State of the Art of Geothermal Energy Regulations and Research

And

Research and Energy Regulatory Framework for Renewable Energies in Aruba, Barbados, El Salvador, Jamaica, Nicaragua, Peru and Trinidad and Tobago

Complementary report to

ALCUE-Net Product N°1 – State of the Art in Science, Technology & Innovation related to Renewable Energy in LAC Countries

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1. Overview of the State of the Art of Geothermal Energy Regulations and Research

1.1 Argentina

Projects Overview

No geothermal power plants are currently operating in Argentina but the country is in the forefront of South America in the direct use of geothermal resources with a total capacity of 150 MWt – installed at 70 different locations – mainly used for bathing and swimming but also with some applications in fish farming, greenhouse and soil heating, individual space heating and snow melting.

Although the country had a pilot geothermal plant in the geothermal field of Copahue, it was decommissioned in 1996 and during the last years, few advances have been made in most of the geothermal fields oriented to power generation.

Although there are more than 300 hundred geothermal sites in Argentina, only four have the potential to be used to generate electricity: Copahue (Neuquén Province); Domuyo (Neuquén Province), Tuzgle (Jujuy Province) and Valle del Cura (San Juan Province).

The Copahue site has received a renewed interest from the local authorities since 2010. The government of the province of Neuquén, through the Agency for the promotion and the development of investments of the Neuquén (ADI-Nqn), called a public bid for private investors interested in building and operating a future plant for the generation of electrical power of 30 MW, with an investment of 100 million US dollars. The electricity produced would be sold in the wholesale electricity market and transported through the already existing system of 33 kVa. The Canadian company Geothermal One was awarded with the tender in 2015. The construction of the facility would take 4 years and it would become the first of such facility in South America.

The local government of Neuquén also launched another international bid in 2015 for exploratory research in the Domuyo site. These news studies will complement earlier ones done by the Ministerio de Planificación Federal de la Nación and the Japan International Cooperation Agency (JICA).

Legal overview

There is no specific law related to the development of geothermal energy.

1.2 Aruba

There is no installed thermal capacity and the potential for generation of electrical power from geothermal sources is low.

1.3 Barbados

There is no installed thermal capacity and the potential for generation of electrical power from geothermal sources is low.

1.4 Brazil

Projects Overview

Systematic investigations of geothermal resources in Brazil began in the 1970s carried out mainly by the Geothermal Laboratory of the Observatório Nacional. However, despite 360.10 MWt of installed thermal capacity, geothermal energy sources are not used for electrical power generation and hence not formally recognized by the National Council of Energy Policy (CNPE).

The installed capacity is mainly used for bathing and swimming with 16 MWt for bathing, recreation and tourism; 343 MWt for potential industrial use and space heating but mainly used for recreational purposes; and 3 MWt for therapeutic uses.

The National Department of Mineral Production (DNPM) under the Ministry of Mines and Energy is the lead government agency involved in setting guidelines for the development and use of geothermal water. The Geological Survey of Brazil (CPRM) works in close cooperation with DNPM and has been engaged in mapping geothermal areas and in compiling related geological and geophysical data. It has also carried out drilling and logging operations as part of projects for development of geothermal energy resources.

Legal overview

There is no specific law related to the development of geothermal energy.

1.5 Chile

Projects Overview

There has been interest in geothermal exploration in Chile since the beginning of the 20th century and preliminary analyses have established that the Chilean Andes has more than 300 hot spring areas with an estimated high-temperature potential of some 16 000 MWt. However, for now geothermal energy in Chile is mainly used for recreational purposes. The current use in spa and swimming pools accounts for all the 19.91 MWt of installed thermal capacity.

During the last five years geothermal exploration in Chile has been very active due to the need for energy security. Detailed exploration studies are being carried out by 14 private companies in 76 geothermal concession areas with the objective to narrow the focus and identify areas of highest technical and commercial potential. In the geothermal zone of Northern Chile, 45 exploration concessions are being surveyed. The

most advanced exploration programs have been carried out in the Colpitas, Apacheta, Pampa Lirima and El Tatio-La Torta geothermal sites. Exploratory wells have been drilled in all of these areas, and the estimated combined power potential of exploitable geothermal energy of these four prospects is between 400 and 1,000 MWe. Exploitation concessions have been granted for the Apacheta and El Tatio geothermal fields, and the environmental assessment for the installation of a 50 MWe power plant has been approved for the Apacheta field; the exploitation concession at El Tatio recently has been canceled due to the company failing to comply with project's environmental and safety requirements. Geotérmica del Norte, a joint venture of CODELCO, the State Copper Company, ENAP, the State Oil Company and ENEL, has indefinitely suspended geothermal development at the site.

In the Central-Southern Zone 31 exploration concessions have been granted; the most advanced exploration studies have been completed at the Tinguiririca, Calabozos, Laguna del Maule, Chillán and Tolhuaca geothermal areas. Exploratory wells have been drilled in these areas and their combined power potential estimations range from 650 to 950 MWe. Exploitation concessions were granted for the Laguna del Maule (Mariposa) and Curacautin/Tolhuaca projects, where production size wells have been drilled. An environmental impact assessment was submitted to the authorities for the approval of the installation of a 70 MWe power plant in the Tolhuaca geothermal area, where well Tol-4 has an output of 12 MW.

The two projects that have more potential of becoming the first completed geothermal facility in South America are the Pampa Apacheta field, with the beginning of the construction phase on a 50 MW facility that should be operational in 2017 with an investment of US\$320 million; and the Curacautin field with the approval of the environmental impact assessment for a 70-MW geothermal project that would represent more than US\$ 400 million in investments. This last project should start operating in 2019.

Legal overview

In January of 2000, Chile established a geothermal law, Nº 19.657, that represent the legal background to support geothermal business in exploration and exploitation concessions. The Ministry of Energy is in charge of granting concessions for exploration or exploitation through direct requests or through public bids.

1.6 Colombia

Projects Overview

Although geothermal reconnaissance studies were conducted as far back as 1968 by the National Geological Survey of Colombia at the Nevados del Ruiz complex, current utilization of the geothermal resources are still restricted to recreational purposes.

The national inventory that was conducted in 1982 identified the following geothermal sites: complejo Volcánico Parque Natural Los Nevados, Cumbal, Azufral de Túquerres

and Paipa-Izade. As of recently, exploration studies of geology, geochemistry and geophysics have been carried out in the Azufral and Paipa-Iza geothermal areas and drilling of exploratory wells has also been considered.

Despite the limited use for recreational purposes, a new and more favorable context has emerged recently for development of geothermal energy in this country. Several stakeholders, including power generation companies, universities and governmental institutions, are promoting prefeasibility exploration studies and improving the regulatory and institutional framework, in order to promote the development of nonconventional renewable energy sources, including geothermal.

A Development Plan for Non-Conventional Energy Sources has been formulated by the Mining and Energy Planning Unit which is part of the Ministry of Mining and Energy. The main goal of the plan is to create the conditions to encourage the non-conventional energy sources and it includes specific strategies for geothermal, mainly complete prefeasibility studies in priority geothermal areas: Azufral Volcano, bi-national project between Ecuador and Colombia, Tufiño – Chiles – Cerro Negro, and Paipa – Iza; and and the conduction of studies on regulations necessities for the exploitation of the geothermal resources.

In 2011, the former INGEOMINAS, created in 1916, became the Servicio Geológico Colombiano (SGC), transforming it into a scientific and technical institute part of the science and technology national system, and responsible of carrying out basic and applied scientific research from subsoil resources potential, among other duties.

Currently, geothermal power plants of 50 MW of installed capacity are being planned by the companies CHEC-EPM and ISAGEN. The latter is also projecting with CELEC a 138 MW power plant in the bi-national Ecuadorian – Colombian geothermal project.

Legal overview

The Natural Renewable Resources and Protection of the Environment National Code: of 1974 regulates the management of renewable natural resources, including the geothermal resources.

The 2011 law for Rational and Efficient Use of the Energy assigns to the Ministry of Mining and Energy, the responsibility to promote, organize, and ensure the development and monitoring of the programs of rational and efficient use of energy. More recently, in 2013, the law 1665 approved the statute of the International Renewable Energy Agency (IRENA) and also includes as renewable energies, bio-energy, geothermal energy, hydraulic power, marine energy (tidal wave power), oceanic thermal energy, solar energy and wind power.

Additionally, in 2014 the law 1715 started to regulate the integration of nonconventional renewable energy in the National Electricity System and also promotes the development of activities of production and use of non-conventional sources of energy from renewable sources from a social, public and national interest perspective,

essential to the diversification of energy supply, the competitiveness of the Colombian economy, and the environmental protection. This law also states that the Energy and Gas Regulatory Commission should define the technical regulation of geothermal energy.

1.7 Costa Rica

Projects Overview

Costa Rica leads the Central American region in terms of installed geothermal capacity and is well on its way to achieving its goal to be "carbon neutral" by 2021. Two geothermal power plants, Miravalles (163.5 MWe) and Las Pailas (42.5 MWe), provide a total installed capacity of 206 MWe and are operated by the Instituto Costarricense de Electricidad (ICE). These plants generation contributes to 15% of the national energy mix of Costa Rica. Various other geothermal sites are currently under development in Pailas, Borinquen and Pocosol.

Because geothermal plants produce constant energy throughout the year, they are used as a base load for the country's electrical generation due to the seasonal variations in the hydro electrical plants production.

Since 2010, the country has seen a large increase in the development and exploration of other geothermal sites. Feasibility studies for a second unit in Las Pailas are underway, as well as prefeasibility studies in the Borinquen for two 55 MWe units.

Legal overview

The electrical generation system of Costa Rica is organized as a regulated utility, where the Instituto Costarricense de Electricidad (ICE) is legally mandated to fulfill the country's electricity needs. ICE is an autonomous institution of the government, vertically integrated in generation, transmission and distribution divisions. The Autoridad Reguladora de los Servicios Públicos (ARESEP) ensures the quality and price of public services provided by ICE and the other electric companies.

1.8 Dominican Republic

There is no installed thermal capacity and the potential for generation of electrical power from geothermal sources is low.

1.9 El Salvador

El Salvador is the world leader in terms of the percentage of electricity output from sustainable geothermal resources with approximately 24% of its total electricity production coming from geothermal resources and with an aim to reach 40% by 2020. In terms of Mw, the country is just about tied with Costa Rica, with just over two hundred Mw connected to the grid from two geothermal fields operating plants: Ahuachapán and Berlin.

Exploration for geothermal energy sources began nearly 60 years ago with the assistance of the United Nations and this exploration is still ongoing with work in two other fields: San Vicente and Chinameca. Geothermal energy has been a priority for decades which has given the right legal and institutional framework for investment. With this clear framework, the government of El Salvador has been able to secure funding from international development banks and governments for its geothermal projects and consistent tax incentives, such as tax exemption for ten years for projects under 10 MW of generating capacity, and duty concessions have also incentivized the growth of the sector. The tax exemptions also apply to expenses necessary for research, exploration and preparation of power generation projects based on renewable energy.

The Superintendencia General de Electricidad y Telecomunicaciones (SIGET), acts as the regulator and helps to facilitate the success of the geothermal market by ensuring correct regulation and monitoring of the project evaluation process to further the dual objectives of sustainability and energy security. SIGET is also responsible for promoting competition, overseeing compliance with the General Law on Electricity, approving tariffs, granting concessions, resolving sector conflicts and regulating procedures, technical standards and methods.

The country has also put in place a system for Renewable Energy Development that provides the creation of a Revolving Fund for the Promotion of Renewable Energy to support loans, guarantees and assistance to finance feasibility studies for new projects. Additionally, the country recently received a US\$ 2 million grant from the Inter-American Development Bank to found an international geothermal training center for Latin America and the Caribbean, which has help to train representatives from El Salvador and countries throughout the region to develop and operate geothermal facilities.

Legal overview

The legal framework for the El Salvadoran electricity sector is made up of the following legislative and regulatory orders:

- Law creating SIGET was issued by Legislative Decree No. 808 of 12 September 1996.
- General Electricity Law, issued by Legislative Decree No. 843 of 10 October 1996.
- Electricity Law Regulations, established by Executive Decree No. 70 of 25 July 1997.
- Electric Power Marketing Activities Regulations, issued on 24 October 2000, which aims to promote competition in energy market.
- Amendment to the General Electricity Law, issued by Legislative Decree No. 1216, April 2003.
- Legislative Decree No. 405, August 2007.

1.10 Jamaica

There is no installed thermal capacity and the potential for generation of electrical power from geothermal sources is estimated to be around 100 Mw but there are no country specific geothermal resource assessments for Jamaica so this figure is considered to be overestimated.

Besides the stated intentions of a businessman to raise \$4 million USD to finance the construction of a \$15 million geothermal power plant there are no specific geothermal project for energy production in the country.

1.11 Mexico

Projects Overview

The geothermal installed capacity of Mexico is 1,017 MWe, distributed into four geothermal fields in operation: Cerro Prieto 720 MWe, Los Humeros 94 MWe, Los Azufres 194 MWe and Las Tres Virgenes 10 MWe, owned and operated by the state utility Comisión Federal de Electricidad (CFE). The production was about 6,100 GWh, representing 2.4% of the total electric output in the country. Two additional geothermal projects are currently under construction: Los Azufres III with 50 MWe and Los Humeros III-A with 27 MWe.

With 720MW, Cerro Prieto is the third largest geothermal plant in the world. It features four plants, the first was commissioned in 1973, while the fourth plant was commissioned in 2000. The turbines at the complex include four 110MW condensing type, four 110MW double-flash type, four single-flash of 37.5MW each, four single-flash of 25MW each and one 30MW single-flash. All supplied by Toshiba and Mitsubishi Heavy Industries. A fifth plant is currently under construction.

With this installed capacity, Mexico ranks fourth at the global level and there are high expectations for future geothermal development, due to a new regulatory framework of the power and geothermal markets and the foundation of a national geothermal innovation center (Centro Mexicano de Innovación en Energía Geotérmica; CEMIE-Geo) in 2014.

The center is a consortium composed of 22 entities headed by the Center for Scientific Research and High Studies of Ensenada (CICESE). Twelve members are public research institutes and universities, nine are private companies, and the 22nd entity is the CFE. It is headed by a steering group composed of three representatives from private companies, six representatives from the academia and one from CFE. The CEMIE-Geo won't have any physical offices, labs or administrative structure, but instead uses the infrastructure of its 22 parties.

One of the goals of the center for the 2014-2017 period is to conduct 30 research projects that will encompass improvements in exploration tools and methods, development and testing of direct-use prototypes, improvement of conduction pipes

and turbine materials, and specific studies in geothermal areas. All the 30 projects are clearly defined, programmed, scheduled and budgeted. The total investment for all the projects will be around US\$ 87 million, with 88% provided by the federal government and the rest by the private companies as in-kind contributions. After 2018 the CEMIE-Geo will have to seek its own resources to continue development.

Legal overview

One of the most challenging reform that the present Mexican government has undertaken is energy reform passed by the Mexican Congress in 2013, which involves a profound transformation of the oil and gas industry, including the state companies Petróleos Mexicanos (PEMEX) and Comisión Federal de Electricidad (CFE) in the oil and power industries, respectively.

With this reform, both companies will still be owned by the government but will be operative, finance and manage as autonomous companies that will compete with private companies in free power and oil national markets. Another change was the issuing of the two first permits for geothermal power projects in the state of Nayarit, which are still in their exploration and construction stages of development.

Two of the new laws related to the reform are the electric industry act (Ley de la Industria Eléctrica) and the geothermal act (Ley de Energía Geotérmica) that were approved in August 2014. The latter divides the process of geothermal development into three successive stages: reconnaissance, exploration and exploitation, for whose implementation it is necessary first to obtain a registration, permit or concession, respectively, issued by the Ministry of Energy. If the concession is granted, the concessionaire will have a maximum of three years to get the other authorizations, particularly the environmental licenses and the grant for using geothermal waters. The exploitation concession is valid for 30 years.

1.12 Nicaragua

The World Bank has called Nicaragua "a renewable energy paradise in Central America" because of its estimated potential reserves of 1,500 MW. However, just 154 MW have been installed in two power plants: Polaris and Momotombo.

Exploitation of geothermal power began in 1983 with a 35 MWe unit commissioned in the Momotombo area. A second 35 MWe unit was added in 1989. Thirteen years later the total nominal generation capacity stood at 77.5 MWe. Nicaragua's net geothermal electricity output it reached 289.8 GWh, just under 10% of total net generation, in 2008. Now it stands at 16% of the total electricity production. The government has set a very ambitious goal to produce 94% of its electricity from renewable resources by 2017, and 100% by 2025. For this to happen, the plan requires an investment of over \$2 billion, with \$638 million proposed for geothermal power.

Although the significant geothermal potential of the country still remains to be exploited, in 2011, Ram Power Corp., a US geothermal developer, completed the first

phase of its expansion to the San Jacinto geothermal resource, bringing 36 MW of geothermal capacity online. And additional 36 MW where online at San Jacinto in December 2012. Ram Power is also conducting exploration of the Casita San Cristobal geothermal resource in northwest Nicaragua. It is believed that the geothermal resource, if found to be commercially viable, could support 85 MW of geothermal generation. GeoNico, a joint venture between the Italian company Enel and LaGeo of El Salvador, is exploring areas located in El Hoyo-Monte Galán and Managua-Chiltepe.

Legal overview

In 2002 Nicaragua instituted the geothermal Law 443, which regulated the exploration and development of geothermal resources by private companies. The law put in place a feed-in tariff (FIT) policy that was not effective. In 2005, the government introduced the Renewable Energy Promotion Law with a second FIT scheme that was adjusted in 2007 and 2009. However, the scheme has yet failed to promoted the private investment expected, mainly because of legal and regulatory uncertainties.

1.13 Panama

No installed capacity and the geothermal sources are mainly used for recreational purposes, although one 5 MW power generation plant is in development in the Barú-Colorado area.

Some research initiatives were started in the 70s and out of 23 geothermal sources, three were deemed to have the technical conditions for energy production: Veraguas, Chiriqui and Coclé.

In 2000, Empresa de Transmisión Eléctrica (ETESA) with the Secretaría Nacional de Ciencia, Tecnología e Innovación (Senacyt) started new researches on the geothermal potential of the country that estimated the potential of energy production from geothermal sources to be of 42MW.

No other specific projects are in place and no specific legal framework has been implemented to support geothermal development.

1.14 Peru

The use of thermal resources in Peru is still mostly limited to recreational uses. The evaluation of geothermal potential begun in the 70's. Six regions have been identified has having geothermal potential. The greatest potential is in the southern area of the country, especially in the regions of Puno and Cusco.

Since 2007, Peru has received economical and technical assistance to develop of geothermal energy, mainly from Japan. The last pre-feasibility studies done with Japanese support in two of the most promising geothermal fields in the country, Calientes and Borateras, estimated 150 MWe be found. In 2010, the Japanese government also elaborated "The Master Plan for Development of Geothermal Energy

in Peru" that estimated 3,000 MWe of geothermal potential for the country after assessing 15 geothermal fields.

The government has granted more than 30 authorizations areas, but until now no electricity from geothermal resources has been produced and there have not been any drilling for production wells done in the country.

Legal overview

Peru has a specific geothermal legislation, Ley Orgánica 26848 Recursos Geotérmicos, and that has been revised in 2010. This has created an interest for geothermal companies to look for opportunities to develop the geothermal resources in the country. From 2011, five companies have been authorized to explore 26 geothermal areas.

The legal framework promotes the rational development of geothermal resources in order to ensure the supply of energy required for economic growth, well-being and efficient diversification of the Peruvian energy matrix.

1.15 Trinidad and Tobago

There is no installed thermal capacity and the potential for generation of electrical power from geothermal sources is low.

1.16 Uruguay

Present geothermal uses in Uruguay are mainly for recreational purposes and limited use in agriculture of heating greenhouses.

Furthermore, there is a low potential for electricity generation and no specific legal framework for the exploitation of geothermal sources for energy production.

2. Research and Energy Regulatory Framework for Renewable Energies in Aruba, Barbados, El Salvador, Jamaica, Nicaragua, Peru and Trinidad and Tobago

2.1 Aruba

Despite recent efforts towards diversification of the energy production matrix, more than 80% of the island's electricity is produced with heavy fuel oil. Although, today this generation of electricity uses 40% less oil than what it did 10 years ago.

With high potential for wind, solar and ocean energy, Aruba launched at the Rio+20 conference in 2012 a very ambitious goal of having 100% of its energy coming from renewable sources by 2020. Currently, 20% of Aruba's energy comes from renewable sources, with 17% coming the 30MW Vaderpiet windfarm, and two new projects in wind and solar energy could boost this capacity to 50% in the short term. The island also is implementing the first Waste-to-Power plant in the Caribbean and South America that will initially produce 2MW with a goal to reach 7MW in the near future.

In 2011, the government of Aruba signed an agreement with The Netherlands Organization for Applied Scientific Research (TNO) to develop the Aruba Sustainable Research Institute (ASRI), an initiative that was included in the "Green Gateway" plan. The objective of the center is to carry out research in the areas of photovoltaic applications, wind energy generation and new sources of renewable energy such as deep see water cooling and wave energy development.

Regarding incentives, Aruba has policy and regulatory frameworks related to renewable energy for net metering/billing; tax reduction/exemption and green public procurement. Additional incentives have been put in place for import duties reduction on wind turbines, solar panels and electric/hybrid cars.

2.2 Barbados

Barbados is highly dependent on imported fossil fuels for electricity generation as the entire 239MW country's matrix of installed capacity is powered by oil and diesel fuel. Moreover, 104MW of installed capacity is scheduled for retirement by 2020.

Without any utility-scale renewable energy generation on the island and with an extreme vulnerability to the external oil markets, Barbados, in a 2012 Declaration on Achieving Sustainable Energy for All in Small Island Developing States, set a goal for renewable energy of 29% of electricity from renewable sources by 2029 and 22% reduction in energy consumption by the same year.

Before that in 2006 the country had launched the National Energy Policy of Barbados that established the reduction of fossil fuel consumption via renewable energy. Then, in 2010, the island started the Sustainable Energy Framework with support from the Inter-

American Development Bank. In 2013, the island passed the Electric Light and Power Act that exempted residential and non-residential renewable energy systems from licensing requirements under 5 and 50 kW respectively.

Since 2010 net metering is allowed in Barbados, and consumers with wind and/or solar self-generation facilities can supply energy to the national grid via the Renewable Energy Rider program. Currently more than 2MW of solar distributed generation has been installed on rooftops on the island.

The Barbados Light & Power Company (BLPC), a private vertically-integrated utility, manages the island's electricity market and is responsible for the generation, transmission and distribution of electricity. The Energy and Telecommunications Division in the Prime Minister's Office is responsible for developing and implementing energy policies.

In 2015, the BLPC published the Barbados Wind and Solar Integration Study that concluded that the existing grid can accommodate up to 20MW of distributed photovoltaic, 15MW of wind and 20MW of centralized photovoltaic. The study also suggested mitigation measures to maintain grid reliability and security.

2.3 El Salvador

Out of the 5.8TWh of electricity produced in 2014 in the country, 42% came from oilbased generation, 30% from hydro and 25% from geothermal. The remaining power is generated by biomass plants.

The new 2010 - 2024 policy establishes that energy is a public good and that the State must guarantee access to it for all citizens and places the use of renewable energies, the rational use of energy and technological innovation as key aspect to develop.

Five strategic lines have been defined: diversification of the energy matrix and development of renewables sources; strengthening of the institutionally of the energy sector; promotion of a culture of rational use of energy; increased coverage and preferential tariffs for certain groups; innovation and technological development; Regional integration. The final goal is to have the following distribution of generation by 2026: wind 60 MW, solar photovoltaic 90 MW, solar thermal 200 MW, geothermal 60-89 MW, small hydro 162.7MW, biomass 45 MW. and biogas 35 MW.

With an executive board composed by several ministries (Economy, Finance, Transport, Environment and Natural Resources, among others) the National Energy Council (Comisión Nacional de Energía, or CNE) oversees the electricity sector in the country. Created in 2007, the CNE concentrates every aspects involved in the formulation and coordination of the national energy policy. The Superintendencia General de Electricidad y Telecomunicaciones (SIGET) is the power sector regulator. State-owned Empresa Transmisora de El Salvador (ETESAL) is charged with transmission; Unidad de Transacciones (UT) regulates the wholesale power market and acts as the system operator. El Salvador is also part of the Central American Electrical Interconnected System (SIEPAC) and is connected to Guatemala and Honduras by 286km of transmission lines.

The largest generators in the country is LaGeo, which initially was a joint-venture between Enel Green Power and El Salvador's state-owned Inversiones Energeticas (INE). After a long litigation process, El Salvador will acquire Enel Green's stake in the project (36.2%) and will become the single owner of LaGeo.

2.4 Jamaica

Like other islands of the Caribbean, Jamaica is highly dependent on imported fossil fuels for energy generation as more than 90% of the island's electricity is generated from petroleum-based fuels. The renewable share for energy generation is at 4,8% with hydroelectric at 3,3% and wind at 1,4%.

Wigton Farm, with 38,7 MW, is Jamaica's largest commercial-scale wind farm and also the largest wind installation within CARICOM. 24 MW of additional capacity, that would bring the farm total to 62.7 MW, have been approved in late 2014. In January 2015, 34 MW of wind energy capacity were also approved and should begin commercial operation in early 2016.

The island has very limited installed solar energy capacity as it has only been used for applications in rural electrification, street lighting and some stand-alone generation. Sugarcane bagasse is currently the main source of biomass fuel. There are currently no utility-scale waste-to-energy electricity generation facilities in Jamaica and no country-specific geothermal resources assessments or installed geothermal capacity.

Despite that limited use of renewable sources, the potential for renewable energy could be used to meet the entire island's electricity demand. Several locations in Jamaica have extremely strong wind energy potential and improving the efficiency of current biomass generation facilities and connecting them to the grid could provide nearly 10% of the country's electricity demand with agricultural waste alone.

In 2009, The Ministry of Science, Technology, Energy and Mining (MSTEM) launched its first comprehensive long-term energy plan, the National Energy Policy 2009 – 2030. It set a 20% by 2030 target, that was later scaled up to 30%, in renewable electricity generation and also targeted a reduction of the energy intensity of the Jamaican economy by more than 70% by 2030. The government has also targeted a 30% reduction in energy costs for public buildings. The plan also established science, technology and innovation (STI) as fundamental in fostering economic growth and competitiveness. Key challenges identified by the document were low levels of funding, no explicit role for STI in national vision and development objectives, weak research and innovation culture and inadequately developed infrastructure.

Despite the National Energy Policy, the importance placed on energy efficiency and renewable energy continues to vary among government agencies. Even with the recently created Ministry of Science, Technology, Energy and Mining, energy

diversification plans are still centered around fossil fuels, either Liquefied Natural Gas or coal. The Planning Institute of Jamaica Vision 2030 Plan supports the deployment of renewables but argues that fossil fuels will still dominate until at least 2030.

Jamaica has also policy and regulatory frameworks related to renewable energy for net metering/billing, interconnection standards; tax reduction/exemption and green public procurement. It has tax exemptions for energy efficiency equipment, energy labeling for refrigerators and freezers and utility-led energy audit programs.

In the National Energy Policy, MSTEM recognized time-consuming administrative procedures for Project development as a major barrier to renewable energy Project development. MSTEM is currently developing a National Electricity Policy and accompanying legislation, the Modernize Electricity Act, using the National Energy Policy for 2009 to 2030 as the larger framework for the legislation. The Cabinet must approve the Electricity Policy before the legislation can proceed to Parliament.

MSTEM regulates the energy industry and promotes efficiency, diversification and competitiveness of the energy market. The Jamaica Public Service Company (JPS) is the country's grid operator and has a monopoly until 2027 on electricity transmission and distribution in the country. JPS was privatized in 2001 and is now 80% privately held and 20% government owned. JPS is regulated by the Office of Utilities Regulations (OUR), and independent regulatory agency. OUR is also responsible for the procurement process for new generation capacity.

The Jamaica Energy Council serves as an energy decision-making forum that brings together diverse government and non-governmental stakeholders. MSTEM established the Council in early 2012 as a bipartisan, multi-stakeholder platform with the goal of reducing energy costs for households and businesses and increasing competition in the electricity sector.

Under the direction of the Ministry of Science, Technology, Energy and Mining, the science, technology and innovation sector of Jamaica is guided by two primary institutions: The National Commission on Science and Technology (NCST) and the Scientific Research Council (SRC).

NCST is responsible for fostering and advancing the national STI policy and strategy in Jamaica and also provides expert direction to government institutions and private sector enterprises seeking to implement projects related to the application of science and technology.

SRC is Jamaica's principal public sector agency for science and focuses on the coordination of scientific research island wide and the promotion of its application. Most of the Council's projects support the growth and development of the agro-industrial sector in Jamaica through research, adaptation of available technologies, creation of new and appropriate technologies and the provision of training and technical assistance. It was reconstituted in 2014 after being inoperative for a few years and a revision of the S&T policy was launched.

The 2012 Strategic Roadmap for Science and Technology highlighted funding in STI as a major issue for Jamaica. Critics pointed at the lack of a single national pool of public R&D funding, allocated with formal processes and with investments in priority areas that could yield the greatest return on investment for the country. The roadmap consequently places STI at the center of national development efforts

The University of West Indies is the largest producer of refereed publications among Jamaica's institutions involved in S&T research activities.

2.5 Nicaragua

The World Bank has called Nicaragua "a renewable energy paradise in Central America" because of its estimated potential reserves of 1,500 MW. Historically, Nicaragua has had to put up with high oil imports for electricity generation, up to 82% in 2009. Currently the share of renewable resources is of nearly 75% of the gross domestic primary energy supply, and about 50% of the total electricity supply, according to the Nicaraguan Energy Institute (INE) (INE, 2014). According to the country's November 2013 national plan for electricity expansion, Nicaragua established the voluntary target of 91% of energy generation by 2017.

The gross electricity sources of production in 2013 was 50% from fossil fuel plants; 15% from wind power plants; 16% from geothermal plants, 12% from hydropower plants and 7% from biomass power plants.

The ambitious goals of the government in renewable energies and transparent policies have allowed Nicaragua to attract over USD 1.4 billion since 2006, which represents 5.4% of its GDP in 2013, in clean energy investments. This is the largest investment per capita in clean energy in Latin America.

Law 532, approved in 2005, for the Promotion of Electricity Generation with Renewable Resources is Nicaragua's main policy supporting renewable development and is currently being reviewed by the government. Renewable energy developers enjoy a full range of tax breaks, including import duty, VAT and income tax exemptions. Distributors must prioritize the purchase of energy coming from clean sources by allocating a percentage to renewable power in tenders for electricity.

Electricity generation can be contracted via tenders organized by distributors or through bilateral contracts between generators and distributors and/or large consumers. The Instituto Nicaragüense de Energía (INE) regulates the electricity sector, where transmission and distribution are subject to regulated tariffs and generators can compete freely in the market. INE is also responsible for defining the percentage allocated for renewables in tenders based on MEM's strategic expansion plan. The Comité Nacional de Despacho de Carga (CNDC) is Nicaragua's electricity market operator, while the Ministry of Energy and Mines (MEM) oversees energy policy and planning.

2.6 Peru

Renewable sources - wind, solar, biomass and small hydro - have a significant potential in Peru but only represented 9% of the total 45TWh generated in the country in 2014. The rest was 41% from large hydro (23 hydropower plants in 2013), 27% from natural gas and coal and fuels for the rest (32 thermal power stations in 2013).

The Ministry of Energy and Mines (MINEM), the cornerstone of the institutional framework for renewable energy in Peru, has calculated that electricity demand will grow at an average annual rate of 8.8% per year up to the year 2017. To keep up, Peru has to invest more than USD 5 billion by 2016 in electricity generation to bring an additional capacity of 4 300 MW, including 1 400 MW of hydro and 600 MW non-hydro renewables. The industrial sector, especially mining, is driving this electricity demand with over 55% of the total demand.

MINEM develops regulations and standards in the energy and mining sectors, including those related to renewable energy. Peru has been one of the pioneers in the region in implementing renewable energy auctions and the policy and regulatory guidelines for conducting those auctions are set by MINEM. The first two renewable energy auctions awarded almost 1 400 gigawatt-hour (GWh)/year of renewable power from solar, wind and biomass and 281 MW from small hydro, attracting total investments of almost USD 1.5 billion. The results of a third auction process were recently announced; this resulted in the award of 16 hydropower projects with a total energy supply of 1 278 GWh/year.

The electricity market framework of Peru has 57 public and private companies engaged in generation, transmission and distribution and a regulatory body, Organismo Supervisor de la Inversión en Energía y Minería (OSINERGMIN). Of the 57 companies, almost half are engaged in generation, 10% in transmission and 40% in distribution.

The legal framework for the renewable electricity sector relies on two legal instruments: legislative Decree No. 1002; for the Promotion of Investment for Electricity Generation with the use of Renewable Energy and the Regulation for Electricity Generation with Renewable Energy.

The first promotes renewable energy resources as a national priority and the connection of renewable electricity to the national grid through regular auctions. It also sets a five-year rolling target share of energy demand to be met by electricity from non-hydro renewable energy resources.

The Regulation for Electricity Generation with Renewable Energy determines the administrative procedures for announcing renewable energy auctions and granting concessions for the development of renewable power generation. It also sets the requirements for submitting, evaluating and awarding bids, as well as marketing procedures and renewable energy generation tariffs. Renewable energy also benefits from fiscal incentives.

2.7 Trinidad and Tobago

In 2014, 97% of the energy generation of Trinidad and Tobago came from natural gas, as the island state is among the five largest exporter of liquefied natural gas (LNG) and before the rise of shale gas in the United States it supplied 60 percent of American LNG imports. The remaining generation comes from petroleum. As a result of the availability of low cost fuels, the islands have some of the lowest electricity prices in Latin America and the Caribbean (\$0.05/kWh), which are a disincentive to the support for renewable energy deployment. However, in 2013, the Sustainable Energy Action Plan described possible enabling policies for renewable development.

Renewable energy projects in Trinidad and Tobago have been limited to the pilot scale. The most successful renewable technology to date has been solar water heating systems with more than 25.000 customers in 2009. The electricity market is dominated by the state-owned Trinidad & Tobago Electricity Commission (T&TEC), the sole transmission and distribution company in the country.

Under the Petroleum Act (1969), the Petroleum Regulations (1970) and the Petroleum Taxes Act (1974) the Ministry of Energy and Energy Affairs (MEEA) is responsible for the overall energy and mineral policy and for monitoring and regulating the energy and mineral sector as well as issuing licenses for exploration and production.

In 2011 MEEA launched its Renewable Energy Policy Framework, which established recommendations and analysis of policies, technologies and targets for the deployment of renewable energy in Trinidad & Tobago. That same year, the Inter-American Development Bank approved \$140m USD in two loans to support the islands transition to a more sustainable energy matrix, incorporating energy efficiency and renewable energy and strengthening its policy framework to integrate climate change into national economic development. In 2014, the government launched the Sustainable and Renewable Energy Business Incubator, a partnership between the Arthur Lok Jack Graduate School of Business, the University of the West Indies, Citibank and the National Gas Company of Trinidad and Tobago (NGC).

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