Critical challenges and capacity building needs for renewable energy deployment in Pacific Small Island Developing States (Pacific SIDS)

Hugo Lucas[1,5], Solomone Fifita[2], Ilham Talab[3], Cornelia Marschel[4], Luisa F. Cabeza[5,*]

[1]Sustainable Energy Initiative (SEI), Faculty of Environmental Studies, York University, Toronto, Canada.
[2]Secretariat of the Pacific Community (SPC), SPC Suva Regional Office - Private Mail Bag, Suva, Fiji.
[3]International Renewable Energy Agency (IRENA), PO Box 236, Abu Dhabi, United Arabs Emirates.
[4]Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety[1]
[5]GREA Innovació Concurrent, Universitat de Lleida, Edifici CREA, Pere de Cabrera s/n, 25001 Lleida, Spain.
*Corresponding author: lcabeza@diei.udl.cat

Abstract

The Pacific Small Island Developing States (SIDS) are among the most vulnerable to the impacts of climate change. Besides, they are some of the most dependent on imported petroleum products in the world, the use of renewable energy (RE) can help minimize the economic risk associated with the price volatility of fossil fuels. The region is increasingly adopting renewable energy (RE) targets and policies. Successful examples of RE deployment in the Pacific SIDS exist; however, many barriers persist and prevent the use of the region's RE resources in a larger scale. Challenges for RE deployment in islands can be grouped in six categories: i) lack of RE data, ii) need for policy and regulatory frameworks, iii) scarcity of financial opportunities, iv) lack of human resources, v) costly infrastructure, and vi) socio-cultural impediments. Based on a survey conducted among main stakeholders in the region, within the framework of the Pacific Region Capacity Building Initiative of the International Renewable Energy Agency (IRENA) carried out in cooperation with the Secretariat of the Pacific

[1] The views expressed in this article are the authors' and do not represent official positions of the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety.

Community (SPC), this paper identifies the specific characteristics of these challenges in the context of the Pacific SIDS, provide a qualitative assessment and identifies recommendations to overcome these challenges.

Key-words: Renewable energy; Pacific SIDS; challenges; capacity building.

1. Introduction

Understanding the unique context of the Pacific Small Island Developing States

The vulnerability of SIDS to natural disasters and sea level rise caused by climate change, combined with the unique set of challenges that shape the fabric of their economies, energy supply and environment, have led to their recognition, by the United Nations Conference on Environment and Development in 1992, as a special group of developing countries. This recognition is justified by two particular characteristics: their small size and their geographical isolation. These characteristics entail limited economies of scale, reduced land area, high cost of transportation, and significant vulnerability to natural disasters and sea level rise caused by global climate change. The Pacific SIDS consists of 20[2] low-lying coastal countries and jurisdictions scattered in one of the world's largest oceans.

Despite the similar characteristics among the islands, the Pacific SIDS feature widely varying land areas, populations, annual power generation, and Gross Domestic Product (GDP), as depicted in Figure 1. The level of diversity in the region is clear as the population ranges from over 1,500 inhabitants in Niue to more than seven million in Papua New Guinea (PNG). Only 1.8% of the region is landmass, with five Melanesian

[2] The Pacific SIDS consist of a total of twenty islands: American Samoa, Cook Islands, Federal State of Micronesia, Fiji, French Polynesia, Guam, Kiribati, Nauru, New Caledonia, Niue, Northern Mariana Islands, Palau, Papua New Guinea (PNG), Republic of the Marshall Islands (RMI), Samoa, Solomon Islands (SI), Timor-Leste, Tonga, Tuvalu and Vanuatu.

Pacific SIDS accounting for 97.8% of the land area and 87.8% of the population. Furthermore, the annual electricity generation ranges from about 500 to 500,000 MWh.

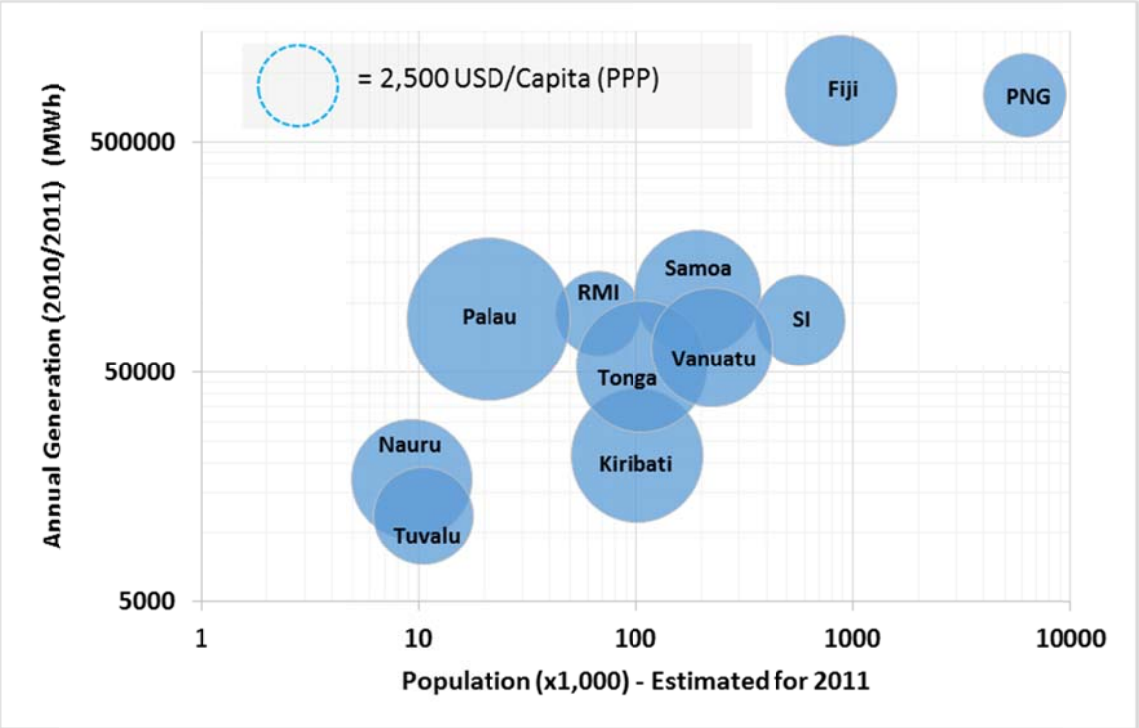

Figure 1. Indicative annual power generation, Gross Domestic Product and population in 2011 for Pacific SIDS. Sources: Pacific Power Association [1] and World Bank.

In terms of social development, as shown in Figure 2, the trend shows a positive change in the Human Development Index[3] (HDI) between 2000 and 2013. While some islands have even registered HDI levels above the world's average, others like PNG and Solomon Islands lag behind with the lowest HDI in the region, according to 2013 data.

[3] A composite index measuring average achievement in three basic dimensions of human development—a long and healthy life, knowledge and a decent standard of living. United Nations Development Programme (UNDP); http://hdr.undp.org/es/data

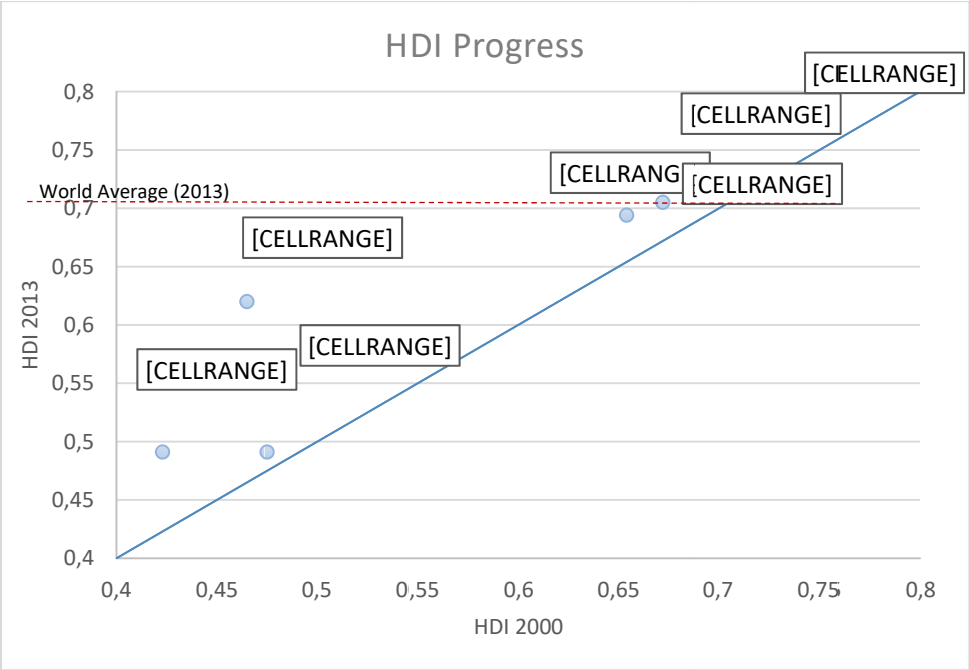

Figure 2. Human Development Index (HDI) progress between 2000 and 2013 in some Pacific SIDS compared to world's average [2,3].

Main energy challenges in the Pacific SIDS

The Secretariat of the Pacific Community[4] (SPC), within their framework for action on energy security in the Pacific Community, has identified four main challenges in the energy sector in the Pacific SIDS: (i) access, (ii) affordability, (iii) security, and (iv) safe and efficient operation of the system.

Regarding access to energy, it is estimated that 70% of households in the Pacific SIDS do not have access to electricity [4]. However, different Pacific SIDS have different rates of electrification, varying from 17% to 100%. Among the islands with particularly low electrification rates are those with a higher population (e.g. PNG). Within the

[4] The Pacific community is an Intergovernmental organisation founded in 1947. Membership includes the 22 Pacific Island countries and territories along with Australia, France, New Zealand and United Sates of America.

78 electrification, different relative importance is given to off-grid solutions. Table 1 shows
79 the share of the population with access to electricity.
80
81 Table 1. Population of households accessible to utility grid and off-grid in 2009 [5].

Country	**% of households connected to the utility grid**	**% of households connected to small-scale or mini grid (off-grid) (Rural)**	**Total**
Fiji	98%	2%	100%
Kiribati	44%	36%	80%
Nauru	100%	-	100%
Palau	99%	1%	100%
PNG	12.4%	6.5%	18.9%
RMI	70%	30%	100%
Samoa	99%	1%	100%
Solomon Islands	14%	3%	17%
Tonga	89%	5%	94%
Tuvalu	94%	6%	100%
Vanuatu	28%	6%	34%

82
83 With regards to affordability, the Pacific SIDS are highly dependent on imported fossil
84 fuels and their energy infrastructure cost [6] are higher than the average cost in
85 mainland countries. Due to these factors, Pacific SIDS have one of the highest costs in
86 the world for electricity generation, with a consumer tariff averaging USD 0.39 – 0.47 /
87 kWh in 2011 [1].
88 Considering the high cost of electricity generation from imported diesel, and the fact
89 that in most islands the retail tariffs are subsidized and do not reflect the actual cost of
90 generation, power utilities could experience a net saving scenario if the share of
91 renewables in the generation mix increases. This in turn would help avoid the cost of
92 fossil fuels. However, other factors such as the impact of a higher share of renewables

on the efficiency of the diesel generators running at lower capacity and the fixed costs of the utility assets, need to be considered by utilities.

Energy security is a particularly acute problem. Recent figures show that oil accounts for about 80% of the primary commercial energy consumption in the Pacific SIDS, with transportation accounting for about 75% and electrical generation for over 20% of the final use. Consequently, the volatility of oil prices, supply disruptions, and inefficiencies are all factors that have a considerable impact on the economies and energy security of the Pacific SIDS [7]. Even PNG, the only country of the Pacific SIDS endowed with indigenous petroleum resources, experiences significant market exposure due to its high dependency on imported goods, which are indirectly affected by oil prices.

Moreover, oil dependency has been a major factor in the slow economic growth in the region. In 2009, the Asian Development Bank has cited rising oil prices [8] as one of the factors for the sharp drop in GDP growth across the region [9]. For example, Fiji's oil imports accounted for approximately 14% of the country's GDP in 2010 [10]. The small island state of Tuvalu imports about 4.5 million litres of fuel per year, the bulk of which is diesel fuel to generate electricity. This is about twice the volume imported in the mid-1990s and accounts for over 20% of the island's GDP [11], four times more than the world average.

Finally, most grid power systems in Pacific SIDS are relatively small and managed by public utilities vertically integrated. Average distribution losses are 20% or higher [5], Nauru's utility company, for instance, has reported 34% of distribution losses [5]. Further work is needed for the development and compliance with safety standards in the existing power and petroleum facilities as well as the installation, operation, and maintenance of RE technologies.

118 ***Renewable Energy Potential and Present Use***

119 In terms of RE potential, islands such as Fiji, PNG and Solomon Islands have a wide
120 variety and abundance of RE resources. Other islands, such as Kiribati, Nauru and
121 Marshall Islands have lower potentials due to a smaller landmass and resource
122 availability [12]. On average, the three most abundant RE resources across the islands in
123 order of potential are solar, geothermal and hydro. Other resources such as bioenergy,
124 ocean and wind exist with varying potential [13]. In addition to solar energy,
125 geothermal energy applications can be found in PNG; hydro energy is utilised in PNG,
126 Fiji, Samoa and Vanuatu; and wind energy is utilised in Fiji, New Caledonia, and
127 Vanuatu. Table 2 summarises the results of the survey (see section 2) on RE use and
128 potential availability.

129

130 Table 2. Renewable Energy Potential and Present Use in selected Pacific SIDS. Source:
131 own elaboration.

Country	**Existing RE use**	**RE share[5] (in %)**	**Potential RE resources**
Fiji	Hydro Solar PV systems (grid-connected and off-grid) Solid biomass (bagasse) Liquid Biofuel (biodiesel) Wind	67%	Hydro Solar Biomass
Kiribati	Solar PV systems Solid biomass residues (coconut trees)	0.1%	Solar Biomass
Nauru	Solar PV systems	0.3%	Solar

[5] RE share calculated as Quantity of RE (GJ)/Total Supply of Energy (GJ).

			Ocean waves
New Caledonia	Hydro Wind	11%	Hydro Wind Solar
Palau	Solar PV systems	0.3%	Solar Ocean waves
Papua New Guinea (PNG)	Hydro Geothermal	65.8%	Hydro Geothermal
Republic of Marshall Islands (RMI)	Solar PV systems	Not captured	Solar Ocean waves
Samoa	Hydro Solar PV systems	40%	Hydro Solar
Solomon Islands	Solar PV Hydro	0.04%	Hydro Solar
Tonga	Solar PV systems	0.03%[6]	Solar
Tuvalu	Solar PV systems	Not captured	Solar
Vanuatu	Hydro Solar PV systems	Not captured	Hydro Solar

Renewable Energy Policy Initiatives

At the regional level, the Framework for Action on Energy Security in the Pacific (FAESP) and its Implementation Plan (IPESP 2011-15), which were endorsed in April 2011 by the Pacific Energy Ministers, aim to supplement capacity and provide support to national governments and stakeholders in the implementation of RE policies and roadmaps. The desired outcome is to provide both, national and regional institutions with the tools to improve the region's energy security. Increasing RE production and

[6] This figure does not take into consideration the 1.3 MW PV grid connected project completed in 2012.

141 supply is one of the main targets of this initiative. The long-term objective is to increase
142 investment in RE technologies that have proved their practicality in the Pacific Islands.
143 Four key priorities are defined: i) resource assessment; ii) investment in RE; iii)
144 capacity development; iv) an increase in the proportion of RE in the energy mix [14].
145 More recently, 2014 was declared the International Year for Small Island Developing
146 States; in September Samoa hosted the UN International Conference on Small Island
147 Developing States. The outcome paper from the Conference called SIDS Accelerated
148 Modalities of Action (S.A.M.O.A.) Pathway highlights the crucial role to play by RE in
149 their sustainable development the focus of the cooperation with developed countries is
150 placed in capacity building [15]. To move to action the SIDS Lighthouses initiative was
151 lunched during the UN General Assembly in 2014. This public-private partnership aims
152 to provide a holistic approach to capacity building on renewables in the region [16].
153 Pacific SIDS, with the support of its development partners, are marshalling towards RE
154 sources to decrease their reliance on imported fossil fuels, alleviate their vulnerability to
155 fluctuating oil prices, and contribute to global efforts in reduce greenhouse gas (GHG)
156 emissions. Almost all the Pacific SIDS have adopted ambitious RE targets (mostly for
157 the electricity sector) and some have designed and implemented support mechanisms to
158 achieve those targets. Figure 3 and Table 3 summarize the results of the survey (see
159 section 2).
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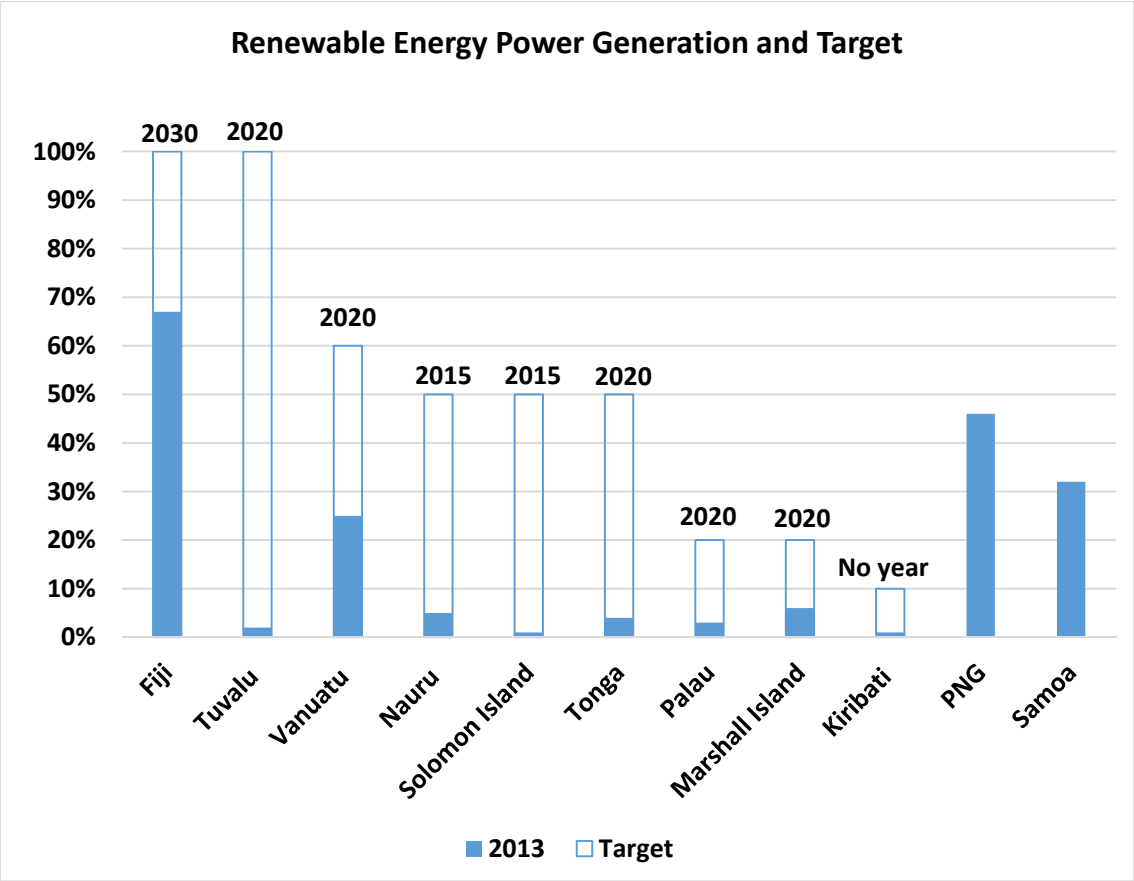
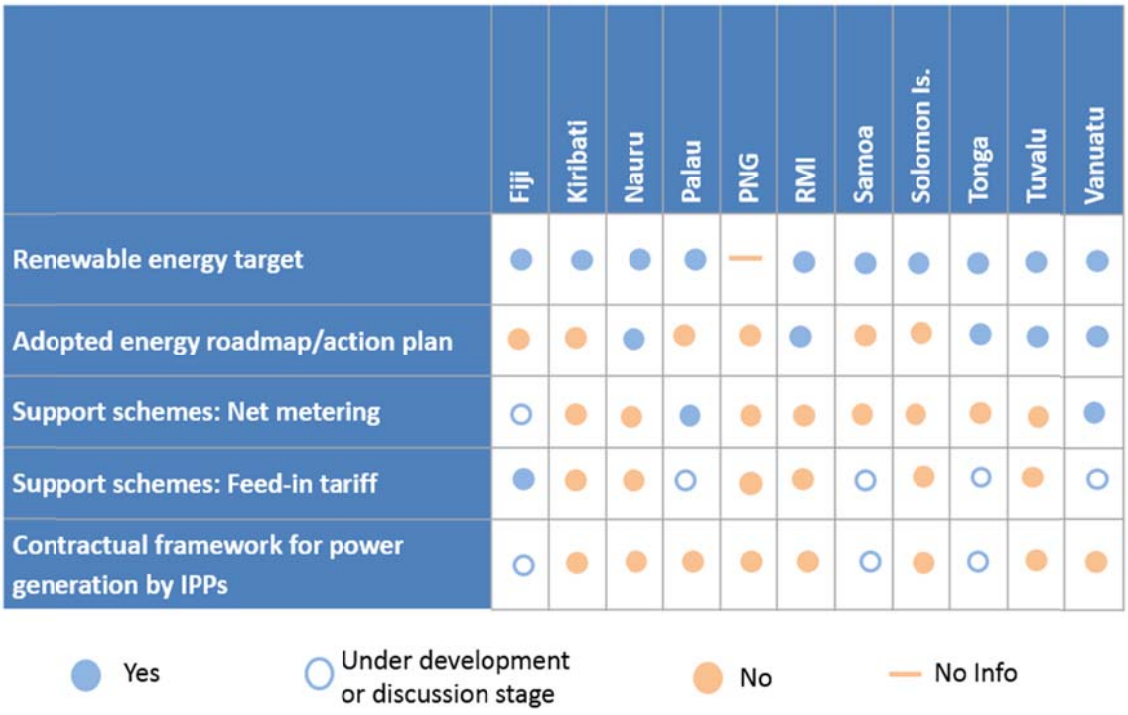


Figure 3. Overview of renewable energy power generation targets of a number of the Pacific SIDS. Source: own elaboration.

Table 3. Overview of the status of RE support mechanisms in a number of Pacific SIDS. Source: own elaboration.



Regarding fiscal measures, Fiji offers tax incentives for biofuel production, for RE generation projects, and cogeneration. These incentives consist of a 5 to 10 years tax holiday and they only apply to new private investments. In other Pacific SIDS such as Kiribati, Nauru, Palau, PNG, Samoa, Solomon Islands, Tonga, and Tuvalu, a tax exemption is applicable but only to government or donor-funded RE projects. The Republic of Marshall Islands (RMI) provides a duty exemption for imported RE equipment. In Vanuatu, even though there are no tax exemptions, the government offers grants for RE projects on a case-by-case basis.

Summary of the introduction

In summary, dependency on fossil fuels is threatening the fragile and small economies of the Pacific SIDS. Governments in Pacific SIDS are increasingly aware of the

183 possibility to supply a part of their energy needs from renewables in an affordable,
184 reliable and more secure manner. Most governments of the Pacific SIDS have adopted
185 ambitious RE targets and are now designing and implementing policies and support
186 measures to achieve these targets. It can be noted that many Pacific SIDS have
187 committed to RE targets and developed policies to promote the deployment. However,
188 market development is still lagging behind.
189 The paper is structured as follows: section 2 describes the methodology to identify main
190 challenges for RE deployment and capacity building needs in small islands and assesses
191 their importance for Pacific SIDS. Section 3 presents the results. Section 4 provides
192 conclusions.
193

194 **2. Methodology**

195 The work was conducted in two phases. In the initial phase, a comprehensive literature
196 review was carried out to identify the main challenges for RE deployment in small
197 islands. In the second phase, a survey was designed and circulated to main stakeholders
198 in the Pacific SIDS. The survey was structured to: (i) identify the specific characteristics
199 of these challenges in the context of the Pacific SIDS, (ii) gather recommendations to
200 overcome these challenges, and (iii) provide a qualitative assessment on their
201 importance.

202 The survey was conducted during 2013, within the framework of the Pacific Region
203 Capacity Building Initiative of the International Renewable Energy Agency
204 implemented in cooperation with the Secretariat of the Pacific Community [17]. It
205 focuses on 11 of the 20 Pacific SIDS due to the availability of data and the engagement
206 of local stakeholders. A total of 32 survey forms were received via email, and
207 completed through telephone interviews and face-to-face consultations. Out of the 32

208 survey forms, four were received from the utilities, 15 from the private sector, eight
209 from financial institutions, and five from governments. List of institutions can be found
210 in Annex 1. The survey takes two different approaches for RE uptake into
211 consideration: grid connected and off-grid application.

212 Even though the transportation sector plays a crucial role in any insular country,
213 particularly due to their reliance on aerial and maritime transportation, currently there
214 are no RE alternatives to fossil fuels in this sector at a large scale. For this reason, the
215 focus of this article is power generation from RE sources. We do recognize, however,
216 the importance of the transportation sector, particularly in the context of climate change,
217 as well as the need to find sustainable heating and cooling solutions for the tourism
218 sector, and the high value of undertaking energy efficiency and conservation measures.

219

220 **3. Results**

221 3.1 Literature review

222 The literature review shows that challenges for RE deployment in small islands can be
223 grouped in six categories: i) lack of RE data, ii) need for policy and regulatory
224 frameworks, iii) scarcity of finance opportunities, iv) lack of human resources, v) costly
225 infrastructure, and vi) socio-cultural impediments.

226

227 ***Lack of renewable energy data***

228 Whereas data for fossil energy sources is readily available, factors like dispersed
229 consumers and producers, small-scale projects, and lack of structured markets for
230 biomass fuels make the collection of RE data a very difficult task, particularly for

islands. Since accurate and complete energy data is pivotal for design and implementation of policy initiatives, as well as for investment decisions, gaps on RE data may result in a challenge for these purposes [18-20].

Need for policy and regulatory frameworks

Policy design and implementation is one of the greatest challenges for governments when promoting the deployment of new technologies and structural changes. RE policy instruments have to provide favourable market conditions for such deployment, particularly by attracting financial resources from the private sector [18-22]. Besides market deployment policies, policy makers will have to consider also policy and regulations for aspects related with: education and awareness, geographical and spatial planning, infrastructure development, research and development, energy efficiency, environment and in the case of biomass agriculture [20, 22-23].

Scarcity of financial opportunities

Other key players in the deployment of RE are the financial institutions that facilitate loans to RE projects. This includes financial players from the public and private sectors, as well as microfinance institutions. It is important that these players have the required knowledge to evaluate the financial aspects of RE projects, such as profitability margins, intrinsic risks, technology viability, industry standards, and social and environmental benefits of the project. The lack of this expertise makes financial institutions, especially in developing countries, reluctant to provide the necessary resources to support RE projects [19-22].

Lack of human resources

RE technology requires proper installation and maintenance. Before any deployment or investment in any RE technology can take place, it is essential that the technical process is assessed and the needed skills are acquired for the successful and sustainable implementation. Education and training in the RE field is a concern. While there is greater awareness of the benefits of RE systems, educational and training programs are still scarce in the small islands states; and those that exist are localized in the bigger islands. The lack of educational programs seems to be the consequence of a market-oriented trend for educational systems: they are available only where a current demand for them already exists. This, in addition to the shortage of experienced instructors, results in a very limited supply of such programs at a local level [18-21, 24].

Costly infrastructure

A precondition for scaling up energy generation from renewables is the existence of a basic infrastructure. However, due to small economies of scale, remoteness, and climatologic and geographical conditions, the costs of infrastructure in small island states are likely to be higher. The lack of road transport infrastructure is an impediment to access project sites in the case of hydro and wind, or to gather the resource as it is the case for biomass. Access to remote sites is particularly important for off-grid applications. Besides, a reliable grid is a critical infrastructure for power generation from renewables due to their variability [1, 18, 20].

278 ***Socio-cultural impediments***

279 As disruptive technologies, RE technologies are exposed to the reaction from people to
280 the change of their established ways of life. Socio-cultural impediments are intrinsically
281 linked to societal and personal norms and values. Such values and norms affect the
282 perception of RE technologies and their deployment. Inadequate attention to behaviour;
283 natural habitats and natural and human heritage sites, including impacts on biodiversity
284 and ecosystems; landscape aesthetics; and water/land use and water/land use rights as
285 well as their availability for competing uses may lead to failure of RE projects [20, 22].

286 In the context of RE deployment, there are three dimensions of social acceptance,
287 namely socio-political, community and market acceptance [25]. While socio-political
288 acceptance refers to the broadest and most general level, community acceptance refers
289 to the specific acceptance of siting decisions and renewable energy projects by local
290 stakeholders, particularly residents and local authorities [25]. The inherent distributed
291 nature of renewable energies, together with the modularity of those technologies, and
292 the development of innovative business models and financial mechanisms, are factors
293 triggering and facilitating a more active participation of citizens in grass root RE
294 community projects. Community approaches, and so policies promoting them, will
295 avoid the opposition to development, promote locally appropriate and beneficial
296 technology trajectories and generate greater understanding and support for renewable
297 energy investments [26].
298 Furthermore, in remote islands with limited access to operation and maintenance and in
299 particular for off-grid projects, the success of the system depends not only in the
300 adequate design to the conditions and needs of the community but also on the active co-
301 operation of the users in the operation [27-28].

302

3.2. Specificities of RE deployment challenges in Pacific SIDS and recommendations to overcome these challenges

This section summarises the findings of the survey on the specificities in the Pacific SIDS of each of the six challenges identified and the possible solutions to address them. It ends with a qualitative assessment on their importance.

Lack of renewable energy data

Not all of the Pacific SIDS gather energy data systematically. In particular, long time series of detailed and accurate energy data is missing, which makes energy planning very difficult. Data from RE resource assessments and RE equipment retail cost for each island are not available. Mapping the physical (theoretical) potential provides the first order magnitude and helps to identify what RE resources they have in their area. Integrated resource and technology cost data can provide information on the economic potential of RE technologies in Pacific SIDS to be fed into energy planning and policy.
On the policy recommendations, it is imperative to improve energy data collection, processing and dissemination processes. At the same time, the training of national statistical experts in the area of energy data must be a priority. Furthermore, efforts must be made to ensure that these experts are provided with sufficient resources and with the tools and equipment that they require to perform their jobs.

The availability of RE resources is site specific. As the Pacific SIDS cover a vast area, irradiation and wind conditions vary greatly between islands. Also the availability of biomass varies from island to island. Hence, the assessment of the RE potential demands not only regional but also island specific efforts. Increased financial resources

for resource assessments and a strong academic network are needed to generate reliable and current data and knowledge on RE resource potential.

Additionally, the development of a regional repository on planned and existing RE projects, including both technical and financial information, could facilitate access to data and knowledge for energy planning and project developers. Such a repository could help reducing cost of future projects by making use of this information during the preparatory phase of future projects. The repository of projects could also be used by donors for improving programme design and coordination.

Need for policy and regulatory frameworks

Renewable energy targets are set politically. However, in most Pacific SIDS, specific budget lines for RE promotion are missing. Moreover, human capacities in the public administrations are limited. Clear responsibilities for renewable energies in the administration are often non-existent. Also, there is a lack of a comprehensive approach to deploy renewables which would require coordination among different policies and ministries, including energy, infrastructure, education, and agriculture.

The presence of well-designed incentives as a clear success factor for RE upscaling is wide and well understood. The survey shows that stakeholders give a high importance to setting up a regulatory framework for renewable power generation through independent power producers. Among the most pressing capacity needs, respondents highlighted practical and analytical guidance for the implementation of feed-in tariffs for independent power producers (IPP), a clear and transparent framework for power purchase agreements between IPPs and the utilities, net metering policies supporting generation at consumption point, and tax/duty exemptions. Finally, specific grid

connection regulations are to be developed as well as, the implementation of mechanisms for integrating variable electricity sources.

On the policy recommendations, the experience provided by the Tonga Energy Roadmap [29] suggests the convenience of an effective and timely implementation of the energy plan, including a well-thought-out logical framework of objectives, expected outputs and action plans, as well as a strategy for monitoring and evaluation of the policies and the energy plan's budget and timeline. A clear direction from governments on how to integrate RE into the energy mix is needed, with supporting laws and regulations to give certainty to the private sector and other stakeholders.

In order to enable (and prepare for) significant scale-up of RE, countries should consider to identify a focal point within the administration that has the authority to support and streamline RE development. The roles of such focal points could include: i) developing, managing, and reviewing national RE plans; ii) coordinating effort across the related ministries or departments in order to minimize inter-departmental conflict or contradiction, and ensuring that RE planning is effectively aligned with other planning; iii) providing financial incentives, to assist local private business; and iv) serving as a central one-stop shop for the required permits, applications, approvals and other that generators may need to process. This measure requires the retention and hiring of qualified personnel within the public sector.

The development of policy and regulatory frameworks demands specific and on-going training and technical exchange for public servants. Respondents highlighted that the design of new regulations requires consultation with all stakeholders.

Finally the provision of tools, such as quality standards for RE equipment, or standardised power purchase and net metering agreements will improve efficiency of policy implementation.

375 ***Scarcity of financial opportunities***

376 Analysis of feedback provided by financial institutions indicated that all the Pacific
377 SIDS rely on grant funding for the development of RE. The most comprehensive
378 initiative is the sustainable energy financing policy (SEFP) facility implemented by the
379 Fiji Development Bank (FDB), the national development bank, with the support of the
380 World Bank. The SEFP facility provides loans with advantageous conditions to RE
381 income generating projects. Besides, under Fiji's Reserve Bank Act's Section 44, which
382 became effective on 29 Feb 2012, commercial banks are required to hold 2% of their
383 deposits and similar liabilities for loans to the RE sector. Other development banks,
384 such as the ones in Kiribati, Tonga, and Vanuatu, provide loans for individuals
385 interested in the purchase of RE technology. Individual loan customers are mostly
386 public employees such as teachers or nurses who are stationed in rural areas.

387 The survey shows that there are no funding opportunities for phases prior to the
388 implementation of RE projects, making the conduct of energy resources assessment and
389 feasibility studies even more difficult (Table 4).

390

391 Table 4. Summary of Financial Institutions and RE portfolio. Source: own elaboration.

Country	**Development Bank**	**Donor funding for RE**	**Commercial Bank**
Fiji	FDB - 1. Solar photovoltaic System 2. Pico – Hydro System 3. Fuel switching system where coconut oil will be used as a diesel fuel alternative for generating electricity. 4. Wind, biomass, biogas, wave, tide and geothermal systems.	This is funded through the World Bank.	2% of its portfolio to RE for all commercial Banks.
Kiribati	DBK - No Energy portfolio but approved personal loans to finance RE technology.	n.a.	No
Nauru	No	AusAID- funding support to the energy sector.	No
Palau	NDBP- Energy Efficiency Subsidy Program.	Projects involved in the energy sector in Palau include Social and Economic Development through RE applications (SEDREA) -Global Environment Facility, International Union for Conservation of Nature (Italy funding) and the North-REP project.	No

PNG	n.a.	n.a.	Bank South Pacific - welcome RE investments but will have to meet commercial banks criteria.
RMI	No	Projects involved in the energy sector in RMI include AusAID funding, EU/EDF 10, North-REP project, International Union for Conservation of Nature- an Italian/Australian RE project and ADB with MEC.	No
Samoa	No	No	Yes- welcome for commercial loan but will have to meet lending criteria.
Solomon Islands	n.a.	n.a.	n.a.
Tonga	No	Funding from Development partners.	No
Tuvalu	No	Funding from Development partners for RE-solar.	No
Vanuatu	NDB -Personal loan.	Solar, Wind, Bio-fuel- funding partners' private investments with Utility company.	No

392 n.a. – not available

393

Apart from Fiji's financial incentives, public finance programmes aiming to leverage private finance are lacking in the region. There are no specific RE policies and incentives to safeguard the financial sector in lending for RE financing. In addition, qualifying human skills are missing in the financial sector. The gap on financial skills along project cycle is presented in the next subsection. Finally, regarding other market barriers, stakeholders mentioned the small market size in the Pacific SIDS and the lack of awareness among the potential consumers about renewable energies, their cost competitiveness and reliability.

On the policy recommendations, assuming that the countries interested in RE initiatives within the region face similar challenges, it is wise to explore regional initiatives, so that available resources are better utilized and projects are more cost-effective. Respondents to the survey suggested that there is room for better coordination and transparency for donor funding. Joint procurement of RE equipment could help to safe budget. Also, there is the need to increase education and training offers on renewables for financial institutions within capacity building programmes.

Seeking to avoid competing interests between different policies, public finance for RE programs should be prioritized and a sense of collaboration and coordination within and between the different governmental bodies should be promoted. To overcome the high upfront capital costs, the need for meaningful public finance programmes that offer flexible finance packages instead of single or fixed mechanisms was highlighted, These packages may employ credit lines to local finance institutions; project debt financing; loan softening programmes; guarantees to mitigate lending risk; and grants and contingent grants for project development costs.

Furthermore, it was acknowledged that, in many of the islands, utility scale grid connected PV (without storage) produce cheaper electricity than from imported diesel.

Respondents suggested that to benefit from this circumstance while addressing the lack of capital the involvement of IPPs through Power Purchase Agreements (PPAs) should be promoted. In this line, setting the right regulatory framework to allow big consumers such as tourist resorts to invest in generation for self-consumption was also mentioned as a successful case in several islands.

Lack of human resources

The respondents to the survey on this particular section have identified that the most common technical skills missing in the private sector and in public utilities are: drafting of feasibility studies; costing studies of viable RE technology; project planning and design; project development and installation of RE systems; project development monitoring and evaluation; operation and maintenance; grid stability and integration; use of information and communication technologies; and development of smart grids.

Individuals with financial skills are missing all along the project cycle. Private sector actors lack the skills and knowledge to develop a business plan, write funding proposals, design investments proposals, and understand different finance models, cost analyses, and financing structures. The private sector is further lacking marketing skills to increase awareness among potential consumers about RE products and their benefits. Existing private financial institutions lack technical expertise among their staff, which makes it difficult to offer adequate advice to applicants and to undertake the proper financial assessment of funding requests.

Government and public institutions are missing skills on: project management, budget and finance management, public relations, and raising awareness. Responsible government agencies do not have sufficient expertise and experience for the development of RE projects. This fact is often aggravated by the absence of capacity

444 building initiatives within the public sector. In addition, there is a high staff turn-over in
445 these organizations due to the fact that qualified employees often change positions to
446 higher-paying jobs, or pursue employment overseas. This results in a regrettable loss of
447 valuable human capital.

448 Table 5 provides an overview of the results of the survey for each of the participating
449 stakeholder groups in the Pacific SIDS.

450

451 Table 5. Summary of key stakeholders on skills needs for each country. Source: own elaboration.

Country	Stakeholders	Technical skills needs	Financial skills needs	Institutional skills needs
Fiji	Utility	Standards Technical feasibility Costing studies of viable RE technologies	Understanding different finance models	Project management Staff management Continuous professional development courses/trainings
	Private sector	Standards for design and installation of RE systems	Understanding different finance models. Least cost analysis and financial structuring	Project management level
	Government	Monitoring & evaluation Select areas to collaborate with private sectors Grid stability and integration Standards and technical guidelines	Design of investment proposals, understanding different finance models, and in-depth knowledge about different finance institutions	Project management, Monitoring and Evaluation and High education learning (includes vocational training)
	Financial Institution		RE loan structuring Interest subsidy plans Risk management for RE finance Monitoring & Evaluation	Technical training for Bank's staff.

Kiribati	Utility	All technical aspects needed)	Design of investment proposal, understanding different finance models, need for subsidies and viable business models	Project management, staff (technical & non-technical), Public relations and customer service, high education and vocational training.
	Private sector	Technical feasibility, project development generation, operational/maintenance, grid stability	Writing of proposals and design of investment proposals, understanding of different financing institutions	Project and staff management, PR work, research and advertising of RE products /services
	Government	Standards and technical guidelines, monitoring and evaluation, select areas of collaboration with private sectors, ICT and gender sensitizing	Design of investment proposals, understanding different finance models, and in-depth knowledge about different finance institutions	Project management, staff management, monitoring and evaluation, high education learning and vocational training.
	Financial Institution		All financial aspects needed	All institutional needed
RMI	Utility	All technical aspects needed	All financial aspects needed	All institutional needed

	Private Sector	All technical aspects needed	All financial aspects needed	All institutional needed
Samoa	Government	All technical aspects needed	All financial aspects needed	All institutional needed
	Utility	Standards and technical guidelines	Needs financial experts to assess viability of IPPs and certification	More training on IPPs
	Private sector	Technical feasibility PPA	Different financing institutions.	---
	Financial Institution	More awareness of RE technology, grid stability		---
Tonga	Utility	All technical aspects needed	All financial aspects needed	All institutional needed
	Government	Technical feasibility, Planning & design, project development, smart grids, partnership with private sectors, standards and technical guidelines and ICT	All financial aspects needed	Project and staff management, Revenue management and PR work, High Education Institution (vocational training)
	Private sector	Grid stability and RE integration (solar and wind)	Writing funding proposals	Project Management
Tuvalu	Utility	Technical feasibility, Planning & design, project development, smart grids, partnership with private	All financial aspects needed	All institutional needed

		sectors, standards and technical guidelines and ICT		
	Government	Technical feasibility, planning & design, project development, smart grids, partnership with private sectors, standards and technical guidelines and ICT	All financial aspects needed	All institutional needed
Vanuatu	Government	Technical feasibility, Planning & design, project development, smart grids, partnership with private sectors, standards and technical guidelines and ICT	All financial aspects needed	All institutional needed
	Private sector	Technical feasibility	All financial aspects needed	All institutional needed
	Financial Institution			All institutional needed

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As summary, human resources are scarce among all stakeholder groups along the whole value chain: governments, finance institutions, private sector, and public utilities. Most respondents suggested that the challenge of the lack of human resources for policy makers and finance institutions could be addressed through a focused capacity building programme. In particular for the private sector, installation, operation and maintenance, curriculum development within the existing education programmes was suggested as a solution.

In addition, there is a need to increase visibility of the RE education to create awareness among students and professionals.

Costly infrastructure

Due to the poor road infrastructure prevalent in the Pacific SIDS, project developers face the challenge of transporting RE equipment long distances on precarious ways. It also hinders the maintenance of the equipment in case of failure. This would ultimately result in an increase of the overall cost for the RE project.

Representatives from the utilities highlighted the challenge of grid management when integrating large shares of variable renewable-based power into the existing electricity grid infrastructure, and the need to assess the impact of the efficiency of the existing fuel generation.

Discussion on possible solutions was focused on the introduction of variable generation of electricity into the weak networks of the Pacific SIDS that has been identified as one of the greatest challenges. As a first step, grid stability assessment will be needed. The introduction of solar PV systems has been successful in a step-by-step approach. First, utility scale projects feeding up to 30% of the daytime peak demand through grid

478 connected PV systems, and second, after studying the efficiency effects on the existing
479 diesel system, progressively increase the PV capacity.
480 There is the perception among the participants of the survey that battery based systems
481 are difficult to design and too costly to implement since electricity consumption in the
482 Pacific SIDS is growing at such a fast and dynamic pace.
483
484 ***Socio-cultural impediments***
485 The main social socio-cultural impediment is the possible lack of support from the
486 communities to off-grid RE projects. Experience from the stakeholders shows that
487 insufficient consultation and poor communication often result in misunderstandings or
488 lack of information on the part of the communities regarding RE technologies. This
489 concerns the community's expectation to be eventually connected to a traditional
490 electricity grid as opposed to the implementation of off-grid RE systems.
491 The result of the survey to main actors suggests that these challenges could be solved by
492 addressing all concerns regarding the different RE technologies and creating awareness
493 on the benefits of RE in order to gain community support. Besides, with purpose of
494 increasing the sustainability of projects and to avoid bad reputation of these
495 technologies as a result of small failures, there is a need to train local people in basic
496 maintenance and provide them with tools to handle bigger failures. One practitioner
497 suggested that training women for deployment of RE equipment in isolated areas is
498 more efficient since brain drain is less often happening among women.
499
500
501

502 3.3. Qualitative assessment of main challenges for renewable energy deployment in
503 Pacific SIDS

504 Table 6 summarizes the results of a survey on the qualitative importance of the different
505 challenges that need to be addressed in order to improve the implementation of RE
506 projects in the Pacific SIDS. It is important to take into account that on-grid and off-grid
507 projects may face different challenges and/or have different priorities.

508

509 Table 6 Qualitative assessment of main challenges for renewable energy deployment in
510 Pacific SIDS. Source: own elaboration.

Key issues	**Priority (On-grid)**	**Priority (Off-grid)**
Renewable energy data		
Data sets for quality energy planning	Medium	Medium
Resource assessments data to be defined for investment ready projects	Medium	Medium
Renewable energy policy and regulatory frameworks		
RE targets high but not supported by costed implementation plans	High	High
New policy tools designed + implementation (net-metering, FiT, PPAs etc)	High	High
Clarity of roles between various policy and implementation actors	Medium	Medium
New institutions (ex, regulatory body, renewable energy departments)	Medium	Medium
Finance opportunities/ market		
Budgetary constraints	High	High
Limited experience of RE projects and their risk/return profile	Medium	Medium
High perceived risks by financial institutions	High	High
Limited resource for marketing RE	Medium	Medium
Human Resources		
Lack of RE skilled personnel in the private sector	High	High
Lack of RE skilled personnel in the public	High	High

sector		
Operation and maintenance skills	High	High
Infrastructure		
RE technologies specific to island market	Low	Low
Grid integration – lack of feasibility studies to assess grid stability	High	Low
Lack of standards and design guideline implementation	High	Medium
Social impediments		
Low awareness about RE	Low	Medium
Low level of consultative processes	Medium	Medium

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512

513 ## 4. Conclusions

514 The significant reduction in the cost of RE technologies experienced in recent years,
515 improved reliability, the modularity of these technologies, and their simplicity of
516 operation and maintenance, make these technologies an attractive alternative for the
517 Pacific SIDS as opposed to the centralized electricity generation from imported fossil
518 fuels. Regardless a strong political commitment, the targets adopted and the regulations
519 put in place, the uptake of RE technologies in the region still far from its potential.

520 Due to the present competitiveness of renewable energies, practitioners consider that
521 donor support should move away from the delivery of turn key projects financed with
522 grants on to capacity building and technical assistance.

523 A qualitative assessment gives high importance to the lack of qualified human
524 resources, all along the value chain of RE as a present barrier to RE deployment in the
525 Pacific SIDS. Public sector is missing the expertise to design and implement support
526 mechanisms aiming to promote private investment. Private sector needs improvement in
527 designing, installing, operating and maintaining RE projects, in addition insufficient
528 knowledge in financial institutions is creating the perception of RE as a high risk
529 investment. To address this challenge, capacity-building programmes should be

530 comprehensive and address all the skills needed along the RE project cycle. In addition,
531 there is a need to increase the offer of RE curricula within the existing education and
532 training system to provide the market with skilled personnel for operation and
533 maintenance.
534 High importance is given to assess existing infrastructure and its availability to handle
535 variable generation. There is a need to conduct grid stability studies in Pacific SIDS to
536 identify the maximum share of variable power each grid admits without compromising
537 security of supply.
538 The need for a policy and regulatory framework, targeting the leverage of private
539 investments is also graded with high importance. The analysis of existing experiences
540 and discussions with local stakeholders suggest that for succeeding in large scale
541 deployment of renewable in the Pacific SIDS, comprehensive RE programmes
542 embedded in national energy roadmaps and coordinated with other national policies is
543 needed. The implementation of public support mechanisms and regulations such as
544 feed-in tariffs and net metering will provide security for investments, including self-
545 generation of big consumers such as touristic resorts. Besides, the development of
546 standard agreements with the public utility will reduce uncertainty and administrative
547 burden for private project developers.
548 Finally, generation and dissemination of RE data, and social acceptance are given less
549 importance. Nevertheless data availability will facilitate project development and
550 devoted policies to increase awareness and strengthen community participation will
551 promote social acceptance in particular for off-grid applications and will help to expand
552 their market share.
553
554

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646 Apendix-A. List of institutions participating in the survey

Institution	Sector	Country
Fiji Department of Energy	Government	Fiji
Clay Engineering	Private Sector	Fiji
Powerlite	Private Sector	Fiji
CBS Solutions	Private Sector	Fiji
ANZ-Kiribati	Financial Institution	Kiribati
Development Bank of Kiribati	Financial Institution	Kiribati
Ministry of Public Works and Utilities; Energy Planning Unit	Government	Kiribati
Kiribati Solar Energy Company	Private Sector	Kiribati
Kiribati Electrical Co Company	Private Sector	Kiribati
Public Utilities Board	Utility	Kiribati
Island Eco	Private Sector	Marshall Islands
Marshalls Energy Company	Utility	Marshall Islands
Capelle & Partner	Private Sector	Nauru
National Development Bank of Palau	Financial Institution	Palau
Project Support Services PNG	Private Sector	PNG
Development Bank of Samoa	Financial Institution	Samoa
ANZ-Samoa	Financial Institution	Samoa
Samoa Commercial Bank Ltd	Financial Institution	Samoa
Ministry of Natural Resources and Environment	Government	Samoa
Bio Gen 3 Samoa Ltd	Private Sector	Samoa
Samoa Chamber of Commerce and Industry	Private Sector	Samoa
Electric Power Corporation	Utility	Samoa
Willies Holding Company	Private Sector	Solomon Islands
Energy Division- Ministry of Lands, Environment, Climate Change & Natural Resources	Government	Tonga
Alpha Electric	Private Sector	Tonga
Koli Moa Electric	Private Sector	Tonga
Tuvalu Electricity Corporation	Utility	Tuvalu
BRED Bank	Financial Institution	Vanuatu

National Bank of Vanuatu	Financial Institution	Vanuatu
Department of Geology, Mines, Minerals & Water Resources and the Energy Unit; Vanuatu Energy Unit	Government	Vanuatu
Rapid Electrical	Private Sector	Vanuatu
Greentech	Private Sector	Vanuatu

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