Improvement Of Electric Power Supply to A Typical MTN Base Transceiver Station in Nigerian City.

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Abstract-* *This study is focused on solving the problem of unreliable and inadequate power supply to reduce downtime, environmental pollution, operational and maintenance cost in our telecommunication industries. The aim of this study is to improved power supply to MTN Base Transceiver Station (BTS) site at T0188, Chinda Estate, Nkpolu, Oroworukwo, Port Harcourt. Using the relevant data collected from the Base Transceiver Station site, a simple algebraic and optimization methods were used to achieve the mathematical mode of the hybrid system. The results showed that the simulation executed for BTS site with a geographical location of $(4''.48.2°N, 6''.59.2° E)$. The daily energy consumption monitored and recorded is 480 kWh/day. The peak demand for site is approximately 20kW. The economic comparison of the existing system to the proposed hybrid system configuration shows that the proposed hybrid design can be deduced to obtain a level cost of energy at N76.92/kWh with a net present cost of N175,068,300.00. The application of hybrid optimization model for energy renewable (HOLMER PRO with version 3.11.2) Software for simulation is adopted. The determination of the telecommunication industries in developing countries such as Nigeria, is to achieve its connectivity demand and for such to happen the network operators, will depend on the utility grid for a reliable and stable power supply. However, due to inadequate and unreliable power supply from the national grid, the customers expresses poor quality network service. It is recommended that the introduction of hybrid system in our telecommunication industries will led to a reduction of Operational Expenditure (OPEX). An improved power availability will reduce the incident of environmental pollution such as noise pollution, diesel spillage, etc. Thereby, achieving a greener operation.

Indexed Terms-* *Power Supply, Base Transceiver Station (BTS), Maintenance cost,

I. INTRODUCTION

Nigeria has been experiencing an extreme electricity shortage for over two decades. Only about 40% of Nigerians are connected to the national electric power network (utility grid [22]. In addition, the utility grid is characterized by high unreliability index. The power supply reliability varies from 39 to 66 % with an average duration of power access between two power outages of 4.5 hours per day. At any period when grid power is available, the supply voltage fluctuates mostly between 160V and 205V [26]. The inadequacy of the utility grid has consistently led to load shedding, with adverse effects on domestic, commercial and industrial activities [23]. As a result, most entrepreneurs have resorted to using fossil-powered sources.

The operation and maintenance of diesel generators accounts for about 78% of the total cost of operations of the GSM BTS sites [1]. Consequently, the use of fossil-fuel generator as an alternative source of electric power for GSM BTS sites increases the unit cost of cellular mobile services in emerging cities. Besides, the environmental consequences of harnessing and utilizing fossil fuels are assuming alarming proportions [18],[27], [24]. Power supply is one of the critical challenges confronted by telecommunications Base Transceiver Stations (BTSs) operators in deplo-ying their networks, this challenge is readily overcome in developed countries as a result of up-to-date power infrastructure. In the developing world, where a national electricity grid exists, it is always the energy solution of choice for powering Base Transceiver Stations (BTSs). Unfortunately, it is not always reliable and has limited coverage. MTN Nigeria, one of the four mobile telecoms operators in Nigeria with 4,798 base stations, spends a whopping $82.8 million on generator acquisition almost every three years, and $3.5 million monthly on diesel-oil and generator maintenance [14].

The hybrid energy systems are capable of providing the needed energy in the cellular mobile telecommunication sectors, but critical issues such as reliability and the enabling technologies are yet to be resolved [28], [12]. The dynamic interaction between the utility grid, green energy sources, and energy demand lead to system reliability of a power system. It is worthy to note that the operational specifications of green energy systems are location dependent. In addition, green energy technologies have higher initial cost of investment compared to conventional (fossil) technology. However, for regions characterized by high unreliability index, such as Nigeria, the grid electricity is not always available [20].

Taking into consideration the excess cost of normal operation that the utilization of diesel generating sets brings to the operators, it is inevitable that consumers pay more for mobile service. Wireless telephone users in Nigeria were meant to believe right from the time when GSM/wireless telephony became fully integrated into Nigerian society in 2001, that it was due to rising cost of operations (high cost of diesel) that made calls to be costly [5]

Hybridizing diesel with renewable energy sources (solar PV system) is one method of reducing call cost and improving the service of wireless telephony in terms of powering base station sites. This will allow telecom companies to circumvent rising energy costs and receive an excellent Return on Investment (ROI) [6]. It will also make communications more accessible and reduce the environmental impact. A hybrid power system is therefore proposed to solve these aforementioned problems. The renewable energy system design, usually, integrates renewable energy mixes, such as biomass, wind and solar. Inauspiciously, large area of land, water usage and social impacts often characterize the electricity generation from biomass and this requires further study to verify the techno-economic viability of its power generation [13].

According to [9], data on solar radiation and its components at a given location are a fundamental input for solar energy applications such as PV design. Long-term average daily global irradiation is one of the most important parameters needed in solar applications [25].

In addition, the knowledge of the diffuse solar radiation and its contribution to global solar radiation are essential for efficient assessment of solar energy potential. These data should be reliable and readily available for the design, optimization and evaluation of solar systems for any particular area [2];[17].

II. PAST REVIEW

A recent estimate indicates that there are about 20,000 GSM Base Transceiver Station (BTS) sites in Nigeria with a corresponding annual growth rate of approximately 20% from 2007 to 2012. The auction for Digital Mobile Licenses (DML) conducted by NCC in January 2001 brought about the emergence of three mobile operators. These companies are Comet Wireless now Airtel, Mobile Telecommunications Network (MTN) and MTel (a subsidiary of NITEL) while a fourth DML was issued to Globacom in 2002 [8].

[15] examined various techniques for improving the power efficiency of cellular networks such as efficient resource management, low energy spectrum sensing, energy-aware medium access control and routing, and cross-layer design. The objective was to reduce both the operational costs and the environmental effects.

Renewable energy technology is capable of alleviating the already overstretched ecosystem; it can supply the energy required for rapid development [11]. The prospects of renewable energy resources in sustainable energy development in Nigeria are enormous [21]. In spite of the availability of abundant renewable energy resources (including, hydro, solar, wind and biomass), such renewable power solutions are not commonly used in GSM BTS sites in Nigeria presently. The underutilization of the renewable technology in Nigeria may not wholly be due to unawareness of the vast potential of available resources but also on technological constraints such as the enabling technology for deployment [19].

The radio-frequency consumes over 80% of the total energy consumption [16]. Power amplifier is the largest energy consumer. It has a share of around 65% of the total energy consumption [10]. Other base station components with significant energy consumption are air-conditioning (17.5%), digital signal processing (10%) and AC/DC conversion systems (7.5%). The key issue is how to reduce the energy consumption of the GSM BTS while guaranteeing quality service delivery and increased service availability for users. The problem has led to the concept of the green-mobile technology, a process that utilizes energy efficiency technology. Investments in energy efficiency could result in long-term gains such as reduced energy consumption, local enhancement of 17 ecosystem and overall economic development [11], [21].

III. METHOD ANALYSIS

Improved system usage and operation may be more easily achieved with a hybrid system than with a single-source application. Hybridizing a PV system often reduces the need for over-sizing the PV array to achieve system autonomy especially when complementarily of different energy sources can be used effectively [3]. Photovoltaic systems can be combined with fossil fuel-driven generators in applications having higher energy demands or in climates characterized by extended periods of little sunshine (e.g., winter at high latitudes) to form hybrid systems.

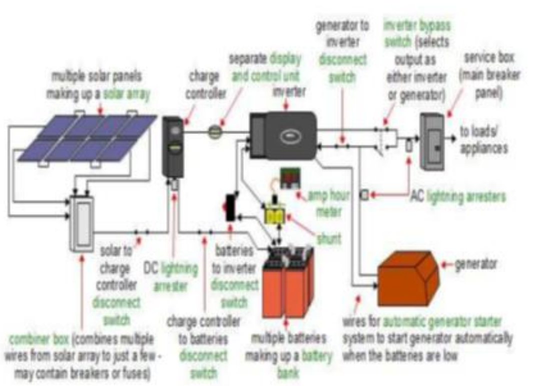

Figure 2: Solar power system structure and working principle [3]

A. Energy Consumption at MTN Base Transceiver Station (BTS) at T0188 Site, Chinda Estate, Port Harcourt, Nigeria

In identifying the energy consumption at MTN Base Station sites and assessing the impact of various operational strategies, we used a macro BTS as a model. The BTS controls the radio interface to the Mobile Station (MS). The BTS comprises the radio equipment such as transceivers and antennas which are needed to serve each cell in the network. Others are generators, automatic transfer switch (ATS), rectifiers, shelters, distribution boards, lighting circuits, air-conditioners, diesel bulk tank and PHCN installation.

B. Physical Conditions of MTN Base Transceiver Station (BTS) at T0188 Site, Chinda Estate, Port Harcourt, Nigeria

BTS site load profile depends on multiple parameters including radio equipment, antenna, power conversion equipment, transmission equipment. It is important to outline an accurate power profile in order to select the energy components and their sizing.

Diesel generators are widely applied as an alternative electricity supply from the grid [4]; MTN Base Transceiver Station (BTS) at T0188 Site, Chinda Estate, Port Harcourt, Nigeria is not exceptional with two diesel generator set (40kVA and 33kVA as backup) since the site is disconnected from the grid and the site is a backbone, carrying more than 50 sites.

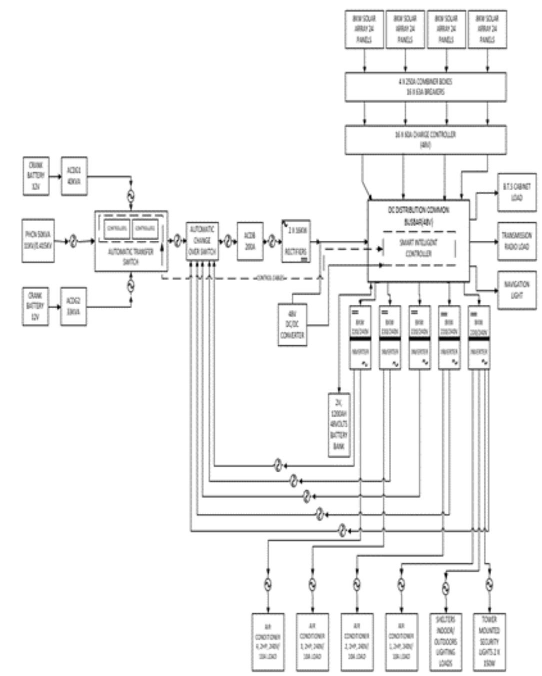

Figure 1: Schematic Block Configuration of Solar PV/Battery/Diesel GenerIators with a Grid Connected System

C. Determination of the maximum load current of a 40KVA diesel generator set with a voltage range of (380V-415V)

We have: $I_{TLDG1} = ?, DGC_{40} = 40KVA, V_{DG} = 400V,$

Where

I_{TLDG1}Represents the total load current of the first diesel engine generator set

DGC_{40}Represents the capacity of the first diesel engine generator

V_{DG}Represents the Voltage of the diesel generator

$$I_{TLDG1} = DGC_{40} \times \frac{1000}{\sqrt{3} \times V_{DG}} \quad (1)$$

$$I_{TLDG1} = \frac{40 \times 1000}{\sqrt{3} \times 400} = \frac{40000}{692.8} = 57.7A$$

The (1996) NEC (National Electrical Code) recognizes that over current protective devices (OCPD) will be affected by heat in the system. As such, it defines the concept of continuous loads and the 80% rule to try and offset the effects of heat in the system.

$OCPD_{CB} = ?, NC_L = 0A, C_L = I_{TLDG1} = 57.7A, Eff_{100} = 100\% = 1.00,$

$Eff_{125} = 125\% = 1.25$

Where

$OCPD_{CB}$Represents the over-current protective devices (Circuit breaker)

NC_LRepresents the non-continuous load current

C_LRepresents the continuous load current

Eff_{100}Represents the efficiency of the non-continuous load current

Eff_{125}Represents the efficiency of the continuous load current

$$OCPD_{CB} = [Eff_{100} \times NC_L] + [Eff_{125} \times C_L] \quad (2)$$

$$OCPD_{CB} = [1.00 \times 0] + [1.25 \times 57.7] = 72.125A$$

Therefore between the ranges of 75A-100A continuous load circuit breaker is applicable.

D. Determination of the current rating of a contactor in an automatic transfer switch of a 40KVA generator set

The site uses an Automatic Transfer Switch (ATS) to alternate the running of diesel generators to ensure a reliable energy source for the MTN (BTS) network. Note voltage range (380V-415V).

We have

$CR_{ATS} = ?, DGC_{40} = 40KVA, V_{Input} = 415V,$

Note: the voltage range (380V-415V)

Where

CR_{ATS} represents the contactor rating of the automatic transfer switch

DGC_{40} represents the capacity of the diesel generator set

V_{Input} represents the input Voltage of the contactor

Hence,

$$CR_{ATS} = DGC_{40} \times \frac{1000}{\sqrt{3} \times V_{Input}} \quad (3)$$

$$CR_{ATS} = \frac{40 \times 1000}{\sqrt{3} \times 400} = \frac{40000}{692.8} = 57.7A$$

E. Determination of circuit breaker rating for a 33kVA generator set

Circuit breakers are devices capable of switching [making (closing) and breaking (opening)], an electric circuit under normal and abnormal operating conditions like short circuits. It also capable of handling the maximum short circuit current of the system, they are made to operate automatically to interrupt or clear fault (short circuit) currents quickly and in a safe manner [3].

We have

$CB_R = ?, DGC_{33} = 33KVA, V_L = 400V,$

Where

CB_R represents the continuous load current of the circuit breaker

DGC_{40} represents the capacity of the diesel engine generator

V_{DG} represents the Voltage of the diesel generator.

From eqn. (1)

$$CB_R = DGC_{33} \times \frac{1000}{\sqrt{3} \times V_L}$$

$$CB_R = \frac{33 \times 1000}{\sqrt{3} \times 400} = \frac{33000}{692.8} = 47.6A$$

IV. RESULTS AND DISCUSSION

This work presents the results and discussion of the data collected from the BTS site. The results are based on the simulation carried out by the HOMER PRO software in generating optimization data. The hybrid power system components such as (PV/Grid/DG/ Batteries) undergoes modelled calculations for its measurement. The calculated data were used to optimize the hybrid power system configuration to generate solar energy, temperature resource chart, capital costs, replacement cost and emissions etc.

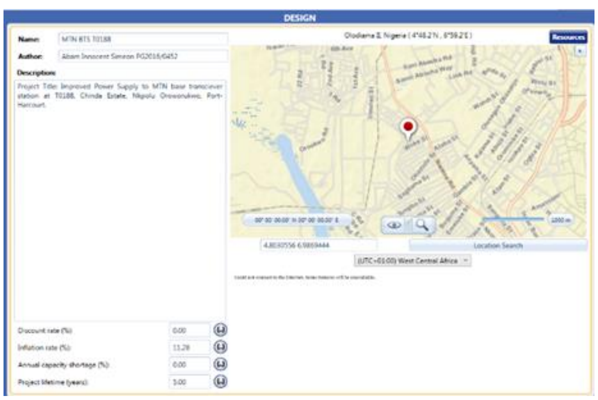

Figure 5: BTS site location

The figure 4 shows the location of the MTN BTS site at T0188 Chinda Estate, Nkpolu Oroworukwo, Port Harcourt metropolis with coordinates(4”48.2°N, 6”59.2°E)

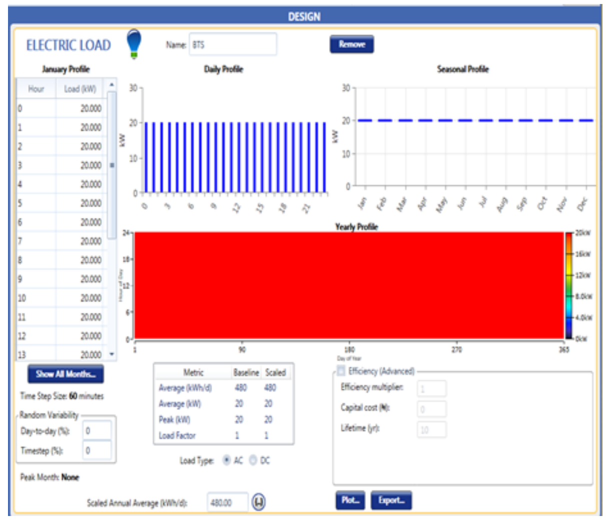

Figure 6: Electric Load

The figure 6 shows the monthly electrical load profile distribution for the whole year. The steady nature of the load profile exhibits the seasonal constant load experienced on monthly basis.

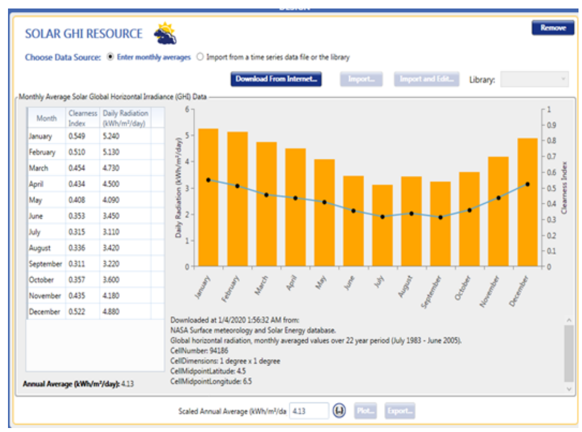

Figure 7: Monthly Clearness Index

The figure 7 indicates the monthly clearness index(where the low index value signifies cloudy months and the high index value signifies sunny months) and annual average solar GHI of 4.13kwh/m2/day Chinda Estate BTS site, Nkpolu, Oroworukwo (HOMER 2020).

CONCLUSION

The determination of the telecommunication industries in developing countries such as Nigeria, is to achieve it connectivity demand and for such to happen, the network operators has to depend on the utility grid for a reliable and stable power supply. However, due to inadequate and unreliable power supply from the national grid the customers experiences poor quality network service. Additionally, the growing number of customers have led to congestion of traffic and as a result of the inadequacy of power supply from the grid, the operators alternatively source elsewhere for a reliable and efficient power supply to service their load demand.

The reliance on conventional diesel generators as a source of alternative back up to meet the load demand of the telecommunication operators lead to environment challenges. Therefore, the introduction of renewable energy such as solar energy will help to avert this challenges. Essentially, this study propose a hybrid-optimization system configuration which comprises of solar PV, the utility grid, battery storage, converter and inverter.The main objectives of the proposed hybrid-system was to forcast the techno-economic feasibility of the prosposed model. HOMER software was used in the simulation to attain feasible and optimum system configuration.

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