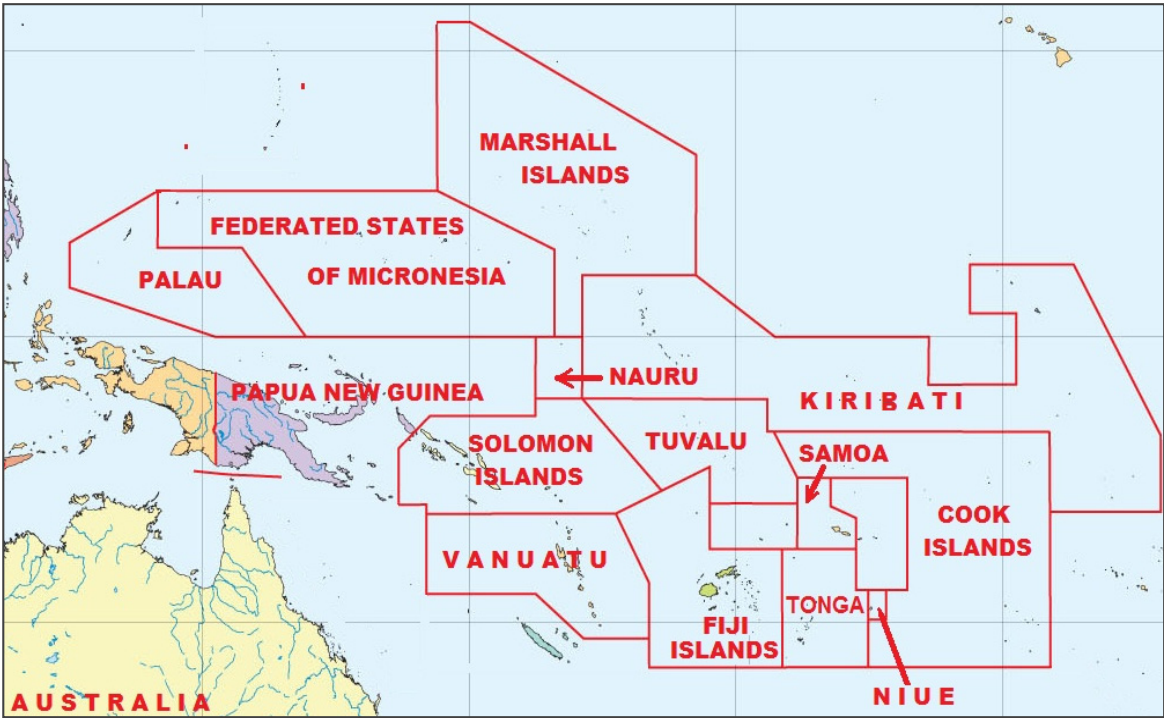
for almost all of their energy needs, have been adversely affected by oil price volatility over this period. Investment in renewable energy is therefore seen as a means of diversifying energy supplies, with the objective of mitigating risks associated with changes in the price of fossil fuels. Strengthening the position of Small Island Developing States in climate change negotiations has also been an objective.

Renewable energy investments in Small Island Developing States of the Pacific have been largely funded by development partners. This is hardly surprising, given that these countries receive very high levels of development assistance. There are a number of challenges and trade-offs involved in expanding the use of renewable energy technologies notwithstanding external assistance. An absence of economies of scale, limited technical skills, and regulatory arrangements act as barriers to the development of renewable energy resources. Trade-offs also exist in the use of public funds and development assistance to support renewable energy investments.

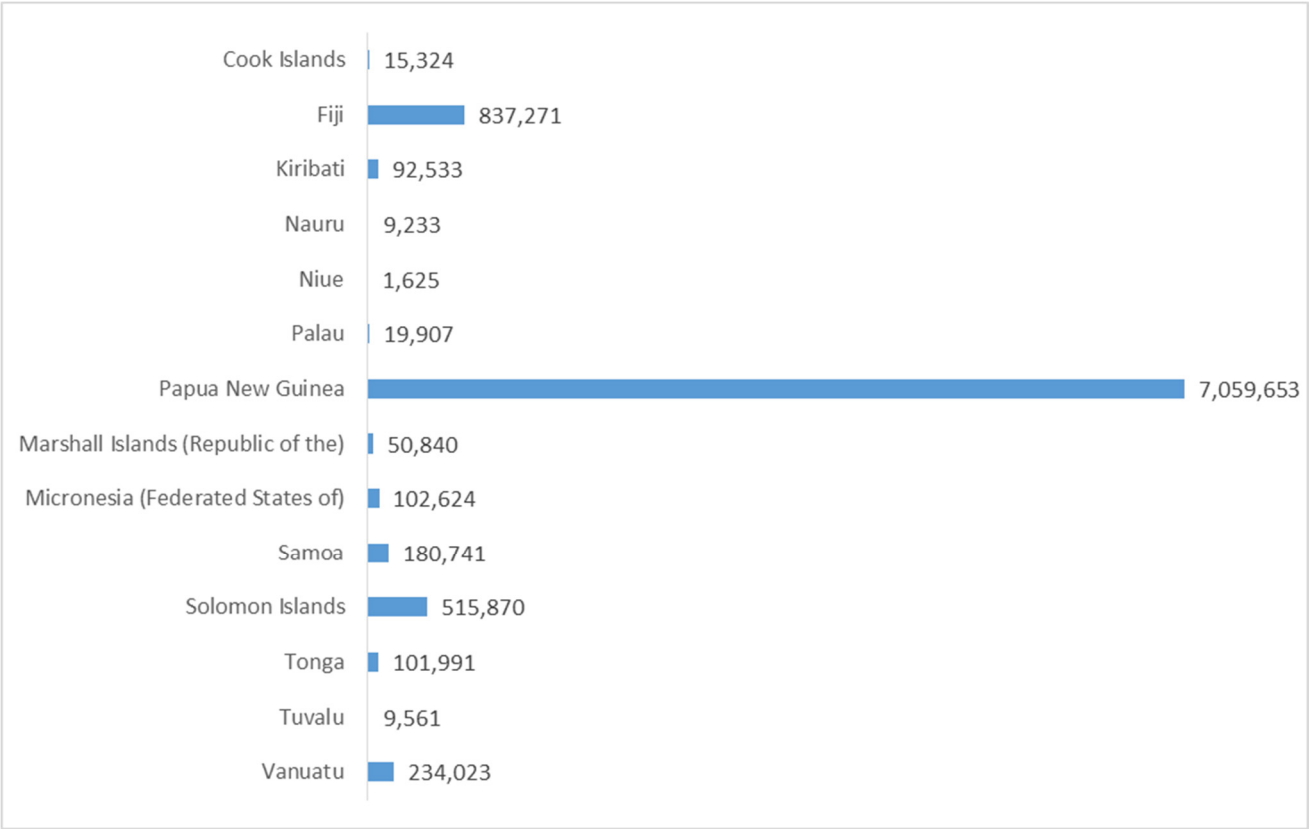
This paper explores the development of renewable energy resources in the Pacific through a public policy lens, examining the economic and institutional challenges and trade-offs posed by ambitious renewable energy targets. Section 2 provides the context for development of renewable energy resources, highlighting the impacts of oil price volatility. Section 3 discusses the potential for renewable energy technology investments to address problems currently facing Small Island Developing States in the Pacific. In doing so, it draws on assessments of renewable energy resources and on analysis of economic impacts renewable energy investments. Section 4 details the challenges and trade-offs to renewable energy investments in Pacific Small Island Developing States. Section 5 concludes the discussion.

## 2. Background

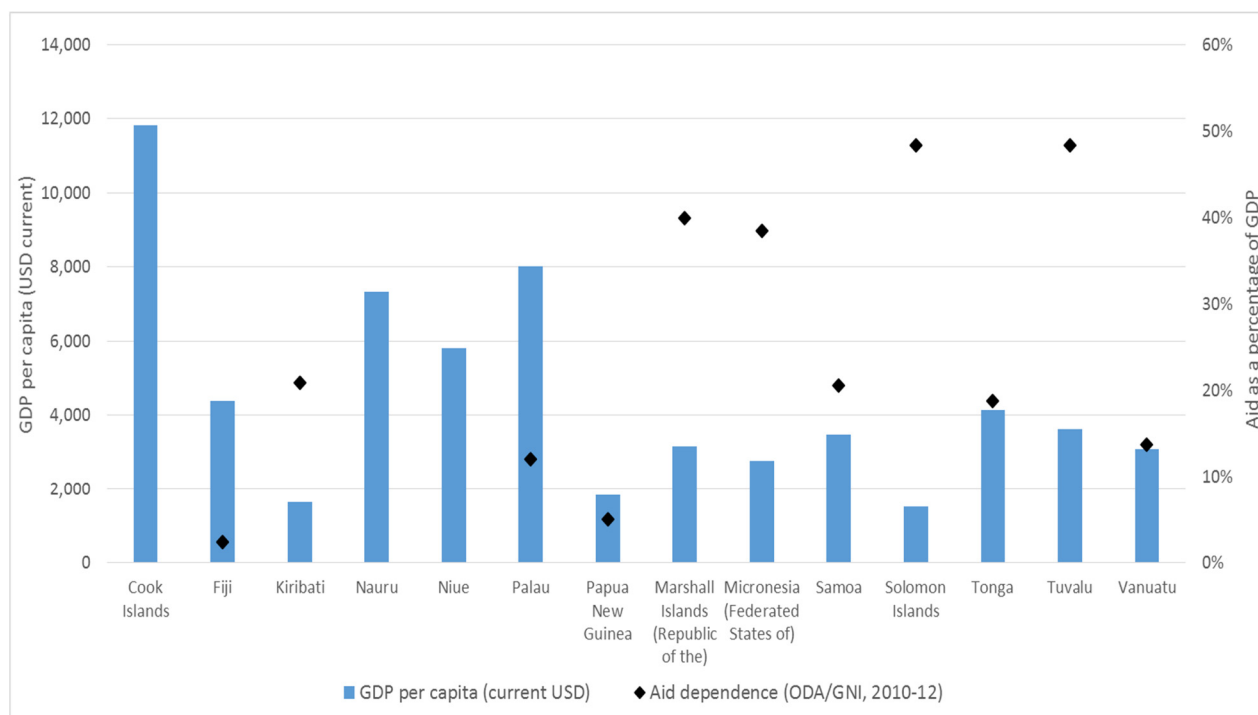
The Small Island Developing States (SIDS) of the Pacific, with the exception of Papua New Guinea, are among the smallest independent nation states in the world, as evident in Figures 1 and 2. These states, which are often referred to collectively as the Pacific island countries, share many common characteristics, such as the continuing importance of traditional forms of governance, including communal land ownership; geographical features such as distance from major markets and exposure to natural disasters; poor and/or costly transportation services; and high levels of development assistance (with some exceptions). There are also important differences among these countries. Some Pacific SIDS, such as Cook Islands, enjoy high per capita incomes, as illustrated in Figure 3. Others, such as Papua New Guinea, suffer some of the worst development indicators in the Asia Pacific region. The quality of government also differs across countries, with the public sector in Polynesian countries such as Samoa generally more effective than in clientelistic Melanesian countries such as Solomon Islands and Papua New Guinea.



**Figure 1.** Map of Pacific Small Island Developing States.

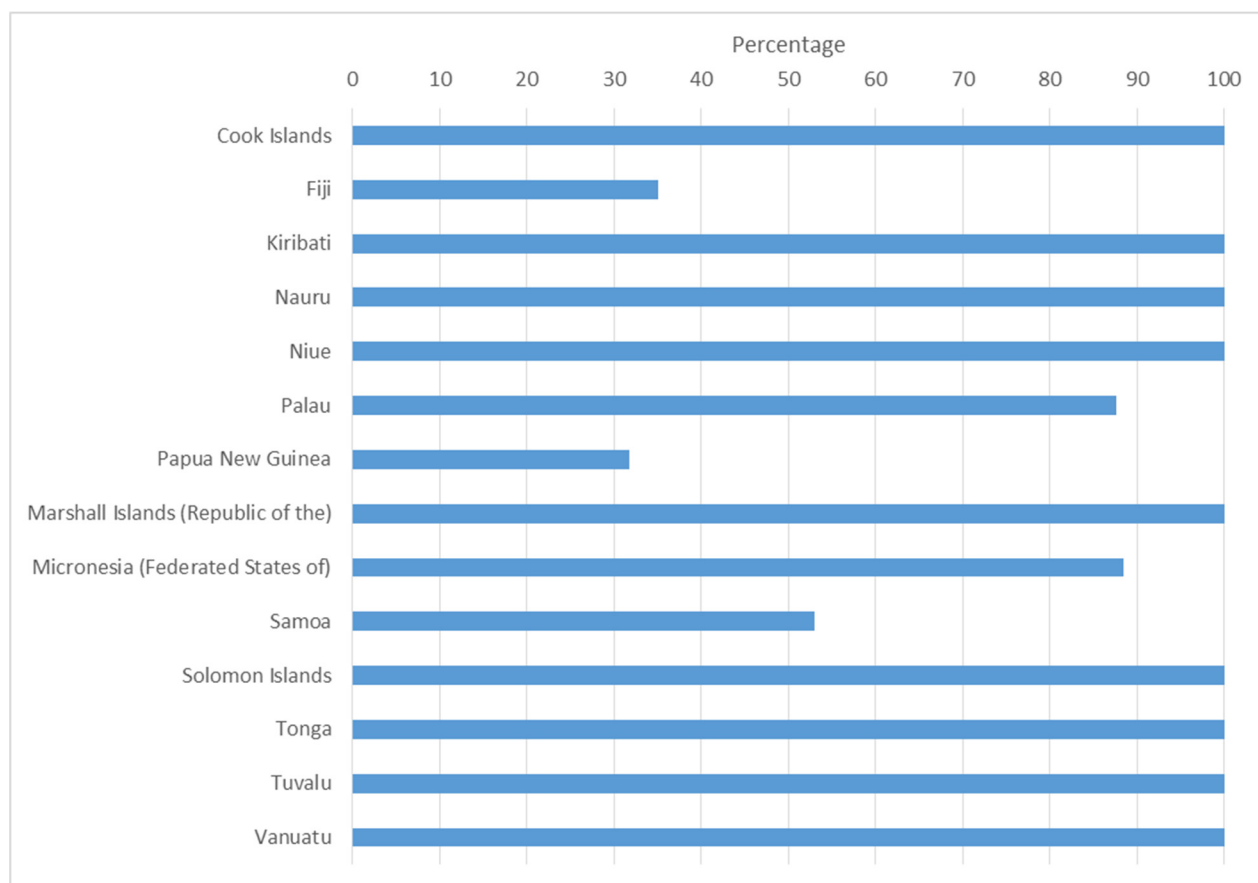


**Figure 2.** Population of Pacific Small Island Developing States.



**Figure 3.** Pacific Small Island Developing States: Per capita income and aid dependence (data not available for Cook Islands, Nauru and Niue).

Small Island Developing States in the Pacific are heavily dependent on fossil fuels to meet their energy needs. Reliance on fossil fuels is actually a feature of SIDS across the world, but it is particularly notable in the Pacific [1]. This is illustrated in Figure 4. In many of these countries, fossil fuels account for almost all energy use, with the exception of small-scale burning of biomass for cooking and waste disposal, which generally involves the use of wood collected in forests and rural areas. Reliance on fossil fuels stems from two main uses of energy in these countries. One is transportation. Transportation is extremely important in SIDS of the Pacific, which are among the most remote countries in the world. Analysis by the World Bank has shown that Pacific SIDS face considerable economic challenges as a result of their distance from major markets combined with the absence of scale economies [2–4]. Modern transportation in the form of fuel-consuming boats, automobiles, and aeroplanes is therefore very important to Pacific SIDS. Modern transportation has largely replaced traditional forms of transportation, and is almost entirely reliant on oil-based products such as petroleum and heavy fuel oil. A number of pilot projects involving the use of (native) coconut oil as biofuel in vehicles (whether blended or alone) have not resulted in the widespread use of such products [5].



**Figure 4.** Reliance on fossil fuels for power generation (percentage of total generation).

The second main use of energy takes the form of electricity consumption for refrigeration, air conditioning, lighting, and household appliances. The widespread use of oil-based generators for electricity production explains the high level of reliance on fossil fuels in Pacific SIDS. Despite ambitious renewable energy targets, the use of renewable energy technologies for power production has to date been limited in Pacific SIDS. Large-scale reliance on renewable energy is limited to a small number of larger SIDS with hydro-power resources that have been developed such as Fiji and Samoa. The use of coal and gas is also limited, exposing Pacific SIDS to changes in the international price of oil.

The economies of Pacific SIDS are also energy intensive. This means that these countries consume a large amount of energy for every dollar of income that they generate. There are a number of reasons for this. One is the importance of energy-intensive economic activities, such as fisheries. Another set of reasons relate to geography and the population distribution of Pacific SIDS. The distance of many of these countries from major markets means that they are reliant on long-distance transportation, which involves extensive energy consumption [4]. This situation is made worse by the way in which populations are dispersed over large areas in these countries. The majority of Pacific SIDS are archipelagos, including the Solomon Islands, Vanuatu, Fiji, Papua New Guinea, Tonga, Tuvalu, Kiribati, Federated States of Micronesia, and Cook Islands. The populations of these countries are dispersed across many islands (in some cases, hundreds of islands). Transportation to such widely dispersed populations is both costly and energy intensive. The ability to achieve economies of scale in energy consumption also declines as a result of this population distribution, both for provision of transport services, and electricity generation.

The reliance on fossil fuels to meet energy needs, coupled with inefficient use of energy, makes Pacific SIDS especially vulnerable to movements in the international price of oil. Pacific SIDS are almost completely reliant on the importation of fossil fuels, with the notable exception of Papua New Guinea, which is an oil and gas producer. In the Asia-Pacific, the ADB in 2009 estimated that Pacific island economies were among the most vulnerable in the region to oil price volatility as a result of this dependence (of the ten most vulnerable economies in the Asia-Pacific, seven were Pacific island countries) [6].

The impacts of high oil prices on importers of fossil fuels have been evident in the last decade. The oil price spike that occurred prior to the global financial crisis caused price inflation and led to major declines in the terms of trade of Pacific SIDS ([6–12]. In 2008, inflation among Pacific SIDS increased from an average of 2.5 to 12 per cent per annum as a result of fuel and food price increases [11]. The IMF [13] notes that the “pass-through” of oil prices increases in the form of inflation was almost total in Pacific island countries, whereas “pass-through” of food price increases was only partial due to price controls.

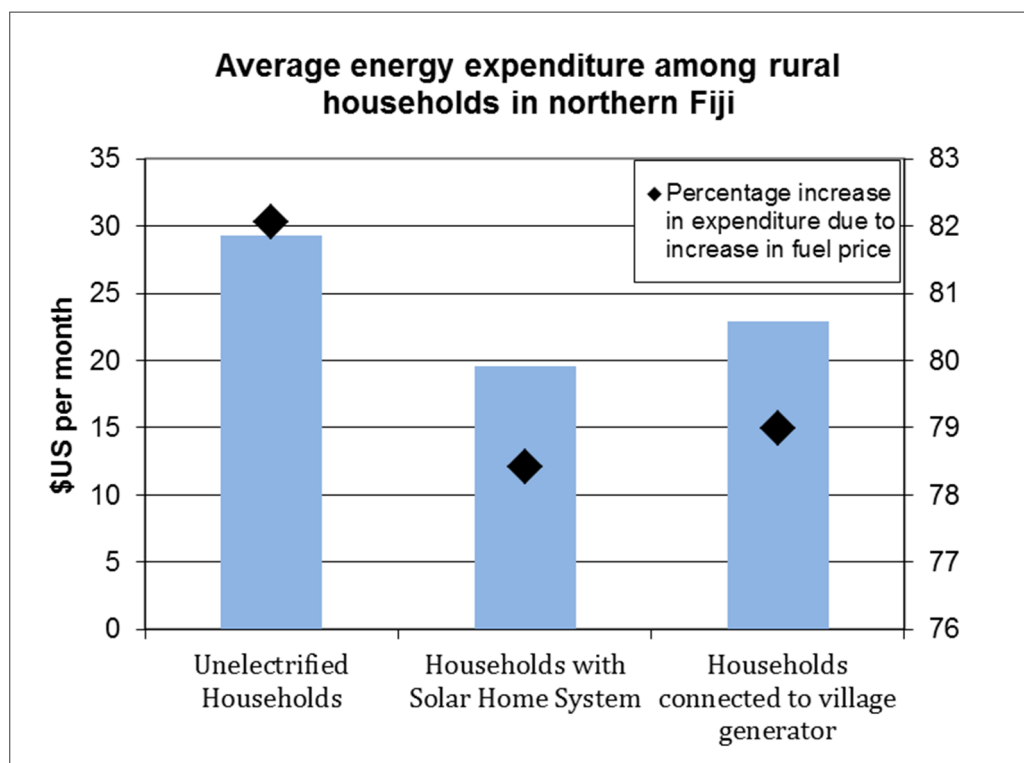
There was an impact on incomes in Pacific SIDS as well. In Fiji, the value of oil imports rose from five to 12 percent of GDP between 2002 and 2008, effectively reducing gross national income by approximately seven percent. In Kiribati, the effect was greater still, with an estimated loss in national income in the order of 12 percent [8]. This was experienced by households as a reduction in their purchasing power. High oil prices also led to a deterioration in the fiscal situation of a number of countries where electricity is produced by state-owned enterprises, and where electricity prices did not rise sufficiently to reflect increased generation costs.

The impact of oil price changes in SIDS is felt through various channels. Increases in the price of fuel directly affect consumers, whether directly as in the case of motorists, or indirectly as in the case of commuters that use public buses or shipping services. Electricity consumers connected to a centralised power grid are also affected by changes in the price of fossil fuel. The reliance on oil-based generation for electricity supplies in SIDS has meant that power prices have often increased significantly. In Fiji, power prices rose by 102 percent between 2005 and 2011, attracting front page coverage in Fiji’s newspapers. Oil price increases also affected the finances of the Fiji Electricity Authority (FEA). FEA spending on fuel as a proportion of its total operating costs increased from less than 20 per cent in 2002 to almost 60 per cent in 2010. This was equivalent to 12.6 per cent of Fiji’s total revenue from merchandise exports, and was higher than revenue generated by any single merchandise export, with the exception of fish [14,15].

In cases where prices are subsidised by government (often through loss making state-owned enterprises that provide electricity), tax-payers have instead been affected, including rural households that are not connected to the centralised electricity grid. In one extreme case, the Government of the Republic of the Marshall Islands declared an “economic state of emergency” in July 2008 when it appeared that electricity provision would cease as a result of the government-owned utility’s inability to pay for diesel fuel required to operate its generators. This was averted at the last moment through funding support from Taiwan, a major development partner [8].

Households also use fossil fuels for lighting and for decentralised electricity supplies. Surveys have shown that rural households without access to the electricity grid are particularly exposed to increases in the price of fossil fuel. Energy consumption is typically the second largest consumption item for

cash-poor rural households in Pacific SIDS, after food. The increase in commodity prices that occurred in 2008 adversely affected rural households of Pacific SIDS. One survey conducted in northern Fiji found that rural households spent approximately 24 percent of their income on energy purchases: primarily kerosene, petrol and diesel fuels for lighting (in some cases fuel was used for cooking, and to power refrigerators, chainsaws, brush-cutters, and washing machines) [16]. Households spent between \$20 and \$31 USD per month more on energy as a result of prices increase. The worst affected were households without an electricity supply, which rely on kerosene fuel for lighting (and in some cases, also cooking). These households saw an increase in expenditure of 82 percent, as can be seen in Figure 5.



**Figure 5.** Impact of fuel price increases (2005–2008) on energy expenditure among households with different electrification technologies.

### 3. Renewable Energy: Resources and Opportunities

Small Island Developing States of the Pacific have pursued investments in renewable energy technologies in recent years in response to oil price volatility. In doing so, almost all have established ambitious renewable energy targets, as evident in Table 1. Most of these targets are focused on investments in the electricity sector, recognising the considerable potential that exists in the region for replacing oil-based power generation with electricity produced by renewable energy technologies. In some cases, targets extend beyond the electricity sector, often with a view to the production of biofuels from domestic crops (coconut trees).

**Table 1.** Renewable Energy Targets among Small Island Developing States in the Pacific.

Country	Target *	Target Date	Current Renewable Share of Power Generation
Cook Islands	100%	2020	0
Fiji	81%	2020	45%
Kiribati	45% urban, 60% rural	2025	0
Marshall Islands	20%	2020	0
FSM	10% urban, 50% rural	2020	28%
Nauru	50%	2020	0
Niue	100%	2020	0
Papua New Guinea	50% GHG emission reduction	2030	Over 40%
Palau	20% **	2020	12%
Samoa	10% **	2016	30%–40%
Solomon Islands	50%	2015	0
Tonga	50%	2020	4%
Tuvalu	100%	2020	5%
Vanuatu	65% **	2020	15%

Notes: \* Target refers to electricity supply; \*\* Target refers to primary energy supply.

The establishment of ambitious renewable energy targets also serves other purposes. Small Island Developing States of the Pacific are among the most vulnerable countries in the world to the effects of climate change. In the case of atoll states such as Kiribati, Tuvalu and the Marshall Islands, rising sea levels threaten the livelihoods of entire countries, with periodic flooding already causing widespread damage due to salinisation of crops and the water supply [17]. Climate change mitigation in these countries will have a negligible impact on global greenhouse gas emissions. However, it does have the potential to strengthen the negotiating position of Pacific SIDS, promoting action by more significant polluters. The Pacific Small Island Developing States Group (PSIDS) has already proven influential in climate change mitigation discussions in the UN Framework Convention on Climate Change [18].

The cost of most renewable energy targets established by SIDS in the Pacific is very high. This reflects the ambitious nature of these targets. It also reflects the fact that meeting these targets is expected to involve funding from development partners; governments in establishing the scope of targets are not responsible for their financing, so are less constrained than might otherwise be the case. This has resulted in criticism of some of the more ambitious targets in countries with few low-cost renewable energy resources available for development [16]. Tuvalu, which as a country is extremely vulnerable to climate change and where migration is seriously being considered in response, provides a good example. The absence of renewable energy resources that could produce electricity at low cost, such as a good wind resource, biomass, or hydro-power potential, has not stopped the government from establishing a target of generating 100 percent of its electricity using renewable technologies. Government documents indicate that for this to occur, the electricity grid will rely at times on the use of batteries for power supplies. This would mean high generation costs, and in the words of the government, will result in a “rate of return less than that normally considered attractive by a private sector investor” [19].

The appropriateness of renewable energy targets is of course dependent on the availability of renewable energy resources that can produce electricity or primary energy supply at low cost. An



overview of the renewable energy resources that are available in Pacific SIDS is provided in Table 2. The table includes only technologies that are commercially proven, and is based on available information, which is incomplete. Pacific SIDS have a long history of failed experimentation with new (yet to be commercialised) technologies in the energy sector. This includes the installation of thousands of solar home systems in rural areas in the 1980s, as well as experimentation with village biofuel facilities, all of which have failed in time due to lack of appropriate operation or maintenance. Such experimentation should be avoided in the region, given the limited technical skills available to maintain or repair technology, and the difficulties in establishing sustainable institutional arrangements for maintenance (which by definition must both complement and be supported by traditional village governance structures) [16,20].

**Table 2.** Renewable Energy Resources for Power Supply (good, moderate, some, no resource, or to be determined).

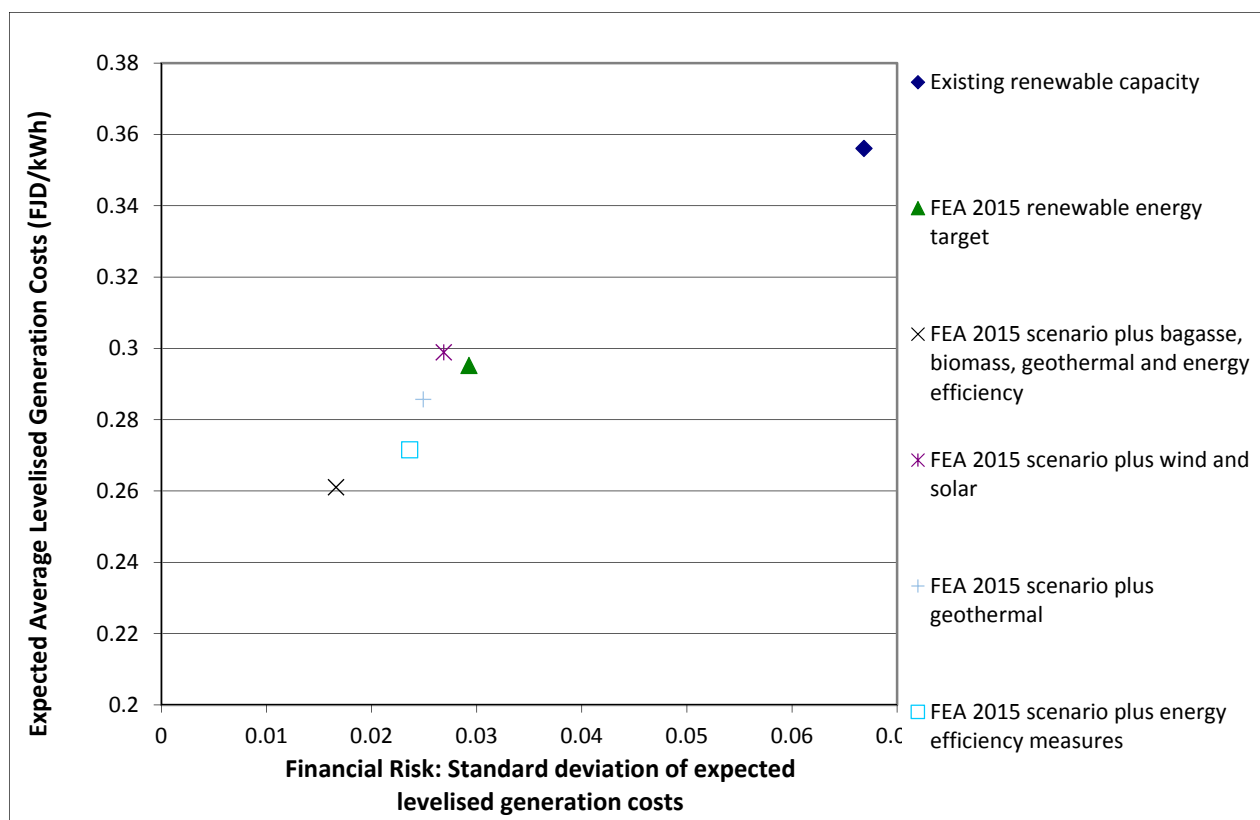
Country	Hydro-Power	Wind-Power	Solar-Power	Biomass	Geothermal
Cook Islands	No	Moderate	Good	Some	No
Fiji	Good	Moderate	Good	Good	Good
Kiribati	No	Moderate	Good	Some	No
Marshall Islands	No	n.a	Good	Some	No
FSM	No	n.a	Good	Some	No
Nauru	No	n.a	Good	No	No
Niue	No	n.a	Good	No	No
Palau	No	No	Good	No	No
Papua New Guinea	Good	Moderate	Good	Good	Good
Samoa	Good	Moderate	Good	Moderate	No
Solomon Islands	Moderate	n.a	Good	Good	TBD
Tonga	No	Moderate	Good	TBD	No
Tuvalu	No	No	Good	Some	No
Vanuatu	No	Moderate	Good	Moderate	Good

**Notes:** A “good” assessment refers to a resource that is capable of cost-effectively providing a “good” or significant proportion of the total electricity supply of a country. A “moderate” resource is capable of cost-effectively providing a “moderate” proportion of the total electricity supply of a country. An assessment that there is “some” resource available means that the resource can provide only a very limited proportion of a country’s total electricity supply. n.a. means that no data are available. **Source:** These are subjective assessments of the author based on analysis of studies detailed in Pacific Regional Energy Assessments [21]; national energy plans, and renewable energy scoping studies.

Ambitious renewable energy targets are warranted in some cases. Modelling of electricity generation in Fiji, for example, has shown that there are strong economic grounds for increasing the existing target of generating 85 percent of the country’s electricity using renewable energy. This is due to two reasons. One is the financial risk mitigation benefits associated with diversification and reduced reliance on oil; financial risk being defined as the standard deviation of expected average levelised generation costs (FJD/kWh) for the electricity grid and calculated using historical data. The second reason for supporting renewable energy investments is that these would lead to reductions in average levelised generation costs (FJD/kWh) for the electricity grid. The modelling suggests that the reason ambitious targets are

warranted in Fiji is the availability of abundant renewable energy resources that can be used for low-cost electricity generation [1].

The cost reduction and risk mitigation benefits associated with investments in renewable energy investment in Fiji's electricity grid are shown in Figure 6. Both expected average levelised generation costs (FJD/kWh) and financial risk are higher under the current scenario, labelled "existing renewable capacity". The program of renewable energy investments established by the Fiji Electricity Authority (FEA) (labelled "FEA 2015 renewable energy target") leads to both lower expected average generation costs and financial risk than in the current scenario. The modelling exercise also finds that further renewable investments, beyond those flagged by the FEA, lead to even lower expected average levelised generation costs and financial risk. The authors concludes that investments in renewable-based generation are likely to lead to reductions in both average generation costs and financial risk in other SIDS, however, only where SIDS have sufficient low-cost renewable energy resources available [1].



**Figure 6.** Cost and Risk Implications of Investments in Renewable Energy Technologies by the Fiji Electricity Authority (based on a 10 percent discount rate). Source: Calculations and modelling details available in [1].

Investment in renewable energy technologies in rural areas not connected to the electricity grid has also been found to mitigate risk associated with oil price volatility. Results of a survey of energy expenditure conducted in northern Fiji were presented in Figure 5. That survey found that households with a solar home system spent less on energy than households with a diesel/petrol generator or un-electrified households. These households were also less affected by the increase in the international price of oil in 2008, which both increased the price of diesel/petrol fuel and the price of kerosene used

by un-electrified households for lighting. In examining these latter results, it is important to emphasise that the single most important threat to the security of power supplies in rural areas not connected to the grid is poor maintenance. Institutional arrangements for operation and maintenance of off-grid power generation technologies are therefore of most importance to rural households not connected to the electricity grid [16,20].

#### 4. Challenges and Trade-Offs

There are a number of challenges and trade-offs posed by the ambitious renewable energy targets established by SIDS in the Pacific. These can be broadly categorised as financial and institutional. The financial challenge posed by ambitious renewable energy targets relates to how investments in renewable energy technologies will be financed. Pacific SIDS are among the most aid dependant nations in the world, comprising ten of the 25 most aid dependent countries when official development assistance is measured as a proportion of gross national income (GNI). Most of these countries face significant development challenges, have low per capita incomes, and enjoy very limited domestic revenue raising capacity. Governments in SIDS have been unwilling to fund new electricity generation infrastructure as a result.

The establishment of ambitious renewable energy targets has not changed this situation. Governments in SIDS have in fact emphasised the limited resources available in order to argue for additional development assistance. Many Pacific SIDS have also sought investment from the private sector, sometimes with support from development partners. The case of Fiji, which features one of the more developed power sectors, demonstrates the difficulties associated with attracting such investment. The Fiji Electricity Authority has received expressions of interest for the development of renewable energy resources in various part of Fiji, and in doing so, has signed power purchase agreements with parties interested in becoming independent power producers. However, none of these investment has come to fruition, with the exception of state-owned companies for which power generation is a by-product of the production process.

There are various reasons for why it has been difficult to attract private sector investment in renewable energy technologies. One is the small-scale of operation in SIDS and the corresponding absence of economies of scale, which limits the financial return available to investors [22]. The same issue has also limited access to climate change funding, such as that available under the Clean Development Mechanism. Global climate change funds typically involve significant transaction costs (in the case of the CDM, \$200,000 is common), which limits their ability to fund small-scale projects [23]. Another issue specific to the CDM has been that funds are provided after implementation, leaving the issue of finance unresolved [24].

A second constraint is the institutional environment for private sector investment. Investment is most likely to come from overseas. The financial base in Pacific SIDS is thin, and credit from financial institutions for large projects is extremely difficult to access. It is well known that foreign direct investment is generally risk averse and flows to countries with a good enabling environment, including sound and stable regulatory structures. This is reflected in the fact that there has been very limited investment in the least developed countries or countries considered to have poor governance or insecure property rights. Frameworks for investment in the Pacific are diverse; the institutional environment in

Fiji is more conducive to investment than that of Nauru or Papua New Guinea, as shown by the World Bank's *Doing Business Indicators*. In general, however, bureaucratic hurdles for foreign investors and an inability to secure rights over land make Pacific SIDS an unattractive destination for foreign investment—a point highlighted in much economic analysis in the past [25–27].

Difficulties in attracting private sector investment coupled with constraints in government spending have meant that the vast bulk of investments in renewable energy technologies have been funded by development partners. Section 3 highlighted the problems that this can cause, with governments setting very ambitious renewable energy targets in the knowledge that the cost of meeting targets will be borne by development partners.

The use of development assistance to fund renewable energy investments also raises the question of whether this is an appropriate use of aid funds. Development partner support for renewable energy investments has been sourced primarily from “traditional partners” such as New Zealand, the European Union, Asian Development Bank, and to a lesser extent, Japan, the World Bank and Australia. These partners, which are members of the OECD Development Assistance Committee, regard poverty reduction as a central objective of their development assistance programs. Support for renewable energy technologies can be viewed as contributing to this objective insofar as it protects consumers from higher electricity prices. At the same time, investments are centred primarily on the electricity grid, meaning that they most benefit urban consumers, who tend to have higher incomes than rural households. Lower power prices also disproportionately benefit households that consume more electricity, which again, tend to have higher incomes.

This is an important issue in a region where only 30 percent of the population has access to electricity in the first place [16]. Rural households without access to electricity do not benefit from renewable-based power generation linked to a centralised electricity network. The ambitious renewable energy targets established by SIDS in the Pacific have been the subject of criticism as a result. Criticism stems from the fact that renewable energy targets as currently established favour investment in the electricity grid over rural electrification. This is due to their focus on electricity produced (MWh) rather than services provided. Electricity consumption in rural areas is very limited even where households do have access to power, owing to lower incomes and low ownership of electrical appliances. Thus, targets focused on total electricity consumption inevitably are concerned primarily with consumption by urban households, where demand for electricity is highest. Indeed, there is some evidence that targets have resulted in a shift in development assistance away from rural electrification and toward grid-based investments [16].

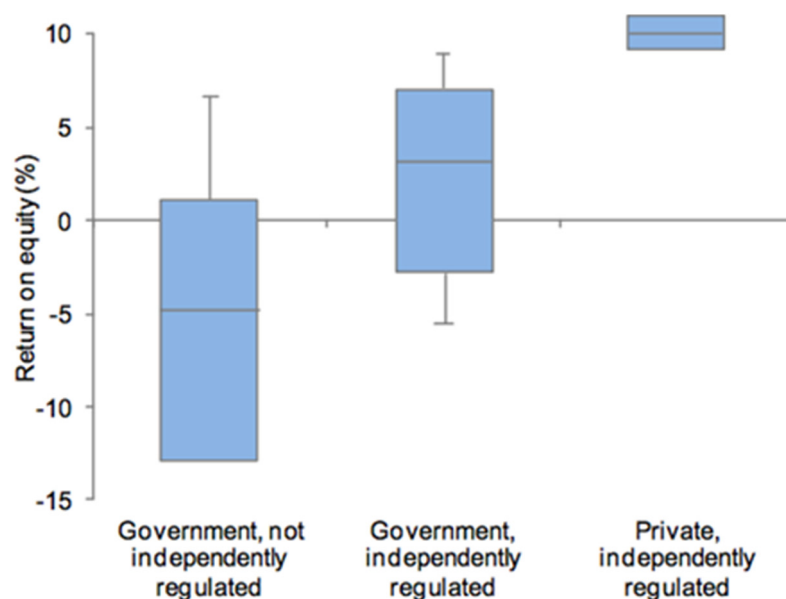
The diversion of aid funds from rural electrification toward grid-based investments could be argued to contradict the poverty-reduction objectives of development partner programs. At the very least, there is tension between the poverty alleviation objectives of renewable energy investments, which would favour rural electrification, and the risk mitigation objectives which would favour investment where it most reduces fossil fuel consumption, which is in the existing electricity grid.

The second set of challenges to expansion of renewable energy investment in Pacific SIDS are institutional. Some constraints to attracting private sector investment have already been discussed. Regulatory arrangements in the electricity sector are another barrier. The prevailing model of electricity supply in Pacific SIDS is that of a vertically integrated monopoly utility that is owned by government. Among the independent SIDS in the Pacific, only one country (Vanuatu) sees the bulk of its electricity provided by a private sector company. In most countries, electricity is provided by a single state-owned

enterprise. In some countries, small amounts of electricity are also fed-in to the electricity grid by independent power producers.

Electricity sector monopolies are in many cases legislated in Pacific SIDS, meaning that it is illegal for alternative providers to supply electricity, whether to the existing power network or to un-electrified households in rural areas. This affects potential installation of mini-grid and village-based systems by entities other than the dominant electricity utility. It is also a barrier to the provision of electricity through decentralised systems, using fee-for-service models. Households are still able to purchase their own decentralised systems, however, the limited technical support available is a barrier to their success.

Limiting investment by power utilities in both renewable energy technologies and rural electrification is the fact that state-owned power utilities are generally in poor financial positions, owing to governments setting tariffs for electricity that do not reflect the true cost of production and distribution. This is the result of regulatory arrangements in the sector. Indeed, the financial impact of regulation on power utilities is evident when comparing the financial performance of electricity utilities where prices are set by government with those where prices are set by an independent regulatory authority or board. The latter arrangement is associated with better financial performance by utilities across Small Island Developing States and territories of the Pacific, as can be seen in Figure 7.



**Figure 7.** Financial return on equity of power utilities in Pacific island countries and territories.

A number of SIDS governments have sought to promote investment in renewable energy technologies by reforming the electricity sector. Ambitious reforms aimed at privatising elements of the electricity sector have failed [28]. Less ambitious reforms aimed at establishing independent power price regulation in order to facilitate cost recovery and attract private sector investment have proceeded in some countries, including Fiji. However, even in these cases, state-owned utilities have often been hostile to the entry of new players. Prices offered to potential independent power producers, for example, have included very high transmission and distribution charges paid to the state-owned monopoly distributor and retailer, and in some cases, have actually been below the cost of power generation [28].

The key to addressing such challenges is strong regulation that is independent from government. This has already led to improvements in the performance of power utilities in a number of countries [29]. However, it does not address constraints to investment associated with an absence of economies of scale and the general investment environment. The establishment of independent regulatory bodies in very small countries is also likely to be costly relative to the potential benefits of such arrangements, given fixed costs associated with regulation [29,30].

A broader point is the interplay between the decisions of political leaders and technical organisations in the electricity sector. National renewable energy targets are useful insofar as they guide public policy (including regulatory arrangements) and indicate where potential investment opportunities lie for the private sector. But appropriate targets must be supported by advice and information from technical organisations, which include both regulatory authorities and electricity producers. Some (not all) of the renewable energy targets established by Pacific SIDS have not met this requirement. Renewable energy targets that set an objective of generating 100 percent of electricity using renewable energy resources in countries where no low-cost renewable energy options are available point toward political decision-makers acting without (or irrespective of) advice from technical organisations in the electricity sector. Indeed, discussions with power utilities and regulatory authorities in several Pacific SIDS confirm this view. The use of targets to strengthen the negotiating position of SIDS in international climate change negotiations (which understandably are of great importance to SIDS) and to attract funding support from development partners is likely to explain this disconnect between political decision making and advice from the electricity sector. Such a strategy is entirely rationale on the part of political leaders. However, it complicates planning in the electricity sector and poses some difficult questions for development partners.

## 5. Conclusions

The focus on investments in renewable energy technologies in the last decade is probably the most significant development ever in the energy sectors of Small Island Developing States (SIDS) of the Pacific. The desire to diversify energy production and lessen reliance on fossil fuels is understandable, given the significant impact of high oil prices prior to the global financial crisis (and to a lesser extent in 2011–2014). Governments in Pacific SIDS that are currently highly dependent on fossil fuels have sought to mitigate financial risks associated with oil price volatility through promoting investment in renewable energy technologies. This has involved the establishment of ambitious renewable energy targets, efforts to attract funding from development partners, and to some extent, reform of regulatory arrangements in the energy (and especially electricity) sector.

This paper has explored the development of renewable energy resources in the Pacific through a public policy lens, examining the economic and institutional challenges and trade-offs posed by efforts to promote renewable energy technologies. The promotion of electricity production using renewable technologies is justified in most Pacific SIDS on risk mitigation grounds, and in some cases, on the basis that such investment is likely to result in lower power generation costs. At the same time, the ambitious targets established in the region are not always appropriate, and in some cases, are very clearly not cost-effective given the renewable energy resources that are available in these countries.

There are various financial and institutional challenges to the development of renewable energy resources in Pacific SIDS. Governments and state-owned power utilities are not in a position to fund the

considerable investments required to even come near to meeting renewable energy targets in Pacific SIDS. There is little prospect of significant private sector investment, given a thin domestic financial sector and institutional arrangements that in most Pacific SIDS are not conducive to foreign direct investment. Reform of regulatory arrangements in the power sector could help to facilitate such investment, and is worth pursuing in any case given the detrimental impact of current arrangements on the performance of power utilities (and efforts to extend electricity grids to un-electrified households). Independent price regulation is particularly important, although will prove challenging in the smallest of Pacific SIDS. Such reform is unlikely to be a complete panacea, however, as demonstrated by the successful implementation of reform in Fiji (one of the largest and most developed Pacific SIDS) and the subsequent failure to attract private sector investment in renewable energy technologies.

Pacific SIDS have to date sought assistance from development partners for the development of renewable energy technologies. This is not surprising, given the high levels of aid dependence observed in the region. This paper has raised questions about whether such assistance is consistent with the poverty alleviation objectives of development partners, given that the majority of investment has focused on grid-connected infrastructure, thereby disproportionately benefitting higher income households. It has also highlighted a trade-off for aid-funded renewable energy programs. On the one hand, the risk mitigation benefits of renewable technology investments are designed to lessen reliance on fossil fuels, and therefore logically require investments in the existing electricity grid. On the other hand are the potential poverty alleviation objectives of renewable technology investments, which would focus investment on un-electrified households that primarily reside in rural areas of Pacific SIDS. The poverty alleviation and risk mitigation benefits of renewable energy technology investments are not always mutually exclusive, but there are trade-offs that should be recognised. The current emphasis on targets that specify that a percentage of total electricity or energy be sourced from renewable energy technologies reduces the focus on poverty alleviation.

There is a disconnect more broadly between the targets established by political leaders in Pacific SIDS and technical organisations responsible for implementing the policies and investments that will see those targets met. This paper has argued that this is the result of other objectives that these targets support. One objective of ambitious targets is to bolster the negotiating position of SIDS in international climate change negotiations. All of the SIDS considered in this paper are vulnerable to climate change, with the very existence of atoll states such as Tuvalu threatened by rising sea levels. The second objective behind ambitious renewable energy targets is to attract funding from development partners to meet those targets. The use of targets to achieve these objectives creates problems for energy sector organisations in some countries, given that planning becomes more aspirational and less realistic, and as completion of objectives comes to depend on outside assistance rather than the actions of energy sector organisations themselves. Unless the views of energy sector organisations are taken into account by political leaders, this disconnect will only continue to undermine effective planning in the energy sector.

## Conflicts of Interest

The author declares no conflict of interest.

## References

1. Dornan, M.; Jotzo, F. Renewable Technologies and Risk Mitigation in Small Island Developing States: Fiji's Electricity Sector. *Renew. Sustain. Energy Rev.* **2015**, *48*, 35–48.
2. Dornan, M. Trade-Related Infrastructure in Pacific Small Island Developing States; The World Bank: Washington, DC, USA, 2014.
3. Winters, L.A.; Martins, P.M. When Comparative Advantage Is Not Enough: Business Costs in Small Remote Economies. *World Trade Rev.* **2004**, *3*, 347–383.
4. World Bank. *Pacific Futures: World Bank Discussion Note*; World Bank Group: Sydney, Australia, 2011.
5. Cloin, J.; Woodruff, A.; Furstenwerth, D. *Liquid Biofuels in Pacific Island Countries*; Pacific Islands Applied Geoscience Commission: Suva, Fiji, 2007.
6. Asian Development Bank. *Taking Control of Oil: Managing Dependence on Petroleum Fuels in the Pacific*; ADB: Manila, Philippines, 2009.
7. Asian Development Bank. *Living with High Prices: A Policy Brief*; ADB: Manila, Philippines, 2008.
8. Dornan, M. Methods for Assessing the Contribution of Renewable Technologies to Energy Security: The Electricity Sector of Fiji. *Pac. Econ. Bull.* **2009**, *24*, 71–91.
9. Levantis, T. Oil Price Vulnerability in the Pacific. *Pac. Econ. Bull.* **2008**, *23*, 214–225.
10. Levantis, T.; Groeger, C.; McNamara, S. Are Pacific Countries Coping with Surging Oil Prices? *Pac. Econ. Bull.* **2006**, *21*, 115–125.
11. Sugden, C. Responding to High Commodity Prices. *Asian Pac. Econ. Lit.* **2009**, *23*, 79–105.
12. United Nations Development Program. *Fuel to Change: Overcoming Vulnerability to Rising Oil Prices*; UNDP: Bangkok, Thailand, 2007.
13. International Monetary Fund. *Regional Economic Outlook: Asia and Pacific, Managing the Next Phase of Growth*; IMF: Washington, DC, USA, 2011.
14. Fiji Electricity Authority. *Annual Report*; FEA: Suva, Fiji, 2010.
15. Reserve Bank of Fiji. *Quarterly Review: June 2011*; Reserve Bank of Fiji: Suva, Fiji, 2011.
16. Dornan, M. Access to Electricity in Small Island Developing States of the Pacific: Issues and Challenges. *Renew. Sustain. Energy Rev.* **2014**, *31*, 726–735.
17. Nurse, L.A.; McLean, R.F.; Agard, J.; Briguglio, L.P.; Duvat-Magnan, V.; Pelesikoti, N.; Tompkins, E.; Webb, A. Small Islands. In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*; Barros, V.R., Dokken, D.J., Mastrandrea, M.D., Mach, K.J., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., et al., Eds.; Cambridge University Press: Cambridge, UK; New York, NY, USA, 2014.
18. Fry, G. Recapturing the Spirit of 1971: Towards a New Regional Political Settlement in the Pacific. In *SSGM Discussion Paper*; State, Society & Governance in Melanesia Program: Canberra, Australia, 2015.
19. Government of Tuvalu. *Enetise Tutumau 2012–2020: Master Plan for Renewable Electricity and Energy Efficiency in Tuvalu*; Government of Tuvalu: Funafuti, Tuvalu, 2013.



20. Dornan, M. Solar-Based Rural Electrification Policy Design: The Renewable Energy Service Company (Resco) Model in Fiji. *Renew. Energy* **2011**, *36*, 797–803.
21. Wade, H.; Johnston, P.; Vos, J. *Pacific Regional Energy Assessment 2004: Regional Overview Report*; South Pacific Regional Environment Programme: Apia, Western Samoa, 2005.
22. Wade, H. *Financing Mechanisms for Renewable Energy Development in the Pacific Islands*; South Pacific Regional Environment Programme: Apia, Western Samoa, 2005.
23. Millar, I. *Enabling Pacific Island Countries to Participate More Effectively in Cdm Activities*; Foundation for International Environmental Law and Development: London, UK, 2007.
24. World Bank. *State and Trends of the Carbon Market, 2010*; World Bank Environment Department: Washington, DC, USA, 2010.
25. Australian Government. *Pacific 2020: Challenges and Opportunities for Growth*; AusAID: Canberra, Australia, 2006.
26. Australian Government. *Making Land Work*; AusAID: Canberra, Australia, 2008.
27. *The Political Economy of Economic Reform in the Pacific*; Duncan, R. Ed.; Asian Development Bank: Manila, Philippines, 2011.
28. Dornan, M. Reform Despite Politics? The Political Economy of Power Sector Reform in Fiji, 1996–2013. *Energy Policy* **2014**, *67*, 703–712.
29. Dornan, M.; Alejandrino-Yap, C.; Austin, J. Power Benchmarking in the Pacific: Assessing Key Influences on Operational Performance. In *Pacific Economic Monitor*; Asian Development Bank: Manila, Philippines, 2013.
30. Weisser, D. Power Sector Reform in Small Island Developing States: What Role for Renewable Energy Technologies? *Renew. Sustain. Energy Rev.* **2004**, *8*, 101–127.

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