**Implementation of Solar Photovoltaic System for BTS Power Supply in Nigeria**

**Otasowie O. Paul Ph.D**

**Department of Electrical Electronics Engineering University of Benin, Benin City, Nigeria**

**Email: potasowie@yahoo.co.uk**

**ABSTRACT**

Global System for Mobile Communication (GSM) is one of the major dividends of Nigeria’s democracy. GSM has helped Nigeria in terms of increased access to telephony and data services, job creation and increased tax revenue for government among others. In Nigeria, GSM network operators face the problem of non-availability of steady power supply especially in rural areas where the National Grid is not in existence. Generators are been used but they are very expensive to operate due to high cost of diesel.

This work discusses the implementation of a low cost and efficient system (solar photovoltaic system) for powering GSM Base Transceiver Station (BTS) in Nigeria. This system uses Deep cycle batteries, direct current appliances, bulbs and wiring accessories.

The proposed system if implemented will help to provide power that is cheap, efficient and reliable for GSM Base transceiver station in Nigeria and any other developing countries that has epileptic power situation and thus enhance the performance of mobile communication.

**Keywords**: GSM, Diesel generator, Solar panels, DC appliances, epileptic power.

1. **Justification for the Work**

In Nigeria, electric power Grid services are very erratic and unavailable especially in rural areas. Diesel generators are used but the prices of diesel and other petroleum products are continuously increasing. Diesel generators also need regular maintenance. Diesel thefts at base station are also enormous and could be as much as twenty percent. Fumes from generator also pollutes the environment.

In view of the above points, there is need to explore other means of providing a low cost, reliable and environmental friendly alternative power supply for BTS. This work proposes solar photovoltaic systems.

1. **Introduction**

Mobile communication is one of the most important technologies that contribute to the social and economic development around the world [1]. The advent of mobile communication into the Nigerian market has contributed greatly to the economic development of the country.

Energy is one of the most expensive item for mobile communication network operators. In Global System for Mobile Communication (GSM), the Base Station Transceiver (BTS) is the network components that contain the radiofrequency components and provide the air interface for a particular cell. It is the GSM network components which communicate with the mobile station [2]. The BTS consume a lot of power; in short it consumes more than eighty percent of the network operator’s power consumption which makes the BTS network component very important.

There are currently over 15,000 BTS sites in Nigeria and more than eighty percent (80%) of them are powered by diesel generators necessitating the need for between 2,000-6,000 litre capacity storage facilities on each BTS site. The operators have recorded many incidents of ground water and land pollution cases in the last three years around the BTS facilities. These incidents are due to:

1. Malfunctioning of the fuel flow regulators or functional failures
2. Unwholesome activities of vandals/thieves who after breaking the diesel lines, carry large quantity of diesel and leave the lines open to flow freely into water bodies and lands

The mobile phone network operators are saddled not only with the challenges of replacing lost diesel to ensure uninterrupted services, clean-up and remediate the environment but also to contend with bogus claims by the affected parties.

In Nigeria power supply is epileptic and unreliable. Despite all efforts made by government of Nigeria to improve electricity, it is still epileptic. The total generating capacity of power in Nigeria as at August 2014 is still about 30,000 MW for a population of about one hundred and fifty million people. This translates to about 200W per person [3,4,7]. Therefore there is need to harness other sources of energy like solar energy.

**Solar Energy**

Solar energy uses photovoltaic system (solar cells) to capture the sun rays and convert the energy into electricity. Such systems allows home owners to generate electricity in a clean, reliable and quiet way that can offset the cost of future electricity costs and decrease their dependence on the energy grid [5].

Solar power depends on energy from the sun, there has to be adequate sunshine for the solar panels to produce sufficient power for use. In cloudy and snowy conditions, it would be impossible to invest in solar power.

**Solar Energy Usage in Nigeria**

Nigeria lies within a high sunshine belt and thus has enormous solar energy potentials. The mean annual average of total solar radiation varies from about 3.5 KW h/m 2/ day in the coastal latitudes to about 7 KWh/m 2/ day along the semi arid areas in the far North. On the average the country receives 19.8 MJ m of solar radiation. The average sunshine hours are estimated at 6 hours per day [6]. Therefore solar energy can be used for power supply in the Base transceiver stations around the country especially at the rural areas where there are no Grid electricity.

1. **Load Demand in a BTS**

A typical BTS operating in Nigeria has the load demand in Table 1.

**Table 1: Base Transceiver Station Equipment and Their Rating/Hours Used [7]**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **S/N** | **Description** | **Model** | **Quantity** | **Power Rating (Watts)** | **Hours Used** | **Daily Hour Used (kwh)** |
| 1. | Air conditioner | 1G | 2 | 1492 | 24 | 35.81 |
| 2. | Base Transceiver/3G | Huawei | 1 | 2400 | 24 | 57.60 |
| 3. | Bulb | Philips | 2 | 120 | 12 | 1.44 |
| 4. | Rectifier | Kathrei | 1 | 1800 | 24 | 43.20 |
| 5. | Radio | Kathrei | 2 | 480 | 24 | 11.52 |
| 6. | Aviation light | Ericsson | 1 | 25 | 12 | 0.30 |
| 7. | Security light | Ericsson | 1 | 200 | 12 | 2.40 |
| 8. | Microwave antenna | Ericsson | 4 | 18 | 24 | 0.43 |
| 9. | Pillar antenna (VHF/UHF) | Huwaei | 2 | 20 | 24 | 0.48 |
|  | **Total average energy consumption** | | | **6555** | **180** | **153.180** |

From Table 1, the total average energy consumption is 153.180 KWh. This energy consumption can drop if we change all the equipment to direct current(dc) in which case the air conditioner, bulbs, aviation and security lights will all be dc. This arrangement is capable of reducing the power requirement of a BTS to 1000 KWh.

1. **Methodology**

A low cost and efficient system for BTS can be achieved using a combination of;

1. Photovoltaic solar panels
2. Solar charge controller
3. Deep cycle battery bank
4. Dc bulbs

**Solar charge controller:** This works the same way the voltage regulator works. A solar panel pumps electricity into a battery that stores it. The solar panel has no control over how much power the battery receives. The solar charge controller is positioned to regulate the voltage and the current and halts charging activity when necessary.

A charge controller is necessary because overcharging the battery will damage it or reduce the effective life of the battery.

**Deep cycle battery:** This is an electrical energy storage device. They are needed to store the energy collected from the solar panels.

**Dc bulbs:** These could be light emitting diode (LED) or compact fluorescent lamp (CFL).

1. **Implementation of the Low Cost and Efficient System for BTS**

The proposed low cost and efficient system for BTS can be achieved using Figure 1.



**Figure 1: A low cost and efficient system for home lighting.**

1. **Factors Impacting the Proposed System Performance**

The factors are grouped into three areas;

1. Environmental
2. Site location
3. Equipment
4. **Environmental**
5. **Sun hours – irradiation**

The more sun hours a location receives, the more energy will be produced from a solar module installed at that location. One sun hour is energy produced by the peak noon sunlight intensity in the middle of summer over one hour.



**­Figure 2: Daily sun profile**

Before a solar system is installed, a feasibility analysis must be conducted to confirm that the site have enough solar energy to meet the electricity needs efficiently and economically.

1. **Temperature**

Solar temperature module operating temperature increases when placed in the sun. As the operating temperature increases, the power output decrease due to the properties of the conversion material. This is true for all solar modules but different per technology. A typical decrease in power output is approximately 12% for crystalline based modules [8].



**Figure 3: Current voltage relationship under the influence of temperature**

Figure 3 displays response of a solar cell to voltage temperature. The current increases slightly while the voltage decreases rapidly. The result is a lower overall power yield. It is therefore extremely important to keep solar panels well ventilated such that air is able to cool on all sides including the underside.

1. **Soiling – Particulate Building up**

When a solar module is installed outdoors, airborne particulates (e.g dust, debris) settle on the glass surface of the module similar to dust settling on glass automobile windshield. This particulate block the amount of light reducing the module and therefore reduce the power produced by the module. The reduction in power from particulate build up can range from 5% to 15% [8].

It is therefore extremely important to clean the solar panels regularly to ensure that the maximum amount of sunshine hits the panels

1. **Site location**
2. Solar module tilt angle

The solar module produces more power when the light source is located perpendicularly to the surface of the module therefore solar module installations are often tilted towards the sun to maximize the amounts and intensity of light exposure. As the sun angle changes throughout the year, the amount of light falling directly on the module changes as does the energy output.

Large commercial system have solar tracks system that automatically follow the sun’s tilt through the day.

1. Shading
2. Trees, roof gables and other building and other buildings that cast a shadow on the solar panels during peak sun light hours will negatively impact performance with poor design, even a little shade on one panel can shut down solar production on all other panels. Installers use special gadgets to instantly reveal any shady spot on the roof at any time of the year, shading from obstructions, such as trees and buildings should be avoided as this decrease exposure to the sun’s radiation.
3. **Equipment factors**
4. Module ratings

All solar module manufacturers test the power of their solar modules under specific standard test condition in the factory. The standard test condition includes but not limited to a specific light intensity, light angle and module temperature. Any difference from these specific test conditions affects the power output of the solar module. Modules with the appropriate performance rating best suited to the business case of the project should be selected.

1. System wiring

Typical solar electric system require more than one module to be connected to one another, the wires used to connect the modules create a slight resistance in the electrical flow, decreasing the total power output of the system. The slight difference in power output from module to module reduces the maximum power output available from each module. A typical value available for these losses is 5% [9].

1. **Discussion**

In Table 1, the load demand for a typical BTS was shown. But this load demand can be further reduced if all the loads are dc powered, instead of ac powered as shown in Table 1.

In Figure 1, the propose low cost and efficient system for BTS was shown. This system comprise a solar panel connected to a solar charge controller which regulates the voltage and current and also regulates the charging on the battery. In this method an inverter is not needed, as the load are all dc powered.

This method will be suitable for BTS in Nigeria.

1. **Conclusion**

This work describes a low cost and efficient system that can be used to supply power in Base transceiver station in Nigeria. The proposed system if implemented will help to provide stable power for BTS and also save up to 2.5 billion litres of diesel per year and cut annual carbon emissions by up to 6.3 million tons.

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