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Exploring the Economic and Environmental Benefits of Solar Energy Generation in Developing Countries: The Nigerian Perspective

Michael D. Oisamoje[1*] Esther Eguono Oisamoje[2]
1. Department of Business Administration, Benson Idahosa University,Benin City, Nigeria
2. Legal Department, Dadev Ventures Nigeria Limited, Benin City, Nigeria
* E-mail of the corresponding author: mikeoisamoje@yahoo.com

Abstract
Fossil fuels are the main sources that are being used to produce energy today. They are not only fast depleting but they are also polluting the environment, and affecting the economic stability of many countries. While renewable energy has been spoken about for more than three decades, fossil fuels have increased in use and reduced in supply. Although some gains have been made in the quest for alternative energy sources, there is an urgent need for a switch to renewable energy sources in time enough to avoid significant and permanent environmental and climatic changes Solar energy source of generating electricity among others represents a new opportunity that promises a clean and environmentally friendly and economic energy production for developing countries in tropical regions. This paper examines the economic and environmental benefits of solar energy generation in Nigeria, and also evaluates the economic and environmental viability of the sun's potential to generate electricity power for majority of the residents of Nigeria.
Keywords: alternative energy, economic stability, environmental viability, fossil fuels, renewable energy, solar energy

1. Introduction

Since the oil embargo in 1973, oil prices have persistently skyrocketed to levels that have threatened the economy of many countries. The quest to develop a cheaper and non-polluting source of energy has been on the front burner of the agenda of several countries. Ever since the 1973 crisis, the study of renewable energy sources has been of universal concern to the world, and has led many institutions and organizations like the European Commission and others to undertake research on sustainable approach to meet the challenges of sustainable energy generation.

From the onset, it is important to remark that the five renewable energy sources used most often are: Biomass (including wood and wood waste, municipal solid waste, landfill gas and biogas, ethanol and biodiesel), Water (hydropower), Geothermal, Wind and Solar and other sources of energy that are obtained from sun energy and that are renewed indefinitely as a course of nature. Unlike fossil fuels which are exhaustible, renewable energy sources regenerate and can be sustained (Wieman 2011; Energy Information Administration 2012, The World Summit on Sustainable Development 2002). In 2011, consumption of renewable sources in the United States totaled about 9 quadrillion Btu (9,000,000,000,000,000 Btu) or about 9 percent of all energy used nationally. About 13 percent of U.S. electricity was generated from renewable sources in 2011 (Energy Information Administration 2011).

In the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC), it was projected that without further action to reduce greenhouse gas emissions, the global average surface temperature is likely to rise further by 1.8 to 4.0°C this century, and by up to 6.4°C in the worst case scenario (IPCC 2007). The projected global warming this century is likely to trigger serious consequences for mankind and other life forms, including a rise in sea levels of between 19 and 59 cm which will endanger coastal areas and small islands coupled with a greater frequency and severity of extreme weather events. As a result, beginning with the 1972 Stockholm Declaration of the United Nations Conference on the Human Environment (Sohn 1972), international agreements came to reflect a desire to limit damages to the environment. These international agreements paralleled national legislations which increasingly sought to preserve the environment. Therefore, the international response to climate change was launched in 1992, at the Earth Summits in Rio de Janerio, with the signing of the U.N Framework Convention on Climate Change – UNFCCC, (United Nations 1992). The UNFCCC has identified the adverse effects of climate change as those "changes in the physical environment or biota that result from climate change which have significant deleterious effects on the composition, resilience or productivity of natural and managed ecosystems or on the operation of socio-economic systems or on human health and welfare" (p.3) (Enete 2001).

The Convention established a long-term objective of stabilizing greenhouse concentrations in the atmosphere to a level that should prevent dangerous anthropogenic interference with the climatic system. The target of reducing

emissions from developed countries was not achieved and in 1997, the Kyoto Protocol was negotiated. The Kyoto Protocol is an amendment to the international treaty signed in 1992 on climate change, assigning mandatory emission limitations for the greenhouse gas emissions to the signatory nations (American Society of International Law 2013). Under the Kyoto Protocol, parties agreed to reduce the four greenhouse gases (GHGs), that is: carbon dioxide, nitrous oxide, sulphur hexafluoride and methane, as well as hydroflurocarbons and perflurocarbons produced by them. It is important to observe that Nigeria is a party to the UNFCCC and that she has ratified the Kyoto Protocol. Never the less, as a developing country, Nigeria presently has no quantitative commitments under the Kyoto Protocol. However, together with all other countries, Nigeria is already committed under the UNFCCC to formulate, implement, publish and regularly update national and, where appropriate, regional programs containing measures to mitigate climate change by addressing anthropogenic emissions by source and removal of all greenhouse gases.

In view of the above, renewable energy is a viable alternative for GHG emitting sources of energy. Renewable energy is a clean energy system that has no effect on the environment during or after generation. This fact has led to the drive by nations to strive towards the use and continuous improvement on solar energy as an appropriate approach and strategy to reduce greenhouse effect in the future. This scenario has also helped developed and developing countries to take full advantage of this free gift of nature to promote ecological and social innovation that will ensure more sustainable economy growth, conservation of the environment and stability of the social system.

A critical challenge that continues to constrain the advancement of many developing countries is the prevalence of poverty. In spite of abundant solar energy, most developing nations lack stable power supply. This is due to low technological advancement, pervasiveness of poverty, pitiable corporate governance culture, and poor management of existence facilities. It is widely acknowledged that access to electricity is an essential ingredient for the growth and development of any nation's economy. It is also regarded as a vital requirement for modern economic and social development. These assertions stem from the fact that electricity opens the door to a host of technologies that promote quality education, enhanced public health, and economic development. These technologies include emissions-free light, refrigeration and communication devices. Without electricity, communities are unable to participate in the benefits of modern advances and are left isolated and literally in the dark.

The development of Nigeria's power sector is presently seriously challenged by many inhibiting factors. Corruption, unhealthy politics and corporate mismanagement are only constituents of the basket of challenges. A greater proportion of the power generated in the country is hydrocarbon-driven. It may be recalled that Nigeria is heavily endowed with the hydrocarbon-based petroleum oil, and has had half a century's experience with the use of this commodity. With the benefits of hindsight however, it appears that this natural endowment has become a kind of curse rather than the blessing it is expected to have been. As Oisamoje (2012) reveals, there has been phenomenon destruction of the eco-system arising from the effects of oil-related pollution of the environment (air, land and water inclusive). The restiveness in the Niger Delta is, to a very great extent, a result of the perception by many that they have not benefited sufficiently from this natural resource. In addition to the wanton mismanagement and waste of the huge resources that accrued from the export of the oil, there was also skewed growth of the oil sector in relation to all the other sectors put together. It is not surprising therefore that this whole scenario deleteriously affected the country's overall development. In order to address many of the problems mentioned above, the use of renewable energy sources is an alternative that the country could consider.

This paper posits that the adoption and the utilization of solar energy would be an important launching pad for the growth and development of any nation in the medium and long terms. It recognizes the huge potential benefits inherent in the use of this renewable energy and advocates that nations like Nigeria that have adequate sunshine should pursue with vigour, all efforts required to remove constraints that militate against the adoption and effective utilizations of this source of energy.

The next section of this paper examines Nigeria's energy demand and supply, as well as the potentials for the use of renewable energy, especially solar power. Section three looks at the economic and the environmental factors that influence the use of solar energy, while section four critically analyses the socioeconomic and environmental benefits of the use of solar energy. Section five concludes and makes recommendations.

2. The Nigerian Case Study

Following the facts given in the foregoing, and as a consequence of the gamut of challenges besetting the country's power sector, Nigeria certainly presents a clear case where the adoption and utilization of renewable energy sources should be given premium. In view of these considerations, this section reviews the demand and supply dynamics within the country's energy sector, and examines the potentials for the application of renewable energy, especially solar power, within the nation's power sector.

2.1 Energy Demand and Supply

Nigeria is a country in West Africa with rich energy resources such as petroleum natural gas, coal, tar sand, and biomass. Its economy is majorly dependent of revenue accruing from oil production and export. Also, Nigeria relies heavily on fossil fuel to meet her energy needs. For instance in Nigeria, electricity produced from fossil fuel and hydro power account for 61.9 percent and 38.1 percent, respectively. From a financial viewpoint therefore, and since Nigeria is endowed with massive fossil fuel reserves, and also since the majority of the power generating systems in Nigeria rely on petroleum products, it is very likely that the use of fossil fuels will remain an attractive source of energy for Nigeria for a long time to come. The nation should however recognize that the emissions of greenhouse gases from the use of fossil fuels such as coal and petroleum products has led to increasing concerns worldwide, about global climate change. While Nigeria is well endowed with renewable energy resources that can be sustainable alternatives to fossil fuels, so far, these have remained largely untapped. The Nigerian government has the potential to strengthen the role of renewable energy as a cornerstone for energy generation (Energy Information Administration 2007; Oji *et al.* 2012).

Electric power is the most widely used form of power in the industrialized countries. However, the situation in developing countries is different. People are struggling to receive enough power even for their basic needs. It is believed that Nigeria has problems with her power sector, which operates well below its estimated capacity. It is also estimated that about 20 percent of the total electricity generated by the Power Holding Company of Nigeria (PHCN) is lost through transmission and distribution before reaching the customers, and that as a result of the inadequate electricity supply, Nigeria is losing around $600 million a year (Lawal 2007). In order to compensate for power shortages, the commercial and industrial sectors are using privately operated diesel generators to supply electricity that they need. Only about 40 percent of people in Nigeria have access to electricity, and the majority of them are living in urban areas (Komolafe *et al.* 2003; Lloyd 2007).

The Nigerian commercial demand for energy is projected to continue its upward trend from 1,273 gigawatt hour (GWh) in 1970, it increased to 13,700 (GWh) in 2001. This consumption growth is mainly driven by industrialization. As it is a common perception that a nation's economy and use of energy will always grow hand-in-hand. The Nigerian government has included renewable energy in the country's energy supply mix (portfolio) to diversify its energy source. In 2006, total energy consumption for Nigeria was approximately one quadrillion Btu. According to the2004 Annual Report of the EIA, the country's energy consumption mix is made up of 53 percent oil, followed by 39 percent natural gas, and 7 percent hydroelectricity. Coal, nuclear and other renewable energy sources are currently insignificant part of Nigeria's energy consumption mix. This however excludes biomass which is often used to meet rural heating and cooking needs (Uwakonye *et al.* 2006).

It is recognized that energy is central to all human activities and that it is needed to support development. Access to energy is inevitable for poverty alleviation, and if Nigeria is to achieve development targets and meets the millennium development goals (MDGs). The National energy supply is at present almost entirely dependent on conventional energy sources, which are depleting fast. Accordingly, recent estimates indicate that the reserve for crude oil stood at 23 billion barrels in 1998, natural gas 4293 m3 at the beginning of 1999, was made up of 53 percent associated gas and 47 percent non associate gas. Coal and lignite stood at 2.7 billion tones, tar sand at 31 billion barrels of oil equivalent and a large-scale hydropower at 10,000MW (Lawal 2007).

In relation to production, by 2006, the total Nigeria's oil production was around 2.45 million bbl/d but the government with the help of new projects is willing to increase it to 4 million bbl/d by 2010. The Oil and Gas Journal (OGL) stated that Nigeria's proven reserves of oil in January 2007 accounted for 36.2 billion barrels and it is likely to expand to 40 billion barrels by 2010 (Sambo 2005).

2.2 Potential for Solar Energy in Nigeria

Photovoltaic, or "PV" solar panels and other devices capture the energy in sunlight and convert it to electricity produce solar power. This electricity can then be fed directly to a consumer, an electric power grid, or a storage device. Typically, solar panels are installed on the roof of residential or domestic buildings, and use the power generated to meet the owner's energy needs and provide surplus electricity to the grid. Other applications include heating water and providing power in areas where electricity connections are not available.

Nigeria has several advantages for the development of a solar energy industry. Nigeria lies between a high sunshine belt and thus has enormous solar potentials. The nation is endowed with an annual average daily sunshine of 6.25 hours, ranging between about 2.5 hours at the coastal areas and 9.0 hours at the far northern boundary (Solar Energy International 2011). Similarly, Nigeria has an annual average daily solar radiation of about 5.25 KW/ m^2/day. This varies between about 3.5KW/m^2 /day at the coastal areas and 7.0KW/ m^2/day at the northern boundary. The country receives about 4.851*1012KWh of energy per day from the sun. This is equivalent to about 1.082 million tonnes of oil equivalent per day (Odetunde 2008) while domestic consumption of oil is 297 thousand barrels per day (Oliver 2007) and about 13 thousand times that of natural gas daily production based on energy unit. This huge energy resource from the sun is available for about 26% only of the day.

Based on the land area of 924 * 103km2 for the country and an average of 5.535 kWh/m2/day, Nigeria has an average of 1.804 * 1015kWh of incident solar energy annually. This annual solar energy insulation value is about 27 times the national total conventional energy resources in energy units and is over 117,000 times the amount of electric power generated in the county (Ajayi 2009).

From the foregoing, it can be estimated that only about 3.7 percent of the national land area is needed to be utilized in order to annually collect from the sun an amount of energy equal to the nation's conventional energy reserve. Nevertheless, Nigeria needs to generate fourteen to fifteen gigawatts of power but as at march 2008, it only had the capacity to generate four gigawatts of electricity. Knowing that Nigeria has an annual average daily solar radiation of about 5.25 kWh/m2/day, and average sunshine hours all over the country of about 6.5 hours (Chineke *et al.* 2008). Some amount of certainty has been created suggesting that implementing a solar strategy is a great opportunity to implement infrastructure in previously difficult areas.

3. The Environmental and Economic Importance of Solar Energy

Solar energy is both environmentally and economically important to every nation. Hence it plays a key role in cost effectiveness of any nation's economy. It also creates among other benefits, direct employment of labor and fosters the development of micro- industries. Economic considerations appear to be the most important factor that drive the process of the generation of solar energy systems. Factors other than economic that are considered when deciding whether or not to use solar energy include issues of pollution, greenhouse gas generation and the security of the energy resources, among others. The cost of energy produced however appears to almost exclusively dominate design decisions. Environmental factors are however also becoming increasingly significant in such decision making procedures.

3.1 The Economic Perspective

The economical benefits of the application of solar energy are as follows:

- It helps to extend the productive work-day.
- It provides a constant and superior lighting at minimum cost compared with other energy generators or the use of power from the public system.
- Solar energy helps to create enhanced direct and indirect employment opportunities.
- Solar energy assists in conserving the nation's foreign exchange. This is because some of the earnings from export which would otherwise have been spent on importation of various spare parts of power generators would then be saved. Moreover, the money so saved can be deployed to other sectors like health and education that require attention.
- Despite the challenges of power shortages and sometimes complete unavailability of same, micro-enterprises have still survived. Hence, the use of solar energy would encourage the growth and development of the micro-enterprises in the country.

It may be added that solar energy is environmentally friendly. This is because the energy produced by the system is very clean. Besides, when compared with the economic indices of other power generating systems of similar capacity averaged over the lifetime of such systems, the economic parameters of the solar energy system is superior per unit of power produced. For this reason solar energy systems should be financially supported by the government and industrialist in order to reduce the cost of implementing the solar panel for industrial, commercial as well as residential consumers.

Abundant Supply: Solar power could meet today's electricity demand by PV systems covering only 0.4 percent of the nation in a high sunlight area such as the Southwest – an area about 100 square miles. These panels, in reality, will be installed across the country on roofs and other structures close where it is consumed. Technologies such as PV roof shingles, windows, and flexible fabrics that are easily and cheaply integrated in to new and existing buildings are emerging.

Secure and Stable Supply: Because solar power is generated domestically, often at the site where it will be consumed, prices and supplies are immune to blackouts, international uncertainty and do not rely on long-distance supply networks.

Cleaner Air: Solar power does not pollute air or water. It replaces electricity generated from facilities powered by coal, natural gas and other non-renewable fuels, eliminating threats to public health such as carbon monoxide, particulate, and toxic chemical emissions from those facilities. Additionally, when a solar power replaces electricity from coal-fired power plant, it also eliminates a potential source of sulfur emissions that is a major component of acid rain.

Reducing Global Warming: Solar power does not produce CO2 or any other greenhouse gases, thus helping to reduce the risk of climate change.

3.2 The Environmental Perspective

In this part of the paper, the economical impact of the fossil fuels will be examined. Also, the environmental

advantages and disadvantages of the solar energy will be discussed.

Fossil fuels impact on the environment: The largest disadvantage of the fossil fuels is the emission of carbon dioxide to the atmosphere, which creates the "greenhouse effect". Also, this type of energy not only affects the degradation and deforestation of land but as well water, air pollution, human illness and accumulation of solid waste. Those factors contribute to the current issue of the global warming, formation of the smog, endangerment of the flora, fauna and marine life, and others (Greenhalgh 2002). Furthermore, burning coal produces sulphur dioxide that contributes to the formation of the acid rain. The open mining coals, so called "strip mining", harms the environment by destroying quite large areas of the landscape (Siikamäki 2012; Energy resources 2012).

Environmental Benefits of solar energy: As solar energy is produced purely from the Sun, it does not emit any carbon dioxide (CO2) gasses. This prevents greenhouse effect. It is calculated that a one kW PV system prevents 300 lbs. of CO2 gases from entering the planet every month. Furthermore, NO and SO2 gases are not produced at all and this helps to reduce acid rains (Solar Energy International 2011).

An indirect advantage of solar energy is that when people use electricity created by solar energy plant, then they do not have to use diesel generators, kerosene or flashlights for lightning their everyday life. This is mainly an issue in developing countries. Flashlights are included, because they use batteries, which, if not disposed properly, are a huge threat for soil and underground water, as they contain lead-acid cells (Odetunde 2008).

Besides all the environmental advantages, there are some advantages of other types which contribute to better quality life:

- Solar energy plants do not generate any noise (unlike as diesel generators).
- Very little maintenance is required because there are no moving parts
- All the environmental advantages result in better health of citizens
- Solar energy plants can be easily expanded by the addition of extra solar panels.
- Solar panels have long term warranties of up to 25 years, which is much higher than alternative plants.
- In terms of physical size, small or mid-sized solar energy plants are much smaller than coal or other fossil fuel-powered energy sources.

4. Nigeria: A Critical Analysis of the Socioeconomic and Environmental Benefits of Solar Energy

Despite the installed petroleum products refining capacity of 445,000 barrel/day, and electricity generation capacity in excess of 6,000 MW, it was revealed that at a point in time, while electricity generation was about 3,000 MW; an amount that is grossly inadequate for the nations needs. Coal and other renewable energy resources are grossly underutilized in the country despite their availability in reasonable quantities. Huge investment is required to upgrade and expand our power generation, transmission and distribution systems, which government alone cannot provide in view of other pressing demands of the economy. Good potentials exist in the upstream business in the offshore, on-shore and inland basins of the country, as well as in the downstream oil and gas business. Similar potentials exist in the power sector. The level of utilization of the nation's huge renewable energy resources is rather too low.

With the vast renewable energy resource and a National Energy Policy, as well as a National Renewable Energy Master plan. Nigeria is well positioned to up-scale the use of renewable energy (Sambo 2009). Like South Korea, apart from generating clean energy, the project creates an opportunity for direct investment in the Nigerian economy that could simultaneously qualify for 'clean development mechanism' credits, allowing for trading of Certified Emission Reductions under the Kyoto Protocol. It is perhaps important to explain that the clean development mechanism (CDM) is a system or a strategy that allows emission-reduction (or emission removal) projects in developing countries to earn certified emission reduction (CER) credits. Each credit is equivalent to one tonne of CO2. These CERs can be traded and sold, and used by industrialized countries to meet a part of their emission reduction targets under the Kyoto Protocol. The mechanism stimulates sustainable development and emission reductions, while giving industrialized countries some flexibility in how they meet their emission reduction targets (UN, 2013).

In Nigeria, rising atmospheric temperatures, leading to global warming, has exacerbated the challenges of desertification, desert encroachment, drought, rise of the sea level, health problems, as well as food and energy security. Very often mitigation actions are seen as strategies to reduce emissions of green house gases alone. However, in Nigeria several of the actions needed to reduce these harmful gases are the same that would be needed to generate more electricity, create more jobs and reduce local environmental problems. The benefits of greenhouse gas emissions reductions become an added bonus.

Nigeria's best opportunity to reduce these gases is from ending gas flaring and in addition adopting a 30 percent renewable portfolio standard. Latest available statistics show that gas flaring accounts for 31.4 percent of a total 54.9 percent of emissions from Nigeria's energy sector. Making this currently flared gas available for electricity production will be the needed tonic for solving the current power crisis. Also, investments in abundant sources of renewable energy, stipulated in the Renewable Energy Master Plan would assist in addressing energy security.

These will also help industries create new jobs and assist governments at all levels to end the current environmental crisis in the Niger Delta. According to a 2009 study by the International Centre for Energy Environment and Development (ICEED) and the Global Climate Network, over 600,000 new jobs can be created in the short to medium term, from gas and small solar technologies (ICEED 2009).

The above and other strategies for reforestation, energy efficiency, and control of the growth in population, can present valid win-win policy options that can be implemented now and in the near future. In addition to the various benefits that mitigation can bring, they provide access to the carbon market for Nigeria. The primary and secondary carbon markets are markets where developing countries are allowed to trade their emission. In 2009 alone, World Bank estimates showed that the value of the market was about USD$33.5 billion (Onuma **2010**). Nigeria currently has only three projects that that have received financing from this market. Continued use of the clean development mechanism makes many projects in Nigeria potential beneficiaries for this financing opportunity.

Domestic unilateral actions to mitigate climate change present a crucial step in these mitigation actions. Many countries such as Brazil, China, India and South Africa have already seen the benefits of reaching their national development objectives by investing in low carbon technologies. Developing a nationally appropriate mitigation plan of action is therefore imperative in reaching Nigeria's goals for the Vision 2020. This plan would assist in detailing the next steps and help in mainstreaming climate change related issues into developmental plans; a link that has so far been missing.

For plans to be effective, they must be backed by proactive legislation that can be enforced and implemented. Unlocking the potentials for the use of domestic gas lies in the effective implementation of the Gas Master Plan. The Renewable Energy Master Plan presents a framework to increase the use of clean energy. However, consolidating and updating policies that aid market creation in these green technologies is important. Developing a Clean Energy Law that builds upon the existing legislations is therefore vital.

The Gas Flare Out Policy must also be passed and enforced to ensure a more effective domestic utilization of gas in Nigeria. Taking action now can be quite painless, if the proper steps and policy actions are taken. It is a win-win for all, including job creation opportunities, energy security and creating an avenue for addressing the environmental concerns of the region. An added bonus is simply the reduction in the nation's greenhouse gas emissions (Onuma **2010).**

Finally, electric power supply is the most important commodity for national development. With electrical energy the people are empowered to work from the domestic level and the cottage industries, through the small-scale and medium industries to employment in the large-scale manufacturing complexes. Electric power generation in Nigeria should be harnessed mainly from solar source of energy considering all the opportunities open for Nigeria's utilization.

5. Conclusions and Recommendations

In emphasising the importance of electricity 'for all', Oakley (2013) cites Emile Zola who in 1901 looked forward with foresight and declared that "The day must come when electricity will be for everyone, as the waters of the rivers and the wind of heaven. It should not be merely supplied, but lavished, that men may use it at their will, as the air they breathe". Whether this very laudable desire is being pursued on a global dimension, is a different matter altogether. As energy costs continue to rise worldwide, innovators desire to seek out new technologies to meet the rising demand for sustainable energy. Finding an inexpensive and reliable source of energy remains a challenge in many developed and developing countries.

Renewable energy is considered a viable solution to the energy challenges of Nigeria, especially in view of the need for access by the populace in the rural areas of the country. This is particularly so because of the restrictions posed by the rising cost of conventional or traditional energy. In consideration of Nigeria's UNFCCC commitment to reduce the effect of climate change to the barest minimum, solar energy is the most promising of the renewable energy sources for Nigeria, especially in view of its apparent limitless potentials. The sun radiates its energy at the rate of about 3.8*1023 kW per second. Most of this energy is transmitted radially as electromagnetic radiation with strength of about 1.4kW/cm^2 at the boundary of the atmosphere. One square meter of the earth's surface can receive as much as 1kW of solar power, averaging to about 0.5 kW per square meter over all hours of daylight. Studies relevant to the availability of the solar energy resource in Nigeria have fully indicated its viability for practical use.

Although, solar radiation intensity appears rather dilute when compared with the volumetric concentration of energy in fossil fuels, it has been confirmed that Nigeria receives 5.08*1012 kWh of energy per day from the sun. If solar appliances with just 5 percent efficiency are used to cover only 1 percent of the country's surface area, then 2.54*106 MWh of electrical energy, which is equivalent to 2.66 million barrels of oil per day, would be made available to the nation. Converted to monetary values, this would have been a lot of savings for the country.

Moreover, Nigeria has numerous conventional energy resources. Due to mismanagement and corruption, it has often been forced to import virtually most of its energy requirements even petroleum oil of which she is one of the major producers. It is not necessary to belabour the point by stating that importation of petroleum oil represents a significant drain on the nation's economy and a depletion of her foreign exchange. These problems should therefore create a very strong incentive to develop domestically available renewable resources. Solar energy has been identified, as perhaps the best near indigenous resource to meet the energy needs of this great giant country.

In conclusion, it is clear that the rapid depletion of fossil fuel reserves as well as climate change have driven the world towards renewable energy sources that are abundant, untapped and environmentally friendly. In particular, solar energy holds great promises as a component of CDM strategies to reduce green house gases while providing stable electricity supply for residence.

Recommendations

In view of the significance of the use of renewable energy to the development of any economy, and also following the serious challenges faced by Nigeria's power sector, the following recommendations are considered pertinent:

1. The use of solar energy is environmental-friendly. It would thus greatly reduce the problems of pollution associated with the exploitation, production and the distribution of petroleum, the fossil fuel which is the major source of energy in Nigeria today;
2. Solar energy plants can easily be installed and dispersed around the country thus greatly enhancing uniform dispersal of small and micro enterprises which would in turn help to reduce rural-urban migration;
3. The adoption of renewable energy sources should guarantee longer term sustainable development as it is not prone to the vagaries of local and international price, exchange rate, and inflation volatilities;
4. The strategy for the implementation of solar power plants should be such as to discourage corruption;
5. With the absence of moving parts for renewable energy sources like solar plants, the deployment of foreign exchange for purchase of spare parts would be reduced to the barest minimum, thus helping to conserve the nation's hard-earned foreign reserves;
6. The use of renewable energy creates the opportunity for enhanced foreign direct investment due to 'clean development mechanism' (CDM) which enables "compliant nations" to trade in Certified Emission Reductions (CERs);
7. The use of renewable energy would reduce focus on oil and would therefore dampen the problems of youths restiveness in the Niger Delta regions of the country;
8. With the adoption and utilization of renewable energy, a cleaner environment is guaranteed. An important consequence of this is a healthier populace with improved standard of living. This should not only improve the human development index (HDI), but should also help in reducing both infant and maternal mortalities;
9. Regular power supply expected to be derived from the use of solar energy should help to guarantee the viability and survival of micro, small and medium enterprises. This has positive correlation with improved employment opportunities; and
10. The more reliable the overall national power supply, the better the level of safety and security within the country.

It must however be noted that all these laudable objectives cannot be achieved in the absence of the will by those in authority to provide the enabling environment for its take off, and by putting in place the necessary legislations to back up the plans and programs for its execution.

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