SOLAR ENERGY INSTALLATION IN NIGERIA: OBSERVATIONS, PROSPECT, PROBLEMS AND SOLUTION

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Abstract

Solar energy, an energy obtained from the sun, is the world's most abundant and cheapest source of energy available from Nature. It is free and automatically renewable everyday. In the world over, emphasis has shifted from the use of hydro and fossil-powered electricity generation to renewable energy such as solar source. In Nigeria, less than 40% of the country is connected to the national electric grid and less than 60% of the energy demand by this group is generated and distributed. Emphasis in this work is the use of solar system in Nigeria as an alternative renewable energy source and problems encountered in the field spanning decades. This paper presents review on the technical information on the solar energy stand alone and hybrid installations, taking into consideration the various practically encountered problems during installation and operation, and the preferred solutions with more attention being paid to domestic and industrial installations.

Keywords: Solar energy, Nature, Automatically Renewable, Electric, grid, Technical information, Hybrid.

1.1 Introduction

The antecedent problems associated with the present energy supply in the world, most especially the oil glut and its rising cost; environmental problems and disasters from thermal and nuclear power stations, geometrical increase in demand due to industrialization and population growth of which Nigeria is a constituent part. The Energy-induced environmental degradation is already prevalent in the country (1) This is characterized by deforestation as a result of falling of trees for fuel wood and charcoal production, air pollution in urban areas arising from vehicular emission and burning of traditional fuel for traditional cocking in household, noise pollution from use of small generators to provide electricity due to inadequate supply from the national grid, land and water pollution from oil spillage in the oil producing communities (2) This has led Nigeria and indeed the world to look for alternative power supply such as solar energy among others. Unfortunately utilization and development of solar energy is rising in other parts of the world but encountered with low pace of development and utilization in Nigeria. This low pace of development is due to the associated problems such as purchasing power, technology of installation and fabrications, awareness, governmental policy and politics, culture, Nigerian factor, among many other variables (3) In Nigeria, more than 75% of Nigerian populations are rural dwellers .(4) Less than 20% of Nigeria is connected to the National grid, and more than 70% of Nigeria's population of about 140 million live in more than 80% of land mass of Nigeria which is not connected to the national grid. Since the energy production level of any community dictates her pace of development and hence her poverty level, it is possible to alleviate poverty of the large community of Nigerians by providing alternative renewable energy (solar) for them. Solar energy is below.available in two forms, namely Solar Thermal and Solar PV, as stated

I.2 Solar Thermal: Solar thermal is the direct application of solar energy to produce heat. This is dated back to ages, exemplified by sun drying and so on, common in the equatorial region where people have programmed themselves to sun drying of personal effects such as clothing and drying of agricultural commodity, resulting to various researches in solar thermal equipment like cabinet dryers, oven, hatchery, water heaters among others. In Nigeria, solar thermal have been developed for various applications; some of these are solar cookers, solar pulverizes, chick brooding devices (5). Regarding the drying of Agricultural produce, there are four major drying techniques namely: open air drying, fire wood/fuel drying, electrical drying and solar drying (6).

1.2 Solar PV: Solar PV is the conversion of solar radiation to electricity using solar cell. These include Water Pumping for Irrigation in the Rural Areas, lightings and other proposes. The United Nation Commission on Sustainable development has called for much wider access to sustainable energy as a prerequisite for reducing poverty to about 50% by the year 2015 and all world leader reaffirmed in the year 2005 world summit in New York. By sustainable energy, it means energy produced and used in a way that supports human development over the long term in all its social, economic and environmental development (UNDP 2005). Millennium Development goals (MDGs) of halving poverty; will not be possible without increase energy services, production and income, creating job and reducing drudgery, (7) (8). There can be immediate and widespread deployment and application of solar energy which can easily cover large area of Nigeria especially rural and riverine areas because of many advantages of solar energy application over the present energy supply sources; especially when decentralized application is involved. Decentralization of Solar Energy installation means individual acquisition, utilization and application of the system. In this system, no high or low tension Transformer will be required, high or low tension wiring, equipment and logistic will not be involved in the distribution of the energy, which means the solar PV (panels) can easily be carried, deployed and installed on individual establishment and premises in any part of the country at low cost within a very short period.

Table1. Country Statistic of Electricity Generation and Per Capital Consumption

Continent	Country	Population (Million)	Generation Capacity	Per-Capital Consumption(KW)
North America	USA	200	813,000	3.2
South America	Cuba	10.54	4,000	0.38
Europe Central	United Kingdom	57.5	76,000	1.1
Europe Eastern	Ukraine	49	54,000	1.33
Middle East Far East	Iraq South Korea	23.6 47	<4,000 1,800	0.42 1.10
Africa	Nigeria Egypt	140 67.9	<4,000 1,800	0.03 0.27

	South Africa	44.3	45,000	1.03

Source (9)

Table 1 above reveals the poor state of generation and supply of electricity in Nigeria and the need for alternative energy like solar. Brighter future and greater prospect abound for solar energy and it need to be incorporated in the Nigeria national energy mix

2.1 Problems Confronting Solar Installation in Nigeria

There are various problems confronting the acquisition, installation and development of solar system in Nigeria, which need to be addressed if appreciable progress has to be made. These include:

Affordability: Nigeria is still clarified as underdeveloped country with higher percentage of her population living under poverty level. This makes ability to acquire solar energy devices which is still considered expensive, either individually or group of people not easily come by.

2.2 Present Level of Research and Development:

In Nigeria, not much research and development have been carried out on PV or solar thermal energy and associated devices. These devices are yet to become common household commodities in Nigeria. Their uses are only scantly seen in universities and research centers (10). Hence availability in Nigerian market of made in Nigeria brand name solar energy PV generating equipment and accessory is still a dream. This shows that Nigeria has a lot of journey to go (or prospect in disguise) in the area of solar energy research, deployment and device production.

2.3 Lack of Awareness:

Awareness of existence of solar energy as a source of power supply is still very low in Nigeria. Those that are aware of it thought solar energy can only power few watt of lightning. They are not aware of the fact that solar PV is in modular form and can be connected in series and parallel to achieve the desired power output. Solar thermal can produce heat by combining temperature and mass (water or hydrogen and so on) running into Kilowatt or Megawatt to run turbine that can generate equal amount of electric power as the existing conventional power supply. It has also been observed that solar energy awareness is very low in Nigeria. To many Nigerians on the street solar P.V. application seems more of science fiction than reality (10)

2.4 Technology of Equipment And Fabrication:

Presently, neither the technology of equipment nor its fabrication is on ground in Nigeria, which means that virtually all the solar equipment in the Nigerian market that is of commercial value are foreign. These make spare parts repair, and sometimes servicing of broken down solar equipment very difficult. It also create time lag between breakdown period and repairs, and in some cases repair of equipment are never possible. In the case of inverter, which is at present widely used in solar hybrid energy supply; whenever it breaks down, it is always referred back to the manufacturers' repair laboratory. Most of the available equipment in Nigeria in the area of P.V are imported into the country by unqualified personals or vendors; the result of this is that equipment which are technically suitable to Nigerian nation could not be distinguished or certified by them when importation is carried out.

2.5 Environmental Problems and Climate Change:

The world including Nigeria are now seeking alternative energy supply so as to minimize environmental and other related problems created by conventional energy sources like Hydro, thermal, gas/diesel and other electric generating sources such as fission or fussion which create more environmental problems, destruction and risk. Japan, in fact, showed last summer in the early months following the March nuclear disaster that it could cut its consumption by 15 percent. (11) This featured in both Agenda 21 and the Climate Change Convention. Some of these negative impacts from fossil fuels can be remedied to some extent by turning to sustainable energies as alternatives, especially solar energy. Some of the environmental wastes and the primary energy sources are given in Table 2.

Table 2: Environmental wastes from generating plants

Primary Energy Sources	**Environmental Wastes**	**Remarks**
Gas turbine plant	Nitrogen oxides (NO_X), carbon monoxide (CO), Sulphur oxides (SO_X), lubricants etc.	Dangerous to humans, plants and animals and need sophisticated technology to control.
Diesel engine	Nitrogen oxides (NO_X), carbon dioxide (CO_2), Sulphur oxides (SO_X), polycyclic aromatic hydrocarbons (PAHs), particulate matter.	Dangerous to humans, plants and animals and need sophisticated technology to control.

Solar energy plant	Silicon tetrachloride, Cadmium, Selenium, Sulphur hexafluoride, potent greenhouse gas.	Impacts negligible and waste easily disposed off.
Biogas plant	Greenhouse gas, Solid wastes	Impacts negligible and solid wastes used as agricultural manure.
Small Hydropower Plant	Water spill from flood	Impacts negligible and easily controlled.
Nuclear	Radiation of various forms and degrees	Dangerous with non easily dispose waist whenever accident occurs

2.6 Government Policy: .

In Nigeria there is no clear policy, investment, task in the areas of renewable energy like in the case of other energy generating sources like hydro, thermal, nuclear and others. The people in government who are to make policy and the common man on the street are very much unaware of the existence capacity of solar energy; many people in these areas assume that solar energy can power only small bulbs and at most television set. The print media also has not produced enough publicity on the subject matter.It is evident therefore that the problems of Solar energy in Nigeria though enormous, but can be filtered within short period if government gives proper attention to research, development, commercialization and installation of solar equipment through good policy evolution

2.7 Building Compliance:

Much more individual solar power generating capacity are available in Nigeria but it is limited because it is observed that most of the buildings in Nigeria are not solar compliance, the few that are so occur by accident and not by design.

2.8 Component Failure:

Component failure occurs when a fully installed operational device such as street light or home device becomes un-operational shortly after installation. Since the process of solar energy is very new in this part of the world, users get turned off; especially if it does perform

up to the years of guarantee which the equipment is rated With experience, equipment and component failure occur mostly with such ones that does not carry manufacturers address, hence guarantee.

2.9 Cost of generation:

At present**,** comparing equipment and installation cost of solar energy with other energy supply sources, solar energy is higher on the short run but, it is however cheaper on the long run. The result shows that the PV source is more expensive up to 4 years of installation. This is because solar energy components are vey expensive and they are mostly imported except the cables and few accessories, and this result also show that beyond 5years PV power GSM becomes more attractive because of low running cost (12), (13) Higher percentage of the population in Nigerian are low income earners and cannot afford or acquire solar power however upper income earners have access to other energy supply sources like petrol/diesel Gen set, apart from the grid.

2.1.1 Political Problem:

The politics behind acquisition and installation of solar energy at both the governmental and technical level in Nigeria is not encouraging. On the government part there is no clear cut legislation backing the utilization of renewable energy including solar energy unlike other power supply sources like hydro, thermal. Government has not at any time embarked on giant step by installing or acquiring large solar power plants running into hundred of watts or more as in the case of other installed power supply sources and as applicable in other countries.

2.1.2 Technical Problem:

On the Technical side, the electric engineers who are currently saddled with the problems of design and installation of electricity in homes and industry have not come up with clear cut design for provision for solar electricity energy installation in new or already wired buildings, homes or industries.

2.1.3 Research and Development:

In the area of research and development, solar thermal has taken the lead though most of the achievements have not been commercialized. On the other hand, very few indigenous research and development has been recorded in the area of Solar P.V.

2.1.4 Energy Wastage:

In the present day Nigeria, there is unhealthy attitude of energy wastage by some individual and groups. For instance, it is very common with some households to install 500W halogen security light at the four corners of the premises. This is further complicated by the

installation of numerous energy consuming inefficient equipment inside the rooms of the same premises. Considering proper stand alone Solar Energy installation, 500W solar power supply will be enough to power a domestic home when energy saving equipment are employed. .Most homes and industry in the country still use incandescent and halogen lamp which generate light and heaters consequently inefficient. Most industries in Nigeria make use of electric motors. compressors and boilers which are enormous energy consumers and constitute a great percentage of energy been consumed by industry. Consequently there is a great potential for saving in industry given the efficient use of these electrical devices (14)

2.1.5 Theft and Vandalization:

Theft and Vandalisation is one of the principal problem facing solar energy utilisation especially users of P.V. panel. Vandalisation is not prominent in Nigeria because of the level of awareness and utilization which is still very low, however few cases have been repotted unlike other African countries.

3.1 Prospect for Solar Energy

There are various available opportunities and conditions that favor the installation and development of solar energy in Nigeria, as evident in table 1 above and few of them were discussed below.

3.2 Location:

One of the greatest assets that Nigeria has that can facilitate solar energy generation in Nigeria is her geographical location in the Globe, that is, in the equatorial region which is full of large quantity of solar radiation.

3.3 Communication Application:

Application of solar Energy to Communication and Telecommunication in rural and remote areas requires no fuel transportation and thus reduce problems encountered including that of fuel supply to such installation; on the long run it is also economical

3.4 Population:

In Nigeria less than 20% of 140 million population is connected to the national electricity grid. (7) posited that 10% of urban population and 5% of rural population of Nigeria have access to the National Electricity Grid. Going by that submission, it is clear that solar energy installation and utilization in Nigeria is at very low ebb. This implies that prospect for solar energy demand and utilization is great in the near future if developed for domestic and industrial application.

3.5 Inability PHCN To Meet Demand:

The mirage of problems encountered by Power Holding of Nigeria (PHCN) resulting in her inability to supply the required electricity to the Nigerian Nation, due to lower generation capacity, out dated equipment, and others similar factors inclusive make the future of alternative (solar) energy is very bright. The installed capacity for electricity generation, which is 98%owned by the Federal Government, increased by a factor of 6 over the period 1968 to1991 and by 1991, stood at 5881.6 MW. No further addition to generating capacity was experienced over the subsequent decade (15)

3.6 Some Solution Preferred to Solar Energy Installation in Nigeria

Despite the few problems confronting the development of solar energy in Nigeria, the prospect is still high if the relevant solutions prefered are adopted.

3.7 Affordability and Purchasing Power:

Considering the population of Nigeria and her income distribution, the foremost of the problem to be solved is affordability. The problem of affordability can be tackle in two ways: (i) by tax incentive for Nigeria solar generator (P.V) manufacturers or drastic reduction of tax on imported solar generators, (ii) Government subsidies on solar P.V, solar thermal generators and all related accessories. In Germany for instance, security and profitability to the private sector investing in Renewable energy (16) Ability to purchase can be increase through increase in per capital income, subsidize and tax reduction on imported solar materials.

3.8 Creating Awareness:

Taking a holistic view of the situation of things and solar energy use in Nigeria: it seems right to say that government policies have a lot to do with the level of use of this energy. Both issues of cost and awareness can be taken up by government policy. (10) The Federal Government of Nigeria through the Energy Commission of Nigeria has awarded and installed a number of street light projects throughout state capitals of Nigeria. Also, River Basin Development Authorities (such as Ogun-Osun River Basin Development Authority with headquarters in Abeokuta), has awarded and installed numbers of solar water borehole system through the authority's states of operation in Nigeria. These projects have created a lot of awareness among the Nigerian population. The University of Agriculture, Abeokuta in collaboration with Betamag Engineering and Management Services Nig. Ltd. have over the years conducted many National and International workshops and seminars with participants from different walks of life and at the helm of affairs in Nigeria in attendance. All these have

created widespread awareness leading to increase in adaptation of solar energy technology as an alternative native energy source in Nigeria.

3.9 Technology of Installation:

Most houses in Nigeria are connected to the national electricity grid for their sources of electricity while others employ diesel/petrol auto-generating set. The technology of energy mix and hybrid is recommended for effective utilization of solar energy system. Furthermore, the increase of average PV system size may lead to new .strategies like eliminating the DC-DC converter that is usually placed between the PV array and the inverter, and moving the MPPT to the inverter, resulting in increased simplicity, overall efficiency and a cost reduction.(15)

3.1.1Technology of Fabrication and Component:

Since most P.V. equipment presently available in Nigeria are imported, which makes the repair of broken down equipment very difficult most especially, A/C inverter system (A/C inverter system is the interpreter between the DC supply from the PV and the already installed A.C. power supply from the grid etc). The solution to this is to import service station with the equipment to be imported, most especially when large consignment is involved. This is also the solution to the problems of components failure in addition to careful choice component manufacturer from where the component to be used by installer is imported. Alternatively local design and production solar energy equipment with locally available components should be pursued.

3.1.2 Preventing Theft and Vandalization:

There are so many ways to protect or be employed to prevent theft or vandalization of solar equipment. One of such ways is to provide anti theft screws to bolt the frame to the installation rail during installation. Another way is by coloring and inscribe model and serial no on the solar panel's frame. It is obvious that these can not totally prevent theft or vandalization. A practical way of preventing theft is by putting concrete cement on the frame of the solar panels when mounting or during installation it, so that whosoever which to remove the solar panel illegally will end up loosing the solar panels completely..

3.1.3 Identification of good geographical location:

The problem of geography can be solved by integrating the most relevant and important aspect of solar energy regarding installation, generation in the school curriculum of the concerned professional like Civil, Surveying, Elect/Elect who are the first contact point for proponent or users of solar energy. For examples before irradiative equipment that is installed in a building can receive maximum solar radiation, that equipment or building

rooftop must be placed at certain direction and also inclined at certain angle to the horizontal. Regular workshop for various professionals will also serve better.

Result and discussion

Communiqué reached in 2007 National Energy Forum (NASEF) among others, identified challenges to Solar energy development in Nigeria as : Cultural restriction on land use, Lack of appropriate institutional framework, Low level of technical expertise, vandalization and theft of system component ,and lack of local manufacturing of system component-PV. Final recommendation among others include: financial package for solar energy projects, National Energy Master plan and Renewable Energy Master plan should be approve for the country.(17)

Conclusion

In this paper, a review of solar energy system in Nigeria, including its prospect, associated problems and possible solutions was presented. We have over the years treaded the way to success in the areas of solar energy Hybrid and Stand Alone installation technology by taking to cognizance that, in most cases, the proponent of solar power (Domestic or industrial) in Nigeria are those that were already connected to the grid with highly inefficient devices. To minimize cost and avoid ruining the newly installed energy system by the proponent; is to run parallel wiring to new service points as applicable, with highly efficient energy saving devices in the site, having individual templates of L_1 , L_2 , L_3 , L_4 - and so on. In this system connection, L_1 is connected to security devices, L_2 to lighting points, L_3 to medium low power devices like TV, VCR, Radio and so on. Independent supply of energy to devices in hybrid form help to avoids total or complete breakdown resulting in total blackout in a single shot. This method is recommended for installer of solar energy in an environment similar to Nigeria and also advocates for the training of technical personnel that can effectively handle solar system in addition to the problems, prospects and solution preferred above.

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