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Opportunities for Direct Use of Geothermal Energy in the Eastern Caribbean

Charlin Bodley

PO Box Choc 8376, Union, Castries, Saint Lucia

charbodley@gmail.com

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ABSTRACT

Most of the islands of the Eastern Caribbean region are of volcanic origin and are therefore collectively home to one of the world's largest untapped geothermal sources. Despite this potential, most islands in the region remain over 90% dependent on imported fossil fuels. In addition to the intrinsic challenges characteristic of geothermal project development, the Caribbean region faces unique challenges in the development of its geothermal resources, including those posed by the particularities of small-scale economies. Evident of the challenges faced by this region is the fact that thus far the French territory of Guadeloupe remains the only island in the Caribbean which has successfully developed a geothermal power plant. This is despite the long histories of geothermal exploration dating as far back as 1951 which some islands account. In the majority of the Eastern Caribbean Islands, geothermal energy is presently being explored for electricity generation. Although on a global scale 82 countries have reported the application of direct utilization of geothermal energy, this has been very limited in any of the Caribbean islands. Globally, most direct use applications for geothermal is for heating (35%) and bathing (45%). While tropical Caribbean islands have low to no heating demands, direct utilization of geothermal energy is applicable to a host of other end-uses.

This paper therefore presents an analysis of the potential of direct utilization in the Eastern Caribbean. It identifies suitable applications and opportunities to leverage geothermal reservoirs and efforts at exploiting and developing the resource in the region. It seeks to determine whether geothermal development can be enhanced through the application of direct utilization including for agricultural and recreational use and space conditioning applications. Particular focus is placed on the impact on tourism consequent upon the particular energy needs of the sector and the dependence of the small island nation economies on the tourism sector. In the Caribbean context this paper pays particular attention to the cascaded use of geothermal fluids after use for power production.

1. INTRODUCTION

The Energy Sector in the Caribbean region, is notably characterised by a high dependence on imported fossil fuel. This exposes the region's countries to volatility of oil prices and consequently high electricity tariffs. Apart from the obvious environmental impacts of this phenomenon, the limitations to social opportunity and economic growth caused by this dependence are glaring. These challenges are however, outweighed by the immense opportunity for alternative options. The Caribbean region is endowed with indigenous renewable energy sources and enjoys the potential to develop solar, wind, hydro, biomass and geothermal energy.

The geothermal resource in the Caribbean resides in the Eastern Caribbean, where volcanic islands were formed at the subduction zone between the North American Plate and the less-dense Caribbean Plate. The islands of the Eastern Caribbean therefore have significant geothermal potential, enough in many cases to single-handedly meet the host country's energy demands. The islands have in some cases, very long histories of geothermal exploration. One such example is the island of Saint Lucia which has recorded surface exploration activity dating as far back as 1951. Despite this, the region has no installed capacity of Geothermal Energy for electricity generation with the exception of the French territory of Guadeloupe.

2. OVERVIEW OF GEOTHERMAL ENERGY IN THE EASTERN CARRIBEAN

2.1 Current status

Based on strong scientific evidence, 9 islands from the Eastern Caribbean States grouping – institutionalized under the Organization of the Easter Caribbean States (OECS)- are pursuing geothermal energy development to form part of their renewable energy mix. They include, Saint Kitts, Nevis, Monserrat, Guadeloupe, Dominica, Martinique, Saint Lucia, Saint Vincent and the Grenadines, and Grenada. The islands are at varying stages of development with some having completed surface explorations, some exploration drilling, and others production drilling. However, the 15 MW Bouillante Power Plant in the French territory of Guadeloupe, remains to date the only geothermal power plant in operation in the Caribbean.

Though many islands remain in the exploration phase of their projects, the planned capacities are well determined, and are intended to meet the base load demands and in some cases meet or exceed the peak demand. These neighboring islands have embarked on various approaches to overcome the inherent risks and challenges of geothermal development in the characteristic small markets of the Caribbean. The approaches vary from having the development of the resource carried out through public private partnerships to exploration by private developers. Other islands have adopted the ESMAP model of using public financing for the upstream development stages.

Notwithstanding these varying approaches at developing the resource on the islands, the challenges faced by islands are common across the board and account for the delay in the successful installation of geothermal power plants in the OECS.

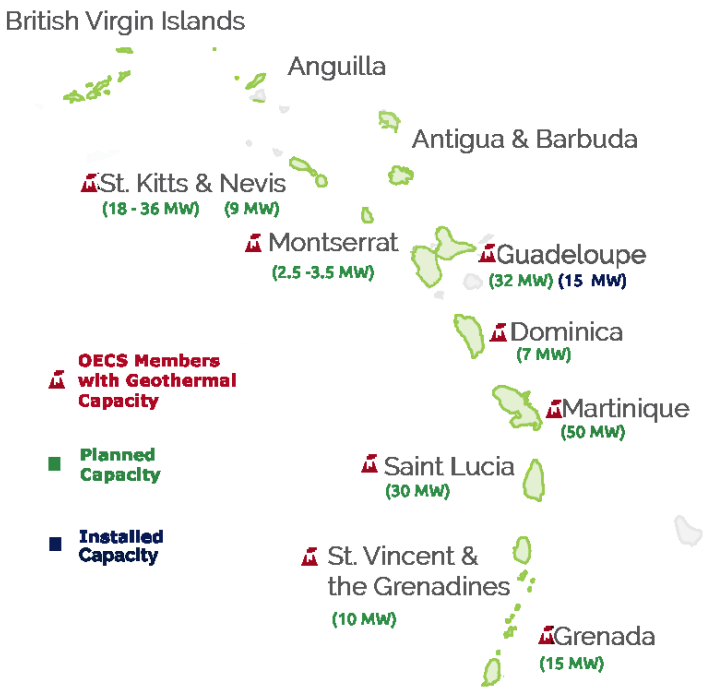

Figure 1 : Geothermal Development in OECS Member States (Source: OECS, 2018)

2.2 Challenges

Among the main challenges associated with geothermal energy across the islands of the OECS, are financial challenges. The early development and exploration phase are particularly risky since large capital costs are required for drilling. This capital-intensive phase may or may not result in proof of a commercially viable resource for the production of electricity. To overcome this challenge many islands have sought the assistance of development banks such as the World Bank and the Caribbean Development Bank. Grant funding and technical assistance have also been forth coming from international donor agencies and donor countries, for example the Government of New Zealand. Another major challenge experienced by the OECS is the avail ability of requisite skills set and capacity in the development of geothermal energy in the region. This is not limited to technical and engineering disciplines, but also in financing, legal matters, transaction management, procurement and the environmental and social impact assessment processes. A particular related challenge is the capacity of the regulatory bodies and the requisite establishment and institutionalization of the appropriate legal instruments, including geothermal energy legislation and ordinances. The negotiation of power purchase agreements (PPAs) is also a major challenge to geothermal energy development in the region. Many islands have never before established PPAs and this process places them on learning ground.

The notable small scale of the island electricity markets is another inherent challenge faced in the Eastern Caribbean. The planned capacity for the geothermal projects in the region range from 2.5 MW to 50 MW. As a case in point, Monserrat has a planned capacity of as little as 2.5-3.5 MW, to match their system peak demand of 2.2 MW (Government of Monserrat, 2019). Saint Lucia has a planned installed capacity of 30 MW, and experienced a historic peak demand of 61.7 MW in 2017. Martinique, an associate member to the OECS, has a planned installed capacity of 50 MW and a peak demand of 254 MW. This creates a challenging investment landscape for investors and developers as these projects suffer from diseconomies of scale.

Though not a forerunner for being the biggest challenge, geothermal development in the Caribbean region has recorded some level of resistance with a lack of acceptance especially noted among settlements in project areas. In cases where the resource or access to it lies on private property, land acquisition is a long and complicated process, which can sometimes be met with significant opposition. This is more apparent where landowners are unable to see a direct benefit for them and their heirs in the development of the resource.

2.3 Justification/status of direct use in the Eastern Caribbean

To date all efforts have been geared towards the development of the resource for the production of electricity. No studies have been identified by the author on direct utilization of geothermal energy in the Caribbean. However, considering all the challenges highlighted in the previous section, exploring direct use and co-generation projects in the Caribbean context can help to overcome these challenges and make the development of geothermal energy more attractive and relatable. Despite a statement from the OECS that suggests a high level of interest in the development of direct use projects, there are currently no projects in the pipeline. The conversation on direct use in the region is therefore quite novel. Direct use is fast gaining popularity globally and impressive technological growth has been witnessed in the industry giving way to many applications of the resource.

Drawing from the experiences of countries within Latin America, direct utilization and/or co-generation projects are likely to follow the development of commercial geothermal power projects. Examples of this lie with El Salvador and Mexico. The Caribbean, however, has a unique opportunity to prioritize direct-use potential to catalyze the all-round development of the resource, drawing from the best practices from around the world.

3 OPPORTUNITIES FOR DIRECT USE IN THE EASTERN CARIBBEAN

3.1 Context

The direct use of geothermal resources can be defined as the direct employment of the heat energy from geothermal resources without its conversion to other forms of energy such as electrical energy. Geothermal energy can essentially be used directly in any process that requires heat input. Direct use of geothermal energy is in fact not a novel concept but has been practiced for bathing, space heating and farming applications even far before geothermal energy was used for electricity generation,. (Jóhannesson and Chatenay, 2014)

Geothermal energy can offer affordable and clean energy solutions for a variety of potential uses. This is not limited to electricity generation but instead runs the gamut of the geothermal energy use. In fact, upon close analysis of the major industries and economic activity the small-scale economies of the OECS are found to be heavily based on tourism. With high electricity prices impeding the economic competitiveness of the tourism industries in these territories, the islands could particularly benefit from the direct utilization of geothermal energy for several applications. Globally, the most common application for direct use is space heating. A classic example is the approximate 90% of all buildings in Iceland heated by geothermal energy.

The climate in the Caribbean does not result in the need for space heating. Therefore, this proven application is not a viable option. However, several other applications exist and can be explored. They include balneology, aquaculture, horticulture, agro-processing and some other industrial uses. Emanating from the conference proceedings of the World Geothermal Congress in 2015, 83 countries were reported as employing direct use applications. In the Eastern Caribbean, small-scale use of geothermal energy exists in a few islands, namely Nevis, Saint Lucia and Guadeloupe for bathing. Geothermal fluids from surface manifestations such as hot springs are captured for recreational bathing purposes.

The potential use of geothermal energy depends largely on a number of factors, including the characteristics of the resource and economic considerations related to the potential market and methods of extraction of the resource. Most direct use applications are applied to geothermal fluids in the low to moderate temperature range of 20°C to 120°C. Geothermal fields are defined as being either low temperature or high temperature fields. Low temperature fields have reservoir temperatures below 150 °C, while high temperature fields have reservoir temperatures exceeding 150 °C. Direct use of geothermal energy can be employed in both cases. Direct use for geothermal energy requires significantly lower flow rates, volume, and temperatures compared to geothermal power generation. Direct use of geothermal energy can be employed through stand-alone systems to use geothermal fluids directly from a dedicated heat source. In many cases shallower wells are needed to be drilled compared to the deep wells required for commercial scale electricity generation. Alternatively, cascading direct usage after a high temperature use (often for electricity generation) is viable in some cases. Successful application of direct use in the Caribbean context hinges on its ability to add value and enhance the exploitation of the resource for electricity generation, already under way in all the OECS at varying levels of development. A schematic of a simple example of the cascade use of geothermal energy beginning with electricity generation as the maximum use of the geothermal energy. The resource is then cascaded to other applications at varying temperature requirements.

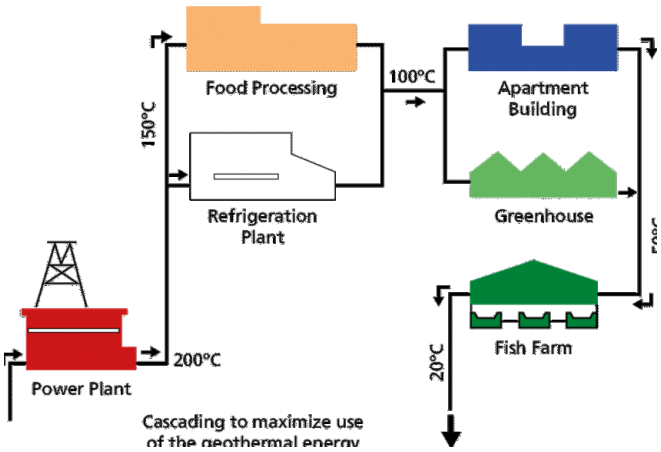

Figure 2: A schematic of an example of geothermal energy cascading (Source: Lund JW (2010))

The method of extraction of the geothermal resource, be it directly from low temperature fields or through cascaded development will highly determine the economic viability of direct use in the Eastern Caribbean states. In the region, it is anticipate that all islands will conduct deep drilling. This may provide opportunities to use slim wells resulting from exploration drilling programmes, or to employ a cascaded development of geothermal. Consequent of the small scale geothermal industries planned for the islands it is important that direct use applications leverage ongoing and planned exploration programmes and investments to add value and increase the economic and social viability for geothermal development as a whole.

Dominica, Nevis and Monserrat have all successfully completed exploration drilling and confirmed the existence of high temperature geothermal fields. With the exception of the pioneering efforts of Guadeloupe, the remaining islands of the Eastern Caribbean are yet to confirm the temperature and existence of geothermal reservoirs. Nonetheless, deep drilling is planned for all the islands. This therefore poses an opportunity for islands to explore cascade systems to leverage the extraction of geothermal fluid both for electricity generation and direct use.

3.2 Market considerations

All the Eastern Caribbean islands depend on tourism as the main economic activity. Agriculture and light manufacturing are also common industries among the islands. New potential industries that require heat as a direct input should also be explored in the context of the Caribbean region. One such example is the agro-processing industry as a means to support the nexus between energy and food security.

Direct use viability according to the application highly depends on the temperature of the geothermal fluid available. The resource must also be able to sustain the extraction of heat and/or fluid proposed. The diagram in figure 2, derived from the classic Lindal shows examples of potential uses for geothermal resources, as a function of the temperature required for the processes (Dickson and Fanelli, 2004). Some of the main industries in the Eastern Caribbean islands such as the textiles, agricultural and agro-processing industries which require heat as an input can surely qualify for direct use applications according to the Lindal diagram. New industrial opportunities for the region are also very evident when examining the contents of both figure 2 and table 1.

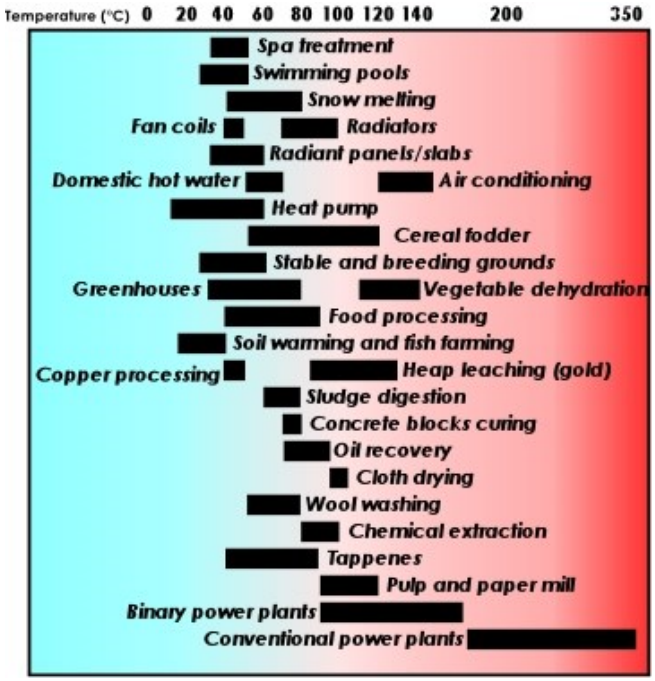

Figure 3: Derived Lindal Diagram (Dickson and Fanelli, 2004)

Table 1: Major industries and status of geothermal energy development in the English-speaking Eastern Caribbean

Country	Population	GDP (USD) per capita	Major industries	Status of geothermal development
Dominica	73,897	11,000	Tourism, agriculture, Manufacturing of soap and other toiletries, shoes, cement, blocks, ceramics, and furniture	Entering construction phase of power plant
Grenada	111,724	15, 100	Tourism, processing and export of cocoa, citrus fruits, bananas, cloves, and cinnamon; Small scale manufacturing of beverages and other foodstuffs, textiles, and assembly of electronic components	Preliminary exploration studies complete. ESIA and feasibility study for drilling next step
Monserrat	5,292	12, 044	Tourism, rum, textiles, electronic appliances	Production drilling complete, early market engagement survey on the way
Saint Lucia	164,994	14, 400	Tourism (65%GDP); clothing, assembly of electronic components, beverages, corrugated cardboard boxes, processing of lime, coconut and cocoa	Entering exploration drilling of slim holes to confirm the resource.
St. Kitts & Nevis	52,715	28, 200	Tourism; cotton, salt, copra, clothing, footwear, beverages, agriculture	St. Kitts: Some site surveys done Nevis: Power plant construction plans advanced
St. Vincent and the Grenadines	02,089	11, 500	Tourism; Agriculture, Cement Manufacture, Flour Milling, Food Processing, Forestry, Rum Distilling, Tourism.	Exploration drilling in progress

Source: Energy Report Cards for CARICOM Member States

3.3 Application industries

To leverage the main existing economic activities, two of the most relevant sectors for consideration of direct use applications in the Eastern Caribbean are tourism and agriculture. While other industries such as rum distilling, textiles and beverages could benefit from direct use, the scale of these industries must be given serious considerations in determining the economic viability. The agricultural and tourism sectors will therefore be examined closer in the subsequent sections.

3.3.1 Tourism

The tourism sector in some of the Eastern Caribbean states account for over 60 % of GDP. Notwithstanding the success of the tourism industry, it is imperative for the islands to lower operation costs within the sector and welcome opportunities to enhance the tourism product. Balneology is one of the dated geothermal direct use applications and is already being practiced on very small scales in some Eastern Caribbean islands. In a case study of the island of Saint Lucia carried out by Deloitte, the assumption that the ongoing drilling work carried out through World Bank support provides a favored position to explore direct use was made. In a report by Deloitte Financial Advisory Services, a case study on a geothermal direct use spa facility in Saint Lucia considered assumptions of projected tourism volume of 170, 000 visitors per year and an average length of stay of 8.4 nights. These assumptions formed the basis of a very preliminary economic analysis, which assumed total capital costs of approximately $33 million US dollars and annual project revenues of over $ 2.5 million US dollars. Further market research is necessary to conduct a full economic and financial feasibility. A critical assumption in this case study was that the tourism direct use project in Saint Lucia would seek to leverage the slim holes funded by World Bank to defray costs and risk. (Deloitte, 2019)

This case study can be replicated and considered for other OECS member states, since they all depend heavily on tourism. As part of the market research it would be important to determine the accessibility to the geothermal resource, and proximity to other popular tourist activity. These factors among others will have significant weight in determining the viability of such projects.

The Caribbean can surely draw from the experiences of Iceland, which has benefited from tourist interest in the Blue lagoon and other geothermal energy direct use spas. Other countries like Kenya have followed suit in creating spas as part of cascade developments of geothermal energy.

3.3.2 Agriculture and agroindustry

According to the Food and Agriculture Organization of the United Nations (FAO), developing countries suffer socio-economic disadvantages where food is concerned due to a lack of affordable energy for aquaculture and food-processing. Another major issue is post-harvest losses, which according to the same report can range from anywhere between 1 and 50 percent in weight and quality. Roughly 30 percent of total energy is consumed by the agriculture and food sectors. 70 percent of this energy is consumed post-farm harvest. (FAO, 2015)

In most agro industrial processes that require high temperatures, steam and heated water are used to provide it. This is signaled as an opportunity for direct use of geothermal fluids, as a more affordable and cleaner form of energy. Geothermal energy therefore can assist in reducing post-harvest loss and increasing food security in general. A plethora of applications of direct use geothermal energy exist in agriculture and agro-industries (Van Nguyen et al., 2015) They are shown in figure 4 with their corresponding temperature requirements in the Lindal diagram specified for the sector.

In the agricultural sector, opportunities for the application of direct use in both existing and new industries and processes exist, as can be gleaned from a comparison between the existing industries in the Eastern Caribbean (Table 1) and the Lindal diagram in figure 4. Some OECS islands produce cocoa and can benefit from geothermal heat in the drying and processing of cocoa, coconut, lime and other crops. Drying of agricultural products is a very important process in reducing wastage and ensuring that nutritious food is available all year round, and during droughts, towards increased food security.

A preliminary market scope identifies seaweed drying as a unique and contextual application of direct use in the Caribbean region. Geothermal energy can be used in the drying and processing of seaweed; an environmental issue which has plagued the Caribbean since 2014. Large volumes of Segassum seaweed wash on to the shores of the Caribbean islands, and becomes an environmental nuisance as it decomposes with notably unpleasant odors. It also makes sea swimming difficult for sea bathers on affected beaches. Drying of this seaweed facilitates its transformation into fertilizer products for commercial agriculture, nursery and garden applications. This provides environmental benefits as it the landed seaweed can be removed from shorelines.

Geothermal direct use provides an opportunity for large scale drying of seaweed for conversion into these commercial fertilizer products (Hallsson,1992). Iceland is once again an excellent success story, and can boast of the early production of geothermally dried seaweed products. Thorverk hf. is a seaweed processing plant founded in 1986 at Reykholar and uses geothermal water for seaweed drying. The annual production of seaweed and kelp is about 4,000 tonnes and the plant uses 28 l/s of 107°C hot water. The geothermal heat which comes from local boreholes, is used in a gentle drying procedure that ensures minerals and organic substance are preserved. (Thorverk hf, 2019) The direct use of geothermal water results in an environmentally benign production process.

Sargassum drying is already carried out on a commercial scale in Saint Lucia. The company, Algas Organics, transforms the seaweed into fertilizer for commercial uses (Deloitte, 2019). The company presently is reported to dry 100 tons of seaweed per month, by placing them on concrete platforms. (Deloitte, 2019) Therefore, there is opportunity to draw from the experiences of Iceland in establishing a drying facility using geothermal water in the seaweed to organic products industry.

The prospect of direct use in the agricultural sectors in the Eastern Caribbean may provide opportunities for new economic activities in the sector. According to the range of agricultural processes highlighted in Figure 4, the rum and other beverages, timber drying, food processing, sterilizing and fruit and vegetable drying are some ideas for new agro industrial pursuits in the Eastern Caribbean.

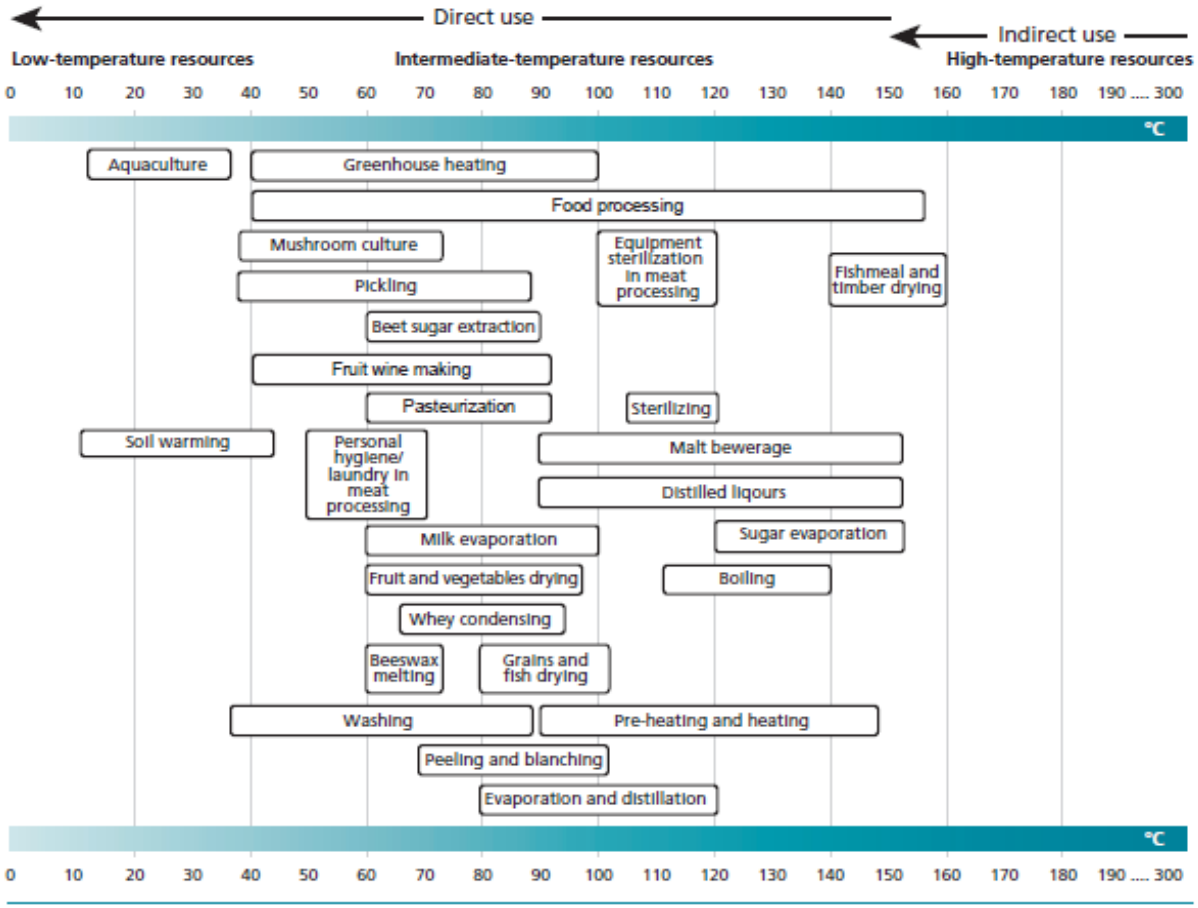

Figure 4: Derived Lindal diagram of potential uses of geothermal energy in the agriculture and agro-industry sectors (Van Nguyen et al., 2015)

4.0 BARRIERS

A number of barriers to the implementation of direct utilization of geothermal energy in the Eastern Caribbean exist. At commercial and industrial scales, legal, economic, market, social, institutional, technological and legislative impediments to renewable energy technologies also apply to geothermal energy. This is especially true for direct use considering its novelty as an option for the Caribbean.

4.1 Policy, legislative and regulatory framework

A 2016 OECS survey report identifies the two most common challenges to geothermal energy development in the region as "Financing" and "Government policy" While some islands have geothermal legislation in place, they do not consider direct use. The latter (government policy) must support certainty and explicitness in regulatory processes to support geothermal direct use.

4.2 Lack of information on resource characteristics

Some islands have confirmed a commercially viable resource and others are yet to engage in confirmative exploration drilling. Therefore, a lack of information on the characterization of the resource poses difficulty in pursuing direct use of geothermal. In addition, robust information on direct utilization applications viable for the Caribbean context must be gathered. To date there is no information on the scale and breadth of the geothermal direct use opportunity. Reliable information and financial data related to economic viability and market drivers are required for direct use developments.

4.3 Market constraints

The small scale of many industries in the Caribbean make it difficult to benefit from economies of scale in the development of direct use applications. The location of existing industrial activity compared to the location of the geothermal resource do not always coincide. This introduces the need to run pipes to transport geothermal fluids, possibly over relatively long distances and complex terrain. Alternatively, it would require the relocation of activities to resource areas, which could significantly affect the economic viability of the direct use applications.

4.4 Acceptance

For existing industries, it would be useful to determine the social acceptance of incorporating alternative processes. For example, the use of green houses in agriculture versus the conventional methods. Therefore, the success of direct use applications also

requires behavior public awareness and change. In some cases, there is a general lack of support for geothermal development due to the perceived negative environmental, social and economic impacts.

4.5 Land use and availability

For small islands, land availability and competing uses of land may become a complex issue. Land area available for development is limited in many cases and creates intense competition between land use options, including urban settlement, agriculture, tourism and other infrastructure. In the case of direct use, land space considerations range from land required for exploration and production drilling of wells, setting up of operating facilities for the various applications, and in the relevant cases running pipes to transport the resource to application activities that are further away from the resource.

Land use planning legislation was introduced into all the OECS countries decades ago. Subsequently, development control legislation was introduced among the Eastern Caribbean States. A disuse of legislation is reported to occur across the region, stemming from the effective abandonment in many OECS countries of the planning legislation in favour of Land Development Control legislation, which is purely regulatory in nature. (Toppin-Allahar, 2013) The creation, updating, and enacting of land use plans will therefore support geothermal development.

In some Caribbean states, the geothermal resource resides on crown lands, while in others it resides on private property. While the legislation makes provision for acquisition of private land for national priority developments, the process can be daunting to all parties. This affects the support and acceptance levels of the land owners, leading to longer lead times and higher costs for geothermal project development.

5.0 ROAD TO IMPLEMENTATION/OVERCOMING BARRIERS

Some critical areas must be strategically tackled to enable the development of geothermal energy direct use in the Eastern Caribbean. They are mentioned and discussed briefly below.

- Market studies: It is imperative that the right information can be used in making informed decisions about the application of geothermal energy direct use, in the context of the region. This is critical to determine the contextual opportunities and challenges.
- Road map: A Direct-Use Geothermal Roadmap for the individual islands in the OECS will provide useful information needed by governments, communities, the private sector, and other key stakeholders to assist them in evaluating, planning and implementing geothermal direct use projects. It should provide practical guidelines for these stakeholders across all stages of the pursuance of geothermal development ranging from surface exploration, land acquisition and permitting, drilling programmes required for the design and development of direct-use geothermal resources. The road-map should be able to identify and make recommendations for filling in critical knowledge gaps that impede OECS countries from developing their geothermal resources. Such roadmaps for the region must lead countries to pursuing the geothermal direct use projects with the most promising economic potential. They must support and outline a stepwise process with a series of go or no go decision points.
- Leadership and institutional arrangements: Compared to geothermal pursuits strictly for electricity generation, direct utilization has a wider group of stakeholders and directly impacts a number of sectors. In the OECS, the governments, through their agencies responsible for energy and public utilities, are the leading agencies for the development of electricity from geothermal energy. Contrarily, a number of other agencies would be key in direct-use applications. Moreover, direct use applications are sector specific. Examples are the tourism and agricultural sectors discussed above. This requires a different approach for each sector, since stakeholder groups and their interest vary widely across sectors. Notwithstanding this, it is critical to have leadership in the national pursuance of direct-use. Leadership will be critical in establishing an effective legal and regulatory framework, and undertaking exploration work. The establishment, and more importantly the successful implementation of a road map requires firm leadership and championing, to bring together the relevant stakeholders and manage their interests. It is also important to harmonize the planning regime for direct use applications in the region in order to foster a coordinated approach. A dedicated national geothermal development organization with explicitly defined institutional responsibilities and transparent and equitable procedures must exist.
- Capacity building: Capacity building at all levels will be critical to the success of direct use. This includes not only technical and engineering applications, but also in procurement, social safeguarding, environmental and social impacts, land-use planning, business development and other areas. Government personnel and community members and land owners alike within project areas, must be empowered through capacity building to catalyse the effective pursuit of direct uses.
- Best practices: Many countries have made significant strides in geothermal development. Iceland, Kenya and New Zealand are just three among the list of countries who are successful in using affordable direct use geothermal energy commercially. It is useful to draw from the experiences of these countries and adopt the best practices the OECS context.
- Legal regulatory framework: Legislation and their accompanying regulations and the right institutional arrangements to enact them will be very critical in the development of geothermal direct use in the OECS. This framework should include concessional arrangements for extraction of the resource, land use planning, environmental and social impact ordinances, among others. The right framework will facilitate successful navigation through the sometimes complex processes, and will significantly limit project delays and stakeholder dissatisfaction.
- Awareness and sensitization: Outreach and building awareness among all stakeholders will support the uptake of direct use applications on commercial levels. This is particularly true since direct use applications are sectoral and include a wide group of stakeholders. Sensitization is necessary at the highest level of governance, since this can influence policy development and implementation. It is also very important among the community stakeholders, including land owners. Awareness building can take many forms, but it is important in the Caribbean context to include proof of concept approaches, for example study tours to countries who are getting it right and have lessons learned to share.

6.0 CONCLUSION

Geothermal energy can transform the energy landscape in the Easter Caribbean, where the resource is concentrated in the regional sense. Some of the islands in the Eastern Caribbean are characterized by long histories of geothermal exploration for electricity generations. To date efforts have been limited to a focus on electricity generation and not direct use. The present situation among the islands suggest a number of barriers where geothermal energy development is concerned including financial and stakeholder acceptance.

The geothermal industry as it stands is not void of opportunity to enhance development plans and redefine the trajectory of geothermal development. The triple bottom line – environmental, social and economic benefits- can significantly be enhanced by the successful pursuit of direct use applications. A high-level and preliminary market scoping confirms opportunities among two main sectors in the region, the tourism and agricultural sectors. This does not exclude other sectors for example light manufacturing sectors, which must be further investigated within the context of each qualifying island. It is critical to explore geothermal energy in the Eastern Caribbean as a value added to the scope for electricity generation. It would therefore be an essential piece of the puzzle in overcoming the inherent barriers to geothermal power plants in the region, notwithstanding the inherent challenges specific to direct use applications.

A suite of action areas is recommended to overcome the hurdles associated with direct use of geothermal in the Eastern Caribbean. They include, but are not limited to the legal and regulatory framework, market considerations, road mapping, capacity building, leadership and institutional arrangements, awareness and best practices.

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