Comparative Analysis Of Cost Effective Of Powering Gsm Based Station With Solar Energy For Economic Benefits (Case Study: Ekiti State)

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Abstract : Considering the socio-economic importance of telecommunication industry, it becomes imperative, to sort out ways in making the service available to all at a reduced cost for economic benefits to the nation at large. The quest to achieving the above objective has led to this research. It is no longer a story that the epileptic power supply experienced in Nigeria has adverse effect on the nation's economy as most of the investors have been scared away and the few ones who dares the situation has to power their equipment using generator sets which has adverse effect on citizenry considering the high cost of running and maintaining the generating sets. This paper thus addresses the economic importance of powering the Global System for Mobile Communications (GSM) base station using solar energy which is environmentally friendly and highly reliable. The study showed that it is cost effective. It was recommended that for effective service delivering of the GSM network at affordable tariff their base stations should be solar powered considering its long term benefits.

Keywords: Telecommunication industry, GSM, Solar energy, Socio-economic, cost effective

The human race is faced with challenges, which had led to the invention of equipment and machines, to tackle those challenges. The field of electrical electronics engineering is at work to make life convenient for man; as human quest for improved life continues.

In Nigeria, there is erratic and epileptic power supply which has ruined many business ambitions and thus hampering socio-economic advancement. Incessant vandalizations of electric cables and transformers nationwide have resulted to persistent power outages. The activities of vandals and saboteurs have diminished close to 6000 MW generation capacity over the years, (Atandare, 2007). The 6000MW cited as existing power stations were delivering about 3000MW until the Ijaw militants struck on February 9, 2006 and destroyed pipelines that supply gas to Egbin power plant in Lagos state and Afam in Rivers state. These two plants account for 75% of the nation's energy supply, (Atandare, 2007). The power sector up till now has not recovered from this vandalization and the activities of vandals are still on. This thus has resulted to decline in business activities and increased cost of production as most firm and business out fits depends mostly on generators for their business activities.

Recent inventions have given way to alternative energy sources apart from the gas fired plants and hydro station to renewable energy sources. Development and reform of the world in this 21st century apparently fast moving towards globalization whereby nooks and crannies of the world are expected to be connected as a way of facilitating tremendous reform and development (Atajeromavwo and Obenob, 2007), with a bid to connecting the world was the invention of the Global system for mobile communications (GSM) mode of communication.

Presently in Nigeria, there are four major GSM original group special mobile operators namely MTN Ng, Glo, Airtel and Etisalat with about 138 million subscribers as reported by industry statistics (IT & Telecom. Digest, 2015). The base stations of these network operators are generator driven thus resulting in high cost of production and this inevitably affects the tariff; hence the need to power the base station using photovoltaic cells (Solar energy) which is more durable with little or no maintenance cost (Ekejiuba, Adeoye & Bamisaye,2012).

I. Literature Review

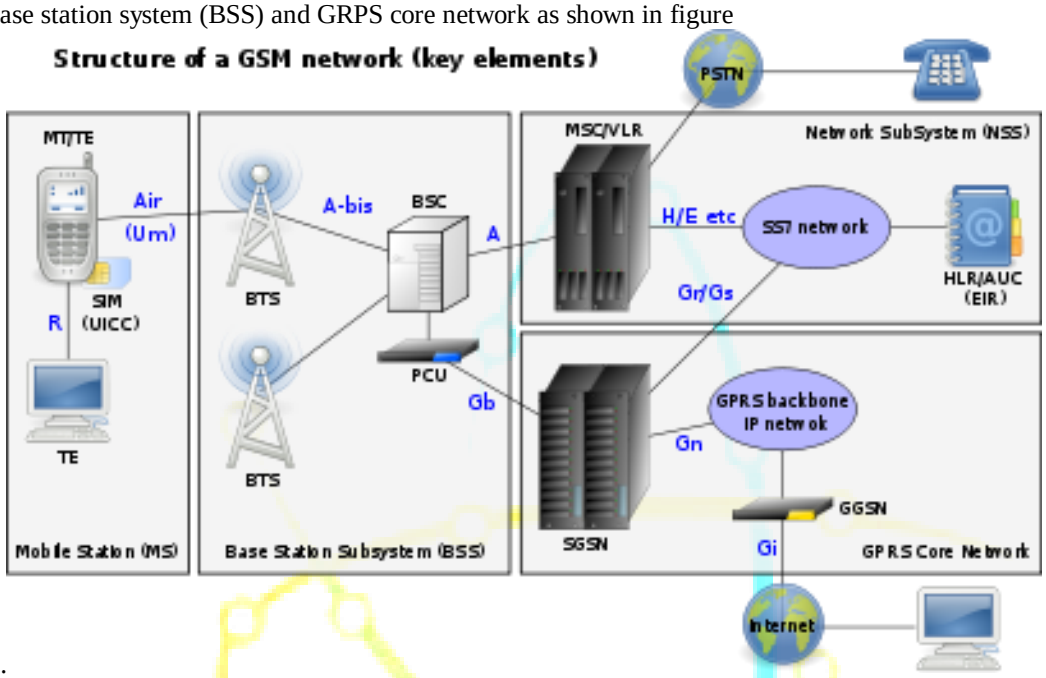
Code division multiple access (CDMA) and GSM are two major radio systems used in cell phones. Both acronyms tend to group together a bunch of technologies run by the same entities.

GSM is the most popular standard for mobile phones in the world. The global spread of GSM came about because in 1987, Europe mandated the technology by law and because GSM comes from an industry consortium, (Segan, 2015). Its promoter, the GSM Association estimates that 82% of the global mobile market uses the standard and it is used by over three billion people across more than 212 countries and territories,(GSM Association, 2007)

According to NCC (2007), GSM was introduced in Nigeria in 2001 during the administration of chief Olusegun Obasanjo, with MTN, ECONET and NITEL given to GLO mobile, Etisalat , ONET, Vodafone, multilinks, Starcomm etc. but most of them have seized operation because of high production cost thus affecting the economy of the nation. In Nigeria we have only four operators MTN Ng, Glo,Airtel and Etisalat as has earlier been mentioned.

II. The Gsm Network

The GSM network is divided into three major systems, this includes: the network subsystem (NSS), the base station system (BSS) and GRPS core network as shown in figure



1.
Figure 1 Structure of a GSM (Wikipedia, 2015)

The Base Station Subsystem (BSS)

This is the station of a cellular telephone responsible for handling traffic and signaling between mobile phone and network switching subsystem it carries out trans-coding of speech channels, paging, and allocation of radio channels to mobile phones quality management of transmission and reception over the air interface and all other radio network. The BSS is subdivided into various subsystems, among which are:

Base Transducer Station (BTS)

This station contains the equipment for transmitting and receiving of radio signals, antennas, and equipment for encrypting and decrypting communications with the Base Station Controller (BSC). BTS consists of many transducers which enables it to serve different frequencies. A BTS is controlled by BSC through the Base station Control Function (BCF). The BCF provides operations and maintenance connection to the network management system and manages operational states of each transceiver as well as alarm collection and software handling.

Packet Control Unit (PCU): it performs some of the processing tasks of BSC. The allocation of channels between voice and data is controlled by the base station but when channels is allocated to the PCU, the PCU takes full control over that channel.

Base Station Controller (BSC): it handles allocation for radio channels receivers' measurement from mobile phone, control handover in BTS.
The paramount function of BSC is that it acts as a concentrator where many different low capacity connections toward the Mobile Switching Centre (MSC)

- Network Switching Substation (NSS): this is component of a GSM system that performs switching function and manages communications between mobile phones and public switched telephone Network (PSTN). NSS allows mobile phone to communicate with each other and telephone at a large telecommunication network. The network switching system is also known as GSM core network and usually refers to the circuit- switched

core network and is used for GSM Service such as voice calls, short messages service (SMS) and circuit switched data.

- Mobile Switching center (MSC): This is the primary service delivery node for GSM and it is responsible for handling voice calls and SMS among other services. The MSC sets up and releases the end to end connection, handles mobility and handover requirement during call and handles charging and real time pre-paid account monitoring.

For subscribers to stay connected avoiding network not available probably due to system maintenance, power outage etc. the need to power the base station with solar technology.

III. Solar Power Technology

Solar energy is energy directly from the sun producing both heat and light. Nigeria is blessed with massive solar energy. The first solar photovoltaic (PV) technology was born 1954 when a group of scientist at the bell laboratories, USA, developed the first solar cell capable of converting enough of the sun's energy to power domestic electric equipment. Silicon solar cell efficiency have improved from 4% to 11% (Owolabi, 2008)

Nowadays, solar technology has been well perfected and is being applied in diverse area for residential as shown in figure 2, commercial, industrial, agricultural and transportation sectors. Satellite communication for voice data and broadcasting will not be possible without solar panel which is the sector. Satellite communication for voice data and broadcasting will not be possible without solar panel which is the sole source of energy powering the satellite and its communication payload. The magnitude of power available from solar cell could be as high as a few million watt needed for calculators to as high as tens of kilowatts for an electrical equipment or for household power supply for lighting , cooking , washing , drying and so on. At present, PV panels typically convert 15% of incident sunlight into electricity, (Owolabi 2008)

Fig 2: Solar Powered House (Source: Connors, 2015)

There is no routine maintenance of the system. The design life of the solar panel is 30years, 15 years on the control electronic, 5-7 years on the battery. And the bulb most of the time will last over 10 year (solar illumination, 2015)

The system has a clean low profile and is structurally and architecturally balanced for strength, appearance and low wind resistance.

IV. Component of Solar Power

The components that make up the solar power are: Solar modules (PV solar panel), inverter, battery (solar deep cycle battery ratted in AH) and charge controller

V. Research Methodology

The base station of three out of the four GSM operators in ado Ekiti, Ekiti state Nigeria was visited to assess the load base and to determine the PV size required for the audited load.

These includes MTN NG, being the leading network provider), Glo and Airtel . The data collected was on the mobile telecommunication base stations located at Ajilosun , Adebayo Federal Polytechnic and Falegan all in Ado Ekiti

This was achieved through visit to the base station where necessary information was gathered from the professional overseeing the base station.

Table 1: MTN, Glo, and Airtel Base Station Load Assessment

S/N	THE EQUIPMENT	MTN & AIRTEL QTY	GLO QTY	MTN & AIRTEL POWER RATING (W)	GLO POWER RATING (W)	DURA-TION (h)	ENERGY DEMAND/DAY (Wh)		
							MTN	AIRTEL	GLO
1.	Halogen Lamp (Euro 2)	2		250	-	12	6,000	6,000	-
2.	Halogen bulb	1		200	-	12	2,400	-	-
3.	AIR CONDITIONER	2	2	746	1119	12	17,904	17,904	26,856
4.	Aviation warning light	4	5	160	160	12	7,680	7,680	9,600
5.	Fluorescent lamp	4	4	30	30	0.3	36	36	36
6.	Base Transceiver System (BTS)	2	2	40	45	24	1,920	1,920	2,160
7.	Connecting microwave	1	1	70	70	24	1,680	1,680	1,680
8.	Incandescent bulb	2	3	60	60	12	-	1,440	2,160
9.	Security light	-	3	-	160	12	-	-	5,760
TOTAL ENERGY CONSUMED							37,680	36,660	48,252

Energy demand per each day is calculated by using;
Energy Demand (Wh)/Day = Power rating x Duration x Qty

Table 2: Cost of Running and Maintaining the Generator per Day for MTN Network Operator

S/N	MAKE	CAPACITY (KVA)	QTY	DURATION(h)	CONSUMPTION	LOCATION
1.	JMG	17.5	2	24	40 L (diesel)	Sigma Motel, Ado-Ekiti
2.	JMC	17.5	2	12	40 L (diesel)	Fed. Poly. Ado-Ekiti
3.	Jubaili Bros	17.5	2	12	40 L (diesel)	Aba Erinfun Ado-Ekiti

Maintenance cost per month

i. Fuel filter #250.00Oil, ii. Filter #1,300.00, iii. Engine oil #4,000.00
iv. Radiator coolant #500.00 and v. Diesel #145,000

S/N	Name of Equipment	Qty	Power rating (W)	Duration (h)	Energy demand per day (Wh)	Reasons
1.	Base transceiver system (BTS)	2	40	24	1,920	The size and quantity cannot be changed
2.	Connecting microwave	1.	70	24	1,680	The size and quantity cannot be changed
3.	Aviation warning light	3	120	12	4,320	One bulb at the top of the mast and the other two at the middle of the mast can give warning to the aviation.
4.	Sodium lamps	4	50	12	2,400	It will give more illumination around the base station
5.	Fluorescent lamp	2	30	0.3	18	Since the shelter will be built, only two fluorescent lamps will be needed.
TOTAL					10,338	

Table 3: Audited Loads for MTN Network Operator

Source: Ekejiuba *et al* 2012.

Table 4: Cost of Maintaining MTN Generator Set Per Month

S/N	Description of Expenses	amount in NGN
1	Fuel Filter	250.00
2	Oil Filter	1,300.00
3	Engine Oil	4,000.00
4	Radiator Coolant	500.00
5	Diesel	168,000.00
	Total (Naira)	174,050.00

Table 5: Maintenance Cost Per Year

Total cost in a month * 12months	2,088,600.00

Table 6: Maintenance Cost for 10 Year

Total cost in per year * 10	20,886,000.00

Table 7: Initial Purchase Cost Of Generating Sets

S/N	DECRIPTION OF ITEM	COST PER UNIT	QTY	AMOUNT
1	JMC 17.5 KVA	2,000,000.00	2	4,000,000.00

Table 8: Purchase and Maintenance Cost

1	GRAND TOTAL	24,886,000.00

Table 9: Cost Analysis for Solar Powered Base Station

S/N	DESCRIPTION OF ITEM	QTY	C/U	AMOUNT
1	3.5kva Inverter	1	110,000.00	110,000.00
2	200Ah Battery	9	53,000.00	477,000.00
3	120 Watts Solar Module	28	25,000.00	700,000.00
4	Charge Controller	1	45,000.00	45,000.00
5	Battery Rank	1	10,000.00	10,000.00
6	Solar Rank	1	40,000.00	40,000.00
7	Rolls Of Solar Cables	4	25,000.00	100,000.00
	Total			1,482,000.00

Table 10: Cost Difference between Generator Powered Base Station (BS) And Solar Powered BS

GENERATOR	24,886,000.00
SOLAR	1,482,000.00
COST MARGIN IN NAIRA	19,404,000.00

VI. Discussion

Table 1, shows the load assessment of the base station of the three GSM network operators visited and their energy demand per day. The energy demand per each day is high for the three networks. For the purpose of this study, MTN Ng will be used for the analysis being the leading network operator in Nigeria.

Table 2, shows the various generating sets used in each of the MTN location visited and the cost for running one of its base station.

Table 3, shows the audited load and its energy demand per day. The table shows a drastic reduction in the energy demanded per day. The reasons for each audited load were given in table 3. It could be observed that the air conditional that has the highest energy consumption was suggested to be removed rather a well-ventilated shelter be built and a number of lighting fitting be used where appropriate.

The cost of running the generator set for a month, one year and for ten years is shown in tables 4, 5 and 6 respectively. The initial cost of purchasing the generating sets is shown in table 7 and the grand total for purchasing and maintaining the base station for the proposed 10years study since that is the life span of a solar PV is shown in table 8, to be close to 25million naira.

With the audited load demand, the number of 120Wp PV modules and deep cycle 200AH 12V batteries required by MTN Ng is 28 and 9 respectively as reported by Ekejiuba *et al* (2012).

With this data it is then easier to compare the economic value of powering the base station with solar PV. Table 9, shows the cost implication of powering the GSM base station with solar energy. From the table it can be seen that is cheaper powering the base station with solar energy for a long term analysis using a period of 10 years. It is true that the initial cost of installing solar PV could be high, but it has long term economic value as shown in table 10.

VII. Conclusion

It is much cheaper running the base station which is the engine room of any GSM network provider. GSM operators can be sure of running their base station with no interruption in power supple with little or no maintenance cost attached there by reducing the cost of running the network which will inevitably reduce the tariff thus encouraging more utilization of the system for better economic output.

VIII. Recommendation

For safety operation and clean environment that eliminates toxic fumes emitted from generating sets solar energy is thus recommended for base stations. Government on the other hand should reduce the tax payable by the network providers so as to encourage more investors in telecommunication industry.

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