NEW ZEALAND
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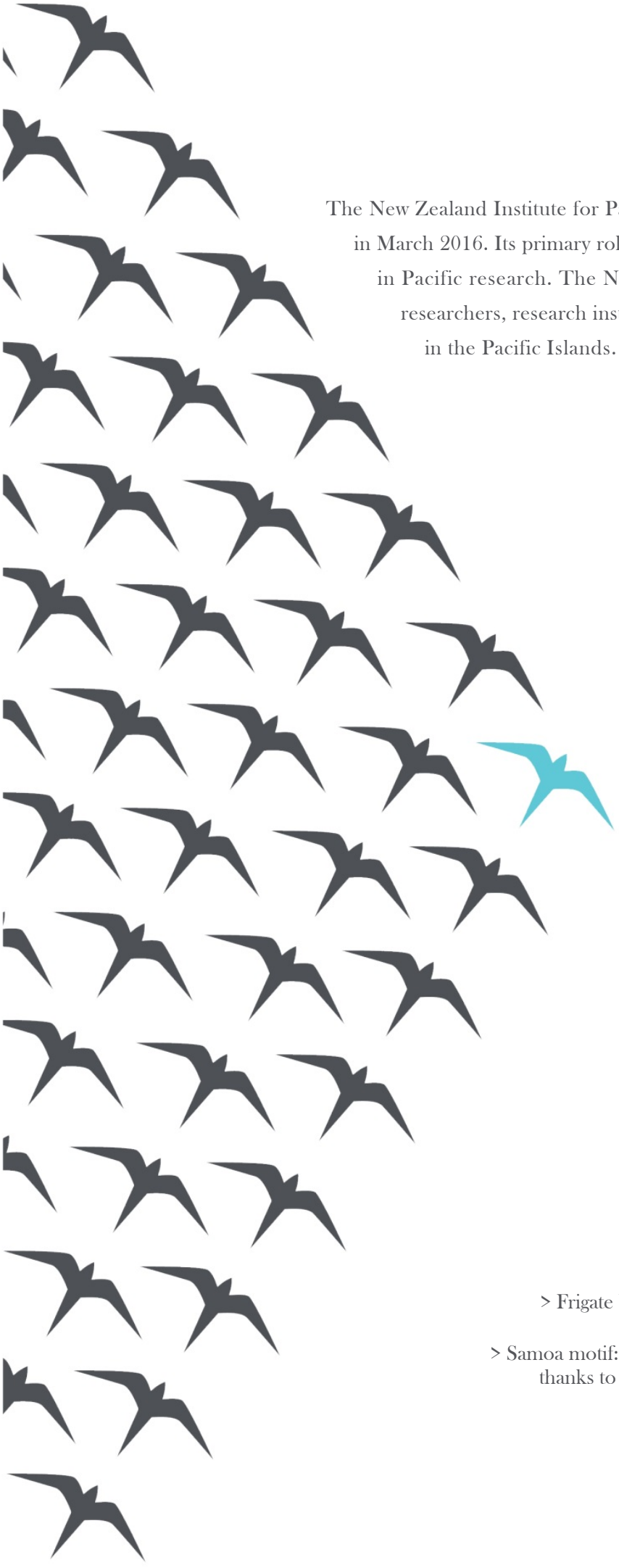
Te Ang Maitoro: Cooling Kiribati and Samoa

Mary Anne Teariki, Ramona Tiatia,
Ian Shearer and Philippa Howden-Chapman

He Kāinga Oranga/Housing and Health Research Programme
University of Otago, Wellington

2019



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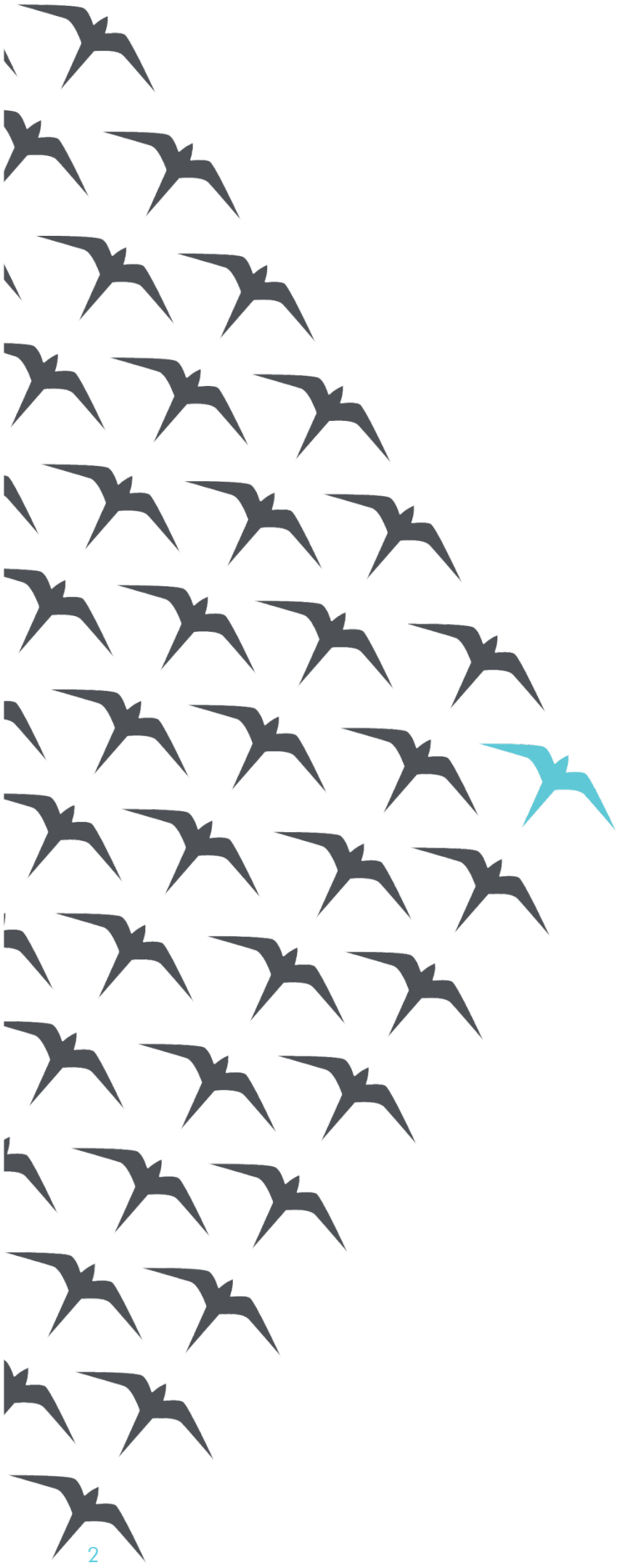

Abstract

The Small Island Developing States (SIDS) of the Pacific are undergoing significant change as they seek to become more sustainable and resilient to risks and disturbances from natural disasters and the effects of climate change. As a key component of sustainable development, Kiribati and Samoa have made commitments under the United Nations Sustainable Development Goals (SDGs) to increase the proportion of their populations with access to clean and sustainable sources of energy and to reduce dependence on fossil fuels. Consistent with these objectives, and with increasing donor assistance in the region, both Kiribati and Samoa have invested in new forms of renewable energy sources. These include the use of solar PV, wind, bioenergy and hydro (in Samoa). To understand the challenges and types of investment that will improve the socio-economic outcomes of their citizens, a wide range of stakeholders were interviewed in Kiribati and Samoa. While responses were diverse on many fronts, renewable energy was considered by stakeholders in both countries as the way of the future, a way of improving socio-economic outcomes for the most vulnerable households and communities, and a way of managing risks and improving resilience. In particular, access to clean and sustainable sources of energy were seen as being critical in improving education, health, and safety outcomes for women, children, and youth, who typically bear the brunt of energy poverty, particularly in relation to access to electricity.

Notwithstanding these benefits and despite their diversity, both Kiribati and Samoa face a number of common challenges, including dealing with rapid urbanisation and capacity constraints. In Kiribati, these challenges have become increasingly complicated as a result of extremely high population densities in South Tarawa, inadequate infrastructure, and environmental degradation, due to climate change (rising sea levels) and other anthropogenic impacts. In Samoa, risks from extreme climatic events and natural disasters have led to increased levels of resilience building led by governance strengthening and the dissemination of key information to communities. The report puts forward a small number of renewable energy initiatives that have the potential to improve sustainable development and resilience in both countries and strengthen the robustness of their electricity sectors.

Preface

The energy of the sun sustains life on land and sea. It influences how the people of Kiribati and Samoa live their lives, represented in song, local dances, and in stories of times gone by. The relentless heat, together with the harsh environment, have contributed to the strength of the people, learning to fish for sustenance by the sun, stars and the moon. Recently, however, the stories from family and friends back in the islands suggest that Kiribati and Samoa are getting hotter, making it harder to work during the day and sleep at night. People are saying that this is because of climate change, as increasing pollution from fossil fuels traps the heat, leading to severe impacts around the world, changing their local environment and the way of life that has sustained them.

The people of Samoa also know that they need to be prepared to manage risks from natural disasters that have wreaked havoc and loss of life. Strengthening their ability to manage these risks means protecting the health and well-being of families and communities and returning back to normality as soon as possible. Electricity services play a vital role in 'bouncing back' from such eventualities, providing people with lights and running water, and reducing food spoilage. Solar-powered lights and communication systems can play a key role, when systems are not up and running, by providing people with an important sense of safety. By providing vital back-up for essential systems when the electricity grid goes down, solar energy has the potential to save lives by warning communities of an impending tsunami.

Overall, increased access to electricity services from renewable energy has the potential to improve the socio-economic circumstances of people and strengthen their ability to manage risks and disturbances from natural disasters and climate change. All of these features pertain to resilience, whether it is economic, social, environmental, or cultural.

Te Ang Maitoro is a Kiribati phrase, composed for this project by my husband Barauti Teariki, an I-Kiribati who lives in New Zealand but whose heart and soul lives in Kiribati. It is our pleasure to share *Te Ang Maitoro* with you, Dr Mary Anne Teariki.

Matagifanua is an ancient Samoan wind which is cooled by passing over and through bush and vegetation; arriving as the evening draws closer, to the welcoming wishes of the elderly people. It is offered as inspiration to this project by Matai'a Dr Ramona Tiatia.

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Acknowledgements

The *Te Ang Maitoro* Team wishes to thank the New Zealand Institute for Pacific Research for funding this research project.

We also wish to thank the many stakeholders in Kiribati and Samoa who so generously gave their time to share their views on the role of renewable energy in furthering sustainable development, and enhancing resilience to manage risks and disturbances associated with natural disasters and climate change. Your input enabled us to understand the complex changes occurring in your beautiful countries and the stoicism reflected in your stories about the future.

We kindly also thank the governments of Kiribati and Samoa for allowing us to undertake this research and for those Ministers who shared their thoughts about policy and interventions needed to achieve greater sustainability and resilience.

Finally, we would like to thank our Technical Expert Team (Mark Apperley, Suzanna Tiapula, Antoine Bittar, Yung Sung, Dianne Sika-Paotonu and Mino Cleverly), who read the report and made useful suggestions and revisions.

Te Ang Maitoro Team

Contents

List of Figures

List of Maps

List of Tables

Abbreviations

ADB	Asian Development Bank
ARENA	Australian Renewable Energy Agency
BFAT	Biomass Feasibility Assessment Team
CCN	Climate Change Network
DMO	Disaster Management Office
EECA	Energy Efficiency and Conservation Authority
EIA	US Energy Information Agency
ICSU	International Council for Science
ICT	Information and communication technology
IMPRESS	Improving the Performance and Reliability of Renewable Energy Power System in Samoa
IPP	Independent power producer
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
ICUN	International Union for Conservation of Nature
KANGO	Kiribati Association of Non-Governmental Organisations
kW	Kilowatt (1,000 Watt)
kWp	Kilowatt-peak (for solar plants)
MFAT	New Zealand Ministry of Foreign Affairs and Trade
MW	Megawatt (1 million Watts)
MNRE	Ministry of Natural Resources and Environment
NECC	National Economic Coordinating Committee
NUS	National University of Samoa

OTEC	Ocean thermal energy conversion
PPA	Pacific Power Association
PUB	Public Utilities Board
PV	Solar photovoltaic
UAE	United Arab Emirates
UNDP	United Nations Development Program
USA	United States of America
RE	Renewable energy
RO	Reverse osmosis
SBC	Sustainable Business Council
SHS	Solar home systems
SDGs	Sustainable Development Goals
SIDS	Small Island Developing States
SPC	The Pacific Community
SROS	Scientific Research Organisation of Samoa
STEC	Samoan Trust Estates Corporation
WHO	World Health Organization

1. Introduction

This research examines the role of renewable energy in strengthening the resilience of Kiribati and Samoa to manage risks and disturbances from natural disasters and climate change. Set against the context of increasing literature on the role of energy and sustainable development, little is known about the potential of renewable energy sources to improve socio-economic outcomes and strengthen the ability of communities in Kiribati and Samoa to manage risks. Recognising the association between clean and affordable energy and sustainable development, both countries have made commitments to meet the objectives set by the United Nations Sustainability Goals (SDGs). Set against the objective of increasing our knowledge of the role of renewable energy and resilience the following research question was developed:

> *How can renewable energy contribute to sustainable development and strengthen the resilience of Kiribati and Samoa to manage risks and disturbances from natural disasters and climate change?*

Research objectives:

1. *What has recent research found regarding the use of renewable energy and adaptive capacity and resilience of local communities at risk of natural disasters and climate change effects?*
2. *What future investments should be considered in renewable energy solutions in Kiribati and Samoa that will strengthen the resilience of local communities?*
3. *What skills and training and regulatory frameworks are needed and how could they be best provided to enable the effective operation of renewable energy equipment now and into the future?*
4. *What knowledge and skills are transferrable from Kiribati and Samoa to other Pacific countries?*

1.1 Research Methodology

As the aim of the research question was to gain an understanding of how renewable energy can contribute to sustainable development and resilience, qualitative methodology was selected to collect the views of key stakeholders in Kiribati and Samoa about the use of renewable energy. A diverse group of stakeholders, including government ministers, public sector officials, non-government organisations (NGOS), churches, business owners, farmers, and utility providers were interviewed face to face in Kiribati and Samoa. To facilitate the interview process, participants could choose whether to respond in English or in their native languages. The interviews were subsequently transcribed and the data analysed using grounded theory methodology. This process involved identifying key categories arising from the data, with direct quotes placed within these and sub-categories. This enabled the identification of commonalities and differences in the data, and linkages between

issues. The data highlighted a significant number of issues, including the adequacy of electricity services, pricing structures and affordability, energy poverty, and capacity constraints in the renewable energy sector. It also highlighted the complexities associated with rapid urbanisation and the suitability of governance structures given changing technologies and increased demand for energy from consumers.

1.2 Shape of Research

The research is broken down in five main sections. The first section reviews the literature on the concept of resilience and its association with sustainability. It examines the evolution of the concept from its use within an engineering framework, centred on 'bounce back' to equilibrium, to more integrated thinking, which is inclusive of socio-economic, environmental, and cultural factors. The review examines some of the key issues relating to adaptive capacity, including governance, institutional capacity, economic factors, and social, environmental, and natural resources. The section also explores the key characteristics of Small Island Developing States (SIDS), and the shape of the energy sectors in Kiribati and Samoa.

The second section outlines the methodology used to gather information from stakeholders and the process utilised to analyse the data. The third section sets out the results of the data collection. It outlines the main categories of issues confronting Kiribati and Samoa relating to the use of renewable energy and sustainability and resilience. Despite significant differences in topography and access to natural resources, some common issues were identified relating to the future success of their respective renewable energy sectors. Importantly, it also identifies the different aspects of risks, from the rapid effects of natural disasters and the impact of slow-onset climate change. It highlights that in both countries, climate change influences will add to already stressed environmental ecosystems and that issues such as access to fresh drinking water will have a significant influence on the viability of human habitation, particularly in Kiribati. The fourth section discusses the findings against the literature review. It identifies some simple, yet effective ways that renewable energy can be used to improve the quality of drinking water in Kiribati, and the usefulness of cool stores to assist those working in the agriculture and fisheries sectors in Samoa. It also identifies the need for capacity building to ensure that renewable energy hardware is well maintained and able to be repaired in a timely manner. The fifth section sets out our conclusions and puts forward recommendations for improving sustainability and resilience outcomes in Kiribati and Samoa. A key conclusion is that sustainability is a key feature of resilience and that there is a need to understand this relationship for new investment to bolster sustainable development that strengthens the ability of these countries to manage risks and disturbances from natural disasters and climate change.

2. Literature Review

2.1 Introduction

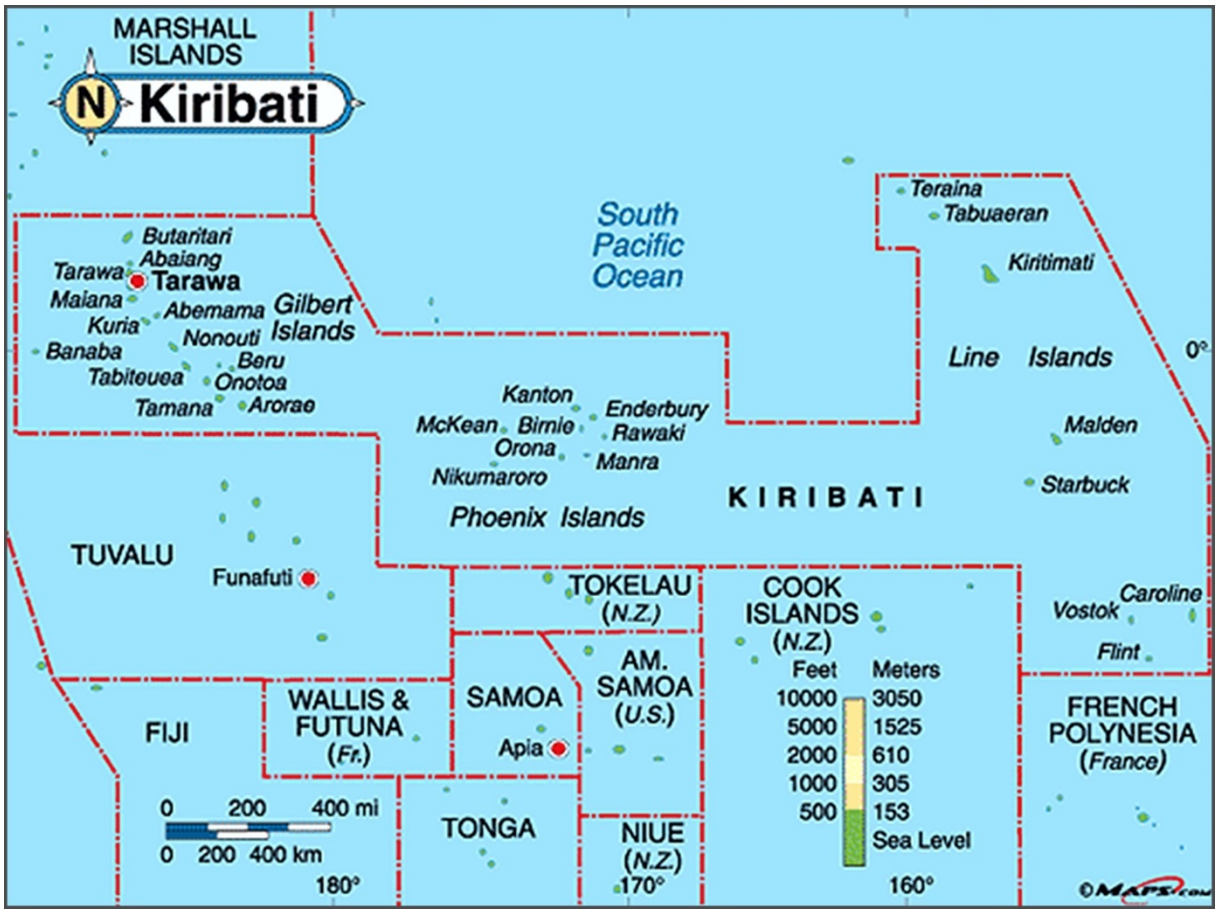
The aim of this review is to examine the literature on the topics of resilience and the adaptive capacity of communities and regions to manage a range of risks, including shocks and disturbances related to natural disasters and climate change impacts. As a focussed literature review, a set of prompts were used to search the Google Scholar database and a number of other databases from the Intergovernmental Panel on Climate Change (IPCC), World Bank, United Nations, and the South Pacific Forum. These prompts included: *adaptive capacity, adaptation, resilience, community resilience, climate change, natural disaster impacts, Kiribati, Samoa, renewable energy, sustainable development*. The scope of the literature search was further refined by focussing on the emergence of theoretical models on resilience from those identified as being experts in the field, and on research concerning SIDS, particularly in relation to Kiribati and Samoa, and the wider Pacific region. Reading through the abstracts of references identified through this process (including the reference lists of these studies), 250 articles and books were identified as comprising the literature sample for this review.

The literature review is divided into six main sections. The first section examines some of the key characteristics of Kiribati and Samoa, as SIDS, including their vulnerability to natural disasters and climate change impacts. This section also explores how anthropogenic changes, such as increasing urbanisation, are having an impact on the local environment, and how the impact of people on natural resources is affecting their resilience. The second examines the United Nations SDGs with respect to renewable energy, and the linkages between renewable energy and other sustainability goals. The third section looks at the issues related to centralised and distributed energy systems. The fourth and fifth sections examine the uptake of renewable energy in Kiribati and Samoa respectfully. The sixth section explores the literature on resilience, and the different approaches taken. This is followed by a section on adaptive capacity resources, identifying some of the key factors that can strengthen the adaptive capacity of communities to manage disturbances. The eighth section discusses the key findings from the literature review, which is followed by a concluding paragraph.

2.2 Small Island Developing States (SIDS): Kiribati and Samoa

As small, remote, and insular countries, it is widely accepted that SIDS are vulnerable to a variety of risks and disturbances, including being prone to natural disasters and climate change impacts (Barnett and Adger 2003; Briguglio 1995). As small entities, SIDS such as Kiribati and Samoa (the foci of this study) face a number of critical economic challenges. These include: limited resources, dependence on a narrow range of products, limited domestic competition, diseconomies of scale and restricted skilled personnel due to outward migration. Adding to these difficulties, remoteness and insularity mean

that these countries face high unit transport costs for both their exports and imports. These costs are further exacerbated by the significant distances between islands of many SIDS, such as the disparate atoll islands of Kiribati straddling the equator.



Map 1 Kiribati

These countries are also recognised as being prone to natural disasters, such as tropical storms, hurricanes, and cyclones. Other risks include earthquakes, volcanic eruptions, and tsunamis. While these events also occur in non-island states, Briguglio (1995) notes that the costs per capita are generally significantly larger for SIDS, due to their small size, remoteness, and insularity. In some instances, natural disasters on SIDS can be far reaching, including the devastation of entire villages, and wider communities, resulting in the injury and death of inhabitants. These risks are particularly poignant in the case of Samoa, which has experienced the devastating impacts of severe tropical storms, earthquakes, and tsunamis. Located on what is referred to as the *Ring of Fire*, Samoa is subject to earthquakes, like the 8.3 magnitude earthquake that struck on 29 September 2009, which triggered a tsunami that killed 143 and injured 310 inhabitants. Adding to these challenges, being at risk of tropical storms between November and the end of April, Samoa also has a history of

tropical cyclones that have resulted in the loss of life, injury, and economic devastation. Some of the most destructive cyclones include Cyclone Evan in 2012, Cyclone Val in 1991, and Cyclone Ofa in 1990.

Map 2 Samoa

(Ezilon.com)

SIDS, such as Kiribati and Samoa, have also been recognised at being at pronounced risk from climate change. While the detrimental effects of climate change affect both countries, it is widely recognised that climate change poses major difficulties for low-lying atoll countries, usually estimated at being between 2 and 3 metres above sea levels. Although atolls are known for their dynamic and adaptive capacity to withstand extreme climatic events (Webb and Kench 2010; Woodroffe 2008), the porous nature of their low-lying land means that atoll nations such as Kiribati are particularly at risk from higher sea levels, increased storm activities, and more powerful sea surges.

While much of the attention on climate change and atolls has focussed on the probability of whole countries disappearing due to increased sea levels, Woodroffe (2008) argues that the risks to atoll countries (such as Kiribati), should be viewed more in terms of environmental degradation resulting from incremental climate change influences and increased climatic events. Viewed in this way, Woodroffe contends that environmental damage is already evident in Kiribati (and Tuvalu), due to the increased prevalence of storms during king tides, which will only be exacerbated by higher sea levels. This means that, rather than being a problem for the future, climate change is already disturbing the ecological and environmental systems of Kiribati, necessary to maintain the way of life of I-Kiribati, including the long-term habitability of the country.

Figure 1 Overtopping of land in Betio (South Tarawa)

(climate.gov.ki)

An example of a risk facing atolls now is the impact of climate change on the supply and quality of freshwater necessary to sustain human habitation (Nunn 2009; White et al 1999). Three climatic factors associated with climate change can be identified as having direct detrimental impacts on the sustainability of freshwater lenses in atolls such as Kiribati. The first is the adverse impact of reduced rainfall in replenishing the supply of freshwater in underground lenses. The second is the impact of increased sea levels and storm surges leading to the overtopping of atolls, which results in sea water entering freshwater lenses through the porous coral. The third is the direct impact of the loss of land from erosion, which reduces the thickness of the base of underground freshwater lenses and leads to a reduction in the size of the lens.

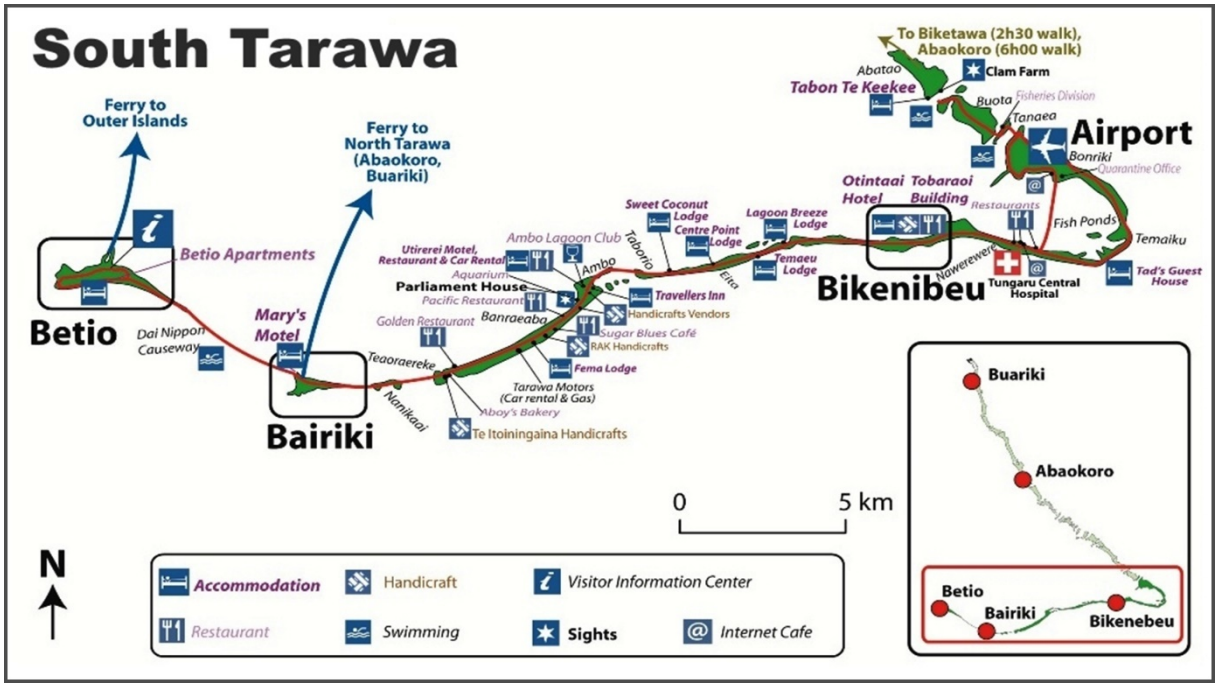
Concerns about the loss of land mass and shrinkage of freshwater lenses on small island islands were expressed by the East-West Center (2002) which estimated that the Bonriki lens, which supplies drinking water to over 54,000 people living in Tarawa, could shrink by 30% due to persistent inundation and flooding from increasing sea levels. Any concurrent climatic events, such as a 25% reduction in rainfall, combined with an increased sea level of 50 centimetres, could have the effect of reducing the Bonriki freshwater lens by over 60% (White et al 1999). Further research on the vital Bonriki freshwater lens in Tarawa showed that the thickness of the lens reduced by 50% during the 1998–2001 drought, and water elevations dropped by around 400 millimetres from its long-term mean (White and Falkland 2009). Analysis by the Green Climate Fund (2018)

suggests that with a sea level rise of 28 centimetres, an overtopping event with a return period of 20 years would render nine out of 22 infiltration galleries damaged, corresponding to a 41% reduction in yield. The duration of this reduction would depend on rainfall in the years before and after the event.

Another set of risks associated with the long-term sustainability of SIDS is the depletion of resources and environmental degradation from increasing levels of urbanisation, over-crowding, pollution, and contamination of land and freshwater systems. Due to the spatial constraints of SIDS, Briguglio (1995: 1617) notes that environmental problems are likely to be particularly intense in SIDS. Nowhere is this intensity more evident than the current problems facing Tarawa. One of the most significant factors has been the move away from the traditional way of life in the outer islands in preference to a more urban lifestyle in Tarawa. This internal migration, coupled with demographic growth (2.2% for Kiribati, and 4.4% for South Tarawa) and spatial constraints has led to very high population densities in South Tarawa (the region between Betio and Buota, just north of Bonriki), now on a par with Hong Kong.

While the population density for Kiribati is 727 inhabitants per square kilometre, the population density in Tarawa is estimated to be over 3,100 inhabitants per square kilometre. This figure is even more acute in the case in the southernmost region of Tarawa, with the population density in Betio estimated at over 6,000 inhabitants per square kilometre, and the population density in Bairiki through to Bikenibeu estimated at 7,500 inhabitants per square kilometre (Republic of Kiribati Island Report Series 2012). The decline of the environment in Tarawa, evidenced by high levels of pollution, contamination of land and freshwater resources, high demand for

Map 3 South Tarawa



(World Maps)

freshwater, and the over-harvesting of natural resources, has been attributed to the combination of population densities and inadequate infrastructure (Wyett 2014).

One of the most concerning aspects of these anthropogenic impacts is the deterioration in the quality of freshwater supplies, responsible for the high rates of diarrheal diseases among those living in Tarawa, and a leading cause of death of those aged 5 years and under (WHO 2012). Some residents have the ability to switch from private bore wells to the supply of reticulated drinking water. However, White (2009) notes that the movement of squatters and their animals from the outer islands, to areas in proximity to the vital Bonriki freshwater lens (responsible for supplying over 80% of the total population of Tarawa with drinking water), is responsible for the presence of E. coli and other microorganism contaminants in freshwater supplies. According to White (2009), these problems have emerged as a result of poorly enforced local regulations needed to protect freshwater supplies.

While not experiencing the same set of acute vulnerabilities facing Kiribati, increasing urbanisation and economic development in Samoa has been associated with a range of environmental problems, including: the loss of vegetation, deforestation, pollution, and contamination of water sources (Kaly and Pratt 2000). An example of the detrimental impact of economic development, in recent times, has been the degradation of mangroves in the coastal villages of Upolu (Pata, Sataoa, Vaitoloa, and Fugalei). Boon (2001) blames the haste with which such developments are approved, without any prior assessment being made of the environmental impacts. The combination of reclamation and economic development has been blamed for the loss of marine resources and the loss of natural barriers from the effects of cyclones and storm surges, exposing these coastal villages to added vulnerabilities.

It was not until the in-depth interviews with villagers in these coastal regions that the full impact of the loss of mangroves was understood (Boon 2001). By exploring the effects of the loss of mangroves at the community level, Boon (2001) was able to identify the impacts of that loss on the day-to-day activities of villagers. At the village level, the destruction of mangroves was viewed as having a number of perceived negative effects, including: the destruction of habitat and spawning grounds for marine organisms, the retreat of the shoreline from coastal erosion, and flooding (Boon 2001: 178). A key indicator of the impact of human development in these coastal regions was the reduction in fish catches: 43% at Pata, 33% at Sataoa, 80% at Vaitoloa, and 100% at Fugalei. While these resources may have been over-exploited for cash, the key finding by Boon (2001) was the impact of development on environmental systems that sustain the local populations and assist in managing the effects of climate change and severe climatic events.

This short exposé of the impact of anthropogenic impacts is particularly relevant in relation to the topic of natural disasters, climate change, and sustainability. On the first of these, anthropogenic pressures in Kiribati and Samoa can weaken the ability of human and environmental systems to respond to the effects of natural disasters and climate change. With socio-ecological systems under considerable pressure in Tarawa (Kiribati) and Upolu (Samoa), regardless of climate change, the concern is that climate change, climatic events, and natural disasters will only add a

further level of unsustainable stress to the ecosystems of these countries (Adger et al 2003; Nunn 2009). Of major concern are the slow-onset effects of climate change that have the capacity to weaken the natural systems necessary to maintain human habitation.

2.3 Sustainability: The Role of Renewable Energy

Noting the importance of sustainability for managing current and future risks and disturbances (from natural disasters and climate change), this section examines the role of energy services, in particular, renewable energy, in improving the lives of the people of Kiribati and Samoa. According to the International Council for Science (Griggs et al 2017) report and Dornan (2014), modern energy is fundamental to human development, enhancing the well-being of people, and playing a key role in the attainment of sustainable development. It enables, among other things:

- Food to be refrigerated, preventing food spoilage, resulting in reduced incidences of bacterial contamination, and associated gastro-intestinal illness, especially among children;
- Medicines and vaccines to be refrigerated necessary for community health;
- Houses, schools, hospitals, and other public institutions to be cooled, creating comfortable spaces for people to live and work;
- Houses to be lit at night, letting children study, and women work from home, allowing them to generate independent sources of income;
- Indoor pollution to be reduced, improving air quality, resulting in improved health outcomes;
- Key activities to be supported, including water extraction, water-treatment centres for safe drinking water, desalination, support for sanitation systems, and improved demand-side power management;
- The emergence of new ideas and technologies, including, among other things, new government approaches to support the retraining and upskilling of workers, and the strengthening of financial institutions for providing capital and credit;
- Building resilient infrastructure, including upgrading and retrofitting infrastructure to make them more energy efficient, reliable and sustainable;
- Urban areas to grow and perform. "Clean, efficient energy systems, in particular, create the conditions for cities, and human settlements to be inclusive, safe, resilient, less-polluting, and more sustainable" (ISCU 2017: 134); and
- The development of new governance structures to reduce conflict between objectives, and ensure that energy remains affordable to the poorest, especially if higher cost renewables are deployed.

With so many linkages between renewable energy and socio-economic and environmental dimensions, successive governments have been aware of the need to ensure that policy development and regulatory functions keep pace with the supply and demand for new renewable

technology. Given the complex array of issues requiring attention, policy coordination will be critical to maximise opportunities, but also minimise unintended consequences, particularly less evident, indirect and downstream impacts. This is particularly important given that the application and implementation of new renewable energy projects are important, not only at the strategic level, but also locally, where people live and work.

The opportunity for renewable energy to improve the lives of people is reflected in its inclusion as one of the 17 United Nations SDGs, adopted in September 2015 (Griggs et al 2017). Under Goal 7, countries have committed to "Ensure access to affordable, reliable, sustainable and modern energy for all" (Griggs et al 2017). Although not legally binding, under this goal, countries, including Kiribati and Samoa, have committed by 2030 to:

- Ensure universal access to affordable, reliable and modern energy services;
- Substantially increase the share of renewable energy in the global energy mix;
- Double the rate of improvement in energy efficiency;
- Enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology;

Expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all developing countries, in particular, least developed countries, small island developing states, and land-locked developing countries, in accordance with their respective programmes of support (ISCU 2017).

2.4 Centralised and Distributed Energy Systems

Notwithstanding a high level of unanimity about the role of energy and sustainable development, a significant body of research focusses on the benefits and drawbacks of centralisation and decentralisation modes of electricity distribution (Alanne and Saari 2006; Dornan 2014). According to Alanne and Saari (2006: 556), "The ability of distributed systems to rise to the challenge of sustainable development is mainly based on flexibility, locality, and networking." Distributed electricity systems are flexible due to their scalability to utilise various energy conversion technologies and fuels. These systems can also use local resources (solar, wind) and enhance energy security spreading the risk from reliance on one energy system. Finally, Alanne and Saari (2006: 556) argue that "When it comes to local decision making and expertise, the 'educative' effect of distributed energy generation should not be underestimated."

Despite these benefits, it is widely recognised that distributed electricity systems commonly experience difficulties associated with fragmentation and remoteness (Alanne and Saari 2006; Dornan 2014; Green 2004). These problems include, among other things, a lack of clarity regarding responsibility, lack of maintenance of equipment, loss of skills, and the lack of common standards and regulations. At the village level, poor operation and inadequate

maintenance of equipment are among the most cited reasons for the failure of stand-alone energy projects, such as solar PV (Dornan 2014). Drawing from research by Alanne and Saari (2006), Table 1, below, summarises some of the key benefits and drawbacks of centralised and distributed electricity systems..

Table 1: Benefits and Drawbacks of Centralised and Distributed Electricity Systems

Centralised Benefits	Centralised Drawbacks	Distributed Benefits	Distributed Drawbacks
Uniformity	Large units	Scalability	Fragmentation
Responsibility, management and expertise easily placed	Large investments	Increased control at the local level	Responsibility and management complexities
Skills can be integrated	'Eggs in one basket'	Flexibility	Difficulty in retaining skills
	Inflexible	Individuality	Need for on-going training
	Lack of individuality	Spreading risk	Lack of uniformity and consistency
	Distance between production and consumers	Work independently	
		Test new technology	

(Sourced from: Alanne and Saari 2006: 553)

These complexities have led many researchers to advocate the use of hybrid systems that combine the benefits of centralised and decentralised electricity systems. Drawing on research of distributed systems in a number of remote islands including Kiribati, Rodrigues et al (2014) have made a number of recommendations. The first of these is the need to pay close attention to the design, components, and software of these renewable energy projects to ensure that they are appropriate to the needs of local communities. Secondly, it is important to ensure that new infrastructure can be maintained in remote locations. To manage these risks, Rodrigues et al (2014) suggest that technical innovations be introduced one step at a time while, at the same time, making sure that local communities are educated about how the new technology works.

Another recommendation is the monitoring and maintenance of renewable energy equipment to ensure reliability and long life-cycles of components, such as lithium batteries. According to many studies, this requires a process for the retention of skilled personnel and the establishment of programmes to build capacity (see for example, Byrne et al 2005; Filho et al 2013; Rodrigues et al 2014). Finally, Mala et al (2008) and the Asia Research Institute (2016) highlight the importance of effective communications in allowing local communities to ask for assistance when equipment is no longer working well or is failing. Research indicates that in the absence of good communications, local communities are unlikely to get their equipment fixed, and will revert back to the use of traditional unsustainable energy

sources, such as the use of fossil fuels like kerosene (Mala et al 2008).

Notwithstanding the ability to implement distributed systems in remote locations, the Asia Research Institute (2016) makes the point that renewable energy processes are not necessarily fail-safe. For example, reliance on solar power can bring new risks to a community when systems fail due to weather or volcanic eruptions, and reliance on micro-hydro means that drought has consequences not just in relation to local agriculture, but also in relation to local energy supply. These examples raise the point that while renewable distributed energy plays a key role in sustainable development, it is incumbent upon those planning new projects to consider the possibility of new risks being introduced to local communities.

As two SIDs, Kiribati and Samoa have had a long history of dependence on the importation of fossil fuels as part of their energy mix. These fuels typically comprised petroleum products, such as automotive distillate oil, petrol, dual purpose kerosene, liquefied petroleum gas and aviation gasoline. In both countries, their growing transport sectors have been identified as significant end-users of petroleum products, followed by their residential sectors, which typically use a mix of kerosene and LPG and biomass. Another significant user of fossil fuels, in which both countries are determined to see reductions, is the use of diesel to power generators to produce electricity. As of 2017, approximately 48% of electricity in Samoa was generated from renewable energy sources and 52% from diesel, with a commitment by the government to be completely powered by renewable energy mix (a mix of hydro, solar, and wind) by 2025. Unsurprisingly, in the absence of hydro resources, Kiribati continues to be heavily dependent on diesel for electricity generation with over 50% of all imported fossil fuels used to power diesel generators which supply the main electricity grid system on South Tarawa. Despite this challenge, increasing investment in the use of solar PV (led by schools, the main hospital, meeting places [maneaba], and street lighting) is expected to reduce the dependence of Kiribati on fossil fuels for electricity (International Renewable Energy Agency [IRENA] 2017; Ministry of Finance of Samoa 2017). The following sections examine in greater detail the new renewable energy projects currently being implemented in Kiribati and Samoa to achieve their goals of reducing their dependence on imported fossil fuels.

2.5 Renewable Energy in Kiribati

In Kiribati, the move towards the use of renewable energy for electricity has become increasingly visible in Tarawa, and across many of the outer islands. PV systems can now be seen in homes, schools, primary health facilities, and other public utilities. This shift has seen the renewable electricity generation increase from 0.2% in 2013 to 10% in 2016. While this positive development means that more people can have access to more affordable sources of energy, the biggest problem facing Kiribati is that the most vulnerable groups (low-income, unemployed families) are either unable to afford electricity services, or live in informal settings so do not have access to

Table 2: Summary of Possible Renewable Energy Sources

Solar Energy

Apart from sunlight there are two usable forms of solar energy. The first is solar photovoltaic (PV) which converts sunlight directly into electricity using PV cells which are combined in panels. A PV cell is a specialised semiconductor diode that converts visible light into direct current that can be stored in batteries or chemical processes. The second form is solar thermal energy which converts sunlight into thermal energy (or heat) (ARENA 2017).

Wind Power

Wind power is the use of air flow through turbine blades connected to generators that convert the wind's energy into electricity. Blade size determines a turbine's maximum power output (EECA 2017).

Hydropower

Hydropower or hydroelectricity refers to the conversion of energy from flowing water into electricity. Hydro plants produce electricity using turbines and generators, where the mechanical energy from moving water spins a turbine which is connected to an electromagnetic generator to produce electricity. (EIA 2017)

Biomass Energy

Biomass is organic material that comes from plants and animals. Biomass contains stored energy as plants absorb the sun's energy through photosynthesis. When biomass is burned, the chemical energy in biomass is released as heat. Biomass can be burned directly or converted to liquid biofuels or biogas that can be burned as fuels. Examples of biomass and their uses for energy:

- Wood and wood processing wastes – burned to heat buildings, to produce process heat in industry and to generate electricity
- Agricultural crops and waste materials, such as palm oil wastes – burned as a fuel or converted to liquid biofuels
- Food, yard, and wood waste in garbage – burned to generate electricity in power plants or converted to biogas in landfills
- Animal manure and human sewage – converted to biogas, which can be burned as a fuel.

Aside from burning, crops such as corn and sugar cane can be fermented to produce fuel ethanol for use in vehicles. Biodiesel, another transportation fuel, can be produced from vegetable oils and animal fats (EIA 2017).

Energy from Coconut Waste

This involves the combustion of all forms of coconut waste, including the husk, shell, bunch, fronds, leaves, and trunk. The Mahachai biomass power plant in Sumut Sakhorn province in Thailand uses a boiler that enables all parts of the coconut plant to be used. With knowledge in corrosive fuel combustion, and the use of modified water-cooled vibrating grate, the combustion of all coconut waste residues occurs (Bioenergy Insight 2016).

OTEC is a process that produces electricity by using the temperature difference between deep cold ocean water and warm tropical surface waters. OTEC plants pump large quantities of deep cold seawater and surface seawater to run a power cycle and produce electricity (Makai Ocean Engineering 2017).

electricity. The proportion of the Kiribati population estimated as not having access to electricity services ranges from 20% to 35% depending on different sources of information. Notwithstanding data shortfalls, information from a variety of sources (Ministry of Foreign Affairs and Trade [MFAT] 2016; World Bank 2016) point to the rise in renewable energy production and consumption in Kiribati, with the increased use of solar PV energy in both the outer islands and in urban Tarawa. As of the end of 2015, renewable energy consumption as a proportion of total final energy consumption was estimated at 4.25%.

Currently only 65% of the total population has access to electricity services (MFAT 2016: 10). According to that report, projects completed or under way since 2013 include:

1. Two projects installing 1,449 kilowatt-peak (kWp) of solar PV on Tarawa;
2. 1,700 leased household solar PV systems in the outer islands;
3. Solar electrification of schools project that is expected to provide solar PV and battery systems to seven outer island schools, up to 78 kW;
4. A small-scale biofuel plant that is being piloted on Abemama;
5. The Kiritimati Island energy sector programme that is expected to provide two new power stations, 200kWp of solar PV generation, and includes the upgrade of the distribution network.

Looking to the future, new projects for investment in Kiribati include: replacing ageing and inefficient electricity generators on South Tarawa, increasing the proportion of solar PV for electricity generation and improving PV storage with the use of the latest battery technology. While the lack of land and the harsh atoll environment is unlikely to be suitable for the introduction of wind energy, new technological solutions, such as ocean thermal energy conversion (OTEC), may become an option in the longer term, dependent on cost and access to donor investment.

While the move towards renewable energy is seen as a positive step for the sustainable development of Kiribati, research by Mala et al (2008) identified both benefits and problems related to the distribution of solar home systems (SHS). Benefits included the ability of children to further their education by studying at night, enhanced security, and the ability of household members to clean their fish at night and run home-run businesses. At the same time, this research raised issues about who benefited from SHS given that the ownership of PV systems were typically owned by the more affluent households (homes of policemen, seamen, and small business owners). Only one private SHS was owned by a villager, whose only source of income was copra and fishing, and who at the time of the study, did not have the funds to fix the system and so resorted back to kerosene lamps for lighting.

According to Mala et al (2008), the difficulties many users experience in paying the up-front costs and the monthly fee confirmed that affordability of these systems was a major concern for poor villagers. This was not necessarily the amount that they had to pay, but more that the sums needed to be paid monthly, while kerosene, diesel and petrol could be purchased in small amounts for a little cash on a daily basis (Mala et al 2008: 3). The absence of banks and money-saving mechanisms on this remote atoll was the key factor affecting the ability of

households to pay the monthly fee. Delving further into the experience of villagers and the use of home solar technology, 54% of participants had recalled experiencing some problems with their systems, including the malfunction of bulb and batteries. Over 60% of respondents could not identify what the problem was. More worryingly, this case study found that in some households, batteries were kept under the bed, near the kitchen fire, and amidst open containers holding kerosene and other combustible materials (Mala et al 2008). Another problem identified in this case study was ready access to technical support. While those systems privately owned were the responsibility of owners, for those households that rented their systems from the Kiribati Solar Energy Company, the technician made rounds only once a month.

While access to technical advice was constrained, the biggest problem was the lack of effective communications to tell the technician that he was needed to fix a problem.

This case study provides some on-the-ground evidence of the type of issues facing villagers regarding the use of SHS. While the research was focussed primarily on Abemama, these problems are likely to also be widespread in Tarawa, where over 54% of the total population live. These findings are also an important reminder that it is often the socio-technical support systems, such as access to technical advice, communications, and education that reduce the effectiveness of these important renewable energy technologies. While the demand for renewable energy sources among Kiribati households is high, it is the whole package that determines its success or demise. The study by Mala et al (2008) also confirms the importance of qualitative research to uncover the 'real' issues facing Kiribati households, including how they feel about these new forms of technology.

Figure 2 Social activities with solar on Tarawa

(Paul Fulton: World Bank Live)

2.6 Renewable Energy in Samoa

In Samoa, the move towards the use of renewable energy has become embedded in the government strategy, known as IMPRESS (Improving the Performance and Reliability of Renewable Energy Power System in Samoa), designed to increase the sustainable and cost-effective use of indigenous renewable energy resources to 100% electricity generation by 2025 (UNDP 2017). The emphasis on renewable energy has seen the renewable generation capacity more than double from 7.5 MW to 15.4 MW between 2013 and 2016 (about 60% of total electricity supply). Renewable electricity projects completed or under construction on the two main islands, Upolu and Savai'i, include:

1. Six PV systems,
2. Two wind turbines (550 kW),
3. Three independent power producer (IPP) PV systems on Upolu (10 MW),
4. One IPP PV system currently in design for Savai'i (2.0 MW) (MFAT 2016).

Proposed projects seeking investment include a mix of initiatives, including:

1. Technical advice and support on policy development, planning, and legislative frameworks;
2. A new wind farm and pump storage hydro system with a capacity of 25 MW to contribute to the network;
3. A third turbine for the Taelefaga hydropower station;
4. A 2 MW hydropower system transmission line to connect to the grid on the southern coastal network;
5. A submarine cable between Upolu and Savai'i to enable the transmission of electricity between the islands;
6. Feasibility study of geothermal energy source in Savai'i;
7. Modelling of the electricity system incorporating renewable energy changes; and
8. Pumping water between Viapu and Afulilo dams to store excess intermittent renewable energy from solar and wind (MFAT 2016).

It is estimated that upon completion of these initiatives, renewable energy will comprise 50% of total electricity generation. While the 2025 target, set by Samoa, could be viewed as being somewhat ambitious, it signals the importance of renewable energy as a tool of sustainable development for the country. While not undermining that resolve, Timilsina and Shah (2016) caution that countries can miss such targets for a variety of reasons. One of these reasons is the need to work through financial issues, including whether there is a need for tax incentives and subsidies for the promotion of renewable energy. A major issue for SIDS, and other developing countries, with limited financial resources, is getting renewable energy off the ground, with risk of crowding out other important areas of expenditure, such as health and education. While this could be managed through

careful planning of the use of external sources of finance, the impact of rapid change needs to be well-thought through. Care needs to be exercised in assessing local impacts of new renewable energy projects, including maximising community buy-in through effective community participatory engagement. According to Timilsina and Shah (2016), it will require governmental administrations to consider new institutional and financial arrangements, including the need for new policies and regulatory systems to enforce standards, and the efficient and affordable delivery of renewable energy service to all.

While the shift from fossil fuels to renewable energy in Kiribati and Samoa is an important endorsement of sustainability, it should also be considered in terms of enhancing the adaptive capacity and resilience of these countries to manage risks and disturbances associated with natural disasters and climate change influences. This has involved a greater focus on the adaptive capacity and resilience of communities that yield higher levels of innovation which can more greatly improve the lives of all people (Callo-Concha 2014; Dornan 2014; Folke et al 2002; Gallopín 2006). To further our understanding of these important concepts, the following section reviews the literature on these issues.

2.7 Resilience

The notion of *resilience* crosses a wide range of disciplines, including engineering, psychology, economic and community development, and disaster-relief planning. An examination of the uses of the term by Folke (2006) and Martin and Sunley (2015) suggest that the concept has been interpreted in three broad analytical approaches. These include: engineering, ecological, and social ecological. In the first of these, the term, which is derived from the Latin 'resilire,' relates to the notion of leaping back to recover form following a disturbance. Here the concept of resilience includes the connotation of elasticity, in terms of a system being able to 'bounce back' to its pre-existing form or path before the disturbance. This association with 'bounce back' relates to the concept of a system once again reaching equilibrium. Under this approach, the focus is more on the speed of a system to recover or return to its pre-disturbance position. This definition, which was termed by Holling (1973) as 'engineering resilience,' emphasises efficiency, constancy, and predictability, all according to Martin and Sunley (2015: 3), "attributes at the core of engineers' desire for a 'fail-safe' design." While the 'engineering' label has continued, Martin and Sunley (2015) note that this interpretation has been used in the study of ecology, relating to the capacity of ecosystems and socio-ecosystems to maintain or regain stability, when subjected to internally and externally-based disturbances. The concept of bounce back can also be viewed as having connections with economic activity, where the assumption is that economies operate at equilibrium, and seek to return to equilibrium after a shock or disturbance. Such disturbances could include economic crises, recession, and depression as a result of one or more event.

A second definition of resilience, found particularly in studies of ecology, is the ability of a system to absorb shocks and disturbance, without changing its structure, identity and function. Holling (1973) defined ecological resilience as "the persistence of systems and of their ability to

absorb change and disturbances and still maintain the same relationships between populations or state variables" (14). Over time, this definition was developed to refer to 'extended ecological resilience,' defined in terms of the capacity of a system to absorb disturbances and reorganise while at the same time undergoing change, so as to retain essentially the same function, structure, identity and feedback loops (Walker et al 2006: 2). While the benefit of this definition is its ability to recognise on-going change, and the ability of a system to change (while still retaining its basic form), the complication with this definition is uncertainty about how much 'change' and 'reorganisation' is permitted for a system to be regarded as still having essentially the same structure, identity and feedbacks (Martin and Sunley 2015). The assumption is that if a disturbance exceeds a system's absorptive resilience, or ability to bounce back, then the system will be pushed to an alternative equilibrium, which could be less favourable than the one that pre-existed. The difficulty is predicting with any degree of certainty the impact of different types and intensity of disturbances and shocks to the emergence of different states of equilibria.

A third interpretation of resilience, widely found in the literature, is that of 'adaptive resilience.' The notion includes connotations of systems adapting in response to shocks and disturbances, having links to ideas of evolutionary resilience and complex adaptive systems. Both of these approaches are concerned with the interplay between continuity and change in self-organising systems, which are subject to disturbances, and the capacity of these systems to absorb and adapt to such pressures. Rather than systems simply returning back to their pre-existing form and function, Martin and Sunley (2015) note that positive responses can emerge, enabling systems to withstand and cope with future disturbances, akin to the idea of 'bounce forward.' In terms of human behaviour, people can prepare for the eventuality of future shocks, thereby increasing the resilience of the system.

Under complex adaptive systems, other concepts are also used in the study of resilience. One of them is the notion of *modularity*, which refers to a system structure in which different component subsystems or elements are only partially or weakly connected, so that if one subsystem or element is affected by a disturbance, the effect remains relatively contained, and its diffusion throughout the systems is minimised. The implication of this is that while one area of a system may lack resilience, the system as a whole may still display robustness in the face of shocks and disturbances. Another way of looking at this is that robustness can also be enhanced if there are multiple means to achieve a specific function, because the failure of one module can be compensated by others.

According to Folke (2006) and Martin and Sunley (2015), this idea encompasses the concept referred to as *redundancy*. This notion generally refers to a situation in which there are identical or similar components or subsystems, which can replace each other when one fails, for example, small-scale systems that can provide back-up to a grid system. While this may be possible, Martin and Sunley (2015) remind us that having multiple identical components as alternatives is rare and that a more common mechanism that provides redundancy is that resulting from diversity of components. This form of diversification can provide components with overlapping, complementary or related functions, whereby a specific system-level

function can be attained by different means available. Drawing from the work of Martin and Sunley (2015) and Folke (2006), the three main approaches to resilience are summarised in Table 3 below.

Table 3: Three Definitions of Resilience

Definition	Interpretation	Main fields of use
Resilience as 'bounce back' from shocks.	System returns, 'rebounds' to pre-shock state or path: emphasises speed and extent of recovery.	Commonly referred to as *engineering resilience*, found in physical sciences, some versions of ecology; akin to self-restoring equilibrium.
Resilience as 'ability to absorb' shocks.	Emphasises stability of system, function and identity in the face of shocks. The size of shock that can be tolerated before a system moves to new state or form.	So-called 'extended ecological resilience,' found in ecology and social ecology; contemplates multiple equilibrium states.
Resilience as 'positive adaptability' in anticipation of, or in response to shocks.	Capacity of a system to maintain core performances despite shocks by adapting its structure, functions and organisation. Idea of 'bounce forward.' This can include transformability, reorganisation, new ideas and innovation.	Found in psychological sciences and organisational theory, akin to 'robustness' in complex adaptive systems theory.

(Source: Martin and Sunley 2015)

2.8 Adaptive Capacity

The review of the literature revealed a number of commonly recurring factors as influencing the ability of systems to achieve positive adaptability, in anticipation or in response to shocks and disturbances. These include, among other things, governance, institutional capacity, socio-economic and community resources, and physical resources. This section discusses some of the key issues falling under these broad themes.

2.8.1 Governance

In their study of governance as resilience, Booher and Innes (2010) contend that 'interactions' and 'relationships' underpin governance, as a source of adaptive capacity, which can be an emergent property of the system. While the assumption that governance plays a key role in resilience would be easily accepted, the argument put forward by Booher and Innes (2010), is that it is not governance per se that matters, but rather the connections made, maintained, and retained that are vital for resilience. Booher and Innes (2010) argue for these connections to be effective, the agents of government need to build collaborative relationships based on authentic dialogue, with key stakeholders, preferably face to face to enable the exploration of ideas and for ideas to flow between government and those at the local level. The argument is that the effects of quality connections propagate through the system, enabling knowledge to be built up in a manner that is distributed

throughout the system. In addition, given that interactions are non-linear, but rather iterative, recursive and self-referential, there are many direct and indirect loops (Booher and Innes 2010). The contention is that for effective relationships to emerge, the behaviour of the system needs to be open and the focus to remain on the 'whole,' rather than simply its component parts. Not only is this likely to encourage coherent and novel patterns of order to develop, but it is expected to assist systems to create learning and innovation from changes, such as those emanating from shocks and disturbances.

In addition to collaborative connections, effective governance needs to have built-in flexibility so the functions of government and decision making can continue at a time of major stress and disturbance. According to Folke (2006), rather than policies seeking to control change, the resilience perspective is about managing the capacity of systems to cope with, adapt to, and shape change. The key argument is that managing for resilience "enhances the likelihood of sustaining desirable pathways for development in changing environments where the future is unpredictable and surprise is likely" (Folke 2006: 253). Aside from built-in flexibility within governmental structures, a commonly held view within resilience literature is that dispersed and locally based processes assure continual adaptation (Folke 2006; Gupta et al 2010). Referred to as *complex adaptive systems*, these systems are non-linear, diverse, dispersed, enabling governmental and local connections to connect in a way that encourages local solutions.

Despite the complexity of the topic, the widely held view among researchers on resilience is that governance structures need to connect with society in a manner that includes diverse participation, open communication, and deliberations based on trust (Harrison 2003; Lebel et al 2006). The contention is that:

> *"...the flexibility provided by polycentric and multi-layered systems of governance can create opportunities for learning and decision making in places and scales that match social and ecological contexts much more closely than is possible in monolithic arrangements. Accountable authorities who also pursue social justice by helping to secure the livelihoods of the most vulnerable groups enhance the capacity of society to manage resilience.* (Lebel et al 2006)

While 'flexibility' emerges as a strong notion within resilience studies, it would be remiss not to acknowledge the importance of governance systems providing stability, if these systems are to retain their ability to regulate behaviour and to provide a place for interaction between actors (Duit et al 2010: 367). The importance of flexibility and stability means that governance structures will need to consider new ways of engaging with stakeholders from the beginning to maximise opportunities for innovation and to reduce levels of conflict about how to manage change. To this end, stable governance is not intended to infer the return to equilibrium, but rather it is a context for managing change, while still enabling administrations to govern in a stable manner.

2.8.2 Institutional Capacity

Institutions, both formal and informal, are recognised as playing a crucial role in the adaptive capacity of systems. Examining the resilience of organisations themselves, Harrison (2003) argues that there are four

critical elements of institutional resilience. The first is the self-organising nature of informal institutions. This refers to a system's ability to change the behaviour of its component parts in response to external stress and continue to remain of benefit to its constituent agents. Drawing on ecological examples, Harrison (2003) notes that:

> *"...self-organizing systems are expected to optimize system adaptive capacity principally through informal institutions in which the participants collectively agree on rules that they enforce among themselves without the intrusion of authoritative governance structures. But most societies now have to contend with increasing authority and the expanded role of formal institutions."* (Harrison 2003: 13)

According to Harrison (2003), a second element of institutional resilience is to increase the adaptive contribution of formal institutions (Harrison 2003. The hypothesis is that formal institutions that are more flexible allow for more innovative solutions to emerge. Harrison (2003) argues that one way that institutions can adapt is through openness to the population, customers or key stakeholders. As noted previously, collaborative processes and openness have the effect of increasing inter-agency cooperation and learning. The argument is that formal institutions that are permissive allow for greater contact between agents, promoting the fostering of ideas. In short, the argument is that organisations that are open to their environment are more adaptive, compared to those institutions that are closed and uncooperative. Consistent with this line of thinking, the third element, proposed by Harrison (2003: 14) is openness, "a criterion of complex systems." The argument here is that "the social system must be fully open to the ecological system" (14). In other words, it is important that social systems do not become disconnected from the source of their sustenance. According to Harrison (2003), this will require the collation and exchange of information from a range of key stakeholders about ecological changes that may be occurring, and how such ecosystems can meet the needs and demands of society.

The final element of resilient institutions is referred to as *subsidiarity*, a term used to describe the principle that all decisions should be made at the smallest practical scale of governance. This is an interesting principle in that it assumes there are significant benefits from enabling decision making to occur at the community level, rather than have it remain at the central authority level. This is not intended to mean that all decision making must occur at the local level, but that systems can benefit from the coordination of local activities through formal institutions. The argument is that if *"rules, regulations, organizational structures, and activities are designed with subsidiary in mind they are more likely to respond to ecological problems at the scale at which they are likely to be most effective"* (Harrison 2003: 15). In terms of risks and disturbances the argument is that subsidiarity provides for smaller scale and quicker moving systems that are able to respond to events such as natural disasters. This thinking is reflected in the theory of panarchy, commonly referred to in the literature, which contends that larger, slower moving systems constrain the smaller scale and quicker moving systems from which the larger systems emerge and upon which they depend (Callo-Concha 2014; Gotts 2007; Gunderson and Holling 2002; Harrison 2003).

2.8.3 Economic Factors

Finally, economic factors also comprise an important feature of the adaptive capacity of communities and social resilience. From a resilience perspective, it is generally accepted that economies reliant on a small number of economic activities for their wealth (as in the case of Kiribati and Samoa), are less likely to manage shocks and disturbances than those economies that are more diverse. Analysing the effects of natural disasters in Florida, whose economy is heavily-dominated by tourism, Tobin (1999) noted the impact of multiplier effects of disturbances such as the temporary and permanent loss of small businesses arising from detrimental impacts on the tourism sector. Tobin (1999) also acknowledges the positive impacts of these effects such as the expansion of new employment opportunities in the construction sector during the recovery period of a natural disaster. Martin and Sunley (2015) argue that "shocks are moments of opportunity as well as times of threat" (37). They go on to suggest that shocks can change expectations and confidence that can lead to changes in local business strategies and commitments. To highlight these opportunities, Martin and Sunley (2015) note that:

> *Major shocks and disruptions can serve as mechanisms of "creative destruction" that can clear a path for new arrangements and priorities – in economic structures, institutions, infrastructures and regulatory architectures....Or put another way, resilience is part of the process of geographically uneven economic evolution and development, and should be theorized as such.* (Martin and Sunley 2015: 37)

2.8.4 Social Resources

Despite the difficulty in applying ecological methods to the study of people (Adger 2000), there is widespread agreement among researchers that there is an intricate relationship between humans and the natural environment (Folke 2006; Gunderson and Holling 2002; Holling 1973). While they could be considered as two separate systems, with conflicting objectives and trajectories, it is widely accepted that elaborate feedback loops between people and their environment mean that this is not be the case. From ancient times, people have managed their relationship with their environmental regarding the management of scarce resources. Nowadays these relationships are either managed at the local village level, in remote localities, or through resource management instruments set by central and local government structures to manage the relationship between humans and the environment.

The review of the literature points to a number of factors that are likely to influence the resilience of people, and their local communities, to manage change. Two of these factors include population growth and spatial patterns and their impact on key infrastructure and resources needed for their day-to-day well-being. For example, the internal movement of people from the outer islands to Tarawa has resulted in significant pressure on key infrastructure (particularly in relation to electricity, fresh drinking water, and waste management systems). These pressures mean that key structures, needed to operate efficiently and to build the resilience of human systems to manage climate change impacts, may not be sufficiently robust, reducing the ability of

people to adapt to change. Other impacts arising from more of the Kiribati population living in urban centres, is the potential for the loss of 'memories,' or knowledge, regarding the management of scarce resources. On the other hand, those left behind in the outer islands may not have the range of resources and technologies to assist them to adapt to change.

Other factors determining the ability of people to manage disturbances include age, household structure, and gender of those living in areas prone to shocks and disturbances. Using the analogy of the outward migration of people from the outer islands to Tarawa, those left behind in the islands are more likely to be the elderly and the very young, with limited resources to manage and maintain new technologies in areas such as renewable energy sources like solar PV. In the case of Tarawa, the dilution of village identities has also resulted in the emergence of new forms of governance structures, including central and local government regulatory functions of the use of land and natural resources. While it is the responsibility of these governance structures to understand the ability of society to manage change, Tobin (1999) reminds us that the social impacts of shocks and disturbances are not gender neutral. The important point here is that as caregivers of children and the elderly, women are likely to be more vulnerable during certain events. Given this, Tobin (1999) warns that women can be expected to absorb the social costs of being excluded from disaster planning, and response and recovery efforts.

In addition to gender issues, any efforts to strengthen resilience need to also take a number of other factors into account, including age, household structures, and other demographic data. Planning needs to consider, among other things, the demographic profile of communities related to planning how to manage risks such as natural disasters and climate change impacts. For example, it would be remiss to consider the communities in Tarawa and the outer islands to be homogeneous, and that similar planning will necessarily strengthen the reliance of these different communities. These differences are not intended to convey that communities in Tarawa have a greater ability to adapt to change compared to those living in the outer islands, but rather that demographic profiles and household structures can have an important bearing on how communities respond to events such as climate change.

It might be assumed that the younger age profile of those living in Tarawa is associated with a greater ability to adapt to climate change, compared to those living in the outer islands. However, Kuruppu and Liverman (2010) found, to the contrary, the attitudes of those living in the outer islands pointed to a greater sense of hope in their ability to manage the challenges arising from climate change. Even if the responses could be viewed as being overly upbeat and lacking realism about the future impacts of climate change, the deep sense of determination conveyed by respondents pointed to their strong resolve not to give up and to do whatever it takes to ensure their survival in their distinct atoll environment. At the same time, while it is assumed that communications would be more efficient in Tarawa, with greater access to electronic media, those living in Tarawa are significantly more likely to rely on government resources to manage risks, compared to those living in the outer islands. At the same time, while communities in the outer islands might find it easier to pull together in times of stress and change, the

absence of young men means that any interventions need to take into account the demographic profile of these communities.

Another key resource identified as influencing the adaptive capacity of people and communities is the breadth and depth of social networks (Newman and Dale 2005). The first of these social networks is characterised by those connections, described by Granovetter (1973) as 'strong ties,' comprising family, kin, friends, and community members that can be readily called upon in times of need. The second type of social networks refers to those connections that are more diverse, or 'weaker ties' (Granovetter 1983) that include social links that go beyond the confines of a community. Although both of these types of social networks are accepted as being vital for the resilience of communities, Newman and Dale (2005) contend that networks comprised of 'bridging' links to a diverse range of resources, strengthen a community's ability to change, whereas those networks composed of only 'bonding' links that impose constraining social norms can have the opposite effect, of reducing resilience.

Indeed, it is commonly accepted that diverse social connections are critical to a community's ability to move beyond adaptive management to proactively maintain and enhance resilience. Newman and Dale (2005) argue that by maintaining a dynamic interplay of bonding and bridging links, communities are able to take a proactive approach to resilience by utilising a range of social ties, many of which are outside of any one community. As with Granovetter (1973, 1983), Newman and Dale (2005) go on to argue that diversity can also expand the scope of vision necessary to make collective decisions that optimise future choices. The pertinent point underpinning this reasoning is that, although social networks are important, diversity of social connections matters more than simply those based on 'strong ties.' The inference here is that social capital, by itself, is unlikely to a be a good indicator of how well a community will be able to manage problems, and that the balance of 'bonding' and 'bridging' social capital will determine whether a community is just 'getting by' or 'getting ahead.'

Education and knowledge are also recognised as key features of the adaptive capacity of communities to mitigate and manage complex issues related to socio-environmental disturbances. The key issue is that the retention of 'memories' is vital if people are to learn from past disturbances, such as how communities coped with rapid-on-set events like natural disasters. While these memories may not extend to climate change, the argument is that education is a key conduit in encouraging more people to engage in key issues like how to preserve the ecology of freshwater systems, and what forms of energy services can best support sustainable development. An example of how education has enabled people to understand the relationship between natural resource and humans, and mitigation of climate change risks, can be seen in relation to mangroves. In Kiribati, public education on the importance of mangroves in defending coastal systems from erosion has played a key role in the efforts undertaken to replant mangroves in exposed coastal regions in Tarawa (World Bank 2006). Through these efforts, the public have obtained a clearer picture of the vital role of mangroves, and the need for this resource not to be exploited for firewood. Adding to this aspect of resilience, the exploration of

alternative forms of energy services need to be considered, where mangroves are retained and new affordable and efficient sources of energy encouraged.

Figure 3 Planting mangroves in Kiribati

(Republic of Kiribati)

2.8.5 Community Resources

Consistent with this, a large body of research on the topic of resilience is focussed on the capacity of communities to adapt to change. While it is widely accepted that central government has a key role in managing major and complex disturbances, local communities also have an important function in the development of mitigation strategies, and managing change. This has led researchers to focus on the key factors that enable communities to adapt (Janssen et al 2006; Magis 2010). According to Janssen et al (2006), a range of factors determines the ability of both rural and urban communities to withstand and manage change. These include: the level of connectivity (or density of links within networks), the level of reachability (or the extent to which all players in the community are accessible to each other), and the ability of communities to accumulate knowledge (social learning). Other factors include: the ability of communities to integrate knowledge in the management of change (Hess et al 2012); the nature of a community's economic resources, and their diversity; and the type of vulnerabilities to stress and disturbance (Norris et al 2008). Norris et al (2008) argue that those communities with limited resources are more likely to struggle in managing change, compared to those communities with a diverse range of resources. While the level of resources may be an indicator of resilience, the Asia Research Institute (2016:9) places a greater weight on the quality of infrastructure servicing communities, warning that: "infrastructure needs to be maintained, not just constructed".

Given that in most SIDS, communities are unlikely to be able to manage large shocks and disturbances (such as the intensity of tropical cyclones and tsunamis, or complex climate change impacts) on their own, drawing on experiences in Australia, Maguire and Cartwright (2008) assert that decision makers need to engage with communities at the local level as part of the planning phase. This view, which is shared by many working in the field of resilience, asserts that social systems have a greater ability to manage disturbances, if decision makers engage with communities when developing mitigation strategies, and planning ways to manage change (Djalante 2012; Olsson et al 2014). The rationale for decision makers to engage with communities is that:

> *Expertise does not lie solely within a central figure (e.g., the government or scientists) – instead it resides in different groups with different related interests. Different stakeholder groups can offer important insights, and their involvement is essential in each phase (planning, implementation and evaluation).* (Maguire and Cartwright 2008: 16)

Despite the high level of unanimity among researchers that decision makers should engage communities on issues of resilience, Cannon (2008) warns about 'idealising' these social groups. Cannon (2008) reminds us that communities are comprised of complex sets of relationships that are not necessarily cohesive or free from inequality, exploitation, or oppression. While communities may be able to stick together and enable collaboration for some purposes, this might not be possible for others. The argument is that decision makers need to be realistic, or disaster preparedness may not work. Based on these cautions, Cannon (2008) further reminds us that it would be remiss to believe that communities are necessarily democratic entities, when much of the decision making is exercised by powers vested through kin relationships, or that the decision to accept or refuse to work with central government is a reflection of the majority within the community. Although communities may involve areas of common interest in some activities, in actuality:

> *The community is also the basis for competition, not collaboration. Disaster preparedness has to recognise that communities do not necessarily allow for the best conditions for reducing vulnerability.* (Cannon 2008: 14)

The contention is that through the process of engagement, decision makers have the opportunity to understand the part that communities can play in managing disturbances, and how their efforts can be supported by central government. There is a need to be realistic, rather than over-idealistic, about what communities can achieve in isolation from outside support. Describing such engagement as *adaptive governance*, Djalante (2012) notes the importance of central government incorporating 'social platforms,' which include local communities. Consistent with this line of thinking, Maguire and Cartwright (2008: 23) argue that:

> A resilient response to change is enhanced when those enacting a change are able to work together with a community to utilise and develop existing resources and adaptive capacities, in the process of navigating change...Rather than attempting to control change, the resilience perspective accepts that change and uncertainty are inevitable. It provides a way of assessing the capacity of a community in the context of change, rather than just its vulnerabilities. In this way, it identifies a core set of capabilities upon which to build strategies.

While communities are recognised as having strengths and weaknesses in their adaptive capacity to respond to disturbances, government and NGOs have the ability to assist communities to develop their capacities. This includes enhancing skills, providing alternative forms of key infrastructure (such as capacity solutions), and developing indigenous mechanisms to assist communities to become more resilient. This collaborative approach also works for managing the complex impacts of slow-onset climate change influences. The difficulty with climate change is that it is not about returning back to an historical status quo, but equipping society and communities to cope with on-going change.

This section underscores the need for collaborative approaches between central government and communities to deal with the vagaries of fast-paced events and slow-onset impacts, such as climate change. In Kiribati and Samoa two different approaches

have emerged with regard to local government. In the case of Kiribati, local government has emerged as the favoured approach to managing resources in urban Tarawa and Kirimati (Christmas Island). An underlying basis for this governance model is the ability of local government to be an important conduit in ensuring that the local needs of their communities are met. In South Tarawa (home to approximately 54% of the total population of Kiribati), two urban local government councils have been established: Betio Town Council (representing Betio), and Teinainano Urban Council (representing South Tarawa). As with the responsibility of local government councils in New Zealand, these urban councils are responsible for a wide range of services, including inter alia: town planning, transport and local infrastructure, environmental and public sanitation, water supply and economic regulation. Unlike the New Zealand model, these councils are also responsible for early years schooling, social welfare services, primary healthcare and health protection. Along with central government, these urban councils are expected to play a significant role in the formation of mitigation strategies and for the implementation of initiatives to manage climate change impacts and other risks.

In contrast to Kiribati, local government in Samoa is based on the traditional village structure. The role of villages is to provide leadership, enforce local laws and influence central government on issues. The distinct path of evolution between central government and traditional village functions in Samoa means that there is a significant level of separation between central government and local village representation, which requires significant engagement resources. While there is no right or wrong form of local representation, both the Kiribati and Samoa models raise issues in respect of building resilience. In the case of Kiribati, the two urban councils represent over 56,000 people, who face major complexities related to urbanisation and a poor physical environment. With only five out of 43 Members of Parliament representing this large urban population, this region has to compete for resources with the outer islands. While not diluting the difficult issues facing the outer islands, the central and local government models of representation of South Tarawa mean that the complex issues related to urbanisation may not be effectively represented.

At the same time, the local form of representation in Samoa at the village level has a number of advantages and difficulties. One of the most significant advantages of this model is the ability of traditional cultural values to be retained, not only within local decision making, but in engagement with central government. Conversely, the significant difficulty of this model is the complex process involved in central government having to engage with 286 rural villages and 56 non-traditional entities. While this model allows for villages to raise issues with central government, the separate and independent nature of villages means that meaningful engagement is intricate and arduous. Despite the establishment of the Planning and Urban Management Agency in 2002, which has assisted central government to engage with key stakeholders regarding land issues, it is still unclear whether this is enough for developing resilience (Jones and Lea 2007).

2.8.6 Natural Resources

Natural resources also play a crucial role in the ability of systems to adapt to change and

to support human life. These include vital support systems such as clean air, clean water, and food that determine the health status and life expectancies of populations. The quality and resilience of these natural systems are critical for ensuring the resilience systems to manage change. An example of the importance of natural resources is the situation in Kiribati. While much of the attention in the media has to date been focussed on Kiribati 'sinking' due to increased sea levels, the reality is that it will be degradation of vital natural resource systems that will render parts of Kiribati inhabitable. Already, the contamination of freshwater supplies by the intrusion of sea water in the outer islands and detrimental impacts of people's activities over parts of the freshwater lens at Bonriki, mean that the loss of drinking water will undermine any efforts to build resilience that do not take into account ways of enhancing the preservation of freshwater supplies.

Drawing on research in the Caribbean, Tompkins and Adger (2004) suggest the management of natural resources is the use of 'adaptive co-management' systems that focus on the nature of relationships between resource users at the community level. The development of these networks means that users of the resource play an important part in ensuring the resilience of vital natural resources. Tompkins and Adger (2004) conclude that processes needed to adapt to significant system changes would involve major restructuring of the economy and society. With regard to climate change, they conclude that:

> *Adaptation to both gradual and signify-cant changes should involve encouraging the evolution of new institutions that are sensitive to the resilience of the ecosystems they are managing and knowledgeable about the specific nature of the risks of climate change.*
> (Tompkins and Adger 2004: 10)

2.9 Summary

The burgeoning literature on resilience and adaptive capacity reflects concerns across a wide spectrum of disciplines about the ability of human and natural systems to manage major shocks and disturbances. While humankind have been coping with change since time immemorial, the increasing number of major climatic events (cyclones and hurricanes), natural disasters (earthquakes and tsunamis), and climate change, have raised questions about the ability of human and natural systems to effectively manage change. This has led to a significant body of literature on the subject of resilience and the adaptive capacity of systems to mitigate and manage disturbances. The complexities associated with systems thinking is akin to the analytical capacity required to assess sustainable development. To understand resilience and sustainable development is to understand systems, and the range of influences within and between systems, including direct, indirect, downstream, and cumulative effects. Resilience requires effective feedback loops that can work to restore a system even after a large shock or disturbance (Meadows 2008: 76)

Influencing these feedback loops are resources that can be used to assist human and natural systems to adapt to disturbances. We are rightly reminded that things change, and to ignore or resist this change we

increase our vulnerability and forego emerging opportunities (Walker and Salt 2006: 10). This is one of important issues to emerge from this literature review, that is, that change offers the prospect to improve the well-being of humankind, and that while sharp shocks are best avoided if possible, it is through destruction that new opportunities surface. For this to occur it requires human systems to understand the state of its adaptive capacity and maximise relationships to improve what people can do together, rather than expect central government to do everything. At the same time, we are reminded not to over-idealise what communities can do, for they are a reflection of wider society, both the good and the bad. Despite this caution, communities hold indigenous cultural values and practices, and an attitude of fortitude to never give up on living in the land of their forbearers (Kuruppu and Liverman 2010). Even if this may be overly aspirational in the case of climate change and for those living on atolls, it provides opportunities for decision makers (with outside assistance) to consider new possibilities. One of these possibilities is the need to improve the life outcomes of communities in Kiribati and Samoa.

By using the adaptive capacities of these countries, and by maximising the quality of relationships between central government and local communities, socio-economic and environmental attributes can be improved for the well-being of these populations. The literature review reminds us that shocks and disturbances do not occur in isolation from people, including where and how they live. It would be remiss to think that we can consider risks such as climate change in isolation from the anthropogenic issues facing Kiribati and Samoa. Indeed, by improving the well-being of these populations, whether by improving access to electrical services, or improving key infrastructure, including access to freshwater, there is the prospect of improving the sustainable development of these countries. In turn, by doing this, these nations will be better equipped to develop and employ mitigation strategies that are focussed on the medium to longer term so that people and the natural systems they coexist with can manage change. While this may appear to be overwhelming in the case of Kiribati, the resilience of people serves as an important reminder that the focus should be on preserving and improving outcomes of human and environmental systems for future generations.

While renewable energy is a small component of adaptive capacity, it plays an important role across socio-economic and environmental dimensions. Not only does it provide households with affordable clean energy, it enables children to study, people to work at home, and schools and hospitals to secure electrical services. It also provides opportunities to ensure that communities can respond more rapidly in the event of a shock. With the rapid escalation in the take-up of new renewable projects in Kiribati and Samoa, the question is where and what type of renewable project would further the adaptive capacity and resilience of these countries? This can only be answered through a process of engagement with key stakeholders in Kiribati and Samoa, set out in the next chapter.

3. Study Method

3.1 Introduction

This chapter discusses the use of qualitative methodology to gather and analyse data on opportunities for new renewable energy initiatives to strengthen the resilience of Kiribati and Samoa. The chapter is broken down into three main sections. The first section sets out the research question and sub-questions addressed in this research.

The second section describes the key stakeholders in Kiribati and Samoa who were interviewed for this project. The following section describes the thematic content method utilised to analyse the data, including the deduction of generalisations emerging from the data.

3.2 Research Questions

The aim of this project was to further our understanding of opportunities for renewable energy to strengthen the adaptive capacity and resilience of Samoa and Kiribati in order to manage natural disasters and climate change impacts. The following research question was developed for this research project:

> How can investment in renewable energy in Kiribati and Samoa strengthen the adaptive capacity and resilience of Kiribati and Samoa to manage the effects of natural disasters and climate change?

This research question was supported by four sub-questions designed to ensure the sustainability of renewable energy investments over the longer term:

1. What has recent research found regarding the use of renewable energy and adaptive capacity and resilience of local communities at risk of natural disasters and climate change effects?

2. What future investments should be considered in renewable energy solutions in Kiribati and Samoa that will strengthen the resilience of local communities?

3. What skills and training and regulatory frameworks are needed and how could they be best provided to enable the effective operation of renewable energy equipment now and into the future?

4. What knowledge and skills are transferrable from Kiribati and Samoa to other Pacific countries?

These questions were designed to explore opportunities for new renewable energy projects that could enhance the resilience of Kiribati and Samoa to manage disturbances while, at the same time, seeking to understand some of the main factors that influence the sustainability of new renewable energy investments, with a focus on the generation of electricity services. The questions recognise the need for us to understand the specific issues that can lead to the failure of renewable energy initiatives,

so that these findings are included in any new renewable energy proposal. The questions serve as an important reminder that the long-term success of new renewable energy developments is reliant on the performance of many aspects of a system. As noted previously, the failure of one part of such a system, such as the lack of investment in skills and communication, can result in the demise of otherwise well-intentioned projects.

3.3 Method Approach

All of the interviews were conducted face to face in Kiribati and Samoa by Dr Mary Anne Teariki and Dr Ramona Tiatia respectively. While not I-Kiribati, Dr Teariki has a deep connection with I-Kiribati in New Zealand and Kiribati. Having lived in Kiribati and being married to an I-Kiribati for over 30 years she has a good understanding of Kiribati social and cultural norms, including understanding some of the language. To assist her with any language issues, she was accompanied by an I-Kiribati friend who has lived in New Zealand, but now resides in Kiribati. In the case of Samoa, Dr Tiatia, who is Samoan, conducted her interviews on her own. The rich data collected in both Kiribati and Samoa indicated that both interviewers were effective in probing and investigating the views expressed by stakeholders on resilience, sustainability, and renewable energy.

3.4 Key Stakeholders in Kiribati and Samoa

We interviewed a number of stakeholders, who represented a wide range of organisations in Kiribati and Samoa, for this research (see Table 4). We took into account a number of considerations when selecting the stakeholder group: representation from central and local government, those in charge of developing and maintain infrastructure, and from civil society. An important objective was to include representatives who could provide a range of insights into the role of renewable energy and resilience at a strategic and local level, together with knowledge about what is needed to ensure the long-term success of new renewable energy initiatives. As noted below, many stakeholders were consulted in Samoa, and we did not consider it necessary to include church representatives. This is in contrast to Kiribati where the list of stakeholders was somewhat more constrained given the smaller number of renewable energy facilities compared to Samoa. We are confident that all key issues were captured in both countries.

3.5 Interview Process

With regard to the interviews, most were conducted in individual settings, with only in a few cases in group situations, where more than one member of an organisation participated in the interview. Prior to leaving New Zealand, the Te Ang Maitoro Team discussed how the interview process would be undertaken and developed an outline of issues to be discussed with participants. These issues related to the key issues facing people in their daily lives, their personal strength in dealing with risks and

Table 4: Stakeholder Groups

Kiribati	Samoa
• Ministers of Environment, Health, and Infrastructure • Chief Executive of the Betio Town Council • Director Strategy, Head of solar systems management and solar maintenance (PUB) • Chief Executive, Kiribati Solar Energy Company Ltd • Director Kiribati Climate Change Network (CCN) • Director Catholic Diocese of Kiribati • Kiribati Uniting Church • Director of Kiribati Association of Non-Government Organisation (KANGO) • Moderator, Kiribati Protestant Church • Private business entrepreneur	• Deputy Chief Executive of Renewable Energy (Ministry of Natural Resources and Environment) • Aid and Project Division (Ministry of Finance and National Planning) • Assistant Chief Executive of Fisheries Division (Ministry of Agriculture and Fisheries) • Samoa Trust Estates Corporation • Office of the Minister of Health • Chief Engineer Electric Power Corporation • Scientific Research Organisation Samoa • Savai'i Farmers Association • Samoa Chamber of Commerce • Businesses of Salafai Association (Savai'i) • Private sector beach resort/hotel owners (Upolu and Savai'i) • Private sector shop and retail business owners (Upolu and Savai'i) • Private sector civil engineering/building specialists • Tertiary science educators

disturbances, and the role of renewable energy in providing electricity in homes, businesses, and public utilities. It was agreed by the team that such a process would allow participants to raise issues as they saw fit, enabling a wider perspective of resilience, sustainable development, and renewable energy matters to emerge. As the focus was on the views of organisations, demographic data of participants was not considered necessary. Upon completion of the interviews it was noted that there was a good balance between men and women, albeit more men were represented working in the operational areas of electricity and renewable energy generation than women. Women were more represented by churches and NGOs. Ethical approval was sought and granted by the University of Otago Ethics Board.

3.6 Qualitative Methodology

From the various qualitative methodological approaches used to shape qualitative research, we considered thematic content analysis the most appropriate method for analysing data collected from stakeholders. Consistent with other qualitative approaches (including grounded theory, ethnography, and phenomenology), the interviews were transcribed and the text examined in detail, by at least two of the research team, to reveal

key themes (Charmez 2014; Liamputtong and Ezzy 2005). This was achieved by grouping similar statements together under a common code, using words from the text, resulting in the emergence of categories and sub-categories, which were discussed by the research team. This process enabled us to identify the key themes put forward by the stakeholders and to examine linkages between topics and analyse areas of commonalities and differences. As an iterative and comparative method of inquiry, this approach enabled us to go back and forth between the data, including going back to stakeholders to clarify points of view and to elicit a greater understanding of the meaning of texts.

4. Results

4.1 Introduction

Using grounded theory, this chapter discusses the results of the initial coding of the data collected in Kiribati and Samoa (Charmez 2014; Glaser and Strauss 1967). By interrogating the data, categories and sub-categories emerged to explain the sustainable development challenges facing Kiribati and Samoa, and how new renewable energy projects can build the resilience of these countries to better manage disturbances such as climate change and natural disasters. To give voice to those interviewed in Kiribati and Samoa, this chapter makes use of direct quotes to illustrate the views of key stakeholders in both countries. The chapter is structured into two main parts. The first part sets the key findings from our field research in Kiribati. This is followed by the second section, which discusses the key findings from data collected from stakeholders in Samoa.

4.2 Research Findings: Kiribati

4.2.1 The Strength of People

To understand how personal attributes influence resilience, stakeholders in Kiribati and Samoa were questioned about the strength of their people. In the case of Kiribati, the common view of stakeholders was that the strength of I-Kiribati was influenced by a mix of factors, in particular the environment, the ability of people to adapt, and the Kiribati culture. On the first of these, there was broad agreement among stakeholders that the strength of I-Kiribati was embodied in their fight to survive the harsh atoll environment, surrounded by vast ocean, where the land sustained few resources. Traditionally, this necessitated all family members (young and old) going out in search of food and firewood, collecting toddy, gathering coconuts, tending to babai (taro) pits, and fishing.

> *I think...it is difficult to live...in a small land surrounded by vast ocean. I think that's what makes them very strong. You survive how to find food in the ocean...make what you can with small land. The agriculture in the islands has very bad soil and that's why I think it makes them strong because they can manage to live with those limited resources, few trees, and little fruit.* (Minister of Health)

> *You have to go out looking for your food...otherwise they don't have anything to eat.* (Director, Catholic Church)

While most stakeholders accepted that this traditional lifestyle no longer typified the way of life for the majority of those living on Tarawa, it was also noted that many families had few options but to continue to undertake activities such as fishing, to sustain their families. In the past when inshore fisheries resources were plentiful, men could go out in their canoes to go fishing. Now men need to go further afield into open waters to gather resources, which mean that

the traditional strength of all I-Kiribati men able to go fishing has become limited to a smaller number of men, characteristically those with boats with outboard motors. It was these and other types of environmental changes, associated with increasing levels of urbanisation, that divided the stakeholder group as to whether those living in Tarawa nowadays had the strength and resilience of I-Kiribati in the past.

The vast majority of stakeholders indicated their concern that the urban environment was having a negative impact on the resourcefulness and resilience of those living on Tarawa. Much of the blame for this 'weakening' of the traditional strength of I-Kiribati in Tarawa was associated with the westernisation of attitudes, preferences and behaviour of the young; reliance on the cash economy for day-to-day activities; and increasing dependency on imported foodstuffs.

Interestingly, these prevalent concerns (raised by nine of 13 stakeholders) pointed to a significant idealisation of the traditional way of life based on subsistence living and rejection of urban-style living, despite the fact that all of the stakeholders resided in Tarawa. Another indication of this nostalgia was the finding that the nine stakeholders did not make any association between strength and the development of linkages with the outside world through the use of new technology. Indeed, some stakeholders argued that young people's access to smart phones and use of media applications, such as Facebook, were weakening the ability of citizens to manage new risks and disturbances such as climate change.

Notwithstanding these negative views about the urban preferences of young people, most stakeholders noted that another factor influencing the strength of I-Kiribati was their ability to adapt to significant environmental changes. This included the ability of people to adjust to the negative environmental effects from climate change and other climatic events ranging from prolonged periods of drought to severe storms and powerful sea surges. Many stakeholders expounded the strength of I-Kiribati for their abilities to live through difficulties and hardships: the decline of fresh water supplies, loss of crops, the erosion of land, and the contamination of bore wells from the overtopping of powerful sea surges. A few stakeholders told of the reputation of those living in the southern Gilbert Islands, such as Onotoa, for preserving and storing food like breadfruit and pandanus to help them get through periods of adversity. Other examples of resilience included the determination of people to manage the increasingly higher tides and powerful sea surges by building sea walls to protect their homes and land. While these examples indicated the resilience and adaptability of I-Kiribati to manage environmental changes, two stakeholders lamented the loss of these traditional practices, with more families moving away from the preservation and storage of food in preference for imported foodstuffs. Unsurprisingly, these stakeholders blamed this shift on the increasing westernisation of lifestyles in Kiribati, including the outer islands which were typically known in the past for practising a more traditional way of life.

Despite these concerns, most stakeholders were of the view that I-Kiribati had the strength to get through difficult times. Some stakeholders spoke of stories handed down over the generations regarding the courage and strength of I-Kiribati in getting through

difficult times, noting the mental and physical fortitude of people to survive. It was against this context that all but one stakeholder thought that I-Kiribati had the ability to adapt to complex environmental changes associated with climate change. This may account for the muted response of most stakeholders regarding the detrimental impact of climate change.

Two stakeholders, representing church organisations, went further to question whether climate change was real, given that some of the issues facing Kiribati had been experienced in the past. While the resilience of I-Kiribati may account for this muted response, a more likely explanation, which became evident when discussing the key issues facing Tarawa, may be that climate change is only one of a number of problems challenging those living on Tarawa. Another reason explored later in this study was the strong adverse reaction to any suggestions that the people of Kiribati could be forced to leave the country they love so much and relocate to another place. The strong connection between I-Kiribati and 'their place,' which underpins their identity, was credited for the strength of people and their ability to adapt to enable them to survive any eventualities. Stakeholders reflected some of these sentiments.

> *You have to adapt, you have to learn how to survive in this part of the world, surrounded by water. We are a seafarer, fisherman nation. You have to be able to survive.* (Mayor of Betio)

> *I think the way they are brought up, the raising up of children in their families, how parents taught their children to remain strong and deal with whatever. Endurance is our survival.* (Director Catholic Church)

> *To be strong is to know where you are and you have a place to live, your family and all those around you.* (Moderator, Kiribati Protestant Church)

> *What makes them strong? I think it's their place and they are used to it. They know all about it...so they can adapt in any way...so we receive high waves, the kids will just jump into the sea and enjoy the swim.* (Director, CCN)

> *We can build up the lands so that we can stay, with climate change.* (Minister of Infrastructure)

Intertwined with environmental and adaptability factors, all stakeholders highlighted culture as a vital factor in sustaining the strength and resilience of I-Kiribati in managing shocks and disturbances. According to many stakeholders, competition over the ages, between families and villages in cultural activities, including song and mwaie (local dancing), accounted for the communal strength of I-Kiribati to excel and succeed. Some other areas recognised as adding to the reputation for prowess of families included the retention of deep knowledge of traditional cultural practices, story-telling, fishing, physical strength in sport and other activities. While the stakeholders indicated that Kiribati culture played a major role in influencing the strength of I-Kiribati, it was also noted that the bad behaviour of individuals, families, or villages could result in the formation of negative reputations that could last over many

generations. Depending on the situation, this could lead to people being restricted or excluded from social and cultural events, resulting in greater levels of isolation and weakening of communal strength.

> *The culture is part of the scenario...You have to be tough; it is part of the culture.* (Mayor of Betio)

> *Every tribe, every family they think they will not defeat from one another. That why the story that we are strong, that...came from our culture...The second thing is, if you are in trouble in some way, if you are defeated in some way, the story, the never-ending story from your family yeah you feel ashamed for the future yeah...That's our culture, that's our attitude. That's where it comes from.* (Minister of Infrastructure)

> *I have a good conversation with somebody from the island of Tamana, who is the grandson of the composer of our national anthem...he's a good musician too, and he said...there are many composers and there is always a competition who is best and who is not good you know, and him being the grandson of who composed the national anthem he is always conscious that the people are always trying to keep him down because of that small relationship. Off course he holds on to that, and that makes him a little bit higher.* (Moderator, Kiribati Protestant Church)

4.2.2 Traditional to Urban Living

Over half of the total population of Kiribati now live on South Tarawa; this section examines the responses of stakeholders regarding some of the key issues facing those living there. While it was widely recognised that the movement of people from the outer islands to Tarawa was not new (having started in the 1950s as people came to ensure their children obtained a good education), all stakeholders considered that nowadays this movement reflected a more fundamental shift. Stakeholders described this movement in terms of a push/pull dynamic that was characterised by young people turning away from the traditional way of life, attracted by the more interesting and appealing lifestyle of urban living. Though some stakeholders lamented the loss of the traditional skills that had served I-Kiribati well since times gone by, most understood why young people were no longer satisfied with a life that was characterised by the daily toils of life in the outer islands. At the same time, while most stakeholders recognised the attraction posed by opportunities to participate in the cash economy, it was hard for stakeholders to understand why people continued to come and live in Tarawa given the high likelihood of unmet expectations.

While stakeholders understood why parents moved to Tarawa to assist their children with childcare, many found it difficult to comprehend why people were attracted to urban life given that the vast majority would not secure paid employment and would experience extreme financial hardship. Digging further, it emerged that a number of non-economic factors influenced the decision of people to live on Tarawa. These included, among other things, greater freedom for young people to express themselves, the ability to forge wider social connections, and access to modern technologies, such as smart phones and computers. Predictably, while most stakeholders understood the role of these factors in 'pulling' people to urban Tarawa,

some (led by the Catholic and Uniting Churches) lamented the adverse impact of these factors, blaming the demise of social and cultural norms that underpinned the Kiribati way of life on the move to a more western lifestyle. They, and some other stakeholders, raised serious concerns about high levels of alcohol consumption, including by youth, the time spent by adults at newly established kava bars, and the attraction of women to bingko (bingo). The increasing uptake of these activities was linked with anti-social behaviour, domestic violence, and crime against children. The increased prevalence of kava consumption, together with bingko, was associated with more children being left alone to fend for themselves, due to parents going out in the evening and being tired during the day. Overall, many stakeholders associated these activities with adverse social and health outcomes, particularly for children.

> *Losing because when they get here, they stop being themselves and they adopt the new ways, and then they are used to these new ways.* (Director, Catholic Church)

> *Some of the parents are too busy, drinking nangkona (kava) and they go and spending less time with their children as observed like in the afternoon, when time that children return from school you can see that some of the maneaba the women are there playing bingko,...until the hour that the children are meant to come home, there's no one there. Or the father is still sleeping, or hung over...whether they tend well to their children or not, but by the observation of what is going on that I can say that it contribute to all this change of the young people.* (Senior Member, Uniting Church)

Increased dependence on imported food was also linked to the loss of traditional skills and poorer health outcomes resulting in obesity and other western non-communicable diseases, such as hypertension, diabetes, and cardiovascular diseases. The move to a more western diet, high in saturated food and carbohydrates, along with an increasingly sedentary lifestyle, was blamed for the rise in these western-type diseases. While some stakeholders attributed greater dependence on imported food to westernisation, other stakeholders pointed out that over-population and detrimental environmental impacts were responsible for the loss of inshore resources and traditional crops, resulting in greater dependence on imported food. An example of the impact of these changes was the need for local fishermen to go further afield to source fisheries resources. Unlike in the past, when most families owned a traditionally built canoe to go fishing, it is now necessary to go further to fish, which has resulted in a greater reliance on outboard-motor vessels, typically out of reach of many households. As a result of this, many households have come to depend on purchasing fish, rather than going out themselves to harvest this main source of protein.

> *Western life, the modern life...where they just go to the shop and buy it and eat...whereas back in the island they have to go fishing, they must cut toddy and they must go to the babai pit. All of these things, they said life in the Tarawa is easy, and it is not easy.* (Moderator, Kiribati Protestant Church)

Predictably, the view of most stakeholders was that urbanisation was to blame for these, and other, adverse outcomes. Although it was acknowledged that the development of Tarawa's urban centre was similar to what was occurring in other Pacific capital cities, all stakeholders noted that the significant problem, in the case of Tarawa, was the severe lack of space. The resulting extreme over-crowding, high population densities, and inadequate housing led some stakeholders to question why people wanted to come and live in Tarawa. Two stakeholders (representing the Uniting Church and the Catholic Church) went further, questioning whether it would not be beneficial for those who had migrated from the outer islands to return. The possibility of people returning to the outer islands had also been mooted by the previous government, although it was unclear how this could be achieved, other than through new investment in the outer islands to attract people back home.

Challenging the premise articulated by all other stakeholders, that urbanisation was to blame for the difficulties facing Tarawa, the Mayor of Betio, who had attended the World Urban Forum, poignantly argued that urbanisation should not be viewed as a problem, but rather as a challenge in how to transform urban spaces for those living there. Although the Mayor recognised that with a population of 17,356, living on only 1.54 square kilometres (a population density of 11,270 per square kilometre; Kiribati Census 2015), Betio faced many problems, he strongly argued that people had a right to live in Betio. Along with the Moderator of the Kiribati Protestant Church, the Mayor rejected any notion that people should be made to return to the outer islands to alleviate the difficulties facing urban Tarawa.

Both of these stakeholders reflected their own experiences of having come from the outer islands, and how they and their families had made their lives in Tarawa. Having lived most of their lives in Tarawa, these stakeholders noted that there was nothing for them back in the islands.

> *When I started being mayor, I thought that urbanisation was the problem. After getting these series of meetings overseas I've been told that urbanisation is not the problem...it's a challenge that you have to make the best out of it, and use it for sustainable development. Well to be honest I know that Betio is over-crowded. I've been living in the place and I know that it is over-crowded. There are people in poor housing, with no water, sanitation.* (Mayor of Betio)

> *Even if it is tough to live...they still want to stay kee...it's their right. They have so many reasons. I ask myself why don't I go back to Arorae, I'm not from Tarawa, I'm from the south, why don't I go back? Well I was born and raised here; I can't go back. They say they have opportunities, school opportunities. Even though they are not working, they want the opportunities for their kids. If it's not for them it's for the parents.* (Mayor of Betio)

The views expressed by the Mayor of Betio raise questions of how international public and private investment can assist Tarawa to create functional urban spaces. The Mayor recognised that this will require all facets of urbanisation to be examined in an integrated way to improve economic development, housing, and local infrastructure.

4.2.3 Housing

Notwithstanding the merit of the argument put forward by the Mayor of Betio that urbanisation per se is not the problem, the question of which issues underpin the main challenges facing Tarawa remains. Investigating this with stakeholders, it emerged that the combination of unsustainable population densities, poor regulatory systems, and inadequate infrastructure were greatly significant for the problems facing Tarawa. All stakeholders recognised the poor outcomes associated with high population densities, most particularly in relation to high-density housing, high levels of poverty, and negative health outcomes. In an example of how inadequate regulatory systems contribute to these results, the Mayor of Betio shared the difficulties his council faced in enforcing housing regulations. Despite the legal requirement that all new housing builds need council approval, the Mayor and other stakeholders noted how the high demand for new houses resulted in the vast majority of new builds going ahead without the necessary approval. This resulted in many houses, over the decades, being built in very close proximity to other dwellings, lacking the sanitation required by council regulations. Some of the adverse effects of high-density housing, raised by stakeholders, included: the lack of privacy, an unsafe environment for young girls and women, the intrusion of disorderly drunken behaviour on the lives of families, and unsafe environment due to pollution and contamination.

> *We are responsible if one wants to build a house, we are responsible for the Land Act. Without applying you cannot build a house. There are people that still go ahead and build, and when we try and stop them, they continue. We tell them that they have to apply, without an application you can't build...our enforcement is not very good...we are doing now is asking the police to assist us. Stop these buildings from carrying on. So they stop just in time, but they get away with it. We apply to court.* (Mayor of Betio)

> *I will be attending the World Urban Forum next week and we are talking about new urban issues which involve building good housing, good spaces for the people – that we are find quite difficult to do because of the land scarcity. Some have put houses next to other houses; they are living in informal housing. Problems arise, social problems you know – kids getting drunk, that is the new version, yeah.* (Mayor of Betio)

Another consequence of population growth has been the increased rate of informal housing occurring on vacant land and green spaces, particularly near the airport. Aside from a rise in land disputes going before the courts to be resolved, one of the most significant problems has been the loss of green spaces, once enjoyed by families for recreational activities, and an increase in environmental damage occurring on land over, and in proximity to, the precious Bonriki freshwater lens. A number of stakeholders expressed their deep frustration at the inability, or unwillingness, of the local council to enforce regulations that would prevent people erecting their houses and keeping animals so close to the lens. Despite these concerns, most stakeholders understood why people sought to develop their own households. With a very small rental housing market, and limited financial resources, the most viable option was for

people to find a 'space' and build their own homes, even if these structures did not meet local council standards, particularly in relation to sanitation.

> *People build houses with no toilet. It is not a first priority, the first priority is the house...in Kiribati, people want to have a house; it doesn't matter about the toilet...but I think too that the council is not doing their job. Like if you have to build a house, the law says, you should present your design to the council, there should be a drawing showing the toilet...the authorities are not working as well.* (Director, CCN)

4.2.4 Water Resources

Unsurprisingly, vast population growth has been linked with a number of detrimental environmental impacts, including impacts on freshwater supplies, inshore marine resources, and land. Foremost among concerns raised by stakeholders is the impact of pollution and contamination of the freshwater lenses supplying drinking water to those living on Tarawa, over half of the total population of Kiribati. Many stakeholders expressed about the contamination of freshwater supplies from surface sources, particularly microbial pollution, such as faecal matter and other pollutants from general waste. The short transit time for pollutants on the land to reach freshwater lenses, including bore wells, has rendered most private bore wells unsafe for human consumption. They linked the contamination of freshwater sources to the high rates of diarrheal diseases among those living on Tarawa, the leading cause of death of those aged 5 years and under (WHO 2012). According to the PUB and the CCN, although people know of the need to boil water for human consumption, the high level of non-compliance was attributed to the widespread nature of gastro-intestinal diseases. In addition to the transfer of contaminants from humans and animals, stakeholders spoke of the effects of increasingly regular incidents of overtopping of the sea on the land, turning most of the private bore wells brackish.

Figure 4 Private bore well in Kiribati

(Kiribati Development Policy Organization)

Notwithstanding that the development of reticulated water, designed in 1987 and upgraded in 2005, has enabled villages and many households to access pumped fresh water from Bonriki and Buota, stakeholders raised concerns about the declining performance of the system. In addition to increased demand from population growth, stakeholders told of customer connections being tampered with and illegal connections being made within the distribution network. Adding to these problems, limited maintenance and the loss of water from damaged pipes has led most stakeholders to view the potable water system as being unlikely to be able to meet future demand for fresh water. Despite these concerns, members of the PUB noted recent efforts to ensure that the water is safe for human consumption. They include the Ministry of Health undertaking periodic testing and the

adding chlorine to the water to make it safe for drinking. The PUB informants added that they were looking to implement 12 pilot zones to enable villages and households 24/7 water supply, but with great demand for household connections they were advising households to consider the use of filters. On a long term scale, the PUB also noted that plans were being drawn up for a major over-haul of the water infrastructure that would result in replacement of the ageing infrastructure and layout of new pipes to enable all households on Tarawa to have access to reticulated water (Green Climate Fund 2018)

> *We have a very big fridge, our big fridge is the sea, you can go out and get the fish from there, you can go and get your food, that's why I tell people, don't use the sea to dump your rubbish, it's our refrigerator, it's our fridge, our cupboard, our food security. Don't use it, don't drop things, and don't drop your rubbish there.* (Minister of Environment)

> *To me, water will be a problem because of the increasing number of people and it keeps on increasing.* (Director, CCN)

> *Water, quality of the water...the water used to be good and now the water is dirty.* (Moderator, Kiribati Protestant Church)

> *I also think there are lots problems with water and sanitation, because water is not enough here on Tarawa. Water tanks and whatever near their homes are very hard to fill.* (Senior Member, Uniting Church)

> *We see some of communities during our community work and I saw, they present us with drink and it's a bit salty. And I ask what are we drinking? And they said we boiled well water. So I agreed to it and I go into homes and I have been drinking water like that, but I have to accept it as a culture that I have to take what is presented. I was just questioning, worried about the small babies in the house.* (Director, CCN)

4.2.5 Rubbish Disposal

Another example of local services not keeping up with population increases in Tarawa, raised by many stakeholders, was the inadequate system for the collection of household rubbish. They viewed the build-up of uncollected rubbish as having the potential for detrimental environmental and health effects, including the spread of diseases and negative impacts around coastal sites. Stakeholders noted how public notices were posted to discourage the collection of inshore marine resources due to contamination of the local environment. Adding to these problems, many stakeholders expressed concerns about the rubbish-dump site at Nanikai nearing full capacity, raising issues as to where future dump sites can be developed given the scarcity of land on Tarawa. Delving further into the issue with the Mayor of Betio, he revealed that there was a simple explanation for the inadequate collection of household rubbish over the past 4 months. He noted that one of the two rubbish collection trucks imported to service Tarawa had broken down and not been able to be fixed due to difficulties finding replacement parts, and the high costs of those parts. With an annual fund of only A$80,000, from central government, the Mayor noted that it was difficult to deal with surprises, such as the breakdown of one of their service vehicles, let alone have the capacity to provide all of

the vital services needed by a growing urban economy. Many stakeholders argued that chronic under-funding was to blame for the limited number of services local government could deliver, including the enforcement of regulations.

As noted earlier, the unreliable disposal of household rubbish, and a tendency for people to use coastal land as waste dumps, was also the reason frequently given for the poor state of local environmental systems in Tarawa. The Minister of Environment admitted his consternation at the conduct of people using coastal regions as dumping sites for household rubbish. In an attempt to educate people about the important role of the coastal environment, the Minister told of how he talked about these environs in terms of a 'fridge,' to which people could go to get their food. The Minister noted that people understood and liked the analogy he used, although he also noted that contamination of these areas was still occurring, raising serious concerns about the future state of the inshore environment. In an attempt to reduce the negative impacts of plastics, the Minister told of his desire to ban plastics, albeit it was unclear how and when this would be achieved, given the large number of goods imported into Kiribati which use plastic packaging.

> *Rubbish is all over the place even though it's under the council authority... because councils here are different from councils in other places because they don't have revenue and the government don't give them much.* (Director, CCN)

> *Most people are getting sick because the rubbish is always there, they meant to come and collect it and even the where they dump the rubbish is all full in there and where are they going to dump the rubbish? You go back to the communities and more rubbish beside the houses and on the sea, you know. Just throwing it in everywhere, they do not trust the council with the rubbish eh? The truck won't come and so many days the rubbish there, so people are saying we'd rather dump the rubbish somewhere...now you can hear from the fisheries division, don't eat the seashells...contaminated because of what people are dumping rubbish. They are using the sea as a toilet.* (Director, CCN)

4.2.6 Roads

One of the most positive comments provided by stakeholders was about the newly developed main road running the length of South Tarawa. The new road, with high-visibility markings, speed restrictions around villages, solar-powered lighting, and spaces for people to walk alongside the road in safety, was viewed as a vast improvement on the poor state of the road in the past. At the same time, some stakeholders raised concerns about the on-going maintenance of the road, including whether the solar-powered lights would be replaced when they were no longer working. As some street-lights were no longer working, one stakeholder expressed her cynicism about how long road users and pedestrians would be able to enjoy this service. This attitude indicated the general pessimism of many stakeholders about the on-going capacity of service providers to carry out vital maintenance to ensure the functionality of equipment. With the harsh coastal environment having the potential to damage key infrastructure such as roads and lighting, stakeholders were worried about whether the things they had come to rely upon and enjoy would be there for them in the future.

4.2.7 Electricity Services and Renewable Energy

As articulated in SDG 7, access to affordable, reliable, sustainable and modern energy was considered by all stakeholders as being key to achievement of sustainable development outcomes, and the ability of households and communities to manage risks. On the first of these, fuel poverty among the poorest and most vulnerable households was viewed as undermining the goals and aspirations of sustainable development. Indeed, with a history of socio-economic 'evenness,' characteristic of Kiribati prior to urbanisation and westernisation, the increasing gulf between those with economic resources and those without has begun to result in uneven socio-economic outcomes across society. Access to renewable energy was seen by stake-holders as one way of improving socio-economic opportunities for all households rather than having the benefits of economic growth limited to only those with economic resources.

In addition to improving sustainable development outcomes, access to renewable energy sources, such as solar PV, was regarded as positive my most stakeholders. Not only was the switch from fossil fuels noted as being consistent with the global approach to reducing greenhouse gas emissions, but access to renewable energy was predicted to improve the ability of I-Kiribati to better manage risks associated with climate change. At the household level, solar PV enables families to run fans to assist them to keep cool as temperatures rise to what has commonly been described as being the highest they have ever experienced. Savings from the use of solar PV for lighting were also highlighted as allowing households to invest in fridges that reduce the incidence of food spoilage and ease the pressure on men to have to go fishing every day. Stakeholders also noted that in the event of a major breakdown with the turbines providing electricity, distributed solar PV systems have the ability to keep households going rather than everything going down. In addition to being important for schools, the main hospital and other public utilities, solar PV was also considered as adding to the sustainability of the tourism industry, where energy needs are often prohibitive due to the use of air conditioners by tourists.

Consistent with these comments, many stakeholders voiced their satisfaction in relation to the improved reliability of electricity services being delivered to customers on Tarawa, particularly the reduced incidences of brown- and black-outs, which, in the past, could last from a few hours to a week. Despite this progress, some stakeholders noted that electricity prices were still prohibitive for some of the poorest households, which often had their electricity services cut off for not paying their bills. In these cases, and for those families living in informal housing, families resorted to old-style energy sources, such as kerosene lighting and wood fires for cooking. Implementing a targeting system, the PUB told of how the poorest household could purchase electricity services at A$0.10 per 100 kW hours. This compared with middle-income earners (not defined by the PUB) where the price was set between A$0.30 to A$0.40 per 100 kW hours, and high-income earners at A$0.50 per 100 kW hours. While this pricing system looked like a reasonable targeting approach, it was curious that this was not mentioned by other stakeholders. A recently returned migrant from Kiribati, who had established a small general shop over the past 2 years, expressed dismay that she had never been informed of

this pricing structure, and wondered just how well this was understood by households. Another difficulty was the lack of clarity regarding the measure used by the PUB to assess the ability of customers to pay.

On the issue of renewable energy, all stakeholders supported the use of solar power as a cheap and clean source of energy, noting its potential in the fight against climate change. They described its current use as being led by the public sector, primarily by secondary schools, church schools, the main hospital in Tarawa, and meeting houses such as maneaba. In the private sector, the uptake of solar PV was being led by business owners seeking to reduce operational costs. While its use is focussed on lighting, a few stakeholders thought it would be beneficial if solar PV could be used for running refrigerators and freezers, but noted the high costs of such equipment. In addition to this, many stakeholders complained about the length of time it takes and the cost to have equipment repaired, particularly in the outer islands. Although one alternative to ownership was for consumers to lease their solar equipment at around A$27 per month, some stakeholders noted that the time taken to fix equipment was still particularly onerous. One stakeholder told of the frustration her brother experienced when it took months for his leased solar equipment to be fixed in North Tarawa, having him resort to less clean and less sustainable sources of energy.

4.2.8 Capacity Building

Explaining why repairs were taking so long, the PUB and the Solar Power Company told of the capacity constraints facing the solar energy sector. These stakeholders spoke passionately about the problems of not having enough trained personnel able to fix repairs and the lack of effective communication between people out in the field and at headquarters. With the past pace of overseas investment in the renewable sector, many stakeholders considered that the lack of skilled personnel would threaten the long-term viability of renewable energy solutions in Kiribati. The PUB and the Solar Power Company, along with other stakeholders, expressed their deep desire for New Zealand to assist Kiribati with capacity building in Kiribati, to enable the renewable energy sector to perform more effectively than it is currently able to do. Both the PUB and the Solar Power Company urged New Zealand to consider the development of a trades college that could provide recognised qualifications that would enhance the renewable energy sector and would include carpenters, electricians, and plumbers. For the PUB and the Solar Power Company, a key objective was for the greater use of routine maintenance to reduce incidences and costs of equipment failure, and to provide customers with better services than are currently available.

> *But we don't have enough resource for that, we have a solar company here, but it's not enough, need human resources for making the repairs. It is very important for building our capacity...Our capacity, our resource; we need all that...don't want to lose them, working somewhere. If that works successfully then can make an agreement, I can make an agreement with those teaching the study, after you complete your study, so please...or maybe they come back to our country...that's much cheaper for us.* (Minister of Infrastructure)

> *And then we can invite people from the outer islands, those representing the*

outer islands, to attend the training. (PUB)

I think its training capacity, operations and maintenance; installation, operations and maintenance, they're the basics we need. Yeah, improve communications, that's one our issues. Isolation is a very difficult thing...limited access to communications. (CEO, Solar Energy Company)

Despite these challenges, all stakeholders expressed their support for the use of renewable energy in Tarawa, and the outer islands. With sunshine being in abundance in Kiribati, many stakeholders expressed the view that solar energy should be more readily available for households, especially for the 40% of the total population in Kiribati currently not connected to the electricity grid. Many stakeholders recognised the benefits of solar power, including the ability of children to do their homework after dark, the capacity of women to work for their small businesses, and increased safety, especially for women and children. In addition, to these positive effects, the Minister of Health highlighted the usefulness of solar power as an important back-up for the refrigeration of medicines at the main hospital in Tarawa, and at clinics throughout Tarawa. The Minister went further to suggest the possibility of using solar power as the main source of electricity at the main hospital to maximise energy efficiency and free up scarce resources for the provision of increased health services.

We don't have back-up, so if we could have solar...if we use it as the main source of electricity, even better, reduce our expenditure on electricity use. (Minister of Health)

In addition to replacing mainstream electricity services, many stakeholders expressed their desire for solar energy to be used in some way to clean water supplies for drinking. With freshwater coming under increased pressure from population growth, contamination, and the effects of climate change, stakeholders considered it beneficial to explore how solar power could be used to desalinate sea water and clean bore-water supplies. With some villages in Tarawa facing significant freshwater scarcity, stakeholders raised the possibility of developing some form of community filtration system that had the capacity to increase supplies of fresh drinking water. Another proposition, put forward by utility providers, was to explore the development of a solar-powered desalination plant. The main problem, raised by the CEO of the Solar Power Company, was the cost associated with such a development. He estimated that a larger community desalination plant would cost in the vicinity of US$40,000 to US$50,000, with a smaller portable plant expected to cost approximately US$30,000. The CEO considered these costs to be prohibitive for a small country like Kiribati, indicating the need for international investment in the sector. Although the Republic of Korea has indicated its intention to develop a solar-powered desalination plant in Kiribati, stakeholders indicated that this would eventuate sometime in the future, possibly 2 to 3 years.

We have two options we have to investigate. The first one well water and convert it to the fresh one; and the second one is desalinisation. (CEO, Solar Energy Company)

For example, you mention desalination plant; we prefer to have some solar

energy for the plant...we are interested in something like that, rather than the diesel. (Minister of Infrastructure)

In addition to these suggestions, the PUB argued in favour of exploring the conversion of plastics and tyres into fuel. A key objective underpinning this idea was utilising the vast amount of plastic waste and tyres deposited at the Nanikai landfill and littering much of Tarawa. The PUB argued that, aside from providing an alternative source of energy, the benefit of this proposal was reducing the high levels of household waste that were placing great pressure on the waste management system. Although the cost of such a plant is likely to be prohibitive, the idea signalled the willingness of agencies like the PUB to consider developments that had multiple purposes, including reducing the amount of unsustainable waste on Tarawa.

I have another idea...that converts plastic into fuel...there's a lot of plastic around...so we could take all the plastic, maybe taking or buying from the community the plastic from them, all the plastic, all the plastic rubbish and then we could use it for fuel for the power station. Plastic and tyres, they can be recycled, turn into fuel...that's one way of cleaning up Tarawa. (PUB)

For those in South Tarawa, yes, they recognise the benefits of solar in comparison with fossil fuels...the advantages of solar, so they know how important it is because they understand as well how fragile is the environment, so they want to limit the amount of fossil fuels. It is a more friendly clean energy source. (CEO, Solar Energy Company)

The government has to raise the awareness of the people on renewable energy...because now the people are now used to the electricity...very hard for them to change again from electricity...so the government has to work more on this. Raise the awareness of people the importance of renewable energy. (Uniting Church)

4.2.9 Climate Change

In contrast to the animated responses relating to the local issues facing Tarawa, the discussion on the issue of climate change was somewhat muted, focussed primarily on the loss of coastal land due to increased incidences of powerful sea surges. Although all stakeholders recognised that climate change was likely to pose many challenges in the future, particularly in relation to the sustainability of freshwater supplies, the stakeholder group was split into three main groups.

The first group, led by the advocacy group CCN, argued in favour of Kiribati doing what it could to enhance the resilience of human and environmental systems to manage the effects of climate change now, and into the future. The impacts of climate change were supported by other stakeholders, including the senior member of the Uniting Church, who pointed to increased occurrences of tides sitting just below the roads linking villages (referred to as *causeways*), and changing currents resulting in the disappearance of small islets. With these changes, the Minister of Infrastructure noted that all new infrastructure projects where now required to consider climate change impacts in order to future-proof these investments as much as possible. An example of this type of future-proofing evident in Kiribati was the raising, strengthening, and drainage of the causeway between

Bairiki and Betio that has been severely damaged over the last few years by coastal erosion. Other initiatives have included increased international and local investment in renewable energy, with significant commitment to solar power in the outer islands, and to a lesser extent, Tarawa.

Figure 5 King tides on Tarawa

(takvera.blogspot.com)

At the other end of the spectrum were a small number of stakeholders, who were not yet convinced about climate change, or, if it existed, whether it would have a significant impact on Kiribati. This group, led by the Kiribati Catholic Church, was not yet convinced that climate change has begun to have an impact on Kiribati. Although these organisations recognised that the quality of water supplies was deteriorating in Tarawa, they noted that this was just as likely to be the result of unsustainable population pressures, as it would be climate change. While the evidence gathered in this research would suggest that this viewpoint was not unreasonable, the comments were intertwined with their beliefs that God would look after Kiribati. This perspective, which was supported by other stakeholders, was also closely associated with rejections of any notion that the people of Kiribati would be forced to leave their beloved homeland, due to climate change impacts. Indeed, all stakeholders rebuffed any plans, even if it was only a back-up plan, to move to the land bought in Fiji by the previous government. Indeed, some stakeholders indicated that the purchase of that land was some form of admission that Kiribati would not be able to cope with climate change. While it could be argued that the purchase of the land was not about 'giving up,' but more about planning ahead, the imagery for most stakeholders was one of admitting failure.

The third group of stakeholders was divided between those who advocated the use of the latest technology (PUB and the Solar Energy Company), and those who expressed their belief that traditional skills needed to be retained if I-Kiribati were to successfully deal with climate change (KANGO, Kiribati Catholic Church). While it could be argued that the opposition of 'new' and 'old' could be overly difficult to reconcile, the common feature of these different stances is that a range of skills is needed to build the resilience of human systems. This may include anything, from the latest solar energy technology to power buildings and homes, and source and clean water for drinking, to drawing on the fortitude and skills that have enabled I-Kiribati to survive in the harsh atoll environment.

> *I worry about climate change..., the rise of the sea level and all the impacts of climate change that we are experiencing at the moment, from time to time, it is a slow onset. So we are experiencing that, the changes in the climate and other things. I observe, unpredictable weather, the change to weather patterns, and also the tides are coming, not like before when it is high tide it hardly come over it...sits up high, now it comes right onto the roads, and now they*

announce on the radio those people living on the seashore...leave home. (Uniting Church)

But so many people agree that so many things are happening and the beaches have gone, the fish are far from them, they used to be so close, but now they have to fish far away, the fruits are not so good, they're getting smaller and not tasting good, the water is changing. They think it's from climate change, but they agree that something's happening, but they still love their Kiribati and they don't want to lose everything that they have, the way they dance. (Director, CCN)

Yeah now we are preparing...if we make some other projects like roads or something like that, we think about climate change. (Minister of Infrastructure)

Well we are mindful about climate change, but this has not come into our system to see that this is true, I know because I have been on committees where...talking about climate change brackish water and that there is need for water, yes I know that there is some... but I don't know because we don't feel the change in the climate. (Director, Catholic Church)

I understand that climate change is here already, but the people are not...they are getting away from all this local knowledge and skills to protect them from climate change. (KANGO)

4.2.10 Summary

Analysis of the data gathered in Kiribati confirmed the widely held view that Tarawa faces a number of serious challenges arising from unsustainable population increases and s

low-onset climate change. A fundamental shift was identified as underpinning the move of people from the outer islands to Tarawa, led primarily by young people turning away from the toil of day-to-day living in favour of the vibrancy and opportunities of urban living. Given the challenges posed by extremely high population densities, high unemployment, and poverty, climate change was considered by many stakeholders as only adding to the stresses facing the inhabitants of Tarawa. Despite human and environmental systems coming under major pressure from inadequate infrastructure, a lack of capacity, and low investment in local government organisations, all stakeholders held the view that I-Kiribati possessed an inner strength based on a strong culture and skills passed down over the ages. At the same time, many stakeholders struggled to come to terms with a modern, more western society and their desire not to lose the social and cultural norms that have traditionally defined the people of Kiribati. Although some stakeholders found it difficult to reconcile these two worlds, many others expressed a desire to work within the urban landscape to not only build the resilience of Kiribati to manage risks but, at the same time, ensure the survival of traditional social and cultural values.

Within this changing environment, the consensus among stakeholders was that renewable energy had the ability to contribute greatly to the development of Tarawa and the outer islands. Stakeholders reminded us that all households should have access to electricity services, and that solar PV systems provided a cheap and cleaner way of providing energy for lighting, cooking, and increased safety for women and children. Another consensus was

investigating ways that solar energy could be used to increase supplies of clean drinking water, including desalination and the filtration of freshwater from bore wells. At the same time, many stakeholders, led by energy providers, raised the issue of the lack of capacity in Kiribati to manage and fix solar equipment when it failed. These and other stakeholders argued that there was a need for capacity building to produce enough skilled workers to undertake routine maintenance and deal with equipment problems in a timely manner. All stakeholders considered that investment in capacity building should be focussed on the development of an educationally recognised course, delivered in Tarawa, to enable people to acquire skills and apply those skills in Kiribati. Indeed, some stakeholders went further, suggesting the establishment of a trades college, similar to the Marine Training College, to enable people to become qualified electricians, carpenters, plumbers, and solar-power technicians.

The increasing international and domestic investment in solar energy in Kiribati underscores the importance of capacity building. This is alongside the possibility of community desalination plants and the filtration of bore wells to expand sources of clean drinking water.

4.4 Research Findings: Samoa

4.4.1 State of Energy

Consistent with commitments made under the SDGs, many stakeholders recognised the potential for Samoa to continue investing in the renewable energy sector to "achieve sustainable and affordable energy for all" (Ministry of Finance 2016). Blessed with an array of natural resources, the renewable energy sector has grown in recent years with new investment in hydro, solar PV, wind, and biogas. According to stakeholders, efforts in these areas have resulted in improved stability of the electricity grid system, and a reduction in costs for consumers. Many stakeholders also noted how simple efforts, such as clearing trees in proximity to power lines, had reduced the risk of electricity outages, particularly during storms and cyclones, the most recent of which was Cyclone Gita in February 2018. Although not as strong as former cyclones, these efforts resulted in electricity supplies being disrupted for shorter periods of time than was previously the case, with most regions coming back on line within days, rather than weeks. Despite these improvements and concerted efforts by the current and previous governments to increase the contribution of the renewable energy sector, stakeholders noted areas for improvement and new opportunities in the sector, particularly in strengthening its contribution in the agriculture and fisheries sectors. The following sections examine in detail the findings from the interviews, using their words to communicate their ideas and thoughts.

4.4.2 Governance

According to stakeholders, significant efforts have been made over the past decade in Samoa to broaden and strengthen the level of coordination in decision making on energy projects. Recognising the benefits of integrated thinking, officials from the Ministry of Natural Resources and Environment (MNRE), noted the benefits of the establishment of the National Energy

Coordinating Committee (NECC), bringing together perspectives from a range of sectors on the use of electricity and other sources of energy. Officials noted the benefits of Samoa employing a whole-of-government approach to energy planning and the management of risks and disturbances as a way of promoting sustainable development and improving sustainable energy outcomes. One example of this has been the development use of 5-year plans to map out new investment in the energy sector. Another example, shared by officials, was the establishment of the Disaster Management Office (DMO) in 2007, designed to coordinate and implement disaster mitigation, preparedness, response and recovery post an event.

> *Coordination is important, something that Samoa invests in. National Energy Coordinating Committee for the NECC...is the House of decisions for any energy project. We are the ones who produce the sector plans...basically that's the policy for the whole sectors...four years, but actually each year it will renew. It's a living document.* (Senior Official, MNRE)

> *There's also the Disaster Management Office or DMO under the MNRE and they've been really great in advancing... Ever since the tsunami in 2009...they've worked really hard to ensure everything, especially the most hit area of Lalomanu and along the coast. They've ensured that they have evacuating paths to go inland, they've also in the past years ensured that they have warning systems.* (Senior Official, MNRE)

In addition to energy and disaster management, other examples of coordinated responses in Samoa include climate change and aid coordination. According to stakeholders, as with energy and disaster management, the expectation of officials is to get all parties with an interest in a particular sector to consider climate change and aid management issues. This approach includes the bringing together of public sector, private sector and NGO interested parties. In the case of climate change, the DMO and the MNRE are credited for being responsible for the issue becoming part of all sector plans. In the case of the coordination of aid:

> *We have...advisory committees...and that's the main purpose of that coordination body is to bring everybody around the table. It's not just the immediate implementing agents, is also includes SUNGO – this is the umbrella body for NGOS, and then we have a representative from the private sector through the Chambers and all other relevant stakeholders.* (Manager, Ministry of Finance)

4.4.3 Renewable Energy in Samoa

Figure 6 Samoa Renewable Energy Strategy

(Government of Samoa)

Hydro

According to the MNRE, hydro constitutes the base load for electricity. While supplemented by other renewable energy sources such as solar PV, wind, and biogas, hydro was identified as one of the most reliable, abundant, and cheapest sources of

renewable energy in Samoa. With increasing investment in this resource and efforts to repair three hydropower stations seriously damaged by Cyclone Evan in 2012 (Loto Samasoni, Fale ole Fee, and Alaoa), stakeholders noted the importance of utilising this resource wisely but in a way that enabled the storage of energy. Notwithstanding the many benefits of hydropower, the sector was identified by many stakeholders as facing a number of significant challenges. These included funding issues, risks from climate change and natural disasters, and resource restrictions. On the first of these two, stakeholders working in the energy industry highlighted the importance of forward-looking integrated planning to ensure that the best investment decisions could be made with regard to hydro, including how the infrastructure could withstand risks from natural disasters.

Learning from the significant damage inflicted by Cyclone Evan in 2012 on hydropower infrastructure, which took 5 years to repair, the government Chief Engineer noted how relatively simple changes assisted in managing future risks from tropical events. One of these interventions was the replacement of wooden piping, placed above ground, with metal piping buried 5 metres below ground. This resulted in minimal damage from Cyclone Gita, which struck Samoa in February 2018. This was described as being a "huge morale booster" (Government Chief Engineer). On the finance side, the high costs associated with the development and maintenance of hydropower was identified as a key consideration for future investment. The various components making up hydro equipment were described by one stakeholder as coming from all around the world.

> *The turbines came from Europe, the turbines came from France...the generators were from Italy, the pipes from Turkey, and the contractor...from New Zealand – the people that built it with some local sub-contractors that helped them out. So we also have some new hydro coming...but smaller hydro schemes.* (Government Chief Engineer)

The process of obtaining community permission to develop new hydropower projects was another significant issue influencing the rate of investment in new ventures. Unsurprisingly, stakeholders interviewed for this research fell into two main groups. The first group, led by stakeholders working in the energy sector, argued in favour of more hydro developments, and bemoaned the difficulties in getting local communities to understand the need for increased hydro energy. Those falling into this group expressed their frustration at the long-drawn-out and ultimately unsuccessful process of obtaining the approval of village elders to develop a hydropower station at Sili, on the southern side of Savai'i. Having obtained funding approval from the Asian Development Bank for this project, the 14-year process of getting the development off the ground continues to be rejected by the local community on the basis of environmental and cultural concerns.

> *That one at Sili would be the ideal because it would be able to deliver two megawatts of power if we were ever able to build it but the village there is just very, very strong against it.* (Government Chief Engineer)

Figure 7 Land Transport Authority Samoa recently purchased six electric motor cycles

While resistance to the development of a new hydro power station at Sili was attributed by some stakeholders to village elders lacking adequate knowledge about the benefits of this renewable energy resource, a Matai interviewed on this matter noted that his objections were based on the likely detrimental impacts on environmental and cultural values. Although one stakeholder stipulated that a younger generation of Matai may be more inclined to support new projects, such as that sought for Sili, this remains to be seen. Despite hydro being a renewable energy resource and adding to energy resilience, the inability of successive governmental administrations to secure an agreement from Sili Matai underpins the importance of local communities having their say in new projects in their area.

> *Well the decisions are still made by our Village Council and the Village Council consists of the Matais. Things are changing now; there are more Matais who are well-educated and well-versed with science...but there are still those who are not well informed about all these things. So, until such a time as the ones who are in position with the Village Council are replaced, there will always be this barrier.* (Senior Official, MNRE)

Taking another position...

> *That is why we hold it [the river] very dear, because of its many beneficial attributes. See and bear witness to how healthy the water is because it is not being used to generate power. However, in the future if we are to use it for such, it will be ruined like...Afulilo is today. Afulilo used to be like this but now we have seen it is ruined and no longer useful. This village drinks from the water as well as bathes in it. When the sun becomes overwhelming and there is no piped running water, we use the waterfall. You can come relax here, but if we are to use it for power, there will be nothing for this village to fall back on if the river is destroyed.* (Village Matai)

Solar PV

All stakeholders noted the benefits of increasing investment in solar PV, either to supply the grid or as stand-alone systems for more remote communities. Currently this form of renewable energy is contributes an estimated 20% of the grid's peak demand, reducing the demand for fossil fuels (Fast Company 2018). Despite the benefits from a sustainability point of view, our discussions with stakeholders revealed that a number of challenges will need to be managed if solar PV is going to make an even greater contribution to electricity generation and increase its proportion of the overall energy sector in Samoa. One of these challenges, identified by some stakeholders, was the high costs of development and on-going maintenance and repair of equipment. According to an educator working in the renewable energy sector, these high costs were one of the reasons why stand-alone systems do not make investment attractive.

Another reason complicating matters was the fickle nature of the energy resource, and the inability to store energy to provide greater stability to the electricity grid.

> *The thing about solar that people forget...the most expensive part of the solar is the battery and storage. This is why there is so much loss on our grid because we don't have battery storage which is an issue that EPC is finally got funding...to put those in place to minimise how much energy we're losing because if it's not being fed into the grid, it's just lost. (Samoa Trust Estates Corporation* [STEC])

> *If you get sun and the solar is pumping a lot of electricity and all of a sudden there is a cloud – if you have 10 megawatts of solar that's on at the moment fuelled by the sun and then all of a sudden you get a cloud, it just drops within 20 seconds, you lose all that... We got to have some sort of supply to be able to provide stability and we have had some serious problems with that.* (Government Chief Engineer)

The unpredictability of this resource, and the inability to store energy, were credited by many stakeholders for the lack of stability of the grid. At its worst, power outages were attributed to these factors, raising concerns from hoteliers, businesses, and the export sector. At its best, Samoa has had to continue relying on diesel power more than it has wanted to. Without investment in energy storage, many stakeholders were concerned about the stability of the grid to support economic growth.

> *The government is saying we want to do 100% renewable by 2025. Now looking at the way it's going from the technical side it's impossible because we don't have a stable grid...we need to build a more powerful cable to hold the renewable energy...* (Educator, Renewable Energy Sector)

> *In Savai'i, electricity supply is not very reliable, once a week it will go down. Impact on tourists, would like greater stability.* (Hotelier)

Looking to the future, the aspirations of the business community were not only to achieve a more stable grid, but for the private sector to be able to sell unused solar energy back to the grid solar energy that is not used.

> *Technically, private houses and commercial businesses could...in the future...sell back to the grid what they don't use.* (Chief Executive, Chamber of Commerce)

Figure 8 Samoa 0.5 MW Utility scale grid-connect solar Salelologa, Savai'i

Other Renewable Resources

In addition to hydro and solar power, stakeholders mentioned efforts in Samoa to manufacture alternative forms of renewable energy, including the conversion of biomass to biofuel and biogas, and wind. On the first of these, stakeholders from STEC and the Scientific Research Organisation of Samoa

(SROS) noted how, with the assistance of New Zealand and other bilateral and multilateral donors, exploration has been conducted on the conversion of coconuts into biofuel, and the conversion of noxious vines and weeds into biogas. Research conducted by experts, funded by MFAT, recommended the use of whole coconuts as sources of material for biofuel (blended coconut oil/diesel fuel, and catalyst). Despite research and trials supporting the use of coconuts for biofuel, a number of constraints were highlighted ranging from the ageing coconut plantations to the high costs of production.

> *We worked on biodiesel, which is the conversion of coconut oil into biodiesel. Our research started...in 2007...After that we started trialling it at the semi-commercial scale. We bought a 200-litre reactor to produce biodiesel...that work was funded by IUCN through Italy and Austria. But if we produce it at a very low scale, like how we were, it will always be at a loss, unless you get some subsidies from the government. But I think at this stage, it's the economics, the costings that holds us back.* (SROS)

Adding to research and feasibility studies of expending coconuts for the production of biofuel, a number of stakeholders noted the innovation of using noxious vines, weeds and invasive trees for the manufacture of biogas. With Samoa facing the spread of the invasive Merrimia vine, estimated to have killed more than 60% of Samoa's forests (UNDP 2014), stakeholders noted the plan to utilise this and other biomass for the production of biogas. According to STEC, nine species of invasive species and five native or indigenous species were tested by SROS for energy content on the STEC plantation in Faleolo, Upolu. Three invasive trees were identified as having the energy content adequate for conversion to biogas: Pulumamoe, Pafiki and Puluvao (SROS 2018). Despite the positive aspect of using invasive species for biogas, one of the difficulties identified by one stakeholder was the conundrum of landowners being incentivised to plant invasive trees for conversion to biogas. Aside from the noxious nature of these trees, their long maturity rates have raised concerns about the on-going sustainability of biogas production in Samoa. This concern was raised by a senior official from STEC:

> *For biogas gasification there is no long-term plan because of the nature of what we're doing which is harvesting trees and we don't want to encourage that everywhere, but I think we it comes to scaling it...we need more feedstock, then maybe there might be discussion about sourcing it from communities, but very careful, very cautious on this technology.* (Senior Official, STEC)

Another concern raised by a senior official from MNRE is balancing the need for biomass for gasification and food security. An example of this is the use of coconuts, a food staple for the population. While discussions with stakeholders noted the high number of coconuts available on vacant land, the issue of food security highlighted the need to consider the effects of decisions in relation to food.

> *Also, food security as well...they are competing at the moment for coconut.* (Senior Official, MNRE)

With regard to wind, the first project funded by the United Arab Emirate (UAE) in 2014, resulted in two 55-metre-high turbines that

power the Lalomanu side of Upolu (Windpower 2014). To manage the risks from cyclones, these turbines can pivot at the base, and be lowered and locked in place in less than an hour. According to a senior official from MNRE, this collapsible design is intended to avoid damage from tropical cyclones and severe storms that periodically hit Samoa. A second wind farm designated for Tiavi, on the hills behind Apia, is expected to add to the base of renewable energy of Samoa, as part of its plan for electricity generation to be 100% renewable by 2025.

Examining the possibility of other renewable energy technologies, several stakeholders noted their interest in OTEC in the future, particularly if there are multiple socio-economic advantages for the country. A small number of participants had heard of OTEC, first developed in Hawaii and adopted most recently in Geneva for cooling and pharmaceutical processing.

> *That's the first I've heard about that – these thermoclines that they have in the ocean and they would be able to generate electricity from temperature differentials. Yeah, but that was 40 years ago so I mean...probably the best thing to do is get out there and beat the drum about it [OTEC].* (Civil Engineer, private sector)

Almost half a decade ago, exploration was done on the viability of geothermal technology which was shown to be too costly.

> *So we were looking at...wave energy. So the issue with that one and the reason why it has never been considered is the cost. It is way too expensive to implement that kind of energy here, but things are changing. I mean this was 5 years ago, but the science is becoming more and more efficient...Who knows. Maybe in a couple of years we'll be able to invest, but MNRE was looking at the energy that uses the waves – they were looking at that, but it was just the [cost].* (Senior Official, STEC)

Stakeholders noted their interest in examining the ways in which the ocean can be used as an energy resource in the future, provided lower costs and funding assistance.

> *That would be interesting because I don't think, for us as a nation – that conversation around that kind of technology hasn't even started yet.* (Senior Official, STEC)

4.4.4 Financing

With regard to financing renewable energy projects, a number of stakeholders raised the difficulties that business owners and households faced in investing in new renewable energy projects due to the unwillingness of banks to provide loans. It is as a result of this hesitance that agencies such as STEC have recently begun to examine the possibility of micro-financing, albeit with few tangible results. In addition to the high entry costs, part of the problems facing financing agencies, other than donor agencies, is the inability to show banks the benefits of renewable energy projects. It is at this juncture that organisations such as the Asian Development Bank (ADB) can provide loans for investment in renewable energy.

> *For businesses – business communities have indicated that for them to go renewable energy, it's too high cost...there's no good return on their*

investment. One of the biggest challenges with renewable energy here in the islands is trying to make it affordable. It is so expensive...just to get even solar heating. I mean a lot of families are...realising it's a better option, but it's not very affordable for everyone. (Senior Official, STEC)

When it comes to the private sector, there are other avenues where they can access funding like, for example, under the ADB; there is a private sector development something which they can access directly. There is no government guarantee required, but only that we vet these private sector companies applying to make sure that these are credible and real businesses applying to the bank. (Manager, Ministry of Finance)

4.4.5 Distribution and Community Involvement

An area of on-going debate regarding renewable energy is the issue of distribution. While currently most established renewable energy is fed directly into the grid, a number of stakeholders discussed the benefits of stand-alone renewable energy projects, particularly in more remote communities. Support for this approach was summarised by one stakeholder as follows:

We're looking at ways to become more sustainable and just be off-grid and I think a lot of my generation are starting to think like that. A lot of my generation are starting to leave their jobs and go back to agriculture. (Senior Official, STEC)

Off-grid is good for communities that are very isolated because it's more costly to get electricity to them and so this is one of the things I remember EPC bringing up on one of the sector discussions about off-grid. The only thing about off-grid is the support that they would need to operate – is there going to be enough support for a community to go off-grid? (Senior Official, STEC)

In addition to greater central government support for a more distributed renewable energy sector, a number of stakeholders noted that for stand-alone systems to be accepted, good quality relationships needed to be developed with local communities. One stakeholder noted that for these relationships to emerge and deliver positive outcomes, communities need to feel included as participants to decision making, rather than simply accepting implementation of new renewable energy projects. This sensible advice highlighted the importance of communities forming part of the process, if new projects were to be accepted.

One of the most important factors that came through was having village participation and not only in...implementing itself, but also in the decision making. If they feel that they were part...of the decision making then they would also be happy to take this on board. (Senior Official, MNRE)

While participation may not, as the Sili hydro power example has shown, always be successful, the notion of enabling communities to make a meaningful contribution to decision making is nevertheless an important aspect of resilience. Nowhere is the issue of community involvement more complex than dealing with owners of customary land. Even using partnerships in the form of "co-ownership" of renewable energy projects,

decision making was identified by many stakeholders as being particularly complex and often not very successful. Some stakeholders noted that increasing concerns about environmental impacts and generational changes of ideas made negotiations with owners of customary land particularly difficult.

> *The biggest hesitation really is when it's customary land you have to deal with families and customary landowners and history. Past experiences with most of these people is that they change their minds too much, there's no set organising of how to go about the lease...Because there's so much barriers...and it change with every generation. So when a new generation comes in, there's another: "This is our land. This is how it should be done." There's no sense of security and they worry about the sustainability of their businesses so that's why they've now started to come and look for freehold land and government-owned land because you just deal with one authority, more secure in a way.* (Senior Official, STEC)

To get around some of these problems, the idea of co-ownership was put forward by the government Chief Engineer with regard to the development of hydro at Faise'elā, where the hydro facility would be privately owned by the village, while the rest of the country shares the benefit. While it is likely that new forms of ownership will emerge to get around some of these complexities, different values and ideas with regard to the use of land are likely to continue for the foreseeable future.

4.4.6 Agriculture and Fisheries

With agricultural and fisheries sectors making a significant contribution to the economy, the discussion with stakeholders focussed on how renewable energy might improve operational efficiency to distribute goods to the domestic and export markets. One idea that emerged in our discussions was the building of cool stores to stock goods from the farms and fishing vessels prior to sale and distribution to markets. According to stakeholders, the development of cool stores would not only assist in preventing food spoilage, but enable harvested products to stay in pristine

Figure 9 Apia Fish Market at dawn attracts hundreds daily

Figure 10 Chilly bins for fish storage at Apia fish market

condition, contributing to the health of consumable food, such as fish sold at local fish markets. While we acknowledge that cool stores may not enhance resilience to any significant degree, we consider it an example of a simple intervention that could not only enhance the value of primary produce, but would also be very useful as stock could be used to feed communities during recovery from a natural disaster.

An option suggested by the Ministry of Agriculture was for the development of cool-store facility (as a pilot project) that would enable information to be gathered on how such a development would work. This would include the costs of running and maintaining equipment, and how these costs would be met by the fishing and agricultural industries. To mitigate some of these difficulties, one suggestion was for the government to own these cool stores, making them responsible for running costs, maintenance, and repairs. While a possibility, another model could place ownership and responsibility for these stores on respective industry organisations, or on those using these facilities to store their produce.

With regard to agricultural produce, stakeholders noted that most farmers did not have cool-storage facilities for their goods, requiring them to resort to old techniques, such as pot-harvest, and making sure that produce stays out of the sun. Well-ventilated community cool-storage facilities powered by renewable energy could be placed in particular locations to enable a number of farmers to use them.

> *We know a lot of them don't have cool room and stuff like that...so we train them on simple pot-harvest techniques like handling, and stuff like that, not to leave them in the sun and shelf-life in terms of once a fruit has left the plant. Simple techniques like that because we know they don't have cool rooms, so we give recommendations like that.* (SROS)

Figure 11 Newly harvested vanilla

With regard to fisheries:

> *I will say...have a central location. For example, there's a fish market at Salelologa, we can have another one like that central place where these fishers have access because that's where the ice machine is needed as well – so all these guys can have access to these places. I would love to have a big facility next to the market, or the other side of the market built for purpose, just for the fishing industry.* (Ministry of Agriculture and Fisheries)

While support was also indicated for the agricultural sector, it was generally recognised that dealing with dispersed farmers may not be as straight-forward as it would be for the fishing industry.

> *Well the problem...is I would say, our farmers are individual and they're all scattered in all villages, so if we're looking at a cool store, it's probably best to have a central place. For a start as a pilot project I would say. Run it first and see what lesson learnt before you actually take it out...You don't want to have a one-off cooling facility...and then by next month...they have bigger problems they don't have the funding to repair it, and then what is the use of the skills without the*

ability to repair it. (Assistant CEO, Ministry of Agriculture and Fisheries)

One way to manage these types of risks suggested by the Ministry of Agriculture and Fisheries is for the government to own these cooling stores, just like it did with the ice machines, situated at Salelologa, Siumu, Mulifanua and Apia, but operated by the Tautai Association. Extending this model to cool stores, they could similarly be owned by the government, yet operated by the Tautai Association, possibly in the same locations as the ice machines.

4.4.7 Business Sector and Tourism

The main issues with regard to energy in the business sector, including tourism, were the cost and lack of stability of the national grid. Stakeholders representing small businesses (hoteliers, retailers, restaurant owners, and bakeries) supported any efforts that would reduce the cost of electricity services. To that end, all of these stakeholders recognised the benefits of using cheaper sources of renewable energy sources, albeit raising concerns about the up-front costs associated with the implementing systems, such as solar PV. At the same time, business owners sought, above all else, security of electricity supplies, citing detrimental impacts on their businesses from electricity outages, including in some instances damage to their electrical circuits due to surges. This was particularly problematic for hoteliers and restaurants catering to tourists. In the tourism sector, during episodes of brown- and black-outs, hoteliers told of having to offer tourists alternative accommodation, particularly if the electricity was off for more than a day. One hotelier noted the negative impact on their business when tourists left or had to be accommodated elsewhere when the electricity was out. This was particularly a problem on the island of Savai'i where disruptions are a weekly occurrence.

In Savai'i, electricity supply is not very reliable, once a week it will go down. Impact on tourists, would like greater stability. (Hotelier, Savai'i)

Figure 12 Electric powered coconut grinder

Figure 13 Coconut drying processor for export coconut oil

Another hotelier in Savai'i said they had an electrical fire caused by a power surge which forced them to replace the old fuse box with a pre-pay cash-meter power box. While most of the hotel and retail businesses said the cash-meter power boxes improved their ability to monitor daily power use, the cost of electricity security in Samoa continues to be an overwhelming issue for many of them.

> *You know what are the biggest issues that always come up in the Chamber is the cost of doing business and the cost of electricity in our country is very, very high.* (Chief Executive, Chamber of Commerce)

On the subject of businesses managing risks and disturbances, the strong view of the Chief Executive of the Chamber of Commerce was that a lot more needs to be done in terms of business resilience, noting the work be undertaken with overseas agencies on providing toolkits in preparation of events, such as natural disasters and climate change impacts. In response to such risks, this stakeholder noted that the Chamber of Commerce was knowledgeable about renewable energy, natural disasters, and climate change, but that:

> *In the long run, the cost of doing business is one of the key things for us.* (Chief Executive, Chamber of Commerce)

On working with overseas agencies on the issue of climate change, this stakeholder raised an important issue regarding the difficulties of managing an increasingly congested landscape of overseas agencies in the area of climate change, which is also relevant in the area of renewable energy.

> *On the issue of climate change, we're dealing with Westpac, UNDP, SBC, BFAT, USA, and we have MFAT...The issue with us having so many agencies is sometimes we see what they're trying to achieve is basically duplicating, almost duplicating what another agency is doing. So, we're taking an approach "guys let's have a consolidated approach." You guys as the donor community, have a conversation first, then come united to the Chamber...because I haven't got the capacity to do a business resilience training for this agency, then turn around and do another one...it's not practical for us.* (Chief Executive, Chamber of Commerce)

Another matter raised by many business stakeholders centred on the importation of sub-standard electrical appliances by newly established retail owners of Chinese ethnicity. While stakeholders recognised the benefit of low-cost products for consumers, the lack of enforced regulations meant that the market was beginning to be 'flooded' by products, such as wall plugs, adaptors, and LED lights that did not meet safety standards. While this could be interpreted as being, in reality, push-back against competition, these concerns exposed the possibility of gaps in Samoa's regulatory regime with regard to quality of imported electrical goods. This finding could have relevance for the renewable energy sector, if inferior products are able to be imported into Samoa. With regard to this issue, one stakeholder concluded that there was: "no regulation on this" (Educator, NUS).

4.4.8 Managing Risks: Natural Disasters and Climate Change

As a country exposed to an array of natural disasters (tropical cyclones, earthquakes, tsunami), and increasing evidence of environmental changes attributed to climate

change, all stakeholders noted the importance of managing these risks now and into the future. With regard to energy and these issues, many stakeholders recognised how investment in recovery management and changes in the energy sector have improved resilience, enabling people to access electricity services, and water supplies, in much shorter periods post natural disaster. Other improvements noted by stakeholders included better communications about down-times of services and expected restoration of electricity, water, and other utilities. otwithstanding that these improvements were only apparent in and around Apia; these advances indicated a level of advancement in the protection and recovery of vital infrastructure and the services they provide for people and their communities. While, as noted previously, more effective recovery efforts need to be made in Savai'i and remote communities, improved governance structures and learning from previous experiences point to greater resilience in relation to the management of disasters. Enhanced resilience was noted by a number of stakeholders:

> *The thing is to try and bring power back ASAP and there's always priority areas that's been given to us by the Disaster Advisory Committee. First thing is to make sure the hospitals have power. Secondly, make sure all those Samoa authority water pumps have power. Third is, I think, district hospitals. Fourthly, make sure all communication towers got power, and then you've got schools and all that.* (Government Chief Engineer)

> *A lot of people have actually said the power and water came back much faster than they expected than previous...with Cyclone Ofa and Val.* (Senior Official, MNRE)

> *The service has improved like during cyclones and that we've experienced in the past, it's been difficult to contact the ministries and get the response... When the electricity is down or water is down, but now like I said the service has vastly improved. I contact them and in 2 hours' time they're here. Or if they're not here, they'll say how long it's going to take them.* (Small Business Retailer)

In contrast to the rapid characteristics of natural disasters, slow-onset climate change impacts were observed by some stakeholders. Most acute was the increased propensity for flooding in low-lying areas from king tides and more powerful sea surges, resulting in significant coastal erosion in some areas of both Upolu and Savai'i.

To manage these and other detrimental environmental impacts, one stakeholder told of how some communities were beginning to prepare themselves in managing the effects of climate change. This included local communities taking the lead to work with the government to fund the erection of sea walls and the replanting of trees and mangroves to mitigate climate change impacts. While challenges still existed, particularly in relation to the maintenance and preservation of roads and fjords prone to flooding, the view of those public sector stakeholders was that more local communities were willing to take ownership of managing risks from climate change. At the same time, the slow-onset nature of climate change meant that, for some stakeholders, climate change was harder to get their heads around compared to the management of natural disasters where they knew what to expect.

> *Fortunate enough to interview some members of a village that are often affected by sea level rise. I interviewed*

with that kind of question – like what helps them cope or adapt to the changing environment. I was surprised that a lot of communities already have their own strategies. Everyone has a role in the village, like the kamaikai [ladies], and the guys, and they organise themselves. Some of them would look to the government for assistance...to establish seawalls and things like that. So they're starting with different projects like replanting, going in softly, like soft projects to encourage the people to protect their own environment. (SROS)

Figure 14 Low-lying fords on Savaii's main transport routes. Lano Village

Figure 15 Ford closed during Cyclone Gita resulting in agricultural spoilage

Figure 16 Erosion, Cyclone Gita, Lelepa Village Savai'i

Figure 17 Fortified seawalls (mid-water) protecting resorts

Reflecting on environmental changes, a number of stakeholders told of how they knew that deviations in their local environment indicated climate change impacts.

> *I can see it in the behaviour of the sea. It goes lower than usual other times and rises higher than normal. You can easily see where the sea is supposed to stop but now it comes much further and has eroded most of the sand.* (Hotelier)

> *It seems almost every week now that the waves become formidable. It never used to be like this. The seas are rough and the other thing is the wind – the winds are so strong and coupled with the violent waves are signs of the changing climate. Another sign is that of the river you can see there next to where I am – it is normally dry, the waterfall. When it rains, the ocean is completely covered in dirt. In this month, the strong winds and rough waves have visited our shores three times a week. Also, it rains, then it's sunny, then it rains, then it's sunny.* (Farmer/Resort Owner)

While the government has invested significantly in the building of sea walls to protect coastal regions, experience indicates that there is a need to educate villagers about these structures and stop them erecting their dwellings on, for example, sea walls.

Despite this increasing knowledge and improved disaster management and mitigation strategies to manage the effects of climate change, some stakeholders considered that Samoa was vulnerable given its high reliance on overseas funding. While appreciative of having access to finance, one stakeholder raised concerns that this dependence was crowding out the willingness of people to consider finding local solutions to mitigate such risks. They considered this as an exacerbation of Samoa's vulnerability.

> *When it comes to climate change adaptation, I think the challenges are really...with our people. If you take away all the donor funding, all the donor aid and just leave it and it's just us, our people and our lands, we are definitely becoming more vulnerable...in that sense...we feel we need the aid in order to adapt to climate change as opposed to what we can do on our own and what it is that we need to put in place so that we're self-sufficient.* (STEC)

4.4.9 Capacity Building and Research

Stakeholders recognised that a key factor for increasing the resilience of the energy sector and strategies to mitigate risks from climate change was investment in capacity building. Although Samoa enjoys a privileged position relative to many other Pacific countries by having the National University of Samoa and research capacity, more complex issues such as climate change mean that finding ways to enhance the skills of its population continue to be an important issue. With increased demand for research in areas such as energy and climate change, the respondent from SROS noted how the team of four researchers was expected to cover a range of important subject areas, including water, biomass, energy, and environmental assessments. So, while having some research capacity, the indication was that organisations such as SROS needed more research capacity to explore complex intersecting issues to inform policy and new investment opportunities.

We are not a big team and all with different specialities, so having to build the capacity to be able to carry out a new project we have to learn a lot of things about one project, and then it's onto the next project. (SROS)

As one way of investing in the skills of scientists employed by SROS, the respondent noted the importance of partnering with academic institutions, such as Victoria University of Wellington, with financial assistance from MFAT. This has enabled scientists to undertake postgraduate studies, such as master's degrees and PhDs. The need for increased capacity was also raised by those working specifically in the energy sector, citing shortfalls in the number of skilled technicians due, in large part, to skilled personnel migrating to work in other countries. Another aspect of capacity constraints noted by some stakeholders was the changing nature of technologies in the renewable energy sector. With technological advancements, one respondent noted the need for overseas consultants to train local technicians in order to sustain the maintenance and functionality of equipment. Another strategy to retain skills was for the renewable energy sector to employ overseas skilled personnel for a period to enable local personnel to be trained.

It's one thing to build all this technology; it's totally another thing to be able to sustain it. So for us to do that, every time we build something, a big part of our projects is the capacity development to ensure that when the contractor leaves we have someone who is able to do it. (SROS)

We've got a team of mechanics that do that. A lot of them are locally trained, most of them are. Now we have the APTC, Australian Pacific Technical College. I'm an electrical engineer...in my team I've got two guys from Australia, qualified from Australia, two guys from New Zealand, and one guy qualified from Fiji. (Government Chief Engineer)

Another important aspect of capacity building raised by a number of stakeholders was the transfer of skills from technical experts to communities in localities where renewable energy projects were operational. A number of stakeholders noted that the sustainability of new renewable energy initiatives was only possible with the skills to look after the equipment, and that without this capacity the long-term future of these projects could not be guaranteed.

Technology's new so our local people have to be trained on how to maintain them because at the end of the day the consultants come over...they do the training and then after the project they leave. So we try to make sure that our local people are trained so they would know how to maintain and sustain these projects. All of the current projects now we make sure there's always a training component that comes with it so I think in that sense there's always a benefit to our local personnel. (Senior Official, MNRE)

Notwithstanding these examples of capacity building occurring in Samoa, the view of most stakeholders was that further on-going investment in skills formation was required at all levels to keep up with changing technology and loss through outward migration. Stakeholders also noted the importance of investment in capacity building at the community level to assistance in the maintenance and repair of equipment.

One option currently under consideration is to hire someone from the village to be responsible for looking after equipment, such as solar PV units. This person would receive training to identify any problems and to request assistance from technical experts to ensure the effective functioning of equipment.

> *At the moment the plan we have is to have one of these village men...be hired as the caretaker for the plant. In the event that there's a technical or a mechanical issue with the plant then MNRE would step in and ask the assistance of others.* (Senior Official, MNRE)

The discussion with stakeholders about capacity building highlighted the importance investing in skills at a number of levels, from high-level science and technical skills to the transfer of skills at the village level. It also underpinned the importance of engaging with village members early in the planning stages so that capacity building can be considered from the outset, rather than at the end of the project. At the same time, like many other Pacific countries, capacity building in the area of renewable energy requires a steady stream of students trained in the area of renewable energy, rather than a one-off investment in skills formation. This was aptly argued by one stakeholder:

> *In Samoa we need more students to graduate with the knowledge in renewable energy having that technical knowledge. All the good students are going overseas and we only have a few.* (Science Tertiary Educator)

4.4.10 Built Environment

Energy saving in association with sustainable building design was acknowledged as being an underdeveloped area of concern for the government in comparison to other more pressing energy priorities such as distributive electricity.

> *This is not part of the conversation at the moment. This is not part of the conversation but it needs to be part of the conversation. It's just not part of the conversation. What people are so obsessed with right now is meeting energy targets and carbon emission and all that. This is something very achievable, something doable and something that we need to go back to our traditional designs.* (Chief Engineer, EPC)

> *The catholic church at Mapuifagalele and the Catholic Church up at Sacred Heart – up in Vailima, it's built in like the Samoan style and it's got the wind – the breeze that comes through it. It's just like a real faleo'o [wall-less Samoan traditional house]. Let's go back to our old traditional designs.* (Chief Engineer, EPC)

Good examples of buildings that were constructed 50 years ago and underwent an intensive maintenance programme during the last decade were those designed by the Latter-Day Saints Church. Several good key design features of these buildings are the high-quality construction techniques and durable materials used, the extended roofs and verandas for shading around buildings to minimise heat gain and the louvre windows in rooms for cross-flow ventilation.

So that approach is evident in the quality of the buildings that they have and indeed there are many of their buildings that are 50 years old and they are still in good condition. One architect, years ago, who was a consultant to them said, "Well, you know this church, they build rock buildings, because they want a long-lasting structure they don't want walls that can be kicked in or walls that will deteriorate with age or walls that discolour because of moss growth or other things." So the materials have also been considered and they have found that rock buildings are – they work and these are reinforced concrete frames and masonry infills. They use textured finishes on their block walls which tend to stay clean and lower the maintenance. So, we've seen that this building approach is very successful. (Senior Civil Engineer/ private firm)

Figure 18 Latter-Day Saints Church in Lufilufi, Upolu. allowing for open cross-ventilation.

(Source: https://www.mormonnewsroom.org.nz/article/new-church-meetinghouse-design-combines-beauty-and-practicality-for-pacific-island-conditions)

Several participants said traditionally designed Samoan architecture and construction is embedded with passive ventilation using techniques which leverage natural airflow.

See, even the way they build Samoan fales now, there's no thatched roof. The thatch roof is what provides so much part of the cooling. 'Cause if you've got roofing iron and all that – it's hot. But the old thatch roof – I don't think there is a thatch roof left in Samoa. (Chief Engineer, EPC)

Several participants emphasised the importance of construction design that can withstand Samoan tropical cyclonic conditions, which are often overlooked or ignored.

> *The most important thing to be mindful of are how the braces are done. The braces for the building, they're small and in most instances are bolts/nails. When the building is locked down, make sure of these things required to lock the building to avoid destruction from cyclones. No matter what we say must be done etc when the cyclone comes, however strong the building is.* (Construction Business Owner, private sector)

When asked to contribute to the structural engineering design of a vegetation roof with voltaic panels for the JICA-funded Secretariat of the Pacific Regional Environment Programme (SPREP), this participant had based the design on their previous work on the net zero carbon American Samoa Environmental Protection Agency building in Pago Pago in 2014. On that project, they had to configure the right types of window frames that would withstand major climatic changes.

At the village level, the biggest energy users were identified as church buildings with poorly designed ventilation that were accruing major electricity and fuel debts from air conditioning utilisation.

> *Just recently I've been seeing a lot of churches running the air condition and I am trying to tell them not to do that because it's very, very expensive to have air condition but for some reason people think that building air conditions in churches is a good thing that the Lord will like and appreciate...But you are talking about 1 ½ hours for one day and who's gonna fork the bill for that? Well, people always want to do good things for their churches and all that so the churches are always – in a normal village without any business – without any, you know – just a normal residence and the church – the church is always the one that takes a lot of electricity which includes the faifeau's [church minister's] house.* (Chief Engineer, EPC)

To mitigate the effects of floods, more buildings are being constructed at the recommended 2.8 metre floor level or above in Apia.

> *Gita, I think was a good example of the effects of storm surge. The Apia town area flooded – all the flat lands in Apia flooded. The storm lasted through at least one high tide, possibly two high tides and from the photos, the flood waters were right back to Taufusi and knee deep. So looking at that level, you would say, that would be around 2 metres.* (Chief Engineer, EPC)

With respect to the barriers confronting Samoa's building sector, some participants felt that there were a number of donor-aid building projects which continued to stifle Samoa's workforce capacity and design innovations. Among those frequently mentioned were the buildings constructed by the 'tied-aid' projects being funded by the Chinese government who brought their own people from China, leaving the supervision and compliance inspections in the hands of local Samoans.

> *The buildings they're building, I don't think they're good buildings. I don't think – because now they're under-cutting all the other local builders. I think some local builders are not that good but some of them are good. I think some of the Chinese builders are not good builders and now they're just*

coming in and putting in lower prices and then – like, the hospital they build and there's big cracks in the wall. (Senior Public Servant.)

4.4.11 Summary

In an effort to become 100% renewable by 2025, the renewable energy sector in Samoa has expanded greatly to include hydro, solar PV, wind, and bioenergy sources. This has been possible by the increasing number of countries and organisations seeking to meet their overseas development assistance commitments by investing in clean and sustainable sources of energy in developing countries such as Samoa. Over the past decade and a half this has resulted in new renewable energy initiatives that have increased the proportion of electricity generation, providing improved stability of the electricity grid and greater choice for consumers. Based on responses from stakeholders, there is little doubt that the growth of the renewable energy sector in Samoa has occurred as a result of efforts by this and past government administrations to improve governance structures and build the capacity of the country to support the development of new renewable energy initiatives. This has resulted in, among other things, improved governance structures to imbed the concept of resilience and adaptation to risks and disturbances within policy formation, and enhanced research capability to provide evidential data in areas such as the conversion of biomass to bioenergy.

With regard to managing risks and disturbances from natural disasters and climate change, these improvements have led to greater confidence in timely restoration of vital infrastructure post an event. Many stakeholders told of improved recovery times in the supply of vital infrastructure services such as electricity and water, increasing the capacity of local communities to get on with other recovery efforts and to get back to normal. An important part of the strategy to improve the resilience of Samoa has also included the willingness of villages to play their part in developing response pathways and to know how to communicate with central response teams in the event of an emergency. Many stakeholders noted efforts being made by government agencies in negotiating and working with local communities, compared to in the past where these communities were simply informed of decisions already made.

Despite these positive developments, the data indicated that Samoa, like many other developing countries, continues to face a number of challenges. These include on-going debate on the configuration of electricity systems between centralised and distributed structures, ways to expand capacity building, and methods of assisting the agricultural and fisheries sectors to get their goods to market. On the first of these, currently the vast majority of renewable energy supplies are fed into the grid, supporting the supply and stability of electricity services to consumers. While this has resulted in improved stability of the grid, with decreased episodes of brown- and black-outs, the lack of storage means that when weather conditions change breakdowns occur, resulting in negative impacts, particularly for businesses and the tourism sector. With recent investment to improve the storage of energy, it is likely that the grid's improved levels of stability can reduce economic losses that have been a feature of the electricity system. Notwithstanding these efforts, feedback from stakeholders indicated the need for further consideration between centralisation and

stand-alone renewable energy systems, as ways of increasing resilience.

The second of these challenges, despite having some important research and technical capability, the consistent views of stakeholders were that continuing investment in capacity building was needed in order to keep up with increasing demand of the sector for new forms of energy. This capacity building includes the need to understand the environmental impacts of new projects to enable a balance between energy progress and environmental and cultural values. While the breakdown of negotiations at Sili was portrayed by some stakeholders as a 'failure,' for at least one stakeholder it raised the importance of community involvement in renewable energy investments. Just like the complex thinking required for sustainability analysis, the data indicated further capacity building is needed to enable the highest standards of environmental assessments.

Finally, renewable energy has the potential to add value to the agricultural and fisheries sector. With increased demand for niche export commodities, such as cocoa, coffee, and vanilla, and fish for domestic consumption, stakeholders suggested that more could be done to improve the process from the land and sea to the market. One option raised in the discussions with stakeholders was the development of cool stores to improve storage and reduce the incidences of food spoilage, particularly in the fisheries sector. This simple but effective intervention was considered as having the capacity to improve sustainable development and, depending on use, provide valuable storage of food in the event of a major emergency.

5. Discussion

5.1 Introduction

This chapter discusses the analysis of data collected from stakeholders in Kiribati and Samoa against the literature on sustainable development and resilience. It also explores three concept proposals for future research that have the capacity to enhance sustainability and strengthen the resilience of these countries to better manage risks associated with natural disasters and climate change. The chapter is divided into three main areas. The first discusses the relationship between changes being undertaken in the energy sectors of Kiribati and Samoa in relation to sustainable development. The second section examines how these changes are contributing to resilience. The last section explores proposals for further research.

5.2 Renewable Energy, Sustainable Development and Resilience

The energy sectors of Kiribati and Samoa have been undergoing significant transformation over the past 2 decades with the aims of reducing their reliance on imported fossil fuels and broadening access to electricity services to their populations. Over the years, these efforts have resulted in a greater proportion of their respective populations now having access to electricity, with a strong emphasis in Kiribati on assisting those living in remote outer islands. The provision of electricity to the most vulnerable households and communities is consistent with the SDGs, the milestones of which both countries have made commitments to meet. The provision of electricity services and other renewable energy products to a broader population base is consistent with the strong links recognised in the SDGs between energy and sustainable development. Our field work confirms that both Kiribati and Samoa recognise the benefits of ensuring that more of their citizens enjoy the benefits of energy services as a way of improving socio-economic outcomes and furthering new opportunities, particularly for the most vulnerable households and communities.

Discussions in both countries revealed a good understanding of the SDGs and the commitments made to ensure access to affordable, reliable, sustainable and modern energy for all (Griggs et al 2017). While our field work revealed the SDGs to be more deeply integrated into the policy-formation process in Samoa, there was a broad understanding in both countries that energy plays a crucial role in reducing poverty through enhancements in, among other things, education, health, water supply, and business development (Griggs et al 2017). Overwhelmingly, stakeholders in both countries understood the benefits of energy sources that provided households with lighting (assisting with education and safety) and cooling (refrigeration of food and the use of fans). Discussions with government ministers, officials, and members of the private sector in both countries also promulgated the benefits of clean and affordable sources of electricity in

underpinning growth of the commercial sector, particularly in attracting investment for new ventures.

In keeping with the SDGs, responses from stakeholders also underlined the benefits of examining the adequacy of regulatory frameworks, and increasing the capacity of renewable energy as more affordable sources of electricity and stand-alone solar PV systems roll-out to more remote locations. As articulated in the SDGs, a strong emphasis from stakeholders was making the most of abundant sources of energy from the sun, wind, and biomass. While hydro was also considered a renewable source of energy, the use of this resource was more complex due to concerns from local communities that it would spoil important river sites and reduce the social and cultural values of this commodity. Notwithstanding, this difficulty in Samoa, support for clean sources of affordable energy to promote sustainable development was well and truly accepted. Rather than Kiribati and Samoa simply seeking to meet the milestones set out in the SDGs with regard to energy, our findings suggest that the SDGs have acted as a 'driving force' for investment in alternative renewable energy sources.

Despite the benefits of this alignment in terms of sustainable development, achieving sustainability is fraught with complexities. As argued by Folke et al (2002), sustainable development is a complex process with a multitude of interconnecting parts. Nowhere is this more evident than the intricacies associated with rapid urbanisation in Tarawa and Apia. The desire of more people to participate in the cash economy through paid employment, and access to better education and health services, has resulted in a great level of complexities, particularly for the most vulnerable households, where a large number of family members are not in paid employment. The move from remote localities to urban living for an increasing proportion of their populations has made sustainable development a more difficult goal to achieve. Nowhere is this most evident than the complexities facing those living on Tarawa.

In the case of Tarawa, the combination of unsustainable population densities in South Tarawa, along with high unemployment, poverty, and inadequate housing suggests the need for a well-coordinated multi-pronged development strategy to enhance the design, form, and function of urban living. While improved access to electricity and enhanced stability of the grid in Tarawa has resulted in improved electricity services to households, public organisations and the private business sector, reforms in the energy sector need to be matched up with reforms in a range of areas related to urbanisation. Among the most important of these is the need for the development of an urban plan for South Tarawa that would have the capacity to identify key areas for achievement by 2030 and beyond. As argued by Storey and Hunter (2010), who refer to Tarawa as the environmental 'perfect storm,' the complexity of issues facing urban Tarawa poses a difficult task that will not be easy to undertake. Indeed, it is likely to require a range of skills, working with key government, local government, and other stakeholders in Kiribati to identify the critical interventions that will enhance sustainability and improve the lives of those living on South Tarawa. One of the most difficult areas identified by our field research is the nature of the governance structure that has the capacity to take sustainable

urbanisation forward in South Tarawa. Currently, we argue that the governance structure is overly skewed towards central government, with local government being left to deal with a small number of functions, such as garbage collection and provision of building permits, with very limited financial resources, as well as being largely unable to determine future urban growth.

While we are mindful of the difficulties in the distribution of resources between urban and remote locations, given the needs of those with few resources living in the outer islands and in areas of Savai'i in Samoa, the reality is that in the case of Kiribati some of the most significant risks lie with those living in urban spaces. High-density informal housing, the lack of an integrated waste management system, and environmental degradation from people and climate change pose a number of risks, particularly in relation to health outcomes, safety to women and children, and social and cultural change. While perhaps not as dire as South Tarawa, recent field-based research by Thornton et al (2013) indicates the increasing presence of landlessness emerging in low-income areas in Apia. This research reveals the expansion of landless urban settlements with households that are alienated from rural village-based kin, and by extension, customary land (Thornton et al 2013). This is not dissimilar with the increasing presence of informal settlements occurring in the northern parts of South Tarawa, where those coming from the outer islands do not have land and set up informal housing wherever they can. In both cases, some of the most vulnerable households and communities are those who have moved to the urban centres of South Tarawa and Apia, but, in the absence of land ownership and familial connections, are living in poverty, and, in the case of Kiribati, living in inadequate informal housing, without access to electricity services, and water/sewage services.

Other significant challenges to the achievement of sustainable development in Kiribati and Samoa include the high cost of electricity services, and concerns about the availability of fresh water to sustain the growing populations, particularly on Tarawa. On the first of these, while our findings identified more people having access to electricity services than ever before, the cost of electricity continues to be prohibitive, particularly for the lowest income households. While both Kiribati and Samoa have implemented targeted pricing systems (based on income) to assist those suffering hardship, the lack of information on this scheme, particularly in Tarawa, was a significant concern. It was not possible to discern why the pricing system was not delivering for the most vulnerable households, as the main provider of electricity, the PUB, was not aware that there was a problem. This difficulty may account for the many stories told by stakeholders on Tarawa of the poorest households being disconnected, and the inventive ways people sought to connect to electricity services.

In Samoa, the introduction of prepayment meters in 2014 was indicated as being a helpful way of managing electricity costs for households and small business operators. While not reducing the costs of electricity, this billing system was credited by many stakeholders as allowing customers to buy electricity credit to match their household income, preventing unaffordable end-of-month power bills which, if unpaid, can lead to disconnection. The success of this system suggests that something similar might be useful on Tarawa, alleviating the stress of

households being disconnected and mitigating risks associated with the use of unsafe practices for accessing electricity. Although the implementation of such a billing system on Tarawa would not be inexpensive, this could become viable with assistance from overseas donors, as it was for Samoa. Analysis of the effects of systems, such as pre-pay billing for electricity services, by Vijay et al (2017) suggests that investment in digitisation and communications can be significantly beneficial, particularly for the poorest households. We argue that these benefits include reducing the marginalisation of the poorest households, thereby improving socio-economic equity, necessary for sustainability and resilience.

Adding to this complexity, climate change was identified as a major risk going forward, not only in terms of declining water levels in rivers used for the generation of hydro power in Samoa, but in terms of access to fresh water sources. Taking a broad approach in analysing the management of risks, water security emerged as one of the most significant issues, particularly for Kiribati. While in Samoa the issue of fresh water centred on the on-going debate between the development of hydro and the preservation of fresh water systems, and risk to water supplies from less rainfall, in Kiribati the issue of water was articulated in terms of risks to human existence. Unsafe water from bore wells, from the transfer of pollutants, combined with concerns about the long-term viability of fresh water lenses and inadequate infrastructure culminated in significant apprehension among stakeholders about risks to the quality of life for citizens. Indeed, it was the risk to this resource, rather than climate change per se, which was viewed by stakeholders as determining the viability of human habitation on Tarawa in the future. Unsurprisingly, the spectre of I-Kiribati being forced to leave Tarawa, or Kiribati, was vehemently rejected as amounting to failure.

It was within this context that the issue of whether solar PV could be used to power desalination plants (large and small), and to what extent this renewable energy resource could be used to make water safe to drink, was raised, particularly in regard to those villages on Tarawa where water supplies are restricted. With contaminated water posing a major health hazard for children under the age of 5 in Kiribati and many other developing countries (WHO 2012), studies indicate two main options for desalination and purification (Karagiannis and Soldatos 2008; Koschikowski et al 2003). These include solar PV coupled with reverse osmosis (RO) systems and solar thermally driven distillation systems. The problem is that while grid-coupled RO systems are well developed, difficulties exist in operating small-scale solar PV-driven, stand-alone systems (Koschikowski et al 2003: 296). This is not to suggest that small-scale stand-alone systems should not be considered, other than to recognise that this method is likely to be of most use in small remote areas. Alternatively, membrane distillation is considered as having several advantages, although these studies would suggest that pilots should be used in a place such as Tarawa to assess its viability there. Given the importance of fresh clean drinking water for the sustenance of the population of Tarawa, we recommend the development of a pilot to assess the viability of solar PV for desalination and purification at a smaller community scale. This diversification would be an important contribution to enhancing

resilience, particularly if the major water lens at Bonriki became damaged, or if the infrastructure somehow failed.

Another issue with regard to the use of renewable energy and sustainability identified by our field research and worthy of consideration was the high set-up costs of solar PV for the lowest income households and poor communities. With a lack of affordability constituting a serious barrier to entry for the most vulnerable households and communities not connected to the grid, the question arises to what extent financial assistance and support could be provided to these people to reduce energy poverty. Without some form of assistance, these households and communities are likely to continue to be marginalised, raising concerns about the achievement of sustainable development in a way that leads to greater social and economic fairness. With access to affordable energy, a key factor for the reduction of poverty (Sovacool 2014), we recommend that more could be done to ensure improved access to renewable energy such as solar PV for the poorest households, including those on Tarawa, Savai'i, and Upolu. Our argument for targeted assistance for those most in need is based on the generally accepted view that there is a two-way relationship between the lack of access to adequate and affordable energy services, and poverty. Commonly described in terms of a vicious cycle in which those who lack access to energy are often trapped in a reinforcing cycle of deprivation, those experiencing energy poverty are unlikely to be able to participate in the economy, further reducing opportunities for further generations (Vera and Langlois 2007).

Finally, although not linked to renewable energy directly, environmental risks from slow-onset climate change raise concerns about the achievement of sustainable development. For example, the loss of coastal land is becoming a significant problem for both Tarawa and Samoa, as increasingly more powerful sea surges destroy valuable land and roads. Accounts from stakeholders of the destruction of coastal land were considered by many as the start of environmental threats that could have significant consequences for the livelihoods of local residents. While it could be argued that where possible coastal residents should move further inland to manage such risks, this line of reasoning does not adequately take into account the critical relationship between people and land. In both Kiribati and Samoa, the land is deeply connected with social and cultural values that sustain the identity of persons, rather than being a commodity that can easily be traded away. The lack of viable options is even more acute on Tarawa where the lack of space often requires families to do the best they can to survive in what can only be described as hazard zones. Although many families living there do the best they can to obtain access to electricity services, the increasing complexities associated with living in these conditions raises serious concerns about sustainability. So, despite being tangential to the issue of renewable energy, our study raises the benefits of integrated programmes being developed in both countries to manage risks associated with coastal erosion.

Figure 19 People on Abaiang standing where their homes used to be.

(Pacific Guardians)

Finally, as with the SDGs, we conclude that access to affordable renewable sources of energy is consistent with the principles of sustainable development. While this research has not been able to cover all aspects of the nexus between energy and sustainability, our findings suggest that access to affordable clean sources of energy is of utmost importance for the achievement of socio-economic inclusiveness. In the absence of energy, the lowest income households and communities can be expected to experience inter-generational poverty, only adding to the equity divide. Any widening of this divide would not only be at odds with the tenets of sustainable development, but also stand in the way of meeting the goals set out in the SDGs. This research indicates a number of ways of improving access to sustainable forms of energy, including fairer pricing systems, pre-pay billing, and support for the lowest income groups to access solar PV. With water being a critical resource for sustaining life, we also suggest the piloting of a solar PV-driven project for the desalination and purification of water. Lastly, with an increasing number of donors seeking to invest in renewable energy in the Pacific, we recommend that investment in the energy sector is coordinated to maximise sustainability and ensure that new projects are not donor driven, but carried out in the interests of donor-receiving countries, such as Kiribati and Samoa.

Table 5: Development Partners of Renewable Energy Projects in Kiribati and Samoa

Bilateral Donors	New Zealand, Australia, Japan, China, Taiwan, Germany
Multilateral Donors	European Union, World Bank Pacific Regional Environmental Programme (funding from the UNDP, World Bank, and Denmark)
Other Funding Agencies	European Investment Bank, Asian Development Bank, International Union for Conservation of Nature (IUCN), Pacific Island Forum Secretariat (PIFS), Secretariat of the Pacific Community (SPC), International Renewable Energy Agency (IRENA)

5.3 Renewable Energy and Resilience

So how does the concept of resilience relate to sustainable development? The review of literature on resilience would suggest that there is not much of a link, as the topics of sustainable development and resilience have emerged from two distinct areas of research. With its origins in 'engineering resilience' (Holling 1973), much of the literature on resilience, until very recently, has been focussed on the ability of systems to 'bounce back' to their pre-existing form or path before a disturbance. The analysis of responses from stakeholders strongly suggests that the bounce back conceptualisation of resilience is inadequate for a number of reasons. One of the most significant of these reasons is the lack of recognition of 'sustainability' as a feature of resilience, and that preparedness and planning to enhance resilience encapsulate the emergence of new baselines, both before and after an event. Another reason is the inability of such a definition to take into account wider strategic issues that influence resilience, including economic, social, cultural, and environmental outcomes. This suggests that to understand, for example, the impact of renewable energy on resilience, there is a need to take a wider integrated-systems approach that examines not only energy resilience, but the wider impact of alternative forms of energy on issues such as socio-economic outcomes, energy poverty, fairness and equity. On this basis, we argue that the positive impact of renewable energy on sustainable development, as recognised by the SDGs, adds to the resilience of local communities and wider society in managing risks.

Adding to this broad view of resilience, this section discusses the potential of renewable energy to enhance the resilience of Samoa to better manage rapid-onset risks, such as those emanating from natural disasters. As noted previously, as a country exposed to a significant number of risks from natural disasters, our research indicates the varied efforts being made in Samoa to learn from the past to strengthen its ability to manage future risks. Most significant among these has been the use of systematic reviews in the aftermath of a natural disaster, which seek to assess the adequacy of Samoa's response with the aim of improving the management of such risks in the future. The participation of internal and external agencies, NGOs, and local communities in this process, suggests a level of organisational flexibility which Gupta et al (2010) argue is important for building resilience.

In addition to organisational flexibility, the establishment of governance structures that have the capacity to enhance the resilience of Samoa to manage future risks can be attributed to the Samoa Disaster and Emergency Management Act (2007). By legislating, among other things, roles and functions, leadership, ministerial coordination and capacity building, this statute has embedded the management of risks within and across government (Samoa Disaster and Emergency Management Act 2007). In addition to the establishment of new governance structures (National Advisory Council, Disaster Advisory Committee, and the Disaster Management Office), designed to clarify responsibilities within government administrations and the public sector, the Act (2007) legislates for the National Disaster Management Plan to be communicated to all sectors of the community so that they can prepare to respond to threats such as natural disasters. While it is clear that legislation alone does not deliver resilience, it is an important tool for enforcing a whole-of-government approach to the management of risks. Most significantly, it holds current and future governmental administrations to account for the effective management of risks, in terms of pre-planning within and outside of government, and the quality of recovery efforts.

Notwithstanding these benefits, it is important to consider the arguments advanced by Duit (2010) regarding the need for governance structures such as these, to maximise opportunities for innovation as to how to best engage with key stakeholders. Although our research indicates that processes of engagement with local communities form part of the tapestry of building resilience, we are unable to comment on the quality of those engagements. The example of Sili is an interesting case in point. While many stakeholders described negotiations between government and village elders, which resulted in the hydro project not going ahead, as a failure, such a portrayal is not particularly useful. Rather, the ability of village elders to represent their views regarding their connection with the ecological system that sustains them indicates a level of 'openness,' which Harrison (2003) argues is an essential feature of resilience. This reasoning underlines the importance of social participation in processes of engagement, particularly when impacts on ecosystems may affect local communities.

At the same time, the Sili process also highlights the complexities associated with the development of renewable energy to strengthen the resilience of the energy sector in Samoa. From an energy perspective, renewable energy has the capacity to enhance energy resilience in a number of ways. One of these, identified by Dornan (2014) and Alanne and Saari (2006) is the decentralisation of renewable energy technologies that enable the production of electricity services in the eventuality of damage to the nation grid from a natural disaster, or other risks. Valentine (2011) argues that the loss of one wind-power turbine or a cluster of wind-power turbines is significantly less damaging to a power grid than the loss of large power stations. Using the example of Japan, Valentine (2011) notes that had Japan had a network of wind turbines spread across the northern island of Hokkaido, the damage to Japan's electricity infrastructure would have been negligible, compared to the major damage incurred by the 2011 Tōhoku earthquake and tsunami

to its coal-fired power stations and four nuclear reactors.

The argument advanced by Valentine (2011) and Alanne and Saari (2006) is that by spreading risks, distributed renewable energy systems can enhance energy resilience. Within the context of managing risks such as natural disasters, distributed energy systems would enable local communities to access vital electricity services in the event of a major failure of the national grid. In Samoa a converse approach has been used to build energy resilience. Rather than promoting stand-alone renewable energy systems (other than a few in remote areas), Samoa's focus has been on using renewable energy to add to the national grid and increase its stability as it comes under increasing demand for electricity services from consumers. The question which arises is whether the centralised approach used by Samoa reduces its energy resilience, particularly in relation to managing risks from natural disasters. While the literature review would suggest this would be the case, a number of key issues suggest otherwise. The first of these is the impact of reducing dependence on fossil fuels. Unable to influence the fossil-fuel market in any way, we argue that any reduction in Samoa's dependence on imported fossil fuels increases its resilience to external market risks. By reducing costs on fossil fuels, Samoa has the capacity to utilise scarce financial resources in higher priority areas such as education and health, adding to social resilience. This logic is not intended to convey that the centralisation of renewable energy is the best approach but, rather, that decreasing its dependence on fossil fuels and making a worthwhile contribution in the reduction of greenhouse gases are important benefits. Having listened to stakeholders in Samoa, we consider that renewable energy can make an important contribution in assisting farmers and fishers with storing their produce in cool stores to reduce food wastage and reduce the number of times people have to go fishing.

Finally, consistent with the model on resilience discussed in the literature review, Kiribati and Samoa continue to be challenged by capacity constraints. While this is particularly worrisome for Kiribati, this is also a problem for Samoa albeit for different reasons. In the case of Kiribati, the implementation of renewable energy systems in the outer islands, and increasingly on Tarawa, has grown exponentially compared to the growth of skills needed to manage, maintain, and repair solar PV systems. We argue that without support for investment in capacity building in Kiribati, this situation will only get worse, with solar PV equipment being unable to be adequately maintained and repaired, reducing energy resilience in the future. While the situation in Samoa is less dire, evidence from our field research unveiled the immense pressure that the small group of experts in MNRE face in managing new renewable energy projects. Given the long-standing relationships between organisations in Samoa and New Zealand tertiary institutions on various aspects of renewable energy that have enabled people to gain educationally recognised qualifications, we consider that the focus on capacity building at this stage should be on Kiribati. We recommend the development of a capacity-building strategy for Kiribati, focussed on enhancing technical training and communications ICT development to enable solar PV equipment to be adequately maintained. Concerns raised by IRENA (2017) regarding capacity constraints within the PUB suggest that the issue requires further investigation.

5.4 Future Investment in Renewable Energy

Analysis of data gathered in the field suggests that energy resilience is an important aspect of resilience. Consistent with Khoo (2015), our research indicates that for Kiribati and Samoa to achieve energy resilience, their systems need to have the capacity to undertake future planning in relation to the effective management of risks. Put another way, energy systems that are unstable, unaffordable, unsustainable, and lacking accessibility undermine energy resilience and the ability of these systems to improve the lives of their citizens. It is this desire to achieve energy resilience that has led Kiribati and Samoa to reduce energy losses. In the case of Samoa, the installation in July 2018 of a battery storage system at Fiaga Power Station able of storing 6 MW of electricity (with a second unit planned near Faleolo Airport that will add another 2 MW of storage) reflects the need to improve the reliability and efficiency of its existing infrastructure. As noted by Prime Minister Tuilaepa Sailele Malielegaoi, not only are these additions "more environmentally friendly than diesel generators, but enhance Samoa's stability and cost-effectiveness" (Radio New Zealand 2018). So, while reliability and diversity of energy sources emerged as key issues for both Samoa and Kiribati, the debate between centralisation and distributed electricity systems was, in contrast, muted.

While the focus on reliability is understandable, we consider that there is a case for greater attention to be paid to the benefits of distributed systems from a resilience perspective. As argued by Panteli and Mancarella (2015), this is particularly relevant given the increasingly destructive forces of natural disasters. They argue that it is becoming more apparent that further consideration beyond the classical reliability-oriented view is needed for keeping the lights on. This is evidenced by several catastrophes that occurred worldwide in the last decade" (Panteli and Mancarella 2015: 58) The reasoning behind this statement is that major disasters can incapacitate large parts of a country's power grid, including sub-station transformers and substations as a result of major natural disasters. O'Brien and Hope (2010) note that while one of managing such risks is to develop larger and stronger centralised electricity network (components which may become redundant over time), smaller more localised approaches have a greater capacity to enhance resilience.

This reasoning suggests that distributed generation systems in Kiribati and Samoa may confer greater resilience benefits over centralised systems alone. For example, while the redevelopment and development of micro-hydro facilities in Samoa will assist the country to reach its goal of achieving 100% renewable energy generation, the question is whether, from a resilience perspective, one or more of these facilities might offer enhanced resilience outcomes if they were not necessarily absorbed into the central grid. While this study is not in a position to answer this question, it serves as an important reminder of the need for strategic energy plans to consider the optimal mix of centralised and distributed electricity systems from a resilience perspective. The issue is also highly relevant given the commitment made by Samoa and Kiribati, under the SDGs, to reduce poverty and increase the health and well-being of its citizens, including the most remote communities.

Overall, we consider that the renewable energy diversification strategy employed by both countries is sound, both from the point of view of reducing their dependence on imported fossil fuels and increasing energy resilience. Looking to the future, Kiribati and Samoa are likely to have new opportunities to diversify further, which will go further to increasing their ability to become more sustainable and resilient to the effects of natural disasters and climate change. These may include the use of battery storage systems, already used in Samoa to store solar PV energy, or newer and more complex technologies, such as new versions of OTEC. The use of such batteries could also be placed at the community level as part of a more distributed strategy to maximise resilience. The key will be to ensure the capacity of these countries to manage new technologies through effective on-going training at numerous levels, including at the community level.

5.5 Research Question and Sub-Questions

Our analysis suggests the following answers to the research question and sub-questions posed at the start of this project:

Research Question:

> How can investment in renewable energy in Kiribati and Samoa strengthen the adaptive capacity and resilience of Kiribati and Samoa to manage the effects of natural disasters and climate change?

Our findings indicate that the use of a wider range of sustainable energy sources adds to the adaptive capacity of Kiribati and Samoa in a number of ways. The first of these is the ability of these countries to reduce their dependence on fossil fuels to enable them to use their scarce resources in higher priority areas, such as education and health. The second is capacity of renewable energy sources to strengthen the national grids of these countries, enhancing energy resilience, resulting in fewer brown- and black-outs which, in the past, stood in the way of economic development. The third way is the ability of new forms of renewable energy to reduce the costs of electricity generation making electricity more affordable for all citizens. This is particularly important for the most vulnerable communities and households who have not previously enjoyed the benefits of lighting for education and business development and increased safety for women and children.

Our argument is that access to affordable and sustainable sources of energy for all citizens has the capacity to reduce poverty and inequality, and increase the participation of people in the economic development of their countries. This wider involvement of citizens enables countries to adapt to new risks. The converse is leaving portions of the population in remote locations with few resources to try to manage complex risks such as increasingly fierce storms and climate change impacts. Our research suggests that an important adjunct to access to renewable energy is the need for increased investment by Kiribati and Samoa in effective communications and ICT systems. This is particularly the case in Kiribati, where outer island 'remoteness' can be exacerbated by a lack of suitable communications.

In conclusion, while it can be argued that renewable energy per se is unlikely to thwart risks, our findings suggest that wise investment in renewable energy sources adds to energy resilience and, by enhancing economic participation, adds to adaptive capacity. Future investment should ideally also examine the mix between centralised and distributed energy systems.

Sub-Questions

1. What has recent research found regarding the use of renewable energy and adaptive capacity and resilience of local communities at risk of natural disasters and climate change effects?

As noted in the literature review, the management of risks such as natural disasters and climate change requires systems thinking. No one factor or intervention has the ability to assist communities to manage complex events that inflict widespread damage, be they in the form of rapid-onset risks or slow-onset changes. Drawing from resilience thinking, strengthening adaptive capacity and enhancing resilience are dependent on many factors, including the quality of governance structures, social resilience, and the flexibility of organisational structures to be effective. The literature strongly posits that a key aspect to adaptive capacity and resilience is dependent on the quality of engagement between central structures and communities. It suggests that processes which are centred on effective participatory engagements are more likely to result in robust systems where local solutions have a voice and where local communities have a role in managing risks. So, while it could be argued that renewable energy has an important role in assisting communities to manage and adapt to risks, it is the quality and strength of whole systems that matter most. These include the ability of communities to maintain local infrastructure, communicate their needs, and be involved in the uptake of changing technology.

2. What future investments should be considered in renewable energy solutions in Kiribati and Samoa that will strengthen the resilience of local communities?

Both countries have made commitments to increase the proportion of renewable energy as part of their energy mix, particularly in relation to electricity generation. In the case of Kiribati, greater investment in solar PV could reap further benefits if the technology was available to a greater range of households, particularly the most vulnerable. Looking to the future, the uptake of solar PV in Tarawa should be further encouraged. With over half of the total population of Kiribati now residing on Tarawa, the use of solar PV should be encouraged at the local, household level. While we recognise that this will not be achieved overnight, solar PV should be considered alongside any new housing developments. With housing being such a critical issue for the health and well-being of those living on South Tarawa, any new housing investment should be future-proofed with solar PV, along with water and sanitation enhancements. Additionally, efforts to plant mangroves should be further encouraged. By slowing sea surges and encouraging the regeneration of inshore marine food sources, mangroves have the capacity to protect local communities from climate change impacts. We also indicate the benefits of using solar PV for the distillation of water, a resource becoming

increasingly scarce which could undermine the viability of long-term habitation on these atoll islands.

While these issues have some relevance for Samoa, the wider range of renewable energy sources available provides more options for future investment. One of these areas referred to previously is examining the balance between centralised and distributed electricity systems from a resilience perspective. With increasing episodes of major rapid-onset events, investment in stand-alone systems should be examined, alongside options for new technology for Samoa, such as OTEC. Other options include the use of solar PV for the storage of agricultural and fisheries produce prior to going to market. In a disaster event, these cool-storage units could also be used as useful cooling storage to avoid food spoilage. We recognise that, while this is a small addition to resilience, it is an example of a simple system of storage that can add value for local communities.

3. What skills and training and regulatory frameworks are needed and how could they be best provided to enable the effective operation of renewable energy equipment now and into the future?

Stakeholders from the renewable energy sectors in both countries noted concerns about the need for on-going capacity building with the increased demand for clean, affordable and sustainable energy sources. In Kiribati, the PUB and a private sector solar PV company interviewed for this research noted the problem of skill shortages, relating primarily to technical proficiency, necessary for maintaining equipment and responding to problems and equipment failure. While the aim of these stakeholders is to invest in capacity building, they noted that in the absence of some form of training organisation on the ground in Tarawa, these skills shortages were likely to be on going. Part of the problem was the need to train people within remote communities who could undertake routine maintenance and manage equipment failures. While these stakeholders acknowledged the possibility of sending people to be trained in New Zealand and Australia, it was the large number of people requiring upskilling that made the costs of training prohibitive.

In contrast to Kiribati, the issue of skills within Samoa's renewable energy sector was conveyed less in terms of a deficit, and more in terms of the development capacity-building strategy based on the retention of technical and project management skills. Consistent with this, stakeholders noted the mobility of skills, with the risk of key personnel taking the opportunity to work and live in other countries seeking to expand their renewable energy sector. At the same time, these stakeholders noted that Samoa had been successful in attracting skilled personnel seeking to use their skills and experience a Pacific island lifestyle. While none of the stakeholders in Kiribati and Samoa mentioned the likelihood of an exchange of skills between the two countries, a review of the literature noted the exchange of information between Pacific countries as a component of the biennial Pacific Energy Ministers Meeting.

In addition to skills, many stakeholders in both countries noted the importance of their regulatory frameworks keeping up with the changing investment profile of renewable energy technology. This includes lease requirements of solar PV equipment for private households and businesses, pricing

structures, and the interface between independent private renewable energy providers and government-owned grid structures. Looking to the future, any growth in electricity generation by private sector companies, whether by feeding into the grid or through distributed systems, will require regulatory frameworks to be reviewed. Currently, electricity monopolies in both Kiribati and Samoa mean that it is illegal for alternative providers to supply electricity, whether to existing power networks or to un-electrified households in remote localities. Not only does this affect the potential installation of mini-grid and village-based systems by entities other than the dominant electricity utilities, but it also sets a barrier to the provision of electricity through decentralised systems, using fee-for-service models. According to Dornan (2015), while households are still able to purchase their own decentralised systems, the limited technical support available is a barrier to their success. The argument is that limiting investment by power utilities in both renewable energy technologies and rural electrification reflects the fact that state-owned utilities are generally in poor financial positions owing to governments setting tariffs for electricity that do not reflect the true cost of production and distribution. This has led Dornan (2015) to advocate for development of regulatory institutions or boards in Pacific SIDs that are independent from government.

4. What knowledge and skills are transferrable from Kiribati and Samoa to other Pacific countries?

As members of the Pacific Energy Group and Pacific Regulatory Group, Kiribati and Samoa have the ability to share their knowledge and skills with other Pacific countries. Meetings at a range of levels (officials, ministerial, business, research) within the region suggest the opportunity for a great deal of transfer of knowledge. The issue is whether these meetings are used effectively to share knowledge or whether they are used by countries to convey their strategic direction. If this is the case, it could mean that these valuable meetings may be missing out on opportunities to share what works and what challenges they face so they can assist each other with common problems. Our research suggests the issue of capacity building, distributed energy systems, and regulatory issues in the face of changing technology are just some of the issues that could be shared between Kiribati and Samoa and other countries.

6. Conclusions and Recommendations.

This study has sought to hear the voices of key stakeholders about the use of renewable energy in Kiribati and Samoa. It confirms that renewable energy has the potential to make a significant contribution to sustainable development and increase resilience on a number of levels, ranging from households and communities in remote regions to large commercial operations in urban centres. Development of the renewable energy sectors in both Kiribati and Samoa has not only increased the number of people who now have access to electricity services, but improved the quality of life of many vulnerable households and communities, which is consistent with the aims of SDGs. In Kiribati, this has resulted in significantly more people in the remote outer islands now having access to electricity services, while in Samoa most households in remote regions of Upolu and Savai'i can now access electricity. These efforts are in line with the aim of these countries to reduce their dependence on fossil-fuel imports, a market over which they have no control and where global prices fluctuate greatly. While it makes sense for Kiribati and Samoa to reduce fossil-fuel imports for economic reasons, the ability of these SIDS to showcase the importance of reducing greenhouse gases is also a strong statement about the detrimental impacts of climate change on these and other countries in the Pacific.

Notwithstanding these very important benefits, both countries continue to face challenges that warrant further investigation and investment. These include the impact of rapid urbanisation on Tarawa, and in Apia, on infrastructure and housing, inadequate regulatory frameworks and enforcement, and the need for increased levels of capacity building. On the first of these, we conclude that one of the most significant challenges in Kiribati is the effects of urbanisation in South Tarawa, where key infrastructure continues to lag behind population growth. While access to electricity is improving on Tarawa, detrimental impacts from high population densities, inadequate sanitation and high levels of pollution are having negative impacts on the environment. Added to these risks, slow-onset climate change impacts will only add to these stresses, threatening the health and well-being of all people, but most particularly the very young and youth. It is on this basis that we recommend the exploration of the development of a strategic urban plan and improved access to clean drinking water for residents living on Tarawa.

Recent investment in the energy sector in Samoa has improved the resilience of the country to better manage risks associated with natural disasters. While diversification in energy sources has played a part in this, other small, but sensible, changes have been shown to matter greatly in managing the effects of tropical cyclones and storms. For example, burying electricity cables underground has greatly lessened damage from the high winds of tropical cyclones. Added to this, improved governance structures, resulting in greater focus on the management of disasters, have, in our view, greatly increased the resilience of Samoa to managing risks. This resilience has been reinforced by the development of strategic disaster management planning and the communication of this planning to local communities and the business sector.

It is our considered opinion that four key areas are worthy for further exploration and development as they appear to offer significant potential implementation benefits. In each case, our suggested strategy would be to work alongside the governments and key stakeholders of Kiribati and Samoa to assist them to realise the potential of utilising further renewable energy resources.

6.1 Recommendations

1. Develop a trial to prove the viability of using solar PV and modular water-treatment technology to provide potable water from a saline-contaminated source. Determine the appropriate equipment size and output for an individual facility and for a community-scale site.

2. Develop and implement a capacity-building training course for solar PV installation, maintenance and repairs in Kiribati. This training should be implemented as a practical course in association with the real installation of both on-grid and off-grid solar-power installations. The course should also provide an understanding of on-going performance and monitoring facilities; and practical requirements for optimal operation and maintenance of the equipment. This capacity-building course should also provide an under-standing of remote data communications equipment that will facilitate remote equipment-performance monitoring to improve maintainability, and also provide connections that will improve community resilience in times of stress and climatic events.

3. Produce a demonstration case study that proves the practical and economic feasibility of using a solar-powered community cool-storage system within a rural community or farm in Samoa. This trial could be used to demonstrate advanced agricultural or fisheries produce processing and storage before distribution to market. The community solar-power system could be designed to include batteries to support community lighting and communications facilities over extended periods.

4. Assist Kiribati and Samoa to enhance their regulatory frameworks to ensure that they keep up with changing renewable energy technologies and other aspects related to any introduction of distributed electricity systems, pricing structures, and urbanisation.

5. Development of a strategic urban development plan for South Tarawa 2019–2030, for staged implementation in line with availability of resources.

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Appendix 1. Information Sheet

TE ANG MAITORO: COOLING KIRIBATI AND SAMOA

BACKGROUND INFORMATION

Kam Na Bane ni Mauri

My name is Mary Anne Teariki, wife of Barauti Teariki. Before coming back to live in New Zealand, I lived in Kiribati for nearly four years. I am currently working as a Research Fellow at the University of Otago, based in Wellington. I am happy to inform you of an important research project on the role of renewable energy in assisting Kiribati to manage risks, like natural disasters and climate change. I am part of a small group of researchers conducting research in Kiribati and Samoa. I kindly ask that you read this information sheet carefully before deciding whether or not to participate. If you decide to participate, we thank you very much. If you decide not to take part, please know that there will be no disadvantage to you, and we thank you for considering our request.

What is the Aim of the Project?

The aim of our research project is to examine how Kiribati can be strengthened to manage shocks and disturbances related to natural disasters and climate change. As a small country, Kiribati faces a number of risks, particularly to climatic events, such as storms, and powerful sea surges that destroy the coasts in Tarawa and the outer islands. In the case of Tarawa, people leaving the outer islands in search of employment and education for their children, has resulted in many people living in a small area. With people coming to Tarawa and increased population, life in Tarawa has begun to be difficult as there is little space for new houses and some systems such as electricity are sometimes unreliable. Other problems include the lack of fresh drinking water as wells have become contaminated and water is available for only a few hours a day. With these challenges in mind, the aim of this project is to examine how new renewable energy projects can make life in Tarawa easier for families and how renewable energy can also support other important utilities, like water, waste management, and housing. With this in mind, our research question we are seeking to answer is: What new renewable projects will assist Kiribati to become more resilient (or strong) to shocks and disturbances?

This research project is funded by the New Zealand Institute for Pacific Research. It is expected to be completed by the end of July 2018.

Stakeholder Engagement

The aim is to interview those who can share their knowledge about the needs and opportunities in Tarawa for renewable energy and its role in strengthening the ability of those living in Tarawa to manage disturbances from natural disasters and climate change. I will be seeking to interview people representing the following organisations:

- Ministers of Energy, Economic Development, and Infrastructure
- Regional Councillors from the Betio Town Council, and Teinainano Urban Council
- Staff from the Public Utilities Board (PUB) with respect to electricity, water, and waste management
- Kiribati Solar Energy Company Ltd
- Officials from the Ministry of Health, and Housing
- NGOs in Kiribati: Kiribati Climate Action Network, Kiribati Youth Panel
- Catholic Diocese of Kiribati, Kiribati Protestant Church of Kiribati
- Kiribati Association of Non-Government Organisation (KANGO)

Interviews

You will be asked to be interviewed on how renewable energy can improve the ability of Kiribati to manage disturbances, such as natural disasters, and climate change. The interview, which expected to last about one hour, will be recorded so that I don't miss anything, and I can concentrate to our discussion. Taking part in this research is completely up to you. For those of you that decide to participate, I would like to thank you very much. If you decide not to participate, I will understand, but will kindly ask if there is someone else in your organisation that I can talk to. I wish to thank you for considering my request.

Use of Information

The information gathered from you will be collected and analysed to identify the key issues relating to the use of new renewable energy services in Kiribati, with a focus on Tarawa. From the information gathered, the analysis will be written up into a report that will be provided to the New Zealand Institute of Pacific Research. Due to the nature of the research, we are seeking to use direct quotes from our discussion, to highlight certain issues. On the Consent Form you will be given options regarding whether you wish to remain anonymous, Should you prefer for us not to refer to you by name, another choice will be to refer to you by organisation.

It is expected that, upon completion, an electronic copy of the report will be made available on the Ministry of Foreign Affairs and Trade website. While people will have access to the final report, they will not have access to the audio recordings, which will be securely stored at the University of Otago for ten years, after which the audio recordings will be destroyed.

Change of Mind and Withdrawing from the Research

Should you change your mind about taking part in the research, you can withdraw at any time with no disadvantage to you of any kind.

Questions That May Arise

If anyone has any questions about this research, either now or in the future, please feel free to contact either:

Philippa Howden-Chapman Department of Public Health, Wellington, University of Otago University Telephone Number: +644 9186047 or +64272201620 Email: philippa.howden-chapman@otago.ac.nz	*Mary Anne Teariki* Department of Public Health, Wellington, University of Otago Telephone Number +6421850254 Email: maryanne.teariki@otago.ac.nz

This research has been approved by the Department of Public Health, as stated above. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (+6434798256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

TE ANG MAITORO: COOLING KIRIBATI AND SAMOA

BACKGROUND INFORMATION

TĀLOFA LAVA

My name is Ramona Tiatia. I am currently working as a Research Fellow at the University of Otago, based in Wellington. I am happy to inform you of an important research project on the role of renewable energy in assisting Samoa to manage risks, like natural disasters and climate change. I am part of a small group of researchers conducting research in Samoa and Kiribati. I kindly ask that you read this information sheet carefully before deciding whether or not to participate. If you decide to participate, we thank you very much. If you decide not to take part, please know that there will be no disadvantage to you, and we thank you for considering our request.

What is the Aim of the Project?

The aim of our research project is to examine how Samoa can be strengthened to manage shocks and disturbances related to natural disasters and climate change. As a small country, Samoa faces a number of risks, particularly to climatic events, such as storms, and powerful sea surges that destroy the coasts in Upolu and the outer islands. With many people coming to Apia in search of paid employment, life in Apia has begun to be difficult due to a lack of space, and sometimes the inability of the infrastructure to keep up with increasing urbanisation. With this in mind, our research question we are seeking to answer is: What new renewable projects will assist Samoa to become more resilient (or strong) to shocks and disturbances?

This research project is funded by the New Zealand Institute for Pacific Research. It is expected to be completed by the end of July 2018.

Stakeholder Engagement

The aim is to interview those who can share their knowledge about the needs and opportunities for renewable energy and its role in strengthening the ability of those living in Samoa to manage disturbances from natural disasters and climate change. I will be seeking to interview people representing the following organisations:

- Government Ministers
- Public Service Officials
- Farmers
- Tourist Operators
- Village Elders
- Infrastructure Operators

Interviews

You will be asked to be interviewed on how renewable energy can improve the ability of Samoa to manage disturbances, such as natural disasters, and climate change. The interview, which expected to last about one hour, will be audio-tapped so that I don't miss anything, and I can concentrate to our discussion. Taking part in this research is completely up to you. For those of you that decide to participate, I would like to thank you very much. If you decide not to participate, I will understand, but will kindly ask if there is someone else in your organisation that I can talk to. I wish to thank you for considering my request.

Use of Information

The information gathered from you will be collected and analysed to identify the key issues relating to the use of new renewable energy services in Samoa. From the information gathered, the analysis will be written up into a report that will be provided to the New Zealand Institute of Pacific Research. Due to the nature of the research, we are seeking to use direct quotes from our discussion, to highlight certain issues. On the Consent Form you will be given options regarding whether you wish to remain anonymous. Should you prefer for us not to refer to you by name, another choice will be to refer to you by organisation.

It is expected that, upon completion, an electronic copy of the report will be made available on the Ministry of Foreign Affairs and Trade website. While people will have access to the final report, they will not have access to the audiotapes, which will be securely stored at the University of Otago for ten years, after which the audiotapes will be destroyed

Change of Mind and Withdrawing from the Research

Should you change your mind about taking part in the research, you can withdraw at any time with no disadvantage to you of any kind.

Questions That May Arise

If anyone has any questions about this research, either now or in the future, please feel free to contact either:

Philippa Howden-Chapman Department of Public Health, Wellington, University of Otago University Telephone Number: (04) 9186047 Email: philippa.howden-chapman@otago.ac.nz	*Ramona Tiatia* Department of Public Health, Wellington, University of Otago Telephone Number +64 0220775137 Email: ramon.tiatia@otago.ac.nz

This research has been approved by the Department stated above. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (03 479-8256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

Appendix 2. Consent Form

Te Ang Maitoro: Cooling Kiribati and Samoa

Consent Form for Key Stakeholders

I have read the Information Sheet concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.

I know that:

1. My participation in the research project is entirely up to me
2. I am free to withdraw from the project at any time without any disadvantage
3. You have a choice to be identified by your name and position or by your position only. If you prefer to stay anonymous, any personal information contained in the audio recordings that could identify you, will be destroyed at the conclusion of the project. Any raw data on which the results of the project depend will be retained in secure storage for at least ten years.
4. The interview will be in the form of a discussion on the role of renewable energy in Kiribati, with a focus on Tarawa. The discussion will explore views about how renewable energy can strengthen Kiribati to manage shocks and disturbances related to natural disasters and climate change.
5. In the event that the line of questioning develops in such a way that I feel hesitant or uncomfortable I may decline to answer any particular questions, stop the interview and/or may withdraw from the project without any disadvantage of any kind.

6. I, as the participant: a) agree to being named in the research ☐ OR;

b) would rather remain anonymous ☐

I agree to take part in this project.

....
(Signature of participant) (Date)

.....
(Printed Name)

Te Ang Maitoro: Cooling Kiribati and Samoa

Consent Form for Key Stakeholders

I have read the Information Sheet concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.

I know that:

1. My participation in the research project is entirely up to me
2. I am free to withdraw from the project at any time without any disadvantage
3. You have a choice to be identified by your name and position or by your position only. If you prefer to stay anonymous, any personal information contained in the audio recordings that could identify you, will be destroyed at the conclusion of the project. Any raw data on which the results of the project depend will be retained in secure storage for at least ten years.
4. The interview will be in the form of a discussion on the role of renewable energy in Samoa, with a focus on Upolu. The discussion will explore views about how renewable energy can strengthen Samoa to manage shocks and disturbances related to natural disasters and climate change.
5. In the event that the line of questioning develops in such a way that I feel hesitant or uncomfortable I may decline to answer any particular questions, stop the interview and/or may withdraw from the project without any disadvantage of any kind.
6. I, as the participant: a) agree to being named in the research ☐

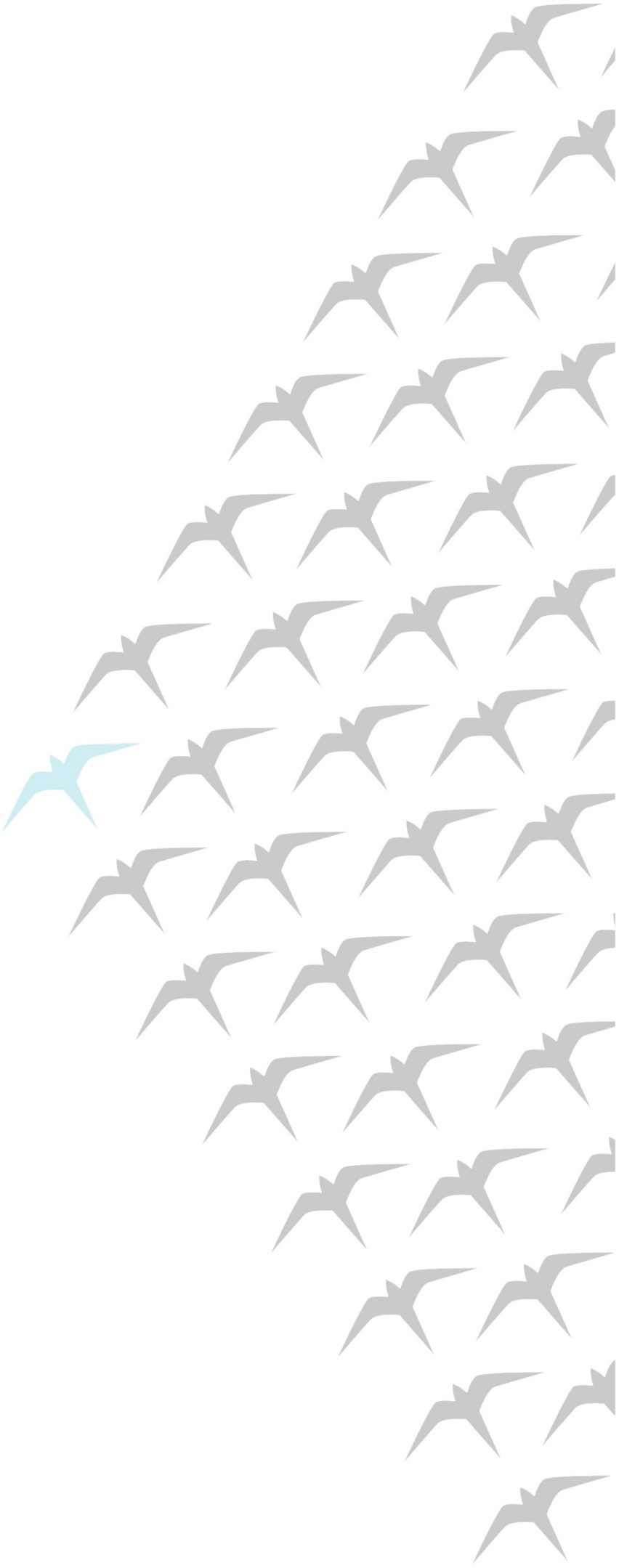
   OR;

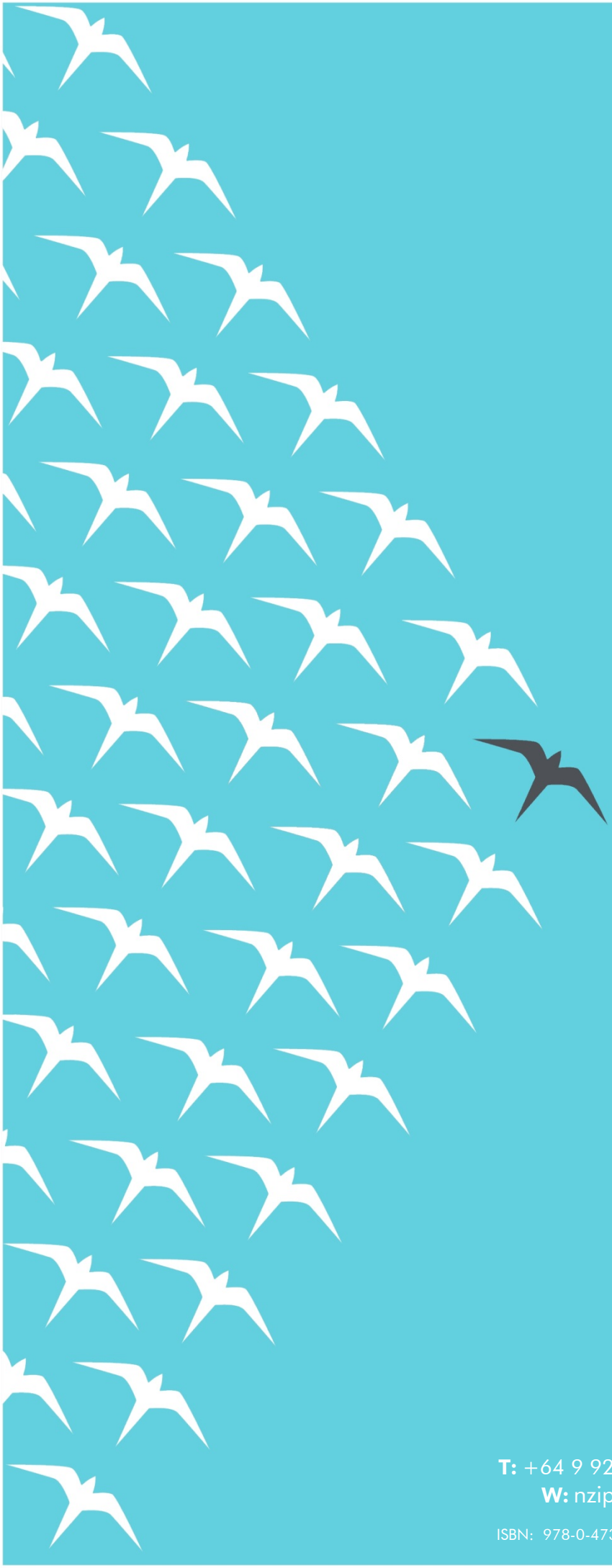
   b) would rather remain anonymous ☐

I agree to take part in this project.

....
(Signature of participant) (Date)

.....
(Printed Name)





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