Global Scientific JOURNALS

GSJ: Volume 7, Issue 11, November 2019, Online: ISSN 2320-9186
www.globalscientificjournal.com

The Impetuses and Hurdles of Renewable Energy Applications and Development in Montserrat

AFAM UZORKA, (Ph. D.)
KAMPALA INTERNATIONAL UNIVERSITY, UGANDA
YAKUBU AJIJI MAKERI, (Ph. D.)
KAMPALA INTERNATIONAL UNIVERSITY, UGANDA
SAMUEL OLUWASEGUN ODEBIYI
KAMPALA INTERNATIONAL UNIVERSITY, UGANDA

Abstract
The economy of Montserrat was severely disrupted by volcanic activity which began in July 1995. Prior to this date, Montserrat is an open and dependent micro-economy with limited economic activity which is the biggest threat to sustainable energy development. Above all, Montserrat dependency on the fossil fuel is the biggest obstacle for the long term economic growth. The combination of these challenges gives impetus for Montserrat to diversify its economy via a green economy that will pave a way for the long term economic stability while addressing environmental and social concerns in the country. Montserrat has adapted long-term plans for a transition to green economy. A major strategy is to replace fossil fuels with renewable energy (RE) sources as the fundamental energy source. Montserrat has substantial RE resources for the provision of energy services and production, yet these resources remain untapped. It is therefore crucial that the use of these abundant resources should be heightened. This paper examines and discusses the potential and current RE utilization and development in Montserrat from the perspective of sustainable development. The status of the different RE resources and their application/utilization, including details of existing projects in the country, are carefully explored and discussed. The possible impetuses for a huge advancement of RE applications and development in Montserrat are also discussed before explaining the major hurdles and challenges faced by the energy sector as regards RE. Measures and policies required to facilitate the utilization of RE in Montserrat are proposed. These evidence-based policies could guide the delivery of affordable and sustainable energy solutions for all by 2030 in Montserrat.

Keywords: renewable energy (RE); geothermal; solar; wind; biomass; energy policy; Montserrat.

1. Introduction

As the current financial, environmental and social challenges increase, the world's leading groups seek more undiscovered methods as a solution for this. Especially, developing countries, as they lack the social-economical means to implement known renewable energy business models. As such they most find new and innovative ways to achieve these goals. Such is the case of Montserrat. Montserrat is primed to become a major proving ground for the viability of renewable energy in the Caribbean region. Although it still has major issues to address, some of the key challenges in Montserrat are the high cost of electricity and generation peaked facilities. Also, the Montserrat electricity sector is dominated by fossil fuels, accounting for 100% of the country's power generation. In response to this, the government has made the international compromise to start the transition from a fossil fuel dependence economy to a renewable energy infrastructure by 2030 with a goal of 100% renewable sources in the generation of electricity. The aim of this paper is to provide the current situation and potential of RE utilization and development in Montserrat before explaining the impetuses and hurdles associated with development of RE applications in the country. The paper also provides a significant analysis of the policy instruments and measures that can effectively contribute to the tremendous growth of Renewable Energy Technologies (RETs) in Montserrat.

2. The State of Renewable Energy Technologies in Montserrat

RE resources are some of the most promising and important assets that can have a multiplier effect on the development of any nation. It is an eminent fact that the degree of industrialization is a function of the quantity of energy available and the extent to which that energy is utilized. Montserrat has substantial RE resources. These include geothermal, solar, wind, and biomass-based cogeneration. In total, the potential for commercial wind farms is estimated at 900 kW nominal capacities. In the last year, plans are also being developed for the integration of up to 1 MW solar photovoltaic system into the new power station in Brades. And the first phase of 250kw solar plant completed. Geothermal power has an estimated potential of generating 16 GWh per year in Montserrat, amounting to roughly 150% of the island’s annual energy demand. Government of Montserrat (GoM) and Departments for International Development (DFID) have undertaken several feasibility studies and drilled test production wells for further exploration of the resource and its viability.

Some of these RE resources have never been developed while others are not fully developed.

However, the diversification of the energy mix of Montserrat can help handle the present power situation in the country and meet a significant portion of its energy needs by increasing investment on other available RE resources. If the Geothermal, solar and wind potential, for instance, is proven to be sufficient for commercial on-grid generation, then these technologies can become an important large-scale diversification option for the country. Nevertheless, since energy is a vital element for economic growth, industrialization, rapid urbanization and improving the standard of living, there is an imperative need for the government to enhance the potential use of Montserrat’s enormous RE resources to avoid stumbling into energy supply crisis in the nearest future.

2.1. Geothermal Energy

Geothermal energy is renewable, sustainable, limitless, cheap, and eco- friendly energy source. GoM and DFID have already undertaken several surface level studies, economic appraisals and technical feasibility studies of potential geothermal reserves in Montserrat. The recent evidence base goes back to Jan 2010 (although there have been various reports going back well before then), when the results of a thorough surface level exploration were presented by EGS Inc. Between March and September of 2013, Montserrat's first two geothermal wells MON-1 and MON-2 were drilled to depths of 2,300 and 2,900 yards, striking temperatures of more than 260°C. While testing is still ongoing, the initial results suggest that the fluid flowing from the wells will be able to generate significant amounts of geothermal power.
The MON-1, MON-2 exploration wells successfully identified a production geothermal resource on the island of Montserrat. Based on preliminary tests either of the wells is capable of producing steam sufficient to generate approximately 2MWe. The evaluated output depends on generation technology and production/injection management but two productive wells represent a significant initial success for the Island's geothermal exploration program.

2.2. Solar Energy

Solar energy is the plentiful, easily obtainable and one of the safest form of the sustainable energy production systems. Solar energy technologies should be divided in three sets. Photovoltaic (PV) system produces electricity through direct conversion of solar radiation by using the semi-conductor material. Concentrating collectors use concentrating solar energy to heat a receiver, which is placed on the focus point of the collector, to reach high temperature, after that heat energy is transformed into mechanical energy by using turbine system and then into electricity. Solar heating and cooling systems use the solar thermal energy for heating and cooling of domestic water and building space. On the basis of the evidence currently available, it seems fair to suggest that solar thermal collectors have a significant potential in reducing the fossil energy consumption for heating and cooling applications. Efficiency and suitability of the solar energy systems are enormously dependent on the daily solar radiation and radiation flux. Due to its geographical location, Montserrat is one of the luckiest countries in terms of solar energy potential. The climate condition of the country gives great opportunities for production of electric and heat energy using solar power. Besides, involvement of Montserrat in application of the Photovoltaic Program (PVP) can partially solve its energy problems.
In the last year, plans are also being developed for the integration of up to 1 MW solar photovoltaic system into the new power station in Brades. And the first phase of 250kw solar plant has been finalized.

While this first phase of 250kw solar plant represents in excess of 10% peak demand renewable energy on the grid, what is even more impressive, is that in completing the 1MW plant with batteries, renewable energy on the grid will produce 40% of the power peak demand generated.

2.3. Wind Energy

Wind energy production is one of the fastest growing RE markets in the world today. The global cumulative installed wind energy capacity has increased progressively from 6100 MW in1996 to approximately 487GW in 2016, surpassing the previous year by 12.6%. It is thus anticipated that wind energy will play a vital role in the mitigation of future greenhouse gas emission. Presently, 90 countries use wind to produce energy. Among this number, about 49 countries have increased

their installed capacity between 2009 and 2016; 9 with more than 10,000 MW installed and 29 have made/passed the 1000 MW mark. Montserrat lies in the trade wind belt and has sites that have 12-15 mph wind speeds for most of the year. In the late 1980s and 1990s Montserrat Electricity Services Ltd (MONLEC) installed a 215-kilowatt (kW) demonstration wind project to utilize available wind. However, the small wind farm later suffered damage during a hurricane and volcanic activity on the island. In total, the potential for commercial wind farms is estimated at 900 kW nominal capacities.

2.4. Biomass energy

The biomass energy is organic material that have been derived from several sources such as wood, wood wastes, agricultural crops, animal wastes, food wastes, and aquatic plants etc. Due to its low cost, biomass energy is seen as a near term solution for energy crisis during transition to the renewable energy sources. Beside the direct combustion of biomass, there are cleaner ways to use biomass like gasification and pyrolysis methods. In order to use biomass source in a gasification process, biomass source should have a moisture content of 5–30%. There are two ways of gasification such as indirectly heated and directly heated gasification. Biomass sources can be also used in pyrolysis method to produce hydrogen and methane.
Montserrat can releases new opportunities for electricity generation from biomass that is derived from following bio substances:
Combustive industrial wastes;
Wastes of forestry and wood-working;
Agricultural and organic wastes;
Domestic and communal wastes;
Many countries have already found methods to solve these problems through the waste combustion plants that are built in densely populated areas in order to fire any kind of domestic wastes in those plants. The nearby residential settlements are then provided with electricity and heat at the expense of energy produced from waste combustion. The remains of fired wastes are widely used as a fertilizer to increase fertility of soil. Therefore, construction of such plants would be significant for Montserrat.

2.5. Hydrogen Energy

Hydrogen energy is not freely available in nature because it is attached to other compounds such as water and organic compounds. Thus, it is considered as an energy carrier not a principal energy source because it takes an effort to distinct the hydrogen from these compounds. It is used in areas such as thermal energy, transportation, electric power production, besides it is even used in portable devices in the form of liquid or gas. Additionally, hydrogen can be produced from both fossil energy and renewable energy sources. The vision to embrace various forms of renewal energy sources is reflected in the national energy policy, the power to change.

3. Impetuses for Renewable Energy Development in Montserrat

Aside from the advantage of having considerable RE resources for energy production and provision of energy services across the country, there are several other impetuses propelling the development of RE in Montserrat. These impetuses for investments in RE development are as discussed below.

3.1. Diesel grid cost parity

The price of electricity (July 2015) in Montserrat is around XCD 1.00 (USD 0.37) per kWh, which is among the highest in the Region. A significant portion of the cost can be attributed to the fuel surcharges of around XCD 0.50 (18.5 cents USD) per kWh, which – even in the current period of "low" global oil prices – constitute half of the charges. The importation of expensive diesel for power generation is causing high electricity bills and concomitantly, increases the overall cost of living to Montserratians and reduces the attraction of Montserrat to energy-intensive sectors. Under the existing energy situation, the paying of energy bills has been difficult and continues to divert funds from other needs related to maintaining the level of economic status on the microeconomic level whilst inhibiting the ability of the country to address its goal of growth and development on the macro-scale. RE has the potential to significantly reduce the cost of electricity generation.

3.2. Reduction of CO_2 Emission/Footprint

Energy is essential for development and human livelihood. However, the production of energy has been associated with the increase in atmospheric greenhouse gas emission (GHE) concentrations. Comprehensive details can be found in the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4). For example, the rapid rise in combustion of fossil fuel has produced a corresponding rapid growth in CO_2 emissions and RETs serve as one of the many options and combinations that are possible for the reduction of these emissions. Thus, the need for climate protection is one of the main factors that have supported the continued increase in the development of RE in Montserrat. Also, desertification is one of the aftermaths of the change in climate as driven by hasty greenhouse emissions. This is because most RETs produce no/low specific emission of CO_2 into the atmosphere relative to fossil fuels, thus making them valuable tools for addressing climate change. As a result, energy generation through different RETs will thus reduce the industrial carbon footmark and will also be a superb measure of decreasing the emission of CO2, thereby extenuating climate change across Montserrat. Montserrat is in full support of the reduction of carbon emissions. Despite its relatively small total carbon emissions relative to the world, Montserrat has a high emission per capita within the worst 20 countries in the world at 12. 98 tones per capita in 2011. Given such statistics, Montserrat intends to demonstrate climate leadership as an island to the rest of the world. Collectively, with other Caribbean nations, Montserrat intends to lead in support of climate mitigation. Moving forward towards 100 percent renewable energy will reduce the use of the high efficiency diesel generators and the total emissions the island contributes to global volumes. This positions Montserrat as a sounding board for effective global governance dialogue. This timing is strategic given the ratification of the Small Island Developing States (SIDS) Sustainable Energy and Climate Resilience Initiative (SIDS DOCK) Treaty on September 30th 2015 during the United Nations General Assembly in New York, USA. SIDS DOCK establishes all small island nations in solidarity against the impacts of anthropogenic climate change and mobilizes actions towards renewable energy.

3.3. Energy Sector Reforms

The endorsement of the energy policy (power to change) by the GoM in 2016 made provision for the introduction of diversification in the nation's energy mix. The reform program aimed at providing a sufficient, consistent, and cost-effective power supply to meet the country's demand, promoting the efficient operation of the power sector. This has led to the implementation of

major structural change in the sector. The energy policy also made way for the establishment of a renewable energy policy (REP) which aims to increase the use of modern RE in the energy mix of the country.
In general, these reforms have resulted in the deployment of considerable private resources for investments, amendment in power-systems planning, and increase in levels of expertise and financial transparency in the sector. RETs will thus play a vital role in attaining these plans in both on-grid and off-grid systems owing to the enormous energy resources in the country.

3.4. The Need for Employment Generation

Promoting RETs across Montserrat will play a vital role in the reduction of poverty as local communities will benefit from employment opportunities, skill acquisition, investment opportunities and technology transfer. Several RE preliminary projects in the least developed countries, such as Montserrat, provide subjective evidence of the roles played by RETs in energy-poor communities. Consequently, an increased investment in RE applications and technologies will lead to the development of indigenous expertise in installations, repairs, and local manufacturing of the different RE components/devices across the rural communities, off-grid communities, and the whole country at large, therefore, leading to the massive generation of employments.

3.5. Economic Impact

Currently, RETs are considered not only as means for improving energy security and mitigating and adjusting to climate change but are also gradually recognized as investments that can offer direct and indirect economic intrinsic worth by cutting down the reliance on imported fuels, improving the quality of local air and safety, increasing energy access and security, creating jobs, and driving economic development. The remarkable growth in RE markets and their wide spread globally has also guided the significant growth of its manufacturers, scale of production, and job creation in term of installations and servicing of RETs such as solar PV and wind energy industries.
For Montserrat the overarching strategic challenge is to accelerate economic development, reduce and eventually eliminate economic dependency on the UK. Major spikes in oil prices can cause severe economic stress for countries like Montserrat since the economy is 100% fossil fuel based. High energy prices on the island– diesel import prices are amongst the highest in the world – are a powerful brake on economic growth. GoM recognizes the challenges it faces in the energy sector, and in the 2008 – 2027 Energy Sector Policy states that its over-dependence on fossil fuels is economically and environmentally unsound. It must reduce its dependence on fossil fuel energy sources to increase its resilience to changes in world fuel prices. Current peak demand on Montserrat in the last few years has been 2 MW although this has fallen recently to 1.7 MW as a result of the increasing electricity costs due to fuel price increases. This has forced people to cut back on their energy use and presents a serious impediment to any private sector activity. Renewable energy has the potential to transform Montserrat's economy by significantly reducing the cost of electricity generation and move Montserrat towards financial self-sufficiency.

3.6. Energy Efficiency

EE is an initiative designed to ensure economical use of energy in all sectors of the economy: i.e., the use of less energy to provide the same amount of service or useful output. RETs tend to

have a greater visibility than EE programs. However, one of the advantages of adopting RE is the resultant increase in the awareness of energy production and consumption in the owner of the installation and also repeatedly with the public who possibly can see or interact with the technology. A good example is the public awareness of RE rose when a solar PV or solar water heating panels is installed on a public building.

For the case of Montserrat in general, approximately 10,780 MWh of electricity is utilized annually by the end users. This is an energy use of around 2.15 MWh per person. This represents about 45% of the total fossil fuel based usage over the year, with the remainder being used for travel and cooking. So in round figures it might be assumed that Montserrat uses (in total) about 4.81 MWh per person per year. If Energy Efficiency is calculated as units of energy per unit of GDP, The United Nations indicates that Montserrat's 2013 Gross Domestic Product (GDP) was $US 11,565. So the Energy Efficiency is 384 W which is very low, compares with the highest Energy efficiency Caribbean countries of the Bahamas (615 W) and Trinidad and Tobago (614 W) respectively. The National Energy Policy (NEP) of Montserrat was drafted in 2008 for the period until 2027. This NEP already suggested the advancement of renewable energy and energy efficiency development. The importance of EE standards as a policy objective can be linked to commercial and industrial competitiveness, energy security benefits, and increased environmental benefits (such as reduction of carbon dioxide emissions). Generally, improved EE leads to reduction in operation costs in most businesses, thus allowing "energy efficient" companies to gain advantage over those that are not energy efficient.

4. Major Hurdles and Challenges of Renewable Energy Development in Montserrat

In order for the GoM to meet with its commitment to achieving the energy needs of its people and promote RE in the national energy mix, a number of hurdles will have to be addressed. The following are thus considered as the hurdles and challenges that may prevent the steady growth of RE development and its utilization in Montserrat.

4.1. Huge Initial Investment Cost

A critical barrier to the development of RE technology in Montserrat resides in the high initial investment and installation costs of RE equipment. Also, there are little or no incentives for local manufacturing or importation of RE technology such as solar devices in Montserrat. Like most RETs, solar and wind are exceedingly cheap to operate—their "fuel" is free, and maintenance is minimal—so the bulk of the expense comes from building the technology.

Even more encouragingly, renewable energy capital costs have fallen dramatically since the early 2000s, and will likely continue to do so. For example: between 2006 and 2016, the average value of photovoltaic modules themselves plummeted from $3.50/watt to $0.72/watt—an 80 percent decrease in only 10 years.

4.2. Lack of Information and Public Awareness

The lack of public awareness has been known to be a main hurdle in the utilization of RETs in many countries. The most common issues associated with this are inadequate knowledge regarding the use, importance, socio-economic and environmental benefits that are derivable from RE and its technologies, and the fears in relation to the economic feasibility of RE installation projects. Because RETs are relatively new in Montserrat, a large number of the

public sector knows nothing or little about them. Also, the public sector is not provided with adequate and sufficient training required to make informed choices (i.e., there is a deficiency of technical information). The absence of vital information and proper awareness has generated a disparity in the RE technology market that has given rise to a higher risk perception for potential RE prospects. However, the accessibility of such vital data could increase investors' interest and thus RE project development.

4.3. Inadequate Attention to Research and Development

Presently, the GoM has not given proper attention to research and development in the subject area. There is a lack of focus on research and development in the RE, and there is not any visible plan/budget provided to universities and institutions of higher learning to precisely conduct research on RETs. That is, there is no well pronounced RE research and development program that is supported with modest funding. Also, no working systems have been put in place for quality international research and development collaborations that can easily accelerate transferable skills and technologies. The negligence of this overall technically supportive environment has slowed down the development of most RET projects. As a result, domestic technical knowledge concerning these products is inadequate and, as such, related technologies are imported at very high cost. However, with an indigenous skilled and averaged-skilled workforce, a sustainable RE industry in Montserrat can be easily achieved.

4.4. Lack of Human Capacity & Training

Developing a skilled workforce to operate and maintain RET equipment is essential for a successful deployment and development of RE projects in Montserrat. The development of RE calls for skills in different fields that may include physics, materials science, chemical, mechanical, and electrical engineering, business management and social science. Nonetheless, the different groups need precise training, since the set of skills may vary in detail for the different technologies. It is also essential that RE technology users understand the availability and explicit operational features of RE sources.

Generally, in most of the least-developed countries, the lack of such an auxiliary industry usually results in higher cost of RE projects and further barriers to deployment. Presently, in Montserrat, there are limited trained personnel and training facilities for the installation, operation, and maintenance of RETs which make it very difficult for the country to achieve a sustainable RE market.

4.5. Institutional Barriers

The institutional structure of the energy sector in low-income/less-developed country such as Montserrat is still under government monopoly, with the responsibility for energy generation and distribution allocated among a number of government departments. However, insufficient coordination due to an array of government bodies with energy authority and the limitation of institutional capacity constituent critical institutional hindrances to the production of RETs in Montserrat. This in turn creates an unsteady macro-economic environment which increases risks and dampens investments. This barrier exists not only because Montserrat is still a low-income/less-developed country, but also as a result of the inadequate attention of the government to R&D and the government's failure to facilitate science activities while improving human resources. In addition, there are no regional or national research centers with the required basic research facilities and infrastructures for RETs. Furthermore, the GoM needs to realize that, at

the institutional level, the centralized energy model is becoming increasingly redundant in developed nations. Instead of expanding its centralized power systems, Montserrat needs to focus more on the development of a decentralized energy structure that would better match its current capital resources and management ability. This will help position the country to adapt to future energy technologies and systems.

5. Efficient Measures and Policies Required in Overcoming the Hurdles to Renewable Energy Development in Montserrat

To prevail over the aforementioned hurdles and hasten the development of RE applications in Montserrat, there is a need for the GoM to introduce favorable policies at different levels of the government.

These policy frameworks are basic premises needed by the GoM to apply, extend and assess its policies and succeeding actions that may include legislation, enforcement, decision-making etc. This will effectively tackle major RE concerns that are captured in the policy framework and others which are not. The following efficient measures and policies are thereby suggested, in order to accelerate RE development in Montserrat.

5.1. Alleviation of Political and Regulatory Investment Risk

Investment risk can be traceable to several factors, but the most prominent one is political and regulatory risk. This displays a major restriction on investment decisions and it is regarded as the utmost deterrent for any investments into emerging markets, such as RE. It is as a result of this risk that some investors, even when looking for investment opportunities urgently, will simply not put into consideration an RE infrastructure asset in an emerging and developing nation. Certainly, a refined system of regulation is beneficial to the society, and RE infrastructure investors mostly do not have any problem with them. Instead, their concern is always about the unexpected changes in the laws and regulation. For instance, how the political and regulatory risk that takes place relates predominantly to RE infrastructure investments. As a result of this discrepancy between political and RE infrastructure sequences, RE infrastructure investors are reasonably guarded. They desire to be quite sure not only that the existing government meets its obligations but also that the decision of a future legislature or RE management will not impinge on their investment in a severe manner. This implies that the RE sector of Montserrat will clearly need thoughtful regulation that can avert the abuse of pricing power.

Furthermore, by taking into consideration the significance of RE development in Montserrat, the government should possibly establish a particular body that will be responsible for the management of all the activities related to RE projects across the country. This will be of great assistance in streamlining the urgent but important needs in the RE sector as it is in some developed countries. As such, enforcing reputable laws are also necessary steps required to decrease the basic hindrances of the political and regulatory risk in Montserrat. The enhancement of vital reform processes in social, political, economic planning can help manage corrupt practices while establishing transparency ethics in the public administration.

5.2. Cost Reduction Measures

It would be a courageous and crucial step for the GoM to consider subsidizing RETs. Another challenge is that there is inadequate funding for RE projects in Montserrat, particularly for small-scale projects. Part of this complication comes from a lack of awareness as regards RETs, and

ambiguity regarding the consistency of energy resource assessments. Moreover, the capital cost of RETs is somewhat high and this discourages funding agencies.
The GoM can make available economic incentives that include tariff waivers, subsidies etc. to promote investments in energy through RE sources. These will hasten the development of RE in Montserrat, particularly solar energy. Thus, the establishment of incentives for households and communities to install small-scale RE systems in their propinquity will be a long-term solution.

5.3. Favorable Feed-in-Tariffs Policies

To achieve a smooth process of renewable energy feed-in-tariffs (REFITs), the government would need to appoint skilled personnel that will be responsible for the handling of the process. This is because favorable policies are primary requirements for the long-term sustainability of RE development. Thus, making sure that laws are established and obligatory is very important as prospective investors will need realistic assurance that the legislative necessities put in place for RE activities will remain steady, explicit and enforced, thereby promoting future stability of investment. This will persuade potential stakeholders to invest in RE applications.
Nevertheless, REFITs in Montserrat can also be a valuable policy means of increasing RE technology deployment, just as FiTs have been lucratively engaged in several developed and developing countries. The implementation of REFITs will be an important policy mechanism that can be used to boost the deployment of RETs and improve affordability. It also assures payment to RE investors at a set price for electricity production over a period of 15 to 20 years. These tariff charges can be predetermined based on the cost of power generation of specific technologies but usually reduced over time.

5.4. Consistent Information and Technology Awareness Creation

The implementation of large-scale RE applications can only be embarked upon successfully if there is an improved understanding and support of the public. Hence, an increased awareness of the prospect and advantages associated with the development of RETs, and the fundamental advantage for climate change alleviation is quite important to swiftly and appreciably enhance the desire and interest among the Montserrat populace. Primarily, a centralized data-based information center that is both comprehensive and accessible to the public needs to be established. This center will be expected to keep records of the various fields experience acquired during the installation, operation and maintenance of RE technology systems and make available information that is related to RE incentives, RETs, RE policies and the utilization of RETs systems for small-scale investors. Such information can act as an important tool for learning and thereby allowing RE contractors to expand and adapt RETs for particular environmental conditions. This center will not only serve a means of assessing resources, but also as a monitoring and evaluation means. Thus, with proper management of the center, there will be increase in general awareness, reception and interest in RETs. It is therefore clear that an increased access to RE technology-related information and technology is crucial to the successful development of RE projects in Montserrat.

6. Conclusions

Montserrat has been struggling to unravel its energy deficiency problems for years now. With the nation faced with an unprecedented energy crisis, the urge to secure efficient long-term solutions to its energy needs is getting stronger by the day. RE resources such as geothermal solar, wind,

biomass, hydro etc. are abundant in Montserrat and they exhibit significant practical potential to meet the nation's energy needs.

Nevertheless, the development of RE projects is hampered by impediments that include informational, economic, institutional, social, and technical hurdles. The Power to Change, Montserrat Energy Policy 2016 - 2030 reinforced the commitment of the GoM to take important steps toward uplifting RE technology deployment. In this paper, we have presented the review of the potential of RE utilization and development in the country. The current status of the RETs has been reviewed and the present RE related policy instruments and measures have also been analyzed. The hurdles and challenges associated with the development of RE applications have been discussed and significant policies required to overcome the identified hurdles and challenges are suggested for the future growth of RE technology in Montserrat.

In our view, we suggest that the Montserrat government should take bold steps towards reforming and implementing its RE policy with the intention of increasing energy security and moving the country towards a sustainable energy future. Obviously, increasing the keenness of RETs only is not enough; disputes such as poor infrastructure, absence of assess to appropriate funding and technology also have to be dealt with. Accordingly, the direction towards a sustainable energy future in Montserrat is in no way simple, yet at the same time a solution definitely exists. Regardless of the numbers of approaches that may have been presented in this study to foster the growth of RE in Montserrat, these solutions will certainly require significant efforts and dedication on the part of the Montserrat government. Montserrat should therefore consider the long-term benefits (economic, environmental, and social) of RE power generation for its citizens. Montserrat's investment on sustainable energy technologies today will thus lead to a secure energy future for tomorrow.

References

Ministry of Communications, Works, Energy & Labour. (2016). *The Montserrat Energy Policy 2016 – 2030.* Available online: http://www.gov.ms/wp-content/uploads/2016/02/The-Power-to-Change-MNEP-Cabinet-Approved.pdf (accessed on 20 July 2019).

Istituto Afari Internazionali (IAI); European Centre for Development Policy Management (ECDPM). A New EU Strategic Approach to Global Development, Resilience and Sustainability; IAI Working Papers 16 (14); IAI: Rome, Italy, May 2016; ISSN 2280-4331. ISBN 978-88-98650-94-1.

UN Africa-Sustainable Development Knowledge Platform "Implementation of the United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa: Report of the Second Committee" (A/70/472/Add.5), 14 December 2015. Available online: http://www.un.org/ga/search/view_doc.asp?symbol=A/70/472/Add.5&Lang=E (accessed on 12 March 2019).

UN General Assembly, Transforming Our World: The 2030 Agenda for Sustainable Development (A/RES/70/1). 25 September 2015. Available online: http://undocs.org/A/RES/70/1 (accessed on 12 June 2019).

Emodi, N.V.; Boo, K. Sustainable Energy Development in Nigeria: Overcoming Energy Poverty. Int. J. Energy Econ. Policy **2015**, 5, 580–597.

Transition to Renewable Energy and Sustainable Energy Development in Azerbaijan. Cihan Bulut, Elchin Suleymanov, Nurtac Vidadili. December 2017. Available online: https://www.sciencedirect.com/science/article/pii/S1364032117308043?via%3Dihub (Accesed on 17 July 2019)

Barriers to Renewable Energy Technologies. Available online: https://www.ucsusa.org/clean-energy/renewable-energy/barriers-to-renewable-energy (Accessed on 17 july 2019)

Minister of Coms & Works Paul Lewis speaks at Solar Energy handover1. Available online: https://www.themontserratreporter.com/wp-content/uploads/2019/04/Minister-of-Coms-Works-Paul-Lewis-speaks-at-Solar-Energy-handover1-2.pdf (Accesesd on 17 July 2019)

A small island sits on a vast geothermal resource, but can't exploit it. Here's why. Ralph Birkhoff. Available online: https://www.renewableenergyworld.com/articles/print/volume-19/issue-10/features/geothermal/montserrat-a-geothermal-economic-exclusion-zone.html (Accesesd on 5 July 2019)

Colombo, E.; Masera, D.; Bologna, S. Renewable energies to promote local development. In Renewable Energy for Unleashing Sustainable Development; Springer: Cham, Switzerland, 2013; pp. 3–25.

Kihwele, S.; Hur, K.; Kyaruzi, A. Visions, scenarios and action plans towards next generation Tanzania

Kiplagat, J.K.; Wang, R.Z.; Li, T.X. Renewable energy in Kenya: Resource potential and status of exploitation. Renew. Sustain. Energy Rev. **2011**, 15, 2960–2973.

Dabiri, J.O.; Greer, J.R.; Koseff, J.R.; Moin, P.; Peng, J. A new approach to wind energy: Opportunities and challenges. In Proceedings of the AIP Conference Proceedings, Berkeley, CA, USA, 8–9 March 2014; Volume 1652, pp. 51–57.

Sathaye, J.; Lucon, O.; Rahman, A.; Christensen, J.; Denton, F.; Fujino, J.; Heath, G.; Mirza, M.; Rudnick, H.; Schlaepfer, A.; et al. Renewable Energy in the Context of Sustainable Development; Cambridge University Press: Cambridge, UK, 2011.

Twidell, J.;Weir, T. Renewable Energy Resources; Routledge: Abingdon, UK, 2015.

Karekezi, S.; Kithyoma, W.; Initiative, E. Renewable Energy Development. In Proceedings of the Workshop on African Energy Experts on Operationalizing the NEPAD Energy Initiative, Dakar, Senegal, 2–4 June 2003; pp. 2–4.

Karekezi, S.; Kithyoma, W. Renewable energy strategies for rural Africa: Is a PV-led renewable energy strategy the right approach for providing modern energy to the rural poor of sub-Saharan Africa? Energy Policy **2002**, 30, 1071–1086

Ahuja, D.; Tatsutani, M. Sustainable energy for developing countries. 2009. Available online: http://journals.openedition.org/sapiens/823 (accessed on 6 May 2018).

Vaughan, E.J.; Vaughan, T. Fundamentals of Risk and Insurance; John Wiley & Sons: Hoboken, NJ, USA, 2007.

COMSATS. Renewable Energy Technologies and Sustainable Development. Islamabad: Commission on Science and Technology for Sustainable Development in the South; COMSATS: Islamabad, Pakistan, 2005.

Economic and Industrial Publications. The Free Library, Cost and Benefit of Oil Subsidy. 2008. Available online: http://www.thefreelibrary.com/Cost+and+benefit+of+oil+subsidy.-a0185951419 (accessed on 10 July 2017).

Mendonça, M.; Jacobs, D. Feed-in Tariffs Go Global: Policy in Practice. Renew. Energy World Int. Mag. **2009**, 12, 1–6.

DeMartino, S.; Le Blanc, D. Estimating the Amount of a Global Feed-In Tariff ; DESA Working Paper; United Nations Department of Economic and Social Affairs: New York, NY, USA, 2010.