



ORIGINAL RESEARCH ARTICLE

HOMER PRO-BASED APPROACH FOR DESIGNING AND OPTIMIZING A GRID-TIED  
HYBRID RENEWABLE ENERGY SYSTEM FOR A RURAL COMMUNITY

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ABSTRACT

One of the most important elements in our planet is energy, there is a daily rise in the global demand of energy and so renewable sources of energy need to be employed to meet this demand. We understand that renewable sources of energy are not continuous; to resolve these issues, research have proven that combining several renewable sources in a hybrid form would compensate for the discontinuity and decrease emission of harmful chemicals to the environment. Based on the epileptic power supply issues for residents in Sango Ota, an alternative source of power is suggested in this study. Sango Ota is a fast-developing area with population increasing daily, and load demand needs to be met for residential and commercial activities. This paper presents the optimal planning, design, operation, and techno-economic assessment of a sustainable hybrid renewable energy Microgrid system using Sango Ota, Ogun State, Nigeria as a case study. The sources of renewable energy considered in this study are wind turbines, solar photovoltaic (PV), diesel generator and storage system (battery). The study employs HOMER Pro application and algorithm to simulate models of the design. This study helps to proffer a solution or an alternative means of generating power at a lesser cost with several options as backup. The study focuses mainly on the residential whose lifetime is 25 years. The Return on investment (ROI) of this study is positive, which indicates that the project is viable, profitable, efficient and should yield a payback after 4 years. This study has been able to show that a sustainable power supply can be generated using hybrid renewable energy sources from wind, solar, diesel generator and battery. Enough energy was generated to meet the load demand, it was cost effective and the capital would be regained in 4 years. Auto size Gen was preferable for the simulation as it is flexible and adjustable to meet the load demand.

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1.0 Introduction

In recent years, renewable energy resources have gradually been recognized as one of the best alternatives in supply side planning for micro grids. A good option to conventional power generated from fossil fuel is renewable energy (United States Department of Energy, 2008). Although the energy of the future is renewable energy, but this energy is not consistently available and a lot of challenges will emerge when a single technology is used to supply the load demand from these resources, challenges like high capital cost and intermittence (Sabhan Kanata et al, 2021). In Nigeria, a lot of people in rural areas rely on diesel and kerosene to meet their energy need due to their easy installation. These fuels have some disadvantage like high maintenance and operation cost, distance to transport the fuel, fluctuation of fuel prices, releases of poisonous gas (Khodayar, 2017; Emilia Ines et al., 2021). A hybrid renewable energy system that is made up of more than two components would help to minimize the aperiodic or discontinuous nature of the system, increase how efficient it is, and maintain balance in the system. Corresponding author's email address: [emmiesakinwale@gmail.com](mailto:emmiesakinwale@gmail.com)

In HRES, an optimized plan is needed for individual component in order to reduce cost, maximize its efficiency and increase its profitability. The continuity of power supply in renewable energy system is a challenge that must be overcome. From the technical perspective, optimal sizing and configuration was considered, from economic aspect, the Net present cost, Internal rate of return (IRR), Return on investment (ROI) and levelized cost were considered while the CO<sub>2</sub> generated to the atmosphere was considered from the environmental perspective. There is an immense growth in renewable energy sources resulting from technological advancement in reduction in cost and production in large quantities in recent years (Green, 2017). HRES can work in both standalone and grid-connected mode (Murugaperumal et al., 2020).

Some software tools like HOMER and MATLAB are introduced and juxtaposed to analyses economical, electrical and environmental performance of hybrid renewable energy system (Junga Jaesung, 2017). In order to promote the investment in sustainable electricity and renewable energy, the Nigerian Energy Support Programme (NESP, 2014) are jointly assisted by European Union and Federal Ministry of economic cooperation and development. A hybrid renewable energy system, in which more than one renewable energy sources are used together, reduces the discontinuity on intermittent nature of renewable energy resources, it provides better overall balances to the energy supply and improves the efficiency of the system.

Conventional power generation may sometimes lead to renewable energy combinations that are properly designed, planned, or oversized (Mohammed et al., 2014). A major source of energy is fossil fuel but it releases a lot of harmful vapors into the surroundings (Md Mizanur, 2021). HOMER software was used by Agelin-Chaab et al (2014) to optimize of a hybrid Diesel, solar and wind system to power hypothetical rural area in Ghana. A standalone wind/photovoltaic/battery (WT/PV/B) was proposed by Krishan (2019) for a rural area in India using HOMER software, the cost of energy and net present cost was estimated as \$0.228\$/kwh and \$1228,353. Micro grids are power systems that are small, autonomous and can operate when the mini grid or main grid experience downtime. The most popular type of mini grid technologies seen is hybrid, wind, solar and hydro (Crijns-Graus et al., 2014).

Maleki and Askarzadeh, 2014) carried out a study that used the techniques of optimization for optimal sizing. An analysis was carried out on wind/PV diesel hybrid system for electrification with battery as storage, this was in Iran. A discrete harmony search-based technique was used for optimizing and sizing the system. The outcomes obtained were compared with the ones of a discrete annealing algorithm that was simulated. An improved ant colony algorithm was proposed by Dong, Li, and Xiang, (2016) for a standalone hybrid wind/battery/PV/ hydrogen system optimal design to provide for the primary load demand of Zhejiang in China. Reducing the cost incurred annually and increasing the systems reliability was the two main objectives.

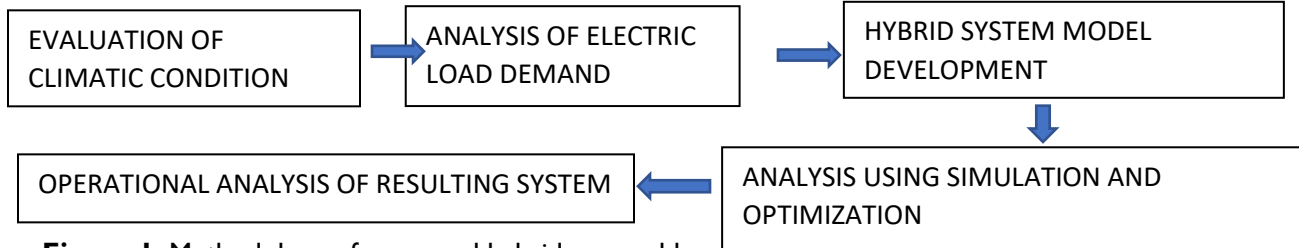
A hybrid wind/PV system plus a pumped hydro storage (PHS) to meet the residential power needs of a hypothetical small and undeveloped village in Hong Kong was studied by Ma et al. (2014). Donnado et al. (2019) examined a contemporary software for the sizing of HREs optimally. The outcome from comparing 23 case studies using the HOMER software and the developed tool revealed that HYREs was acceptable statistically.

One of the objectives of this research is to close the gaps in literature described above by modelling a methodology for optimal planning, design, sizing and techno-economic analysis of a hybrid Wind/PV/Battery/Diesel system to handle the load demand of Sango Ota, Nigeria. The aim of this research is to ensure that the electrical load demand of Sango Ota is met by generating a steady power supply by hybridizing various renewable energy sources at an affordable cost. To meet this goal, wind, sun, battery and generator were taken as the main components of the renewable system. Load consumption of the Sango-Ota is to be studied, while the various components of the renewable energy system are hybridized and the impact of optimal plan configuration and cost component on the net presence cost were analyzed. The feasibility study of generating sustainable power from wind, sun, battery and diesel has been presented. And this study is to show that a sustainable power supply could be generated using hybrid renewable energy sources from wind, solar, diesel generator and battery in Sango area.

## **2. Materials and Method**

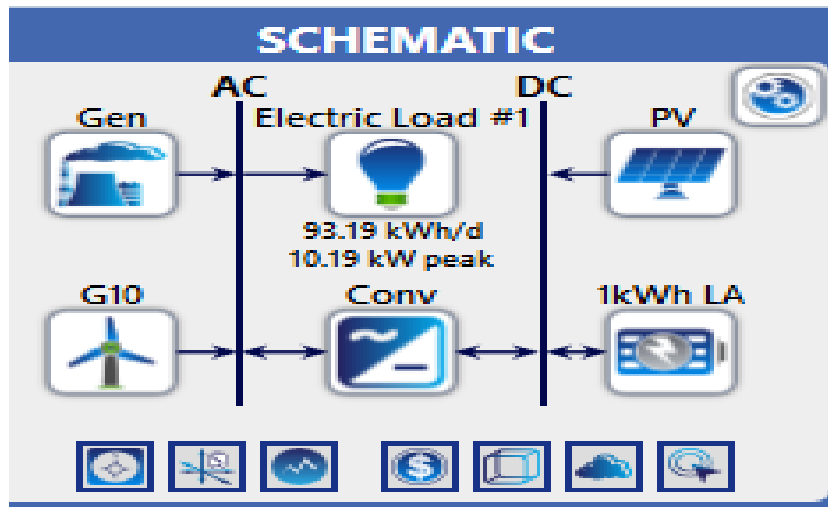
A simulation software that helps in the planning and design of a sustainable renewable energy based micro grid is HOMER (Hybrid Optimization Model for Electric Renewables). HOMER is used to model the physical characteristics of an energy supply system and its lifecycle cost, which is the addition of capital, operation cost and techno-economic feasibility (HOMER Energy LLC, 2016). The cost analysis, constraints, capital cost, technical

performance of the system, environmental assessment and result will be put into consideration as indicated in Figure 1.



**Figure 1:** Methodology of proposed hybrid renewable energy system

The peak load is 10.19KW and the component for the design is as shown in the Figure 2. It also shows the system configuration and operation of the study. **G10** is the Wind turbine, Gen is the generator, **PV** is the photovoltaic, **BAE** is the battery and **CONV** is the converter.



**Figure 2:** Schematic representation for System Configuration and Operation strategy for the study

## 2.1 The Systems Input Parameter

The daily electricity was estimated at 93.19Kwh/day annual average and 10.19Kw peak with July as the peak month.

According to the wind speed profile, the annual average wind for this area is 3.81 m/s.

The annual average sun irradiation for the considered micro-grid is 4.76Kw/m<sup>2</sup>/day. With peak as 5.318 Kw/m<sup>2</sup>/day in November.

## 2.2 Modeling of The System Components

### 2.2.1 Photovoltaic System Modeling

Several PV cells are combined together to give a module of photovoltaic ( $P_v$ ). PV here is 5KW, generic flat plate. The power output of each PV module per hour is given by (Dong W. L., 2016)

$$P_{0(t)} = \mu_{pv} \times I_{(t)} \times A \quad |$$

$\mu_{pv}$  = efficiency, A = surface area of the PV module, and  $I(t)$  = solar insolation (KWm<sup>2</sup>) per hour. The total power generated can be obtained as:

$$P_{pv(t)} = P_0 \times N_{pv} \quad 2$$

To estimate the size of the photovoltaic panels that will be tapped, the solar radiation in Sango Ota can be expressed as (K. R. Kamil et al., 2012)

$$E_{dc} = \frac{E_{ac}}{\sigma_{inverter}} \quad 3$$

$E_{dc}$  = Dc battery energy,  $E_{ac}$  is AC energy and  $\sigma_{inverter}$  is the efficiency of the inverter

(Chul-Young Park, 2020), explains that 90 to 95% is the range for the efficiency of inverter, 0.9 is assumed, the efficient system solar radiation is 0.18, the area of the photovoltaic module is 0.6m<sup>2</sup>, nominal voltage ( $V_n$ ) is taken to be 240V as used in Nigeria, module voltage ( $V_m$ ) is 18V, array current is 4A.

$$E_{dc} = 93.19/0.9 = 103.54\text{Kwh}$$

$$A_{panel} = \frac{E_{dc}}{\sigma_{inverter} \times R} \quad 4$$

R is the solar radiation at kw/day,  $A_{panel}$  is the area of the panel,  $A_{panel} = 103.54/(4.76 \times 0.18) = 120.85\text{m}^2$

$$\text{Number of cells (Nc)} = \frac{A_{panel}}{A_{pv}} \quad 5$$

$A_{pv}$  is the area of PV module

$$Nc = \frac{120.85}{0.6} = 201.42, \text{ Number of series modules } (S_m) = V_n/V_m = 240/18 = 13.33,$$

$$\text{Number of parallel module } (P_m) = Nc/S_m \quad 6$$

$$(P_m) = 201/13 = 15.5 = 16 \text{ modules}$$

$$\text{Total power required from panel (Ppv)} = \text{Total power demanded} \times \text{power lost in the system} \quad 7$$

$$(P_{pv}) = 93.19\text{K} \times 0.2 = 18.64\text{KW}$$

$$\text{PV system size} = \text{Total power required from panel} / \text{Panel generation factor (PGF)} \quad 8$$

$$\text{PV system size} = 18.64/4.76 = 3.92\text{KW} = 4\text{K}$$

### 2.2.2 Wind Turbine Modelling

The power generated by the generator varies directly with the cube of the wind speed as the wind speed rises above the cut-in velocity. Given a constant acceleration, the K.E (kinetic energy) of a body with a speed of V and mass m is the work-done (w) by the body in moving through a distance (S) when a force F is applied to it. Therefore  $W = K.E = F \times S = m \times S \times a$  9

$$V^2 = U^2 + 2aS \quad 10$$

$$P = \frac{dE}{dt} = \frac{1}{2}(v^2) \frac{dm}{dt} \quad 11$$

The rate of change of mass flow rate is  $\frac{dm}{dt} = \sigma \times A \times V$  12

$$P = \frac{1}{2}(v^2) \frac{dm}{dt} = \frac{1}{2} \times \sigma \times A \times V^3 \quad 13$$

Bertz' law (1919), proposed that in a perfect situation, no wind turbine can convert more than 59.3% of the kinetic energy of the wind into mechanical energy that rotates the rotor. (United State Department of Energy, 2015)

The available power ( $P_{available}$ ) is  $P_{available} = \frac{1}{2} \times \sigma \times V^3 \times C_{pmax}$  14

According to the report from royal academy of engineering on wind power calculation, the standard radius of a wind turbine for tapping average wind speed is about 50m. The standard density of air is 1.29kg/m<sup>3</sup>, from the simulation, the average wind speed of the area under consideration is 3.81 m/s. To find the area swept by the turbine from length of the blades by using the equation of the area of circle is shown as;

$$A = \pi r^2, \text{ hence } A = 3.142 \times 50 \times 50 = 7855\text{m}^2, (P_{available}) = \frac{1}{2} \times 1.29 \times 7855 \times 3.81 \times 0.59 = 11.4\text{Kw}$$

Hence 11KW or 12Kw wind turbine is considered.

### 2.2.3 Battery Modeling

In hybrid system, the most used storage system is battery,  $\eta_{bc}$  is the charging efficiency of the battery,  $\eta_{inv}$  is the inverter efficiency, the number of batteries is Nb, the nominal capacity of a battery measured in Kwh is Cb, and the self-discharge rate per rate per hour is  $\alpha$  (K. R. Kamil et al., 2012)

$$\text{Total Ah per day (Ah)} = \frac{(E_{dc})}{(V_n)} \times S_L \quad 15$$

$$\text{Total Ah per day (Ah)} = \frac{(103.5 \times 1000)}{(240)} \times 0.2 = 86.28\text{Ah}$$

$$\begin{aligned} \text{Storage days} &= 9.43 - (1.9 \times \text{peak hours of sun}) + (0.11 \times \text{peak hours of sun}) \\ &= 9.43 - (1.9 \times 2) + (0.11 \times 2) = 5.41 = 5 \text{ days} \end{aligned} \quad 16$$

$$\text{Battery capacity} = \frac{(A_h)}{(D_d)} \quad 17$$

$$= (86.28 \times 5)/0.4 = 1078.54\text{Ah}$$

$$\text{Number of cells in series} = \frac{V_n}{V_b} = 240/12 = 20 \quad 18$$

20 batteries would be suggested for the design in this study.

## Optimization Model Analysis

### 2.3.1 Decision variables

The following are the quantities which can be controlled in this study, the number of batteries ( $N_{bat}$ ), number of wind turbines ( $N_{wt}$ ), number of PV modules ( $N_{pv}$ ) and capacity rating of the diesel generator ( $P_{rd}$ ) (Nasser Yimen et al., 2020)

### 2.3.2 Objective functions

The objective function of this research is to find the minimized total cost of implementing and generating energy through this proposed hybrid renewable energy system. Hence the focal point is the amount of total annualized cost  $C_{ann,tot}$  (Nasser Yimen et al., 2020).

$$C_{ann,tot,K} = \sum_{K \in \{bat, wt, pv, dg, \frac{CON}{INV}\}} (C_{ann,cap,K} + C_{operating,K} + C_{rpl,K} + C_{F,K} - S_{a,K}) \quad 19$$

$C_{ann,cap,k}$ ,  $C_{operating,k}$ ,  $C_{rpl,k}$ ,  $C_{F,k}$ ,  $S_{a,k}$  the annual capital cost, operating and maintenance cost, replacement cost, fuel cost and salvage value respectively of the component k.

The annual present worth is the product of the capital recovery factor CRF and present worth. The

$$CRF_{(i,N)} = \frac{i(1+i)^N}{(1+i)^N - 1} \quad 20$$

where i is the interest rate and N is the life span of the system which is 20 years.

$$\sum_{k \in \{bat, wt, pv, dg, \frac{CON}{INV}\}} (C_{ann,tot,K}) = C_{wt} \cdot P_{wt} + C_{pv} \cdot N_{pv} + C_{bat} \cdot N_{bat} + C_{dg} \cdot P_{rd} + C_{\frac{CON}{INV}} \cdot \frac{N_{\frac{CON}{INV}}}{\frac{CON}{CON}} \times CRF_{(i,N)} \quad 21$$

$C_{wt}$ ,  $C_{pv}$ ,  $C_{bat}$ ,  $C_{\frac{CON}{INV}}$  represents the cost of installing one unit of wind turbines, PV, battery and converters respectively and  $C_{dg}$  is the cost of installing a Kw of diesel generator. The operation and maintenance cost for wind turbine, PV and diesel generator is:

$$\sum_{k \in \{bat, wt, pv, dg, \frac{CON}{INV}\}} (C_{operating,K}) = (O \& M_{wt} \cdot N_{wt} + O \& M_{pv} \cdot N_{pv} + O \& M_{dg} \cdot \sum_{t=1}^{8760} P_{dg(t)}) \quad 22$$

$O \& M_{wt}$ ,  $O \& M_{pv}$ ,  $O \& M_{dg}$  are the operation and maintenance cost of a unit wind turbine, PV and diesel generator respectively. To find the replacement cost for the batteries, diesel generator and converters.

$$\sum_k (C_{rpl,K}) = CRF_{(i,N)} \times \left( R_{bat} \cdot N_{bat} \cdot \left( \frac{1}{(1+i)^5} + \frac{1}{(1+i)^{10}} + \frac{1}{(1+i)^{15}} \right) + \left( \frac{R_{INV}}{CON} \cdot \frac{N_{INV}}{CON} + P_r \cdot C_{dg} \right) \cdot \frac{1}{(1+i)^{10}} \right) \quad 23$$

The salvage value can be found by:  $S_K = C_K \cdot \frac{L_{rem}}{L_{com}}$  24

### 2.3.3 Constraints

These are the conditions which the decision variables need to adhere to

1. The systems variable constraints is  $N_K = \text{integer}$ ,  $k \in \{\text{bat, wt, pv}\}$
2. The bound constraints is  $0 \leq N_K \leq N_{K-\max}$ ,  $k \in \{\text{bat, wt, pv}\}$  &  $0 \leq P_R \leq P_{R-\max}$

Where  $N_{K-\max}$  is the maximum available number of k component

3. The renewable fraction constraints

$$REF = \left( 1 - \frac{\sum_{t=1}^{8760} P_{dg(t)}}{\sum_{t=1}^{8760} P_{l(t)}} \right) \times 100 \geq REF^*$$

Where REF\* represent the minimum allowable renewable energy fraction of power supply in a period t.

## 3. Results and Discussion

### 3.1 Cost summary

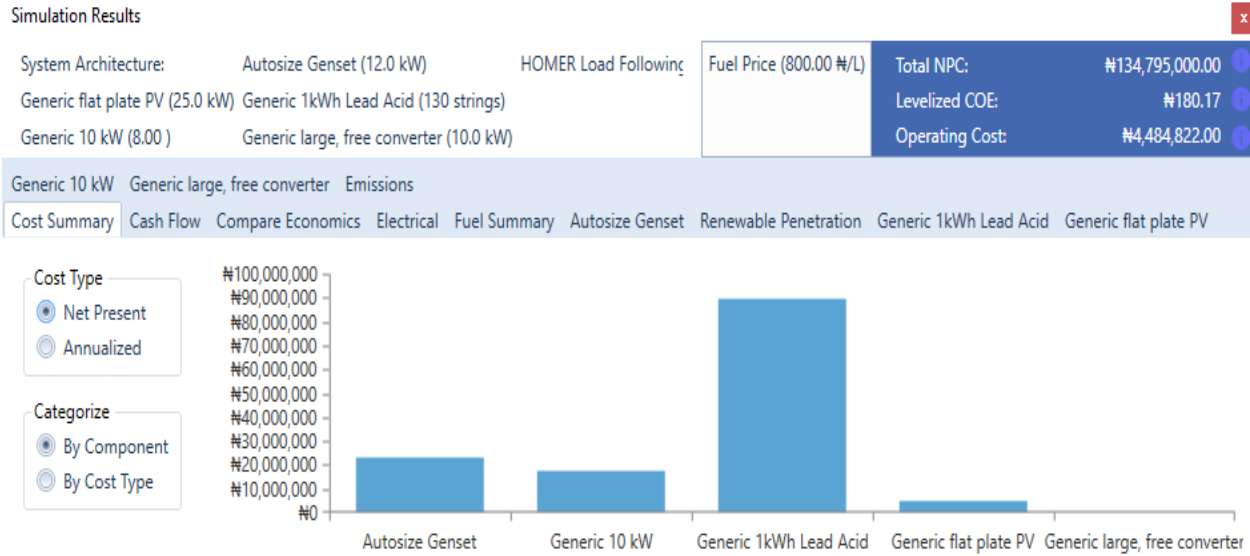
As seen in table 1, the net present cost N134,795,000.00, levelized cost N180.17 and operating cost N4484,822.00 are all based on the model and parameters inputted into the system, one of which the fuel price is N800/liter. Generator = 12.0kw, PV = 25.0Kw, Converter = 10.0kw

**Table 1:** Cost presentation

Total NPC	N134,795,000.00
Levelized COE	N180.17
Operating cost	N4,484,822.00

As presented in Figure 3, the generic lead acid battery has a higher net present cost as a result of the quantities needed to be purchased and cost of maintaining them. Twenty batteries were proposed for this project





**Figure 3:** Cost summary.

As seen in the Table 2, the operation and maintenance cost of generic lead acid battery is the highest with a high cost of fueling the generator throughout the year. The generic flat plate PV has a zero-replacement cost, it has a high life span, although its maintenance and operating cost is appreciably high. The storage, Wind, generic flat plate and converter has zero fuel cost because they don't require fuel to be powered.

**Table 2:** Cost summary

Component	Capital (N)	Replacement (N)	O&M (N)	Fuel (N)	Salvage (N)	Total (N)
Autosize Genset	10,800.00	8,009.01	6,588.15	22,953,208.08	(4,579.81)	22,974,025.43
Generic 10Kw	14,000,000.00	11,450,697.13	52,789.65	0.00	(8,167.124.27)	17,336,362.50
Generic 10Kw Lead acid	19,500,000.00	66,950,125.53	17,156,634.63	0.00	(14,436,646.44)	89,170,113.72
Generic Flat Plate PV	2,562,500.00	0.00	2,474,514.61	0.00	0.00	5,037,014.61
Generic large, free converter	75,000.00	53,753.65	164,976.64	0.00	(16,204.61)	277,516.68
System	36,148,300.00	78,462,585.31	19,855,494.67	22,953,208.08	(22,624,555.14)	134,795,032.93

**3.2 The ROI (Return on investment):** indicates the measure of profitability and performance or efficiency of the systems design, it measures the profit generated from the project. The ROI of this project is positive and it indicates that the project is viable, the value is 13.4%. Following the result in Table 3, the Return on Investment (ROI) is +13.4.0% which is positive. It means the project is viable, feasible and there will be return on investment. Hence there is room for profitability, the project has a good internal rate of return and the simple payback year is 4, Fuel price = 800\$/L



**Table 3:** Compare Economics Metric and value

Metric	Value
Present worth (N)	N94,741,740.00
Annual worth (N/Yr.)	N4,307,288.00
Return on investment (%)	13.4
Internal rate of return (%)	19.8
Simple playback (Yr.)	4.01
Discounted playback (Yr)	4.11

As seen in Table 3, the simple back year is 4.01, by implication, it means in for 4 years time the expenses incurred in implementing the project will be regained.

### 3.1.2 Electricals

As shown in Figure 4, there is almost a zero amount of energy generated from diesel in the month of February. From the solar radiation graph, it is understood that February had a higher solar radiation, this accounts for the low level of energy obtained from the generator as most of the supplies is from the PV and wind as seen in figure 4. The reverse is the case for some months like June, July and August.

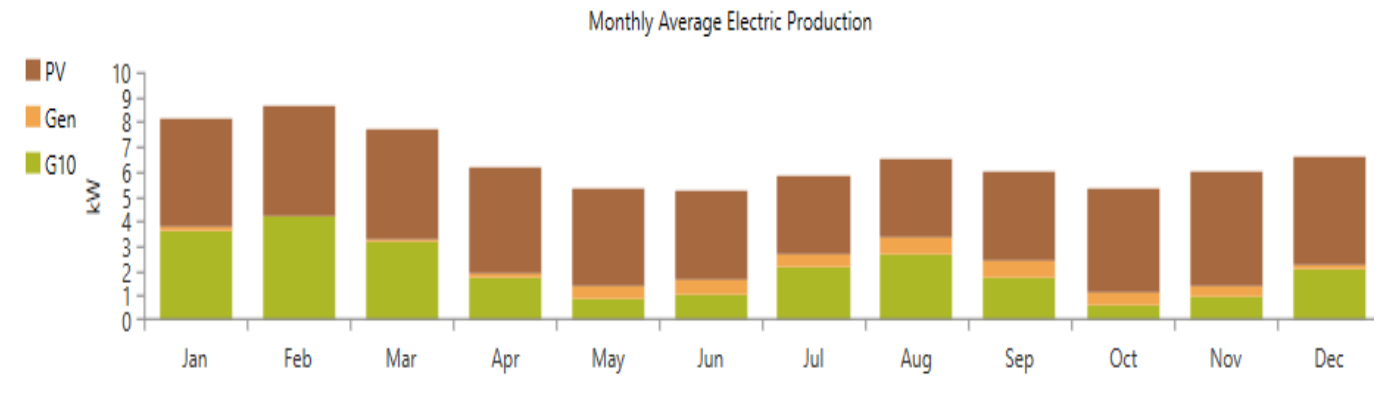


Figure 4: Monthly average electric production

It can be seen from Table 4 that larger percentage of energy is released from the generic flat plate due to the high level of solar irradiation; no DC load was consumed; the system was designed to generate AC load for consumers all through the year and this is why we have a zero DC output.

**Table 4:** Electrical Components

<b>Production</b>	<b>Kwh/yr</b>	<b>%</b>
Generic flat plate PV	35,059	62.3
Autosize Gen set	3,255	5.79
Generic wind turbine	17, 941	31.9
Total	56,254	100

From Table 5 we can see that the load consumption is totally AC, because the system is designed to supply alternating load.

**Table 5:** Load Consumption capacity.

<b>Consumption</b>	<b>Kwh/yr</b>	<b>%</b>
AC Primary Load	34, 013	100
DC primary Load	0	0
Total	34, 013	0

It was depicted in Table 6 that excess electricity of 28.2% is generated over the year and no unmet energy. Which indicates that the energy requirement of the town would be met

**Table 6:** Useful Electricity Breakdown

<b>Quantity</b>	<b>Kwh/yr</b>	<b>%</b>
Excess Electricity	15,846	28.2
Unmet Electric Load	0	0
Capacity Storage	0	0

### 3.1.3 Auto size gen

As shown in figure 5, there is almost a zero amount of energy generated from diesel in the month of February. It is the other way round for some months like June, July, August and September. These months have high rainfall and the weather tends to be cloudy. The implication is that a more energy will be required from the diesel generator and it will be made to do a lot of work in these months, also there will be high cost of diesel and maintenance for the generator.



**Figure 5:** Auto size Gen simulation result.

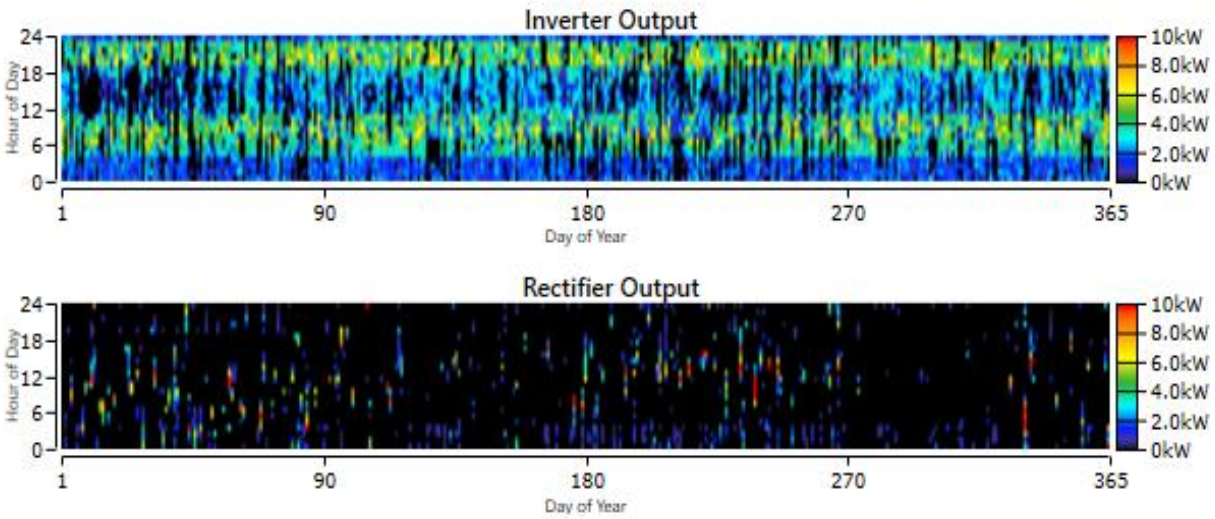
As depicted in the table 7, the year Electrical production for the generator is 3,255Kw/Yr. 3.91Kw being mean power and 3.00Kw minimum power.

**Table 7:** Generator production capacity

Quantity	Value	Unit
Electrical Production	3,255	Kw/yr
Mean Electrical output	3.91	Kw
Minimum Electrical Output	3.00	Kw
Maximum Electrical Output	9.66	Kw

### 3.1.4 Generic large free converter

The PV needs the inverter to convert the power to its alternating form. Hence the inverters work is dependent on the PV shown in the figure 6. The maximum output power of the inverter is 10KW. The converter was originally modelled for 12Kw.



**Figure 6:** Generic large free converter output result.

It can be deduced from Table 8 that the inverter has a higher hour of operation as the system is based on alternating output.

**Table 8:** Performance features of converter

Quantity	Inverter	Rectifier	Units
Hours of operation	6,959	1,011	hrs/yr
Energy out	21,985	2,146	Kwh/yr
Energy in	24,428	2,385	Kwh/yr
Losses	2,443	238	Kwh/yr

### 3.2 Comparing the combination of various components Output

It can be seen that the 56,254Kwh/Yr. produced by the hybridization of the renewable energy sources is higher than the estimated power or load demand of 34,107.54Kwh/Yr. consumed by the residents of Sango Ota annually.

#### 3.2.1 Hybrid of wind and Solar sources

From the simulation result above, the summation of the electrical power generated from solar which is 35,059Kwh/yr and that of the wind is 17,941Kwh/yr is 5300Kwh/yr which is far above the annual load demand. Since 35059Kwh/yr can be obtained from solar, it means it can stand alone. Although for better efficiency and continuity it would be advised to be hybridized.

#### 3.3.2 Hybrid of Diesel Generator and Wind turbine.

From the result the Diesel generator produces 3255Kwh/yr while the wind turbine generates 17941Kwh/yr, to optimize the system, two (2) wind turbines would be needed to hybridize the diesel generator. The expected energy from the five 10Kw wind turbine =  $2 \times 17,941 = 35,882$ Kwh/yr.

Since the diesel generator could generate 3255Kwh/yr, then total energy obtained in the hybrid of diesel generator and five wind turbines =  $3255 + 35,882 = 39137$ Kwh/yr

A total of 39,137Kwh/yr is optimal enough to balance the 34,107Kwh/yr load demand.

#### **4. Conclusion**

In this research paper, optimal design and planning of a sustainable hybrid renewable energy system in micro grids for Sango Ota, Ogun was carried out with wind, solar, battery and diesel generator as the components and inputs on their economic, physical and operational features were put into considerations.

The major aim of this study is to optimize the generation of sustainable power to supply and balance the electrical load demand and this aim has been achieved as the power generated 56,254Kwh/yr exceeds the load demand for Sango which is 34,107.54Kwh/yr.

From this study, it is crystal clear that Sango is potentially filled with high renewable energy resources which if efficiently tapped would reduce epileptic power supply in the Sango. Exploration of renewable energy is a good alternative to promotes continuous power supply to populated cities and rural areas in Nigeria. The design would compensate for the increasing population for a long time, also Homer pro has made the analysis very easy. For continuity and reliability of power supply, the renewable resources should be hybrid. Similarly, from the analysis the capital for the initial investment will be recovered in four years as shown from the payback time. From the value of the ROI and IRR, the system is environmentally friendly has it can be less dependent on diesel since an excess energy is already produced hence reducing emission into the environment. The Return on investment (ROI) of this study is positive, which indicates that the project is viable, profitable, efficient and should yield a payback after 4 years. This study has been able to show that a sustainable power supply can be generated using hybrid renewable energy sources from wind, solar, diesel generator and battery. Enough energy will be generated to meet the load demand, it is cost effective and the capital would be regained in 4 years. Auto size Gen was preferable for the simulation as it is flexible and adjustable to meet the load demand.

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