

Technical and Economic Potential of Photovoltaic Power Generation for Wealth Creation

Anyaka Boniface Onyemaechi, Okafor Charles Onyeka

Abstract- Energy is the lifeblood of economy development around the world and global economic growth depends on adequate, reliable and affordable supplies of energy. Key foreign policy objectives, including support for democracy, trade, sustainable economic development, poverty reduction and environmental protection rely on the provision of safe, reliable and affordable energy supplies. Nigeria receives abundant solar energy that can be usefully harnessed with an annual average daily solar radiation of about 5250 Wh/m²/day. This varies between 3500 Wh/m²/day at the coastal areas and 7000 Wh/m²/day at the northern boundary. The average amount of sunshine hours all over the country is about 6.5 hours. To enhance the developmental trend there is every need to support the existing unreliable energy sector with a sustainable source of power supply. This paper shows some economic potential of renewable energy development in Nigeria. First, the lay out estimates of employment creation that renewable energy has brought and could bring to Nigeria, exploring the issue sector by sector and looking at solar, wind, mini hydro, geothermal, modern biomass, and ocean. Also, mentioning how renewable energy generation can be produced locally to generate employment. Above all, this paper lays out how renewable energy can save the government money, bring jobs to the country, create wealth, expand access to energy for the most vulnerable in poor communities, and foster national energy independence.

Keywords: Solar energy, Renewable Energy Technology (RET), Small and medium enterprises (SME), Photo Voltaic (PV).

I. INTRODUCTION

Since independent, Nigeria, the giant of Africa, has gone from one transition state to another ranging from change in government, currency, the way businesses are conducted, change in the national constitution but since then, one problem remains paramount, epileptic power supply. Report shows that Business owners in Nigeria uses more income to supply power for their business [1] which is not healthy for business as this cut down their profits.

Small and medium enterprises (SME) have been considered as the engine of economic growth and for promoting equitable development. The major advantage of the sector is its employment potential at low capital cost. The labour intensity of the SME sector is much higher than that of the large enterprises. The role of small and medium enterprises in the economic and social development of the

country is well established. The sector is a nursery of entrepreneurship, often driven by individual creativity and innovation. Small and medium enterprises (SMEs) together make up over 90% of the businesses in the world and account for 50 – 60% of worldwide employment [2]. In developing countries e.g.

Nigeria, encouragement of the expansion of private sector and the creation of local business opportunities is the crucial aspect of economic and industrial growth and the key to successful poverty alleviation activities. Strategic efforts to support small, sometimes informal, businesses offer many people a way to work toward improving their own livelihoods and building a secure future for their families. In Nigeria, SMEs are often constrained by lack of infrastructure, communications, financial investment resources and especially power supply. Without these services, SMEs cannot function effectively, and their contribution to economic and social development is limited.

Given the significant contribution of SMEs to worldwide job creation and income growth, it is crucial that infrastructure services be targeted to support these enterprises. Access to reliable, affordable energy services is vital for SMEs to operate efficiently and profitably, yet such access does not exist here in Nigeria. Chronic power shortages and poor-quality electricity services exert an enormous toll on economic development and constrain many of the services on which small businesses rely. Recent studies on energy and SMEs in Nigeria and other developing world have revealed that the highest prices for electricity and modern fuels are generally paid by the smallest enterprises [3]. Energy costs run from 10% to more than 65% of the total cost of production for many SMEs. Electricity is needed to power tools, appliances, and productive equipment, and modern fuels are needed for heating, food processing, and transportation. In Abuja, Nigeria, for example, an assessment of some area was found that 100% of SMEs invest in energy to support their business activities [4]. In cities, SMEs need energy to operate shops, restaurants, hotels, small manufacturing operations, and service industry applications. Better access to energy opens up broad opportunities for income-producing activities. In rural locations, energy is needed to support agriculture, fishing, and aquaculture, which often dominate economic activities in these areas. Modern energy services provide a way for people to move beyond subsistence farming and out of poverty. Dependable, reasonably priced energy services enable SMEs to strengthen their market position, enhance their product and service base, increase business opportunities, and augment income flows in local and export markets.

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Small and Medium scale Enterprises (SMEs) requires constant and cheap energy supply to:

A. Increasing Productivity through Mechanization and Energy Efficiency

Automated machinery and equipment upgrades for agricultural processing and small industries can transform labor-intensive, low-production enterprises into high value-added operations.

B. Improving Food Preservation

Energy for refrigeration and freezing can help preserve agricultural products such as milk and fish for export or retail sales, and energy for drying can be used for improved processing of fruits and meats.

C. Promote Communication

Telephones, radio, and educational television programs help entrepreneurs keep up-to-date on market conditions. Reports on weather conditions can help farmers determine the optimal time to shear animals, bale hay, or harvest crops.

D. Increasing Operating Hours

Lighting allows entrepreneurs to extend their working day and thus increase their income by serving customers in the evening or operating workshops past sundown. Street lighting helps to extend selling hours for street vendors.

E. Improving Working Conditions

Modern energy services are cleaner and safer than traditional means of heating/cooling, cooking, and lighting, which benefits both workers and consumers. Eliminating the use of smoky kerosene lamps, crude cooking stoves, and unstable electrical connections (such as in pirated electricity) reduces the incidence of accidents and indoor air pollution. Renewable energy is the fastest growing energy sector in the world. Globally clean energy continues to set record levels for investment. Bloomberg New Energy Finance estimates that US\$243 billion was invested in renewable energy in 2010, an increase in 30 percent from 2009. Around 2.3 to 3.5 million people around the world may be working either directly in renewables (construction, manufacturing, installing, operating, and maintenance), or indirectly in supplier industries. Solar thermal industry in and of itself is thought to employ at least 624,000, and modern biomass/biofuels are providing around 1 to 1.5 million jobs [5]. Below is a table showing different areas of the world and the numbers of jobs created by solar power generation [6].

Table 1: Areas and the number of jobs created by solar power generation

Area	No. of Jobs
Europe	650,000
Germany	370,000 direct and indirect
Spain	89,000 direct
	99,000 indirect
Denmark	21,000-24,700
UK	99,000
Australia	10,370
	26,000 to be created
USA	1,079 in wind farm
	75,000 in wind industry
	100,237 in solar industry
China	Approx. 1million

	With 600,000 in solar industry
Bangladesh	18,823 direct
	212,753 indirect
Global	2.3-3.5 million

Many other countries are already reaping big benefits from their renewable energy sectors, and Nigeria can too – so long as the government truly stands behind a concrete timetable for renewable energy development, and takes steps to implement what some have described as paper tiger policies. A quick look around the world reveals the tremendous economic benefits of renewable energy. Close to 650,000 people are employed in renewable energy in Europe. Many sources differ, but overall, a strong consensus has emerged that renewable energy are an engine of job creation. In Germany, a Deutsche Bank study found that the Germans have netted about 370,000 direct and indirect jobs out of their commitment to a renewable energy (especially solar) future. According to the German Renewable Energies Agency more people work in Germany in solar than in coal and nuclear [7]. In addition, “investment in new renewable energy plants reached 22.9 billion Euro in 2011” in Germany. Spain has allegedly profited from its booming renewable energy industry to the tune of about 89,000 direct jobs especially in wind and PV and 99,000 indirect jobs, while Denmark domestic wind employment is claimed to be about 21,000-24,700 jobs [8]. Moreover, financial incentives such as tax-free income for wind generated by cooperatives have led to a high degree of citizen participation in the wind industry, with 80% of Denmark’s turbines owned by over 150,000 Danish families. Meanwhile, a study by Innovas in the UK12 reports that “renewable energy employed just over 99,000 people in the 2010/2011 financial year” and that “the total UK turnover for all renewable energy and their supply chains in 2010/11 was around £12.5 billion”. The weighted average market value increase from 2009/10 to 2010/11 was 11%. This is far greater than national economic growth rates of 1.4% over the same period.”In 2009, there were already an estimated 10,370 people employed in renewable energy in Australia, and that number is said to be climbing rapidly: Renewable energy projects under construction or planned in response to the proposed emissions trading scheme will create 26,000 jobs, according to National Institute of Advance research commissioned by The Climate Institute Geneva which shows \$31 billion worth of clean energy projects already in the pipeline. Many in regional areas, will generate 2,500 permanent jobs, 15,000 construction jobs and 8,600 associated positions [9]. This research does not include jobs in domestic solar or insulation. Such jobs are likely to be even more numerous, since over 858,000 of Australia’s eight million homes have now gone solar, generating two Gigawatts (GW) of installed capacity in solar PV, in addition to the 600,000 solar hot water systems installed [10]. In the United States, a National Resources Defense Council report asserted that wind energy has provided thousands of high value jobs, with each typical new 250-megawatt (MW) wind farm creating 1,079 jobs, and that “the wind industry now employs 75,000 Americans.”



Also in the USA, solar is creating new jobs ten times faster than the overall economy, according to a study by Pfund and Lazar. The Solar Foundation reported that American solar companies produced more jobs much faster than the general economy and that in August 2011; the U.S. solar industry employed an estimated 100,237 solar workers, providing much needed job creation despite an historic economic and workforce downturn. A report by the University of Massachusetts-Amherst found “that clean-energy investments generate roughly three times more jobs than an equivalent amount of money spent on carbon-based fuels.” In 2012, in the state of Massachusetts alone, 4,955 clean energy firms employed 71,523 clean energy workers, making up 1.7 percent of the state’s jobs [11].

China can boast of having the world’s largest installed wind power base as well as having the world’s largest declared investment in renewable energy. Though the data on China is not clear or reliable yet, around a million people may work in renewable there, with 600,000 people in solar alone. China’s government claims that the “biogas industry has employed some 90,000 people from 2006-2010, and its solar water heating (SWH) sector -- where it is the world’s undisputed leader” involves hundreds of thousands of jobs.

Other Asian countries have gotten onto the renewable energy fast track too. The International Labor Organization (ILO) estimated 8,823 “direct” sustainable energy jobs had been created in Nigeria, and 12,753 “indirect” jobs associated with core sustainable energy jobs, for a total of 21,576 jobs [12].

Looking at the global jobs future, the European Photovoltaic Industry Association’s 2012 report “Solar Generation VI,” we estimated that “PV could generate up to 3.7 million jobs in the world by 2020 and more than 5 million by 2050.” In addition, “the PV market in 2015 will reach a turn-over of more than 34 billion EUR (48 billion USD) in the world; the total of yearly investments could reach 160 billion EUR (225 billion USD) until 2040 [13].

Energy affects everything, and a mass transition to renewable, sustainable, clean sources of energy is way overdue. Though an essentially contested concept, it is safe to acknowledge that the attainment of sustainable development requires that the growth and well-being of present generations are brought about in such ways that the ability of future people to meet their own needs will not be compromised. The availability of safe and sound energy as a factor of production is a key element in such a development process. Despite the abundance of energy resources, acute shortages of energy services have become endemic in Nigeria. According to a 2008 poll, more than 87% of Nigerians want to support renewable energy, recognizing its potential to create jobs and economic growth and the ability to give a national energy security. The results are shown in Figure 1, which represents the energy preference options by a cross-section of Nigerians (650 respondents) in the oil-rich Niger Delta region of Nigeria. Fig. 2 shows the response from the respondents on whether the government should make renewable energy source a top priority. It is time for government to listen to the will of the “restive” Niger Delta people and pass common-sense policies like the renewable energy investment tax credit/rebates. That will check restiveness, and make not only the region but the whole of

Nigeria and other developing economies stand to gain from the economic and political. It is obvious that the level of solar power available for rural and urban photovoltaic application is high for Nigeria. The lowest value of 3110 Wh/m², recorded at Port-Harcourt in the peak rainfall month of July is higher than our domestic load requirement of 2324 Wh per day [13].

The northern sites of Abuja (Nigeria’s federal capital where having a generator set for home and businesses is almost compulsory), Sokoto and Maiduguri all have abundant potentials for solar electricity utilization. This then means that it will take strong political will for the optimal utilization of the enormous renewable energy available to be actualized. To most developed economies, oil is a “past technology” and if the Nigerian youths have to be discouraged from migrating in large numbers to the “Northern engines”, its economy has to be lubricated using Renewable energy. Given the low income levels of the rural poor and the costs involved in maintaining PV systems, effective policies and incentives for low income earners are fundamental steps toward improvement in the quality of life and widening of access. Although the generality of the Nigerian public know that renewable energy is cheaper than conventional energy sources in the long-run as well as Environmental friendly, it will be difficult for now, for the common man, without government’s political will to afford the sustainable green energy, say solar photovoltaic.

Below are figures showing the Energy preference options by a cross-section of Nigerians and Response on whether Government should make solar energy a top priority [14].

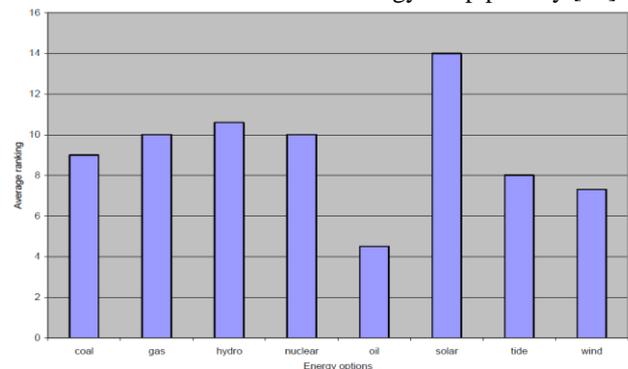


Fig 1. Energy preference options by a cross-section of Nigerians

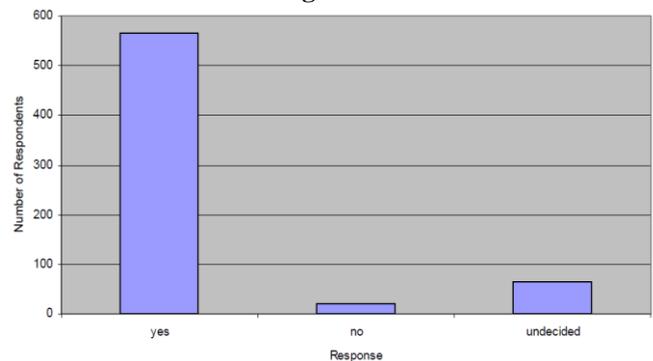


Fig 2. Response on whether Government should make solar energy a top priority



Nigeria is the largest country in Africa, it has a population of 148 million and it is still growing. A lot of people don't have a job and as a matter of fact 70% of the Nigerian population earns less than one dollar a day [15]. The education in Nigeria starts to improve though just less than half of the adults are illiterate. Due to low incomes, health is not a priority and this result in a life expectancy of only 47 years. The large scale corruption, caused by the poverty in the country also affects energy supply in Nigeria. Stable energy supply is of vital importance for the wealth of a country. Energy is needed in hospitals to keep vaccines cool, energy is needed to light schools and energy is needed to keep companies going. Right now only 51% of the people in Nigeria have access to electricity. Most of the electricity is provided by generators, since the central electricity grid in Nigeria is very unstable with power failure being more rule than exception [16].

Renewable energy, like solar power is a solution to this energy problem. It can both be produced centralized and decentralized. Especially the decentralized option is interesting, since it will prevent use of the unstable grid. Renewable energy can also solve the problems with generators. Generators make a lot of noise when running, and they run on fossil fuels, and are polluting as well. Most of all, a generator needs a lot of maintenance, where renewable energy in case of solar cells needs almost no maintenance at all. A pilot project performed in Nigeria should show these advantages of solar energy and improve the local situation.

II. PROBLEMS AND CHALLENGES FACED FROM RENEWABLE ENERGY POWER GENERATION

According to [12], some of the factors militating against the growth of the Solar – PV and concurrently solar thermal Industry in Nigeria include:

1. Government policies which do not support the growth of the renewable energy power generation industry in the country and local manufacturing of the components needed.
2. A basic barrier to the development of solar energy technology in Nigeria as a developing country lies in high initial costs and long payback times.
3. Recently, the technologies for harnessing solar energy are being developed in Nigeria; most components have to be imported which further pushes the investment costs higher.
4. There was virtually no comprehensive energy policy in Nigeria until very recently. Only sub-sectorial policies relating to energy exist.
5. The level of awareness about the immense socio-economic and environmental benefits derivable from solar energy is very low in Nigeria. The current flow of information about the development, various applications, dissemination and diffusion of solar energy resource and technologies is inadequate.
6. Due to high cost of purchase, it is very expensive for a common Nigerian to purchase as more than half of the country's population lives in poverty.

III. RECOMMENDATION

For effective and efficient utilization of solar electricity and renewable energy in Nigeria, the following recommendations will be useful:

1. More research into the techno-economies involving the initial and subsequent costs of solar plants and other renewables and their power efficiencies should be encouraged.
2. Government should subsidize the cost of importation of Renewable Energy Technologies (RET) most especially solar PV to bring down the high cost in Nigeria.
3. Private individuals and organizations should be encouraged by appropriate authorities to invest in solar technologies in the country.
4. Consequently, the wide chasm between research bodies (universities, polytechnics and research institutes) and manufacturing industries must be bridged.
5. Government should create more awareness on the advantages derivable from Renewable Energy Technologies (RET) such as solar technologies.
6. Government can also consider placing restrictions on the importation of diesel and petrol engine generators because of its adverse effects on the environment even as the global community gear towards clean (green) energies.
7. Funding of solar technology researches and development initiatives in Nigerian Universities, Polytechnics and Research Institutes so as to develop solar PVs with increased efficiency that will be adaptable to our environment is advocated as is obtainable in developed countries. Such pilot schemes are seriously undertaken at the National Agency for Science and Engineering Infrastructure, NASENI, FCT Abuja and the Prototype Engineering Development Institute Ilesa, Osun State. The National Energy Research Centres at the University of Nigeria, Nsukka, the Obafemi Awolowo University, Ile-Ife and Usmanu Danfodiyo University, Sokoto [17]

IV. CONCLUSION

In a nutshell, our conclusion is that investing in and facilitating large-scale renewable energy projects can generate thousands of good jobs in Nigeria, both small and medium scale industry, make electricity more economical for customers in the long run, and increase GDP, while posing fewer risks for the nation, as opposed to investing in coal or oil. Renewable energy is good for the environment and good for businesses. This paper focuses on the maximization of the sun's energy supply for generating optimum power. It has presented the viabilities for power generation in Nigeria by the utilization of the sun's energy through solar-thermal or photo-voltaic technologies and using other renewable energy products. The future of solar electricity is brighter than before. Solar energy is free; it needs no fuel and produces no waste or pollution. It is only recently that mankind turned to the large scale exploitation of new, and non renewable sources of energy and those sources have made possible the advance of industrial revolution and large increase in populations. It is clear however, that because of the finite magnitude of these sources, this phase of human development is transitory and the era of extensive dependence on finite fossil energy resources will appear as a brief episode.



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