Feasibility Study and Simulation of Optimal Power System for Off-Grid Voter Registration Centres

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Abstract-There are cases of disenfranchising eligible voters during registration exercises due to unreliable power supply or no access to electricity in powering the Direct Data Capturing Machines (DDCMs) that is used for the registration of voters in polling stations or registration centres. This paper proposes to design an optimized PV-Battery energy system with an energy management system that will be used to control the operations of power supply (supply the load and charge the Battery) at the registration centres in Nigeria. This research is focused on the simulation of Photovoltaic power generation system with energy storage and management system for off-grid voter registration centres in two locations - Nkanu-West (Enugu State – which covers the southern part of the nation) and Kaura (Kaduna State – covering the northern part of the nation). The developed power control system was used to study the operations of the PV-Battery energy system. From the control output results, it was shown that the load and the supplied energy is efficiently and rationally utilized. A simulation analysis was performed using hybrid optimization model for electric renewables (HOMER) software and the results indicate that the most optimized PV-Battery power system for energy consumption of 2.3kWh/day with a 235W peak demand load consists of 0.9 kW solar PV array, 9 Hoppecke 24 OPzS 300 Battery and a 1kW DC/AC inverter. This energy system can be used in any other registration exercises such as the National Identity Registration or Examination registration etc., and may also be applied to other regions of the country.

Keywords-Direct Data Capturing Machines (DDCMs), Power Supply, Solar – PV System, System Design, HOMER

1. Introduction

Over the years, the greatest challenges that had been confronting all electoral bodies in Nigeria were due to inadequate planning or preparation. With the introduction of Direct Data Capturing Machines (DDCMs), which is a new innovation in voter registration in Nigeria, electoral bodies will improve in the conduct of elections. Voters' registration with DDCMs is meant for the purpose of recording the enfranchisement of voters and facilitating the voting operation by which the citizens who are eligible to vote exercise their right to suffrage on a periodic basis [1]. The citizen would have his or her picture taken and the details captured. Voters' registration is the identification of citizens who can vote at an election. It is also the compilation of their personal details in a list called the voters' register in a digital format. But for this exercise to succeed there is equally need to provide a reliable power supply. With a stand-alone energy system to power the system effectively, electoral officials would avoid what happened during the last census (2006), in which up to 20% of Nigerians were not registered as a result of unreliable power supply [2]. It is well known fact that 2/3 of Nigeria voters are living in villages without access to electricity. Many of these villages are in isolated areas far from the main utility grid, especially the small villages or communities in the remote and mountainous areas. Thus access to electric energy is practically impossible due to the no profitability considerations for investing in electric grid extension. Extending electricity grids may prove more costly and take longer than harnessing new and alternative sources of energy. These alternative energies (solar, wind, and hydro) are already available in these communities and through renewable energy technologies (RETs) they can be harnessed. The attraction of these sources lies primarily in their abundance and accessibility. In Nigeria, many of the rural areas lying remotely from the grid have a high potential of renewable energy with solar energy being the most abundant. These remote areas are not supplied by power lines and they are the largest potential voters. A situation whereby there is unreliable power supply or no access to electricity in polling station or registration centre will only result in the disenfranchisement of eligible voters. This situation should not be accepted in any electoral conduct. Therefore there is the need to provide a reliable power supply and thus having registration centres being electrified by local resources such as solar energy. Something which appears to be the most suitable alternative.

The aim of this paper is to design and optimize a PV-Battery energy system that will produce the required power needs of the registration centre.

2. Modelling, Simulation and Optimization

Computer modelling, simulation and optimization can be used to plan, design, and construct energy systems and also diagnose problems that might occur in the system's operation. They can be used to perform a feasibility study (various engineering and economic parameters) on any new energy system. Simulation tools can be used for sizing [3], but the user need to identify correctly the key variables and then runs the simulation repeatedly and manually adjusting the variables to reach an acceptable sizing. Much research has been carried out to optimize energy sizing and evaluate its performance. Elhadidy & Shaahid [4] and Nema et al. [5] carried out system design and configuration using Hybrid Optimization Model for Electrical Renewables (HOMER) software tool. Morgan et al. [6] described the development of a simulation program that enables the designer to find the reliable level of a renewable energy system. The simulation program calculates the system autonomy level when both load and meteorological data are inputed and predicts the power supply range expected from the battery (i.e. the hours or days the battery can supply). During optimization process, analyses were carried out and the best possible design and configurations were obtained. There exist many references of using HOMER as a simulation tool [7–12]. This study concerns with the design, simulation and optimization of PV-Battery system for electricity production using HOMER software.

3. Methodology

3.1. Power Consumptions

Electrical systems used by the registration commission during registrations are laptops and printers including some optional equipment as internet modem, thumb printing and webcam. This optional equipment is accessories connected to and powered by the laptop. The only power consumption from the electrical systems are the laptops, printer and electric bulbs. Ani [13] recommend that the energy designer should outline an accurate power profile of the load(s) in order to dimension correctly the alternative energy components for the system. Therefore, the only way to "outline an accurate power profile" is to answer the question: what are the times when the loads are used, and this will give us a baseline data on energy consumptions. From the acquired data, a profile of the registration centre was created and shown in Tables 1 and 2.

Table 1. Energy needed for the Registration Centre

Description of Item	Qty	Load (Watts per unit)	Load (Watts) Total	Daily Hour of Actual Utilization
Laptop	3	40	120	8 (09:00hr – 16:59hr)
Laser Printer (3 in 1)	1	100	100	8 (09:00hr – 16:59hr)
Electric bulb (Lighting)	1	15	15	8 (09:00hr – 16:59hr)
Security light	2	15	30	13 (18:00hr – 06:59hr)

Table 2. The electrical load (daily load demands) data for the Registration Centre

Time	DAILY LOAD DEMANDS				Total (W/Hr)
	Laptop (W)	Printer (W)	Electric Bulb (W)	Security Light (W)	
0.00-0.59				30	30
1.00-1.59				30	30
2.00-2.59				30	30
3.00-3.59				30	30
4.00-4.59				30	30
5.00-5.59				30	30
6.00-6.59				30	30
7.00-7.59					
8.00-8.59					
9.00-9.59	120	100	15		235
10.00-10.59	120	100	15		235
11.00-11.59	120	100	15		235
12.00-12.59	120	100	15		235
13.00-13.59	120	100	15		235
14.00-14.59	120	100	15		235
15.00-15.59	120	100	15		235
16.00-16.59	120	100	15		235
17.00-17.59					
18.00-18.59				30	30
19.00-19.59				30	30
20.00-20.59				30	30
21.00-21.59				30	30
22.00-22.59				30	30
23.00-23.59				30	30
Total	**960**	**800**	**120**	**390**	**2270**

3.2. *The Pattern of Using Electric Power within the Period of Registration and Voting*

Registration begins daily in all the centres at 9 a.m (09:00hr) and end at 3 p.m (15:00hr). No person shall be accepted for registration after 3 p.m. except those who are already on the queue before that time [14]. That means that the registration may go on till 5pm due to the queue or may well run into the night after voter registration is over for further work processing. The lighting-outdoor (security light) will come on as from 6pm (18:00hr) till 6:59am (06:59hr) to keep the security of the registration centre at night. The electrical load data and daily profile of the registration centre are given in Table 2 and Figure 1, respectively.

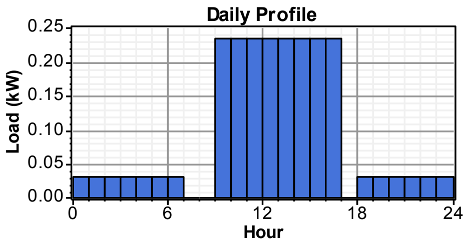

Fig. 1. Daily profile of electricity consumption in the Registration Centre

3.3. Research Areas

This research is focused on the design and simulation of energy system with storage and energy management system for Off-Grid Voter Registration Centres in two locations - Nkanu-West (Enugu State – which covers the southern part of the nation) and Kaura (Kaduna State – covering the northern part of the nation). This may also be applied to other regions of the country - Nigeria. Only PV technology was considered as the energy system for this study. Registration centres at locations in the following geographical areas in Nigeria were studied: Nkanu-West (Enugu State) and Kaura (Kaduna State). For pre-feasibility study of renewable energy system for any particular centre, weather data are an important factor [15]. Therefore, the data for solar resource for this study were obtained from the National Aeronautics and Space Administration (NASA) website [16].

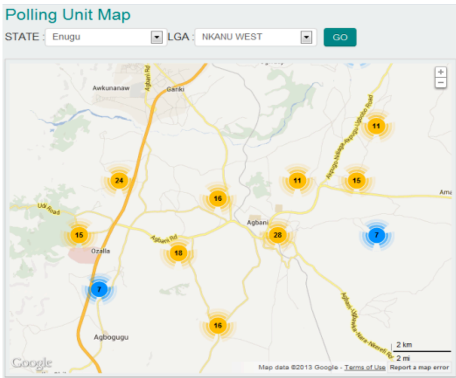

Fig. 2. Polling centre's locations for Nkanu-West (Enugu State) [17]

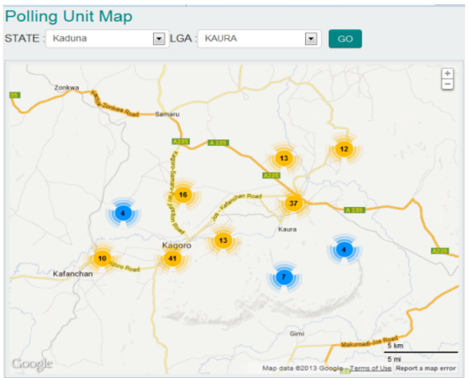

Fig. 3. Polling centre's locations for Kaura (Kaduna State) [17]

The polling centre's locations for Nkanu-West (Enugu State) and Kaura (Kaduna State) were gotten from the Independent National Electoral Commission (INEC) website [17], and are shown in Figures 2 and 3, respectively.

The specific geographical locations based on solar resource are as follows:

Nkanu West Location

Nkanu-West (Enugu State) at a location of 6° 18' N latitude and 7° 33' E longitude with annual average solar daily radiation of 4.92kWh/m²/d. See Figure 4 for the solar resource profile in Nkanu-West.

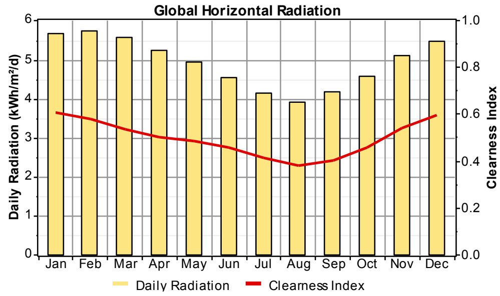

Fig. 4. Solar (clearness index and daily radiation) profile for Nkanu-West (Enugu State)

Kaura Location

Kaura (Kaduna State) being at a location of 11° 18' N latitude and 7° 49' E longitude has annual average solar daily radiation of 5.64kWh/m²/d. Figure 5 show the solar resource profile of Kaura (Kaduna State).

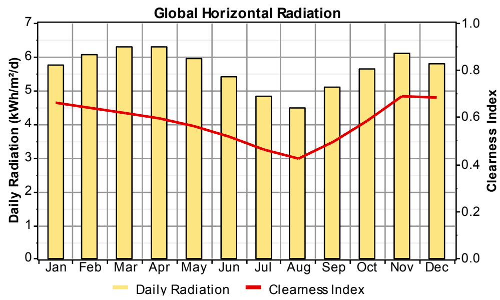

Fig. 5. Solar (clearness index and daily radiation) profile for Kaura (Kaduna State)

3.4. Components of the Photovoltaic Energy System

Solar-electric (Photovoltaic) technologies are used to convert sunlight directly into electrical power. A typical PV system only has an electricity generation device equipped with the necessary balance of system (BOS) components (i.e., the battery bank, the charging controller, the Direct Current (DC)/Alternating Current (AC) inverter, the wiring setup and supporting structures) [18]. In this study, the PV modules used were Polycrystalline Photovoltaic Module with 140W Maximum Power. The PV module has a derating factor of 80% and a ground reflectance of 20%. The Photovoltaic system was considered to have no power point tracking system for the purpose of the study in order to determine the worst case solar resource [to know actually the real solar resources at a point without orienting a solar panel or concentrating a solar reflector or lens towards the sun] from each of the sites. The components added to the module constitute the BOS. Balance of system components can be classified into four categories [19]. They are:

Deep Cycle Battery - stores electricity to provide energy on demand at night or on overcast days. They are used with the PV energy system due to the variations of solar energy generation do not match the time distribution of the energy demand. Battery are designed to be discharged and then re-charged many times. The storage battery chosen was Hoppecke 24 OPzS 3000. From the datasheet given by Hoppecke, the minimum state of charge of the battery is 30%. Its round trip efficiency is 86%. It has nominal capacity of 3000Ah (6 kWh) and nominal voltage of 2V.

Inverters - Required to convert the direct current (DC) power produced by the PV module into Alternating current (AC) power. Most solar power systems generate DC current which is stored in batteries while nearly all lighting, appliances, motors and so on, are designed to use AC power, so it takes an inverter to make the switch from battery-stored DC to standard power (120VAC, 60Hz).

Charge Controller - A charge controller monitors the battery's state-of-charge to ensure that the battery is charged when it should be, and also ensures the battery isn't over charged. Connecting a solar panel to a battery without a regulator is a serious risk; it can damage the battery. The work of the controller can be found in the description of energy management system.

Supporting Structure- used to mount or install the PV modules and other components.

Finally, a microprocessor based controller unit to monitor and manage the system automatically.

4. System Design

The energy system model to be described is the core of the simulation. Figure 6 shows the proposed PV-Battery system set-up. In this study, PV and battery – are connected to the DC bus (V_{DC}). Only AC appliances are used and are connected to the load bus (I_{AC}). An inverter (a DC-to-AC converter) is used to convert DC current (I_{inv_DC}) to AC current (I_{inv_AC}) to serve the AC load. A micro-processor-based controller shown in Fig. 9 is used to coordinates the power generated by renewable energy (PV panels) and to control the charge and discharge current from the battery.

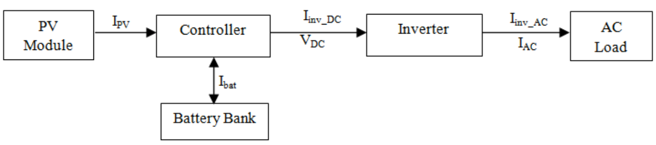

Fig. 6. Proposed PV-Battery system.

During day time, PV is the choice and only source of energy. The extra power produced is stored in a battery system. Moreover, during night time, the battery is the only source of energy while the PV is off. The inverter converts DC power from the battery to AC power for the load. The battery carries on all night till morning when the PV will take over.

4.1. Components of the Photovoltaic Energy SystemConfiguration of the Stand-Alone Energy System

The proposed energy system for the registration centre consists of PV power generation and a storage system (battery bank) as depicted in Figure 7. The system configuration is analyzed for various photovoltaic array sizes to operate in line with the storage (battery) system. The energy consumption of the registration centre is 2.3kWh/day with a 235W peak load demand, and the energy system configured consists of 0.9 kW solar PV array, 9 Hoppecke 24 OPzS 300 Battery and a 1kW DC/AC inverter.

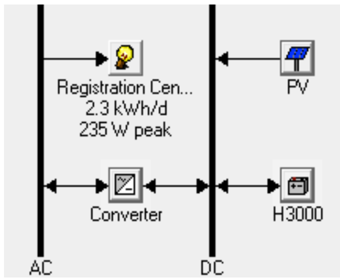

Fig. 7. The network architecture for the HOMER simulator (PV- battery system)

4.2. Energy Management System

The energy management system consist of monitoring and control of the energy system on when to supply to the load, charge and discharge the battery. From the study, the PV power (PPV) generation is the primary source of energy, while the battery bank ($_{Pchar\_max,disch\_max}$) is the supplement and back-up source of energy. The system uses the energy generated by the PV panels to supply the load (P_L), and then charges the battery (P_{char_max}) whenever the PV panels produce an excess of what is needed by the load. Figure 8 outlines the flow between the different modes. During the charging of the battery, if the SOC of the battery is at its maximum possible SOC value, the excess power is sent to a dump load [Dump load is a device to which power flows when the system batteries are too full to accept more power], which can be defined according to the Registration Commission's need, charging of phones, etc. The flowchart inside the dotted line shown in Figure 8 is the charging control circuit. If the SOC of the battery is less than the maximum SOC, the amount of excess power is checked. Battery-Experts [20] advise not using a charging current of more than 60A. The power is then checked to make sure that the current used to charge the battery will be less than 60A. If the excess power is less than this maximum charging power, the battery is charged with the full excess power. If the power is above that of maximum charging of the battery, the maximum battery charge power is used to charge the battery and the excess is used for the dump load.

On the other hand, when the renewable source produces less energy than demanded (the solar radiation is low) or at night, the deficit power should be supplied by the battery bank.

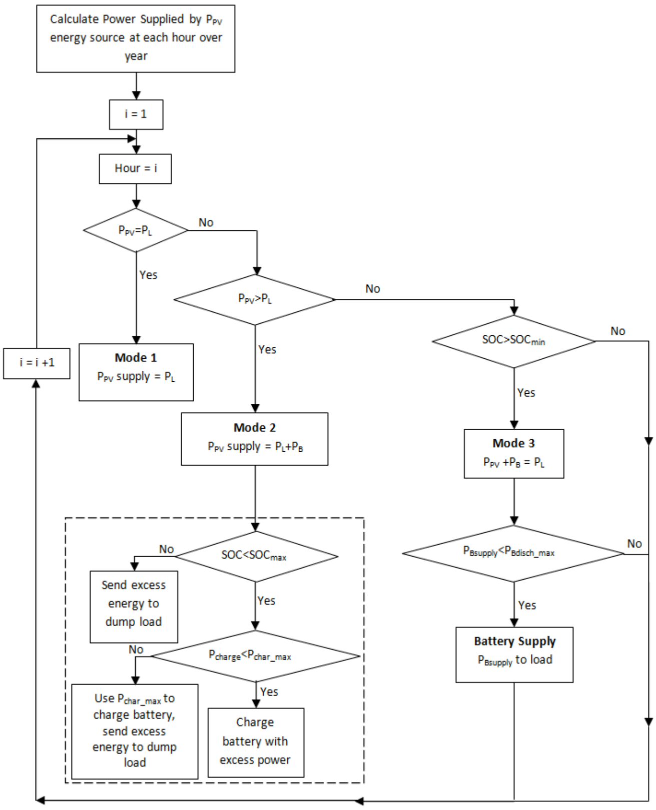

Fig. 8. Flowchart of modes of control for PV-Battery Energy System

The operations of mode of control for PV-Battery energy system which activate (ON) or deactivate (OFF) the charging or discharging of the battery are managed and done by a micro-processor-based controller unit shown in Figure 9.

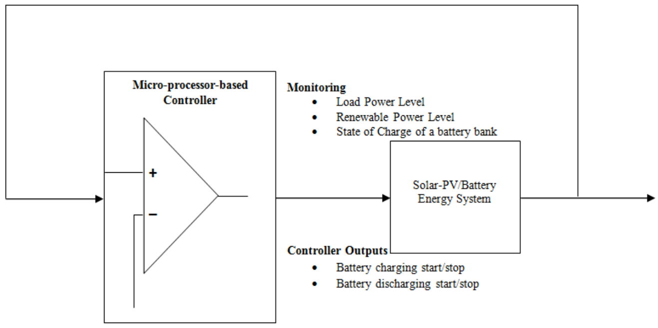

Fig. 9. PV-Battery System controller block diagram

5. Simulation Results

The optimal configuration of the energy system was obtained by gradually modifying the size of the different elements (PV panels and battery units) with the objectives to minimize their size for cost interests and to reduce as far as possible the excess energy. This optimal system was obtained with particular capital, replacement, operation and maintenance costs for each component and these costs are in accordance with the prices of the market.

The simulations provide information concerning the electricity production. The obtained results are presented in Tables 3, 4, and 5, while the detailed analyses obtained are described below.

Table 3. Control output results for Nkanu-West optimized PV-Battery system in 24hrs

Time (h)	Global Solar (kW/m^2)	Incident Solar (kW/m^2)	AC Primary Load (kW)	PV Power (kW)	AC Prim. Served (kW)	Excess Electricity (kW)	Inverter Input Power (kW)	Inverter Output Power (kW)	Battery Input Power (kW)	Battery State of Charge (%)
0.00-0.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.666
1.00-1.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.606
2.00-2.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.547
3.00-3.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.488
4.00-4.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.429
5.00-5.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.369
6.00-6.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.310
7.00-7.59	0.011	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.251
8.00-8.59	0.123	0.123	0.000	0.099	0.000	0.000	0.000	0.000	0.099	99.394
9.00-9.59	0.144	0.144	0.000	0.116	0.000	0.000	0.000	0.000	0.116	99.562
10.00-10.59	0.239	0.239	0.235	0.194	0.235	0.000	0.276	0.235	-0.083	99.423
11.00-11.59	0.203	0.203	0.235	0.164	0.235	0.000	0.276	0.235	-0.112	99.235
12.00-12.59	0.364	0.363	0.235	0.294	0.235	0.000	0.276	0.235	0.018	99.260
13.00-13.59	0.477	0.476	0.235	0.386	0.235	0.000	0.276	0.235	0.109	99.418
14.00-14.59	0.595	0.594	0.235	0.481	0.235	0.041	0.276	0.235	0.164	99.654
15.00-15.59	0.433	0.432	0.235	0.350	0.235	0.000	0.276	0.235	0.073	99.761
16.00-16.59	0.091	0.091	0.235	0.074	0.235	0.000	0.276	0.235	-0.203	99.420
17.00-17.59	0.057	0.057	0.235	0.046	0.235	0.000	0.276	0.235	-0.230	99.033
18.00-18.59	0.076	0.075	0.000	0.061	0.000	0.000	0.000	0.000	0.061	99.121
19.00-19.59	0.032	0.029	0.030	0.023	0.030	0.000	0.035	0.030	-0.012	99.101
20.00-20.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.042
21.00-21.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	98.982
22.00-22.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	98.923
23.00-23.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	98.864

Table 4. Control output results for Kaura optimized PV-Battery system in 24hrs

Time (h)	Global Solar (kW/m^2)	Incident Solar (kW/m^2)	AC Primary Load (kW)	PV Power (kW)	AC Prim. Served (kW)	Excess Electricity (kW)	Inverter Input Power (kW)	Inverter Output Power (kW)	Battery Input Power (kW)	Battery State of Charge (%)
0.00-0.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.672
1.00-1.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.612
2.00-2.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.553
3.00-3.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.494
4.00-4.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.435
5.00-5.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.375
6.00-6.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.316
7.00-7.59	0.019	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.257
8.00-8.59	0.178	0.176	0.000	0.143	0.000	0.000	0.000	0.000	0.143	99.463
9.00-9.59	0.240	0.239	0.000	0.194	0.000	0.048	0.000	0.000	0.146	99.674
10.00-10.59	0.403	0.403	0.235	0.327	0.235	0.000	0.276	0.235	0.050	99.746
11.00-11.59	0.390	0.390	0.235	0.316	0.235	0.000	0.276	0.235	0.039	99.803
12.00-12.59	0.618	0.619	0.235	0.501	0.235	0.175	0.276	0.235	0.050	99.875
13.00-13.59	0.754	0.758	0.235	0.614	0.235	0.310	0.276	0.235	0.027	99.915
14.00-14.59	0.857	0.864	0.235	0.700	0.235	0.404	0.276	0.235	0.019	99.942
15.00-15.59	0.654	0.656	0.235	0.531	0.235	0.242	0.276	0.235	0.013	99.960
16.00-16.59	0.183	0.183	0.235	0.148	0.235	0.000	0.276	0.235	-0.128	99.745
17.00-17.59	0.103	0.103	0.235	0.084	0.235	0.000	0.276	0.235	-0.193	99.420
18.00-18.59	0.115	0.114	0.000	0.093	0.000	0.000	0.000	0.000	0.093	99.554
19.00-19.59	0.033	0.029	0.030	0.023	0.030	0.000	0.035	0.030	-0.012	99.534
20.00-20.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.475
21.00-21.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.416
22.00-22.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.356
23.00-23.59	0.000	0.000	0.030	0.000	0.030	0.000	0.035	0.030	-0.035	99.297

Table 5. Comparison of simulation results of electricity production (kWh/yr)

Quantity	Nkanu-West (Enugu State)	Kaura (Kaduna State)
Production from PV array	1,467kWh/yr	1,700kWh/yr
Losses from the Inverter	146 kWh/yr	146 kWh/yr
Losses from the Battery	42 kWh/yr	34 kWh/yr
Consumption from AC load	829kWh/yr	829kWh/yr
Excess Electricity	450 (35%)	691 (45%)

6. Results and Discussion

From the simulation results shown in Tables (3 and 4), it was shown that solar incident ray falls to the PV panels as from 08:00h and stops by 18:59h. It is observed that during the day when the sunshine is plenty, the excess energy from the sun is stored by the batteries of the system and thus compensates for the shortfall in solar radiation at night, when the sunshine is quite low. The charging and discharging of the battery bank is also shown. Battery power indicates the operating strategy of the power generation system: charging (power positive) or discharging (power negative). The batteries are in charging mode whenever there is excess power available from the source (solar), and in discharging mode whenever there was a shortage of power from the source (solar).

Tables 3 and 4 have the same trend of load demand and battery supply, but slight differences in power supply, due to location (latitude). The battery supplies the load when there is no solar radiation (20:00h – 06:59h). During this time, the load is small (0.030kW) and the battery supplies the same power (0.035kW), while 0.005kW is lost due to inverter inefficiency as shown in Tables 3 and 4.

The battery contributes when the solar radiation is low [either the sun is at the rising stage (sunrise: 10:00h – 10:59h, as shown in Table 3) or it is in settling stage (sunset: 16:00h – 16:59h)].

The electricity production of PV power in Nkanu-West is not the same with that of Kaura as shown in Figures 10 and 11, respectively. These differences in PV electricity production also contribute to differences in the excess electricity in Nkanu-West and Kaura as shown in Table 5 and Figures 12 and 13, respectively. These excess of electricity occurs in all the months (as can be clearly seen in Figures 12 and 13). This excess electricity power supply is guaranteed in the location simulated in order to give room for charging of phones by the staff. It can as well be sold to the compound (family) close to where the site is located to finance operations and maintenance costs of the PV system.

Between 10:00h – 16:59h, the PV power supply in Nkanu-West is not the same with that of Kaura. For instance, at 14:00h, the PV power generates 0.481kW in Nkanu-West, and generates 0.700kW in Kaura as shown in Tables 3 and 4, respectively. This shows that there is more solar radiation in the north than in the south. For instance, at 14:00h, the PV power generates 0.481kW, supplies to the load of 0.235 kW, charges the battery with 0.164 kW when the batteries SOC is at its maximum value (99.654%) and sends an excess of 0.041 kW to the dump load in Nkanu-West; at the same time (14:00h), the PV power generates 0.700 kW, supplies to the load of 0.235 kW, charges the battery with 0.019 kW when the batteries SOC is at its maximum value (99.942%) and sends an excess of 0.404 kW to the dump load in Kaura as shown in Tables 3 and 4, respectively. This difference in solar radiation profiles show that there is more solar radiation in the north than in the south.

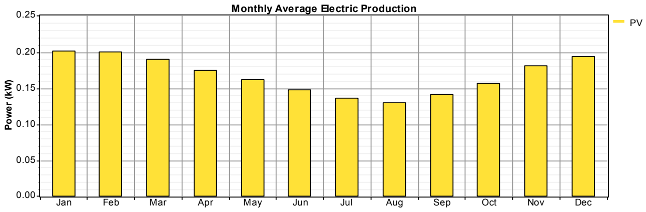

Fig. 10. Electrical production of PV energy system in Nkanu-West

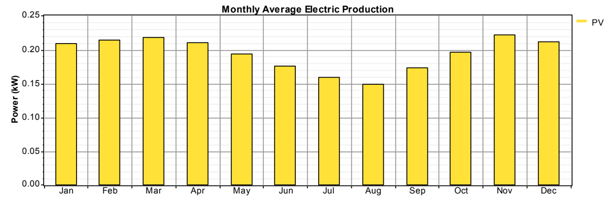

Fig. 11. Electrical production of PV energy system in Kaura

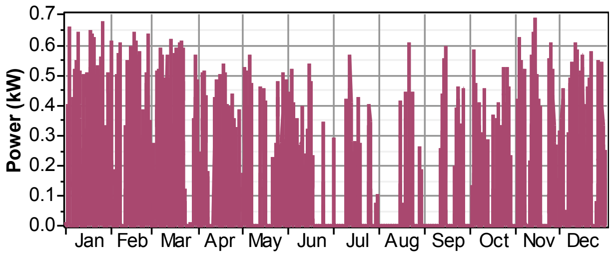

Fig. 12. Excess electricity generated by the PV energy system in Nkanu-West.

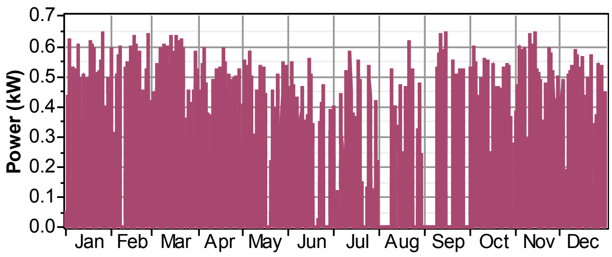

Fig. 13. Excess electricity generated by the PV energy system in Kaura.

7. Conclusion

Solar system has a great potential as one of renewable energy technologies for off-grid power generation. The study indicates that the most optimized PV-Battery power system for energy consumption of 2.3kWh/day with a 235W peak demand load consists of 0.9 kW solar PV array, 9 Hoppecke 24 OPzS 300 Battery and a 1kW DC/AC inverter. These power systems are very well suited to supply the specific load demand of registration centres that present a peak during the daytime when the solar radiation is at maximum. The implementation of PV systems to supply registration centres will minimize the cases of disenfranchising eligible voters during registration and voting exercises. Also, this exercise (PV implementation) can be extended to improve the quality of life in isolated regions through rural electrification scheme.

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