Life Cycle Cost Analysis for the Economic Viability for Solar and National Grid for Powering BTS

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Abstract
In this work, an analysis of BTS power supply cost between solar photovoltaic (PV) system and National Grid in Nigeria. The BTS power supply cost analysed include cost of BTS power equipment acquisition, operation and maintenance. The methodology used in this work was to visit a BTS and access the load demand. The demand was now used to compute the life cycle cost for PV system and the National grid system. The result obtained shows that the cost of the National grid system was ₦47,665,843.00 which was far cheaper compared to solar PV at ₦239.51M but because National grid power is epileptic and unsatisfactory. Solar PV is proposed to be used to power BTS in Nigeria.

Keywords: photovoltaic system, National Grid, Base Transceiver Station, Life Cycle Cost, Solar Array etc.

LIST OF ABBREVIATIONS/ NOMENCLATURE
- BTS – Base Transceiver Station
- C – Capacity of Total Batteries
- Cb – Capacity of one Battery
- E – Load demand
- Er – Energy required
- Esafe – Safe Energy
- Fs – Safety factor
- GSM – Global System for Mobile Communication
- Idc – Current for all modules
- Isc – Short circuit Current
- MDOD – Maximum Dept of Discharge
- NCC – Nigeria communication Commission
- PV – Photovoltaic
- RE – Renewable Energy
- Tmin – Sunshine hour
- Lcca= life cycle cost analysis
- Vb – Battery rated Voltage
- VDC – Direct voltage
- Vr – module rated voltage
- Wh – Watt hour
- WKh- Kilowatt hour
- η – Total product efficiencies (Inverters, Regulators, Batteries)
- D – Days of Autonomy(Days of no sunshine)
- NWS- Net work service
- LRC-Life cycle replacement cost
- ARC-Annual replacement cost
- E_R–Escalation rate (inflation)
- DC- Discount rate
- N- Life cycle period
- LMC - life maintenance cost
- AMC-Annual maintenance cost
- CT- Total cost
- CC-Capital cost
**LFC-** life fuel cost  
**Fe-** Escalation value  
**AFC-** Annual fuel cost  
**LEC-** Life energy cost  
**AEC-** Annual energy cost

**ASSUMPTIONS**  
The economic parameters assumed for this case study are mostly from base station operator in Benin City.  
- Load = 310.566KWh  
- Average monthly sunshine hours = 6hrs/day  
- Solar system operating voltage = 48Vdc  
- Modules support structures, cables battery house, lightning arrestor etc = 5% of modules cost  
- Interest rate = 10.8% [Oyakhilomen, O and grace, Z.R 2014]  
- Inflation rate = 10.8% [Oyakhilomen, O and grace, Z.R 2014]  
- System life span = 30years [Benjamin O. Agajelu et al 2013, Microsoft, 2010]  
- Battery depth of discharge = 90%  
- Battery life span = 5years  
- Inverter life span = 10years  
- Charge controller life span = 10years

1. **JUSTIFICATION FOR THE WORK**  
Electricity supply in Nigeria has remained unsatisfactory despite the huge investment put into the sector by the Government. The network providers are striving to provide effective services with affordable tariffs especially in the remote areas where they are no power at all. The use of alternative sources of energy to power base station in rural areas readily comes to mind.  
LCC analysis is used to compare solar powered BTS with that of the National grid with a view to determine the economic viabilities of power.

2. **INTRODUCTION**  
Obtaining a reliable cost effective power solution for the worldwide expansion of telecommunication into rural and remote areas presents a very challenging problem. Grids are either not available or their extensions can be extremely costly in remote areas. Most of these base stations are in rural areas with or without any power supply from the national grid with two diesel generators as back up source in case of power failure or outages. [Wale Kadeba] In addition, some sites are so far from the point where diesel can be obtained that they required tanks to store up to three months fuel. The initial costs are low for conventional powering systems of sites which require significant maintenance, high fuel consumption and delivery costs due to hike in fuel price especially diesel.  
Using renewable energy source (solar power) as an alternative power source is more cost effective in the long run for a 25-30 year of life span and no pollutions and environmentally friendly over the conventional diesel generator. [Wale Kadeba] The air pollution, CO$_2$ emission and the harmful gasses from conventional diesel generators on the environments can be reduced by using renewable energy source as alternative power.  
The present use of conventional power is assumed to be the reason for the high cost of tariff while the use of renewable energy source in running telecommunication BTS will enhance overall system efficiency through improved sustainable energy, service delivery, network performance, and reduced/stabilized GSM tariff payment plan for subscribers.  
Life cycle cost analysis economic tool was used to compare proposed solar powered BTS with the conventional method and National grid with a view to determine the economics of solar over diesel generator sets. Solar investments become very attractive after ten years.

3. **PREVIOUS WORK**  
Mohanlal Kolhe et al (2002) in a paper economic viability of stand-alone solar photovoltaic system in comparison with diesel powered system in India, stated that the cost of PV systems decreases and diesel cost increase, the break even points occur at higher energy demand.  
Bejamin O. Agajelu et al (2013) in a paper Life cycle cost analysis of a Diesel/Photovoltaic hybrid power generating system stated that the economic analysis shows that the hybrid system has the least life cycle cost and cost of energy out of the three power system considered.  
Bala E.J, et al (2008) in a paper assessment of diesel generator and solar PV for the use in the Global System mobile (GSM) phone industry in Nigeria showed that the solar PV is less costly to be deployed in the...
Sheeraz Kirmani; et al (2010) in a paper techno economic feasibility analysis of a standalone PV system to electrify a rural area household in India, stated that the Life cycle analysis conducted to assess the economic viability of the system shows that it is encouraging to use the PV systems to electrify the rural sites in India.

4. ADVANTAGES OF THIS WORK

All previous work has nothing to do with BTS. Their works dealt excessively on residential buildings. This study concentrated BTS at both remote and urban sites. The power consumption of the sites considered are much higher than other previous works.

5. METHODOLOGY

The methodology adopted in this research work are:

a) The base transceiver station located at Ahor community Quarter, Benin bypass (along the express road) Benin City, Nigeria was visited and the load demand assessed. This is shown in Table 1.

b) A cost analysis using life cycle cost was carried out to evaluate the economics of the system and to compare solar with National grid.

c) Sizing of both solar and National grid were computed.

### Table I: Base Station Load Demand – Remote Site: Ahor Community Benin Bypass (Along The Express Road): Solely On Generator Set.

<table>
<thead>
<tr>
<th>S/N</th>
<th>DESCRIPTION MODEL</th>
<th>TYPE OF VOLTAGE</th>
<th>POWER RATING (Watts)</th>
<th>HOURS USED</th>
<th>DAILY KWh USED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Air conditioner LG</td>
<td>AC</td>
<td>1672</td>
<td>24</td>
<td>40.13</td>
</tr>
<tr>
<td>2</td>
<td>Multiplexer Emerson</td>
<td>DC</td>
<td>480</td>
<td>24</td>
<td>11.52</td>
</tr>
<tr>
<td>3</td>
<td>Fluorescent Tube Philips</td>
<td>AC</td>
<td>38</td>
<td>12</td>
<td>0.456</td>
</tr>
<tr>
<td>4</td>
<td>Base Transceiver Ericsson</td>
<td>DC</td>
<td>960</td>
<td>24</td>
<td>23.04</td>
</tr>
<tr>
<td>5</td>
<td>Rectifier Emerson</td>
<td>DC</td>
<td>3024</td>
<td>24</td>
<td>72.58</td>
</tr>
<tr>
<td>6</td>
<td>Power amplifier Katherine</td>
<td>DC</td>
<td>6144</td>
<td>24</td>
<td>147.47</td>
</tr>
<tr>
<td>7</td>
<td>Converter (48/24) Ericsson</td>
<td>DC</td>
<td>480</td>
<td>24</td>
<td>11.52</td>
</tr>
<tr>
<td>8</td>
<td>Aviation light Ericsson</td>
<td>AC</td>
<td>25</td>
<td>12</td>
<td>0.30</td>
</tr>
<tr>
<td>9</td>
<td>Security light Ericsson</td>
<td>AC</td>
<td>200</td>
<td>12</td>
<td>2.40</td>
</tr>
<tr>
<td>10</td>
<td>Microwave antenna Huawei</td>
<td>AC</td>
<td>18</td>
<td>24</td>
<td>0.43</td>
</tr>
<tr>
<td>11</td>
<td>Pillar antenna (VHF/UHF) Ericsson</td>
<td>DC</td>
<td>30</td>
<td>24</td>
<td>0.72</td>
</tr>
<tr>
<td></td>
<td>Total average energy used</td>
<td></td>
<td>13071</td>
<td>228</td>
<td>310.566</td>
</tr>
</tbody>
</table>

Location of Base station Ahor, Benin City. Longitude 6° 24’ 14.47”N AND LATITUDE 5° 40’ 46’E

6. SIZING OF THE SOLAR ARRAY

Before sizing the array, the total daily energy in Watt-hours (E), the average sun hour per day T_{min} and the dc-voltage of the system (V_{DC}) must be determined. Once these factors are made available, the PV sizing can be determined. To avoid under sizing, losses must be considered by dividing the total power demand in Watt hour by the product of efficiencies of all components in the system to get the required energy E_r.[mohanlal kolhe el al, 2002]

Complete sizing from Table1 for solar array, inverter, charge controller, battery and wiring brought about numbers of items used for the investment cost generated in Table II below.

### Table II: Solar PV Investment Cost for A 17.5KVA Power Station (48Vdc/230Vac)

<table>
<thead>
<tr>
<th>S/N</th>
<th>Item</th>
<th>Qty</th>
<th>Unit cost (₦)</th>
<th>Total cost (₦)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Modules</td>
<td>520</td>
<td>83,950.00</td>
<td>43,654,000.00</td>
</tr>
<tr>
<td>2</td>
<td>Deep cycle Batteries 200AH 12V</td>
<td>640</td>
<td>69,000.00</td>
<td>44,160,000.00</td>
</tr>
<tr>
<td>3</td>
<td>Charge Controller</td>
<td>92</td>
<td>48,300.00</td>
<td>4,259,600.00</td>
</tr>
<tr>
<td>4</td>
<td>Inverter 3000W, 220Vac</td>
<td>1</td>
<td>68,310.00</td>
<td>68,310.00</td>
</tr>
<tr>
<td>5</td>
<td>Supporting structures e.g aviation warning light, installation etc Lot</td>
<td>5% cost of</td>
<td>2,182,700.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>modules</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td>94,324,610.00</td>
</tr>
</tbody>
</table>
6. LCC ANALYSIS OF PV (PHOTOVOLTAIC) SYSTEM

7. BATTERY REPLACEMENT AT 5 YEARS

Mohanlal Kolhe et al. stated that the life span of a well managed deep cycle battery is five years. From table 2 above the initial cost of battery is N 44,160,000.00. Assuming inflation of 10.8%, the cost for five years is N 48,576,000.00

Cost of battery of 5yrs = N 48,576,000.00
Installation cost for battery only = N 2,182,700/4 = N 545,675

\[ LRC = ARC \times \left( \frac{1 + \frac{E_r}{1 + D_R}}{d - \frac{E_r}{d}} \right)^N \]


LCR = Life replacement cost
ARC = Annual replacement cost
\( E_r = \text{Escalation (inflation rate)} \)
A value of 10.8%
\( D_R = \text{discount factor of 9.5%} \)
\( N = \text{Life cycle period (0-30 years)} \)
ARC = \( \frac{48,576,000 + 545,675}{5} \) = N 9,824,335.00
Using LCCA Factor = 5.1380 (appendix 1)
LRC = ARC \times LCCA analysis factor of 10 years
\[ LRC = N 9,824,335.00 \times 5.1380 = N 50,477,433.00 \]

Battery replacement, \( N = 10 \) years
Using the same procedure as used for 5 years
\[ ARC = \frac{N 48,576,000 + 545,675}{10} = N 61,398.50 \]
\[ LRC = ARC \times LCCA analysis factor of 10 years \]
\[ LRC = N 61,398.50 \times 10.5139 = N 645,537.69 \]

Using the equation (53) of replacement above
ARC = \( \frac{6310 + 545675}{20} \)
\[ = N 30,699.25 \]
\[ = 30,699.25 \times 22.0236 \]
\[ = N 676108.00 \]
LRC = ARC \times LCCA factor of 30 years
\[ LRC = N 708,612.00 \]

8. REPLACEMENT OF INVERTER FOR EVERY 10 YEARS

The inverter is used for A.C load as it converts D.C to A.C. Also from previous work replacement period is ten years.

ARC for inverter = \( \frac{\text{cost of inverter} + \text{installation cost}}{\text{No of years}} \)

ARC_{INV} = \( \frac{6310 + 545675}{10} \) = N 61,398.50
\[ LRC_{INV} = ARC \times LCCA analysis factor of 10 years \]
\[ LRC_{INV} = N 61,398.50 \times 10.5139 \]
\[ = N 645,537.69 \]

Using the equation (53) of replacement above
ARC_{INV} = \( \frac{6310 + 545675}{20} \)
\[ = N 30,699.25 \]
\[ = 30,699.25 \times 22.0236 \]
\[ = N 676108.00 \]
LRC_{INV} = ARC \times LCCA factor of 20 years
\[ LRC_{INV} = N 708,612.00 \]

9. REPLACEMENT OF CONTROLLER FOR EVERY 10 YEARS

The controller as the following functions: charges the batteries, switches from solar to batteries depending on the output voltage level, regulates batteries over charge and discharge states level, temperature monitoring etc. Research replacement has been determined at very ten years
Using the same equation for general replacement and LCC analysis factor.
ARC = \( \frac{4259600 + 545675}{10} \)
\[ = N 480,527.50 \]
LRC_{Controller} = N 480,527.67 \times 10.5137 for 10 yrs (appendix) = N 5,050,122.00
LRCcontroller = ARC x LCC factor of 20 years
\[
\frac{4259600 + 545675}{20} = 4805275/20 = 240263.75 \times 22.0236 = N 5,291,472.70
\]

LRCcontroller = ARC x LCC factor of 30 years
\[
\frac{4259600 + 545675}{30} = \frac{160175.83 \times 34.6236}{30} = N 5,545,863.90
\]

10. LIFE MAINTENANCE COST (LMC).
Life maintenance cost of solar is a provision for the minor preventive maintenance which assumed to be 2% of capital cost of annually. It is a recurring cost and it is given as

\[
LMC = AMC \times \left( \frac{1 + Er}{Dr} - \frac{1}{(1 + Er)^N} \right) [\text{Mohanlal Kolhe, et al. 2002}]
\]

Where,
- \( Er \) = general escalation rate of 10.8%
- \( Dr \) = Discount factor 9%
- \( N \) = Life cycle period 30 years used
- \( AMC \) = Annual maintenance cost (2% of capital cost of item)
- \( LMC \) = Life cycle maintenance cost

\[
AMC = 2\% \times N 94,324,610 = N 1,886,492.20
\]

LMC = AMC x LCCA factor for numbers of years (N) needed.
For N for 30 years

\[
LMC = \frac{1,886,492.20 \times 34.6236}{30} = N 65,317,151.00
\]

11. FE REPLACEMENT COST
Life replacement cost consist the overall cost of batteries, inverters controller and installations. Solar is not included because the life span is thirty years.

\[
LRC = ARC \times \left( \frac{1 + Er}{Dr} - \frac{1}{(1 + Er)^N} \right)
\]

Where:
- \( LRC \) = Life replacement cost
- \( ARC \) = Annual replacement cost
- \( Er \) = General escalation (inflation rate). value of 10.5% (CBN December 2011)
- \( Dr \) = Discount factor, 9.5%
- \( N \) = the life cycle period (0,1,2-----30years)
- \( ARC \) = (batteries cost + inverter cost +controller cost + installation cost)

\[
installation cost = N 1637025
\]

\[
ARC = 44160000 + 68310 + 4259600 + 1637025 / 30 = N 1670831.20
\]

\[
\frac{LRC = LCC \text{ factor of 30years} \times N 1670831.20}{30} = N 57,850,191.00
\]

12. COSTS PER KWH
Cost per KWh of PV solar system is given as

\[
C_T = \frac{CC + LFC + LMC + LRC}{N \times 365 \times KWh}
\]

Where
- \( C_T \) = Total cost per KWh
- \( CC \) = Capital cost = N 94,324,610
- \( LFC \) = Life fuel cost = N 600
- \( LMC \) = Life maintenance cost = N 65,317,151.00
- \( LRC \) = Life replacement cost = N 57,850,191.00
- \( \text{KWhday}^-1 = 310.566 \text{ KWh} \)
- \( C_T = \frac{94324610.00 + 65317151.00 + 5785019100}{30 \times 365 \times 310.566} = 63.955097 \)
$C_T = €63.96 \text{ per KWh}$

### Table III: LCC of Solar P.V. System (Cost In Million Naira)

<table>
<thead>
<tr>
<th>Years</th>
<th>1</th>
<th>2</th>
<th>5</th>
<th>7</th>
<th>10</th>
<th>13</th>
<th>15</th>
<th>17</th>
<th>20</th>
<th>23</th>
<th>25</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital investment Solar panel</td>
<td>43.65</td>
<td>43.65</td>
<td>43.65</td>
<td>43.65</td>
<td>43.65</td>
<td>43.65</td>
<td>43.65</td>
<td>43.65</td>
<td>43.65</td>
<td>43.65</td>
<td>43.65</td>
<td>43.65</td>
</tr>
<tr>
<td>Battery</td>
<td>44.16</td>
<td>44.16</td>
<td>48.58</td>
<td>53.43</td>
<td>53.43</td>
<td>58.78</td>
<td>58.78</td>
<td>64.65</td>
<td>64.65</td>
<td>71.12</td>
<td>78.23</td>
<td></td>
</tr>
<tr>
<td>Inverter</td>
<td>0.068</td>
<td>0.068</td>
<td>0.068</td>
<td>0.068</td>
<td>0.075</td>
<td>0.075</td>
<td>0.075</td>
<td>0.075</td>
<td>0.083</td>
<td>0.083</td>
<td>0.083</td>
<td>0.092</td>
</tr>
<tr>
<td>Controller</td>
<td>4.26</td>
<td>4.26</td>
<td>4.26</td>
<td>4.26</td>
<td>4.69</td>
<td>4.69</td>
<td>4.69</td>
<td>4.69</td>
<td>5.15</td>
<td>5.15</td>
<td>5.15</td>
<td>5.67</td>
</tr>
<tr>
<td>Sundry</td>
<td>2.18</td>
<td>2.18</td>
<td>2.18</td>
<td>2.18</td>
<td>2.18</td>
<td>2.18</td>
<td>2.18</td>
<td>2.18</td>
<td>2.18</td>
<td>2.18</td>
<td>2.18</td>
<td>2.18</td>
</tr>
<tr>
<td>O &amp; M Three attendants</td>
<td>0.72</td>
<td>0.79</td>
<td>1.16</td>
<td>1.40</td>
<td>1.87</td>
<td>2.49</td>
<td>3.01</td>
<td>3.64</td>
<td>4.86</td>
<td>6.47</td>
<td>7.83</td>
<td>12.60</td>
</tr>
<tr>
<td>Battery Replacement</td>
<td>50.47</td>
<td>50.47</td>
<td>56.75</td>
<td>56.75</td>
<td>63.85</td>
<td>63.85</td>
<td>71.80</td>
<td>71.80</td>
<td>80.78</td>
<td>90.92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controller Replacement</td>
<td>5.05</td>
<td>5.05</td>
<td>5.05</td>
<td>5.05</td>
<td>5.29</td>
<td>5.29</td>
<td>5.29</td>
<td>5.29</td>
<td>5.46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inverter replacement</td>
<td>0.65</td>
<td>0.65</td>
<td>0.65</td>
<td>0.65</td>
<td>0.68</td>
<td>0.68</td>
<td>0.68</td>
<td>0.68</td>
<td>0.71</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grand Total</td>
<td>90.78</td>
<td>95.11</td>
<td>150.36</td>
<td>150.60</td>
<td>168.35</td>
<td>169.00</td>
<td>181.94</td>
<td>182.57</td>
<td>198.34</td>
<td>199.95</td>
<td>216.76</td>
<td>239.51</td>
</tr>
</tbody>
</table>

13. LCC ANALYSIS OF GRID SUPPLY (PHCN)

Kwh of energy in Nigeria cost N11.36 for a commercial consumer in addition a meter maintenance charge of N750.00 and fixed charge N1,200.0 per month with inflation rate of 10.5%.

Life energy cost (LEC) = AEC \times \frac{1+\frac{r}{n}}{\left(1+\frac{r}{n}\right)^N} \times \left[1 - \frac{1+\frac{r}{n}}{1+r}\right] \quad \text{[Mohanlal Kolhe, el al]………..[6]}

AEC = yearly cost per kWh \times yearly fixed charge + yearly maintenance charge

KWh/day = 310.655KWh

Cost per KWh = N11.36

Cost per KWh/day = 310.566 \times 11.36 = N3528.03

Cost of KWh/year = 3428.03 \times 365 = N1,287,730.90

Fixed charge per month = N1200

Fixed charge per year = 12 \times N1200 = N14,400.00

Cost of maintenance per month = N750.00

Yearly maintenance = N750.00 \times 12 = N9,000.00

AEC = 1,287730.90 + 14,400.00 + 9000.00 = N1,311,130 + 1311130 \times 5% VAT

= N1,376,686.50

LEC = AEC \times LCC A factor of 30 years

= N1,376,686.50, \times 34.6236

= N47,665,843.00

14. COSTS PER KWH FOR NATIONAL GRID.

$C_G = \frac{LEC}{\text{Period} \times 365 \times \text{KWh}}$

$C_G = \frac{47,665,843}{30 \times 365 \times 310,566} = N14.02/\text{KWh}$

15. DISCUSSIONS OF RESULTS

From the result in Table 1 it was observed that the annual power consumption for a BTS is 113,356,590Wh (113.3566MWh). Considering Nigeria of about 30,000 BTS, (as at time of this research case study the total average power consumption will be 3400697700Wh (3.4007TWh) units. It was noted that the power consumptions of power amplifier at 147.47KWh was the highest followed by that of rectifier at 72.58KWh and air conditioner at 40.13KWh. The economic viability of the system was done carefully using Life Cycle Cost analysis calculation of Solar P.V. system, and National grid system. Table 3 shows that the initial cost for P.V system is N94,324,610:00. This because solar energy components are very expensive and imported except for cables and other accessories.

It is well known fact that the National grid is very unreliable and epileptic, this has eventually made mandatory for network providers to generate power through the use of generators for their BTS sites. Previous work by Ezomo P.I and Otasowie P.O, in the paper ‘BTS power consumption cost reduction using solar PV system in Nigeria revealed that for power outage hour observed for six months of 1,728 hours cost N552,960:00 of diesel consumption at the of N160:00 Naira per litre. When translated to one year it is N1, 105,920:00. With 30,000 BTS in Nigeria and 60,000 generator sites the gross total cost diesel consumed for one year is N
66,355,200,000:00 (₦66.355 Billion). While cost PV remains at the cost of ₦94,324,610:00. The LLC cost for PV solar and National grid is ₦90.78 and ₦47.67 respectively. PV system is higher than the National grid. With back up of generators sets and diesel consumption the cost of National grid become very high compare to solar PV system.

The cost per KWh for PV is ₦63.96 while National grid is ₦14.02. When other factors like logistic, pilfering of petroleum products, hike in diesel due to scarcity, unstable political environment, epileptic power failure, therefore for a longer period of time, solar become the cheapest means for powering base transceiver station.

16. CONCLUSION

From Table II the initial cost of installation of solar energy system is high. Considering LLC used the cost of powering BTS at the remote location with National grid is higher when compared with the installation of PV system. The stand alone solar energy to power BTS is a viable alternative to power base station at urban/rural area considering fuel consumption and associated problems such as operation and maintenance, hike in price of product due scarcity pilfering of product and others. Solar PV system is less expensive in cost because it attracts less maintenance at minimal cost as there are no moving parts. From the LCC analysis conducted to assess the economic viability, the result shows that the solar system should be encouraged to power remotely located BTS. This investment will go a long way to reduce tariff and energy efficiency.

Finally, Nigeria is endowed with abundance of solar energy resources. Nigeria lies within a high sunshine belt and thus has enormous solar energy potentials. Solar radiation is fairly well distributed with average solar radiation of about 19.8MJm^{-2}day^{-1} and average sunshine hours of 6 hour per day. It is possible to generate 185x103GWh of solar electricity per year. This is over hundred times the current National grid electricity consumption level in the country [Emmanuel O Akinpelu,]

These resources could be harnessed along side with energy efficiency to stimulate economic growth and social development as well as energy sustainability. The use of solar energy to power BTS will go a long way.

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