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Got Steam? Geothermal as an Opportunity for Growth in the Caribbean

June 2013

Caribbean Knowledge Series

Authors: This note has been authored by Migara Jayawardena (Senior Energy Specialist, The World Bank), Laura Berman (Energy Specialist Consultant, The World Bank), Chandra Shekhar Singha (Lead Financial Specialist, The World Bank), Gerry Huttrer (Geothermal Resource Specialist Consultant, The World Bank), Mandkhai Bayarsaikhan (Energy Specialist Consultant, The World Bank), and Castalia Strategic Advisors.

The Caribbean Knowledge Series is an occasional series that presents World Bank knowledge in an accessible format. It is meant to assist knowledge sharing across the region and trigger policy dialogue on topics relevant for the Caribbean.

This note was prepared to support the participatory policy dialogue in the context of the Caribbean Growth Forum (CGF). The CGF is an initiative facilitated by the Inter-American Development Bank (IDB), the World Bank (WB), and the Caribbean Development Bank (CDB) in collaboration with the Canadian International Development Agency (CIDA), the United Kingdom's Agency for International Development (UK AID), CARICOM Secretariat, the University of the West Indies, the European Union and Caribbean Export. It aims to facilitate a multi-stakeholder dialogue to identify practical solutions for the growth challenge in the Caribbean. To learn more about the CGF methodology and progress in each Caribbean country visit: http://caribgrowth.competecaribbean.org/

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Caribbean Knowledge Series

Promoting Growth in the Caribbean: Geothermal Renewable Energy

The need for more stable, lower cost electricity in the Caribbean

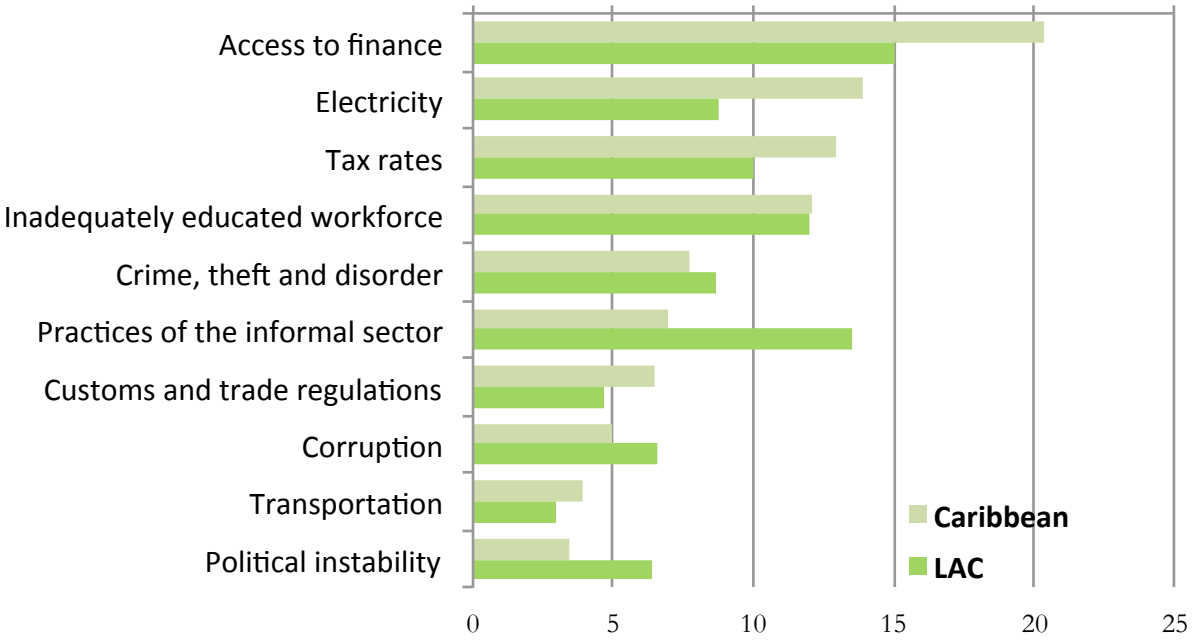
The power sector is integral to economic development and inclusive growth in the Caribbean Region. The Caribbean economies are looking to rebound from the recession the region faced between 2008-10, and while some countries have begun to post some sluggish yet positive growth[1], others have continued to contract[2]. Economies that rely on significant tourism have been particularly hard-hit, as it, along with associated sectors in construction and transportation, make up substantial shares in the Gross Domestic Product (GDP) of many island economies. Services are another key driver of economic activity, particularly in the countries that are a part of the Organization of Eastern Caribbean States (OECS), where it can account for 70 percent or more of GDP. Many of these economies that rely on tourism and services have faced considerable hardship during the recent global economic slowdown, while structural challenges in many have made it difficult for them to adapt. Key among them are high levels of external debt, challenges accessing finance, and the extremely high cost of electricity, which erodes the region's economic competitiveness and stymies growth.

The high cost of electricity is undermining the Region's competitiveness and growth; and creating hardship for citizens. Electricity tariffs in the Caribbean region are among the highest in the world. This is reflected in the fact that businesses in the Caribbean region cite electricity as the second most significant obstacle to successful operation, only surpassed by challenges they face in accessing finance, as illustrated in Figure 1. Since it is a less significant factor across the entire Latin America and Caribbean (LAC) region, electricity creates a regional competitive disadvantage for Caribbean businesses. As an example, a recent hotel benchmarking study[3] indicates that a guest night in a 50-100 room hotel can include an estimated $14 to $18 in electricity costs[4]. Given that tourism is a key economic driver in the region, such costs will make it harder for Caribbean countries to compete for tourist revenues. Hardship resulting from high cost electricity is not isolated to businesses, but it impacts ordinary citizens as well. Given that average residential consumers utilize anywhere from about 113 kWh (Dominica) to some 173 kWh (Jamaica) in developing islands in the Caribbean, at prevailing tariffs, poor households[5] can spend as much as 7 to 11 percent of their income on electricity. Since the poor represent anywhere from 20-40 percent[6] of the population in most developing countries in the Caribbean, the high cost of electricity imposes a considerable and disproportionate burden on the poor.

The high cost of electricity is largely a result of the Region's heavy reliance on expensive, imported fuel oil and diesel for power generation. In 2012, around 95 percent of the electricity produced in the Caribbean region was from fossil fuel sources[7]. While a few islands utilize coal, natural gas, as well as hydroelectric power, the majority of the islands primarily uses expensive imported diesel or heavy fuel oil to generate electricity. This is particularly the case in islands that are members of the OECS, as they do not have domestically available fossil-based resources and the relatively small size of each power system does not allow importing coal or gas economically. Although hydro power, biomass, wind and solar are available options that can be useful in some of the islands, these renewable resources are intermittent and seasonal (in case of hydro and biomass), making them unsuitable to meet base-load requirements throughout the year. Consequently, the high cost of diesel and fuel oil in power generation is often directly passed through to businesses and residential customers

[1] Mainly the commodity exporting countries of Belize, Guyana, Suriname, and Trinidad and Tobago.
[2] The East Caribbean Currency Union (ECCU) saw output fall by 0.71% according to Caribbean Development Bank Annual Report, 2012
[3] Caribbean Hotel Energy Efficiency Action Program (CHENACT) benchmarks, 2012.
[4] Room night consumes an average 44 kWh of electricity, at tariffs that range from US 32-40 cents.
[5] Defined by Economic Commission for Latin America and the Caribbean (ECLAC) as the households at or below the poverty line (monetary measure of the minimum consumption expenditure that is needed to meet basic food and non-food requirements of an average adult at prevailing prices).
[6] Multiple sources: The World Bank; Caribbean Development Bank; Government of the Dominican Republic; University of the West Indies; Economic Commission for Latin America and the Caribbean.that is needed to meet basic food and non-food requirements of an average adult at prevailing prices).
[7] Based on data from the "CREF-Castalia Island Renewable Ranking."Castalia.2012

FIGURE 1: Constraints to Business Success (Percent of Firms)



SOURCE: Business Enterprise Survey, The World Bank Group

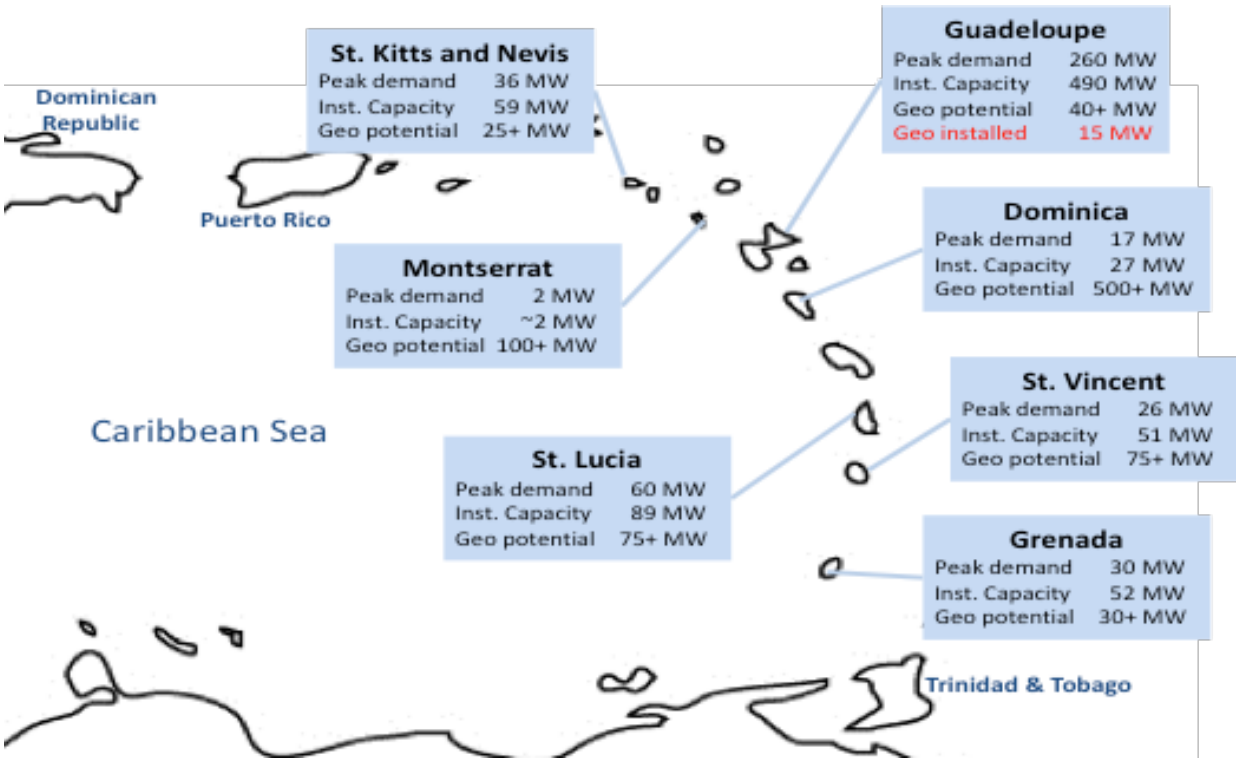
alike through the electricity tariffs. For instance, in 2011, the fuel pass-through represented between 45 to 65 percent of electricity revenues[8] in several OECS countries[9]. Where governments cushion this impact through subsidies, the fuel costs create fiscal burdens that are also unpredictable given the volatility in international prices for petroleum products. The unpredictability of electricity costs makes it difficult for businesses and households to plan for future investments and expenditure as well.

Geothermal provides an opportunity to diversify and optimize the power generation mix

It will be important to diversify the generation mix of power systems in the Caribbean and enhance energy efficiency in order to lower costs and increase reliability as a means towards improving business competitiveness and promoting shared economic growth. It will be essential to make a significant shift away from utilizing costly fuel oil and diesel, and move towards a more optimized generation mix. Renewable energy presents a useful way forward. When combined with measures to enhance energy efficiency – that reduces energy intensity and therefore demand for electricity – expanding renewable energy can provide a lower cost solution that will boost the regions' competitiveness. Unlike fossil fuels that largely need to be imported, many Caribbean islands, especially in the OECS, possess a rich endowment of renewable energy potential, including hydro[10], solar, wind, biomass, and geothermal. Several countries already generate electricity from these resources. However, the availability of most of these resources are either intermittent or seasonal making them poor substitutes for base-load generation[11]. Geothermal is an ideal renewable technology that, once developed, can operate reliably on a 24/7 basis. It is a clean energy option that will significantly reduce local and global environmental impacts; and where it is indigenous, geothermal power can serve as a natural hedge against the volatility of petroleum based commodity prices.

[8] Calculated as fuel cost divided by electricity revenues, based on information from utilities' annual reports. Cost-reflective tariffs are assumed to be a proxy for total cost of supply.
[9] Dominica, Grenada, St. Lucia, and St. Vincent and the Grenadines.
[10] Mostly small run-of-the-river hydro, with the exception of the Dominican Republic and other isolated instances where there are large hydropower stations with storage (reservoir).
[11] Power stations are designed to operate continuously throughout the day.

FIGURE 2: Preliminary Geothermal Potential Estimates in the Eastern Caribbean



SOURCE: Data from various utilities, geothermal potential based on expert review of various preliminary estimates

Preliminary assessments indicate significant unexploited geothermal potential, especially in the Eastern Caribbean that can supply base-load power for local markets and beyond. The Caribbean's volcanic geology has created many geothermal features, especially in the OECS region. Figure 2 identifies seven Eastern Caribbean islands where there is initial evidence of geothermal power generation potential, which can be confirmed with further exploration. Despite this potential, only the French territory of Guadeloupe has developed its geothermal resource by installing the 15MW La Bouillante power plant that is in operation. Although estimates of actual potential vary considerably since much of the geothermal resources in the region are unexplored, expert opinion suggests that the commercially exploitable potential can be as much as 850 MW in the Eastern Caribbean islands depicted in Figure 2, which exceeds the 770 MW of total current installed capacity from all generation technologies in these same Eastern Caribbean islands. Dominica likely has the largest potential with a number of geothermal fields that can be progressively developed. Resources at the WottenWaven/ Laudat field alone, which is already confirmed, far exceed the generation capacity that can be reliably absorbed by the relatively small power system in Dominica. Several other islands face similar challenges where estimated geothermal potential exceeds the relatively small base-load requirement in the respective domestic market. Several islands are exploring options for exporting electricity generated by geothermal sources to neighboring islands through undersea transmission lines. Such efforts could lead to regional integration of power systems within the OECS that would create new markets for trading electricity. Over the long-term, there could be prospects for integration across the wider Caribbean region so that reliable and cost-effective generation can benefit the entire region, not just the islands endowed with the resources.

BOX A: Geothermal Development in Guadeloupe

The 15MW La Bouillante plant in Guadeloupe is the only geothermal power plant in operation in the Caribbean. The initial reconnaissance work was undertaken by the French Bureau of Geological and Mining Research, which helped establish the presence of an exploitable resource at La Bouillante. In 1980, Electricité de France (EDF) constructed a 5MW power plant, which was later expanded to 15 MW of capacity in 2004.

The initial 5MW operation performed well with average availability as high as 95 percent. Repairs to the site's foundations and the installation of a brine reinjection system to preserve the geothermal resource quality have reduced its availability in more recent years. However, the repairs are expected to eventually increase the plant availability.

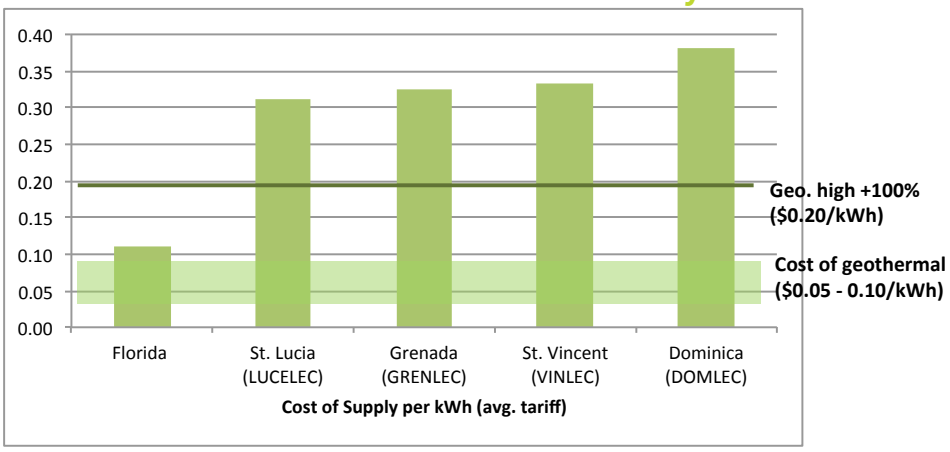
EDF is planning to further expand the La Bouillante operation by possibly adding an additional 30 MW, although this plan is yet to be finalized. EDF is also considering potentially importing electricity generated from geothermal resources in the neighboring island of Dominica through an under-sea transmission line.

SOURCES: Alstom, Bouillante I Case Study; EDF, 2012. BilanPrévisionnel de l'EquilibreOffre / Demanded'électricité; GéothermieàBouillante–50 Ansd'Histoire; International Energy Agency, Geothermal Implementing Agreement, 2010.Trends in Geothermal Applications; Délibération de la Commission de régulation de l'énergie du 22 juillet 2010.

Greater integration of geothermal power in the generation mix can reduce the overall cost of electricity supply making it more affordable, enhance energy security and improve resilience, and provide local and global environmental benefits.

Reducing the cost of electricity–Geothermal electricity generation costs have been observed to be as low as 5-10 US cents per kWh, as illustrated in Figure 3. It is likely that the cost of developing geothermal in the OECS islands will be higher for a number of reasons. Most countries will be attempting to develop geothermal for the first time with limited experience. The initial developments are likely to be modest in size to match domestic requirements, which will reduce potential for economies of scale. The cost of financing large investments in relatively small economies can also be high. However, as Figure 3 illustrates, even if the cost of geothermal electricity generation were doubled to 20 US cents per kWh, it would still be an attractive lower-cost option compared with the high tariffs customers face today in many OECS countries.

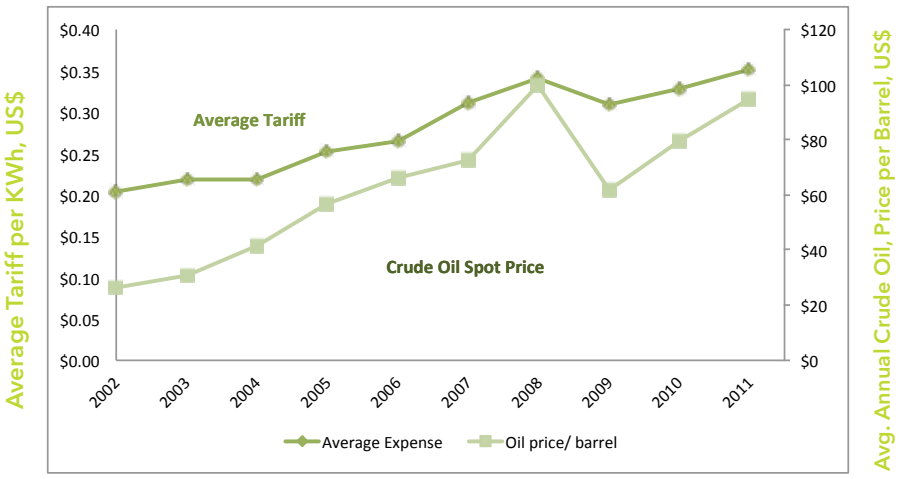
FIGURE 3: Geothermal Electricity Costs Compared to Selected Caribbean Electric Utility Tariffs



SOURCE: U.S. National Renewable Energy Laboratory (NREL);and US Department of Energy.

Working as a natural hedge against commodity price volatility – As Figure 4 illustrates, electricity tariffs in the Caribbean have followed a similar path as the price of oil, which is determined by international markets. This has led to the electricity tariffs rising significantly over the past decade, mirroring the overall increase in international oil prices, which reached historical highs during the same period. During this period, oil prices have also been volatile causing the electricity tariffs to also fluctuate. Such volatility and uncertainty create significant challenges for businesses as they find it difficult to plan future investments and other important functions. In contrast, geothermal generation capacity, once developed, can supply electricity reliably at a steady price increasing the resilience of businesses to electricity price shocks. Similarly, it will reduce household vulnerabilities to changing electricity prices.

FIGURE 4: Average Tariff and Oil Prices in Selected Caribbean Islands



SOURCE: based on data from Caribbean Electric Utility Service Corporation (CARILEC) for selected representative Caribbean countries; Crude oil spot price is the Oklahoma West Texas intermediate crude price (Source: US Energy Information Agency)

[12] Dominica estimate includes electricity exports to Guadeloupe and/or Martinique

FIGURE 5: Illustration of Potential Geothermal Benefits – Electricity, Fuel Savings, &Avoided CO2

Island	Est peak and base load demand in 2023[a]		Est. geothermal capacity in 2023[b]	Est. Annual geothermal electricity generation[c]	Est. Annual savings from avoided fuel imports[d]	Est. Annual avoided greenhouse gas emissions[e]
	MW		*MW*	*GWh/year*	*US$M/year*	*mil tCO_2e/year*
Dominica	27	16	115[f]	907	$ 109 - 150 M	0.65 – 0.80
Grenada	49	29	29	229	$ 28 - 38 M	0.17 – 0.20
Guadeloupe	371	222	20	158	$ 19 - 26 M	0.11 – 0.14
Montserrat	4	2	2	16	$ 1.9 - 2.6 M	0.01 – 0.01
Nevis[1]	52	31	25	197	$ 24 - 33 M	0.14 – 0.17
St. Lucia	85	51	30	237	$ 28 - 39 M	0.17 – 0.21
St. Vincent	43	26	10	79	$ 9 - 13 M	0.06 – 0.07
Totals			**231**	**1,822**	**$ 219 - 301 M**	**1.32 – 1.61**

a Demand estimate for illustration, peak load forecast based on recent growth rates, base load assumed to be equal to 60 percent of peak demand
b Future geothermal installed capacity is assumed to be lesser of base-load estimate or potential geothermal capacity;
c Assumes 90 percent capacity factor for geothermal power plant operation.
d Assumes generation efficiency of 19kWh per imperial gallon of fuel (based on LUCELEC's efficiency as reported in annual reports); and oil price of US$80-US$110 per barrel.
e Based on emissions factors of 91 grams per kWh for geothermal and 893 grams for fuel oil based generation, and range +/- 10 percent.
f For Dominica, exceeds domestic base-load needs due to assumed electricity exports to Guadeloupe & Martinique

Increasing energy security and improving the balance of trade by reducing oil imports– Figure 5 illustrates that over 200 MW of geothermal capacity could be absorbed into the power systems[12] of Eastern Caribbean countries over the next decade based on base-load estimates and geothermal resource potential. As an indigenous resource, the development of geothermal would enhance energy security by displacing an estimated 2.7 million barrels of fuel oil and diesel imports each year. If the international price of oil is $80-$110 per barrel, it would result in total annual savings between $200-$300 million, as indicated in the table in Figure 5.

Environmental benefits through reduction of greenhouse gas emissions and local pollution –Geothermal is a cleaner, renewable power generation option that emits only about 10 percent as much carbon dioxide (CO2) as diesel generation[13]. Based on potential geothermal generation estimates in Figure 5 and the potential displacement of diesel and fuel oil generation, the estimated reduction in CO2 emissions would be about 1.3 to 1.6 million tons per year. This reduction in greenhouse gases would contribute towards mitigation of global climate change impacts. Generating geothermal power can also benefit the local environment. Geothermal power plants release less than 1 percent as much sulfur dioxide (SO2) as the cleanest fossil fuel generation, and do not emit any nitrogen oxide (NOx) or particulate matter[14]. Limiting local pollution and maintaining a clean environment are important for sustaining tourism that is a key driver of economic growth.

[13] Fridleifsson, I.B., et al.,"The Possible Role and Contribution of Geothermal Energy to the Mitigation of Climate Change." Report for the Intergovernmental Panel on Climate Change (IPCC), 2008.
[14] Boyle, Godfrey. "Renewable Energy."(2004) and Kagel, Alyssa, et al. "A Guide to Geothermal Energy and the Environment." (2007).

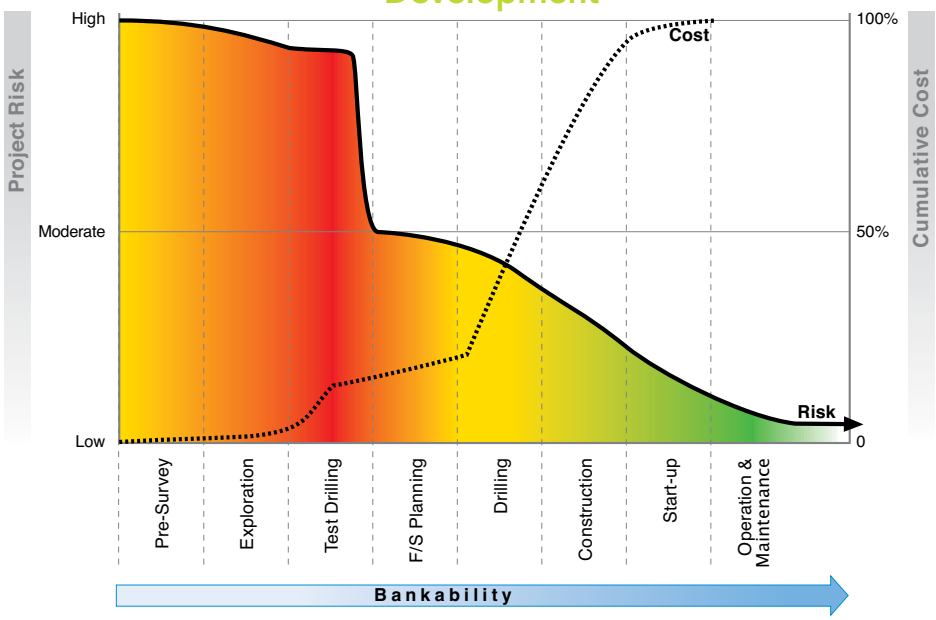
Although Guadeloupe is the only island with a geothermal power plant in operation, there are preparation activities underway in a number of the Eastern Caribbean islands to try and exploit the benefits of geothermal power.

• **Expanding existing operations**–Guadeloupe is considering expanding the installed capacity of its existing 15 MW power plant at La Bouillante[15], while, it is also considering, together with Martinique, to import geothermal electricity from Dominica.

• **Geothermal drilling**–a private developer drilled exploratory wells on Nevis in 2008[16], but the island administration is now seeking a new development partner[17]. Dominica has completed the drilling of three exploration wells, and is poised to advance to the production drilling phase[18]. It is evaluating options for trading electricity with neighboring islands. Montserrat also has exploration drilling activities underway[19]. Some exploratory drilling took place in St. Lucia in 1988[20], but activity since then has been very limited[21].

• **Surface reconnaissance**–Grenada has completed initial surface level reconnaissance, and is seeking a development partner to undertake exploratory drilling[22]. Some surface reconnaissance has been completed on St. Vincent[23], but it has not advanced to the stage of exploration drilling.

Figure 6: Geothermal Resource Risks and the Cost of Development



SOURCE: Adapted from the Geothermal Handbook: Planning and Financing Power Generation, ESMAP, The World Bank, 2012.

[15] Electricité de France (EDF), 2012
[16] SKN Vibes, 2008
[17] Think Geoenergy, 2013
[18] The Government of the Commonwealth of Dominica, The World Bank, 2013.
[19] Caribbean Journal, 2013.
[20] Batocletti, Liz (for Sandia National Labs). "Geothermal Resources in Latin America and the Caribbean." February, 1999.
[21] In 2010 the Government and US-based company Qualibou Energy signed a development agreement, with interim funding for pre-construction activities announced in 2011; but no progress has been reported since.
[22] National Energy Plan of Grenada, 2011.
[23] Batocletti, Liz (for Sandia National Labs). "Geothermal Resources in Latin America and the Caribbean." February, 1999.

Key challenges to developing geothermal as a viable power generation option in the caribbean

Geothermal resource risks are a major barrier during the early phases of development as it creates uncertainty surrounding the viability of the investment. The uncertainty at the early stages of developing a greenfield geothermal site stem from limited knowledge regarding the availability of sufficient steam resource (i.e. resource base) and the cost of extracting the steam for generating electricity. Developers will seek to overcome this shortcoming by conducting surface level reconnaissance work followed by exploration drilling in order to confirm the availability and ascertain the characteristics of the geothermal resource. Although the investments needed at this stage, about $20-$30 million, are relatively modest compared to the overall cost of a full-scale development, investors have few options to share the risks at this stage. So they typically have to resort to utilizing equity (i.e. risk capital) for funding the exploration drilling. Commercial financiers do not accept these early stage risks. There is also reluctance with investors to fund this early stage of development even when projects are predicted to be viable since it will be several years before the project will be in a position to produce electricity and earn revenues. As a result, private project developers face considerable financial exposure that severely constrains their capacity to undertake quick and significant expansion of green field geothermal prospects. Since geothermal resource risks are a common characteristic of the technology, many other geothermal endowed countries have grappled with addressing this barrier in order to develop the sector. A recent global survey commissioned by the World Bank[24] confirms that the role of the public sector, in particular, to incentivize developers and catalyze investments during the early stages of development, has proved to be critical in successful geothermal expansions. Government interventions have varied, and have included a range of options including extending resource risk financing, public sector resource confirmation prior to granting a concession to private developers, open access to early stage surface level reconnaissance work, establishment of risk insurance facilities, and loan guarantees, to name a few. When implemented successfully, they have proven to be vital in attracting private investments, and scaling-up and speeding-up geothermal development. In almost all instances, there was some form of public support, especially at the early stages that helped reduce investor risks and mobilize financing for developing the sector.

Attracting credible and experienced developers is essential for developing the resources in line with proven industry practices, and in compliance with international standards. Given the limited geothermal experience in the Eastern Caribbean islands, it will be important to attract globally experienced geothermal developers who have the technical and financial capacity to efficiently exploit the resource. Improper adherence to common industry practices has led to excessive depletion of the steam resource and degradation of the field causing permanent damage. Examples of such instances include the Geysers field in the USA and Momotombo field in Nicaragua. Given the nascent state of development and the relatively small scale of expansion, it may be challenging to attract top global developers to partake in the Caribbean geothermal investments. The overall investment climates can also deter investors from some countries. Therefore, it will be important to have a credible process for selecting developers and awarding concessions in a fair and transparent manner in order to attract experienced developers.

[24] An Assessment of Geothermal Resource Risks in Indonesia (including a Global Survey), by GeothermEx for Private Participation in Infrastructure Advisory facility (PPIAF), the World Bank, 2010.

BOX B: Geothermal Development in Dominica

Preliminary estimates suggest that Dominica has the largest exploitable geothermal resources in the Caribbean due to the volcanic geology of the island. Of the several potential sites, the Wotten Waven/ Laudat (WW/L) field in the Roseau Valley is the most advanced in terms of preparation, although the development has not reached the stage of power generation yet. Several development partners, including the World Bank are supporting the Government of the Commonwealth of Dominica (GoCD) with this effort.

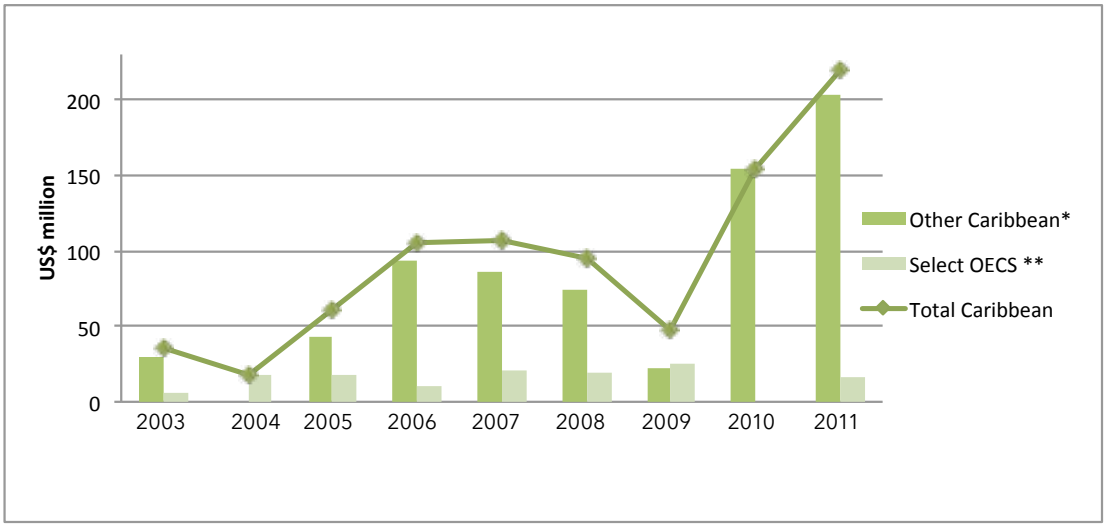
The GoCD is interested in attracting a reputable private investor to develop the WW/L project, but saw the need to provide enough confidence to prospective developers regarding the sufficient availability of the steam resource as well as the commerciality of the investment. Therefore, GoCD, with the support of development partners undertook surface level reconnaissance work and drilled three exploration wells at WW/L field.

This effort has had a significant impact. It has helped confirm the existence of the resource and work is now underway to prove its commercial viability. The GoCD is also taking efforts to ensure that the development is undertaken in line with industry practices and compliant with international standards – something vital for the "bankability" of the WW/L project. As a result of this ongoing work, there has been interest from international developers to participate in the operation, an discussions are underway to not only construct a small power plant to meet domestic needs, but to also scale-up development for exporting electricity to neighboring islands of Guadeloupe and Martinique.

SOURCES: GoCD, The World Bank, 201; photo credits – Migara Jayawardena, The World Bank.

Following successful geothermal resource confirmation, there will be continued need to mobilize greater levels of financing to complete the remaining development. Once geothermal resources are confirmed in a field, there will be less risks and greater certainty regarding the overall viability of the development. However, the amount of financing that is required for implementing the next stage of development can be significantly higher, particularly for larger developments. Unlike conventional power schemes, geothermal development requires funding to develop the upstream steam field as well as the downstream power generation operations. Comparatively, it requires more up-front financing than a conventional power project, which can lead to prohibitive or high financing costs to cover the production drilling, develop the steam gathering system, and to construct the power plant. A 20-30 MW development may require anywhere from $70-$150 million in financing depending on a number of factors; while the total private investment in the entire energy sector in a selected number of Caribbean countries depicted in Figure 7 has averaged no more than $125 million per year. If the commodity exporting countries with larger economies and more robust growth are excluded, then the five selected OECS countries included in Figure 7 have only managed to attract a mere $17 million per year on average in private financing in the energy sector over the past five years. Therefore, it will be a challenge for many of the OECS countries to mobilize the necessary financing in order to develop their geothermal resources. As an example of the challenge they face, the relatively large power plant for export in Dominica may require financing that is comparable to the entire GDP of the country. Furthermore, the limited availability of financing will likely require developers to contribute more equity in order to carry out investments while looking to leverage commercial financing, when available. The Governments' can also finance some undertakings, but high national debt levels in many Caribbean countries will likely limit such contributions towards leveraging financing.

FIGURE 7: Private Investments in the Energy Sector for Select Caribbean Countries



* Other Caribbean countries include Belize, Dominican Republic, and Jamaica
**Selected OECS include Dominica, Grenada, St. Kitts & Nevis, and St. Lucia

SOURCE: Private Participation in Infrastructure (PPI) Database, The World Bank, 2013.

Special consideration is needed for integrating geothermal power into relatively small and isolated island systems in the Eastern Caribbean. The small scale of the electricity networks will pose a number of challenges, including limiting the ability to absorb geothermal capacity, requiring smaller unit sizing in power plants and adequate backup to maintain system reliability, and the need to strengthen existing transmission and distribution networks to accommodate the influx of geothermal power. It will also be important that the policy and regulatory environment is adequately designed to integrate geothermal power. Developers will want to ensure that their investments are secure, that they can receive a return commensurate with the costs and risks associated with the development, and that there is sufficient recourse should issues arise. It is also common for investors to seek agreement regarding the power off-take and pricing. These and other factors that enhance the overall investment climate in the sector will be crucial for mobilizing private investments to develop the geothermal sector.

Inter-island transmission interconnections provide an opportunity to exploit the Eastern Caribbean's full geothermal potential; and promote regional integration. Many of the small power systems in most Eastern Caribbean islands do not allow the full geothermal potential of the region to be exploited. However, this challenge could be overcome by integrating regional power markets through the development of transmission interconnections. A submarine transmission link is being actively considered to connect Guadeloupe and Martinique to Dominica to exploit the full potential in the WottenWaven/Laudat geothermal field and beyond. Nevis and Montserrat may also have geothermal potential in excess of domestic needs, and may benefit from an interconnection with other islands. However, developing and operating submarine transmission lines can be costly and complex, likely requiring international expertise that is not available regionally. Moreover, interconnecting different jurisdictions will require regional cooperation. Although no transmission interconnections exist in the Eastern Caribbean today, the future may bring greater energy trade and regional cooperation.

Geothermal developments largely beneficial for the environment and local communities—and following industry practices and international standards will adequately address its potential impacts. Geothermal is a clean, renewable energy that is environmentally friendly with generally positive impacts. However, as with the development and operation of any power plant, it will be important to comply with internationally accepted environmental and social standards such as the Equator Principles. This will ensure that potential water, air quality, noise, and other impacts are adequately addressed so that investments continue to be sustainable. Internationally compliant safeguards practices are also an integral part of a project's "bankability" as it is increasingly becoming a requirement for securing financing from international investors and banks. Therefore, it will be important for each jurisdiction to mandate its own environmental and social standards based on international best practices; and monitor to ensure compliance with those standards by project developers.

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