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GLOBAL RENEWABLE ENERGY ISLANDS NETWORK

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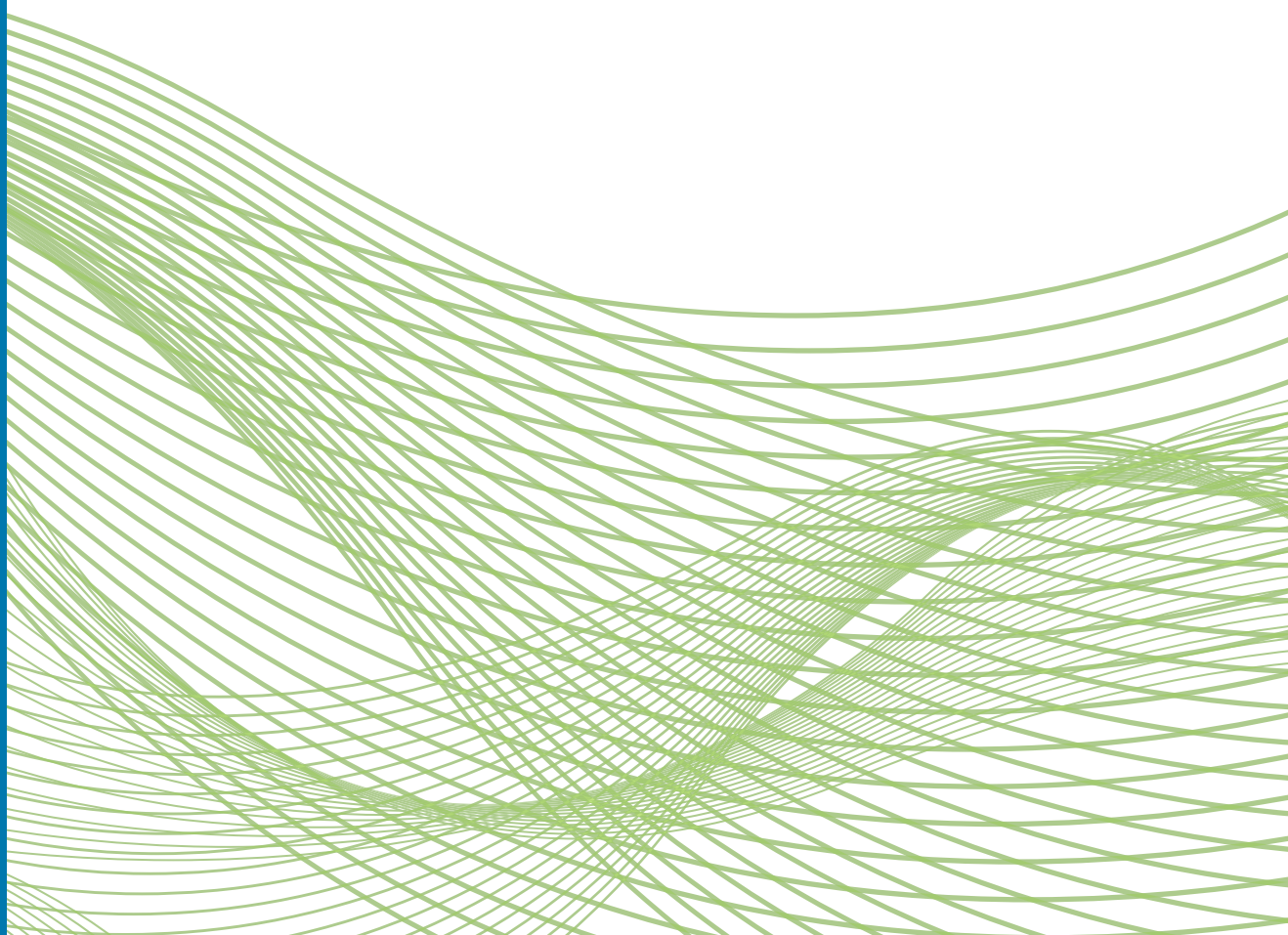
RENEWABLE ISLANDS:
SETTINGS FOR SUCCESS



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The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international cooperation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.

For further information or to provide feedback, please contact *secretariat@irena.org*.

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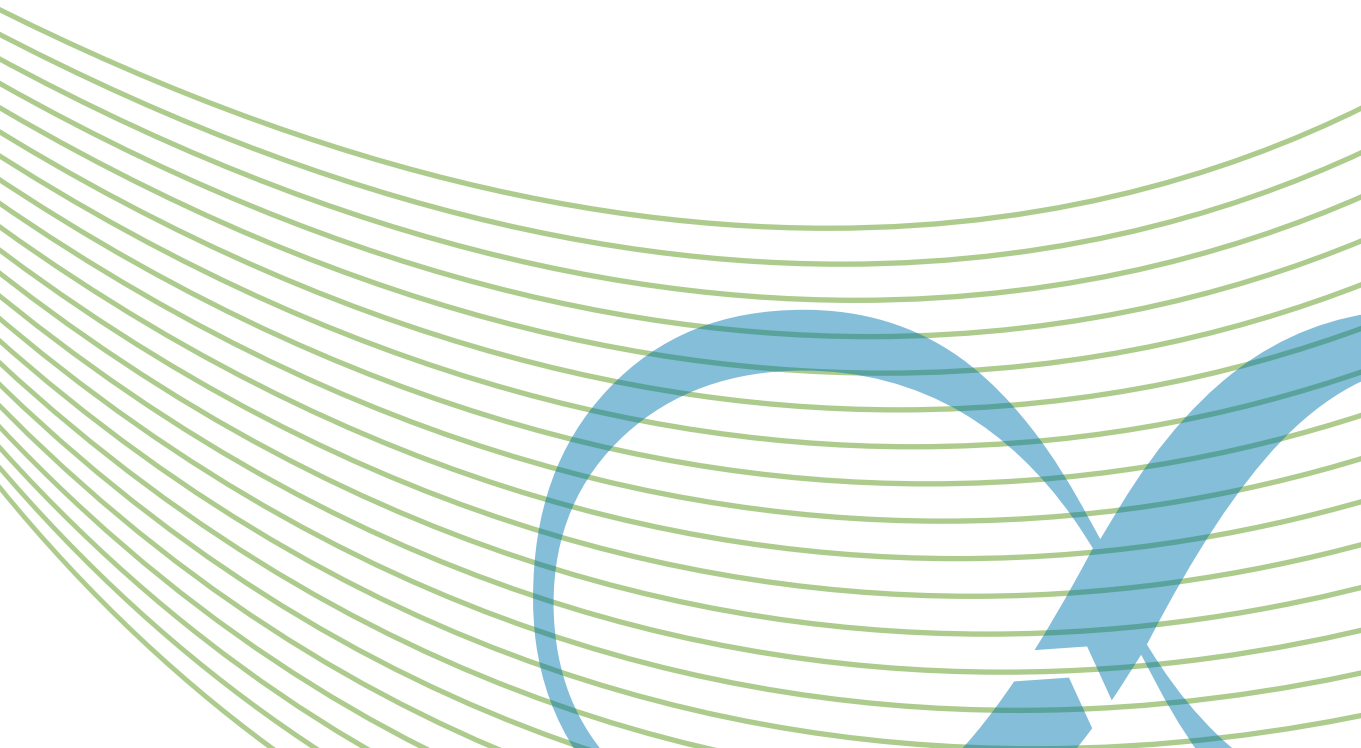
Contents

A report on policies, market frameworks, technical planning and capacity building for renewable energy development on islands, prepared by IRENA in support of the Global Renewable Energy Islands Network



INTRODUCTION

Islands around the world are heavily reliant on costly oil imports from distant locations which can burden government budgets and inhibit investment in social and economic development. Indigenous renewable energy resources such as hydropower, wind power, solar power, geothermal power, bioenergy and wave power can reduce these expensive imports and create important business and employment opportunities.

But how should islands go about attracting the investment to put these resources to use?

The case studies in this short report are meant to show that a wide variety of islands in different locations and at different levels of development can all attract investment in cost-effective renewable energy resources through a mix of four key ingredients:

- Political priority to attract investment
- Market framework for investment
- Technical planning for investment
- Capacity to implement investment

Political priority to attract investment in renewable energy on an island results from a realisation by its people, its utilities and its leaders that it is paying too much money for electricity and renewable power offers a way out. To be credible and have an impact, the political priority must be clearly articulated by ministers and embodied in legislation.

An effective **market framework** for investment must ensure that the electricity market is open

Paradise island panoramic view©nitrogenic.com/Shutterstock

to participation by all types and sizes of players who could profit by installing renewable power facilities. These include incumbent utilities, independent power producers, and building owners. Regulations should make it profitable for utilities to invest in cost-effective renewable power options. They should also make it possible for independent power producers to invest in such options – directly or through power purchase agreements with the utilities. And they should make it profitable for building owners to install photovoltaic power systems through net metering arrangements whereby the value of electricity they provide to the grid is credited to their electric bill.

Technical planning is needed to ensure that investment in renewable power options is consistent with the economic interests of the island and does not impair the reliability of service. Some sort of integrated resource planning should be done to ensure that an optimal mix of energy options is chosen for the island, to minimise costs within the constraints of preserving the environment, promoting public health, and serving other social objectives. And grid stability analysis is needed to ensure that the grid remains stable and service remains reliable as the share of variable renewable generation grows.

Finally, human **capacity building** is needed for successful incorporation of renewable power options on island power grids. A variety of skills are needed to plan, finance, manage, operate and maintain the power grid effectively, safely, reliably and economically.

Looking at islands in oceans around the world, this report shows how these four factors have combined to create successful settings for renewable power investment.

CABO VERDE

Liberalised Markets to Support Renewable Energy Investment

With very high electricity tariffs, yet unable to cover the high costs of generating electricity with imported fossil fuels and suffering from large losses on its power lines, Cabo Verde's utility became insolvent. To make service less costly and more reliable, the government took over the utility and pursued a strong policy to promote investment in renewable energy by independent power producers and public private partnerships. As a result, renewables now account for more than 20 percent of the total electricity generated and should provide as much as half of all electricity production by 2020.

Country Profile

Cabo Verde is an archipelago of 10 islands in the Atlantic Ocean with 500,000 people and 4,000 square kilometers of land area, 400 kilometers off the west coast of Africa in the Atlantic Ocean. It has limited natural resources and poor rainfall and so must import most of its food and desalinate most of its water. The economy focuses on tourism, light manufacturing, fisheries and commerce. After several years of impressive economic growth, the economy has suffered from financial crisis and resulting impacts on tourism revenues. A large diaspora, especially in the United States and European Union, sustain the resident population with a steady flow of remittances.

Renewable Energy Profile

Cabo Verde has developed a mix of wind and solar power, which accounted for 24 percent of its generating capacity and 21 percent of all electricity generated in 2012.

With insolation of 6 kilowatt-hours per square meter per day, the island is highly promising for solar power development. Two Solar photovoltaic (PV) Parks (5 megawatt (MW) at Santiago and 2.5 MW at Sal) were inaugurated in November 2010. Cabo Verde also has good

Electricity Access in 2012	99 percent
Installed Capacity in 2012	140.5 megawatts
Renewable Capacity in 2012 • Wind • Solar	33.9 megawatts (24% of all capacity) • 26.4 megawatts (19%) • 7.5 megawatts (5%)
Electricity Generation in 2012	330 gigawatt-hours
Renewable Generation in 2012 • Wind • Solar	68.7 gigawatt-hours (21% of generation) • 61.3 gigawatt-hours (19%) • 7.4 gigawatt-hours (2%)
Electricity Tariff (residential) in 2012	38 US cents per kilowatt-hour

potential for wind investment with an average wind velocity of 7.5 meters per second, very stable during most of the year. Four large wind farms and three small ones, with over 26 MW of installed capacity, produce nearly one fifth of the country's electricity.

Electric Power Profile

The energy utility Electra is responsible for the generation, distribution and sale of electricity and water in Cabo Verde. It was first incorporated in 1998, and a 51 percent majority stake was sold to a Portuguese consortium with a 50 year concession. But the company was never able to achieve commercial viability in balancing the low regulated tariff with increasing costs. It became insolvent in 2005, and electricity service was plagued by extended blackouts. In 2006 the Government reacquired control of the company and recapitalised it. It currently holds a 90 percent share either directly or through the social security fund, with the local municipalities holding the rest.

In response to the utility's financial problems, the government signed up to the African Development Fund Electricity Transmission and Distribution Network Development Project to upgrade power distribution networks and improve service quality for about 94 percent of the population on six of the country's islands. The project extends existing lines, rehabilitates lines and substations, and generally upgrades the network. The government also opened up electricity generation to independent power producers, and IPP wind plants now generate 18 percent of the country's total electricity needs.

In 2012, Electra was split into Northern Islands and Southern Islands businesses in order to improve efficiency. In 2013, the Minister of Tourism, Energy and Industry was quoted as being interested in reprivatising the utility. The Directorate of Industry and Energy (DGIE) formulates and implements renewable energy policy. The independent Agency for Economic Regulation (ARE) sets electricity tariffs.

The national electricity system is comprised of independent grids on the different islands, with almost no inter island interconnections. Cabo Verde has had one of the highest electricity tariffs in the world, with an average rate of 38 U.S. cents per kilowatt hour in 2012. Yet despite these high tariffs, Electra has not been able to recover its costs due to high generation costs and large technical and non technical losses, which in 2012 averaged about 26 percent and reached 37 percent in the main island of Santiago.

The three main islands of Cabo Verde (Santiago, Sao Vicente and Sal) represented about 90 percent of the country's electricity demand in 2009 of which two thirds was in Santiago. Almost half of the electricity demand is from the domestic sector, while the commercial, industrial and agricultural sectors account for about 38 percent of the demand. Electra also uses around 5 percent of total demand in its desalination plants. Despite high electricity costs, the consistent growth in gross domestic product (GDP) in recent years drove electricity consumption up around 8 percent per annum from 2000 through 2009.

Political Priority for Investment

Cabo Verde's government realised in the 1990s that high dependency on oil imports for electricity generation threatened the competitiveness of the economy and imposed hardship on the population due to high tariffs for electricity. A National Energy Plan 2003-2012 was published in 2003 laying out a pathway for the consolidation of the Energy Sector and a guarantee of national energy security. It also set a policy to achieve commercially feasible electricity tariffs, which supported the competitiveness of the national economy. But the subsequent failure of the utility provided a crisis, which made it even more urgent to rapidly invest in renewable energy.

With support from Gusto Energia S.A., the Government developed a Renewable Energy Plan 2010-2020, with a target of producing half the country's electricity requirements from renewables by 2020. This would entail expanding renewable capacity to a total of 125 MW (of which 94 MW wind, 24 MW solar and 7 MW biomass) with investment of EUR 308 million for the new plants plus 20 MW of associated pumped hydro storage and transmission lines. The Plan seeks to make the economy more competitive through more cost reflective pricing, incentives for competition in the market, decentralised production and self production, incentives to limit waste and losses, and incentives for better efficiency in the energy supply systems.

Market Structure for Investment

Cabo Verde has set up a supportive market structure for investment in renewable electricity generation. The Government aims to achieve its 50 percent renewable target solely through private sector investment, without the use of any form of feed in tariff mechanism. Law n1/2011 sets out a framework for Independent Power Producers (IPPs) that produce renewable energy, guaranteeing a Power Purchase Agreement (PPA) to such IPPs for 15 years. The law has produced tangible results in a very short time, embodied in the 25.5 MW wind project developed by the IPP Cabeólica S.A, established through a public private partnership (PPP) between InfraCo, a privately managed, donor funded infrastructure company, the Government, and Electra.

In 2005, there were only three small wind parks delivering 2.9% of the electrical energy of the country. But in 2010, in response to the market opening provided by the law, the European Investment Bank and African Development Bank agreed to finance the Cabeólica Project, the largest wind project and largest Public Private Partnership in Sub Saharan Africa with a total project cost of EUR 63 million (USD 83 million). The PPP administers the development, financing, construction, ownership and operation of four wind farms. The project was rapidly implemented, with the collaboration of Electra and the government.

A majority of the equity shares have been acquired by the Africa Finance Corporation (AFC) and the Finnish Fund for Industrial Cooperation Ltd. (Finnfund). A 20 year PPA has been signed whereby all power generated from the wind project is sold to Electra though commercial details are not available.

The wind project has won several awards and was registered as a Clean Development Mechanism (CDM) Project by the United Nations Framework Convention on Climate Change (UNFCCC) CDM Executive Board in 2013.

The Law also establishes a regime for micro generation, sets out conditions for self producers, and codifies a tax exemption on the import of renewable power equipment such as solar panels and wind generators. Electra has provision for building owners to install small scale roof PV and receive an offset on their energy bill for the excess electricity they supply to the grid. But only a minority of households can afford the investment even though it is estimated to have a very short payback.

Technical Planning for Investment

As part of the Renewable Energy Plan of 2010, Gesto Energia S.A. created a renewable energy atlas for Cabo Verde to assess its wind, solar, hydro, wave and geothermal resource potential. It also developed three electric demand scenarios to guide energy investment priorities. A base scenario uses business-as-usual demographic and macroeconomic projections. An energy efficiency scenario is based on implementation of a National Energy Efficiency Programme with moderate demand growth. An aggressive scenario assumes a continuation of the high rates of demand growth that have been experienced over the last decade, to be met through ambitious scale-up of renewables.

There is also an interest in small-scale wind projects for small grids in remote locations. The Gesto Energia analysis showed that wind projects were the most cost-competitive renewable generating options, with an average levelised production cost of 10 EUR-cents per kilowatt-hour. Solar photovoltaic projects were found to have an average levelised cost of 23.8 EUR-cents per kilowatt-hour, although they may now be a lot lower since PV system costs around the world have declined sharply. Both wind and PV systems were found to be cheaper than generation from heavy fuel oil and diesel.

The prospects for other types of renewable generation are less promising. Due to its terrain and climate Cabo Verde has a very low biomass potential, and the traditional dependence of traditional biomass for cooking and heating is unsustainable. Due to limited water resources, there is no real potential for hydropower. Gesto Energia has indicated a potential for wave power and identified a high-temperature reservoir that could allow for the development of 3 MW of geothermal capacity on Fogo Island.

A significant partnership has been formed in May 2013 between the Cabo Verde and the Institute for applied material flow management (IfaS) within the renowned Environmental University in Birkenfeld, Germany. IfaS has been mandated by the Government to design a technical and financial feasibility investment roadmap for 100 percent renewable generation in Cabo Verde. IfaS has extended the partnership to include the state government of Rhineland-Palatinate and a number of renewable energy

companies to maximise the collaboration and ensure that the work is strongly anchored in commercial viability.

Capacity to Implement Investment

Cabo Verde has twelve universities and training colleges with campuses across the islands. One of the largest is the University of Cabo Verde, which offers diplomas and degree courses in electrical and mechanical engineering, energy, and environmental studies. The utility, Electra, employs almost 700 staff, among whom a substantial number have expertise in renewable energy including solar photovoltaics, and the firm can hire students trained in various energy courses at the universities and colleges.

Cabo Verde is a member of ECOWAS (Economic Community of Western African States) and hosts the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE). The role of ECREEE is to assist the fifteen ECOWAS Member States in the development, adoption and implementation of national renewable energy and energy efficiency policies and targets, regulatory frameworks, standards (for appliances, generation equipment and building codes), incentives (such as tax exemption, public procurement, portfolio standards for renewable equipment) and financial mechanisms (such as feed-in tariffs, net metering, investment subsidies for renewable electricity generation).

The Centre is also working on a regional capacity needs assessment, the delivery of reliable and updated energy information for investors and project developers, and an investment and business promotion program that aims at mitigating financial barriers to the investments in small, medium and large-scale renewable energy and energy efficiency projects. It assists member countries to make use of their individual renewable energy potentials by providing support to develop a technically and economically feasible portfolio of projects that can attract the interest of possible investors and financiers.

ECREE's 2012 Regional Training Plan for Renewable Energy includes 2016 goals engaging 500 stakeholders in initiatives such as regional training workshops on sustainable energy technologies, train-the-trainer workshops in cooperation with local universities, regional sustainable energy research programmes, and workshops for south-south and north-south knowledge transfer.

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CYPRUS

Transition from Oil Dependency to Renewable Power

Cyprus was almost totally dependent on oil for electricity until it was spurred by an EU Directive to develop the Cypriot National Renewable Energy Action Plan. The island is now on track to generate about a sixth of its electricity by 2020 from a mix of wind, solar and biomass resources. Supportive policies such as auctions, feed-in tariffs and net metering have encouraged the needed flows of investment to make this happen.

Island Profile

Cyprus is an island economy in the Eastern Mediterranean. Settlement dates back to 10,000 BC, with shifting tides of conquest over the centuries, and the island became independent in 1960. It has a sub-tropical climate with mild winters and hot summers. Cyprus suffers from a shortage of water and depends on desalination plants with high fuel needs. The Cypriot economy is diversified into financial services, tourism and shipping. Economic policy has focussed on meeting criteria for membership in the EU.

Renewable Energy Profile

Cyprus generates nearly 4 percent of its electricity from renewable sources. While renewable power accounts for 9.2% of generating capacity, is it mostly comprised of wind turbines which have a lower average capacity factor than fossil-fuelled plants.

Electric Power Profile

Most electricity on Cyprus is generated and distributed by the Electricity Authority of Cyprus. However, following recent reforms, the company also distributes electricity produced by five privately held IPP wind farms with a generating capacity of 146.7 MW. Transmission services are provided by a separate Transmission System Operator.

Electricity Access in 2012	99 percent
Installed Capacity in 2013	1742 megawatts
Renewable Capacity in 2013	160 megawatts (9.2% of all capacity)
Electricity generation in 2013	4,929 gigawatt-hours
Renewable generation in 2013	178 gigawatt-hours (3.6% of generation)
Electricity tariff (residential) in 2013	20-40 U.S. cents per kilowatt-hour

Political Priority to Enable Investment

As a member of the European Union (EU), Cyprus is subject to the EU Directive on Renewable Energy which requires all EU countries to achieve a significant share of energy from renewable sources by 2020. The EU also requires a National Renewable Energy Action Plan (NREAP) from each country that specifies detailed pathways

Ministry of Energy, Commerce, Industry and Tourism, Republic of Cyprus

for the development of renewable energy sources and cooperation mechanisms to achieve renewable energy targets in a cost-effective fashion. Cyprus was notified in 2006 that it would face serious sanctions if it did not achieve rapid compliance with its intermediate renewable target. To avoid sanctions, government instructed the relevant ministries and the electricity authorities to mobilise. The EU intermediate target was set at 4.92% for 2011-12, with substantial fines for non-compliance. Cyprus increased its renewable share from 2.9% in 2005 to 7.8% in 2012, thus substantially surpassing the target.

Market Framework for Investment

An enabling Market Regulatory Framework for renewable energy is administered by the Cyprus Energy Regulatory Authority (CERA) and the Energy Service of the Ministry of Commerce, Industry and Tourism (MCIT). Renewable electricity is granted access to the grid without discrimination, and indeed plant operators are entitled to such access.

To help achieve the target of 165 MW of wind generating capacity that was specified in the NREAP for 2013-14, the Electricity Authority of Cyprus established the first Power Purchase Agreement (PPA) in 2010 that guaranteed a

Cyprus established the first PPA in 2010 that guaranteed a regulated price and feed in tariff of 16.6 euro-cents. The government underwrote the PPA to mitigate risks and encourage investment. By 2013, Cyprus had 146.7 MW of wind capacity installed via contracts with five investors, putting it within striking range to meet the target by 2014.

To help achieve the NREAP target for solar power, including both photovoltaics (PV) and concentrated solar power (CSP), which are to provide 7.2% of electricity by 2020, the government set up a Solar Auction process for 50 MW of PV. The process generated bids from 155 companies, mostly in increments of 1 MW or 2 MW, of which 24 bids were accepted. The bids ranged from 7.41 to 9.99 Euro-cents, which were lower than the utility's marginal production cost of 13-14 Euro-cents. This has strongly influenced the renewables strategy as solar is now clearly cheaper than fossil fuel generation.

To further encourage solar power supply, CERA authorised large-scale application of net metering for buildings, in which solar systems can be installed in less than one month. With net metering, building owners receive credit for the solar electricity they generate, thereby creating a financial incentive for them to install solar electric systems.

Part of the island's strategy for renewable energy focuses on the building sector. Like other European countries, Cyprus has promoted the installation of solar hot water systems in buildings. Some 92 percent of homes already have solar hot water. Green energy incentives reimburse up to 30 percent of solar hot water system investments.

Technical Planning for Investment

The EU laid out a detailed National Renewable Energy Action Plan (NREAP) framework for Cyprus to use to describe how it would meet its target of 13 percent of renewable energy supply in final energy consumption by 2020. How that target is to be achieved is up to Member State to decide. Responsibility for leading the planning process was held by the Cyprus Energy Division within the Ministry of Commerce, Industry and Tourism. A team was set up which carried out a number of simulations and studies to determine how best the EU target should be met. Based on this analysis, it was decided to meet the overall 13 percent target through a 16 percent renewable share in electricity generation, a 23.5 percent renewable share in heating and cooling of buildings (where Cyprus already had substantial use of solar hot water), and a 4.9% renewable share in transport through the introduction of biodiesel blends for automobiles.

In 2000 the Cyprus Institute of Energy was established to develop and promote the use of renewable energy sources in Cyprus. One of its key roles is to carry out applied research, offer technical guidance, and monitor new technology. The Energy Division and the utility are now examining how best to cope with the challenge that increasing amounts of variable renewable power sources present to the electricity network.

They are planning an optimisation study to consider the full range of technical options such as energy storage (for example pumped hydro), diesel generation (to provide spinning reserve that can compensate for wind and solar variability), connection by cable to Greece or

Israel, application of smart grid technology, and introduction of electric charging stations for electric vehicles which also provide energy storage for the system.

The Energy Department has collaborated closely with the Ministries of Agriculture, Natural Resources and the Environment, Interior, Finance, Communications and Works, the Planning Bureau, the Cyprus Energy Regulatory Authority, the Electricity Authority of Cyprus (the generating utility) and the Transmission System Operator to develop strategies for the renewable energy transition which are pragmatic and cost-effective. A particular focus has been on policies, laws and market reforms to enable investment. There is some attention to spacing investment over time, within the target horizon, to take advantage of the fact that the cost of renewable power technology has been steadily dropping. There has also been a focus on projects for improving energy efficiency in residential and commercial buildings, which have helped to achieve a 20 percent reduction in electricity demand that helps renewable to achieve their percentage target (since a smaller amount of renewables now provide a given share).

Capacity to Implement Investment

Cyprus has 13 universities and technical colleges providing a wide range of tertiary courses available in electrical engineering and energy, and a further 8 foreign campuses provide specialist courses on renewable energy, including Cranfield University. Organisations such as the Cyprus Institute for Energy and the Electrical Authority are therefore able to source good candidates for job positions to support such matters as the electrical generation, operation of the grid, management, as well as renewable energy policy, technology and commercial skills. The IPPs that installed the wind farms provided training courses for the construction and operation of the wind turbines. IRENA has developed the IRENA Renewable Energy Learning partnership (IRELP) portal which is designed to provide information, training and education to students, vocational trainees and other professionals looking to develop and update their renewable energy knowledge. Also the Cyprus Institute of Energy (CIE) is very active in providing support for applied research programmes, technical consultation, and promotion of international partnerships.

Given the considerable investment that has occurred over recent years in solar PV and hot water a cluster of local companies have sprung up offering expertise in the supply and installation of rooftop Solar PV and hot water systems. A typical example is Gesolar Cyprus which designs and installs grid-connected and stand-alone PV systems from a range of manufacturers in both residential and commercial buildings.

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FIJI

Utility Investment for Rapid Transition to Renewable Electricity

With leadership from the state-owned Fiji Electricity Authority, FEA, Fiji has come to generate 55 percent of its electricity from renewables and to thus have the lowest oil dependency and lowest electricity tariff among all the islands in the Pacific. FEA has set out a bold investment roadmap to raise the renewable share to 81 percent by 2020. An equally bold National Energy Plan is designed to attract new investment to achieve this goal.

Island Profile

The Republic of Fiji is a Melanesian island nation in the South Pacific, 1100 nautical miles northeast of New Zealand. The country has more than 332 islands, of which 110 are permanently inhabited, with a total land area of 18,300 square kilometres.

The two main islands, Viti Levu and Vanua Levu, have 87 percent of the population of around 860,000. Fiji's main industries and sources of revenue are sugar production and tourism. The islands have a tropical climate, ample rainfall and fertile land but also suffer regular cyclones. Fiji was a British colony up until 1970 but is now an independent republic.

Renewable Energy Profile

Fiji has developed a diversified mix of hydro, wind and biomass power, which accounts for roughly three-fifths of its electric generating capacity and electricity generation.

Fiji has had hydropower for decades, but the hydropower it now has in place came mostly from projects commissioned in 2004, 2006 and 2012. A new wind farm was commissioned in 2007. The FEA has signed power Purchase Agreements with four local IPPs for electricity from biomass and mini hydro plants. Fiji Sugar Corporation has added biomass generating

Electricity Access in 2012	92 percent
Installed Capacity in 2012	263 megawatts
Renewable Capacity in 2012 • Hydro • Wind • Biomass	164 megawatts (62% of all capacity) • 129 megawatts (49%) • 10 megawatts (4%) • 25 megawatts (9%)
Electricity Generation in 2012	823 gigawatt-hours
Renewable Generation in 2012 • Hydro • Wind • Biomass	493 gigawatt-hours (60% of generation) • 452 gigawatt-hours (55%) • 33 gigawatt-hours (4%) • 8 gigawatt-hours (1%)
Electricity Tariff (residential) in 2012	Subsidised: 8 U.S. cents per kilowatt-hour Unsubsidised: 17 U.S. cents per kWh

capacity based on use of residues (bagasse) from sugar cane cultivation.

Electric Power Profile

The state-owned Fiji Electricity Authority (FEA) was established in 1996, and has a staff of 600. It is responsible for the generation, transmission and distribution of electricity in Fiji. It operated 263 MW of capacity, including 139 MW of renewable capacity, as of 2012. Reforms introduced by the FEA in 2001 have enabled participation in the market by independent power producers (IPPs) which now account for 4 percent of generation. However, these are sugar companies in joint ventures with FEA, not truly independent IPP's. Rural electrification efforts over the last two decades have increased electricity access to 92 percent of the population with a goal to achieve 100 percent access by 2016.

Political Priority to Enable Investment

In view of heavy reliance on oil imports, the government has had ambitious goals for increasing the proportion of generation from renewable energy sources for some time. Fiji made a commitment to renewable energy at Rio de Janeiro Climate Change Summit in 1992. The National Energy Policy (NEP) of 2006 provides a common framework for the public and private sector to work together towards the optimum utilisation of energy resources for economic growth and development. The Fiji Department of Energy (FDOE), with 70 staff, is responsible for implementing the NEP which includes specific strategies for national energy planning, energy security, the power sector and renewable energy development.

FEA's strategic plan shows that a dramatic increase in power sector investment will be required to meet growing electricity needs and reduce costly oil imports. The Government commissioned a new National Energy Policy in 2013 which includes an action plan for renewable energy and policies to promote new investment by both FEA and IPPs. The action plan set goals of 67 percent renewable share in electricity generation by 2015, and an 81 percent share by 2020. Measures to attract new investors include a transparent process for IPP procurement, principles for Power Purchase Agreements, and avoided cost benchmarks.

The Reserve Bank of Fiji aims to raise overall investment in the economy to 25 percent of gross domestic process. A substantial part of this investment will come in the power sector. To promote renewables in the power sector, the Reserve Bank has extended the eligibility list on its Import Substitution and Export Finance Facility to include renewable energy. The importation of renewable energy equipment, including wind, hydro and solar, is duty-free.

Market Framework for Investment

The relevant legislation in place at present is the Electricity Act 1966, which established and empowered the FEA. Also important is the Environmental Management Act 2005, which provides the legislative framework for the sustainable development of land and water resource management. The Public Enterprise Act provides for restructuring and regulating of government commercial companies in the public interest, and the Commerce Act promotes competition and empowers the Commerce Commission to set electricity tariffs.

The technical regulation and enforcement of the Electricity Act falls under the responsibility of the regulatory arm of the FEA; this includes licensing of new IPPs. FEA supports a proposal by the Government to transfer the Regulatory function that FEA currently administers to an independent entity within the Government, intended in part to create a more attractive market for IPPs. In order to facilitate this transfer, the Regulatory Unit has been ring-fenced within the FEA's organisational structure for several years.

A key influence on the operational performance of FEA and on the attractiveness of the electricity market to IPPs was the Commerce Commission determination on electricity tariff rates released in 2010. Both feed-in and retail tariffs were substantially increased, with the objective of removing anomalies (such as hidden subsidies) on the one hand, and on the other setting a realistic tariff. This took into account the costs of FEA, its need for efficiency and its ability to fund renewable energy projects from profits and healthy balance sheet. The Commission also took account of FEA's need to provide incentives to IPPs to sell electricity from renewable sources to FEA's grid.

The Pacific Power Association's Power Benchmarking Report 2011 for electric utilities across the Pacific found that the setting of tariffs by an independent regulator has resulted in economically viable tariff levels rather than non-sustainable subsidisation. Utilities in countries with this regulatory structure are able to operate with funding for investment and maintenance, thereby improving service delivery. The Board of FEA has acknowledged its increased ability to invest in maintenance and new developments, and to focus on its commercial objectives, since the higher tariff was set and subsidies removed. PPA finds that FEA has become one of the best-performing utilities in the region, with an experienced management team and clear directives from government about its commercial objectives.

In 2013 the government had the Fiji energy policy and market framework comprehensively reviewed by consultants, funded by the German Aid Donor GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit). The review focused on the extent to which the NEP and Strategic Plan had been implemented and incorporated in other policies, plans and processes. It found that progress had been made in some areas, including an (unpublished) draft review of the Electricity Act, expansion of both grid-based and rural electrification and strengthening of public awareness on energy programmes, projects and developments. However a National Energy Bill had not been developed as yet. The review recommended that Fiji establish a planning and regulatory authority to develop national energy plans and to scrutinise FEA's power sector expansion plans, with DOE's capacities and powers expanded to assume this role. But it recommended that regulation of electricity sector pricing and competition should rest with the Commerce Commission.

Technical Planning for Investment

FEA has compiled and reviewed its Power Development Plan 2020 and has presented the Plan to stakeholders in Government for their input. The Plan shows the road map of hydro, wind, solar, biogas and geothermal power options to reach a 90 percent share of electricity generation by 2015. The National Energy Plan calls for an 81 percent share by 2020.

According to Bobby Naimaw, FEA's Chief Finance Officer, achieving an 81 percent renewable generation share would require capital expenditure of FJD 450 million by FEA and FJD 49 million by IPPs for renewable power facilities, as well as capital expenditure of FJD 669 million by FEA for transmission, distribution, and retailing. FEA's current capital expenditure budget is only around FJD 111 million over the next ten years, so the agency is working closely with the Fiji Trade and Investment Board to streamline processes for private investment. There are press reports that the government plans to restructure FEA to achieve the ambitious renewable power investment goals, perhaps to list it on the South Pacific Stock Exchange, in which case FEA's regulatory functions would be transferred to a government department. Wind farms have been set up at three locations and wind studies over the years have demonstrated the potential for more wind generation including small scale wind turbines, using battery storage to provide power to remote communities. Technical studies recognise the need to manage the risk from regular cyclones which can damage the turbines. Initial geological research shows there is a geothermal resource in Fiji in two Vanua Levu sites where perhaps 5-15 MW could theoretically be developed. But the cost of exploration drilling (which can be USD 15-20 million) to prove the resource with additional drilling cost for its subsequent development, and the cost of roading access and connection to the grid makes it less attractive than other renewable options (IRENA, 2013a)

Capacity to Implement Investment

FEA which has built up strong skills not only in grid management, transmission, and retail but also in assessing new generation options. Given their background in hydro over the past decades, FEA has substantial understanding of the hydro sites worthy of future investment. But it has also been developing expertise in wind, starting with construction of a wind plant in 2007. But perhaps the most important capability FEA has is in its commercial skills, both in running a profitable utility, and in assessing and planning new investment projects.

Fiji also has an important capacity asset in the University of the South Pacific (USP) campus in Suva. USP has strong capability in Renewable Energy research, and in tertiary level education in energy and sustainability. USP has conducted island Renewable energy assessments in Fiji in conjunction with the various regional bodies resident in Fiji including the United Nations Development Programme (UNDP), South Pacific Commission, International Union for Conservation of Nature (IUCN), Pacific Regional Environment Programme, as well as donors such as the EU, and GIZ. In all, Suva is a centre of excellence in the Pacific across all the types of expertise required for a fast transition from oil to renewables.

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SAMOA

Bringing in the Market to Diversify Renewable Power Supplies

Samoa has a wide range of renewable resources – hydro, solar, wind, geothermal, and biofuels. Growing electricity demand and rising oil imports have created an imperative for investment in these resources. The island has therefore reformed its power market to make it more attractive to independent power producers. Close coordination between government agencies, power utility, IPPs and donors helps to ensure the best investment decisions are made to meet the country's renewable energy supply targets.

Island Profile

Samoa is located in the western Pacific Ocean with a population of 187,000. The two main islands of Savaii and Upolu are tropical, humid and warm with distinct wet and dry seasons. There is considerable rainfall and sunshine, but the islands are subject to cyclone damage. Samoa was once a colony of Germany, was ceded to Great Britain after World War II, and in 1962 became the first independent Pacific nation. The economy is based on agriculture, manufacturing, tourism and remittances from Samoans living overseas. The island is known for its stable political leadership.

Renewable Energy Profile

Samoa's dependency on imported fossil fuels has been increasing in recent years as electricity demand has grown without substantial new investment in the island's legacy of run-of-river hydropower which supplies between 30 and 40 percent of its electricity generation in a typical year. But hydropower has come to seem less dependable due to periodic droughts and floods which have been linked to climate change. Other installed renewable energy includes biomass and small amounts of solar photovoltaics and solar hot water heating. Some growth in renewable share is expected with the introduction of a 400-kilowatt solar grid system and a 500-kilowatt biomass gasification unit. The island has had consistent energy-related policy frameworks. In 2013, the residential tariff, including a 48 percent fuel surcharge, was 43 U.S. cents per kilowatt-hour.

Electricity Access	95 percent
Installed Capacity in 2011	31.7 megawatts
Renewable Capacity in 2011	12.5 megawatts (39% of all capacity)
Electricity generation in 2011	109 gigawatt-hours
Renewable generation in 2011	31 gigawatt-hours (28% of all generation)
Electricity tariff (residential) in 2013	43 U.S. cents per kilowatt-hour

Note: Renewable hydro generation was below average in 2011 due to low rainfall.

Electric Power Profile

The state owned Electric Power Corporation (EPC), founded in 1972, is the currently the sole provider of electricity, building and maintaining all electricity generation and distribution facilities. Two IPP agreements have been signed, and a tender has been issued for another, but these projects have not yet been developed. EPC also houses projects for the testing and piloting of RE technologies that feed into the country's grid. It has an independent Board of Directors which brings together government, management, consumer and business representatives.

EPC has eight small hydroelectric plants (950 kW to 2 MW each, mostly run-of-river) at five locations on Upolu, with aggregate generating capacity of 9.71 MW, as well as 18.5 kW of diesel-fueled capacity. Overall, the dry season capacity of all systems is about 21 MW of which 16.9 MW (81 percent) is diesel and 4.2 MW (19 percent) is hydro.

Because of the heavy reliance on diesel fuel for electricity generation, retail tariffs for electricity are high. Rising oil prices have made it necessary for EPC to introduce a variable monthly fuel surcharge. EPC's Corporate Plan states that "the most critical threats to the Corporation are the fluctuation of world oil prices and the impact of climate change on the availability of water resources for hydro generation of electricity. This results in the unpredictability in the cost of electricity production"

Political Priority for Investment

A goal of Samoa's Energy Sector Plan is to "promote the use of indigenous energy resources and renewable energy technologies." The Strategy for Development of Samoa calls for an 8 percent increase in renewable energy supply from 2012 through 2016. Samoa's government is committed to investment in renewable power to reduce the burden of high electricity costs to its residents and businesses. Its commitment is shown in the goals of the EPC, which it owns. The EPC Corporate Plan 2011-14 aims to:

- Maximise the utilisation of coconut oil and other fuel sources derived from agricultural products, for the generation of electricity where cost effective;
- Increase hydro generating capacity and optimise its use, monitoring potential hydro sites in Savaii and Upolu with the view to start developing one new site by 2014;
- Extend the monitoring and investigation of the utilisation of other renewable energy options including wind, solar, ocean, and biomass resources.

A National Energy Coordination Committee was established in 2010 to coordinate decision making in the energy sector. It is chaired by the Minister of Finance and includes all Ministers whose portfolios relate to energy. Such coordination is apt to benefit cost-effective renewable energy options. The NECC's objectives are to:

- Advocate for energy as an enabling tool for realising national development goals,
- Promote the mainstreaming of energy into decision-making processes at all levels of government and society, including national planning and budgetary processes;
- Promoting evidence- and knowledge based decision-making on energy matters;

» Create an environment for sustained, coordinated and harmonised support from regional entities, international organisations and development partners.

EPC's strategy is to lower electricity costs with substantial renewable investment:

» A tender was issued in November 2013 for highly-efficient diesel generators which will provide spinning reserve to handle a greater share of renewable generation.

» Hydro plants damaged by a recent cyclone are to be refurbished, and there are plans to build 2.5 MW of new run-of-river hydro capacity.

» Photovoltaic investments of 200 kW in Opulu and 150 kW in Savaii are being made with assistance from Japan and the Asian Development Bank.

» Wind power is to be built with an expected donor project announcement in 2014.

» Bio-diesel production from coconuts is anticipated through an IPP investment.

Market Structure for Investment

Samoa has taken key steps in recent years to open up markets to renewable power. The Electricity Act 2010 establishes an Electricity Regulator to promote competition in electricity generation and the use of new technology for electricity generation, transmission or supply. The Electricity Regulator is implementing the Cabinet's decision to open up the electricity sector competition from Independent Power Producers (IPP's). It is charged to regulate electricity tariffs not only to benefit producers, in the sense of allowing adequate rates of return on investment, but also to protect consumers from high electricity prices. With this dual mandate, the Electricity Regulator is well-positioned to consider renewable power sources that reduce tariffs by generating electricity at a lower cost than diesel generation they displace.

To help encourage private investment by IPPs, the government has recognised the need to develop Power Purchase Agreements (PPAs) which are fair to both project investors and EPC. Samoa fully understands the requirements for appropriate PPA provisions to mitigate risk so that private investors are more likely to consider investment in renewable power options. The November 2013 IPP tender for photovoltaic capacity is being managed by EPC, but the PPA arrangements are in commercial confidence.

To seek out investment partners to develop renewable energy proposals, the Energy Division of the Ministry of Finance has set up an "Expressions of Interest" scheme to canvass new proposals. Donor-funded experts assess the proposals' economic and financial viability based on their internal rates of return, with sensitivity analyses performed for product prices and for key variables affecting project costs.

EPC has developed interconnection agreements that allow private consumers to install their own small-scale renewable power systems. Electricity from such systems that is surplus to the consumers' needs is fed into EPC system and earns credits that allow consumers to offset electricity purchased from EPC. This form of net metering reflects a realisation by EPC that renewable energy generation from small, distributed private systems can grow

significantly over the coming decade and reduce requirements for investment in the distribution network.

Technical Planning for Investment

The Renewable Energy Division of the Ministry of Natural Resources and Environment (MNRE) undertakes feasibility studies and research into renewable energy sources for Samoa whilst ensuring that environmental sustainability is maintained. The Ministry of Finance believes in a balanced portfolio of renewable power projects, since some types of projects are likely to prove more promising than others.

An analysis of renewable energy opportunities in Samoa by IRENA shows that the most promising options for electricity generation are small run-of-river-hydro, wind, solar and biofuels, which has been reflected in the EPC strategy described above. With recent declines in photovoltaic costs, there is growing interest in solar generation, for which Samoa has high technical potential. IRENA's Renewable Energy Atlas shows that most of the island has daily average insolation of over 5.0 kWh/m^2 with little seasonal variation.

In view of the high wind and solar resource potential, Samoa requested support from the Government of New Zealand for studies of grid stability with substantial new wind and solar power additions. Separate studies were performed for Savai'I and Upolo by KEMA, a Dutch consultancy, in 2012.

Savai'I has a population of 43,000 people and a 2.8 MW peak load in early evening. The electricity generation is entirely diesel powered. Its peak load is projected to grow rapidly to 4.2 MW by 2020 at which time annual electricity use will amount to 15.8 GWh. Wind capacity of 6.8 MW has been proposed, with three small 275 kW turbines at Safotu and three large 2 MW turbines at Salelologa. In addition, solar photovoltaic capacity of 0.9 MW has been proposed at Salelologa, Vaiaata and Asau. Steady-state simulation revealed that the island could take on 1.625 MW of wind and 0.81 MW of PV without system performance concerns or energy storage requirements. Assuming a capacity factor of 20 to 30 percent for wind and 12 to 15 percent for PV, this amount of capacity would generate between 26 and 37 percent of the islands' electricity needs.

Upolu has a population of 135,000 people and a 17 MW peak load in early afternoon. Electricity is generated from a mix of diesel and small hydro facilities. Peak load is projected to increase by nearly half, to 25.2 MW, by 2020, when the annual load will amount to over 133 GWh. Wind capacity of 7.1 MW has been proposed, with four small 275 kW turbines at Mount Le Pue and three large 2 MW turbines at Mount Fagaga. Solar photovoltaic capacity of 8.0 MW has been proposed at Flaga, Faleolo Airport, Yazaki, Sports Complex, Apia Park and Samoa College. Both steady-state and dynamic simulations showed that 5.1 MW of wind and 7.9 MW of PV could be added to the island's grid without raising performance concerns or requiring energy storage. These 13 MW of renewables would generate between 13 and 18 percent of system energy.

There has been a lot of research and prototyping work on biofuels from coconuts. Of particular

interest is a government-owned 2,500 hectare coconut plantation near the airport. A 2006 report by the Asian Development Bank recommended that EPC should consider establishing a power plant and an oil mill within the plantation to process fuel harvested from the coconuts. The challenge may be continuity of supply and sufficient commercial returns when competing with petrol and diesel. However, the prospect of being able to refine coconuts into biodiesel that can be blended with transport fuel is very attractive given the high cost of oil imports. Since 2008, the Scientific Research Organisation of Samoa has developed and piloted the use of biodiesel in eight vehicles.

Capacity to Implement Investment

In addition to the Renewable Energy Division of the Ministry, the EPC set up in 2007 a Renewable Energy Unit to research, manage and develop projects associated with wind, solar, hydro and bio-energy. The EPC Human Resources Department provides skills development programs including apprenticeships and technical training. EPC has considerable skills in hydro engineering given its long history of operating hydro plants.

Samoa recognises that accelerated introduction of renewable energy requires human and institutional capacities. Lead agencies for each energy sub-sector are responsible for identifying any resource and capacity building requirements and looking to resolve them. The Energy Policy Coordination and Management Division, as Energy Sector Coordinator, is a center of excellence along with technical and commercial staff in EPC.

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The Global Renewable Energy Islands Network (GREIN) has been established by IRENA to pool knowledge, share best practices, and seek innovative solutions to accelerate the uptake of renewable energy on islands. GREIN works through autonomous clusters of islands interested in renewable energy roadmaps, grid integration, tourism applications, resource assessment, desalination and waste-to-energy systems.

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