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COST ANALYSIS OF PROPOSED SOLAR PHOTOVOLTAIC SYSTEMS PERFORMANCE FOR ENGINEERING FACULTY, UNIVERSITY OF PORT HARCOURT

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ABSTRACT

In Nigeria, grid connected solar based system are not common as most connections are stand-alone This work analyze costing of proposed solar photovoltaic systems performance for Faculty of Engineering (FOE), University of Port Harcourt. With unit cost of grid power at ₦48.35/kWh based on MYTO sets for a 10-year tariff path with bi-annual minor reviews for Port Harcourt Electricity Distribution Company (PHEDC), it is expected that FOE spends ₦5,894,541.9 annually on electricity consumption when the supply is fully dependent on PHEDC.it is worthy to note that the generation source is fossil fuel which is harmful to the ecosystem. If however solar photovoltaic source as an alternative means of power generation is used at a unit cost of electricity production from proposed PV plant at the rate of ₦75/kWh, simple payback time is 7 years and 4 months and performance ratio is 81.8%. The proposed PV plant is expected to meet power requirement of FOE efficiently and reliably. Within life span of 25 years, 907.666 tons of carbon that would have wreaked havoc to the environment would have been saved. Various losses were also considered and calculated accordingly. Effect of weather condition on the overall performance was also discussed. The proposed PV plant is viable and will address the lingering energy crisis in the faculty.

Contribution/ Originality: This study contributes to existing literature by analyzing costing of proposed solar photovoltaic systems performance for Faculty of Engineering (FOE), University of Port Harcourt.

1. INTRODUCTION

Data about Nigeria solar energy capacity and projects is lacking. As a result of this, assessing solar integration status is quite difficult. In recent study by Ohunakin, et al. [1] solar integration is classified into grid-tie and stand-alone system. The study reveals that grid-connected solar system does not exist in Nigeria, and that most of the solar systems are stand-alone application. Ozoegwu, et al. [2] indicates that, regarding solar energy application and projects in Nigeria, there is no comprehensive data to rely on, and that data from various websites are difficult to harmonize. Hence, the only source of information to rely on is Nigerian Electricity Regulation Commission (NERC). According to the solar integration projects endorsed by NERC, 364 MW capacity of solar projects would have been completed between 2015 and 2030 at various geographical locations of Nigeria. Table 1 shows proposed Nigeria Solar Energy Projects Details as at 2014.

Table-1. Proposed Nigeria solar energy projects details as at 2014.

Licencee	Capacity	State	Geographical zone
Rock star investment Ltd	50	Osun	South-West
Quaint global nigeria Ltd	50	Kaduna	North-West
Nigeria solar capital partners	100	Bauchi	North-East
Anjeed kafanchan solar Ltd	10	Kaduna	North-West
Lloyd and barter LP	50	Abuja	North-Central
KVK power PVT Ltd	50	Sokoto	North-West
Pan African solar	54	Katsina	North-West

It is quite amazing that there is no database to verify if the projects scheduled to be completed by 2015 have actually been completed. According to Ozoegwu, et al. [2] Nigeria aims to generate certain percentages of renewable energy between 2015 and 2030. With that, solar energy capacity would have improved in the country. Currently, there is no available information to ascertain if targets were met. This paper aim at the following:

i. Cost analysis of PV system using life cycle cost tool.
ii. Simulation using PVsyst programming software.
iii. Detailed loss analysis of the system.

2. RELATED WORKS

Rajyaguru [3] designed and simulated grid connected Photovoltaic (PV) system using Matlab/Simulink. This work aim to discuss the need to turn to solar photovoltaic source as it holds tremendous potentials to meet the increasing daily demand of energy. In order to solve the problem of climate change or global warming, renewable energy, especially solar PV system has to be given serious consideration. Study also showed that solar PV source is widely useful as it is pollution-free, maintenance-free and abundant in nature. Al-Refai [4] designed and simulated grid connected solar PV system using maximum power point transfer (MPPT) integrated grid-tie inverter. The concept of the work is to harness maximum power from solar module using maximum power point tracking scheme. Study also suggested implementation of solar photovoltaic system as intentional measure against greenhouse emission and other environmental effects of electricity production. The researcher also found out that only 20% of total solar radiation emitted is intercepted by the earth. Menon and Madhumitha [5] designed and modelled solar micro inverter with multiple loads. The main idea is to emphasize the need to use smaller inverter ratings to ensure reliability and efficiency. The researcher also defined electricity generated from sunlight as solar electricity and the process of conversion from solar light into electricity as solar PV process. This energy so generated, the researcher found out, could solve power crisis in developing countries. In spite of dynamic nature of sunlight, energy produced by PV system is considered the most essential resources for renewable energy due to its sustainability and abundance of sun's energy. It was also found out in the study that panel temperature and energy from the sun determines electricity to be converted by solar module.

For the power sector of any nation to be strong and have a future, there must be workable and implementable energy policy. Energy policies are designed to manage environmental challenges as they relate to generation and consumption of electricity. They would also improve energy efficiency.

According to Ifeoluwa, et al. [6] there are three basic renewable policies in Nigeria, which are:

a. Nigerian Renewable Master plan (NREMP).
b. Nigerian Feed-in Tariff for Renewable Energy (RNSE).
c. Multi-Year Tariff Order (MYTO).

Ozoegwu, et al. [2] highlighted five policies that are currently in place, which are:

i. Reduction in sales, VAT, CO_2, energy or other taxes.
ii. Feed-in tariff/other premium payments.
iii. Public investment, grants or loans.

iv. Capital grants, subsidies or rebates and finally.
v. Biofuels mandates/obligations.

3. METHODOLOGY

This study presents cost analysis of a proposed connected solar PV system for Faculty of Engineering (FOE), University of Port Harcourt. It is based on site survey in Choba community. Climatic data between January 2014 to December 2018 for Choba community was obtained and evaluated appropriately. Literature review was done within the field of cost analysis of solar PV power system. Other scientific articles were studied to evaluate equations and methods for dimensioning solar power system. Computer programming simulator PVsyst, designed by energy institute of Geneva was used for the work. This software program contains all the subprograms that enable design, optimization and simulation of PV system connected standalone and dc power pump. The program also has database that stores over 7200 models of PV modules and 2000 models of inverter. Significant advantage of this program is seen in its ability to study, size, simulate and analyse extensively complete PV system. It makes provision for accurate analysis of different configuration, with results evaluated with the best techno-economic solution, and also compares performances of different technologies for a particular photovoltaic project. It gives access to import meteorological data sources available from web from any location of choice. Plant capacity is estimated at 100KW which was entered into PVsyst software. PV modules types and required inverters for the proposed plant were determined. Effects of temperature and irradiance are also demonstrated using PVsyst software. The proposed plant is to supply power during office hours and receive power during continuous cloudiness. This system comprises of Photovoltaic (PV) array, connected inverter, net metering and circuit breakers. The design is a connected system due to the presence of conventional grid system nearby. Performance Ratio is employed to estimate performance of the proposed plant. Life cycle cost was used to estimate viability of the project. Life cycle cost analysis tool was used to determine the cost of setting up the PV plant over its life span. Standard design procedure was used to calculate various unavoidable losses in the system.

3.1. Cost Analysis of Solar PV System for Foe

One of the most useful financial tools for evaluation of renewable energy projects to ascertain its viability is life cycle cost, which assesses economic implication throughout the life span of the plant. This tool covers initial investment cost of the project, cost of operation and maintenance throughout the life span of the plant, as well as replacement cost if need be. Robert, et al. [7] described life cycle cost tool as comprehensive and comparative tool which takes cognizance of both initial investment and future cost to determine total system cost over it life span. According to El Shenawy, et al. [8] and Adel and Hassan [9] life cycle cost of energy in #/kWh and simple payback time can be estimated with the following standardized formula:

$$\text{Life Cycle Cost (LCC)} = \text{PVc} + \text{Invc} + \text{Ic} + \text{OMc} \quad (1)$$

$$\text{OMc} = 2\%\text{PVc} \times \left(\frac{1+i}{1+d}\right) \left[1-\left(\frac{1+i}{1+d}\right)^{25} / 1-\left(\frac{1+i}{1+d}\right)\right] \quad (2)$$

$$\text{ALCC} = \text{LCC} \left[1-\left(\frac{1+i}{1+d}\right) / 1-\left(\frac{1+i}{1+d}\right)^{25}\right] \quad (3)$$

$$\text{Unit Cost} = \frac{ALCC}{365 \times Energy\ Produced\ in\ a\ Year} \quad (4)$$

Where:

Pvc=Photovoltaic cost, Invc =inverter cost, Ic =installation cost, Omc =operation and maintenance cost.

ALCC=Annual life cycle cost

i = inflation rate = 14%

d = discount rate = 42.5% [10].

Inflation rate and discount rate were obtained from Central Bank of Nigeria (CBN) database.

According to www.solaris.shop.com/retrieved April 29, 2019:

Equation 1 defines initial cost of installing the solar plant, with maintenance and replacement cost over its lifespan. Equation 2 gives estimate of cost of maintaining plant over lifespan of 25 years. Equation 3 gives estimate of the total amount spent in a year. Equation 4 gives cost of generating energy per kilowatt:

Cost of each 315Wp solar panel = 275USD

275USD = ₦83,875

320 panels = ₦26,840,000

Cost of 10KW inverter = 3,727USD

3,727USD = ₦1,367,350

10 units of 10KW inverter = ₦13,673,500

OMc = 0.02×26,840,000×0.8×4.98 = ₦2,138,61

Installation cost is 10%PVc = 0.1×26,840,000 = ₦2,684,000

LCC = 26,840,000+13,673,500+2,138,611+2,648,000

=₦45,300,111

From Equation 4,

ALCC = ₦9,096,408

$$UC = \frac{9096408}{121251} = ₦75/kWh$$

UC=unit cost

$$\text{Simple Payback Time (SPBT)} = \frac{Capital\ Cost}{Energy\ produced\ in\ a\ year\ x\ cost\ of\ energy/kWh} \qquad 5$$

Capital cost=pv cost, inverter cost and installation cost.

$$SPBT = \frac{43197500}{121251\ X\ 48.35} = \mathbf{7.4\ years}$$

From the result, a minimum of 7years and 4 months would be required to recover the life cycle cost of the proposed PV plant installation. Since the project has lifespan of 25 years, it therefore means that setting up a grid-tie solar power plant in the faculty of engineering is economically feasible.

Hence, a minimum of 369m^2 area of the roof is required for the installation.

Table 2 shows cost analysis of PV system used for the study.it consist of all the components involved.

Table-2. Cost analysis of PV system.

Item	**Value (₦)**
PV cost	26,840,000
Inverter cost	13,673,500
O&M cost	2,138,611
Installation cost	2,684,000
Total initial cost	43,197,500
LCC	45,300,111
UC	75/kWh

3.2. Simulation Results

System efficiency is a highly significant factor that influences power generation, and hence general performance of power plants. Losses in subsystems contribute greatly in reducing system efficiency; as a result, final energy is low. PVsyst software package along with internal tools are used to calculate energy loss factors for the proposed PV plant. The main simulation results of the system production are energy generated in MWh/year and specific production in kWh/kWp/year, as well as performance ratio.

Table-3. Proposed grid connected PV system.

	GlobHor kWh/m²	T Amb °c	GlobInc Wh/m²	GlobEff Wh/m²	Array kWh	E_Grid kWh	EffArrR%	EffSysR%
January	130.7	27.40	134.2	130.1	11442	11029	13.65	13.16
February	122.8	28.18	124.9	121.3	10542	10158	13.51	13.02
March	135.0	28.00	135.6	131.6	11527	11111	13.61	13.12
April	131.2	27.00	130.0	126.1	11082	10680	13.64	13.15
May	130.7	27.18	128.2	124.2	10957	10957	13.68	13.17
June	116.6	25.79	113.9	110.2	9882	9882	13.88	13.36
July	110.5	25.61	108.2	104.6	9394	9394	13.90	13.35
August	104.2	24.92	102.2	99.6	8945	8945	13.92	13.36
September	116.3	25.15	116.2	112.7	9985	9985	13.75	13.23
October	123.1	26.07	124.6	120.9	10618	10618	13.64	13.13
November	121.7	26.40	124.8	120.9	10669	10669	13.68	13.18
December	131.5	27.42	135.6	131.5	11576	11162	13.67	13.18
Year	1474.3	26.59	1479.1	1433.7	126619	121914	13.70	13.19

Source: NIMET [11].

Table 3 shows results of the proposed grid connected PV system. Yearly global horizontal irradiation is estimated to be 1474.3kWh/m². The annually global incident energy on the collector plane is estimated as 1479.1kWh/m². At the output of PV array, energy available is 126619kWh. The average yearly efficiency of PV array/rough area, EffArrR, is 13.70% while average efficiency of the system annually is 13.19%. The average ambient temperature is 26.59⁰C. And finally, energy at the output of inverter is 121914kWh.

Table-4. Yearly readings of solar panel efficieny losses and maximum and minimum power.

	EoutInv kWh	EffinvR%	InvLoss kWh	IL Oper	IL Pmin kWh	IL PmaxWh	IL Vmin	IL Vmax
January	11029	27.40	134.2	130.1	11442	11029	13.65	13.16
February	10158	28.18	124.9	121.3	10542	10158	13.51	13.02
March	11111	28.00	135.6	131.6	11527	11111	13.61	13.12
April	10555	27.00	130.0	126.1	11082	10680	13.64	13.15
May	130.7	27.18	128.2	124.2	10957	10957	13.68	13.17
June	116.6	25.79	113.9	110.2	9882	9882	13.88	13.36
July	110.5	25.61	108.2	104.6	9394	9394	13.90	13.35
August	104.2	24.92	102.2	99.6	8945	8945	13.92	13.36
September	116.3	25.15	116.2	112.7	9985	9985	13.75	13.23
October	123.1	26.07	124.6	120.9	10618	10618	13.64	13.13
November	121.7	26.40	124.8	120.9	10669	10669	13.68	13.18
December	131.5	27.42	135.6	131.5	11576	11162	13.67	13.18
Year	1474.3	26.59	1479.1	1433.7	126619	121914	13.70	13.19

Table 5 describes various losses associated with inverter and final output energy. It is shown that global inverter loss is 4705.077kWh and inverter loss during operation is also 4705.077kWh. Average efficiency of inverter is 96.28%. And final output energy after all the various loses is 121914kWh. There were no losses attributed to power threshold (IL Pmin), power overcharging (IL Pmax), low voltage maximum power point window (IL Vmin), upper voltage maximum power point window (IL Vmax).

Table-5. Detailed inverter loss.

Month	EOutInv kWh	EffInvR %	InvLoss kWh	IL Oper kWh	IL Pmin KWh	IL Pmax kWh	IL Vmin kWh	IL Vmax kWh
Jan	11029	96.39	412.875	412.875	0.0000	0.0000	0.0000	0.0000
Feb	10158	96.36	383.725	383.725	0.0000	0.0000	0.0000	0.0000
Mar	11111	96.39	416.704	416.704	0.0000	0.0000	0.0000	0.0000
Apr	10680	96.37	401.908	401.908	0.0000	0.0000	0.0000	0.0000
May	10555	96.33	402.039	402.039	0.0000	0.0000	0.0000	0.0000
Jun	9509	96.23	372.462	372.462	0.0000	0.0000	0.0000	0.0000
Jul	9025	96.07	369.414	369.414	0.0000	0.0000	0.0000	0.0000
Aug	8584	96.96	361.126	361.126	0.0000	0.0000	0.0000	0.0000
Sep	9507	96.21	378.588	378.588	0.0000	0.0000	0.0000	0.0000
Oct	10217	96.23	400.838	400.838	0.0000	0.0000	0.0000	0.0000
Nov	10277	96.23	391.312	391.312	0.0000	0.0000	0.0000	0.0000
Dec	11162	96.42	414.026	414.026	0.0000	0.0000	0.0000	0.0000
year	121914	96.28	4701.017	4705.017	0.0000	0.0000	0.0000	0.0000

Table-6. Monthly energy output of inverter.

Month	E_GRID (kWh)
January	11029
February	10158
March	11111
April	10680
May	10555
June	9509
July	9025
August	8584
September	9507
October	10217
November	10277
December	11162
Year	121914

Table 6 shows final useful energy at Choba site. It describes the monthly average energy exported in kWh. From the table, it is seen that maximum energy injected into the grid occurred in December and it is 11162kWh, whereas minimum energy injected was in August at 8584kWh. The total energy injected is 121914kWh/year.

Table-7. Detailed system losses.

Month	ModQual kWh	MisLoss kWh	OhmLoss kWh	EArrMPP kWh	InvLoss
Jan	-46.467	116.6	104.9	11442	412.875
Feb	-42.842	107.5	104.2	10542	383.725
Mar	-46.817	117.5	106.5	11527	416.704
Apr	-45.014	113.0	103.3	11082	401.908
May	-44.481	111.6	96.3	10957	402.039
Jun	-40.075	100.6	76.8	9882	372.462
Jul	-38.097	95.6	72.4	9394	369.414
Aug	-36.286	91.1	71.4	8945	361.126
Sept	-40.556	101.8	92.6	9985	378.588
Oct	-43.143	108.3	102.4	10618	400.838
Nov	-43.325	108.7	97.0	10669	391.312
Dec	-47.011	118.0	106.4	11576	414.026
Year	-514.111	1290.4	1134.3	126619	4705.017

Table 7 shows in detail various losses as introduced by subsystems of the proposed grid connected PV system in kWh. Module quality (ModQual), which is estimated from PV module tolerance, contributed to 514.111kWh energy lost in the system annually. Module mismatch (MisLoss), which depends so much on module technology, was responsible for 1290.4kWh energy annually. Ohmic wiring loss (Ohm Loss) 1134.4kWh annually. Array virtual energy at maximum power point (EArrMPP), which is the DC energy produced at PV array, is 126019kWh annually. Finally, total loss in inverter system is 4705.017kWh annually.

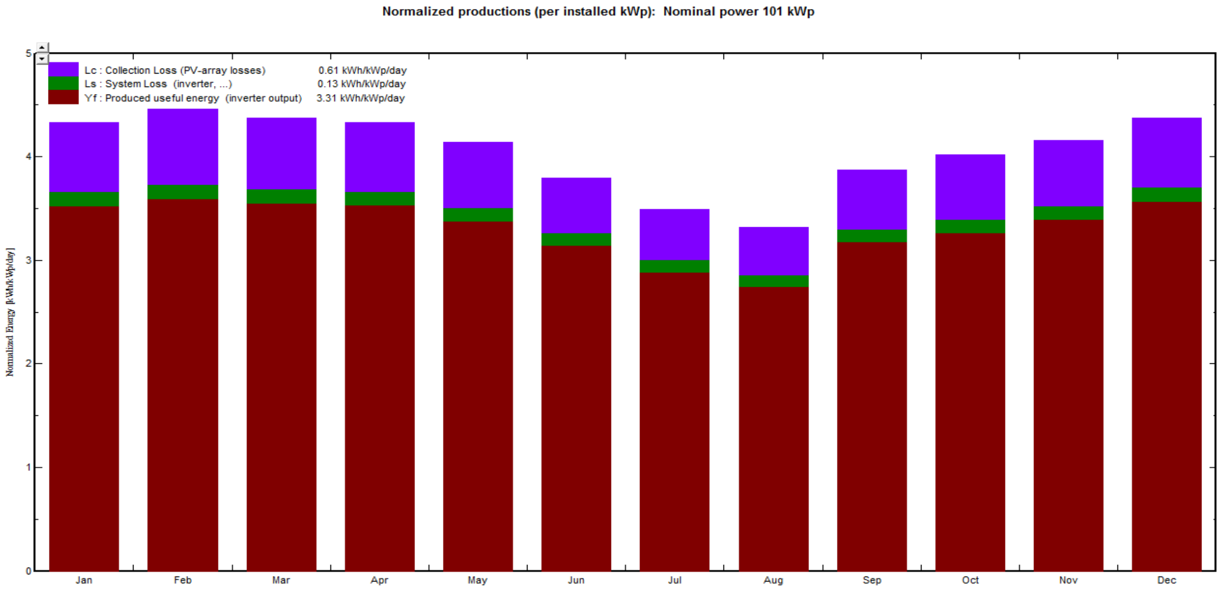

Figure-1. Normalized production (per installed kWp).

Figure 1 is a chart that describes normalized production of energy in kWh/kWp. It gives ratio of average daily energy produced in kWh to nominal power in kWp. It also compares the average energy losses to nominal power. From the graph, it is observed that collector losses (Lc), which is PV array losses is 0.61kWh/kWp/day. System losses (Ls), which is inverter losses is 0.13kWh/kWp. Finally, the average daily normalized energy output 3.3kWh/kWp.

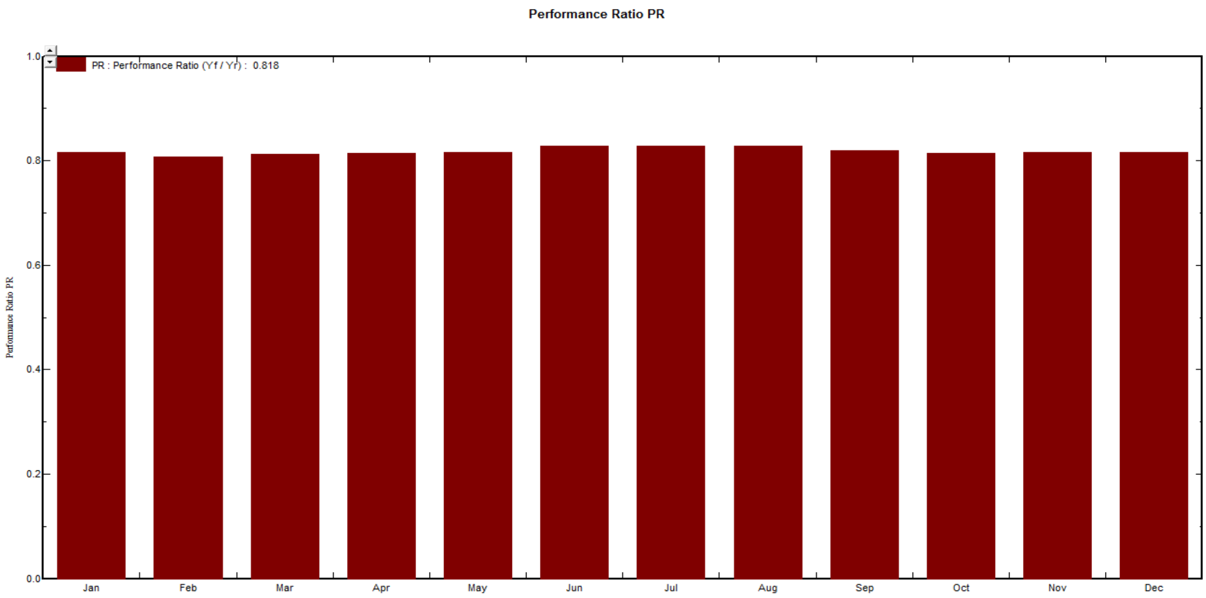

Figure-2. Performance ratio.

Figure 2 is a chart that shows performance ratio of the proposed grid connected solar PV in Choba site. This parameter is significant and determines plant availability. Performance ratio defines the ratio of reference yield to the final yield. Parameters in this case are normalized with respect to solar radiation that is incident on the PV array. The quantity has no dimension. It is significant in providing important information on the overall impacts of losses while energy is converted from DC source to AC source. This parameter evaluates long term changes in the performance and decrease with years. From Figure 2, the average performance ratio is 0.818 or 81.1%. The value is indicative of less than 20% losses in the proposed system.

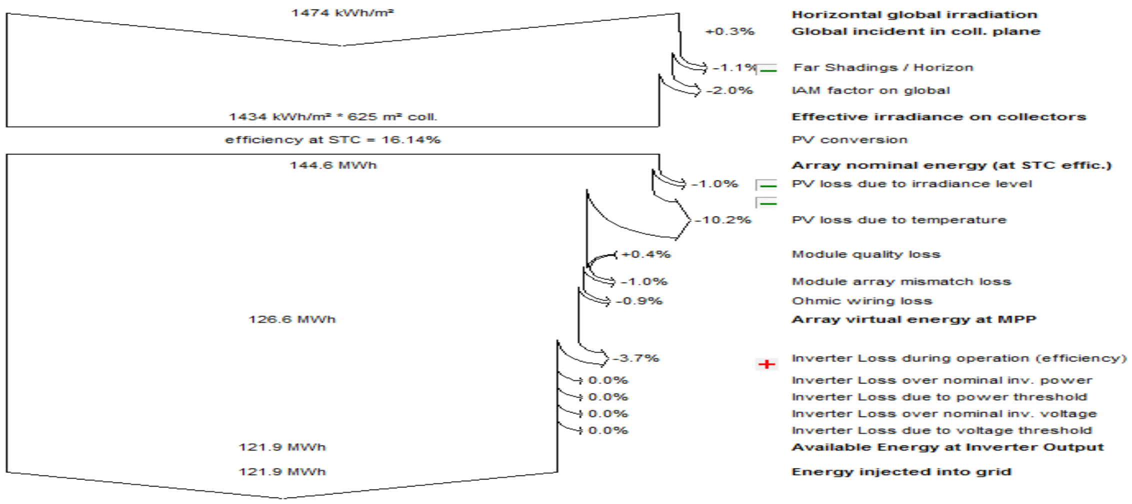

Figure-3. Loss disgram.

Source: PVsyst software.

Figure 3 shows the loss diagram for the proposed PV system. Energy losses for a whole at various levels of the system was estimated and quantified. Loss factors such as: irradiance, temperature, module quality, mismatch, ohmic and inverter affect overall system performance. Horizontal global irradiation is seen to be 1474kWh/m². After losses due to independent angle modifier (IAM) and shading, effective irradiance on the collector was reduced to 1434kWh/m². As solar radiation is being converted to electricity by solar modules of 16.14%, energy is also lost in the system. Array nominal energy at STC is then shown to be 144.6MWh/year. At this point, factors such as irradiance, temperature, module quality and ohmic wire contributed various levels of losses which then reduced the array nominal energy to 126.6MWh. This resultant energy is called array virtual energy at MPP. During operation of inverter as it converts DC power to AC equivalent, energy is also lost in the system. As a result, final output energy of the inverter is reduced to 121.9MWh. This is the final energy that is fed into the grid. Loss diagram helps in identifying system weakness and gives in-depth insight on the quality of the PV system design.

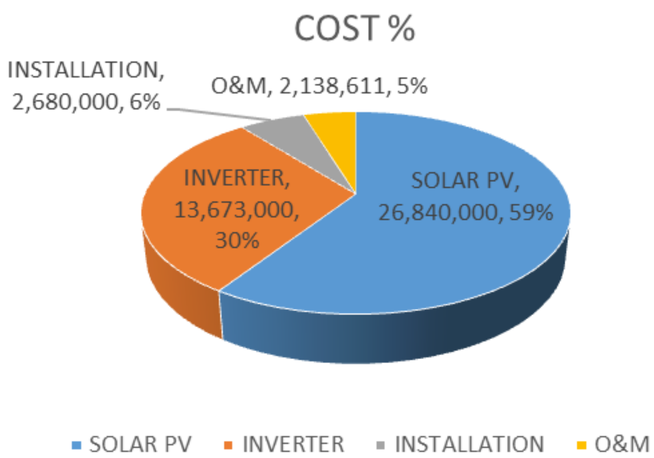

Figure-4. Cost percentage of various PV solar components.

Source: Researcher finding.

Figure 4 gives cost percentage of each component that makes up grid tie solar PV system. From the chart, Solar PV cost amount to 59% of the total system cost, while the Grid-tie inverter cost is 30%. Installation cost is 6% and finally, O&M cost 5% of the total cost of the system. This implies that more than half of the cost was spent on purchase of solar PV module. Figure 5 shows carbon balance of proposed PV system if installed in the proposed location. It is estimated from PVsyst that a saving of 907.666 tonnes of carbon dioxide emission is expected of the PV plant installation over its life cycle would be saved. This power generation scheme conserves the environment by its clean and none polluting characteristics.

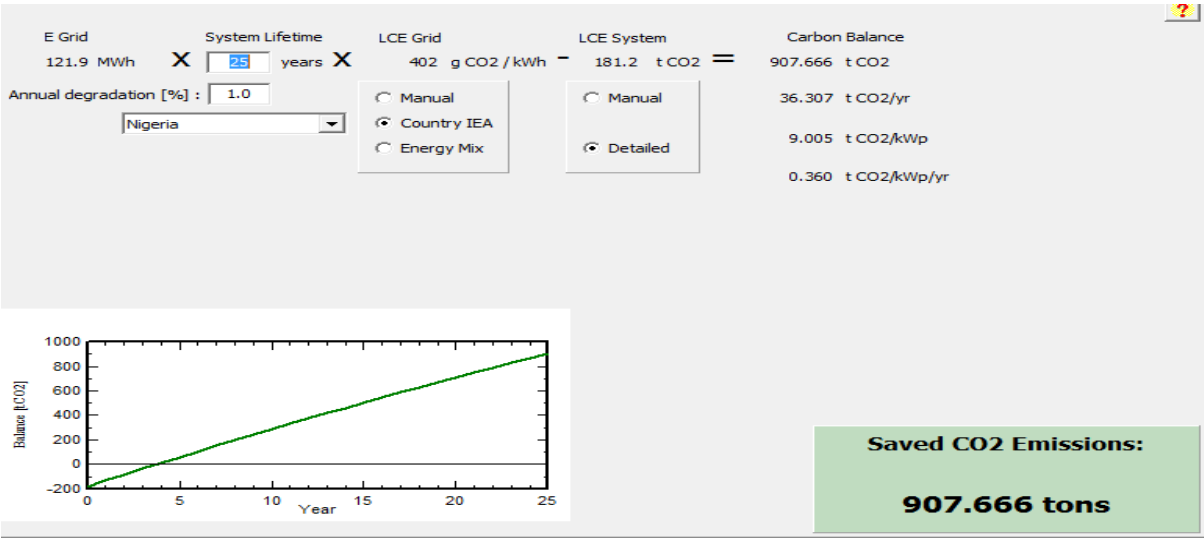

Figure-5. Carbon balance.

Source: PVsyst software.

3.3. Data Analysis

From Table 6 it is shown that the balance and main results of the proposed grid connected PV system. Yearly global horizontal irradiation is estimated to be 1474.3kWh/m². The annually global incident energy on the collector plane is estimated as 1479.1kWh/m². At the output of the PV array, energy available is 126619kWh. The average yearly efficiency of the PV array/rough area, EffArrR, is 13.70%. The average efficiency of the system annually is 13.19%. The average ambient temperature is 26.59⁰C. And finally, energy at the output of inverter, which is injected into the grid is 121914kWh.

Table 5 describes various losses associated with inverter and final output energy. It is shown that global inverter loss is 4705.077kWh and inverter loss during operation is also 4705.077kWh. Average efficiency of inverter is 96.28%. And final output energy of the inverter after all the various loses is 121914kWh. There were no losses attributed to power threshold (IL Pmin), power overcharging (IL Pmax), low voltage maximum power point window (IL Vmin), upper voltage maximum power point window (IL Vmax).

Table 6 shows final useful energy at choba site. It describes the monthly average energy exported to the grid in kWh. From the table, it is seen that the maximum energy injected into the grid occurred in December and it is 11162kWh, whereas minimum energy injected was in August at 8584kWh. The total energy injected into the grid is 121914kWh/year. Table 7 shows in detail various losses as introduced by subsystems of the proposed grid connected PV system in kWh. Module quality (ModQual), which is estimated from PV module tolerance, contributed to 514.111kWh energy lost in the system annually. Module mismatch (MisLoss), which depends so much on module technology, was responsible for 1290.4kWh energy annually. Ohmic wiring loss (Ohm Loss) 1134.4kWh annually. Array virtual energy at maximum power point (EArrMPP), which is the DC energy produced at PV array, is 126019kWh annually. Finally, total loss in inverter system is 4705.017kWh annually.

3.4. Discussion of Findings

The site for the proposed grid connected PV system receives annual average energy of 1474kWh/m^2/year. The annual performance ratio of the system is 81.1% and capacity utilization factor of 13.9%. With nominal energy of 144.6MWh and useful energy of 121.9MWh, it is estimated that over 80% of total energy is exported to the grid. These useful findings indicate that plant would be operated with good performance ratio and capacity utilization factor. It is also indicative of the fact that plant will feed enough power to the grid station at maximum available percentage. Factors such as irradiance and temperature have tremendous impact the power output of the system. PV system should be sited where appreciably high irradiance and temperature close to standard test condition of the panel, as temperature adversely affects efficiency of panel. Subsystems of the PV system contribute to various levels of losses as power travels from one point to another and during conversion process. This also affects efficiency of the entire system. In order to absorb maximum solar irradiation, solar PV array should be tilted at angle approximately close to the latitude of the location. This will help in effective utilization of incident radiation on the array.

4. CONCLUSION AND RECOMMENDATION

This work focused on performance evaluation of grid-connected solar PV system for FOE in University of Port Harcourt. FOE represents an ideal site for installation of solar PV system as the location records high insolation. In summary, the present generation capacity and use of private generators to provide electricity in FOE faces enormous logistical challenges making it less cost effective with a very high operating cost. This paper evaluated the performance of a proposed grid connected PV system with a view to providing reliable, cost effective and clean solution for power supply deficiency in FOE. The present power supply from the grid is very unstable and unreliable. Huge sum of money is spent on running generators on daily basis. The findings after evaluating performance of the proposed grid connected solar PV indicated that Renewable Energy sources (RES) are feasible and viable technically and economically in Choba community and in FOE. These RES are readily available and can be harnessed by the government or private sectors to provide clean, cheap and reliable electricity supply. For FOE, performance ratio result clearly shows that 100kW grid connected solar PV can produce the required energy.

The paper is limited to theoretical estimation of performance of proposed grid-connected solar photovoltaic system for FOE, University of Port Harcourt using PVsyst software. The study addressed the issues of lingering inadequate power supply in Nigeria, FOE, University of Port Harcourt that is currently experiencing epileptic power supply as a reference point. It will also discourage huge cost of running generators on daily basis, which adversely have negatively impacts on the environment and cause noise pollution, and global warming. The significance of this paper will result to employment opportunities when there is stable power supply. The environment will be preserved if the proposed grid connected PV plant is deployed in the FOE.

4.1. Recommendation

It is recommended that there should be implementation of most renewable policies as practiced in developed countries to help reposition Nigeria's power sector. Moreso, Government should also prioritize renewable energy for power production to maximize available energy potentials. Policy makers, in the private sectors and implementation agencies, should give more publicity to renewable energy policies in educational institutions. Net metering and financial incentives such as preferential feed-in tariff for solar-generated electricity will help to support solar PV installation at large scale.

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