Chapter 9

Strengthening Communities and Economies through Sustainable Energy

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9.1 Introduction[1]

Energy underpins the growth of every sector of a nation's economy. It is used, *inter alia*, for lighting, cooking, heating, cooling, pumping water, irrigating crops, preserving food and medicine, and transport. It is therefore a key resource in improving human development, food security, and alleviating poverty, emphasised in the 2030 Agenda on Sustainable Development through Sustainable Development Goal (SDG) 7 that aims to 'ensure access to affordable, reliable, sustainable and modern energy for all'. SDG 7 is closely related to SDG 9 (build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation) and SDG 13 (take urgent action to combat climate change and its impacts).[2] Meeting the energy goal is central to the achievement of most SDGs as energy is an input to most human endeavours.

Despite making only a negligible contribution to global greenhouse gas (GHG) emissions, estimated at 0.03 per cent of global emissions, the Pacific region is extremely vulnerable to the effects of climate change and natural disasters, as witnessed with Cyclone Pam in Vanuatu (2015) and Cyclone Winston in Fiji (2016). The early ratification of the Paris Agreement and preparation of nationally determined contributions (NDCs) has demonstrated the willingness of the people of the Pacific to lead the world by example in their readiness to implement solutions.[3]

This chapter focuses on the energy sectors of Fiji, Kiribati, Nauru, Papua New Guinea (PNG), Samoa, the Solomon Islands, Tonga, Tuvalu and Vanuatu – the Commonwealth Pacific small states.[4] Without access to an affordable, secure and clean energy supply, based on a strong foundation of energy efficiency and renewable energy, the people of the Commonwealth Pacific small states are likely to face severe consequences on their sustainable development.

The chapter is based on a desk review and is intended to stimulate discussion on possible long-term national and regional directions in the energy sector towards 2050. It is not intended to be a replacement for national and regional energy policies and strategies. The chapter outlines the context of the energy situation in the Commonwealth Pacific small states, before highlighting the common challenges and key regional and national responses. Remaining gaps and possible solutions are then discussed, followed by a discussion on the scenarios expected for 2050 before concluding with policy options that can help Commonwealth Pacific small states achieve sustainable energy security.

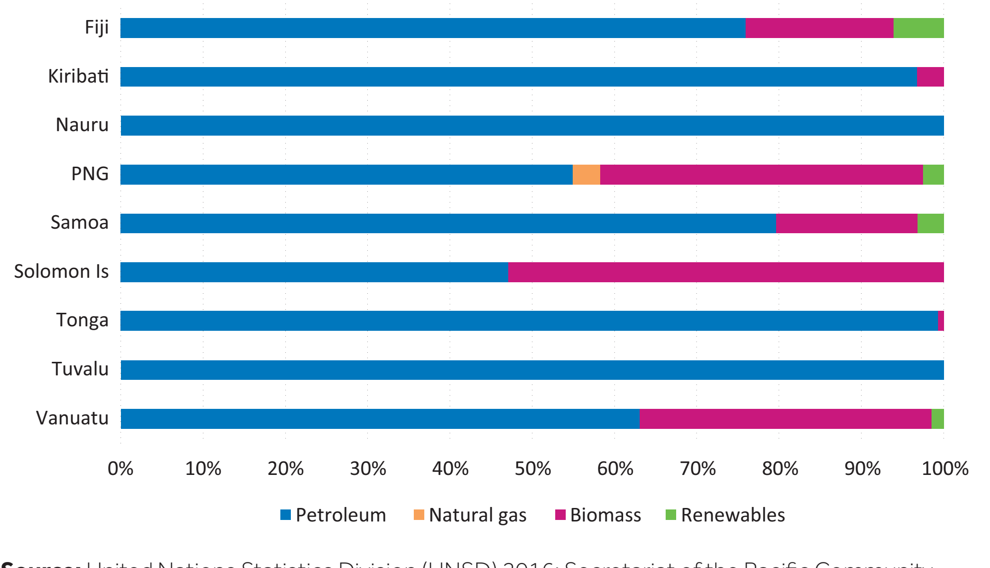
9.2 Context

The nine Commonwealth Pacific small states are spread across vast distances of the Pacific Ocean. Located in Melanesia (Fiji, PNG, Solomon Islands and Vanuatu), Micronesia (Kiribati and Nauru) and Polynesia (Samoa, Tonga and Tuvalu), they include a total exclusive economic zone (EEZ) of approximately 12.5 million km^2. They consist of atolls and volcanic islands from less than 3 metres above sea level to almost 5,000 metres above sea level and total land areas between, the smallest Nauru, 21 km^2 and, the largest PNG, 462,840 km^2. The populations of these countries range from 10,800 (Nauru) to more than 8 million people (PNG) for a total of some 10 million people, with densities as low as 18 people per km^2 in PNG to as high as 514 people per km^2 in Nauru.

The gross domestic product (GDP) of each country in 2015 ranged from US$38 million to US$17 billion, while GDP per capita is as low as US$1,258 in Kiribati to a high of US$10,741 in Nauru.[5] The countries rank between 90 and 158 on the United Nations Development Programme (UNDP) Human Development Index (HDI). Official development assistance (ODA) in 2014 ranged from US$22 million in Nauru to a high of US$681 million in PNG. As a proportion of GDP, Tuvalu is the most aid dependent at 91 per cent of GDP, whereas PNG's and Fiji's ODA is equivalent to only 4 and 2 per cent of GDP, respectively.

Commonwealth Pacific small states are largely dependent on imported petroleum products for energy production and consumption, accounting, on average, for 74 per cent of total energy supply in 2013. Kiribati and Tonga rely on petroleum for more than 95 per cent of their energy supply, while Nauru and Tuvalu rely completely on petroleum (Figure 9.1).

Figure 9.1 Energy supply (Terajoule), 2013



Source: United Nations Statistics Division (UNSD) 2016; Secretariat of the Pacific Community (SPC) 2012

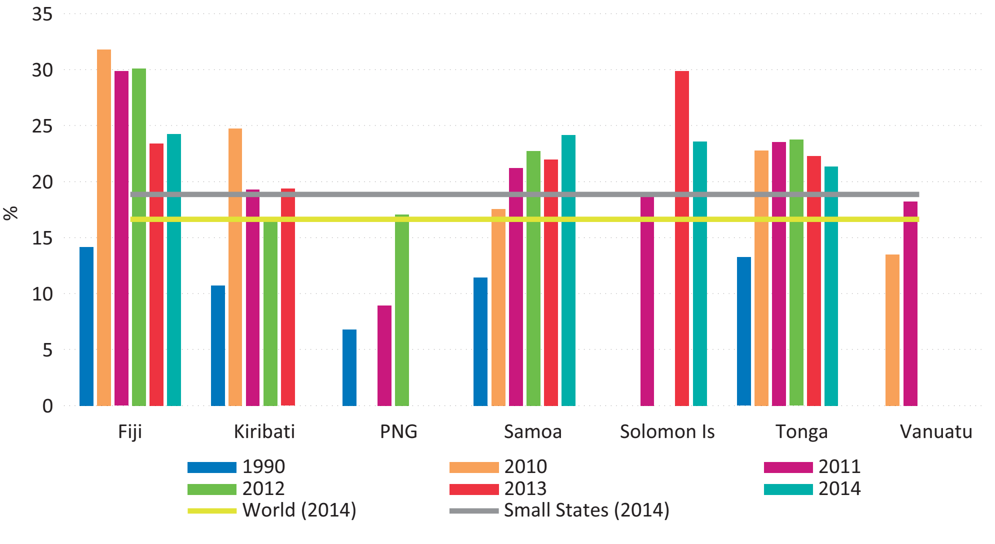
Fuel imports make up close to or more than a quarter of total merchandise imports for the majority of the Commonwealth Pacific small states; a higher percentage than the global and small states' levels recorded in 2014 (Figure 9.2). For all countries, fuel imports have risen steadily since 1990.

Energy consumption in the Commonwealth Pacific small states is split mostly between transport and electricity for power generation (Figure 9.3). It is estimated that transport accounts for about 70 per cent of fuel consumption, while electricity makes up about 20 per cent. The ratio of energy consumption for land transport as compared with sea transport is approximately 2:1. Sea transport is often the only transport for many small island communities, as many islands are too small for significant air and land transport. Energy consumption by the manufacturing sector is significant only for PNG (29%), Fiji (20%) and Samoa (10%). The remaining consumption of energy is likely to be biomass for cooking, fuel for cooking, lighting and heating water, and electricity production through individual diesel power generation.

Transport provides services that assist in every aspect of socio-economic development in the Pacific and dominates fuel consumption due to the large distances that must be travelled by air and sea and between nations and islands. Transport in the Pacific is mainly operated by the private sector and is used for moving people and goods for work, education, health and trade as well as evacuation and disaster assistance relief. The sector is beset by high costs due to a lack of economies of scale and powered mainly by fossil fuels as development of renewable energy alternatives is limited.

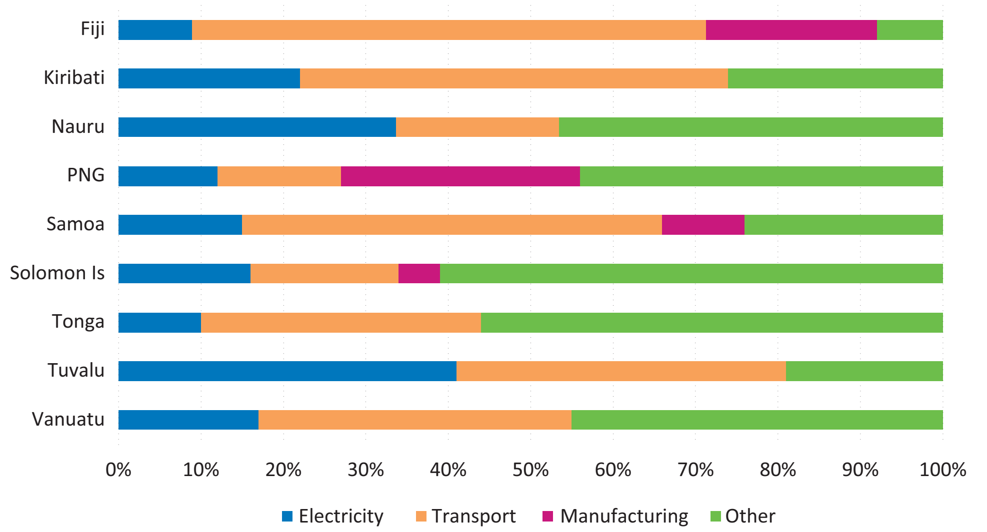
The electricity sector is the second highest consumer of fossil fuels. Most electricity grids are in urban areas and either serve a majority of the population on island atoll

Figure 9.2 Fuel imports (% of merchandise imports)



Note: Nauru and Tuvalu unavailable
Source: World Bank Development Indicators 2016

Figure 9.3 Energy consumption by sector*, 2013



Note: *Excludes international aviation and shipping but includes only some domestic shipping.
Source: United Nations Statistics Division (UNSD), 2016 except for Tuvalu, which was estimated from its second national communication to the United Nations Framework Convention on Climate Change (UNFCCC) on its GHG emissions

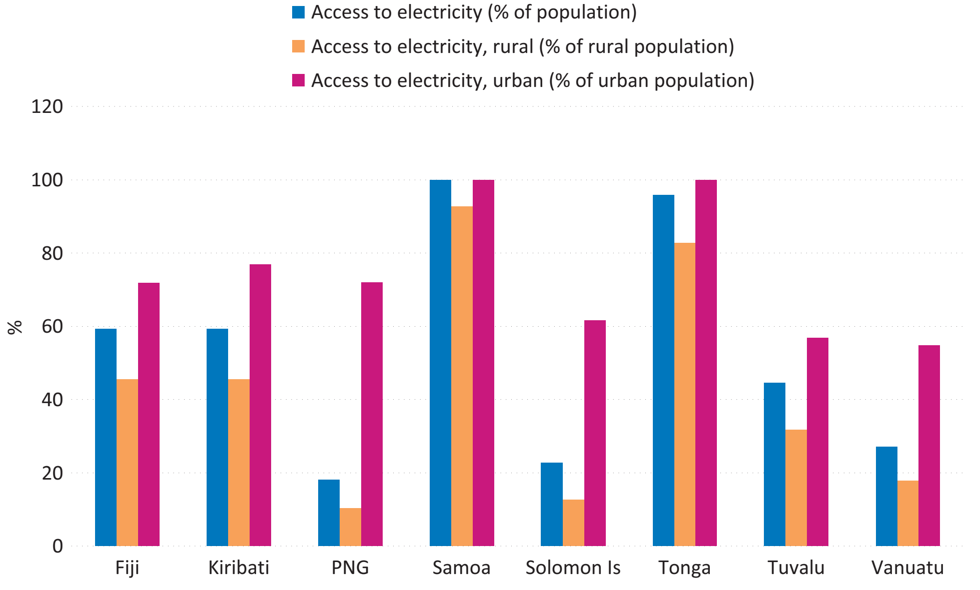
nations or only a small part of the population on larger volcanic islands where there are still large rural populations. The percentage of the population that has access to electricity ranges from 18 per cent in PNG to 100 per cent in Samoa (Figure 9.4). PNG, Solomon Islands and Vanuatu, which have 80 per cent or more of their populations living in rural areas, have relatively low levels of access to electricity (Figure 9.4).

The average residential electricity tariff in each country ranges from US$0.17 in Fiji to US$0.87 in the Solomon Islands (Figure 9.5).

Electricity tariffs can fluctuate from year to year depending on the proportion and cost of the petroleum used to generate the electricity and the proportion of other fuel sources in the fuel mix. A larger proportion of hydro power, for example in Fiji, is likely to reduce the electricity tariff, whereas a country that relies mostly on fossil fuels, such as Kiribati or Tuvalu, is more vulnerable to increasing oil prices. Another factor affecting the residential electricity tariff is whether it is subsidised through the Government budget, for example in Fiji, or using a cross subsidy from larger users of electricity, for example in Vanuatu. Each power utility in each country determines its tariffs differently. Some utilities have maximum demand and/or service charges (Fiji, PNG and Vanuatu) to ensure that larger users pay the appropriate proportion of the use of the grid and total cost of supply. Others (Fiji, Nauru, PNG, Samoa, Tuvalu and Vanuatu) have lifeline tariffs, which lowers the cost for a specified usage amount to assist with affordability of what is an essential service for low-income households.

Fiji, PNG and Samoa have the highest proportion of renewable energy generated electricity through hydro power, at 67, 32 and 25 per cent (IRENA 2013), respectively.

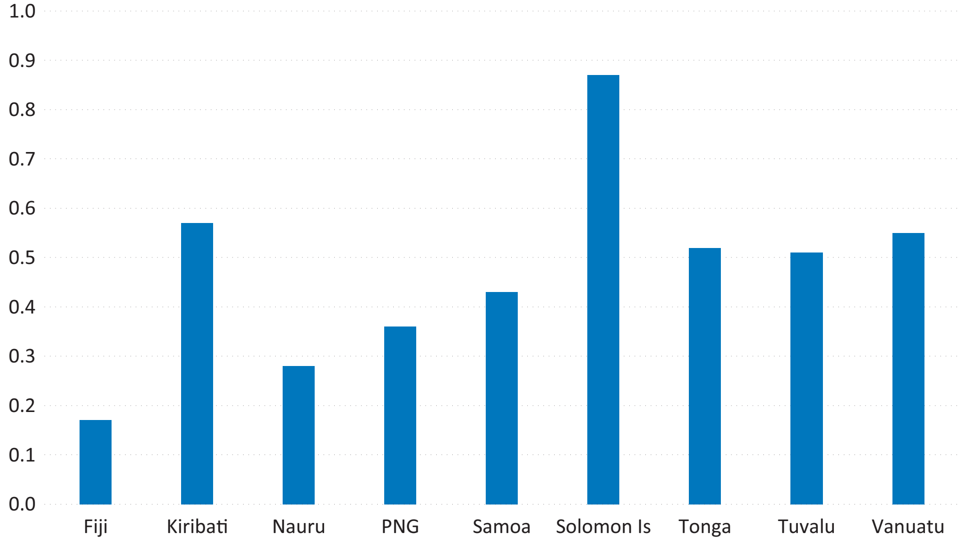
Figure 9.4 Access to electricity



Source: World Bank Development Indicators 2016.

Vanuatu relies on a combination of hydro power, wind and coconut oil, which makes up 25 per cent (IRENA 2013) of renewable electricity generation. All the other Commonwealth Pacific small states have renewable electricity generation rates of less than 5 per cent. Solar photovoltaic (PV) electricity generation is increasing in all countries. If biomass is harvested sustainably it can be considered a renewable

Figure 9.5 Average residential electricity tariffs US$/kWh



Source: SPC, 2016 (various years 2012–2013)

Table 9.1 Renewable energy targets

Country	Renewable energy target	Year
Fiji	90% electricity generated using renewable energy	2030
	25% renewable energy share in total energy consumption	2030
Kiribati	45% reduction in energy coming from fossil fuels for electricity generation (Tarawa)	2025
	60% reduction in energy, coming from fossil fuels for electricity generation (Kiritimati)	2025
	60% < renewable energy in rural public infrastructure (outer islands)	2025
	100% renewable energy for rural public and private institutions (outer islands)	2025
Nauru	50% grid electricity supplied from renewable energy sources	2020
PNG	100% carbon free electricity sector	2030
Samoa	100% renewable energy generated electricity	2017
	100% of renewable energy generated electricity maintained in light of growing electricity demand	2025
Solomon Is	50% use of renewable energy sources for power generation in urban and rural areas	2020
Tonga	50% of electricity generation via renewable energy	2020
	100% renewable energy in total electricity production	2030
Tuvalu	Zero GHG emissions from the electricity sector	2025
Vanuatu	100% renewable energy generated electricity	2030

Source: Collated by the author from national policy documents and NDCs

energy resource. However, most developments in renewable energy have been in technologies used to generate electricity.

Each Commonwealth Pacific small state has a national energy strategic and/or policy document that outlines their targets for increased renewable energy (Table 9.1). Some of these targets have been superseded by those stated in the NDCs for each country. These are generally ambitious targets designed to rapidly reduce the vulnerability to fossil fuel dependency and show leadership to the rest of the world in combating dangerous climate change. Only Samoa has included reference to the likelihood of continued growing electricity demand.

Energy conservation and efficiency can be more effective in reducing a country's vulnerability to high oil prices and use less investment than is required by renewable energy. However, measures to improve this area are lagging behind developments in renewable energy and are not featured as prominently in sectoral policy targets.

9.3 Common challenges

The Commonwealth Pacific small states face many common challenges in the energy sector that include energy security, people and geography, lack of information, lack of institutional and technical capacity, transport and energy efficiency, electricity tariffs and supply, financing constraints, and a lack of gender perspectives.

9.3.1 Energy security and co-ordination

Ensuring a secure energy supply, including through co-ordination of various stakeholders, is made difficult by the remoteness of Pacific countries, small markets, distance from trading partners, long and fragmented supply chains that are vulnerable to disruption, lack of economies of scale, lack of competition, and their dependence on trade and aid. These issues increase the risks, and therefore also the costs, of providing goods, services and infrastructure. These costs, in turn, increase energy prices and hinder the goals of energy affordability and poverty alleviation.[6] Many of these challenges also impact on the ability of countries and development partners in the region to co-ordinate and work with each other to improve the situation.

Fossil fuel dependence means that the economies of the Commonwealth Pacific small states are exposed to fluctuating prices for fossil fuels that are linked to world oil prices. A UNDP Oil Price Vulnerability Index for 19 Asian and five Pacific island countries (Fiji, PNG, Samoa, Solomon Is and Vanuatu) showed that of the 13 most vulnerable countries, four were from the Pacific - Vanuatu was the most vulnerable, followed by the Solomon Islands, Samoa and then Fiji (UNDP 2007). This high oil price vulnerability can have flow-on effects that increase the cost of the fuel import bill, deplete foreign currency reserves[7], accelerate inflation, reduce economic growth, and increase the cost of transport and imported products. This was especially evident during 2008 when oil prices rose to almost US$150 per barrel, while, for example, Fiji's economy contracted by 2.5 per cent and its imports increased by almost 25 per cent in 2008 due to the higher cost of petroleum, and inflation rates in Kiribati soared to 18.6 per cent in 2008.[8] More recently, between July 2015 and July 2016, this pressure eased to where a barrel of oil was trading as low as almost US$25.

Overcoming this fossil fuel dependency is made difficult due to the limited indigenous sources of energy in Commonwealth Pacific small states. The only proven reserves of oil and natural gas are found in PNG and there are no known sources of coal in the region. Furthermore, not all the countries have access to the different types of renewable energy resources. Some have potential hydro power capacity (Fiji, PNG, Samoa, Solomon Islands and Vanuatu), but this can be affected by climate variability and drought. The availability of biomass may be limited, especially on atolls, and on volcanic islands, where the resource is plentiful, it can also be affected by climate change exacerbated drought. Some have wind resources but these may be too small to economically exploit as the closer to the equator, the less plentiful the wind resource (Kiribati, Nauru and Tuvalu). On the other hand, at times the wind is too strong for wind turbines due to storms and cyclones, making them vulnerable to damage and potentially difficult to insure. Good wind locations are also not necessarily near population centres and roads are needed for construction and maintenance access. With respect to geothermal energy, Fiji, PNG, Solomon Islands and Vanuatu have been identified as countries that could be conceivably powered by 100 per cent geothermal energy (Holm 2010). However, geothermal energy is a costly resource to extract and sources are not necessarily found near population centres.

9.3.2 People and geography

The population, growing rapidly in some countries (e.g. Kiribati, Solomon Islands and Vanuatu), is often widely dispersed across rural areas, islands and atolls or migrating from rural to high-density urban areas (the 'urban drift' to 'urban villages'), placing pressure on existing energy services and infrastructure and increasing the costs of expanding these services. Rural electrification also faces the difficulty and politics of providing services to rural areas when these rural areas are mostly governed from an urban area or capital city.

These challenges are exacerbated by geographical barriers, such as natural disasters (earthquakes, cyclones, volcanoes, tsunamis) and the increasing effects of climate change, i.e. sea level rise and the greater intensity of climate change related weather events, which make increasing access to energy and other essential services in rural areas costly and difficult. The existing energy infrastructure is also vulnerable to the climate, e.g. erosion and corrosion resulting from the harsh tropical climate, as is the supporting infrastructure, such as roads, ports, information and communications technology (ICT), and water, which are essential inputs to operate sustainable energy systems and underpin the energy supply chains that provide spare parts, maintenance personnel, and access to markets. In a recent example, the deterioration of the runway at Bauerfield Airport on Efate in Vanuatu negatively affected its tourism industry, with Air New Zealand, Qantas and Virgin airlines ceasing flights to the airport until the tarmac was repaired to a satisfactory standard.

Where there is available land to undertake energy projects, acquiring approval for use of this land is sometimes subject to land tenure issues, particularly in Melanesia. Resolving whether the land can be used and who receives payment may take several years or not be achieved at all. There are also competing priorities for land and water use. Land cannot be used for all purposes. If it is flooded to create reservoirs and dams for hydro power, irrigation or drinking water, then crops cannot be grown in that area for export or domestic consumption, or a wind or solar farm cannot be constructed, for example. If the water is used for hydro power, then it cannot be used for irrigation or as drinking water. The food-energy-water nexus is a key challenge to overcome.

9.3.3 Lack of information

In undertaking energy projects in the Commonwealth Pacific small states, there is often a lack of current data and statistics, or site-specific renewable energy resource information to adequately assess the viability of an energy project. Petroleum companies are not necessarily forthcoming with data related to the specific type of activity each type of fuel is used for. There has also been a history of overly ambitious and unrealistic renewable energy target setting, which has raised expectations and unfortunately largely gone unachieved, especially when targets are announced without underlying data or financing to support this ambition.

9.3.4 Institutional and technical capacity

In the energy sector, there is also a lack of technical and functional capacity, a 'brain drain' of qualified labour moving to higher wage economies, and the limited resources that are available are often overexhausted. In addition, government agencies and regional institutions often lack budget funding and staffing to address challenges in the energy sector. SPC, which is the key regional development partner in the energy sector in the Pacific, has recently stated that it relies heavily on project funding and has tried too often to do too much for too many stakeholders (Islands Business/ PacNews 2016).

9.3.5 Electricity tariffs and supply

In most cases, electricity tariffs do not reflect the true cost of producing electricity. They may be kept artificially low for political reasons, which results in power utilities not recovering the full costs of production, meaning that there are insufficient funds to cover operation and maintenance expenses and the capital costs of replacing ageing infrastructure. Tariffs that are subsidised can foster a culture of overconsumption, which can lead to payment difficulties for consumers, especially when high oil prices result in higher tariffs.

There is a lack of legal and regulatory frameworks that allow for independent power producers (IPPs), both commercial and residential, to easily connect renewable energy to electricity grids. There is also a lack of standards and certification to ensure that only robust renewable energy equipment is installed in the Pacific. Cheap generic copies of brand-name products increase the risk of market spoilage due to unpredictable quality and a lack of warranties or after-sales service (World Bank 2016).

When it has been possible to connect renewable energy to the grid, this is mostly from intermittent energy sources such as solar PV and wind. However, there is a limit to the penetration of renewable energy into electricity grids, as this intermittency needs to be supported with baseload generation, such as predictable hydro, biomass or fossil fuel based generation, or through emerging energy/battery storage technologies. If electric vehicles emerge as a clean technology for Pacific nations, these are only as clean as the electricity generated by the grids that recharge these vehicles. Electricity grids in the Pacific will need to be strongly interconnected, flexible enough to accommodate this change, and resilient enough to withstand climate impacts, as well as cope with potential demand growth from growing populations and growing electric vehicle use.

9.3.6 Energy efficiency and transport

The recent focus on grid electrification and increased dissemination of stationary renewable energy, i.e. grid connected solar PV for example, often leaves the issues of energy efficiency, clean energy for cooking (that benefits women and children) and sustainable land, sea and air transport in the shadows. Commonwealth Pacific small states are more dependent on the fossil fuels used in cars, trucks and boats than for generating electricity, and more cost-effective displacement of fossil fuel can occur through energy efficiency. However, the attention and funding of development partners is not always directed accordingly to these areas. Development partners may find it easier to fund and install renewable energy generation technologies that provide a tangible output rather than what may appear as intangible energy conservation and efficiency programmes.

Furthermore, while power utilities have been involved in energy conservation awareness campaigns, they base their business models on selling more electricity rather than less, so, even though excess electricity consumption can put strains on a utility's network and budget, generating profits from essentially higher electricity usage remains a priority. Moreover, although this is improving, consumers generally lack awareness on how they can reduce their energy consumption or be more energy efficient.

It has been estimated that for every US$1 of grant funding for renewable energy, roughly US$0.07 has been invested in energy efficiency, and a preliminary analysis of over US$300 million of grant aid committed for new energy initiatives in Pacific island countries suggests that this percentage is not increasing substantially (Johnston 2010), with only an estimated 2 per cent of energy aid allocated towards energy efficiency in the Pacific between 1970 and 2010 (Niles 2013).

9.3.7 Financing constraints

The International Energy Agency (IEA) and the Sustainable Energy for All initiative (SE4All) estimated that nearly US$50 billion a year is needed to achieve universal access to electricity and clean cooking facilities by 2030. The International Renewable Energy Agency (IRENA) estimates that deploying renewables worldwide on the scale necessary to limit global temperature rise below 2 degrees would require current investment to double by 2020, and triple by 2030 to around US$900 billion annually (IRENA 2016b).

The rapid ratification of the Paris agreement by Commonwealth Pacific Small State countries, and subsequent conversion of intended nationally determined contributions (INDCs) to NDCs is heartening, but these are voluntary (non-binding) commitments that are reliant on external financing from development partners and the regional/multilateral development banks and funds. A huge challenge will be seeing these contributions financed and implemented, considering that energy aid to the Pacific between 1970 and 2010 is estimated to have amounted to only US$1.4 billion (Niles 2013). Significantly more financing, therefore, will be needed to achieve SDG 7.

However, national and local government budgets have been insufficient to provide full access to modern energy services and there is little experience with commercial and sustainable financing mechanisms for the development of renewable energy resources (SPREP 2005b). At the project level, while there may be financing available, due to high transaction costs it is often only for larger projects. There is some difficulty obtaining financing for smaller energy projects by small businesses and individuals, rehabilitation projects and in some subsectors like energy efficiency (SPREP 2005a). Financial institutions do not necessarily understand the opportunities or risks involved in current and emerging energy technologies and may be reluctant to provide loans. Also, project developers may not have the training to prepare project documents, business plans and the financial analyses to satisfy finance providers that they have 'bankable' projects. Energy technologies often have high upfront costs, which is a significant barrier for low-income earners, those without security, and those without a credit history. When finance is available, the process can face delays, have procurement restrictions and be overly bureaucratic, and ultimately loans need to be paid back.

9.3.8 Lack of gender perspectives

There are many challenges related to gender and youth in the energy sector. Women provide the majority of energy to the household in the Pacific but are not sufficiently represented in the energy sector and are often excluded from stakeholder discussions (UN Women 2014). For example, in those countries with a large biomass resource women and children are traditionally involved in gathering firewood, which reduces the time available spent on other productive activities, as well as potentially exposing them to greater risk of harm as they are more vulnerable the further they have to search for biomass. The burning of biomass for cooking also impacts on women's health as they are generally the most involved in food preparation and are exposed to smoke inhalation.

There are legal and cultural reasons that may also prevent women from fully engaging within the sector. This includes laws that prevent them from owning land or registering companies, limited access to courts and lending institutions, lack of opportunities to develop skills, as well as deep-seated cultural practices that discriminate against them (ADB 2016a). There is also a lack of awareness of the importance of gender equality.

It is often the case that gender expertise is not included during project planning stages. There is usually no sector-specific gender analysis, including involvement of women and women's organisations in stakeholder consultations. Further, there is a lack of gender-responsive monitoring and evaluation, including use of gender-disaggregated indicators.

9.4 Key regional responses

9.4.1 Addressing energy security and co-ordination

To address many of the common challenges, especially energy security, the Pacific has in place a strategic policy framework for energy sector action at the regional level. 'Towards an Energy Secure Pacific – A Framework for Action on Energy Security in the Pacific (FAESP) 2010–2020' was adopted by the Pacific Islands Forum Leaders in 2010. Based on a whole-of-sector approach and the premise of 'many partners, one team', the framework sets out the following themes for action to improve energy security:

- Leadership, governance, co-ordination and partnerships;
- Capacity development, planning, policy and regulatory frameworks;
- Energy production and supply (petroleum and alternative liquid fuels, renewable energy);

- Energy conversion (electric power);
- End-use energy consumption (transport energy use, energy efficiency and conservation);
- Energy data and information;
- Financing, monitoring and evaluation.

The themes recognise that energy security is about access to modern energy services, affordability of energy services, efficiency at all levels of the energy chain and the environmental sustainability of the sector. It also recognises the critical need for all stakeholders in the energy sector to better co-ordinate their efforts and for a more holistic approach to addressing the energy challenges of the region rather than assuming that renewable energy is a panacea. For this to occur, the FAESP highlights that the appropriate capacity, and policy and regulatory frameworks, need to be in place to reduce the dependency on imported petroleum products, while increasing reliance on local renewable energy resources. The FAESP also recognises the need for the energy resources to be accessible and used productively and efficiently. The importance of collecting and sharing energy data is also emphasised in the FAESP. The final theme accentuates the need for financing and measuring the performance of the energy sector to assess its success.

The Pacific Energy Oversight Group[9] (PEOG - Council of Regional Organisations of the Pacific (CROP) agencies only and the International Union for Conservation of Nature (IUCN)) and the Pacific Energy Advisory Group (PEAG - broader membership) provide the oversight and co-ordinating mechanisms for the FAESP. The PEAG allows Pacific island countries and territories (PICTs)[10], development partners, regional agencies and the private sector to share best practices, foster joint activities, minimise costs, ensure consistency, and avoid duplication on an annual basis.

To better appreciate the impact of FAESP, baseline energy security indicators were established to benchmark performance. Through stakeholder consultations involving country representatives, regional organisations, the private sector and development partners, this resulted in the compilation of the 2009 Country Energy Security Indicator Profiles, which served as the baseline for the FAESP 2010–2020. The process culminated in the adoption of the 2011–2015 Implementation Plan for Energy Security in the Pacific (IPESP) at the Inaugural Regional Meeting of Ministers of Energy, ICT, and Transport in April 2011.

The IPESP was a five-year plan for pursuing the vision, goal and outcomes of FAESP. It reflected the priority regional activities that were to be collectively delivered by the participating members of the CROP to support, complement and add value to national efforts on energy security. The energy security indicators formed part of the IPESP monitoring and evaluation framework.

A midterm review (PEOG 2014) of the IPESP was undertaken for the PEOG in 2014. The review found a lack of clarity of the roles and responsibilities of many of the agencies involved in the energy sector, e.g. SPC, Pacific Power Association (PPA), South Pacific Regional Environment Programme (SPREP) and the Pacific Islands Forum Secretariat (PIFS), with many working relationships based on informal arrangements, making effective co-ordination difficult in achieving the objectives of the IPESP. The review also found that there was a need to better incorporate the FAESP themes into the IPESP, as well as to further prioritise activities under the IPESP, which was quite broad in focus. In addition, the IPESP lacked funding and a resource mobilisation strategy, including for monitoring and evaluation. Moreover, there was a lack of national ownership of the IPESP compared to the FAESP. The review recommended improving regional co-ordination by strengthening the PEOG and PEAG, including providing clarity on the roles and responsibilities of its members, as well as the improvement of the monitoring, reporting and evaluation of the IPESP. The importance of regional co-ordination in the energy sector was also highlighted by the review of the CROP working mechanisms, which concluded that 'energy security in the Pacific will be an ongoing priority that will require a long-term regional co-ordination and information sharing mechanism within CROP' (PIFS 2015).

A progress report on the IPESP, together with updated energy security indicator profiles, is soon to be published, and a new implementation plan for 2016 and beyond has been prepared but has not yet been finalised.

In other efforts to address energy security, the Pacific considered bulk procurement of fuel. With small markets and high transport costs due to distance, purchasing fuel in bulk had the potential to lower the price of fuel through harmonising legislation, fuel standards and procurement rules. Consequently, regional bulk fuel procurement was one of the initiatives outlined in the Pacific Islands Forum Leaders' 2005 Pacific Plan. However, efforts to implement the initiative were beset by conflict between stakeholders, lack of support, unwillingness to incur costs, uncertainty regarding the benefits, lack of benefits for larger countries, and conflicts of interest between signatories. The project ended in 2011 when donor funding expired, and the project had not progressed past the feasibility study stage (Dornan and Cain 2014).

In terms of improving co-ordination, the energy sector has benefited from the Pacific Region Infrastructure Facility (PRIF), a mechanism that commenced in 2008, which co-ordinates the development assistance of the Asian Development Bank (ADB), the Government of Australia, the Government of New Zealand, the World Bank Group, the European Commission, the European Investment Bank, and the Government of Japan in the infrastructure sector. The PRIF provides investment co-ordination, research and technical assistance focusing on energy, transportation, telecommunications, water, sanitation and waste, as well as environmental and social infrastructure. In the energy sector, the PRIF has been involved in the co-ordination of donor activities, energy efficiency and conservation programmes, the Tonga and Vanuatu Energy Road Maps, petroleum supply chain studies, institutional capacity-building in Tuvalu, and support for the Vanuatu Utilities Regulatory Authority. The PRIF also published its first Pacific Infrastructure Performance Indicators report in 2016, which includes monitoring and reporting of the performance of the energy sector in the Pacific (PRIF 2016b).

9.4.2 Improving information on energy

To better inform evidence-based energy policies, a number of regional initiatives and projects are in place. The Sustainable Energy Industry Development Project (SEIDP) will provide technical assistance to increase data availability and capacity in Pacific island power utilities for renewable energy (PPA 2015b, p. 4). The Pacific Regional Data Repository (PRDR) project uses a web-based portal and database management system that supports Pacific governments and their development partners working in the energy sector by facilitating access to up-to-date and reliable energy data and project information.[11]

Various studies have also been carried to assist policy-makers. SPC has published a Pacific Islands Fuel Pricing Manual to inform and support the work of Pacific island officials who regulate or monitor the price of fuel. To improve renewable energy resource information in the Pacific, SPC also recently completed a study on the wave energy resource of the Pacific Ocean (Bosserelle *et al*. 2015). In addition, PRIF, SPC and PPA completed a recent study on liquefied petroleum gas (LPG) and natural gas as alternative energy sources for the Pacific (PRIF 2016a). Moreover, a regional co-operation project has been proposed to collate all coconut biofuel regional experiences and learnings to date and to identify state-of-the-art coconut-to-biofuel technology.

The SEIDP, along with the benchmark and system losses studies undertaken, is a promising way of improving information for power utilities. The PRDR is also a good start to centrally collating energy data in the Pacific region, although SPC has stated that more financial support, without reliance on donor funds, is needed for it to be sustainable. While a subscription/fee-based system was considered for the PRDR to ensure its sustainability, it was contrary to the aim of freely providing this information for accountability and improving evidence-based decision-making (SPC 2016, p.3).

The midterm review of the IPESP also highlighted the importance of ensuring the sustainability of resources to improve energy information, finding that:

> *significant effort and resources should be committed to activities that build capacity of PICTs themselves to collect data and track results including impacts. Currently some efforts are underway for instance work done by SPC to support the production of energy security profile reports and its current energy data repository. However, these efforts need to be scaled up, coordinated between CROP agencies and linked in with individual CROP agencies M&E and Progress reporting.* (PEOG 2014)

9.4.3 Enhancing institutional and technical capacity

There have been several notable initiatives to address the lack of technical capacity in the energy sector in the Pacific. The Sustainable Energy Industry Association of the Pacific Islands (SEIAPI), in collaboration with the University of the South Pacific (USP), was established to provide a certification and accreditation scheme for technicians. This is an important effort in growing the private sector renewable energy industry, as well as ensuring that renewable energy companies share ideas and solutions, keep up to date with the latest training methods, and install renewable energy systems that conform to the latest competency and electrical standards. SEIAPI will conduct a series of workshops in Pacific island countries over the next four years and promote the SEIAPI/PPA guidelines to governments, donors and other stakeholders as well as updating existing PV guidelines and developing new guidelines.

In addition, the European Union Pacific Technical Vocational and Education Training (PacTVET) project aims to raise the standard of training and increase potential employment opportunities by developing a regionally accredited Certificate I-IV programme in Resilience and Sustainable Energy. Furthermore, the Faculty of Science, Technology and Environment at USP offers undergraduate and postgraduate subjects on renewable energy, as well as a Postgraduate Diploma and Master of Science in Climate Change. Other regional collaborative efforts include the establishment of the Pacific Centre for Renewable Energy and Energy Efficiency (PCREEE), a SE4ALL Centre of Excellence that aims to strengthen local capacities for the development and implementation of sustainable energy systems, policies and standards, and improve south-south, and north-south co-operation and technology transfer.

9.4.4 Tackling electricity tariffs and supply

There have been a number of regional responses to address the costs and challenges of supplying electricity in the Pacific, led by the PPA. The PPA pools national capacity-building efforts to facilitate co-operation between Pacific island power utilities, as well as providing training and enabling the exchange of information and expertise.

The PPA led a regional benchmarking exercise, prioritised under the FAESP, for all member power utilities. Under this initiative, several benchmarking reports have been produced since 2012 to help power utilities formulate performance improvement programmes, including analysis of generation efficiency and system losses to improve the overall energy efficiency of grid-produced electricity. The PPA also commissioned KEMA International in 2012 to undertake a study to quantify the power system energy losses in southern Pacific utilities, which included all the Commonwealth Pacific small states except Vanuatu (PPA and KEMA 2012).

There are also plans to establish a Pacific Islands Energy Regulators Network to foster co-operation, improve communication, and share regulatory approaches to determining energy prices and tariffs and other information between regulatory agencies, energy offices, power utilities and petroleum industry stakeholders, regional organisations, development partners and the private sector.

9.4.5 Improving energy efficiency

Although energy efficiency has largely been overlooked in the Pacific, there have been some recent developments. Following on from the recently completed Pacific Appliance Labelling and Standards Programme, which aimed to increase the importation and sale of more energy efficient appliances, the Pacific Efficient Lighting Strategy (PELS) is being implemented to assist in the Pacific's transition to high efficiency and environmentally sound lighting by 2020. PELS consist of a set of national and regional actions for on-grid and off-grid lighting, targeting lighting end-uses in residential, commercial and government buildings, as well as street and outdoor lighting (SPC 2015, pp. 5–6).

The potential net economic benefit from implementing standards and labelling for electrical appliances and lighting in Pacific island countries is estimated at over US$640 million (in the period up to 2030). The projected electricity savings are over 2,100 gigawatt hours, with associated fuel import savings of about 720 million litres and emission savings of 1.9–2.0 metric ton equivalent carbon dioxide. Cost–benefit analysis demonstrates that adopting minimum energy performance standards and labelling programmes for appliances, lighting and equipment is far more cost effective than importing an equivalent quantity of fossil fuel or investing in capital-intensive renewable energy generation (SPC 2016).

9.4.6 Energy solutions for the transport sector

To improve the efficiency, effectiveness and sustainability of Pacific transport services, the Pacific island countries developed the 2011–2020 Framework for Action on Transport Services (FATS) (SPC 2011). Similar to the FAESP in the energy sector, the FATS is based on the premise of 'many partners, one team', promotes a whole-of sector approach and has several themes for action to improve aviation and maritime transport services:

- Leadership, governance, co-ordination and partnerships.
- Capacity development, policy, planning and regulatory frameworks.
- Transport safety and security.
- Improved access.
- Environmental impact, technology and energy.
- Transport data, information and knowledge.
- Sustainability, monitoring and evaluation.

The FATS aims to ensure safe, reliable and sustainable transport by creating an enabling environment for the private sector to operate services in an efficient and commercially viable manner, and providing effective safety oversight. The FATS also addresses the energy use of aviation and maritime transport, including mitigating climate change through reduced GHG emissions, by encouraging emissions trading and carbon credit and/or offset mechanisms, alternative fuels, and more efficient air traffic, port and sea transport technology, management, operation and routing.

In terms of research and development in sustainable transport, at USP, the Oceania Centre for Sustainable Transport (OCST) is involved in developing national sustainable transportation roadmaps and strategies, co-ordinating research and development, developing educational programmes, building capacity in policy and planning, co-ordinating expertise, monitoring and evaluation, economic modelling, and implementing appropriate technologies.[12]

On sustainable sea transport, the OCST has been working with private operators in remote communities and hopes to gain funding for a 'greenheart boat', which would use solar charged lead acid batteries to provide auxiliary propulsion for its primary sail rig and provide close to 100 per cent fossil fuel savings.[13] IRENA also identified a number of applications of renewable energy that could be applied to sea transport in the Pacific, including wind (e.g. soft sails, fixed wings, rotors, kites and conventional wind turbines), solar PV, biofuels, wave energy and the use of super capacitors charged with renewables (IRENA 2015).

Improving the energy efficiency of sea transport is also important. To this end, existing ships are required by the International Maritime Organisation to have an energy efficiency management plan in place, including improving voyage planning, regular cleaning of the propeller and underwater parts of the ship, as well as introducing efficiency improvement measures such as waste heat recovery systems, or even fitting a new propeller.[14]

9.4.7 Responses to gender issues

Both the FAESP and IPESP make reference to gender issues and gender mainstreaming but do not elaborate on the issues or provide specific details regarding how they will be addressed. In addition, while the midterm review of the IPESP makes reference to the CROP Gender Working Group, co-chaired by PIFS and SPC, there is no specific recommendation on how to address gender issues in the energy sector.

9.5 National challenges and responses

Commonwealth Pacific small states share similar challenges, including dispersed populations, geographical barriers that make energy distribution and maintenance difficult, lack of capacity and financing, lack of attention to energy efficiency, land tenure issues and vulnerability to natural disasters, which impact energy, and supporting, infrastructure. The majority of the countries have national energy plans, policies and programmes in place to meet these challenges. Development partner support is crucial for many countries in achieving their energy targets. While it may be too early to measure the success of these activities, the targets set are very ambitious and will need continued efforts into the future.

9.5.1 Fiji insert correct note and reorder

Most of the population (880,400) and land area of Fiji is located on the two largest of Fiji's 330 islands - Viti Levu and Vanua Levu. The largest proportion of energy consumption occurs in Viti Levu, where the majority of the people, a large part of the tourist industry, and Suva, the capital city, can be found. Petroleum accounts for approximately 70 per cent of Fiji's energy needs, followed by biomass and renewable energy (Figure 9.1). Fuel imports as a percentage of merchandise imports more than doubled in 2010, compared with 1990 levels, but eased thereafter to 2014 (Figure 9.2).

The transport sector accounts for over 50 per cent of fuel imports (Figure 9.3) and approximately 15 per cent of GDP (ADB 2013). Land-based vehicles are the largest users of energy, with vehicle registrations increasing by 40 per cent between 2003 and 2013 (Government of Fiji 2013). Fiji is also reliant on open sea and inter-island shipping, and aviation, for transporting passengers and goods, and for its tourist industry.

The Fiji Electricity Authority (FEA) is the government-owned power utility and the Fiji Commerce Commission is the regulatory body for overseeing electricity tariffs. Heavy sulphur diesel fuel is imported for electricity generation, and in times of drought, diesel generation is increasingly relied upon. However, FEA has made efforts to increase energy supply through biomass from independent power producers, including from the state-owned Fiji Sugar Corporation, which generates electricity from bagasse cogeneration plants. FEA has also installed additional mini-hydro plants to further boost hydro power capacity. Rural electrification efforts over the last two decades involving grid extension and solar home systems have increased electricity access to 60 per cent of the population (Figure 9.4). The average residential electricity tariff in 2013 was US$0.17 (Figure 9.5) and the most recent household expenditure survey indicates that 10 per cent of household income is spent on energy (SPC 2016).

Fiji's experience with renewable energy dates back to the 1980s with hydro power and biomass dominating, although solar PV installations are steadily increasing, especially for commercial buildings and rural electrification. Current plans also include enhancing mini hydro systems, bioenergy (coconut oil) and wind systems. Biogas/bioethanol gasifiers were trialled in the 1980s but were not found viable. However, there is considerable potential for geothermal power generation. In the area of transport, use of fuel-efficient cars has increased, with more than 2,000 Toyota Prius hybrid cars registered in Fiji since 2013 (anecdotally, this increase is due to the removal of import duties on hybrid cars, and taxi drivers are reporting up to 50% fuel savings) (*Fiji Sun* 2015).

Fiji's main challenges in the energy sector include a dispersed rural population over many islands, which makes energy supply difficult and costly to implement and manage, as well as vulnerability to natural disasters, especially cyclones and flooding, that damage energy infrastructure (IRENA 2013 – Fiji). In terms of electricity supply challenges, Government's rural electrification programmes remains unsustainable in the absence of an effective cost-recovery framework and there is also no clear regulatory framework for encouraging third party electricity generation (Government of Fiji 2013, 11). In addition, there are difficulties in achieving renewable energy targets with increased use of diesel generation, an inability to encourage private sector investment as past failed projects have increased the risk perception of renewable energy investment, and the absence of national standards or certification to ensure that renewable energy equipment is suitable for local conditions (Government of Fiji 2013, 11).

Fiji has a National Energy Policy 2013–2020, driven by the Ministry of Infrastructure and Transport. The National Energy Policy includes the goal of achieving 100 per cent access to electricity by 2020. It also outlines the potential for increasing the contribution of renewable energy in electricity production from 67 per cent (hydro 62%, wind 4% and biomass 1%) to 80 per cent through undeveloped hydro sites, and unexplored geothermal, solar and wind resources. Further potential for reducing GHG emissions and the dependency on fossil fuels has been identified through energy efficiency in transport, the power sector, industry, businesses and households. The goal in Fiji's NDC is to increase the electricity generated by renewable energy to 99 or as close to 100 per cent as possible by 2030. The National Energy Policy also highlights the negative health impacts, particularly on women, of traditional cooking and the need to more actively involve women in determining future forms of energy sources for cooking.

9.5.2 Kiribati[15]

Kiribati is made up of three main island groupings – the Gilbert Islands, Phoenix Islands and Line Islands. Energy consumption is concentrated in the Gilbert Islands, where 90 per cent of Kiribati's 112,900 people live, particularly in the capital atoll of Tarawa. Kiribati relies on fossil fuels for 97 per cent of its energy needs, with the rest provided by biomass (Figure 9.1). Fuel imports have almost doubled since 1990, making up close to 20 per cent of Kiribati's merchandise imports in 2013, which is higher than the world and small states average (Figure 9.2). The Kiribati Oil Company (KOIL) imports fuel from Fiji and is also responsible for distribution. The demand for energy and increasing reliance on fossil fuels is underpinned by population growth. Over half of Kiribati's energy is consumed by the transport sector (52%), followed by the electricity sector (Figure 9.3).

Fuel usage for inter-island shipping represents the bulk of the diesel fuel imported for transport purposes, with both government and private ships providing passenger and freight services between islands or across the lagoon on an atoll. Although there are no data regarding the relative amount of diesel and petrol use for land transport, there are an increasing number of diesel vehicles on the road, with the Kiribati government preferring diesel-powered vehicles both for their fuel economy and relatively low maintenance requirements.

Around 59 per cent of Kiribati's population has access to electricity, with access rates lower for the rural population, compared to urban areas (Figure 9.4). Around 44 per cent of households in Kiribati are connected to the public grid network provided by the Public Utilities Board (PUB), with 87 per cent access in Tarawa, while access to grid-connected electricity for the rest of Kiribati is significantly low at an estimated 5 per cent (SPC 2009). Energy in the outer islands is provided by biomass (coconut husks and shells, and mangrove wood), small generators, kerosene and solar power. LPG use is growing on Tarawa to replace kerosene for cooking.

Solar energy is the most commonly used renewable resource and Kiribati has been successfully using solar outer island electrification for over 20 years. The government owned Kiribati Solar Energy Company (KSEC) provide 17 per cent of homes with off-grid solar power systems. Harnessing ocean energy (wave and ocean thermal energy) is currently at the technical development stage but may become useful in the future.

In terms of regulatory frameworks, there are price controls for petrol and kerosene from KOIL (diesel is not under price control), while PUB and KSEC Boards set their tariffs (although government has intervened in the past). The average residential electricity tariff in 2013 was US$0.57 (Figure 9.5). The three companies are state-owned enterprises, as private sector investments are extremely limited because the energy market in Kiribati is considered to be unattractive.

Kiribati's key energy challenges stem from its geographic and population dispersion. Kiribati's 32 atolls and one island are scattered over all four hemispheres in an expanse of ocean equivalent in size to the continental United States. This makes management of energy systems difficult, and installation and maintenance of energy equipment slow and costly. Environmental conditions also regularly impair energy equipment. Furthermore, with limited economic resources, Kiribati is highly dependent on official development assistance (accounts for 50% of GDP), with almost total dependence on external funding for energy projects, which results in long lead times and adds complexity to implementation. Moreover, there are significant capacity issues in the energy sector, lack of awareness regarding renewable energy and energy efficiency, and availability of energy data is limited.

The Ministry of Public Works and Utilities is responsible for the planning, management and co-ordination of the energy sector. With the assistance of SPC and other partners, Kiribati is in the process of developing a long-term energy sector strategy, which will include several renewable energy targets. In its recent national plan, the Kiribati Development Plan 2016–19, the government has focused on improving infrastructure for the energy sector, including in renewables. The Kiribati Joint Implementation Plan on Climate Change and Disaster Risk Management notes the vulnerability of women, youth and children.

9.5.3 Nauru[16]

Nauru is a small single oval-shaped and raised coral equatorial island. In the past, Nauru's economy was dependent on the phosphate industry, which also fuelled its energy demand. However, since the decline of phosphate production from its peak in 1975, the domestic residential sector is now the dominant user. Nauru relies entirely on petroleum (Figure 9.1), with fuel imports accounting for 8 per cent of GDP in 2014 (SPC, 2016). The Nauru Utilities Commission (NUC) provides all energy services to Nauru except for the Australian refugee camp and the main processing plant of the Republic of Nauru Phosphate Corporation (RONPHOS), which generate their own power. The government purchases petroleum for supply to all customers except RONPHOS, which does its own purchasing. The electricity sector is the biggest user of fuel, followed by the transport sector (Figure 9.3).

All of Nauru's population (10,800) have access to electricity provided by NUC and subsidised by the government (the energy subsidy accounts for one-quarter of all government spending). The average residential electricity tariff in 2013 was US$0.28 (Figure 9.5). Artificially low tariffs due to the subsidies, and lack of bill payment enforcement has resulted in a culture of very high electricity use. Consequently, prepayment meters have been introduced to limit usage. Although Nauru has experimented with solar energy, less than 1 per cent of Nauru's electricity is generated from renewable resources. Current renewable energy projects in the pipeline should increase this to around 3 per cent.

Land vehicles are the largest component of the transport sector, followed by small domestic fishing boats and aviation (Government of Nauru 2014, p. 53). A recent census found that 46 per cent of households owned one motorcycle, 29 per cent of households owned at least one vehicle, and 6 per cent of households owned a boat.[17] Bicycles are not widely used in Nauru but there is a limited bus service in the morning and afternoon for commuting by school children and civil servants (Government of Nauru 2014, p. 53).

Some of the main energy challenges in Nauru include high logistics cost to access the island, land tenure problems for large projects, a harsh marine environment, lack of economies of scale and limited capacity (particularly technical energy capacity and project management).

Nauru adopted a National Energy Policy Framework in 2009 that included a target to supply 50 per cent of the total energy use from renewable energy by 2015. The target was not met and was revised to 50 per cent of grid electricity, rather than total energy use, for achievement by 2020, in the subsequent Nauru Energy Road Map (Government of Nauru 2014, p. 13). The Road Map also outlines targets for uninterrupted grid electricity supply and 30 per cent improvement in energy efficiency by 2020. According to Nauru's NDC, the government's main strategy for renewable energy is to replace a substantial part of diesel electricity generation with a large-scale grid-connected solar PV system, as well as implementing demand-side energy management improvements. The Environment Division of the Department of Commerce, Industry and Environment has responsibility for energy policy and planning but is faced with staffing issues and there is also a very limited framework for monitoring and evaluation of progress in the energy sector (SPC, GIZ and IRENA 2013), which can hamper Nauru's efforts to achieve its energy targets. Of all the relevant documents from Commonwealth Pacific small states concerning this issue, the Road Map makes the most reference to gender and youth, noting the need for gender mainstreaming, collecting and disseminating information, disaggregation of data, and greater involvement of women in decision-making.

9.5.4 Papua New Guinea[18]

PNG has the largest land mass and is the most populous of the Commonwealth Pacific small states, with an estimated 8 million people, of whom 87 per cent are based in dispersed and remote rural areas (SPC 2016). PNG's total energy supply is led mostly by petroleum (55%), followed by biomass (39%) and smaller shares of natural gas (3%) and renewable energy (3%) (Figure 9.1). PNG is different to the other Commonwealth Pacific small states as it has its own indigenous fossil fuel resources (oil and gas). Although crude oil production has declined steadily since its peak in 1993 (as the resource becomes depleted), PNG embarked on a US$19 billion Exxon

Mobil LNG project, with the first shipment of LNG exported to Japan in 2014.[19] More than 70 per cent of PNG's export earnings come from mining and petroleum.[20]

Nevertheless, PNG continues to import refined petroleum but since 2004, after the construction of its own refinery, petroleum usage is increasingly from local sources. Therefore, the increase in fuel imports as a percentage of imports from 1990 to 2013 (Figure 9.2) was likely a result of a combination of relatively higher oil prices and lower overall imports. In 2013, fuel imports were worth 21 per cent of GDP (SPC 2016). Manufacturing is the largest consumer of energy in PNG, followed by transport and electricity (Figure 9.3). Due to their contribution to PNG's economy, the largest subsector users in the manufacturing sector are most likely to be mining and quarrying, wood and wood products, and construction.

In terms of transport, land transport is the largest user of energy and the number of motor vehicles in PNG has been increasing in recent years in line with economic development in the main population centres and the increasing preference for private motor vehicles. The government has considered improving public transport by using energy efficient buses in the shorter term and trams and trains in the longer term.

Given PNG's largely dispersed population in generally hard-to-access remote rural areas, only 18 per cent of the population have access to electricity (Figure 9.4). However, the majority of urban residents have access to electricity. PNG Power Limited (PPL) is the government-owned electricity supplier. There are also a number of private electricity suppliers that service the resource extraction sector. PNG is unique in that private electricity generation matches that of the public utility. The average residential electricity tariff in 2012 was US$0.36 (Figure 9.5). Renewable energy provides 47 per cent of electricity generation and this is likely to increase to 50 per cent once current projects are completed (SPC 2016). There is also the potential for further solar, hydro and geothermal expansion as well as a large biomass resource to utilise.

Some of the main challenges in the energy sector in PNG are a lack of renewable energy awareness, education and capacity, lack of funding for energy sector oversight by government, land access issues, vulnerability to natural disasters, dispersed rural populations lacking cash income to pay for a modern energy supply, the absence of an energy policy, and an electricity tariff that does not recover the full cost of supply.

The Department of Petroleum and Energy has oversight of the energy sector in PNG. PNG has not adopted an energy policy since 2005. However, PNG's Vision 2050 strategic plan, launched in 2009, outlined an aim of providing 100 per cent power generation from renewable energy sources. PNG is also currently in the process of finalising its National Energy Policy and National Energy Plan. The policy intends to reform the energy sector and electricity services industry, opening competition, setting new institutional and regulatory arrangements, and restructuring the sector, including PPL, to be more efficient and effective. It includes an electricity access target of 70 per cent by 2030.[21] The NDC for PNG outlines replacement of fossil-fuelled electricity generation with renewable energy sources with a target of having a carbon-free electricity sector by 2030. Solar PV, geothermal, biomass fuelled plants, additional hydro, and energy efficiency and conservation are to be investigated.

9.5.5 Samoa[22]

Samoa consists of two large islands where majority of the 194,000 population reside – Upolu (76%) and Savai'i (24%). The large majority of energy supply in Samoa is petroleum (80%) (diesel, petrol, kerosene and LPG), with a much smaller percentage coming from biomass (17%) and renewable energy (3%) (Figure 9.1). Fuel imports account for 11 per cent of GDP (SPC 2016), and have risen as a percentage of merchandise imports from 12 per cent in 1990 to 24 per cent in 2014 (Figure 9.2). The transport sector is the largest consumer of energy in the economy (Figure 9.3).

The transport sector consists of mainly land vehicles and domestic shipping fleets, which use fossil fuels and a very small amount of biodiesel. The government has attempted to restrict GHG emissions in the transport sector but has lacked the capacity and financing to do so. The government has also recognised the possible improvements in energy efficiency from a better planned and managed public transportation system.

Close to 100 per cent of Samoa's population have access to electricity (Figure 9.4). The Electric Power Corporation is the government-owned power utility in Samoa. The average electricity tariff in 2013 was US$0.43 (Figure 9.5), with an increasing gap between real costs and revenue. In 2014, 26 per cent of electricity was generated by renewable energy (solar PV, wind and hydro power). This was a reduction from the 48 per cent generated by renewable energy in 2007 due to three of five hydro power stations being destroyed by Cyclone Evan in December 2012, and drought and deforestation affecting hydro inflows.

Some of the main challenges in the energy sector in Samoa include its dependency on fossil fuels, land tenure issues, the harsh tropical environment, lack of technical capacity, and the impact of environmental events on its hydro power supply.

The National Energy Coordinating Committee is the co-ordinating body in the energy sector in Samoa. It comprises key cabinet ministers and chief executive officers of ministries and agencies in the energy sector and is chaired by the prime minister. The Energy Policy and Coordination Division of the Ministry of Finance is responsible for oversight of the energy sector, including the petroleum supply.

Samoa has in place several key sectoral plans and policies related to energy and energy issues are prioritised in its national development plan. The Strategy for Development of Samoa (SDS) 2012–2016 included renewable energy investment as a strategic outcome. Samoa is in the process of finalising its next Strategy for Development (2016–2020). The Samoa Energy Sector Plan 2012–2016 set out a plan to deliver outcomes consistent with the SDS, with an overarching goal of increasing energy self-sufficiency. A new energy sector plan has not yet been released. The Electricity Act 2010 introduced key regulatory changes to allow the entry of private sector IPPs and will contribute to the achievement of 50 per cent renewable electricity generation once current projects are completed. Other key policies include the Greenhouse Gas Abatement Strategy, Climate Change Policy 2007 and the draft Energy Efficiency Act. As part of its NDC, Samoa has a target of generating 100 per cent of its electricity from renewable energy by 2017 and a target of maintaining 100 per cent by 2025 in light of growing electricity demand, which a recent study proved feasible if a few measures are incorporated into the existing power system and if water supply remains steady (IRENA 2016a).

9.5.6 Solomon Islands[23]

Solomon Islands consists of nearly 1,000 islands, 350 of which are inhabited by 651,700 people, with 80 per cent living in rural areas. Biomass (53%) and petroleum (47%) are the main sources of energy supply (Figure 9.1). Fuel imports as a percentage of merchandise imports rose to around 30 per cent in 2013 from 19 per cent in 1990, before falling to 24 per cent in 2014 (Figure 9.2). The largest consumers of fossil fuels in the Solomon Islands were the 'other' (61%), transport (18%) and electricity (16%) sectors (Figure 9.3)[24]. For the Solomon Islands the largest subsector users from the 'other' sector are most likely to be forestry, fishing, and households.

The transport sector uses more than 50 per cent of fossil fuels for land vehicles and domestic shipping vessels. To improve energy efficiency in the transport sector, the government is raising awareness regarding the economic and climate change mitigation benefits of public transport, and is trying to promote the use of biofuels for transportation to reduce GHG emissions and minimise the dependency on fossil fuels.

Around 23 per cent of the population have access to electricity, with a larger proportion of those in urban areas with access compared to those in rural areas (Figure 9.4). The government-owned Solomon Islands Electricity Authority is responsible for electricity supply and operates nine electricity systems, including in Honiara. For the past 20 years, peak demand in Honiara has usually exceeded supply, causing frequent blackouts, although recent upgrades of the power systems have improved the situation. The average residential electricity tariff in 2012 was US$0.87 (Figure 9.5), with cross-subsidies in place from Honiara consumers to other users. Although the technical potential for renewable energy is considerable, suitable sites are far from demand centres and only little of the renewable energy has been accurately assessed. Electricity generated by renewable energy should increase from less than 1 per cent to 5 per cent once current projects are completed.

Some of the main challenges in the energy sector include lack of staffing and financial resources in the Energy Division, lack of government capacity to absorb donor assistance for energy projects, lack of technical skills, lack of energy and related data, geographical challenges (rough terrain and archipelagos spread over a wide expanse of ocean), low cash incomes in rural communities to pay for a modern energy supply, land tenure problems, few standards and regulations for energy use and development, and inadequate legislation.

The Energy Division of the Ministry of Mines, Energy and Rural Electrification is responsible for energy policy, renewable energy development and project implementation. The 2014 National Energy Policy sets a target of 50 per cent of electricity generated by renewable energy by 2020. The NDC for the Solomon Islands includes several renewable energy projects (hydro and solar) and reductions in energy usage through energy efficiency that will contribute to decreases in future fossil fuel use. The Solomon Islands Government has indicated that it will consider market-based mechanisms to raise funds to support the establishment and operation of a National Climate Change Trust Fund that will co-ordinate and manage the allocation of climate finance for climate change adaptation and mitigation activities. The National Energy Policy notes that gender-sensitive approaches are required when considering the needs for, and decision-making processes in, sustainable energy systems.

9.5.7 Tonga[25]

Tonga consists of 176 islands, 36 of which are inhabited. The islands are clustered in five groups – Tongatapu, Vava'u, Ha'apai, 'Eua and Niuas. Majority of Tonga's 100,600 population live in Tongatapa (73%). Tonga relies almost exclusively on petroleum, with less than 1 per cent accounted for by biomass (Figure 9.1). Fuel imports accounted for 10 per cent of GDP in 2014 (SPC 2016). As a percentage of total merchandise imports, fuel imports rose from 13 per cent in 1990 to 21 per cent in 2014 (Figure 9.2). The 'other' (56%), transport (34%) and electricity (10%) sectors are the predominant users of fossil fuels (Figure 9.3). For Tonga, the largest sub-sector users from the 'other' sector are most likely to be fishing, public services and households.

Land transport is the largest energy user in the transport sector. The government has noted the lack of available technological solutions for the transport sector and considers that opportunities for cleaner transport are limited.

Around 96 per cent of Tonga's population have access to electricity (Figure 9.4). Electricity is supplied by the government-owned Tonga Power Ltd (TPL), which is regulated by the Tonga Electricity Commission. The rural areas in Tongatapu have grid electricity supplied by TPL and the outer islands have solar power or mini-grids that are operated on a community-based management model. The average residential electricity tariff in 2013 was US$0.52 (Figure 9.5). Tonga has used solar energy since the late 1980s although biomass remains the primary renewable energy source. There is no potential for hydro energy and assessments indicate that geothermal energy is uneconomical. Wind resources have potential, although not on a large scale, with biogas and biofuel also having limited capability. However, there is potential for tidal resource although cyclones pose a serious problem. In 2015, renewable energy accounted for approximately 9 per cent of total electricity generation, and this is expected to increase to 13 per cent in 2016 on the completion of already confirmed and funded investments.

Some of the main energy sector challenges in Tonga are a scattered population on numerous atolls that makes centralised management of energy supply costly and problematic, lack of capacity in the energy sector, lack of data, lack of awareness regarding renewable energy and energy efficiency. Also, transport within and to Tonga is expensive, which increases the costs of replacement parts and maintenance, and the environmental conditions are harsh on energy infrastructure. Tonga is also almost totally reliant on donor funding for energy projects, which results in long lead times, and complicated implementation and maintenance.

The Energy Planning Unit of the Ministry of Lands, Environment, Climate Change and Natural Resources is responsible for energy planning, policy development and project co-ordination. Tonga has in place the Tonga Energy Road Map (TERM) 2010 – 2020, which includes targets of 50 per cent of electricity generation via renewable energy by 2020, and reducing the level of electricity network losses to a maximum of 10 per cent. The government also aims to replace all diesel-based water pumping engines by 2017 using solar power. Although the TERM did not include land transport, which is the largest consumer of fuel imports, it is in the process of developing transport sector measures and has undertaken training and public awareness actions on vehicle maintenance, public transport and bicycle usage.

While there was also a plan to increase renewable energy from 50 to 100 per cent in total electricity production by 2030, this was revised in the NDC. Tonga now aims to have 50 per cent of electricity generation from renewable sources by 2020, and 70 per cent by 2030. It also aims to improve energy efficiency through reduction of electricity network losses from an 18 per cent baseline in 2010 to 9 per cent by 2020. It will also have an emission reduction target for transport.

Tonga's climate change policy, 'A Resilient Tonga', aligns with the INDC and promotes the use of innovation, high technology, energy efficient appliances and disincentives for inefficient appliances. The government is also interested in investigating biofuels for transport and electricity generation, and in diesel engine efficiency services training to help reduce fossil fuel consumption in the country. The government has also identified interest from the private sector in a solar car public transport campaign for tourists and claimed 'the world's first solar powered tuk-tuks' at their launch in November 2016.[26] The TERM states that special consideration will be given to women and gender equality in the Tonga Strategic Development Framework 2015–2025.

9.5.8 Tuvalu[27]

Tuvalu has a very small land area (26 km^2), spread over six atolls and three islands, with around 48 per cent of its 10,100 population living on the atoll and capital, Funafuti. Petroleum accounts for 100 per cent of Tuvalu's energy supply (Figure 9.1) and 10 per cent of GDP (SPC 2016). Petroleum replaced biomass as its major energy source in the 1990s. Fuel is imported into Tuvalu via Fiji by Pacific Energy, which owns all storage and distribution facilities. This fuel is mainly used for electricity generation (41%) and transport (40%) (Figure 9.3).

Around 45 per cent of the population have access to electricity (Figure 9.4). Electricity is supplied by the Tuvalu Electricity Corporation (TEC) and the average residential electricity tariff in 2013 was US$0.51 (Figure 9.5), which is highly subsidised. Currently, only 2 per cent of electrical energy comes from renewables (solar). However, there is significant potential for renewables (solar, wind and coconut oil based biofuel). It is expected that after completion of current energy sector projects, 43 per cent of electricity will be derived from renewables.

With limited land area, the transport sector is dominated by outboard motor boats that travel within the atolls and islands.

Some of the main energy sector challenges facing Tuvalu are lack of capacity in the energy sector and in preparing energy project proposals for financing, the TEC not recovering sufficient revenue from subsidised tariffs to ensure sustainable operation, high cost of sea and land transport, land tenure issues, geography and dispersed population, the high cost of providing electricity in a harsh environment, lack of capital, and a lack of awareness of energy efficiency and renewable energy.

The energy sector is managed by the Department of Energy within the Ministry of Public Utilities. Tuvalu's NDC provides a commitment of reducing GHG emissions from the electricity generation sector by 100 per cent by 2025 (Tuvalu's 2009 National Energy Policy stated 100% by 2020) and from the entire energy sector to 60 per cent below 2010 levels by 2025. This is conditional upon the necessary technology and finance. Tuvalu also has a Master Plan for Renewable Energy and Energy Efficiency (2012–2020) that includes a goal of increasing energy efficiency on Funafuti by 30 per cent, a planned energy efficiency appliance subsidy scheme in co-operation with the Development Bank of Tuvalu, and the use of prepayment meters to limit the consumption of electricity. The 2009 Tuvalu National Energy Policy included gender equity as a principle of the policy.

9.5.9 Vanuatu[28]

Vanuatu is made up of 80 islands, 65 of which are populated, with 76 per cent of the 289,700 population based in rural areas. Vanuatu relies heavily on imports of fossil fuel for its energy needs with 63 per cent of its total energy supply coming from petroleum, followed by biomass (35%) and renewables (2%) (Figure 9.1). Fuel imports accounted for 6 per cent of GDP and 14 per cent of merchandise imports in 2014. The transport sector and the electricity sector are the largest users of fossil fuels (Figure 9.3).

With Vanuatu made up of so many islands, inter-island shipping and aviation are heavily relied upon for transport. Roads are being upgraded and Port Vila has a unique minibus service that serves as the main public transport system.

Only 27 per cent of Vanuatu's population has access to electricity, with only 18 per cent coverage in rural areas (Figure 9.4). Grid electricity in urban areas is supplied by private companies. The Union Electrique du Vanuatu Limited supplies electricity to Port Vila (capital city), East Malakula and Tanna. Vanuatu Utilities and Infrastructure Limited supplies electricity to Luganville (second largest city). These companies' tariffs are set by the Utilities Regulatory Authority. The average residential electricity tariff in 2013 was US$0.55 (Figure 9.5). Vanuatu has capitalised on its renewable energy to some extent, with a wind farm and solar PV system connected to the Port Vila grid, and a hydro power station that serves Luganville, as well as use of coconut oil for generators.

Some of the main energy sector challenges in Vanuatu include insufficient capacity and financial resources of the Department of Energy, limited cash income in rural areas to pay for electricity, geographic challenges and inadequate transport to reach remote rural villages, low population density making the costs of grid extension and maintenance high, and high vulnerability to natural disasters, especially cyclones, and land tenure.

The Department of Energy in the Ministry of Climate Change and Natural Disaster is responsible for the energy sector in Vanuatu. The key energy sector policy document is the Updated National Energy Road Map (NERM) 2016–2030, which has five energy sector priorities and associated targets: increasing access to electricity, reducing reliance on petroleum products, affordable energy services, a secure energy supply, and mitigating against climate change through renewable energy and energy efficiency (Radio NZ 2016). Vanuatu's NDC outlines a target of increasing the electricity generated by renewable energy from about 25 to 100 per cent by 2030. The government's updated NERM also has a target of increasing the proportion of the population with access to electricity to 100 per cent by 2030. The Rural Electrification in Vanuatu Nationally Appropriate Mitigation Action (NAMA) serves as a replicable model for achieving this access target and includes establishing five microgrids for rural communities, tourism and agricultural facilities, health centres, and schools and extending five existing electricity grids to households, public institutions and tourism/commercial consumers in the proximity of power lines.[29] In terms of addressing gender issues, the NERM notes the disproportionate impact of traditional cooking on women, whereas the NAMA discusses providing equal employment opportunity for women, and the 2015 Infrastructure Strategic Investment Plan includes reference to inclusive and gender balanced economic growth.

9.6 Remaining gaps and possible solutions

The following section identifies key gaps in the current responses at the regional and national level that will need to be addressed to ensure the best possible chance of achieving SDG 7 by 2030 and sustaining an energy secure Pacific through to 2050. While some of the 'gaps' may have been highlighted in regional and national policy responses, from the perspective of a desk review it is difficult to ascertain whether policy implementation has been successful. Therefore, continued efforts, upscaling or fast-tracking of already identified policy interventions may be needed to effectively address these gaps.

9.6.1 Strengthening energy security and co-ordination

The FAESP and IPESP are key regional responses to ensure energy security and co-ordination in the Pacific, with the midterm review of the IPESP indicating several important areas of improvement, as discussed previously. Crucially, co-ordination of energy sector activities should continue in the Pacific to avoid duplication. With many agencies involved in the energy sector in the Pacific, it is vital that consistent approaches to encouraging energy sector development are used to avoid overburdening national capacity, minimise time and costs, avoid competition and conflict, and produce consistent outcomes using a 'Team Pacific' approach.

In addition, many of the Commonwealth Pacific small states have no national standards or certifications to ensure that imported renewable energy technologies are suitable for local conditions. Therefore, co-ordination in this area is important to develop standards for these technologies, as well as having basic templates for due diligence, for example in areas such as project appraisal and IPP connection agreements. This could assist with more certainty for investors in renewable energy in the Pacific and save funds, resources and duplication. Countries that could collectively benefit from high-cost capital-intensive energy projects could also pool their financial resources to spread their risks. While these areas have been highlighted in the revised IPESP and FAESP, there has been little apparent progress in implementation.

Despite the lack of success with bulk procurement, Commonwealth Pacific small states should consider ways to individually or collectively negotiate for more cost-effective supply and logistics, and develop relationships with the petroleum companies to manage the transition away from petroleum-based economies to clean energy economies. Individually, a larger country like Fiji may be able to maintain a strong bargaining position, but smaller countries need the support of others.

Continued strengthening of co-ordination at the national level is also important as different ministries may have responsibility over the sectors of the economy that impact on the energy sector and provide supporting infrastructure, e.g. energy, utilities, ICT, transport, the environment, and climate change. These ministries and the activities they undertake need to be co-ordinated at the national level to minimise duplication and ensure co-ordinated action in reducing fossil fuel dependency, increasing access to energy, increasing clean energy and reducing GHG emissions. While the revised IPESP and FAESP recognise the need to strengthen co-ordination in the energy sector, progress has been slow.

Governments have led on international climate action through the Paris Agreement and NDCs, but further action on the ground is needed to influence the shift to a cleaner and more sustainable energy system. There is a need to raise the awareness of all stakeholders on the benefits of moving to a clean energy supply system based on energy conservation, energy efficiency and renewable energy. Thorough stakeholder consultation, including with women and youth, should also be undertaken to ensure that these perspectives are taken into account in all stages of energy policy. Encouraging the private sector to transition to a low carbon energy system will be critical.

Governments can lead by example as 'green governments' by ensuring that public procurement guidelines include preference for energy efficient and renewable energy practices in providing goods and services. This will raise awareness, as well as stimulate the supply chain in energy efficient and renewable energy practices. This may also encourage the use of renewable energy equipment in remote areas, if these products and services are being procured for government buildings, e.g. health centres and schools. Governments can also consider subsidised solar programmes for schools, health centres/hospitals and other buildings to encourage use of solar PV systems.

However, while governments' ambitious renewable energy targets are commendable, they may unrealistically raise expectations and undermine pragmatic attempts to bring change to the energy sector. Development partners, other finance providers, and investors may also prefer to support plans with more realistic targets that can be achieved, rather than fund plans with unrealistic targets that are continually missed.

This is especially true for plans that target 100 per cent access to affordable, reliable, and sustainable modern energy services by 2030, which may ultimately be unachievable and, in the process, divert resources away from needier sectors, such as health and education. For energy systems to be truly sustainable, they have to be paid for by Pacific energy consumers. Given the economic profile of many of the Commonwealth Pacific small states, this is unlikely to be achievable.

9.6.2 Information

Although there are a number of regional initiatives and projects in place to improve energy information, a sustainable resource stream is needed to scale up current efforts. Furthermore, current initiatives may not be sufficient to meet the needs of energy stakeholders in the Pacific. Efforts to improve information collection, collation and dissemination through SPC, SEIDP and the PRDR should continue. However, a single platform is needed where key and updated energy statistics are kept in a centrally accessible online database, at SPC for example, that becomes the authoritative reference for energy statistics in the Pacific. Greater national data collection is needed to support this, along with the capacity-building that is required to enable it.

9.6.3 Importance of building capacity

Renewable energy usually involves labour-intensive employment, but there appears to be insufficient absorptive capacity within countries to undertake these type of projects. Therefore, it may be that more complex projects are being undertaken prematurely, when more support should be provided for education, training and building existing capacity before proceeding. Regional and national institutional capacity is also lacking, resulting in insufficient financial and human resources to implement energy sector strategies and policies.

To ensure that the Pacific has a flexible and adaptive workforce to embrace emerging renewable energy technologies, energy sector studies, finance and project management should be entrenched in nationally and regionally recognised vocational and tertiary courses, curricula and qualifications. In addition, to promote and improve guidelines and technical standards for renewable energy technologies and ensure consistency across the region, renewable energy companies from all Commonwealth Pacific small states should be encouraged to make use of the PCREEE and be members of SEIAPI, of which USP is also a member, so that their employees can access training and support, exchange ideas and become certified, thereby raising the standard of renewable energy installations and maintenance in the Pacific.

Training courses and financial support should be provided for project developers to build their capacity to complete early project milestones in the early development process of energy sector projects, i.e. business plan development, feasibility studies, project design documents, financial structuring etc., so that they can confidently submit proposals with sound economic and financial analysis to financial institutions and development partners for funding. Training should also be developed for the commercial and development banks, and the broader financial industry, to better understand the business opportunities, products, technologies, barriers and perceived risks associated with energy sector projects.

While building capacity is tackled to some degree in the revised IPESP and FAESP, there is a need to accelerate implementation of identified initiatives.

9.6.4 Improving electricity supply, access and tariffs

If renewable energy is to account for 100 per cent of total electricity supply by 2030 in some countries, then electricity grids will need to be stable enough to cope with this level of integration. Those electricity grids that include renewable energy in their baseload power (such as hydro power or biomass), will be more stable than others. Those that do not have renewable energy integrated in their baseload power will have to integrate battery storage to cope with losses of intermittent renewable energy power, such as with the use of solar and wind power. Vanuatu has integrated wind and coconut oil into the fuel mix of its electricity generation, but other countries have not had similar success with integration of these particular types of renewable energy sources.

To integrate greater levels of renewable energy into electricity grids, especially solar PV, grid stability studies should continue to be conducted to determine the feasible amount of renewable energy that can be connected to the grid (including with cloud predicting solar PV technology, and rapid advances and cost decreases in battery storage). In addition, electricity grids can be developed in such a way that allows for the adoption of emerging technologies (marine energy, electric vehicles) in the future. The current and future use of smart grids and electric vehicles in developed countries and other island regions should be closely monitored for potential replication in the Pacific at the appropriate time.

However, expectations should be managed. As the diffusion of grid-connected solar PV technology and wind turbines, for example, has largely trailed the adoption and dissemination of those technologies in developed countries, Commonwealth Pacific small states should not expect the latest sustainable energy technologies to be implemented before, or at a quicker rate than, these technologies have been adopted in more developed countries. Regardless of whether particular technologies can be adopted immediately, investing in the electricity grid to reduce losses, blackouts, brownouts and power rationing to ensure greater efficiency in the energy supply system is likely to reduce fossil fuel consumption and associated GHGs more quickly and at lower cost than an inefficient system with increased renewable energy.

In addition to making the system more efficient, legal and regulatory frameworks need to be established to provide enabling environments for greater private sector investment in the energy sector, i.e. arrangements that allow for IPPs (commercial and residential) and emerging renewable energy technologies to access electricity grids. This should include a transparent process for procurement of new large-scale capacity from IPPs, that includes an economically justified feed-in-tariff[30] or pricing principles/framework to be applied in all new power purchase agreements, and associated grid connection standards. There should also be a framework for greater expansion of the grid to those places where it is economically feasible to do so.

To improve access and expand rural electrification, some countries are developing plans to show how each unelectrified area will be served with least-cost solutions or how the grid could be extended to ensure that renewable energy generation can displace as much diesel fuel, kerosene, and unsustainable biomass use as possible. Authorities should develop management models for off-grid rural electrification using renewable energy service companies to provide electricity to isolated communities and areas not served by the utility. This needs to be done in a way that is appropriate for the particular cultural, geographic, remote and rural circumstances, taking account customers' willingness and ability to pay, and utilising a sustainable business model that ensures that there is technical capacity to make repairs, a resilient supply chain to provide spare parts, and a tariff (whether this includes subsidies or not) that covers these costs and those of replacement systems at the end of the current system's lifetime.

While grid extensions will meet the need of some customers, small plug and play solar systems may suit the needs of others. Authorities should consider solar PV plug and play approaches that ensure that the economic costs are contained to ensure affordability for customers, while allowing for the adoption of appropriate emerging technologies, such as better battery storage technologies. Authorities should also develop complimentary battery collection/return programmes to ensure that they are recycled or disposed of appropriately. An extra environmental fee/deposit could be included in the cost of batteries and repaid to the customer when the battery is returned.

Decisions regarding electricity tariffs need to be made free of political interference to ensure that utilities can recover the total costs of production, including capital replacement costs. Without cost reflective electricity tariffs, there is not much incentive to conserve energy and be energy efficient. In addition, without cost reflective electricity tariffs, there will be a lower financial return on every investment made in energy conservation, energy efficiency and renewable energy. Power utilities should also regularly review the costs of electricity supply and set tariffs accordingly, as well as ensure that the application of subsidies is transparent to all stakeholders.

However, the influence of incumbent energy utilities and petroleum companies needs to be managed carefully, especially if governments are heavily reliant on revenues from taxing petroleum products, so that the transition to a cleaner energy system is not frustrated by utilities and companies that have vested interests and hold significant market power. Governments need to communicate and implement clean energy policies, along with the associated legal and regulatory frameworks, to minimise political interference and the dominance of incumbent monopolistic power utilities.

Electricity tariffs should only be subsidised or cross-subsidised for genuine lifeline and livelihood reasons, and not for political gain. Lifeline tariffs should be targeted to low-income earners (means tested) and targeted to a consumption rate that only meets essential needs, to avoid subsidising excessive users of energy. Excessive users should pay more for their usage, which can also cross-subsidise lifeline tariffs. In addition, larger customers could be charged a levy to fund renewable energy and rural electrification. The funds from this levy could be incorporated into an energy access/ national climate fund, which would also receive contributions from the government, donor aid agencies, individuals, and others (see section 9.6.7).

9.6.5 Focusing on energy efficiency

There is generally a low level of awareness and policy response for improving energy efficiency in the Pacific. The following are some practical examples of actions that can be implemented to improve energy efficiency.

To ensure that energy consumption in buildings constructed in urban and rural areas is minimised, authorities should consider establishing or reviewing national building codes to incorporate requirements for higher energy efficiency standards. Climate resiliency should also be included to ensure that these energy efficient buildings are located away from rising sea levels, storm surges and floods, and can withstand cyclones. These could be mandatory for new homes. If it is difficult to establish or change the building code; as a start, an energy efficiency programme could be established to influence these changes. To rapidly achieve compliance with new codes and encourage this investment, grants and/or concessionary finance could be offered for new and retrofitted buildings.

Governments could also undertake a replacement/retrofit programme in government buildings to promote energy efficiency in the public sector and as a platform for demonstrating the feasibility of energy efficiency projects. The private sector could be involved in the replacements and retrofits. Strengthening the enabling environment for private sector energy efficiency auditors and energy service companies to undertake energy efficiency assessments and projects is also important.

Innovative financing solutions to encourage energy efficiency and renewable energy should also be considered. For example, Palau established the Palau Energy Efficiency Programme to encourage energy efficient housing (see Box 9.1). This programme could be replicated in the Commonwealth Pacific small states. Similar programmes could be extended to small businesses, as well as complement the review and upgrade of building codes and regulations. Provident funds that allow early access to pension funds for housing loans could also be made conditional on incorporating energy efficiency design or measures. These alternative initiatives demonstrate a way of encouraging energy efficiency without mandatory policies or building codes in place.

In addition, current energy labelling and minimum energy efficiency programmes should be scaled up, with the aim of eventually extending them to all imported electrical appliances and industrial equipment. A list of approved energy efficient appliances could be developed to better inform consumer purchasing choices. A

Box 9.1 Palau Energy Efficiency Subsidy Programme

As a result of rising electricity tariffs in Palau, which had the potential to adversely impact home loan repayments, the National Development Bank of Palau (NDBP) developed the Energy Efficiency Subsidy Programme. Under this Programme, homeowners received grants of up to US$6,000, deducted from their loans, for incorporating energy efficient measures into their homes, such as east-west orientation, white roofs, radiant barrier insulation under roofs, tinted windows, shading, ceiling fans, energy efficient lighting, and solar or instantaneous hot water systems.

NDBP reported more than 100 participating homes, with energy savings at an average of 38 per cent (the target was 15%). Following the adoption of the programme by the Palau Housing Authority, every new housing loan in Palau is eligible for the grant. The programme was later revised to include existing houses and for loans for solar PV.

Source: IUCN 2016

'rebate and turn in' programme could be established to increase the market for private sector companies that produce or distribute the most energy efficient appliances (e.g. white goods, air conditioners, solar hot water) and by replacing old, inefficient equipment (e.g. machines and power generation) with new more efficient equipment, e.g. in the tourism and manufacturing industries.

9.6.6 Prioritising the transport sector

While addressing the energy consumption of the transport sector is covered in regional and national responses, there has been little progress in advancing solutions. Given the significant amount of fossil fuels consumed in the transport sector and the lack of action in achieving solutions in this area, this area needs greater focus if the Pacific is to achieve the SDGs by 2030 and become an energy secure region by 2050.

Governments and development partners need to be made more aware that land and sea transport needs attention so that whole-of-sector strategies to reduce fossil fuel consumption can be developed to encourage direct investment in improving transport efficiency.

For those Commonwealth Pacific small states where land transport comprises a significant part of energy consumption (Fiji, Samoa, Tonga and Vanuatu), public transport and non-motorised transport (cycling and walking) should be promoted, including developing appropriate traffic and freight management plans for major urban centres to improve traffic flow, deal with traffic congestion and reduce vehicle emissions, noise and travel time. The possibility of having clear ways during peak periods (e.g. bus priority/rapid transit lanes) should be explored, with upgraded intersections and bus stops, cycle lanes and footpaths, undertaking traffic impact assessments for new development and ensuring pedestrian safety. Incentives such as concessional or guaranteed lease financing of efficient buses could be used.

To reduce the dependency on fossil fuel, car import regulations could be established to ensure that only the more energy efficient vehicles are imported using the cleanest fuel, as well as ensuring cars currently on the road that are not well maintained, or are too polluting, are serviced or removed from the roads. Any extra cost of a more energy efficient vehicle is likely to be repaid through fuel savings in the average life use of the vehicle. This could be achieved by enforcing age limits on all second-hand vehicles (e.g. five years and less) and by providing incentives for importation of new vehicles with better and more fuel efficient engine technologies, and for subsequent servicing and repair.

Commonwealth Pacific small states should also closely follow the adoption of electric vehicles in other small states. For example, Barbados is making strong progress towards the use of cleaner, more efficient vehicles, including use of electric vehicles. However, Commonwealth Pacific small states are expected to adopt electric vehicles at a slow and incremental rate, similar to the trends in surrounding developed countries, e.g. Australia, New Zealand, Japan and the United States. Limited financial resources and lack of supportive infrastructure are expected to hinder rapid adoption and deployment of electric vehicles in the Commonwealth Pacific small states.

However, authorities could consider introducing Euro 4[31] standard fuel and vehicles, and incentives to comply with Euro 4 fuel standards, including the setting up of relevant infrastructure and a review of fuel prices. As Fiji is the major regional petroleum distribution hub in the Pacific, where fuel is bunkered before being transported on smaller ships to other countries, a change of fuel standards in Fiji would influence outcomes in downstream countries. Fiji currently uses Euro 2 standard fuel (Australia is on Euro 5 and 6) but could reduce emissions by raising the standard to Euro 4. Euro 5 is likely to be cost prohibitive at this stage as it requires the use of diesel particulate filters.

Renewable energy for marine transport is not included in the FATS, and although transport is included in some of the NDCs, there are no transport targets set for any of the nine Commonwealth Pacific small states (Goundar 2016). This is a significant omission which should be rectified by regional and national stakeholders.

9.6.7 Sustainable financing for energy

With national energy policies, renewable readiness assessments, national energy road maps, national climate change policies, national development strategies and plans that all deal with the energy sector in some form or another, there is growing potential for confusion, fatigue, duplication, and ultimately uncertainty by investors as to what a nation's current strategy and goals are at a particular point in time. Furthermore, despite national political will, all NDCs rely on obtaining external funding and many do not necessarily quantify the costs of the total investment needed or delineate how the intended actions will be achieved.

Development partners are likely to continue to provide energy financing and Commonwealth Pacific small states should continue to work with all their partners on this front. However, anecdotally, there is still likely to be a significant gap in the finances and resources that are needed to achieve the NDCs and SDG 7 by 2030. At the regional level, regional institutions need more financing to operate with a long-term view, and not from a project to project, programme to programme basis. At the national level, governments need more financing to supplement current inadequate budgets in place for the energy and related sectors.

Climate financing options for energy solutions are likely to take a greater role in the future, especially as it is envisaged that the Green Climate Fund (GCF) will provide US$100 billion annually. Some of the activities that are likely to be eligible for climate financing include renewable energy, lower-carbon and efficient energy generation, energy efficiency, transport, and low carbon technologies, as well as adaptation activities that ensure the resiliency of energy systems and supporting infrastructure. Therefore, Commonwealth Pacific small states should co-ordinate their climate finance strategies with their energy initiatives, including meeting GCF guidelines to ensure that they are able to secure funding for energy projects under the GCF.

In addition, Commonwealth Pacific small states could consider establishing a National Climate and Energy Fund that would serve as a central repository for GCF funds and other sources of energy financing, including ODA to the energy sector. The Fund would require significant donor engagement and consultation and an initial injection of funds to be operationalised. Other revenue raised from excise taxes, levies or import duties on inefficient appliances and vehicles, and/or equipment to generate electricity from fossil fuel, 'green fees', tourist fees, carbon offset charges could support the capitalisation of the fund, and it could act as a revolving fund.[32] It could also include an interface for crowdfunding.[33] The Fund could provide a good mechanism for sustainable, long-term, transparent and predictable sources of climate/energy finance if given clear objectives, a strong and effective governance structure that protects the investments, and measures to ensure that volatile returns are managed.

Operationally, the Fund could be kept in a trust account with a commercial bank or the Government, e.g. at the Ministry of Finance, for reasons of transparency. Strong governance and accountability mechanisms, as well as prudent financial management practices, can help limit macroeconomic and governance risks. The Government or an independent agency would then disseminate these funds, based on appropriate criteria, to government departments, businesses, non-government organisations, community groups and individuals to implement energy efficiency, renewable energy and energy access projects. With a central repository, the government would be able to better monitor the overall financial envelope for climate and energy projects.

Moreover, the National Fund could provide finance for an energy/climate access investment facility, with a concessional interest rate or full/partial guarantee through development and commercial banks. This could be supplemented with a small grants programme with simple administrative requirements. Furthermore, the National Fund could provide an insurance facility to manage the risks of climate change induced disasters on energy sector, and supporting, infrastructure.

In other innovative financing mechanisms, authorities could enforce a renewable energy loans ratio, that requires all commercial and development banks to allocate a minimum percentage of their deposits, and similar liabilities, in loans to the renewable energy sector, such as the system in place in Fiji. Authorities could also develop climate/green energy bonds for large-scale (and capital-intensive) sustainable energy projects. In addition, sovereign wealth and national provident funds could be used for similar projects. Public-private partnerships are also another option although there is some research[34] that suggests that PPPs can be an expensive way for governments to invest in infrastructure.

To mitigate the perceived financial risks in energy projects, authorities should ensure environmental regulations are in place, develop green credit ratings, and improve environmental risk disclosure and analysis to guide investor behaviour.

9.7 Looking to 2050

There are many challenges for the Commonwealth Pacific small states to overcome to achieve a sustainable low carbon pathway. The region has shown leadership in ratifying international climate agreements. Action in the energy sector to ensure sustainability is tied very closely with action on climate change. There are many co-benefits of climate change action that flow to the energy sector, which include access to clean and safe sources of energy and ensuring climate-resilient infrastructure. If the identified responses, solutions and contributions to combating climate change (NDCs) can be financed and implemented at the same time as extending access to energy to all of their populations, Commonwealth Pacific small states will achieve real independence through energy and economic security.

Integrating climate change and energy planning through national planning and budget processes and sourcing finance for projects and programmes that decouple development from a dependency on fossil fuels by harnessing local renewable energy sources and maximising energy efficiency are fundamental to achieving these objectives. Building local employment capacity to undertake these tasks, and reducing the need for imports, especially through local food production, will also assist in strengthening the economy and reducing fuel import bills. If this is done in an incremental way that adopts and integrates emerging technologies at the appropriate times, using a flexible approach that accounts for the topography, remoteness, culture, economic cost, and willingness and ability of energy consumers to pay, then many of the ambitious national energy targets may be realised. It should also ensure that there is a healthy, educated, trained and mobile workforce equipped to support this modern energy system, and a modern energy system that supports a healthy, educated, and vibrant population.

Ultimately, this will mean increased energy security, economic independence and increased standards of living, which will contribute to achieving the Pacific Islands Forum Leaders' Vision under the Framework for Pacific Regionalism (PIFS 2014):

> *Our Pacific Vision is for a region of peace, harmony, security, social inclusion, and prosperity, so that all Pacific people can lead free, healthy, and productive lives.*

However, whether the current regional and national responses will be sufficient to achieve SDG 7 or many of the NDCs by 2030 or even 2050 will depend on several factors. Increases in energy efficiency will reduce the renewable energy required, while increases in the renewable energy to total energy mix will reduce the amount of fuel imports, as long as the renewable energy targets are maintained. However, the latter is dependent on population growth, which will drive energy demand. Given these factors, three possible scenarios can be envisaged:

1. In a 'business as usual' scenario with current population growth, continued migration to urban areas, growing energy demand, and little improvement in regard to access, energy efficiency and renewable energy, Commonwealth Pacific small states will increase fuel imports and become more dependent on petroleum, increase their vulnerability to macroeconomic impacts (GDP decline), and generate greater GHG emissions.
2. In a scenario with moderate population growth, some migration to urban areas and other countries outside the Pacific, subdued energy demand, and some improvement to access, energy efficiency and renewable energy, Commonwealth Pacific small states are likely to moderately lower their dependence on petroleum, mitigate macroeconomic impacts to some extent and generate moderate levels of GHG emissions.
3. In the more optimistic scenario of maintaining population at current levels, including urban and rural population ratios, some migration to neighbouring states, reduced energy demand, and escalated action on access, energy efficiency, and renewable energy, Commonwealth Pacific small states will significantly lower their dependence on petroleum, have greater economic independence (GDP increase), and will achieve SDG 7 and the NDCs.

Based on the current trajectory, Commonwealth Pacific small states are likely headed for Scenario 1. Current responses are also unlikely to be sufficient to result in Scenario 3. This is because even though energy targets, policies and NDCs are in place, there is not enough financing to achieve these targets. If financing is secured, Commonwealth Pacific small states are likely to realise Scenario 2, while moving towards Scenario 3. However, to fully achieve Scenario 3, there needs to be a more concerted effort and more financing than currently exists, particularly to scale up and/or develop effective solutions for cleaner transport, energy conservation and efficiency, and to build institutional and technical capacity.

9.8 Recommendations

Based on the gaps highlighted earlier, the following policy options are recommended to assist Commonwealth Pacific small states to shift towards lower fuel dependence, greater economic independence and achievement of the NDCs and SDG 7 of access to affordable, reliable, sustainable and modern energy for all. While many of the recommendations may not be new, they highlight the need for renewed and continued efforts to ensure that the appropriate policy responses result in scaled up action and improved implementation and outcomes.

9.8.1 Energy security and co-ordination

Strengthen co-ordination, share experiences (Pacific, small states, south-south, north-south) and use the period of low oil prices and low interest rates by investing in energy efficiency and renewable energy. Ensure that the energy sector genuinely engages women and youth, and effectively supports other sectors of the economy, such as energy for education, health or water.

9.8.2 Information on energy

Continue efforts to improve information collection, collation and dissemination through SPC, SEIDP and the PRDR. Devise a way of ensuring that the PRDR is sustainable. Enhance capacity-building initiatives for national collection of energy data. Regularly update regional and national energy policies, ensuring they are easily accessible.

9.8.3 Institutional and technical capacity

Build the capacity of project developers and the financial industry. Incorporate energy sector studies, finance, and project management in curricula (including online/distance education), and foster the growth of the PCREEE and SEIAPI. Build the capacity and encourage the use of private sector energy efficiency auditors and energy service companies. Strengthen regional and national energy institutions and ministries, ensuring that they are well governed, sustainably funded and have sufficient human resources to implement their energy sector strategies, policies and plans. There is also a need to maximise the opportunities for accessing available energy and climate finance. In addition, development partners should strengthen existing capacity-building processes, such as SEIAPI and PacTVET, by mandating the use of these processes in their projects and programmes.

9.8.4 Electricity supply, access and tariffs

Ensure that electricity tariffs are cost reflective, cost efficient and fair. In addition, ensure that electricity tariffs can accommodate lifeline tariffs for the most vulnerable, encourage energy conservation and efficiency, and provide investment signals. Electricity tariffs should also allow energy service providers to recover the full cost of the services they provide, including the use of flexible payment methods, such as prepayment meters, mobile phones, and the internet, to improve cost recovery. Electricity bills should include explanations on the full cost of supply, subsidies and any other relevant information for transparency, as well as to raise consumer awareness.

Establish efficient, resilient and reliable electricity grids that are economically and technologically appropriate. Formulate legal and regulatory frameworks that allow the integration at the appropriate time of emerging technologies (e.g. smart grids, electric vehicles, battery storage, biofuels, geothermal and marine energy) that are proven and commercially viable. Develop consistent guidelines and technical standards/testing. Continue grid stability studies, closely monitor smart grid developments elsewhere, and maximise the amount of solar PV in electricity grids.

Develop an integrated rural energy supply that provides grid extensions, and/or decentralised mini- or microgrids, solar PV home systems, plug and play systems and/or other emerging technologies that are proven and commercially viable. Account for the culture, topography and remoteness of target locations, as well as the economic costs of each system, and the willingness and ability of consumers to pay. Ensure that there is a management model in place that recovers sufficient fees to pay for the sustainable operation and maintenance of these systems.

9.8.5 Energy efficiency

Encourage an efficient, affordable, clean energy system that provides access to appropriate modern energy services according to the circumstances and remoteness of consumers. Develop national building codes based on tropical architecture design, with strong energy efficiency and resiliency measures. Consider housing loan programmes that encourage energy efficiency, replacement, retrofit, rebate and turn-in programmes, and extend energy efficiency labelling programmes to all appliances.

9.8.6 Energy for transport

Prioritise and rebalance efforts to target energy use in the transport sector, which has been largely absent from regional and national responses. Develop an efficient, affordable and cleaner transport system that is flexible enough to adopt and integrate, at the appropriate time, new transport technologies (e.g. efficient and/or electric vehicles, cleaner fuels, efficient ships utilising renewable energy) that are proven and commercially viable. Review import regulations and taxes to promote imports of energy efficient cars, and introduce improved fuel standards. Closely monitor international aviation and shipping emission agreement negotiations, and electric vehicle developments.

9.8.7 Gender perspectives

Greater efforts are needed to ensure that gender perspectives are genuinely accounted for in energy sector planning, budgeting, implementation, and monitoring and evaluation processes, rather than cursory references in policies and documents.

9.8.8 Development approach and finance

The energy sector should be developed incrementally rather than radically. Picking any single technology 'winner', e.g. electric vehicles, marine energy, biofuels or offshore wind, should be avoided. Instead, there should be a greater focus on energy efficiency, so as to reduce total energy consumption, the cost of the fuel import bill, and the capacity and cost of the additional investment in renewable energy required to displace the remaining fossil fuel consumption. Lower-risk commercially viable and proven technologies and measures, such as replacing refrigeration and cooling with newer and more efficient equipment and maximising solar PV, should be preferred.

Governments should continue to lead by example, providing the strategic policy signals and frameworks for investment in clean energy and improving energy access. Governments should also provide an enabling environment for the private sector to engage in clean energy practices, as well as adopting best-practice public-private partnerships. In addition, governments should incorporate the SDGs and NDCs into planning and budget processes, undertake green procurement and energy efficiency retrofits, and install solar PV on government buildings using the private sector.

Ensure that there is resilient supporting infrastructure, e.g. roads, ports, buildings, ICT, and water, etc., that is adapted to the impacts of natural disasters and climate change to enable efficient energy supply chains, transport of maintenance staff and replacement parts, and access to markets.

Quantify the financing required to meet the SDGs and NDCs. Develop clear project and programme pipelines based on the NDCs. Continue working with multilateral and bilateral development partners. Strengthen co-operation and co-ordination to better access energy and climate finance. Establish national energy and climate funds. Encourage sovereign wealth, national provident, and foreign pension funds to invest in sustainable energy systems. Consider energy efficiency/rural electrification/ renewable energy loan ratios and levies.

Notes

1 This chapter benefited from valuable comments from UNDP (Thomas Jensen), the University of the South Pacific (Associate Professor Atul Raturi), the Secretariat of the Pacific Community (Solomone Fifita) and the Commonwealth Secretariat (Resina Katafono, Denny Lewis-Bynoe, Motselisi Matsela and Naadira Ogeer).

2 See United Nations Sustainable Development Goals 7, 9 and 13: https://sustainabledevelopment.un.org/sdg7, https://sustainabledevelopment.un.org/sdg9, and https://sustainabledevelopment.un.org/sdg13 (accessed 27 November 2016).

3 See Paris Agreement - Status of Ratification (UNFCCC), at http://unfccc.int/paris_agreement/items/9444.php

4 Small states are classified by the Commonwealth as sovereign states with a population size of 1.5 million people or less. Papua New Guinea is designated as a small state because it shares many characteristics of a small state.

5 Kiribati, Solomon Islands, Tuvalu and Vanuatu are also least developed countries which are defined by the United Nations as countries experiencing extreme poverty, structural economic weaknesses, lack of growth capacity, and exposure to external economic shocks, natural and man-made disasters and communicable diseases (See http://unohrlls.org/about-ldcs/). The UN General Assembly decided to extend the preparatory period before graduation for Vanuatu by three years, until 4 December 2020, due to the unique disruption caused to the economic and social progress of Vanuatu by Cyclone Pam (See https://www.un.org/development/desa/dpad/tag/vanuatu/).

6 Within these smaller countries, the effects tend to be higher at lower incomes (PFTAC, 2010).

7 Additional flows of foreign currency are needed to replace the increase in hard currency needed to pay the import bill. This may come from other areas of the current account – from tourism receipts, grants from development partners or private remittances. If this is not forthcoming, countries must draw on foreign savings - through foreign direct investment or borrowing. Pacific Island Countries and Territories (PICTs) generally aim to keep reserves that cover at a minimum 3–4 months of imports. Declining reserves can also affect the availability of credit and interest rate levels in countries as declines in foreign reserves deplete banking sector liquidity (PFTAC 2010, 5–6).

8 As advised by the Secretariat of the Pacific Community (SPC).

9 This was formerly the CROP Energy Working Group and it may soon change its name to the CROP Energy Security Working Group (CESWG).

10 PICTs include the nine Commonwealth Pacific small states plus Cook Islands, Federated States of Micronesia, Niue, Republic of the Marshall Islands and Palau, as well as the territories of American

Samoa, French Polynesia, Guam, Northern Mariana Islands, Pitcairn Islands, Tokelau, and Wallis and Futuna.

11 Pacific Regional Data Repository (PRDR) project: http://prdrse4all.spc.int/production (accessed 20 July 2016).

12 Oceania Centre for Sustainable Transport (OCST) http://pace.usp.ac.fj/ocst/Activities/land.aspx (accessed 27 May 2016).

13 The Greenheart Project http://greenheartproject.org/en (accessed 27 May 2016).

14 ESI-NUS 2016 and IMO Energy Efficiency Measures http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Technical-and-Operational-Measures.aspx (accessed 28 November 2016).

15 This section is drawn largely from IRENA, 2013c, unless otherwise stated.

16 This section is drawn largely from IRENA, 2013d, unless otherwise stated.

17 Nauru 2015 Household Electrical Appliances, Lights, and End-use Survey – Background, Process, and Findings, Final Version – 9 December 2015

18 This section is drawn largely from IRENA, 2013e, unless otherwise stated.

19 https://pnglng.com/About/History

20 Papua New Guinea Country Presentation, Group and Region-Focused Training hosted by JICA, 21 June – 11 July 2015, Tokyo, Japan. Presented by Kepsey Puiye, Assistant Director, Petroleum Economics – Department of Petroleum and Energy PNG.

21 National Energy Policy 2016 - 2020 - Final Consultation Workshop https://www.facebook.com/events/717179181744261/?active_tab=highlights (accessed 10 June 2016).

22 This section is drawn largely from IRENA, 2013f, unless otherwise stated.

23 This section is drawn largely from IRENA, 2013g, unless otherwise stated.

24 The 'other' sector is a UN classification that includes energy consumers from agriculture, forestry, fishing, commerce and public services, households and those not elsewhere specified.

25 This section is drawn largely from IRENA, 2013h, unless otherwise stated.

26 Tonga launch World's First Solar Powered Tuk Tuk http://www.mic.gov.to/news-today/press-releases/6422-tonga-launch-worlds-first-solar-powered-tuk-tuk- (accessed 28 November 2016).

27 This section is drawn largely from IRENA, 2013i, unless otherwise stated.

28 This section is drawn largely from IRENA, 2013j, unless otherwise stated.

29 Rural Electrification in Vanuatu http://www.nama-database.org/index.php/Rural_Electrification_in_Vanuatu (accessed 29 May 2016), UNDP, 2015

30 Feed-in-tariffs for renewable energy generation should be determined based on the true value that this type of generation provides, i.e. including emission reductions, energy, reductions in peak loads, and delaying of network capacity expansion, for example.

31 Euro 4 (January 2005) and the later Euro 5 (September 2009) concentrated on cleaning up emissions from diesel cars, especially reducing particulate matter and oxides of nitrogen. (see: http://www.theaa.com/motoring_advice/fuels-and-environment/euro-emissions-standards.html (accessed 28 November 2016)).

32 The value-added taxes charged on fossil fuels, national park/world heritage location fees, inefficient electrical equipment, airport arrival taxes, could be transferred to a national climate change trust fund, to fund priority climate change action.

33 Crowdfunding websites could be established seeking voluntary contributions from concerned citizens of other nations.

34 Public-private partnerships: The global debt iceberg? http://www.brettonwoodsproject.org/2016/06/21111 (accessed 30 June 2016)

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