The Status of Geothermal Power in Emerging Economies

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GEOTHERMAL ENERGY ASSOCIATION

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Contents

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Cover Photo of Menengai, Kenya is courtesy of Samuel Abraham of Baker Hughes

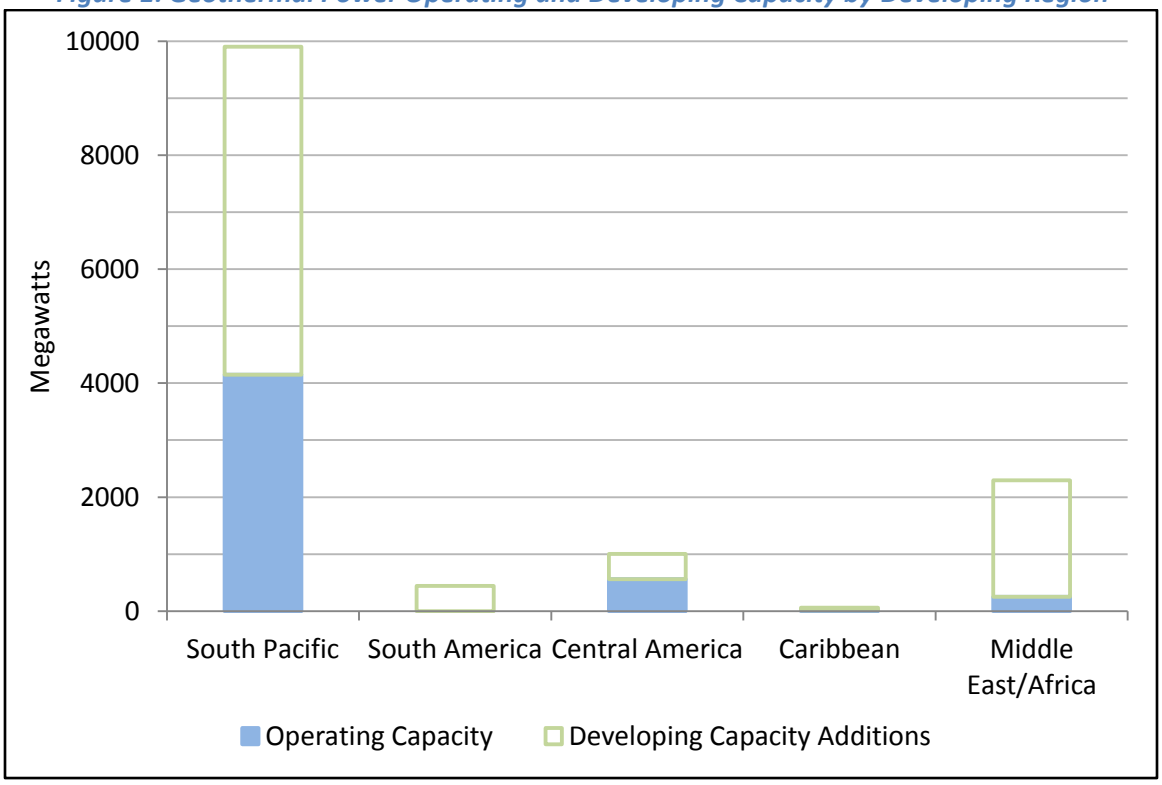
Introduction

Global capacity of geothermal power rests just over 12.1 GW about half way through 2014. While growth in the U.S. might have slowed, emerging economies in East Africa, Central America, the Caribbean, and the South Pacific are some of the fastest growing geothermal nations worldwide. Together these nations are developing nearly 730 sites and another 12.1 GW of potential power. Of that 12.1 GW about 1.6 GW are under construction. A regional breakdown of developing and operating capacity is depicted in Figure 1 below.

The potential power under development is only a fraction of the estimated total. The Intergovernmental Panel on Climate Change estimates global potential is around 200 GWe of geothermal power, with only a fraction of that total potential tapped. With the ever growing threats caused by climate change, geothermal energy can be an emission-free and cost-effective option to produce electricity in many emerging economies.

Most importantly, there are nearly 80 countries developing geothermal resources that fall adjacent to the Pacific Ring of Fire or East African Rift. In total, this market is estimated to reach nearly $9 billion dollar by 2019.

Figure 1: Geothermal Power Operating and Developing Capacity by Developing Region

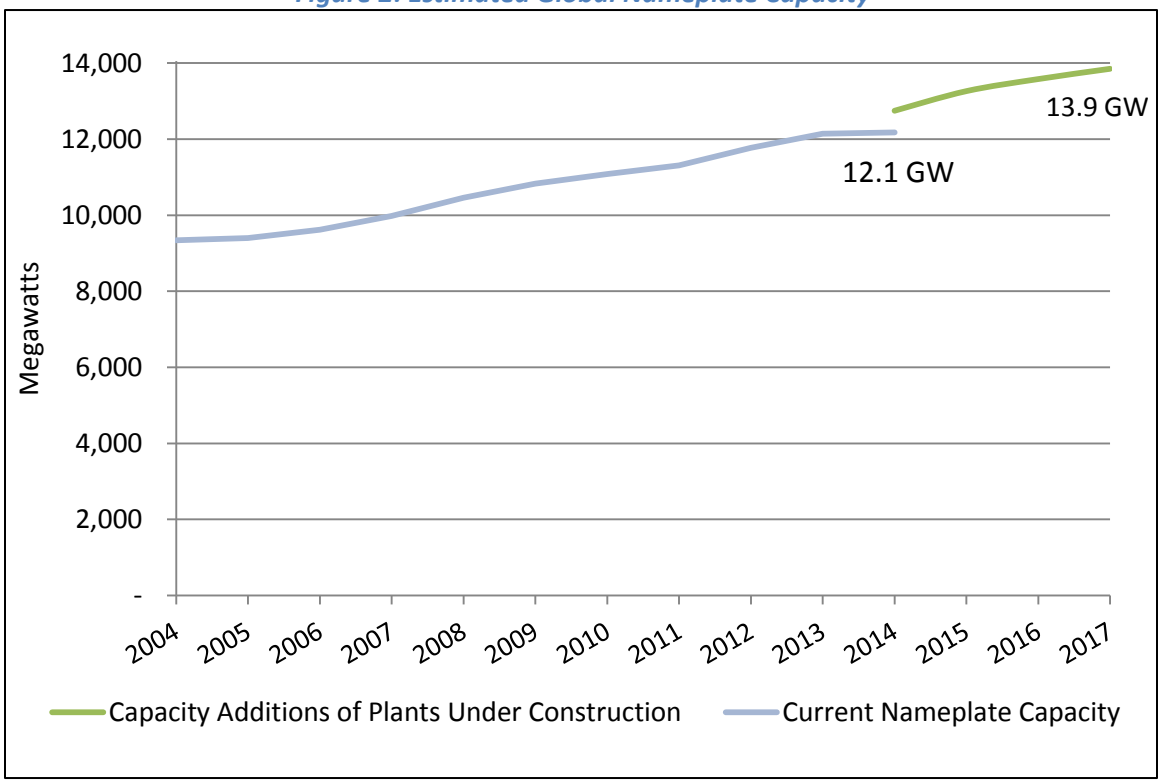


Source: GEA

Additionally, geothermal power provides a number of environmental values unmatched by other energy technologies. Geothermal power has low emission levels and a smaller land footprint than most other energy sources, particularly when compared with other renewables. Binary plants produce near-zero GHG emissions while flash and dry steam plants represent a significant reduction compared to fossil fuels based generation. Lastly, geothermal plants can ramp up or down quickly, allowing them to adjust

to the changing needs of the power system and act as a flexible power source in addition to baseload. As a result, geothermal plants can replace natural gas, coal, or oil generation in emerging economies starving for power.

Figure 2: Estimated Global Nameplate Capacity



Source: GEA

Some Highlights of Leading Geothermal Regions

Geothermal power has particular values to lower and moderate income countries. About half of the countries currently developing geothermal power are countries that need development assistance as categorized by the World Bank. Definitions of these categories are available on the World Bank's website. The following sections highlight some of recent developments in select countries by region.

Central America

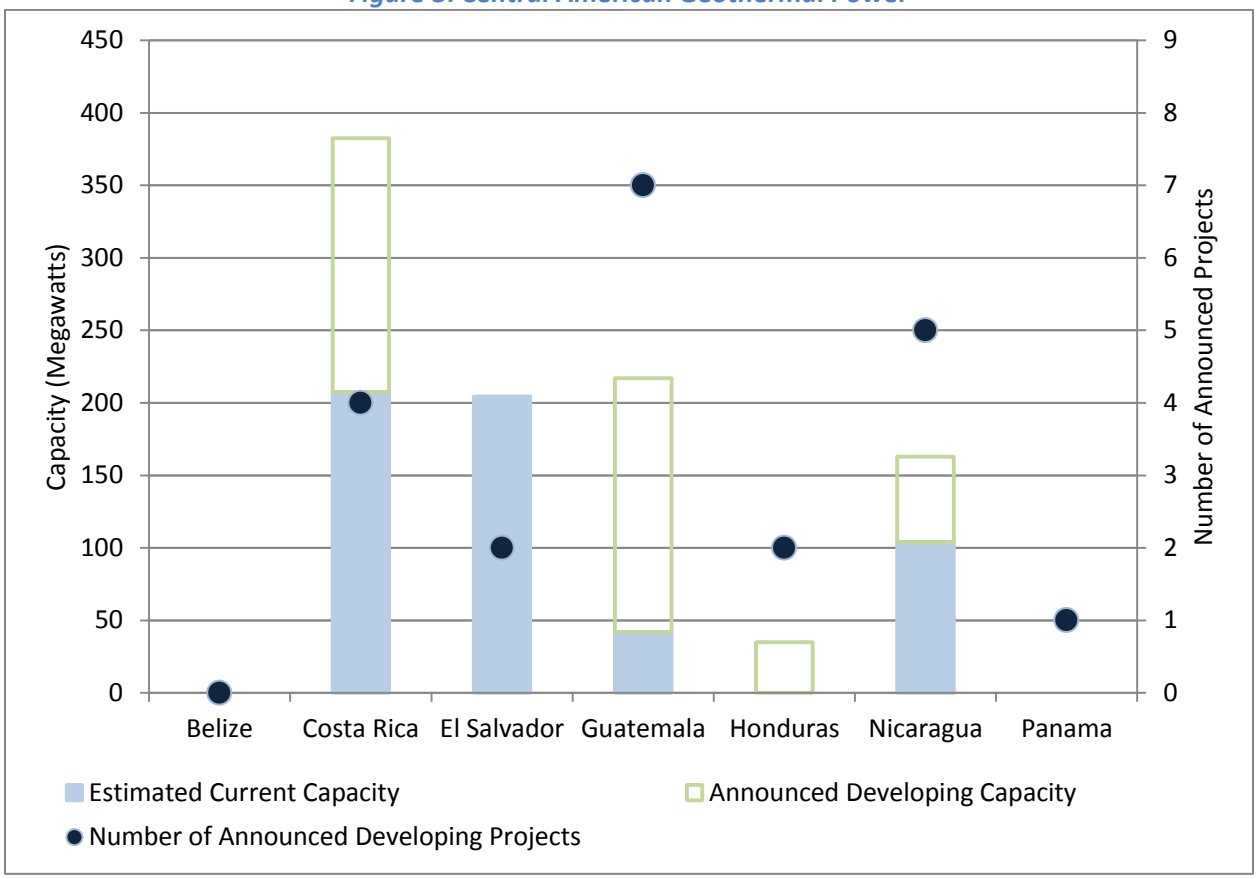
According to the Energy Unit of the Latin America and Caribbean Region of the World Bank, geothermal potential for power generation in Central America is estimated to be between 3,000 and 13,000 MW over approximately 50 sites. As of August 2013, the European Investment Bank committed to providing $230 million for renewable energy projects in Central America including hydropower, wind, geothermal and photovoltaic energy to develop this potential.

Costa Rica

Costa Rica continues to lead the region in terms of installed geothermal capacity and is well on its way to achieving its goal to be "carbon neutral" by 2021. GEA estimates that the current operating capacity in the country rests just over two hundred megawatts.

In August of this year, Costa Rica officials met with representatives of the Japanese government to sign a loan to help finance geothermal power plants in the province of Guanacaste. The $550 million loan from the Japan International Cooperation Agency will go towards financing three geothermal plants - Pailas II, Borinquen I, and Borinquen II- each planned for a 55 MW of potential capacity additions. The loan will cover three quarters of the costs, with an additional $70 million loan from the European Investment Bank and the rest covered by the Costa Rican Electricity Institute. Construction is expected to begin in 2018, with the plants planned to be fully operational by 2020. Local media reports the power plants will help to supply much needed jobs, and curb rising electricity rates in Costa Rica, which saw an increase of 30% in 2013.

Figure 3: Central American Geothermal Power



Note: The figure above compares current installed geothermal capacity to "announced developing capacity." "Announced developing capacity" is the estimated power plant capacity reported for specific sites by a private company, government agency or contractor associated with the site.
Source: GEA

El Salvador

El Salvador is just about tied with Costa Rica in capacity, with just over two hundred megawatts connected to the grid. Experts estimate the geothermal potential of El Salvador to be approximately 2,210 MW. Currently, El Salvador obtains 25% of its electricity from geothermal energy with an aim to achieve 40% in the near future. There are four new areas being considered for geothermal development, with the goal to attract private investors through public-private partnerships. In this plan, the El Salvador government must always control over 50% of geothermal investments.

Nicaragua

With just over one hundred megawatts online, Nicaragua is situated to experience significant growth in the geothermal sector. Past energy problems such as blackouts and power rationing caused Nicaragua's government to provide tax breaks for renewable energy back in 2005. As a result, Nicaragua's current system generates a little more than two-thirds of its energy from renewable resources.

A plan proposed in July 2014 aims to supply 90% of Nicaragua's energy from renewable resources by 2020. To make this happen, the plan requires an investment of over $2 billion, with $638 million proposed for geothermal power. Main geothermal areas include Managua-Chiltepe, Casitas-San Cristobal, and Mombacho Volcano, with a total of 12 sites determined as prime locations for the production of geothermal energy.

Ram Power has invested $1.5 billion in geothermal energy projects in Nicaragua. They have spent $425 million on the remediation of an existing plant near San Jacinto and added special turbines to infiltrate underground heat reservoirs. They also restored four production wells to increase the amount of steam available in the plant. According to Ram Power, this plant, which operates at 72 MW, generates over 10% of Nicaragua's energy needs.

Ram Power is also working on the Casita geothermal project in northwest Nicaragua. In 2008, they received a grant for geothermal energy exploration, and they are now preparing to sign the contract for the operation of the Casita project with the Nicaraguan government. With environmental assessments already underway, the project could begin construction this year.

Guatemala

The Ministry of Energy and Mines of Guatemala is considering the creation of a 300 MW tender for geothermal energy, following the successful bidding process of the 150 MW tender that was offered last year. This will contribute to the government's plans to use geothermal power to meet two thirds of Guatemala's energy needs by 2022, which will reduce oil imports and stabilize the country's energy supply.

US Geothermal is building a geothermal power plant at El Ceibillo, after receiving an Environmental License for the construction and operation of their plant in September 2013. The power plant will be located near Guatemala City, and will produce 25 MW. As of July 2014, the company has finished their second phase of drilling, increased their surface lease, and started preparation for drilling.

Additionally, Ormat Technologies recently lengthened the term of their PPA for their Zunil geothermal power plant in Guatemala from 2019 to 2034. The plant, built by Ormat Technologies in 1999, currently only operates at 50% of nameplate capacity because of problems with the geothermal field. Plans to increase generation by improving the heat supply are underway.

Honduras

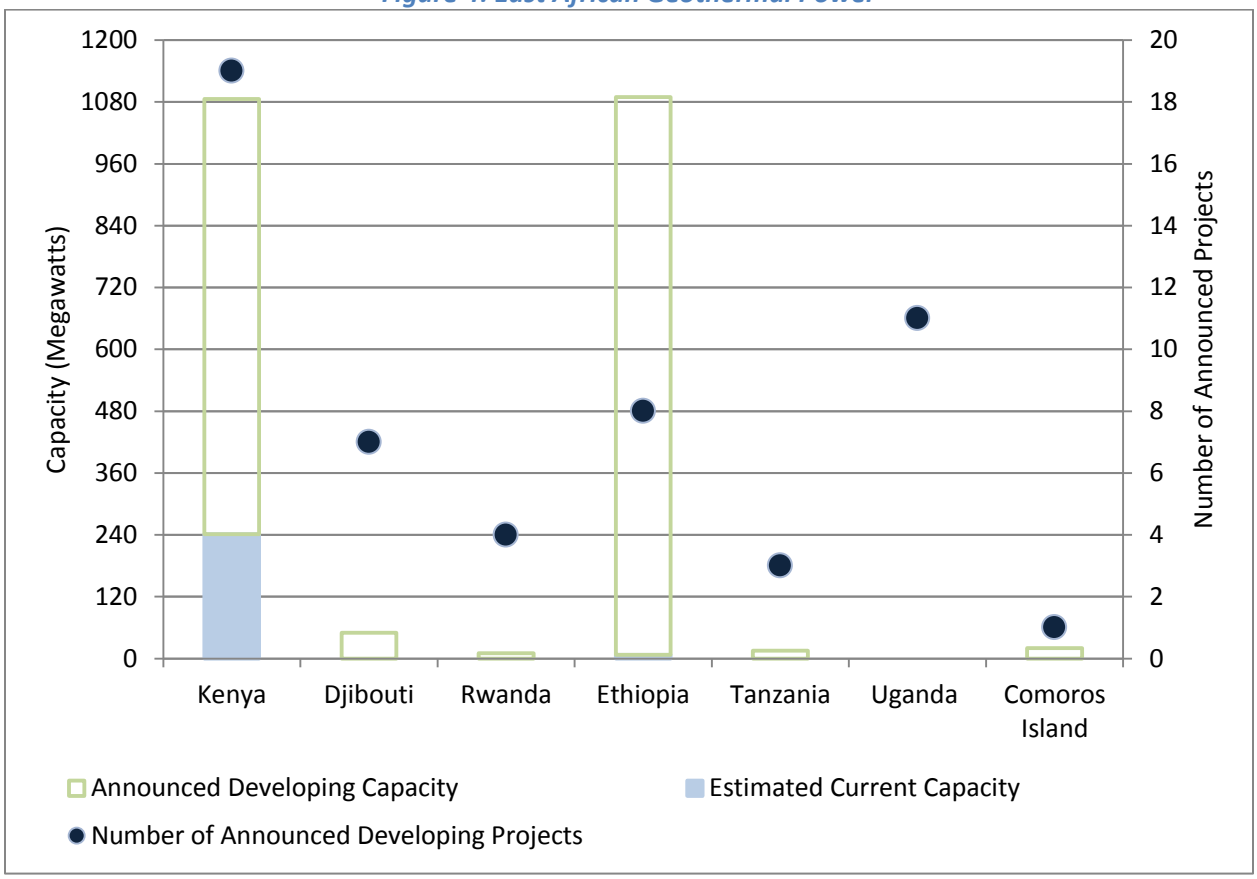
In January 2014, Honduras opened opportunities for private development in its energy market by breaking up its national electric company, ENEE. The company has faced huge loses and economic troubles, which prompted Honduras to open the energy market in hopes to attract private investment that will rejuvenate the market. ENEE is now divided into three sectors - generation, transmission, and distribution - all of which are open to private investments.

Ormat Technologies Inc. acquired the Honduras Platanares project in December 2013 from ELCOSA, a Honduras energy company. The project was already in late-stage development with previous exploration work already completed, and Ormat planned to start development and begin drilling wells in 2014. The company expects capacity around 18 MW with an operation start date in approximately three years.

East Africa

East Africa is an area of great interest for geothermal development due to its countries' geology. In addition, the economies of East Africa are in great need for energy as they transition off their current expensive and unsustainable energy options, and build energy infrastructure to meet the needs of their populations. The main countries of interest in the region are Kenya, Ethiopia, Djibouti, Rwanda, Tanzania, and Uganda; however there are projects elsewhere such as the geothermal plant at Comoros Island. Additionally, there is work towards a regional interconnection where energy could be traded among East African countries. GEA estimates that at the moment the region has about 250 MW of operating capacity, mostly concentrated in Kenya. However, capacity is expected to grow substantially over the next decade, since East Africa is one of the fastest growing geothermal regions in the world.

Figure 4: East African Geothermal Power



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Djibouti

Djibouti has an estimated geothermal resource potential of at least 1,000 megawatts, though there are currently no operating geothermal projects. In the past, geothermal development stagnated due to a lack of government support. However, this mentality is beginning to change.

In 2013, the Government of Djibouti created the Djiboutian Office for Development of Geothermal Energy (ODDEG) to identify resources, assist with exploration and feasibility studies, and develop geothermal energy. In addition, the government recently announced their intention to become the first country in Africa to reach 100% renewable energy, with geothermal power as the main source of electricity.

Currently the World Bank is working with AFD, AfDB, OFID, and ESMAP on a project to continue the work done and Lake Assal and Lava Lake by drilling exploratory wells and putting together a feasibility study. The goal is to facilitate an IPP to continue the work in this area and create a 50 MW plant. The project was approved in May 2013 and then subjected to various delays, but is now on track to start in September 2014, with an estimated time frame of four years.

Ethiopia

The energy demand in Ethiopia is projected to increase by over 25% every year for the next few years. The Ethiopian government is working with the World Bank to expand electricity access, with the goal to reach 75% of towns and add four million more people to the grid in the next five years. With an estimated geothermal resource of 5,000 MW, Ethiopia is looking towards geothermal to help with their growing energy needs.

Presently there are about 7 MW of geothermal online, but that will likely change in the next few years. The International Finance Corporation is working to help the Ethiopian Government set up the proper governmental agency management and the legal and regulatory structures necessary for geothermal development in the country.

Reykjavik Geothermal is heading up the Corbetti Geothermal Power Project, a $2 billion project with a projected output of 500 MW. Exploration and drilling are expected to begin in late 2014 or early 2015 once PPA negotiations are finalized, with the project expected to be completed by 2020. Additionally, the World Bank is providing loans and grants for the Ethiopian Government to develop the well fields at Aluto Langano.

Kenya

Kenya has a large geothermal resource estimated at 10,000 MW, with just about a quarter of a gigawatt online. However, there are multiple projects underway that will bring several hundred megawatts online in the next five to ten years. Most of the country's geothermal resources are found in the Rift Valley, with 14 geothermal fields located between Lake Magadi and Lake Turkana.

The Kenyan Geothermal Development Corporation (GDC), created in 2009 by the Kenyan government, oversees geothermal development in the country. It was created in part to help reach Kenya's 2030 plan, and has the goal to produce 15,000 MW of electricity every year, with one third of that coming from geothermal energy. The Kenyan government hopes to diversify energy sources to help with their problems of high energy costs and unreliable hydropower sources, and provide power to some of the 84% of the population who do not currently have electricity access.

The financers of the Menengai project, which include the World Bank, African Development Fund, Climate Investment Funds, French Development Agency, European Investment Bank, and the Government of Kenya, are hoping the project generates 100 MW by 2015. GDC Managing Director, Dr Silas Simiyu, claims "Menengai will be the fastest developed field in the world to produce in just less than five years."

The Kenya Electricity Generating Company (KenGen) operates most of the geothermal projects in Kenya, including the 280 MW Olkaria project. With 140 MW already operating, more plants are expected to be completed by early 2015. Local media reports that negotiations are underway in the surrounding area by potential investors who want to capitalize on the cheap energy from the geothermal operation for factories and other industrial purposes.

Rwanda

Rwanda lacks any operating geothermal capacity, but ongoing studies demonstrate that the country has around 700 MW of geothermal potential. This potential could meet and even exceed current energy demand in the country and provide stability through reducing dependence on oil imports. With a significant portion of Rwanda's citizens not connected to the energy grid as of 2013, geothermal power has the potential to transform Rwanda's economy.

The Ministry of Infrastructure and the Renewable Energy Group are overseeing geothermal development in the country, although there is currently no framework for developers. The Japan International Cooperation Agency (JICA) is currently working on data collection and surface studies that will hopefully guide the country to a better plan for geothermal development. The study results are expected in October 2014, with future drilling and exploration projects on hold until that time.

Tanzania

The estimated geothermal resource in Tanzania stands around 380 MW; however, the country currently has no operating capacity. The Tanzanian Geothermal Development Company, created by the government, has a mission to help develop the geothermal resources in the country. Tanzania hopes to gets its first geothermal plant online to help with the country's energy crisis and improve socio-economic development in the country. According to the Vice President, the first 140 MW geothermal plants could be operating in Tanzania by 2018.

The Climate Investment Fund has provided $70 million to assist Tanzania with the development of its renewable energy resources. This includes funds from Scaling-Up Renewable Energy Program in Low-Income Countries (SREP), the African Development Bank (AfDB), the World Bank, and others. From this fund, $70 million from SREP and AfDB will go towards developing 100+ MW of geothermal power in the country.

Uganda

The government of Uganda has expressed interest in improving electricity supply and reliability by building geothermal power plants. Unfortunately, details about the country's geothermal resources are not fully known. Therefore, the top priority for geothermal development in Uganda is surface and subsurface studies. Sites with known geothermal potential are located in the western part of the country along the Great Rift Valley and include the Kabale, Hoima, and Kasese regions. The Government of Uganda recently created the Geothermal Resources Department to help with further studies and the overall development of geothermal power, and the Japan International Cooperation Agency (JICA) is providing additional support by funding studies and collecting data to promote geothermal development.

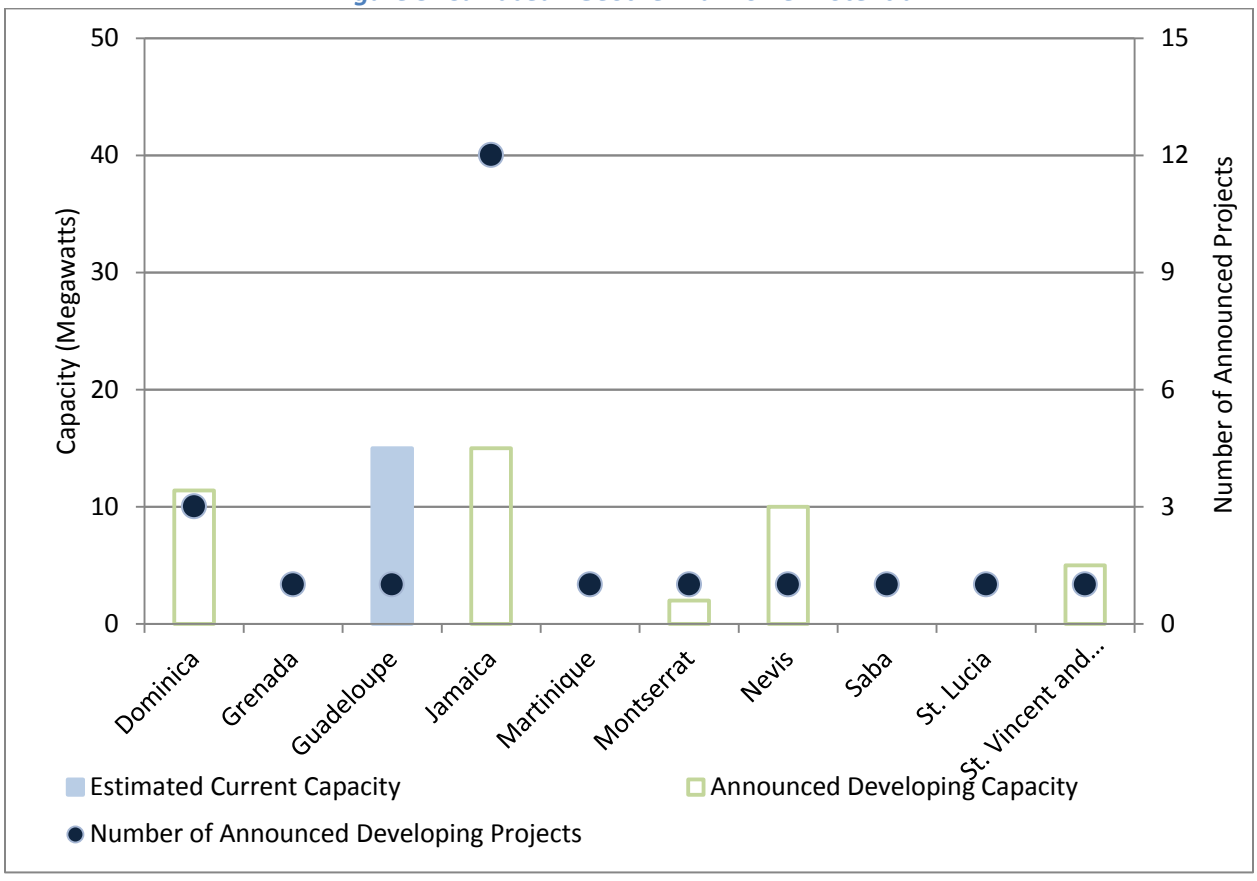
The Caribbean

Most countries in the Caribbean rely on expensive oil for their energy needs, and therefore have high electricity costs. The World Bank recently recommended geothermal power as a solution, with an 850 megawatt potential in the area. Geothermal development is particularly valuable in this area as the islands are situated on continental plate boundaries.

The development of geothermal energy in the Caribbean will help to lower energy prices, reduce energy independence, increase competitiveness, encourage economic growth, and reduce poverty while providing a baseload source of energy. Furthermore, there is enough geothermal potential in the region that these countries could meet their own needs and export the energy they have leftover.

The Caribbean Development Bank (CDB), Japan International Cooperation Agency (JICA) and the Inter-American Development Bank (IDB) recently signed a cooperative agreement to encourage renewable energy in the Caribbean. They plan to diversify energy sources through renewable energy, with an emphasis on geothermal energy.

Figure 5: Caribbean Geothermal Power Potential



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Source: GEA

Saint Lucia

Saint Lucia will receive $2 million from the World Bank to begin a Geothermal Resource Development Project. They plan to use the funding for exploration, development and the implementation of a geothermal program in the area. This plan should help the country to reach their goal of 35% energy production from renewable resources by 2020. The country is also working to modernize its energy regulatory body to attract developers to develop the energy industry.

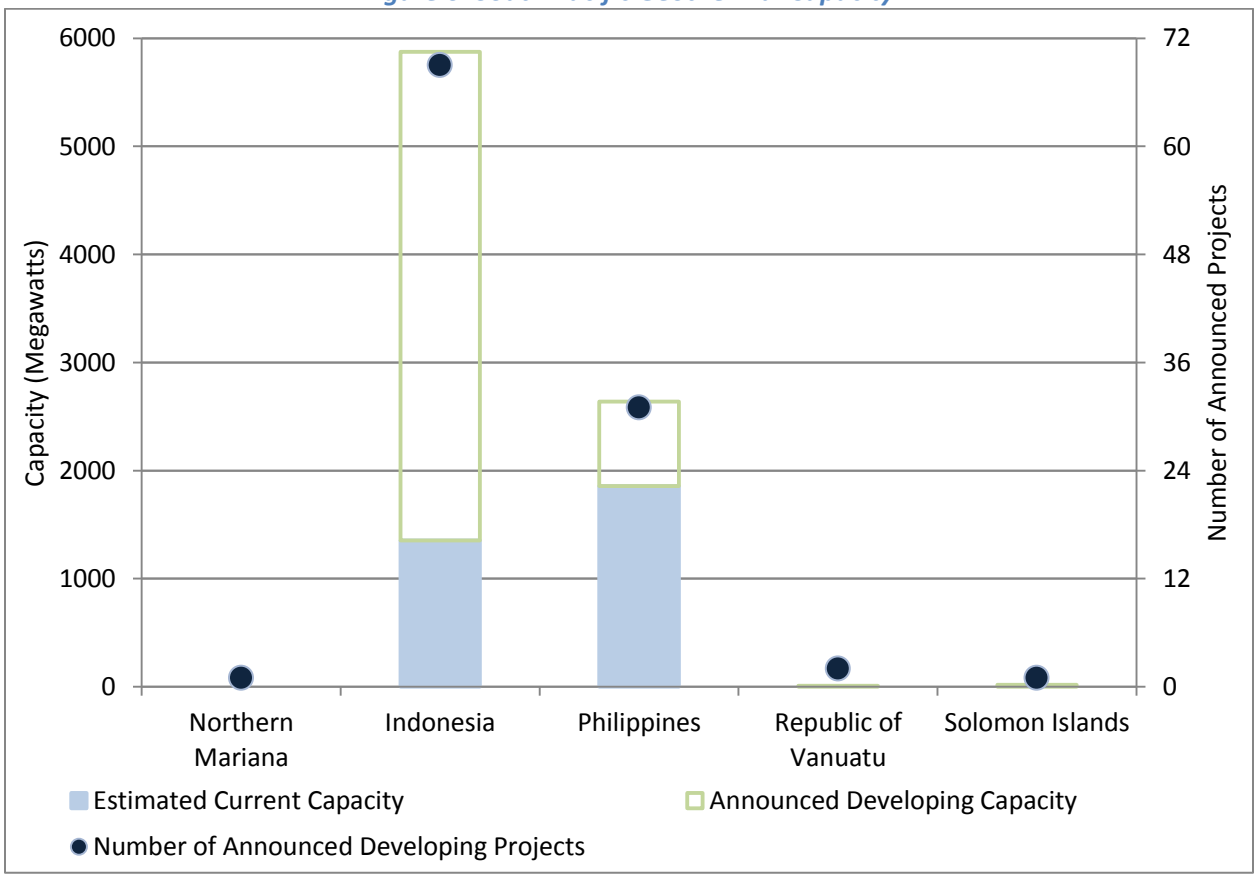
St Vincent and the Grenadines

As of September 2014, St Vincent and the Grenadines announced plans for a potential small geothermal power plant. Surface exploration indicates high geothermal potential near Mount Soufriere. Companies Emera and Reykjavik Geothermal will provide financial support for exploration in the area while the New Zealand government is helping with technical guidance. However, the St. Vincent and the Grenadines government is still seeking additional funding for the project, and hopes to finish the plant by mid-2018.

South Pacific

The South Pacific leads the world in developing capacity. Indonesia alone has announced substantial capacity additions to meet its need for new power. Within the next decade the South Pacific will likely not only be the world's leading region on geothermal power but also have nearly double the operating capacity that it has today.

Figure 6: South Pacific Geothermal Capacity



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Source: GEA

Indonesia

Indonesia's geography and 130+ volcanoes make it a prime country for geothermal development, while various legal and governmental problems have hindered development. The country has an estimated geothermal potential of 29,000 MW, and a significant portion of the world's geothermal resources, but is currently only tapping into a fraction of that potential. At present, most electricity in the country comes from the fossil-fuel producing resources coal, oil, and natural gas.

A long-awaited law passed on August 26, 2014, declassifies geothermal as a mining operation and allows geothermal development in forested areas. This law opens the door for geothermal development as Indonesia has large expanses of protected forests where mining is illegal. Additionally, under the law, the fixed price at which geothermal plants can sell electricity will be raised, which will help developers cover the cost of energy production.

The Indonesian Geothermal Association (API) predicts this new law will speed up geothermal development in the country, increasing geothermal output to 2,000 MW by 2020. There are 35 proposed geothermal projects that have been delayed, but the API hopes the new law will get these projects back on track.

The Philippines

The Philippines is the second biggest producer of geothermal energy in the world, and meets about a fifth of its energy needs with geothermal resources. By 2030, the Philippines' Energy Department plans to increase installed capacity in the country to 3.3 GW. In addition, the Filipino Energy Department is undertaking an updated resource assessment to be finished in 2014.

In March 2014, The United States Export-Import Bank and the Philippines Department of Energy signed a memorandum of understanding (MOU) for 1 billion dollars to go toward geothermal energy financing in the Philippines. The MOU focuses specifically on renewable energy projects. In the past the Ex-Im Bank has financed geothermal energy projects in the country, including the Cebu Geothermal and Mahanagdong Geothermal projects.