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An Assessment of the Prospects of Introducing Solar Energy in the UNEC Energy Mix

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ABSTRACT

With the continued annual increase in the number of students and staff within the University of Nigeria Enugu Campus (UNEC), the demand on energy has continued to rise. There is need for an efficient and regular power supple to meet the growing demands in order to ensure proper functioning of the academic environment. The Campus currently receives an average of about 5 hours of electricity from the national grid daily. This is due to the erratic power supple and inherent in the country, making learning conditions stressful, administration more tedious and the living conditions in the students and staff housing difficult. As an alternative the campus relies on fossil fuel powered generators which apart from high cost of maintenance, are grossly inefficient and constitute environmental pollution with the constant release of harmful gases and noise. The study investigated and assess the current state of energy supply within the various zones of the campus, and explored the potentials of introducing an efficient, safe and alternate source of power in the campus energy mix. It evaluates potential of solar energy installations and possible challenges associated with the University of Nigeria, Enugu Campus.

KEYWORDS: *solar energy, fossil fuel, power generators, grid electricity, UNEC*

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1. INTRODUCTION

Power (electricity) supply has been considered as one of the catalysts of development as well as a major determinant of productivity and efficiency. From small residential units to large commercial or industrial layouts, the consistency of power supply has a direct influence on the efficiency of the facilities. In educational institutions, conditions conducive to learning like adequate lighting, proper ventilation and access to the internet, as well as proper administration all rely on efficient power supply. In addition, the age of information technology places an even greater demand on electricity within campuses, with computers replacing paper documents, smart phones replacing notebooks, libraries becoming digitalized, etc. With the increase in the number of students and staff within the campus, the demand on power supply is also on a continuous rise. The University of Nigeria, Enugu Campus (UNEC) currently receives from the national grid less than an average of three hours of Electricity on a daily basis, due to the erratic power supply that has become the norm in the country, thereby making learning conditions stressful, administration more tedious and the living conditions in the hostels and staff quarters very uncomfortable. As alternative to public power supply, the campus relies on fossil fuel powered generators which are not an efficient alternative as they constitute environmental pollution and the high cost of fuel and diesel means that they are run on a limited time frame. This calls for an efficient and a renewable means of alternative power supply that can meet up with the demand in order to ensure proper functioning of the institution. This paper explores the prospects of an alternative and efficient source of power viz a viz Hybrid solar energy, the possible challenges associated with it and the practical ways to establish solar energy as an active and passive means of electricity supply within the University of Nigeria, Enugu campus.

2. THE STUDY AREA: THE UNIVERSITY OF NIGERIA ENUGU CAMPUS (UNEC)

The University of Nigeria, Enugu Campus (UNEC), formerly known as the Nigerian College of Arts, Science and Technology, is one of the campuses of the University of Nigera. It was incorporated into the university in 1961, and its buildings now form the Enugu Campus (200 hactares) of the University located in the heart of Enugu Metropolis, the administrative capital of Enugu State of Nigeria.

2.1. ZONING AND SITE LOCATION

The Campus has an irregular shape, which affected landuse and zoning. The campus is zoned into the following areas, (see fig 1):

- The Core (administration and academic)
- The Residential Areas (students hostels and staff housing)
- Communal buidings (commercial and and Works and services zone)
- Sports

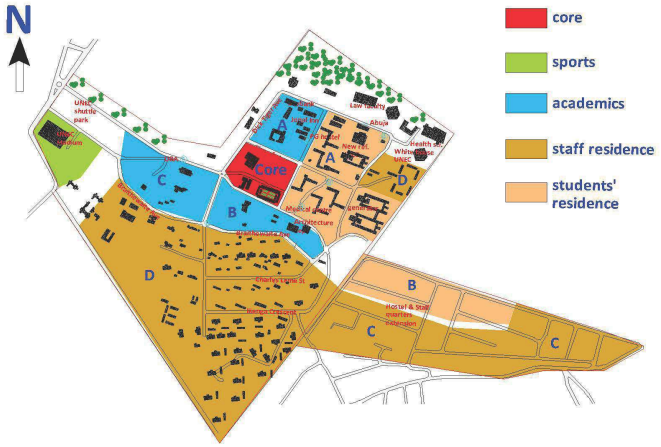

Figure 1 Map of the Enugu Campus, showing present site zoning. (Source: Master Plan, University of Nigeria, Enugu Campus)

The original core of the campus contained the following main facilities:

- Administration block/ examination hall (commonly called Main Hall)/ library complex
- A 3-storey academic complex designated blocks A and B (popularly called), arranged to enclose an ornamental court
- An ICT/ e-learning Centre (formerly housing the students' refectory (also known as the) and common room
- A students' medical centre

The Academic area is grouped as follows:

- Academic zone A (Faculty of Medicine and the Paramedical Department located north of the Faculty of Medicine)
- Academic Zone B (Faculty of Environmental Studies)
- Academic Zone C (Faculty of Business Administration and, over time, the Faculties of Law and the Division of General Studies)

The residential areas have the following zones

- Students' Residential Zone A
- Students' Residential Zone B
- Staff Residential Zone C
- Staff Residential Zone D

The sports and recreation grounds are located at the west end by the main approach/entrance into the campus. The campus also has some ongoing projects in the various zones listed above.

3. THE CURRENT POWER/ELECTRICITY SITUATION IN UNEC

UNEC currently receives its electricity supply from three main sources:

- The National Grid, controlled and managed by the Enugu Electricity Distribution Company
- Fossil fuel-powered generators, two located in Zone A (800KVA and 500KVA in capacity) to service the buildings in Academic Zones A and B and Students' Residential Zones A and B, two 500KVA generators along Braithwaite Avenue in Zone D (with only one fully functional), to service buildings in the Core area and Staff Residential Zones C and D. (Works department, UNEC).
- Others: this include private owned generators used by business within the campus, staff housing, and offices and department to supplement the irrational supply from the two mains sources mentioned above.

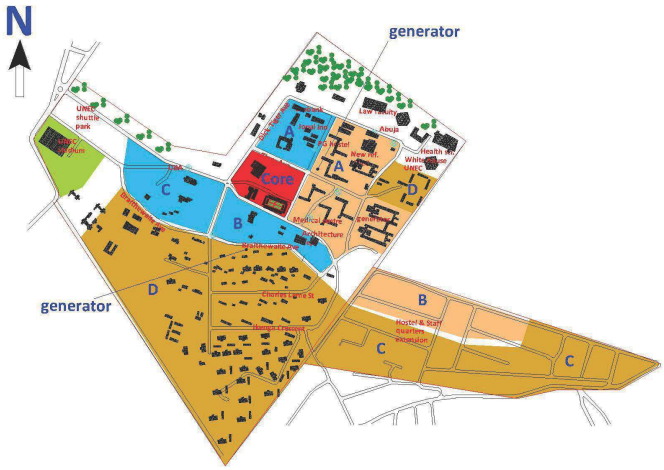

Fig 2a

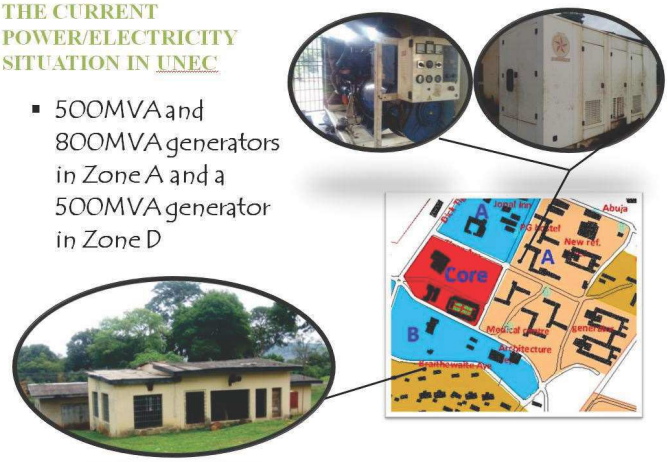

Figure 2a (above) & 2b (below): Map of the Enugu Campus, showing location of University owned generators. (Source: Works department, University of Nigeria, Enugu Campus)

The EEDC supplies cumulatively less than 3 hours of electricity per day due to the campus. The Campus substitutes with self-generation of petrol and diesel powered generators, which currently supply electricity for an average of 3 hours (between 7pm and 10pm), and this supply is rationed among the 8 hostels within the campus, so each hostel receives less than 1 hour of uninterrupted electricity supplied by the generators daily. This is way below adequate required for efficient administration, learning and living standards for both staff and students.

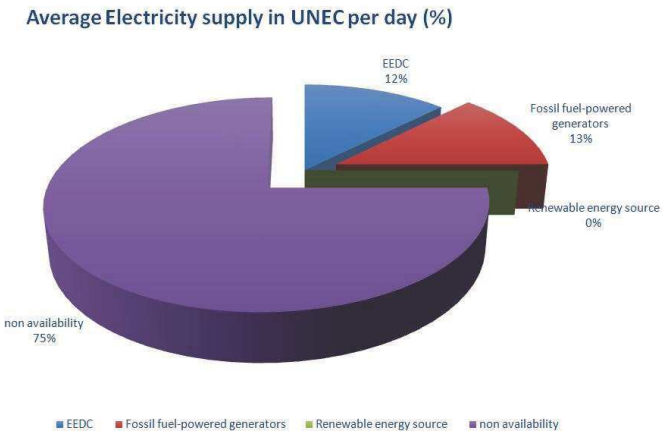

Figure 3 Chart showing the average Electricity supply in UNEC per day (Source: authors field work)

Privately run fuel powered generator is a common sight around UNEC. In a desperate need to supplement the erratic

supply from EEDC and the time-controlled school generator, business owners, individual department and offices resulted to the use oftheir own generators. This ranges from the small 2000 watts generators to the big 100kva generators. The generators not only constitute nuisance (noise pollution) and dirt, but they also distort the land use of the university campus.

4. EFFECTS OF THE ERRATIC POWER SUPPLY IN THE CAMPUS

Academic Staff Union of Nigerian Universities have over the years embarked on incessant strikes that led to months of learning disruption, for reasons including irregular power supply and inadequacy of learning support services and infrastructures for conducive teaching and learning environment. Skelton (2014) stated that extremely poor infrastructure has an effect on teachers, as well as pupils [1]. Diniz et al (2006) in assessing the Contribution of Photovoltaics in a Rural School Electrification Program, [2] observed that a major impact of electrification has been reducing illiteracy and improving the quality of education. This implies that without electricity there is no optimal education. UNEC faces major challenges in the area of electrification and the negative effects of the poor and erratic power supply have taken a toll in virtually every sector of the campus.

4.1. ADMINISTRATION

Staff "are understandably reluctant to work in deprived areas, which lack basic facilities such as electricity, good housing and health care." [3] (UNESCO, 2014). Considering that virtual storages have replaced shelves and cabinets, e-files and folders have taken over most of the paperwork in offices and schools, emails and social media have overridden paper memos, computers have replaced typewriters, and the list goes on. For digitallization to take full effect, a constant supply of electricity is required. In UNEC, proper administration is clearly hampered by the lack of constant electricity and this reduces the general output of work done in terms of precision and promptness.

4.2. ACADEMIC AREAS

Classrooms, libraries and laboratories (including the physical structure and internet/e-library) are the primary learning spaces for students. For this reason a lot of thought needs to be put into the design and comfort of these spaces. In this age where almost every facility runs on electricity, it goes to say that without proper electricity supply, learning spaces become unconducive for learning and this affects the students' productivity. A study carried out by [4] Makoto et al (2008) showed a strong correlation (above 66%) between electricity consumption per capita and higher scores on the education index—a proxy for the mean years of schooling a student receives—across 120 countries.

Productivity is not limited to students alone. The lecturers also in their teaching and lecturing, employ some equipment to aid them in teaching. The use of computers, projectors, smart boards and other equipment require electricity. Even with the presence of proper day lighting and natural ventilation, electricity supply is of utmost importance in teaching and lecturing. Electrified schools provide teachers with better training, new skills and techniques for improved practices in the classroom. In both Sub-Saharan Africa and South America, electrification enabled teachers to become familiar with computers that they then used to engage in professional societies, conduct e-learning, better manage student marks and parental reports, search for educational content, and plan lessons [5]. (UNESCO, 2011).

E-learning has also become a major aspect of learning globally. Scholars can partake in courses and forums online, interact with scholars in foreign schools as well as other parts of the globe and associate with professionals in similar fields worldwide. Today, there is a general decline in teaching and learning in UNEC and one major cause of this decline is inadequate power supply.

4.3. STAFF AND STUDENTS' HOUSING

Hostels and staff housing: The hostels are poorly ventilated thereby placing greater demand on artificial ventilation. Poor electricity supply within the campus, makes it difficult for artificial ventilation, and thus increasing thermal discomfort which generally affects the students attention span, retention capacity and general academic performance.

Lighting: For a typical student, most of the daytime is spent in classrooms, lecture halls, laboratories and libraries. The evenings and night hours are mostly spent in the hostels. This implies that a greater amount of artificial lighting is required in the hostels for optimal student life. From interviews with students it has been discovered that the hostels receive an average of less than 3 hours of light, from both EEDC and the fuel-powered University owned generators. This restricts their hostel activities and inadvertently affects their academics.

4.4. COMMUNUAL AND OTHER FACILITIES

Small businesses within UNEC: Apart from the primary academic activities taking place within the campus, there are other small scale commercial activities which contribute to the effective running of the campus as a university community. Business centres, internet cafes, relaxation spots and eateries all require power supply for their smooth and effective running. The erratic power supply has driven most of these businesses to draw electricity from their individually owned generators. This not only increases cost of running these activities, but also contributes to air and noise pollution and general discomfort within the campus.

5. PROPSECTS OF SOLAR ENERGY

Besides the abundant oil and gas resources that we currently hold, Nigeria is still fortunate to be situated in Sub-Saharan Africa, a region described by the International Council for Science as having the world's best solar resources. Nigeria has 485.1million MWh/day of solar energy in natural units and we enjoy an average of 6.2 hours of daily sunshine.

The use of solar electricity systems aids the capture of solar energy using photovoltaic (PV) cells which convert the sunlight into electricity. This resource has been found to have the capability of providing more power than all the fossil fuels we currently hold if properly harnessed and used to generate green and cheap electricity. Eventually, it can play a part in reducing our huge dependence on fossil fuels like crude and gas for power generation.

5.1. Benefits of solar energy

- Renewable: Solar Energy is a renewable energy source that will always be available and never run out like other non-renewable energy sources like fossil fuels, coal and nuclear. According to NASA, we will have access to solar energy for as long as the sun is alive, which is estimated to be around 6.5 billion years.

- Abundant: The earth presently receives around 120,000 terawatts of solar radiation (sunlight). This is 20,000 times more than what is needed to meet the world energy demand [7]. (US department of Energy)
- Sustainable: solar Energy is sustainable as it is renewable. It meets the needs of the present without compromising the ability of the future generation to meet theirs. We can never over consume solar energy.
- Environmental Friendliness: it is safe and does not constitute any harmful damage to the environment. Though, there are emissions associated with the manufacturing, transportation and installation of solar power system, these is nothing compared to those generated by conventional energy sources.
- Good availability: Solar Energy is readily available in our clime, countries close to the Equator (tropics) receives direct radiation from the sun when compared to those in the temperate regions, so their fore it is imperative that we harness this available resources to the fullest.
- Reduces dependence on fossil fuel generator their by leading to reduction on environmental pollution
- Low Maintenance: one of the major advantages of solar power system is low maintenance. Most solar panels require cleaning once or two times in a year and come with 20-25 years warranty.

5.2. Challenges of Solar Energy System

- Expensive: One of the key challenges in investing in solar energy is the initial capital outlay which is high. Though Solar Energy installation can be said to be expensive at the initial stage, cost of installing photovoltaic panel, batteries and inverter are expensive when considered side by side to other available source of energy but on the long run, this disadvantage becomes an advantage when you compare the numerous benefit of solar panel, and the low cost of maintenance as oppose to conventional power source (Fossil fuel and power from national grid). Also with the recent hike of electricity tariff in Nigeria, the high cost of initial installation of solar can be overlooked. Nonetheless, more recently, the cost of solar technology has reduced by 40% in the last two years Due to advancement in technology and incentives by government and UN agencies.
- Intermittent: Solar Energy is an intermittent energy source. Access to sunlight is limited at certain times (e.g morning and night). Predicting overcastting days can be difficult. To overcome this, solar powered inverter is employed, used to store up excess energy during the day (peak solar hour) and this stored energy is used during evening and night hour (off-peak solar hour). 10 -20 hours of electricity can be stored depending on the capacity and sizes of the inverters.
- Requires Space: power density or watt per square meter (w/m^2) is essential when looking at how much power can be delivered. The global mean density for solar radiation is 170 w/m^2 (European Union) this is more than any other renewable energy source, but not comparable to oil, gas and nuclear power.
- Storage Challenges: Though solar power battery chargers have made it possible for solar energy to be used even during the night, storage and portability remain the main challenges of solar power. Unlike conventional electricity it is not yet possible for solar power harnessed in sufficient quantities and to be transported over longer distances

5.3. Case Study of Universities that have integrated solar into their campus energy mix

Universities across the United States are not only working to make their students smarter, but also to make their campuses smarter and more energy efficient. And solar power is big way that these schools are accomplishing their goals**.**

1. Northwestern University: Northwestern made its foray into solar power in 2011, with a student led initiative to install a 16.8-kilwatt panel display that generates around 20,000 kilowatt- hours (kWh) per year. The student saw to the funding via a fund raising and oversaw installation and project management from start to finish.
2. Drexel University: In addition to installing solar-powered trash cans and compactors on campus and committing to purchase 100 percent of the campus's energy from off-site wind and solar power facilities, Drexel has a program that supports their students, faculty, staff, and alumni in their efforts to obtain solar power for their own homes.

   The University of Arizona: The U of A has been adding more solar panels to their campus every year since 2009, reaching 28,095 kilowatt capacity in 2014.
3. BUTTE COLLEGE: Located on a 928-acre wildlife refuge in Oroville, Calif., this small school was the first college in the U.S. to become a grid positive college. The school provides over 100 percent of its electricity needs via 25,000 solar panels. Together these panels generate 4.5 megawatts of direct current, or over 6 million kWh of electricity per year.
4. UNIVERSITY OF BUFFALOW: The University at Buffalo has one of the most publicly accessible solar panel installations in the world.
5. COLLORADO STATE UNIVERSITY: CSU has a solar power system that generates 8,500,000 kWh annually — that's 1,000 watts every hour for 8.5 million hours — and provides students with hands-on experience in solar power hardware maintenance and output analysis.
6. PRINCETOWN UNIVERSITY: Princeton touts one of the largest single installations at a
7. U.S. college or university that, even on a cloudy day, can provide enough electricity for 7,800 laptops.
8. Alex Ekwueme Federal University Ndufu Alike Ikwo, Ebony State Nigeria. The University has a 2.8MW solar hybrid power plant. The off-grid power plant ensures that both students and staff have access to clean reliable energy. The solar power plant replaced over 1.54MW capacity of petrol and diesel generators within the campus, and an annual carbon dioxide CO^2 savings of 8,139,298Ibs within the campus.

5.4. Prospect of Solar Energy in UNEC

UNEC has the space to locate a solar farm within the campus. This will lead to an appreciable reduction in fossil fuel consumption within the campus thereby lead to savings in CO^2 emissions. They will also provide a tourist site and case

study for students with research interests in renewable energy resources and generation.

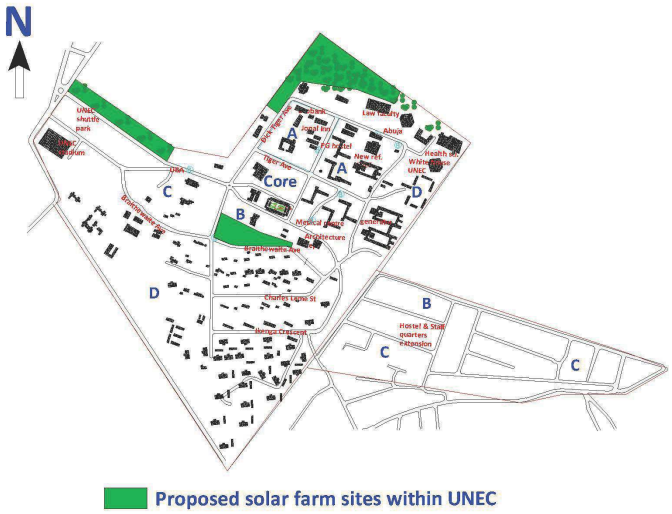

Figure 4 Map of UNEC showing proposed solar farm sites within the campus

6. DISCUSSION AND CONCLUSION

To improve the standard of education in the University of Nigeria, and UNEC in particular, there is a need to put in more effort in providing adequate power supply. Though erratic power is more or less a national issue in Nigeria, and not peculiar to UNEC, it is possible to totally eradicate this problem in several ways. One way is to speedily migrate to alternative energy sources that are cleaner and safer. Since we have established existing and growing interest in this technology, the government needs to assist significantly in funding private solar energy research in research institutes and universities. Government subsidies will also be helpful in the importation of solar panels and other equipment that cannot be manufactured locally. This will support independent investors and individuals who have interest in the energy source.

Borrowing from the UK's feed-in tariff concept, the government can also encourage independent electricity generation through solar panels by providing more incentives for consumers and suppliers who choose to invest in this source. It will always be soothing to the ear when you know you will get rewarded for generating your own electricity. Installing and understanding this infrastructure is still considered by many as technical and expensive, but through extensive awareness programmes and public and private sector initiatives, this process can be simplified and will eventually become cheaper to install and use in the long run. The most important point to know in installing a solar system is that though the investment may be high, the operational cost is low or relatively zero, which some degree of returns on any solar project within 5 years and a solar system can last for 25 years.

One other very important point to note is the employment of passive design in building for the tropics. Every climatic zone has its own peculiar architecture. In building for the tropics, the use of wide windows and openings, shading devices, soft landscapes and proper building orientation reduce the dependence on active ventilation and lighting systems thereby improving the energy efficiency of buildings especially in the tropics. This should be employed for new building projects within the campus.

Conclusion

For University campus to have more productive staff, the need for constant power supply cannot be downplayed. The benefits from electricity-based lighting, ICT, and improved teaching lead to better outcomes in school performance—less truancy and absenteeism, higher enrollments rates, higher graduation and completion rates, and the achievement of higher test scores [8] (UNDESA, 2014).In essence, without adequate electricity supply, it is virtually impossible to produce scholars and researchers who can confidently compete globally because they will be intellectually incompetent.

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