

THE PROMISE OF PHOTOVOLTAIC SOLAR ENERGY: AN OUTLINE FOR ELECTRICAL ENERGY FEASIBILITY IN NIGERIA

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Abstract

This is a review-based theoretical paper, where literature on the feasibility of the photovoltaic solar energy perspective is highlighted and developed to provide an alternative to electrical power hitches in Nigeria. High transmission losses and system failures are expected, leaving only 10% out of the rural populace accessible to electrical power and an 80% gap in electrical power supply demand. These results in gasoline/diesel-powered generators by most households and business owners to self-generate electrical power. The paper concluded that photovoltaic solar energy is the most steady and consistent source of electrical energy that can be adopted for commercial and household motives. Moreover, the country is blessed with ample sunshine and has vitreous insolation favorable to solar energy hoards. It finally suggests and recommends the establishment of national solar energy research and development laboratories, subsidizing importation rates of solar photovoltaic modules, and encouragement of private individuals, organizations and communities in photovoltaic solar energy investment as few among developmental strategies that can be adopted in making photovoltaic solar energy feasible for electrical power hitches in Nigeria.

Keywords: Photovoltaic, Electrical power, solar energy, feasibility, power hitches

INTRODUCTION

Because of its regional location around the equator and a land area of 923,800km², Nigeria receive a reasonable intensity of the sun of about 3000h annually and solar energy of around 17,459,215.2 MJ daily, with a range of about 25.2 MJ/m² daily in the north and 12.6 MJ/m² daily at the coastal region. When exploited, it will positively affect Nigeria's economy and Africa at large (Okon, 2019). Venturing into photovoltaic solar energy technology by a growing nation (economically) such as Nigeria needs to be encouraged; hence its advantages like optimum reliability, free polluted environment, low cost of maintenance, and free solar energy source can contribute immensely towards its future technological advancements (Bala, 2018). Household and other domestic electrical energy requirements are more cost-effective with photovoltaic solar energy than fuelled generators, safer and environment pollution free (Shaaban, 2018).

Adeniji *et al.*, 2019 cited that conventional energy sources in a fast-growing population like Nigeria cannot flexibly meet the populace's electrical energy demand. He further opined that an unavailable grid is required to transmit conventional energy to rural dwellings due to proximity and circumstances; hence the massive deployment of photovoltaic solar energy



remains an available option because of its accessibility and convenience, photovoltaic solar energy is still viewed by many researchers and scholars alike as the most proficient and bright electricity power source other than specific electrical energy sources; more especially for a growing nation like Nigeria (Masini and Menichetti, 2016).

Unlike other renewable energy sources such as hydropower and wind energy, Photovoltaic solar energy does not require enormous water bodies or substantial open areas. Therefore, it applies to recreation, engineering, agriculture, medical sciences, and education (Adeyanju, 2019). Nigeria in its entity need not be wholly reliant on non-renewable sources of electrical energy because it is hallowed with abundant solar energy, which is an ultimate source and favors investments in photovoltaic solar energy (Omisore, 2020). Because of its nature and limitless, by the year 2020, almost about 345 GW was estimated to be delivered by photovoltaic cells. This is around 4% of the world's total energy, and about 1081 GW is expected by 2030 (Bala, 2015).

Similarly, the nation's electrical energy supply predicaments can be overcome by investments into solar photovoltaic advancements and technologies and can help national economic advancement (Oseni, 2019). Thus, for Nigeria's economic future, it is pertinent that the nation transposes itself by investing in this valuable and precious resource because it is estimated to play a vital role in national and global energy requirements, particularly in the developing nations (Agbo, 2021).

THEORETICAL DEFINITIONS

- Photovoltaic – also known as PV- is a device that produces electric energy directly from sunlight through an electronic procedure that naturally transpires in certain kinds of materials referred to as semiconductors. Solar energy frees electrons in the semiconductors, induced in an electrical circuit to electrical power equipment or national grid (Augustine, 2019).
- Electrical power is referred to as the rate of electric energy transfer per unit time by an electric circuit, its unit of measurement is Watt (Oseni, 2019).
- Solar energy - is perceived as radiation obtained from the sun that generates heat enough to cause chemical reactions and further produce or generate electrical energy (Okon, 2019). The obtained energy can be utilized in solar heating and thermal energy, salt power stations, photovoltaic, solar architecture and synthetic photosynthesis (Amankwah, 2018).
- Feasibility is a term used to describe the possibility or state of being possible or feasible. In energy research and findings, it is usually assigned to describe the positive probability of an occurrence, implementation or adaptation (Shaaban, 2018).
- Power hitches are often described as technical problems, difficulties, complications, snags and drawbacks connected to electrical energy generation, transmission, and distribution (supply) (Okon, 2019).

BASES OF POWER HITCHES IN NIGERIA

Nigeria is a West African Power Pool (WAPP) member and mostly applied the hydro and thermal means of power generation of around 12,522 MW to provide steady electrical power (Sambo and Bala, 2018). However, unsteady power usually generates fluctuations or even power outages that can last for minutes or hours, days or weeks; hence power outages can cause partial system collapse (outage not across the country) or a total system collapse (nationwide power outage) (Ozoegwu *et al.*, 2017). They further cited that investigations had indicated that about 142 of such collapses were documented from 2009 to 2013, and other 103 from 2014 to 2021, respectively; thus, a system disturbance of about 259 times was experienced in the country in about 12 years.

Specific causes of electrical power hitches across the country, as highlighted by Osiniwo *et al.*, 2015 includes:

- ✓ Festered electrical power generation capacity growth
- ✓ Inadequate human capacity development
- ✓ Inadequate maintenance technique/maintenance culture
- ✓ Constant use of aged appliances
- ✓ Ransacking of funds kept for power sector improvement
- ✓ Corruption

Use and applications of underrated transformers, fuse and cables, improper and poor maintenance of switchgear, the effect of environmental influences (such as sabotage, corrosion, flood menace and insulation) and tripping of the electrical power transmission lines are few of the causes of power hitches in the country as viewed by Nnaji and Unachukwe, 2018.

Power hitches can also occur due to poor maintenance in generality, human fault, natural grounds (such as storms, rain, harsh weather, freezing, etc.), system/appliance failure, an interruption between transmission, generation and supply, and animals/birds meddling (Ohunaki *et al.*, 2019). However, peculiar causes of electrical power difficulties faced in the country, as noted by Aliyu *et al.*, 2015 comprises the following:

- Recurrent overload
- Constant load increase
- Workers attitude
- Phase supply system
- Application of copper wires as the fuse on bus bars

INFLUENCE OF PV SOLAR ENERGY ON NIGERIA'S ELECTRICAL POWER SECTOR

For a country like Nigeria, where the need for electrical power is on the increase, utilization, development and application of photovoltaic solar energy are vital to the development and advancement of the nation's economy (Agbo, 2021). As a result, there will also be an increase in

the country's GDP, economic expansion and business diversifications. In addition, photovoltaic solar energy can readily influence poverty alleviation, especially in rural settings with no access to the grid lines. It will create more business and employment opportunities (Omisore, 2020).

Apart from the known photovoltaic solar panel technology, concentrating solar power (CSP) technology is usually used in massive power plants (though not recommendable for domestic or household use). It is a technology that involves the reflection and concentration of sunlight by mirrors to receivers for conversion to heat, which is further used to drive a steam turbine connected to an electrical power generator for electricity generation (Augustine, 2019). Sambo, 2018 cited that photovoltaic solar energy is safe from geopolitical conflicts and constraints and safe from greenhouse gasses and pollutants. It can also make an immense contribution towards power stability in the country, serve as a prospective source of energy diversification, and increase the domestic electric energy supply share of the nation.

Application of solar photovoltaic energy to various energy sectors will readily minimize industrial carbon footprint, thus serving as an exceptional reduction of carbon dioxide emission, providing a desirable impact on a moderate climatic change across the nation (Adeyanju, 2019). Furthermore, it can also serve as a viable means or alternative in providing water supply to the rural populace (especially in the northern part of the country affected by low water table due to desertification) through solar water pumps (Bala, 2018). He further viewed that local proficiency in the development, repairs, productions, maintenance, and management of solar energy devices will evolve across the nation if there are more investments in solar energy application, hence leading to immense employment opportunities and job creation.

Conventional energy, even if available, is not readily reliable, and for the country's sustainability due to its enormous population explosion, the country requires a massive amount of electrical energy. Hence photovoltaic solar energy can be adopted as a supportive means of electric power generation (Osiniwo *et al.*, 2015). Moreover, it is a most viable source of energy as about solar irradiation of 120 000 Terawatts is received by the earth surface, representing about 20,000 times extra power than the whole earth requires; hence 18 days of the said irradiation comprises abundant energy as the earth's natural gas reserves, coal and oil put together (Adeniji *et al.*, 2015).

Recently, renewable energy, especially photovoltaic solar, is becoming cheaper than other sources of the conventional energy supply, thus becoming the most sustainable and reliable solution. Moreover, it is most economical in powering the nation and environmentally friendly (Amankwah, 2018). Moreover, Bala, 2015 figured that an alarming rate of global climate change is much of a concern; hence photovoltaic solar energy can be used as an alternative for obtaining clean energy other than that obtained from other fossil fuels. Thus, half an hour's sunlight strike on the earth's surface is rich enough to take care of the whole world's energy consumption requests for a year (Ohunaki *et al.*, 2019).

BARRIERS TO PROPPER ENACTMENT OF SOLAR ENERGY IN NIGERIA'S ELECTRICAL POWER SUPPLY SYSTEM

Photovoltaic solar energy is one of the most effective, reliable, readily available and enthusiastic resourceful sources of energy, but discoveries have indicated that it is least utilized in most countries (Nnaji and Unachukwe, 2018). Specific barriers such as political unsteadiness, short-term strategies, insufficient solar initiatives research and lack of technological knowledge are highlighted among the significant setbacks making solar inventiveness virtually impossible in Nigeria (Masini and Menichetti, 2016).

Shaaban, 2018 pointed out the lack of financing of solar energy projects, quality and standard control, regulatory and legislatives, socio-cultural insight, technical capability, squat economic exploitation, strategies and institutional and little awareness as few barriers to proper enactment of solar energy applications in the country. As opined by Oseni, 2019, other barriers include sabotage, insecurity, political and policy issues, the dependence on fossil fuel, and lack of data processing and recording locations. He further cited other barriers to include social, political, financial, technological hurdles, high-tech risks, configuration, steadfastness, and startling cost.

As highlighted by Okon, 2019, other barriers include traditional restraints on land usage, solar systems and components mugging, inadequate commitment in solar energy projects by the government, materials and technology failure, lack of public consciousness, theft and vandalism. Lack of appropriate planning and long-span government backing, inadequate geographical and demographical features in realizing solar parks, the nonexistence of feed-in tariffs, and inability to access loans to procure solar systems are also linked to obstacles limiting the adequate adoption of photovoltaic solar energy in the country (Amankwa, 2018). Inadequate standby technology, sector control in energy development and varied solar energy technologies, obstacles and challenges for transactions in new developments/products are sighted by Agbo *et al.*, 2021 as hurdles to the proper adaptation of photovoltaic solar technology.

Some of the obstacles limiting solar energy adoption in the country can be connected to the inadequate lawful, strategy and supervisory framework, non-existing configuration for power procurement bargains, influential framework, poor established cross-sectoral links, and communal consciousness (Sambo and Bala, 2018). Furthermore, technical know-how and support are minimal, even with much awareness of solar developments. Hence, installation experts, assembling, and managing new and existing facilities are paramount (Ozoegwu *et al.*, 2017).

CONCLUSION

Photovoltaic solar energy has abundant gains that make it the utmost promising. Its impact and feasibility can never be overemphasized; it is the most steady and consistent source of electrical energy that can be harnessed to benefit both commercial and domestic drives. It is a worthy strategy in accomplishing the targeted, sustainable developmental goals in minimizing carbon fossils usage. It is available, environmentally friendly, accessible, and sufficient with good insolation favorable for energy investments. If integrated and adapted into the nation's power

grid system, photovoltaic solar energy will stabilize and make electrical power feasible. Still, it will play a significant role in boosting its national economy.

RECOMMENDATIONS

The following recommendations are viewed worthy in electrical power feasibility in Nigeria:

- I. The challenges should be addressed by integrating recommendations from numerous researches, mainly the technical and institutional obstacles.
- II. Financial support and encouragement to private personnel, individuals and communities to invest and participate in photovoltaic solar energy developments.
- III. Establish more solar energy research and development laboratories and maintain existing ones properly.
- IV. Government should put in place strategies that will make an enabling environment for photovoltaic solar energy generation.
- V. Public awareness and orientation on photovoltaic solar energy's numerous benefits and advantages.
- VI. Subsidy in photovoltaic solar products importation.
- VII. More research and findings on the impact of photovoltaic solar energy on future energy feasibility and sustainability should be adhered to.

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