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The Caribbean Islands Are Tapping Their Geothermal Potential

Abstract:

The Caribbean region is made up of 38 islands, eleven of which, Saba, St Eustatius, St Kitts, Nevis, Montserrat, Guadeloupe, Dominica, St Lucia, St Vincent and Grenada, are volcanic islands. They were formed from the interaction between two tectonic plates, the North American plate sinks beneath the Caribbean plate in a process called subduction. As a result, these islands have geothermal potential. Surface manifestations include fumaroles, hot springs, mud pots, solfataras and steam vents. Globally, the Caribbean region enjoys a tropical climate and has only two seasons, the dry and wet seasons. It is important to point out that hurricane season runs from June to the end of November. During these months the islands are more vulnerable to cyclonic phenomenon, which may sometimes be devastating. Other natural hazards can affect the islands, such as the earthquakes that struck Haiti in 2010, volcanic eruptions on the island of Montserrat in 1995 and tsunami threats. Thus, we can conclude that the Caribbean region is not immune to natural disasters. However, another phenomenon has been affecting the islands for a number of years, resulting in sea level rise, heat waves, droughts, heavy precipitations, hurricanes that are more devastating and many others; this climatic event is known as global warming.

Keywords: Caribbean islands, fuel importation, energy transition, geothermal potential, under-exploited

Introduction

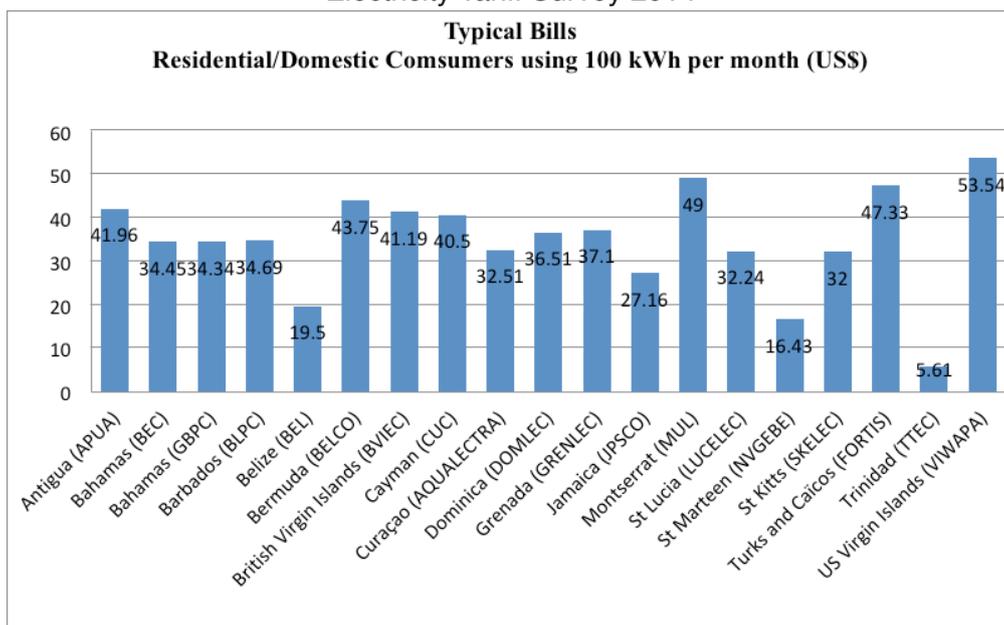
Worldwide, global warming has become a major issue for humanity. The increased use of fossil fuel linked to human activities contributes to the emission of greenhouse gases in the atmosphere. Many governments have decided to turn to cleaner energy sources, commonly known as renewable energy. These energies come from natural sources, which are available, sustainable and great alternatives to fossil energy. As a result, different types of renewable energy have been aggressively developed and used. Despite this keen interest in renewable energy, only a small percentage of the world's total energy production is generated from renewable sources compared to fossil fuels. By opting for renewable energy, government leaders have embarked on the path of energy transition, with the prospect of integrating the goal of sustainable development for environmental protection. While some countries have a head start regarding energy transition, others, such as the Caribbean region, are struggling to replace diesel or fuel oil with renewable energy, which include geothermal power. Many years ago, the volcanic islands were the subject of numerous geological studies to assess their geothermal potential. Although the results obtained showed great potential, the development of geothermal energy has been a slow process, prolonging the continued use of imported fossil fuel. Firstly, we will analyze hindrances to this transition. Secondly, we will draw attention to different geothermal projects in the region.

Fossil Fuel Importation

The cost of electricity in the Caribbean region is estimated to be among the highest in the world (Graphic 1), and this can be linked to the geographical location. A similar situation exists in the Pacific Ocean where the volcanic island of Hawaii also depends heavily on the import of fossil fuel [1]. Compare to other states in the USA. [2] For example, in 2014 the electricity rate was “33.43 cents per kWh” in Hawaii, whereas the electricity rate in the state of California was “15.15 cents per kWh” (EIA: US Energy Information Administration). In fact, none of the Hawaiian Islands are interconnected for, either natural gas, or by a submarine cable for electricity and it is necessary to use expensive generator systems.

Graphic 1

Electricity Tariff Survey 2014



Graphic 1 Caribbean Electric Utility Services Corporation (CARILEC)
Electricity Tariff Survey End of Year (December) 2014

Another reason that can be put forward is the size of their market – the smaller the market, the higher the unit cost of fuel. It is worth stressing, that on June 29th 2005, an oil alliance was launched between the Caribbean islands and Venezuela, excluding Guadeloupe and Martinique, which purchase their oil from other nations. However, as the *Caribbean Community Energy Policy - Approved 01 March 2013* points out “The PetroCaribe Agreements provide for the importing countries to be supplied with a stipulated amount of crude and refined oil products from Venezuela at intervals through its state owned oil company *Petróleos de Venezuela S. A. (PDVSA)*. Based on the Agreements, a percentage of the payments for oil purchases are converted into a low interest long term loan with sliding rates of interest and repayment periods depending on the price of oil” (Energy Programme 13). In other words, the fuel oil would be sold at a preferential price, meaning at a cheaper price. However, focusing their energy development on one single source of energy presents a tremendous risk for these islands. Actually, the price of oil on the international market is falling, affecting oil-producing countries, like Venezuela, from whom most of the Caribbean islands are importing, weakening the established agreement. In one report published by the American Security Project (ASP) dealing with the energy security in the Caribbean, it was said concerning Venezuela that: “Declining oil prices over the last year have significantly harmed the Venezuelan economy. A significant portion of these revenue streams come from the country’s involvement in the PetroCaribe program. Venezuela’s declining influence

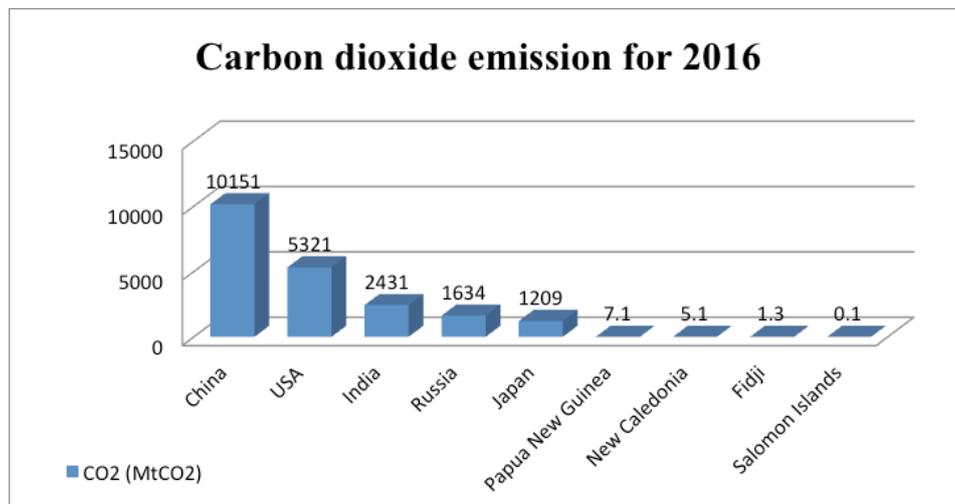
in the region, presents potential problems for Caribbean energy security; it also creates a unique set of circumstances for the US to take the lead” (George 5). If the oil price decline continues, it will have an impact not only on the cost of importation, but also on the cost of production, as well as on the sale price of electricity. As a result, the economic situation of the Caribbean islands has been plagued by external and internal issues, hindering their economic and social development, undermining regional integration and competitiveness, creating difficulties in attracting foreign capital and creating a constraint for the citizens.

Furthermore, the Caribbean is undergoing societal changes. As the world’s population increases, the demand in electricity will continue growing. This will lead to more fuel imports and financial difficulties. Therefore, the Caribbean islands must control their energy dependence on fuel import and oil products. According to the World Bank press release issued July 25, 2012 in Washington D.C, entitled *Central America/Caribbean Can Reduce Their Oil Dependency*. “Central American and Caribbean countries can reduce their oil dependency and shield themselves from high oil prices through a combination of renewable energy, energy efficiency programs and regional energy integration.” Adding to these statements, Ede Ijjasz-Vasquez, World Bank Director for Sustainable Development in the Latin America and Caribbean region said “we estimate that the implementation of a strategy that combines a more diversified power system, better energy efficiency in electricity production and use, and regional integration can significantly reduce Central America and the Caribbean’s vulnerability to high and volatile oil price” (cited in World Bank). In effect, the Caribbean region has a great opportunity to counteract their dependence on diesel and heavy fuel oil by turning to renewable energy. The question to ask is: what are the impediments to this energy transition?

A Slow Energy Transition

Some analysts point out that oil reserves are dwindling, yet still a complete independence from fossil fuels is not possible for now, despite the desire for cleaner energy. During the different international conferences on the climate, emphasis was put on the fight against global warming, goals to be achieved were avowed - developed countries committed themselves to limit the rise of the earth’s temperature to less than 2 degrees Celsius, to reduce the emission of CO₂ and to help developing countries turn to renewable energy. In this regard, now is the time to act against climate change, because the small islands, whether in the Pacific or in the Caribbean region, are the first to be concerned by rising sea levels, just one of the numerous effects of climate change, yet they are the countries emitting the fewest greenhouse gases (graphic 2).

Graphic 2



Graphic 2. Global Carbon Atlas. *Territorial Chart (MtCO2)*. CO2 Emissions, 2017. Web.

Thus, aware of their vulnerability, some islands have been engaged in energy transition, while others are in a slow process of energy transition:

Guadeloupe is a French territory, and also part of the European Union and the Eurozone. It is located north of the Commonwealth of Dominica, and enjoys a tropical climate. Guadeloupe is made up of two islands, Grande Terre which is flat and limestone, and Basse-Terre which is mountainous and volcanic. Basse-Terre is dominated by La Soufrière, also called “the Old Lady,” an active volcano located in the National Park in the town of Saint-Claude. These two islands are connected by bridges and viewed as a single island. Guadeloupe, just as the other Caribbean islands, is electrically isolated and remains heavily dependent on fossil fuels. The electric utility Electricité de France (EDF), the electric utility, transmits and distributes electricity on the island and operates a diesel power plant of 220 MW (edf.gp). Faced with climate change, France is committed to the process of energy transition and promoting an energy mix. To this end, EDF has made the development of renewable energy a priority (Table 1), with the aim of gradually reducing their dependence on fossil fuel.

Table 1

Distribution of energy production

Guadeloupe Energy Mix	
Energy Type	Contribution (%)
Bagasse	3.2%
Coal	23.1%
Geothermal	4.7%
Hydroelectric	1.2%
Petroleum	59.1%
Solar	5.8%
Wind	3.0%

Table 1. Electricité de France. *Mix énergétique 2015 en Guadeloupe*. Nos Energies, 2015. Web.

Guadeloupe is the first and only island that currently possesses a geothermal power plant, located in the town of Bouillante in the west of Basse-Terre. The first power plant was put into operation in 1986 and a second unit in 2005, bringing the capacity of the plant to 15 MW and representing 4, 7% of Guadeloupe's electricity generation. Moreover, a project to expand the plant is under consideration. The Bouillante geothermal power plant was operated by EDF and the Bureau de Recherché Géologiques et Minières (BRGM), a French governmental geological survey company. However, due to financial difficulties, 85% of the company shares were acquired by Ormat Technologies Inc. (Ormat), a world leader in the geothermal sector engaged in many geothermal projects worldwide. The inflow of foreign capital will help to renovate the plant in order to increase its capacity. Ormat's aim is to attain a total of 45 MW by 2021, which would represent 15% of the electricity needs of Guadeloupe. Compared to the rest of the Caribbean islands, the energy transition is underway in Guadeloupe, although there is much to do in order to transition away from fossil fuel. Nevertheless, Guadeloupe is not the only island engaged in this energy transition. Others are following this path as well.

Dominica is a former British colony located between Guadeloupe to the north and Martinique to the south. The island is crossed from north to south by a chain of mountains, many of which are volcanic. The Boiling Lake, the second largest lake of its kind in the world after Frying Pan Lake in New Zealand, is situated in Morne Trois Pitons National Park. There is also a three-peak volcano, bearing the same name as the park, and the Valley of Desolation, an area of "steaming vents, geysers, hot water, rivers and cascades, boiling grey mud and a crust of sulphur-stained rock" and other natural attractions (Crask 114). Studies were conducted in the Roseau Valley in order to confirm the geothermal potential of this part of Dominica, and it appears to far exceed the island's own energy demands offering the potential to export a valuable product in the form of electricity. Dominica Electricity Services (DOMLEC) mainly uses two types of energy, hydropower

and diesel. Other forms of energy are used, but are underdeveloped (Table 2).

Table 2

Distribution of energy production

Dominica Energy Mix	
Energy type	Contribution %
Wind	1%
Solar	0.25%
Hydro	27.4%
Diesel	71.4%

Table 2. National Renewable Energy Laboratory (NREL).

“Energy Snapshot – Dominica.” Energy Transition Initiative: Islands, March 2015. Web.

Decades ago, hydropower was widely used in Dominica. As a matter of fact “the first two hydro-turbines were introduced in 1952 to generate electricity in Roseau. These two generators, located at Trafalgar, have a capacity of 320 kW each...in 1967 the second hydropower station was commissioned at Padu on the Roseau River downstream from Trafalgar” (The Caribbean Conservation Association 111). However, with the growth of the population and an increased demand of electricity, Domlec (Dominica Electricity Services) has relied on diesel fuel in order to satisfy the electricity needs of its customers. As a result, since 1984 the quantity of fuel used yearly has tripled. In “1978 almost 90% of total demand was met through hydro” (The Caribbean Conservation Association 116). Today, though diesel fuel is the primary source for electricity generation, hydropower is still being used, accounting for approximately 30% of the total electricity generated.

Recently, exploratory drilling has been carried out to confirm the quantity and quality of the geothermal resource with an aim to build a small power plant that will generate 10-15 MW and to ensure energy independence in Dominica. A large power plant of 100 MW, for electricity export to Guadeloupe and Martinique via submarine cable, forms part of the long-term plans. Following the passage of Tropical Storm Erika, the project had to be suspended due to damage to the road infrastructure, among other reasons. While Dominica was still recovering from the devastation of Tropical Storm Erika, two years after hurricane Maria, a category 5 hurricane severely damaged the island and seemingly jeopardized the geothermal project’s progress. However, the government is determined to complete the project, Dr. Collin McIntyre highlights that “the project is moving forward ... it’s not at a standstill” and added that “the project is on. We will continue to sensitize as we move on so let’s embrace it because it is for us, and it’s clean energy and the world is headed towards clean energy. We do not produce fossil fuels in Dominica” (thinkgeoenergy.com)

Therefore, we will hopefully see the construction of a 7 MW geothermal plant in Laudat, as a production well, and probably a reinjection well in Wotten waven and other selected sites by 2019.

Realization of the project will make possible an interconnection between three islands, a first in the Caribbean region. As stated in the report *Caribbean Regional Electricity Supply Options: Toward Greater Security, Renewable and Resilience for the Region*, “Electricity interconnections can also unlock the potential of various large-scale renewable energy resources in the Caribbean. Through interconnections with other islands..., there is the possibility of gaining access to the needed markets in order to transform these investments into viable option” (Gerner and Hansen xi). Indeed, interconnection offers numerous opportunities to the Caribbean islands.

For instance, the island of Leyte located in the Philippines archipelago is known for its geothermal power plants. Owing to its geothermal potential, two interconnection projects were implemented in Leyte. The first project was a submarine interconnection between the islands of Leyte and Cebu. The second project connected Leyte and Luzon. The aim of these two projects is “to meet the rapidly increasing demand for electricity in Cebu and Luzon” (Dolor 7). Other interconnection projects have been implemented in other parts of the world. For example, in Europe, there are electricity transmission connections linking Finland with Estonia via submarine cable. The objectives of these interconnections are to “improving power system security and enabling power market integration in the Baltic region” (Pidlisna 39). Europe’s target is to increase electricity interconnection for unification of the European electricity market establishing a common electricity price zone. Thus, a similar interconnection can help Dominica to increase its market size, strengthen existing interregional links, to supply the needs for electricity, decrease its dependence on fossil fuel, lessening the effect of fluctuations in the price of oil, to better develop the inter-island energy trade, and improve or strengthen intraregional cooperation.

Saint Kitts and Nevis, like Dominica, was colonized by the British Empire. They are two separate volcanic islands, forming a federal state. Saint Kitts and Nevis is located northwest of Guadeloupe, and enjoys a hot and humid tropical climate. Both islands are characterized by a volcanic mountain chain located at their centers. Saint Kitts and Nevis is heavily dependent on fossil fuels for electricity generation and is confronted with the fluctuations in the price of oil faced by the rest of the Caribbean islands. As highlighted in (Table 3), diesel fuel holds the first place in energy production there, whereas wind and solar energy are relatively under-developed. Similar to Guadeloupe and Dominica, these two islands have geothermal potential. Exploratory wells on Nevis have verified the presence of a geothermal resource.

Table 3

Distribution of energy production

Saint Kitts and Nevis Energy Mix	
Energy type	Contribution %
Wind	4%
Solar	1.77%
Diesel	94.33%

Table 3. National Renewable Energy Laboratory (NREL).

“Energy Snapshot – St. Kitts and Nevis.” Energy Transition Initiative: Islands, March 2015. Web.

In this regard, Nevis was among the first islands showing a keen interest in geothermal energy. A license was granted to West Indies Power Company to explore the geothermal resource on the islands. This same company was given a license for exploration works in Dominica and Saba, but they did not complete any exploration. The goal of the project was to ensure energy independence for Nevis, and export electricity by a submarine cable to the island of Saint Kitts. However, the company failed to honor its commitments because of financial difficulties. Therefore, the Nevisian geothermal project was suspended until the license was awarded to another contractor. Despite the hurdles that have hindered the progress of the project, in 2015 the geothermal project in Nevis was revived with the arrival of a new purchaser, Nevis Renewable Energy International (NREI), an associate of Texas-based Thermal Energy Partners LLC. (TEP) (Caribbean Now!). Since then, the project has made a significant move. In December 2017 the exploratory drilling process was underway with plans for the production well drilling early in 2018. Their aim is not only to build a power plant that will produce 9-10 MW of electricity for the local market, and commercialize power to others islands, like Saint Kitts. It is also to make Nevis, as indicated by Nevis Deputy Premier Mark Brantley, a “clean, green fossil fuel free island” (Washington).

At the same time, the island of Saint Kitts, which is also interested in geothermal energy, has signed an exploration agreement with Teranov, a French engineering and services company for new and renewable energy established in Guadeloupe (“Feasibility study”). From all this, it shows that both Saint Kitts and Nevis have the same goal, to generate clean energy , lower the cost of electricity, supply the needs of their population, and depend less on diesel fuel. Nevis, like Dominica, has the capacity of exporting electricity to other islands due to the quantity of resource it possess. These three islands we just examined are well advanced in their respective projects, and plan to build their power plant in the near future. However, French geothermal developer Teranov has received the exploratory license by the Executive Councils of the islands of Saba and of St Eustatius, in order to assess their geothermal potential (Richter).

Saint Vincent and the Grenadines is a former British colony located between Saint Lucia to the north and Grenada to the south. Like the aforementioned islands, Saint Vincent is a volcanic island and is highly dependent on fossil fuels. VINLEC (St Vincent Electricity Services Ltd) is the only licensed utility company to produce, transmit, and distribute electricity in Saint Vincent and the Grenadines, including some dependencies. The other small islands are supplied by privately owned electricity systems. Two methods are used to produce electricity, fossil fuel and hydropower (Table 4). The high percentage of petroleum used highlights their dependence on fossil fuel.

Table 4

Distribution of energy production

Saint Vincent and Grenadines Energy Mix 2011	
Energy type	Contribution %
Petroleum	78%
Hydroelectric	22%

Table 3. National Renewable Energy Laboratory (NREL).

“Energy Snapshot – Saint Vincent and The Grenadines.” Energy Transition Initiative: Islands, August 2015. Web.

Like many of the other volcanic islands, Saint Vincent and the Grenadines has embarked on the development of geothermal energy. To successfully carry out its project, the government of Saint Vincent and the Grenadines has formed a partnership with the Icelandic firm Reykjavik Geothermal Ltd, which is experienced in geothermal development, Emera, a Scotia company, and assistance from the international community (Chance). With the St Vincent Geothermal Project on track to start-up in 2018, Peter Williams said “the aim of the project is to bring stable pricing and a lower cost to energy consumers” (“St. Vincent Geothermal project”). If the project is a success, Saint Vincent and the Grenadines will have a geothermal power plant with a capacity of 10-15MW to supply the local market.

The four islands that were examined are pursuing the same objective, taking full advantage of their natural resources, particularly geothermal energy so as to promote clean energy and, at the same time, be on the path to energy independency. However, the road leading to this process requires profound changes in the energy system. This means giving more emphasis to renewable energy. It involves social, economic, and behavioral changes both individually and collectively, as well as adopting the concept of sustainable development. The energy transition is a slow and lengthy process that must accommodate countries and territories. Although the Caribbean politicians acknowledge that the price of electricity is very high, the development of geothermal energy in the region can help to reduce not only the electricity rate, but also their dependence on

fossil fuel. The question to ask is “what are the impediments to rapid energy transition, from oil to geothermal?”

The Caribbean region is composed of 38 islands, each with a different status. Some are independent and, others are not independent. Nevertheless, they all share the same colonial past, which has left many footprints. In addition, when we closely observe the Caribbean, there are infrastructural disparities and a disproportionate distribution of natural resources. Indeed, among the four islands that were analyzed, Dominica appears to have the largest geothermal resource. However, in the energy mix Guadeloupe has a long lead over the islands, which makes it a model in the energy field to the other islands. Due to its dependent political status on the state of France, Guadeloupe is engaged in the energy transition in developing projects based on renewable energy.

However, for others the road to energy transition will be a slow and a lengthy process that should accommodate the countries. Energy transition requires profound changes in the energy system, which means giving more emphasis to renewable energy. Therefore, the implementation of projects related to the environment is mostly financed with European funds by European governments. With this aid, Guadeloupe was able to develop its energy mix.

Others do not have these opportunities. Such is the case for Dominica, Saint Kitts and Nevis, Saint Vincent and the Grenadines. These are all independent islands. In contrast to the Guadeloupe, these islands are poorly developed, and in addition do not have the financial means to develop large-scale projects despite their potential in geothermal energy. Several reasons explain why geothermal energy is undeveloped. For instance, the islands face challenges: in particular the high upfront cost for exploration and uncertainty of finding a geothermal resource. Indeed, the development of geothermal can be a risky investment because proving the existence of the geothermal resource requires high upfront capital expenditure. Furthermore, the demand in electricity for Dominica, Saint Kitts and Nevis, Saint Vincent and the Grenadines are low compared to other markets, which, proportionally increases the drilling costs and makes it more important to be successful with early drilling. Also the total project costs become higher on a per megawatt basis than a larger project. The poor financial standing of some of the governments makes it harder to invest, or investors want a higher return on the investment, by switching to geothermal as a base load you take generation away from the utility, which means that they are less financially viable as a business. It is important to keep the utility viable as they are invested in by national insurance scheme, city councils and other local parties. These islands have a small size market, unlike Guadeloupe whose market is bigger and can generate more electricity for a larger proportion per person.

Nevertheless, on November 20, 2017 at a meeting held in New York in the presence of the President of Caribbean Development Bank, Dr. Warren Smith, European Commissioner

for International Cooperation and Development, Neven Mimica announced a European financial contribution to geothermal energy development in Dominica, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Saint Lucia and Grenada. He said that “this funding will add momentum to our ongoing efforts to transform the energy sector in the region, and support our borrowing member countries in harnessing their renewable energy resources” (“The European Union”). This financial supposition represents a real boost to their desire, and not only to embrace energetic transition.

It is worth noting that to carry out energy transition, it is important to have environmental laws in order to know the principles and uses of geothermal energy. Guadeloupe has been under French governance and applies environmental laws enacted by France and Europe. The English speaking islands with geothermal resources have implemented geothermal regulation, which is necessary as the geothermal project develops. Therefore, the renewable energy sector and particularly that of geothermal energy is something new for them.

Conclusion

In conclusion, Guadeloupe, Dominica, Saint Kitts and Nevis, and Saint Vincent and the Grenadines, are all heavily dependent on fossil fuel to generate electricity to satisfy the needs of their citizens. However, the use of fossil fuel contributes to the emission of CO₂ in the atmosphere causing greater impacts on global warming and the environment. After hearing the call of different scientists, who point out the need to act against the effects of climatic changes, political leaders have decided to turn to clean and renewable energy and to enter into the phase of energy transition. Though this transition is important for the planet and the human race, it is difficult to put in place in certain parts of the world, especially in the Caribbean. Indeed, in the Caribbean region, there is inequality that hampers the economic development and growth of the islands. The main reasons to explain the slow pace of the process to energy transition include lack of financial means, the risk of not successfully locating the geothermal resource, and attracting investment capital. However, for some years geothermal development projects have been underway in the Caribbean, improving the awareness of the politicians and their desire to take full advantage of that resource in the hope of reducing electricity rates and producing green energy so as to fight against global warming. Furthermore, the fluctuation of the oil prices presents a big issue for the Caribbean islands. We can say that the energetic transition in Caribbean region is on the way, but the process will be long and much remains to be done in order to attain the objectives set during the COP 21. Yet, the withdrawal of the United States from the Paris Climate Agreement could have serious environmental consequences. In addition, signatory countries may find it difficult to maintain their commitments made at COP21 and honor their financial support for developing

countries, hindering energy transition to renewable energy sources. As a matter of fact, we are hoping that despite the withdrawal of the United States from the Paris Agreement that efforts will be made to continue promoting geothermal energy, and help countries engaged in this path.

Endnotes

[1] Deriving nearly 90% of its primary energy resources from oil (Arent Doug et al 1).

[2] With 83% of electrical production based on fuel oil, the price of electricity in Hawaii is also more than twice the U.S. average (Arent Doug et al 1).

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