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ENERGY ACCESS IN NIGERIA: AN ASSESSMENT OF SOLAR UTILIZATION IN IBADAN

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ABSTRACT
Electricity is a major driving force of an economy. Mostly, its generation in developing countries is from hydro sources, oil and gas as well as firewood/charcoal. As a maritime and an oil and gas economy, Nigeria generates its energy from hydro, oil and gas. Concerns about depletion, environment and effectiveness of distributing produced energy are shifting research direction to other natural sources especially solar energy. The paper evaluates the consumption pattern and attitude of Nigerians towards solar energy utilization. The findings reveal that about 60% of the residents in the region receive less than 4hrs of electricity energy supply daily from the regulatory Power Holding Company of Nigeria (PHCN) in the country; which is absurd to the residents; fuelwood consumption is the main alternative; the level of solar energy awareness is high, and, its utilization is only limited to traffic lights on 3 main roads, ATM machines and few water pumps in 2 new residential estates. The challenges towards enhanced adoption of the source of energy and the implication for development are discussed.

Keywords: Energy, Efficiency, Sustainability, Solar, Nigeria.

1. INTRODUCTION

Energy is an essential stimulant for social and economic growth. It exists in chemical, mechanical, electrical, heat and light forms. The final end-products are electricity and fuel. Ensuring regular generation and supply for respective needs has always been important to every nation and newer sources and technologies are designed from time to time always. The earliest sources of energy are from biomass as fuelwood, animal and crop residues. Over time, interests shifted towards fossil hydrocarbon deposits such as coal, crude oil, natural gas and tar sands (Kupchella, 1993; Botkin and Keller, 1998). These sources deplete fast and upset natural balance of important atmospheric gases depending on the rate of exploitation thereby being unfriendly environmentally and unsustainable in meeting the needs of increasing human population. They contribute to the phenomenon of global warming (Lohman *et al*., 2007). Electricity supply in Nigeria is traced to 1896 when the first power station was built in Lagos. As documented by NEPA (1998), it spread to Port Harcourt (1928), Kaduna (1929) and Enugu (1934). Numerous changes had since been witnessed since then. In particular, the initial unit of the Public Works Department providing supply up till around 1946 was changed to Nigeria Government Electricity Undertaking (1946 – 1951), Electricity Corporation of Nigeria (1951 – 1974), National Electricity Power Authority (1974 – 2002) and Power Holding Company Nigeria (2002 till date). The sector is accorded paramount significance in Nigeria national development plans, policies and budgets as well as the strive by the country to be one of the first 20 largest world economies by the year 2020 (Energy Commission of Nigeria, 2008).

Power Holding Company of Nigeria (PHCN) is responsible for electricity generation, transmission, marketing and distribution in Nigeria solely. The few exemptions are around the tin mining and the oil producing areas of Jos Plateau and Bonny Islands where National Electric Supply Company and Shell Petroleum Development Company are in charge. Supply over the past 3 decades has been from oil and gas. Some 79% of the supply between 2002 and 2007 were from petroleum products, 16% from hydro, 5% from natural gas and 0.04% from coal (Fig. 1). Demand for electricity has always exceeded supply. As shown in Fig. 2, access is far below the world value and that of the African continent. The value of about 136 kWh/capita is less than 3% of that of the Republic of South Africa about half of that of Ghana. Further analysis of the figures assumes a strong correlation between the energy access and the per capita income of the countries. PHCN is always undergoing a reform or the other. It is owned by the government fully but with some private sector involvement in recent times, all with a view to improve performance (National Electricity Power Authority, 1997).

As argued in Sambo (2005), electricity generation is barely understood and achieved while access is rather deplorable. The oil and gas sources are unfriendly environmentally. The technology for distribution is intensive and prone to disaster and safety intricacies which are worsened by recent socio-political crisis in the producing Niger Delta area. Hydro sources suffer from water level fluctuations in dams while coal deposits are depleting and becoming obsolete. Akarakiri (2002) and Adesiji (2007) identified the specific challenges to

energy access in the country to include (i) scarcity of manpower and capital for facility maintenance; (ii) obsolete transmission equipments and distribution grids which break down frequently; (iii) poor monitoring of distribution networks with a view to reduce losses to uncontrolled system expansion and (iv) low awareness on alternative and renewable sources. Many households depend on traditional fuel wood consumption still.

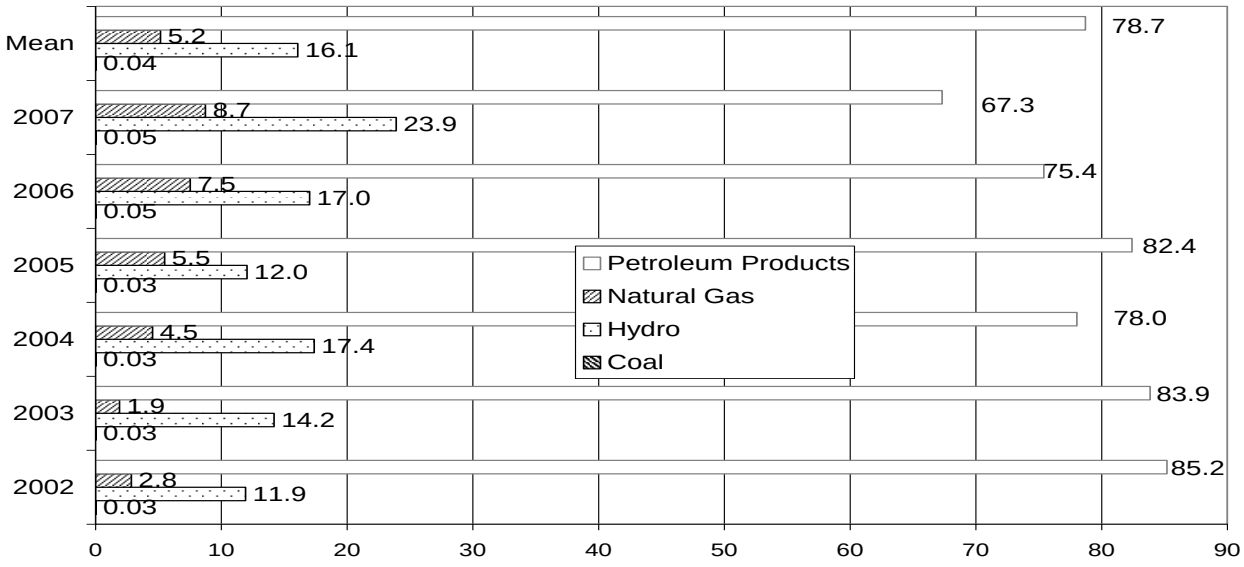


Fig. 1 Energy Consumption by Type in Nigeria (2002 – 2007)

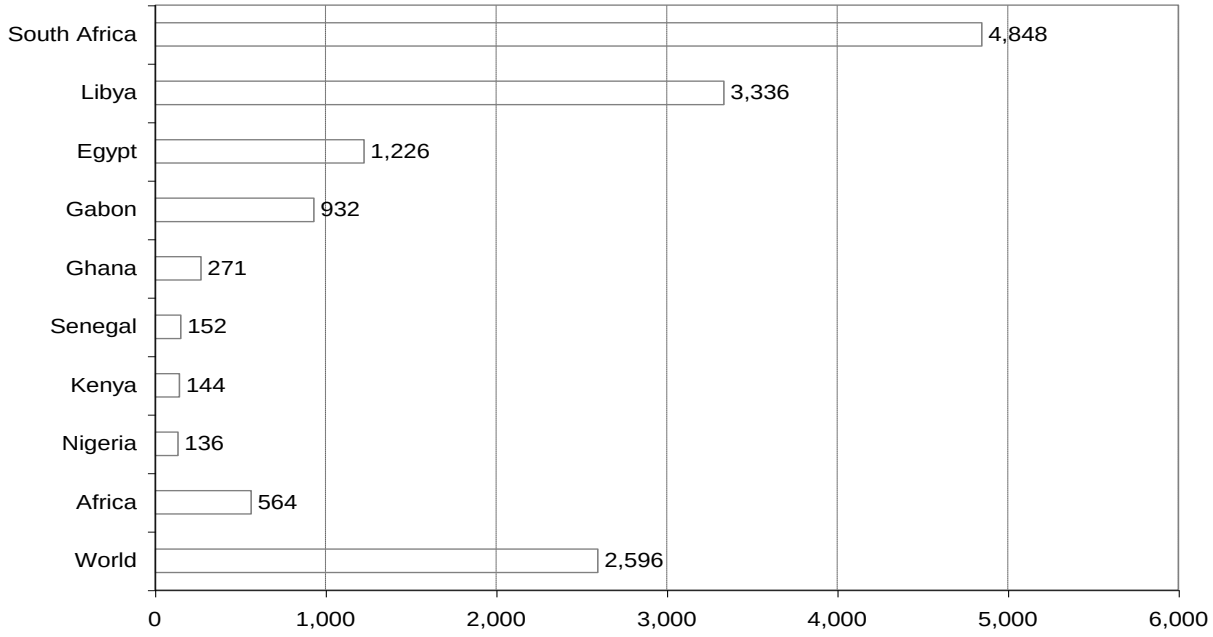


Fig. 2 Comparative Access to Electricity in selected African countries (kWh/capita)

The consequences on the development and the need to drive up supply are reviewed in Subair and Oke (2008) viz.: (i) demand exceeding supply increasingly; (ii) costs of producing goods and services rising astronomically (iii) manufacturing industries and small scale enterprises (SMEs) folding up; (iv) substandard goods and services being produced and inefficiently; (v) foreign products proliferating into the country (vii) employment and other social vices rising against the GDP (vii) undue stress being witnessed within the socio-political landscape and environment; and (viii) socio-economic development being retarded. The strong nexus identified between electricity and socio-economic development of the country led to a National Energy Policy (NEP) being

formulated in 2003 to propel access to the resource (Sambo, 2005). The objectives are:

(i) To ensure the development of the diverse electricity resources, with option for enhanced achievement of national energy security.
(ii) To guarantee adequate, reliable and sustainable supply of the energy at appropriate costs and in environmentally friendly manner.
(iii) To guarantee efficient and cost effective consumption pattern of the resources.
(iv) To accelerate the process of acquisition and diffusion of technology and managerial expertise in the relevant sectors of the economy.
(v) To promote increased private sector investments and development of the energy sector industries.
(vi) To ensure comprehensive, coherent and coordinated plans and programmes of the sector, and;
(vii) To foster international cooperation in the energy resource trade and projects development in Africa and the world at large.

Solar energy is one of the eleven sources identified including wind, wave, solar, geothermal and nuclear. The policy sought to integrate it in a mix that could ensure optimum exploitation, conversion, distribution and consumption. It is planned to be pursued "aggressively" in order to be integrated into the national power grid. A summary of the solar energy potential in Nigeria is provided by Sambo (2008). He argued that the country receives about 5.08 x 10^{12}kWh of energy per day from the sun; that if solar energy appliances with just 5% efficiency are used to cover only 1% of the country's surface area, then 2.54 x 10^{6}mWh of electrical energy could be obtained. This, he estimated as being equivalent to 4.66 million barrels of oil per day. He supported his argument with the achievement of the solar photovoltaic pilot research project plants that were installed for some villages in the early 1990s by the United States in the semi-arid north-western Sokoto State of the country on stand-alone basis. They reveal that solar systems are most viable, economical and sustainable of all the sources.

Aggressive pursuant of solar energy for the country is imperative based on the forgoing. Its utilization over time and space deserves being examined comparatively relative to other sources. This study attempts an assessment of the status of electricity supply in the Ibadan Nigeria currently; the level of satisfaction with supply, and the alternatives in use including solar energy. Awareness and adoption of solar energy as well as the existing solar powered facilities in the area are evaluated. Also examined are the challenges towards a more rapid adoption.

2. THE AREA OF STUDY

Ibadan Metropolis (Latitude 7^{o}25'N, Longitude 4^{o}00'E) is the capital of present Oyo State in southwestern Nigeria since 1991 (Fig. 3). It was the administrative capital of the whole of Southern Nigeria (1946-1960); the Western region (1960-1962); Old Oyo state (1976-1991). Eleven (11) of the 33 Local Government Areas (LGAs) of the state are within Ibadan region. Five of these are within the Ibadan Metropolis and the remaining six in predominantly rural hinterlands. The Metropolitan area is about 3,123.30km^2 and the traditional city core about 463.33km^2 (Agboola, 1995). In view of its latitudinal location, the state enjoys a tropical equatorial climate with high insolation all the year round. Mean length of day light varies between about 11.5 hrs in dry season to 12.7hrs in the wet season. Mean daily full sunshine hour is about 7.3hrs of the possible sunshine and is highest around the peak of the dry season in March. The study area, Ibadan, was the largest African City up till the 1960s and has a population of about 750,000 presently. Two of its five Local Government Areas of administration are studied which are Ibadan North and Ibadan North East (Fig. 3). The combined population is about 639,563 (Federal Government of Nigeria, 2006). This is about 48% of the population of the city. Its physical development reflects mixed traditional and modern African layout. Farming is the main occupation in the rural axis. Manufacturing, dominated by SMEs, white-collar jobs and informal services dominate the urban areas. In particular, the local industries include brewing, canning, publishing, tobacco processing, and manufacture of furniture. Traditional handcrafts such as blacksmithing and ceramics, as well as weaving, spinning and dyeing retain important roles in the economy of the city. They all depend a lot on electricity supply.

3. METHODOLOGY

Using a questionnaire, a total of 240 households were sampled with respect to (i) the status of electricity supply in the area presently; (ii) the level of satisfaction with supply, (iii) the alternatives in use (iv) the level of solar energy awareness and adoption (iv) the existing solar powered facilities, and; (iv) the challenges towards adopting the more sustainable solar option. Data for the study were collected through a set of multiple sources. A detailed reconnaissance of the LGAs was embarked upon in October 2009 with a view to determine the sampling protocol and procedure. This was supported by a set of township maps and field assessment, administrative records interviews and social survey. Some field assessments, interviews and measurements were accomplished during the period. A set of social surveys was designed for the research. In parts, the questionnaire instrument covers the aspects of current electricity supply and demand in the area, the attitude and behavior of respondents on the current situation, the alternatives in use and their perception of renewable energy systems. Knowledge of the relative significance of solar power system and hindrances against adopting it were covered.

A total of 120 of the questionnaires were administered at household (HH) levels in each of the 2 LGA on a stratified random protocol. A total of 113 were recovered duly completed in Ibadan North and 104 in Ibadan North East, representing 94% and 87% respectively. The analysis was done using interactive SPSS (ver. 16.0) and GIS packages.

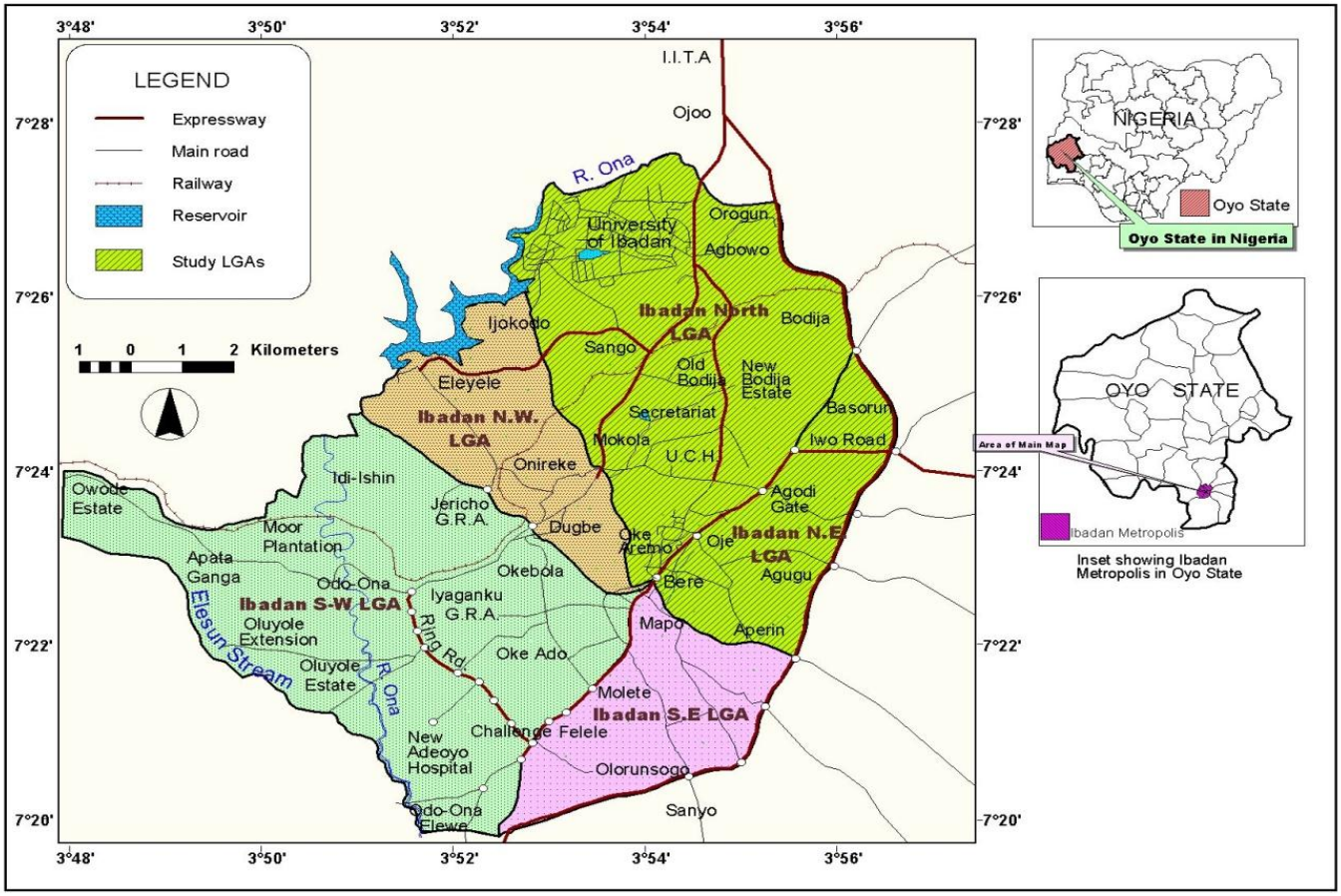
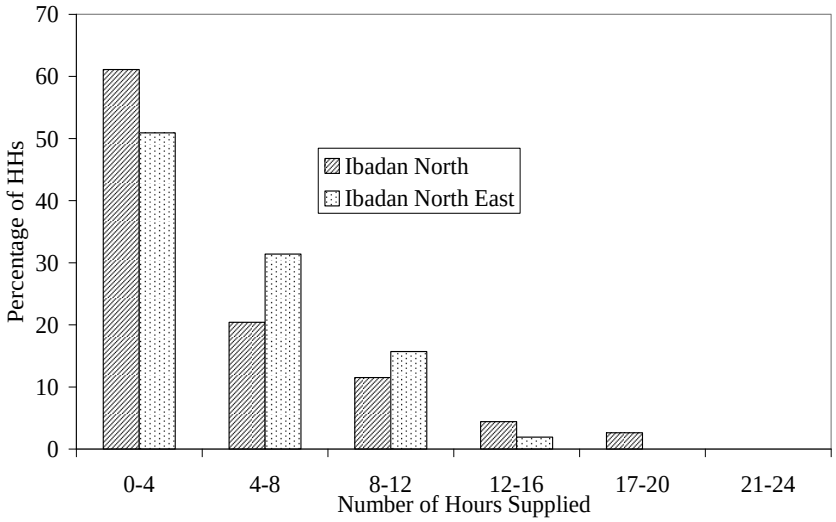
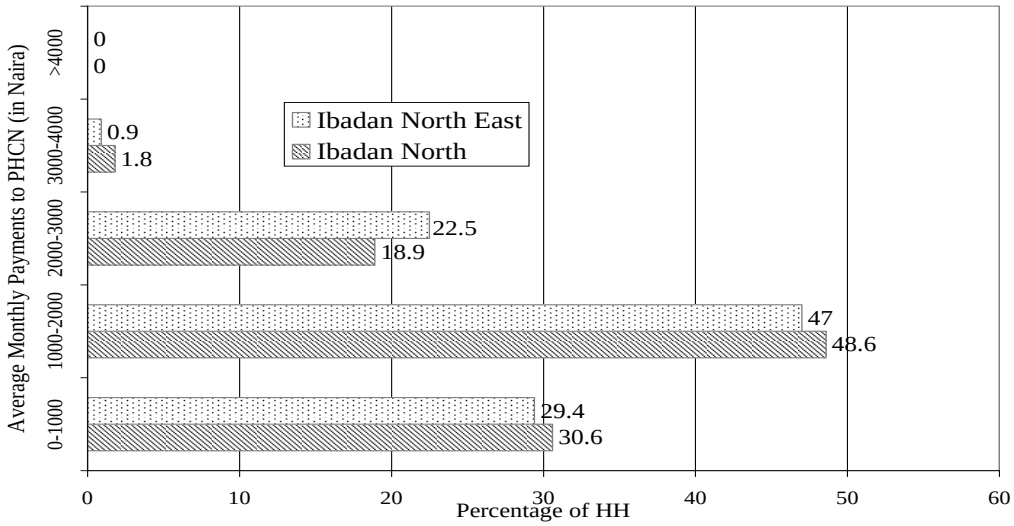


Fig. 3: The Study Area



(a) Average Daily Supply by PHCN



(b) Average Monthly Bills paid to PHCN

Fig. 4: Status of Electricity Supply in the Study Area

4. RESULTS AND DISCUSSION

Electricity Supply in the City

No single HH informant in the area ever received uninterrupted supply for a whole day (i.e. of up to 21 hrs – 24 hrs) since about the past one year in either LGAs. As shown in Fig. 4, only 2.6% of the HH have been receiving between 17 hrs - 20 hrs in Ibadan North while a larger proportion of 61% and 51% in Ibadan North and Ibadan North East receive less than 4 hrs. The epileptic supply situation is berated by almost all the interviewed. Some 48.6% and 47.0% of the HHs are paying between ₦1,000 – ₦2,000 to the supplier PHCN as monthly bills in Ibadan and North East LGAs respectively. About 1.8% and 0.9% pay the highest of N3,000– N4000 monthly. Only 1% of the interviewed HHs Ibadan North East LGA adjudged the supply status as good. Some 65% view it as bad in both LGAs and 34% as fair. The billing system is regarded unfair by all the HHs because everyone is charged almost the same amount monthly, whether there is any supply or not.

HH generators of different models and capacities are used extensively as alternatives. Use of inverter is close to nil. Those who can not afford the facility depend on fuelwoods and kerosene stoves extensively for cooking, in that order. They use torch lights, candles and lanterns for lighting. About 75% in Ibadan North LGA and 77% in Ibadan North East have at least a generator each. But for a few affluent who could afford higher capacity generators, more than 60% of the generators in use are of less than 1kVA, referred to locally as 'I better pass my neighbour'. They can only power a few bulbs and fans at a point in time. The alternatives are unsuitable to the respondents. While kerosene- stoves and lanterns are unsafe in view of common recent incidences of explosions in different parts of the country, generators produce noise and emissions in high proportions. Some families are reported to have died from inhaling such emissions while sleeping overnight.

Level of awareness on solar powered electricity

All the HH informants are aware of solar energy. This is through the mass media and adverts by various stakeholders in the country. Only about 66% noted that they had observed the technology working on a few street and traffic lights, 25% had seen it being used for lighting in houses and 9% for pumping borehole water.

Some 87% of the informants are willing to adopt solar source of energy in their residences as the main alternative to the epileptic supply from PHCN in their neighborhoods. But they all claimed they have no confidence in the technology yet because they doubt its sustainability based on the level of development in the country presently.

The Solar Powered Facilities in the Area

The existing solar powered facilities in the LGAs are shown in Table 2. Those in Ibadan North LGA are street and traffic lights on 3 main roads, some Automated Teller Machines (ATM) on the campus of the University of Ibadan and lighting in a few residences in the New Bodija Housing Estate. Some borehole water pumps are being powered by solar energy in Agugu and Bere neighborhoods of Ibadan North East LGA. The locations are mapped as presented in Fig. 5. Street and traffic lights are community development projects of the state government. Respective banks own the ATM machines while are HH lighting and borehole pumps are by individual HHs.

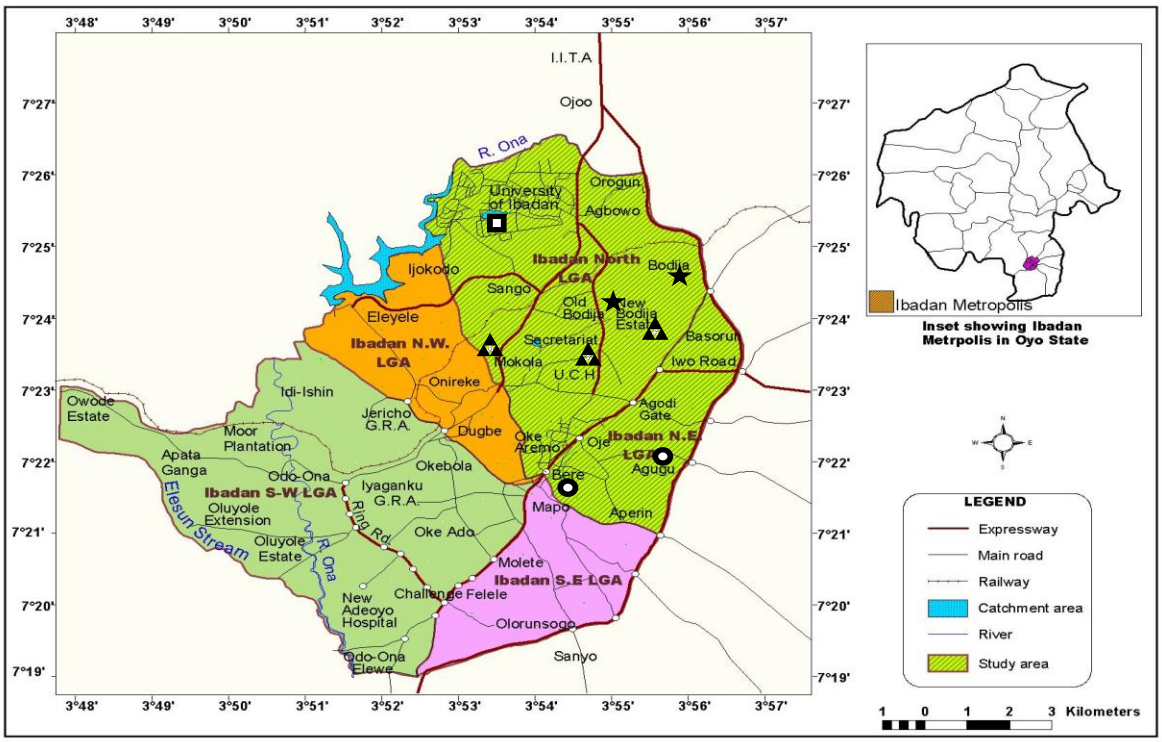


Fig 5: Solar Powered Facilities in the study area

Some solar energy service providers in the city berated the low level of adapting the technology in view of the failure by PHCN, and that almost all those using it are for demonstration exercises. They noted that some others are producing locally-made reading lamps, flashlights, CCTV cameras, billboards and portable mobile fans using the technology but that many of the facilities are highly substandard.

Table 2: Solar Facilities in the area

LG	Facility	Location	Provider
Ibadan North	Street and Traffic Light	Parliament Road Ikolaba Estate (50 Units on a 2.13km length) Sabo	Govt.
	ATMs	University of Ibadan	Banks
	HH Lighting	New Bodija Estate	
Ibadan N/East	Water Pump	Agugu Bere	HHs

Challenges against Solar Energy Use in the area

Lack of trust in new technology is the main challenge identified by informants against the low acceptance of solar technology in the area. Some 73% claimed that the present reports from those who had accepted it are not encouraging enough, and that they would rather tarry a while and get be more convinced before deciding. Next to this is affordability. Some 82% of those who are willing to adopt the energy source reported the present prohibitive costs of the facility acquisition, installation and maintenance. They argued that on the long run, the cost of solar energy to an average HH is about thrice that of generators, kerosene and fuelwood at the current rates. They complained about low voltage from the solar panels available in the country which is below what is required for HH needs. A few others exhibited fear over common fake products and spare parts. All the service providers identified the limitation of the government to support the industry and service providers through fiscal and economic policies. None of them claimed knowledge of any operational public programme on solar energy support, implementation or enforcement, other than occasional patronage of vendors on street lighting and rural water borehole. There are no tax holidays for the technology manufacturers or importers. Yet the local currency has continued to depreciate in the global market and with stiff competition from the growing lucrative business of HH generator importation into the country. These do not support genuine solar energy equipment, cells and accessories which those using the technology complained about.

Implications for Sustenability

The implication from the forgoing is that the monopoly being enjoyed in Nigeria energy industry by PHCN can hardly guarantee more than 4 hours of supply in the study area daily as at present. It was only able to generate about 40% of the installed 6,000MW of electricity in its nine electricity generating stations in 2008 [12]. This has been

exerting pressure on human activities including manufacturing and social well-being of dwellers. Efficient energy sources and access are essential drivers for promoting economic development, job creation and poverty alleviation. Sourcing from hydro, oil and gas resources is highly mechanical, capital intensive and unsustainable environmentally. The alternatives in use encourage biomass depletion. Dependency on generators cannot support employment generation, economic development and growth locally. Their attendant safety, health and environmental challenges pose more challenges. In particular, increasing efforts at mitigating climate change and emission of GHGs focus specific attention on the aspects of electricity supply and energy security.

The inference is that access to viable, economical and cleaner energy such as solar and wind energy can hardly be compromised. They have less negative effects on the environment. As the major providers in the third world, interest in the technologies by respective government organs cannot be overemphasized. It is essential that every feasible sustainable source for generation and distribution be explored. This will not only afford manufacturing companies the opportunities to survive but to also compete favourably in regional and global markets. Respective ones would attract commensurate improvement in production of better energy saving materials. Indeed, it is established that poor accessibility to electricity in the area is a main reason for general lack of confidence in government and its development activities.

5. CONCLUSION

It is established that the current supply is a far outcry from demand. Hence, the need for practical solution through low cost renewable sources like solar energy systems. They are non - depletable and have less negative effects on the environment. Nonetheless, current solar market in developing countries are neither affordable, accessible nor sustainable. Local content input will enhance acceptance, make the facilities more accessible and cheaper and more acceptable. It will serve as an alternative to the ever increasing cost of petroleum products, protect the ecosystem and also support climate change.

It calls for research and development in relevant areas and formulation of achievable policies. It requires decentralization and localization of generation, transmission and distribution. It needs to be more private sector driven, integrate local knowledge system and with aggressive creation of awareness on energy efficiency and conservation. Adequate policies and subsidies would encourage greater participation and lead to competition that will lower the prices of essential components. Environmental concerns through encouraged deployment of other low-carbon technologies and reduced air pollution sources such as wind and wave energy also qualify as alternatives.

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