iJRASET
International Journal For Research in
Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 6 **Issue:** III **Month of publication:** March 2018

**DOI:** http://doi.org/10.22214/ijraset.2018.3451

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue III, March 2018- Available at www.ijraset.com

# Investigation on the Needs of Photovoltaic System in Rural Area in Ibadan Nigeria

Oyinkanola L. O. A[1], Sawal Hamid Bin MD Alli[2],
[1] Physics department, The Polytechnic, Ibadan, Ibadan, Oyo state, Nigeria.
[2] Electrical and Electronic Engineering Department, Universiti Kebangsaan Malaysia, Selangor, Malaysia.

***Abstract: Whenever the system is operating higher than its limit ,can decrease its lifespan and lead to failure.With this, assessments and calculations on standalone PV- system component based on the field assessment and performances in an area in Ibadan, Nigeria. Using relevant formulae to calculate the requirement for each component that constitutes the stand-alone PV-system. The battery as an essential component of the micro grid, its life depends on both depth and rate of discharge. And the result we got shows the abused of components involves the installation especially the battery.The paper suggest an intelligent system to take care of the excess load at a particular time which also will take into account priority of the appliances at the time in relation to the capacity and charge of the battery to control the appliances.***

***Keynote: PV-system, intelligent system, load, battery.***

## I. INTRODUCTION

In most of developing country today there is a persistent problem of inefficient use of electrical power generation and transmission assets. With a lot of energy resources in Nigeria, more than 40 % does not have access to the national grid[1]. Apart from this, the use of hydrocarbon has caused a lot of health problem from a byproduct of this energy generation. The next solution to solve this problem is embracement of renewable energy. And most of the areas normally rich in renewable energy especially Africa, which makes it promising to solve power supply problems by using renewable energy and establishing island microgrid systems. Solar energy is one of the endless unsoiled and prospective energy as a gift from nature among all other nonconventional energy options. Since now most developments are concentrated and focus on the development of renewable energy worldwide. To give room for sustainability of it is necessary to do the technical assessment of the resources for those using it and get discouraged due to the unbalanced installment and calculation[2] [3]. There are many factors that lead to challenges facing by quality and efficiency of renewable energy apart from variation in temperature as we want to observe. The battery is very important in renewable energy due to intermittent nature of the sun. We have various types of storage element but in most of the residential use of the renewable energy, they are using Pb-acid batteries. Charge and discharge of this battery are important. The lifespan of the battery depending on the average Depth of Discharge (DOD) which is the percentage of the rated capacity which utilized per circle. The deeper the discharge of a battery, the shorter it's life. The importance of load management in power system and home electric automation is great.Load management can be simply referred to as the way of changing load profile by the action of the customer in her usage or application of some techniques in order to gain from reduced total system peak load, raise load factor and improved utilization of valuable resources like generation, transmission, and distribution capacity[4].In residential energy, a lot of methods and designs have been applied to control and save energy consumption.Demand side management was applied by[5] [6] in order to manage appliance energy consumption.Likewise [7] used automation system to reschedule the appliance to save consumption and optimise the cost as well.Also, many machine learning approach where use like neural network as in [8], Particle swarm optimization as in [9] in order to schedule appliances demand in automation . Instability occurs as a result of big demand and the number of the appliances on the system. The solution to the existing problems brings about energy efficiency, reliability; economic constraint by integration of renewable energy resources to restore the stability of the power system[10, 11]. Thus, in modern society, regular supply of electricity can bring about good production, development, and prosperity to industrial output. And based on the above, proper information about individual appliances in the house, offices, schools, home, hospitals etc. should be given priority. Load management is an important instrument to provide information as per voltage level, current, and frequency which should be critically monitored to make sure that the system stability and reliability are maintained[12]. Thank for various technology developed and types of equipment such smart meter, home automation and various form of the energy storage gadgets open way for the implementation of home, offices, and industries load management and energy management. Residential which sometimes carries up to half of demand on the utility in some of the areas in grid-connected can be a focus on, in order to improve microgrid and most of the energy quality[13].So, focusing mostly on the residential load management for off-grid to reduce the most of the problems of intermittent production and demand variation and give way for smooth and encouragement for use of renewable energy[14]. For the past years, many research projects focused on demands side management and load control of smart grid technologies for different reasons. Now, energy in the residential building accounts for about 32 % of global total final energy consumption in the world. In s terms of primary energy consumption, buildings represent around 40 % in most International Energy Agency (IEA) country and 65% of the total electric consumption. When talking about $CO_2$ emission also building contribute about 36% accounting to EU (IEA).Not only energy performance but also load management in the building is a key issue to achieve the EU climate and energy objectives, namely the reduction of the greenhouse gases emission by 2020 and 20% energy savings by 2020[15]. The main purpose of this study is to develop an intelligent system to control the power consumption base on the charges on the batteries. Because most of batteries use for autonomous power system are deep –cycle batteies which need proper mentanance and to avoid deep discharging of the so call batteries.Deep-cycle battery shoud not be discharge by more than 80 % of their capacity and the less you regularly discharge a battery the longer it will last [16]. A battery in daily use are discharged by not more than 40 % of its capacity should last for more than 3000 cycles and may not need replacement for up to 12 years. Abattery that is frequently heavely discharge may last no longer than 2 years. Thus ,the controlling system that will so intelligent that comfort state of the owner will remain, the priority of appliances at a particular time of the day will be considered and then optimized the lifespan of the battery will be proposed. The remaining paper is ordered as follow: Section II gives the detail of survey of the visited apartment. Section III review the proposed control system .Analysis and result discourse in section IV. Finally, the conclusion is given in section V.

## II. SURVEY OF THE RESIDENTIAL USING PV SYSTEM

In the area where there is a problem of electricity, the microgrid is one of the promising systems in electricity that can supply electrical energy which usually obtained from renewable energy sources such as wind, sun, and the rest. The system consists of the several groups of appliances as in the Fig.1 below. The content of the microgrid is a solar panel, as a generator of energy, energy storage such as battery and the group of loads that can give desire energy when they are connected as one.

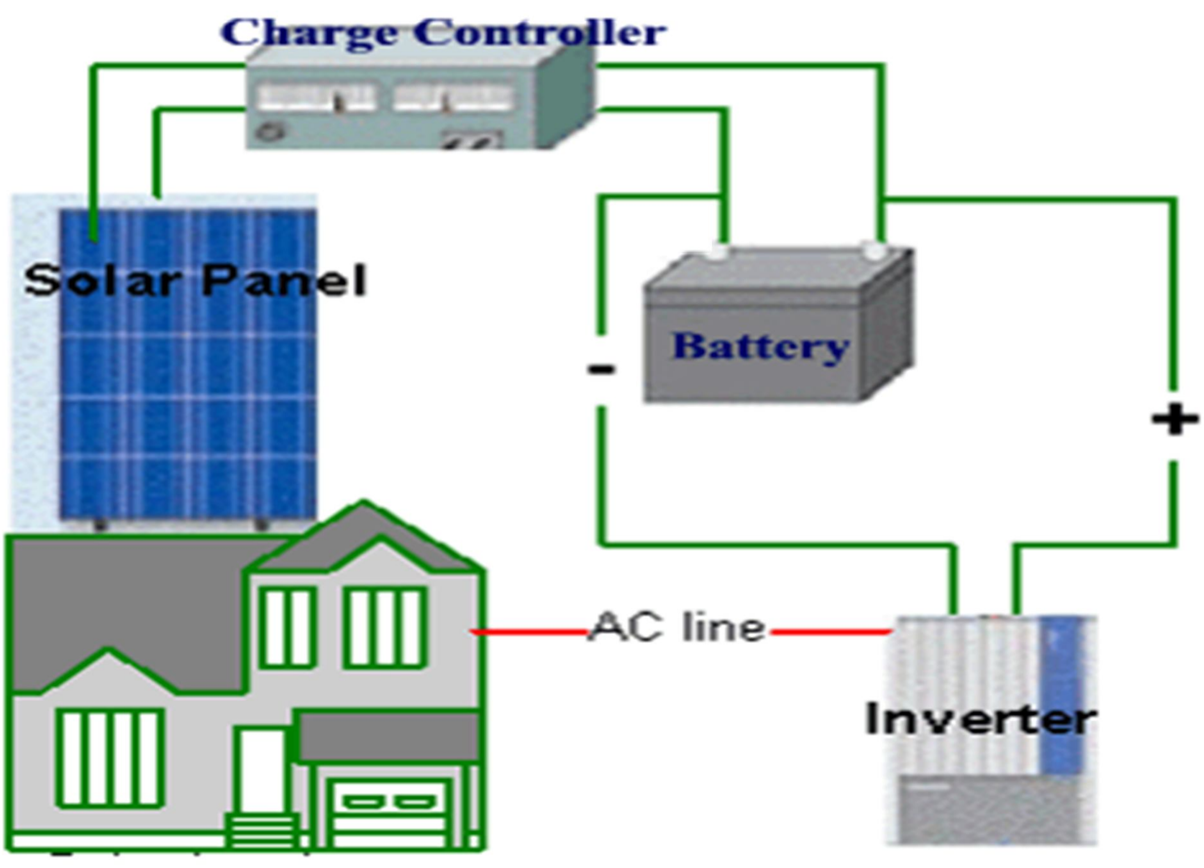



Fig. 1. A complete system of the off-grid stand-alone system.

Various problems that arises in PV system, premature battery failure is most common among them, which serves as most concern in most of PV system users. Well, battery at initial stage of the installation may serve as lowest cost but as time goes on during life time of the system is stand as most expensive component. Knowing the types of appliances and their proper model will give us the way to study behaviors of these load and individual effect on the total load. Likewise, the model of the sources of electricity in off-grid or stand-alone required. To develop an intelligent power management (IPM) to manage the operation of household appliances with the state of the charge of the supply battery, it essential to have good records and accurate model that can simulate the behavior of electric loads. Here are the components of PV system used by the residential take as a case study.

Table I. PV System Component investigated (Case study)

| Components | Quantities | Capacity | Amount |
|---|---|---|---|
| PV -array | 1 | 300 W | # 60,000.00 |
| Battery | 1 | 100Ah | #75,000.00 |
| Charge controller | 1 | 30A,12 V | # 15,000.00 |
| Inverter | 1 | 1000W,12 V | #45,000.00 |

Table II. Loads Table for the residential visited (Case study)

| Appliances | Consumption W | Quantity | Duration | Time of the day | Power/day W/day |
|---|---|---|---|---|---|
| Television | 75 | 1 | 3 | Evening | 150 |
| Radio | 40 | 1 | 2 | Morning | 80 |
| Lighting | 15 | 6 | 5 | Morning | 450 |
| W/Machine | 500 | 1 | 1 | Evening | 500 |
| Ceiling -fan | 50 | 2 | 3 | Evening | 300 |
| PC/Laptop | 60 | 2 | 2 | Evening | 240 |
| Charging | 20 | 3 | 5 | Morning/Evening | 300 |
| Side-Lamp | 20 | 4 | 5 | Evening | 400 |
| Total | | | | | 2,400 |

Note : Assumed the Power factor to be unit .

### A. *Inverter Requirement*

The inverter for PV renewable energy system is an important benefit in running specific AC appliances. The modern inverter is extremely reliable and there are several hundred types, sizes, brands, and models. Choosing the best from such a long list can be a chore and there is no “best” inverter for all purposes. Power is usually the main factor. An inverter needs to meet two needs: peak, or surge, power, and continuous power. The inverter is rated by their continuous wattage output. The larger they are, the more they cost. From Fig.II total power is 2,400W, then due to a little surge of fan and Washing machine, the additional power of 1100 W at the start, making a total of 3500W.Thus the capacity for an inverter to be used most be 3500W.But, looking at the components of the system above, the inverter used is of capacity 1000W without considering the standby and efficiency rate of the inverter.

### B. *Battery Storage Requirement*

The thing that determines the battery size in the stand-alone PV system is the number of loads, autonomy period, depth of discharge (DOD) and round-trip efficiency of the battery. For types of battery used i.e. deep –cycle battery is also known as valve gauge Lead –acid battery (VGLB) the DOD is 50% and round-trip efficiency is 75% with autonomy desire of 3 days.

$$Total\ \ daily\ Ah\, requirement \quad = \ ^{2{,}400\, Wh}/_{12\, V}$$

$$= \ 200\ Ah\ /\, day$$

Require battery bank capacity = (days of autonomy * daily load Ampere-h our/ (Battery z

DOD) (2)

$$= (3\ day * 200 Ah/day) / (0.2 * 0.5)$$

$$= 600\ Ah / 0.1$$

= 6,000 Ah

For deep circle battery generally one needs to design for 10-15% daily DOD. Battery selection in most residential visited comprises of 12V DC at 100Ah capacity each. Series/parallel configuration for the battery bank would be as described in Eq. (1) and (2)

Number of batteries in series = 12V/12V = One battery; and

Number of batteries in parallel = 6000Ah = sixty batteries

Total batteries needed is 1* 6 = 6 batteries.

### *C. Pv -Array Estimation*

To estimate the size of the PV array for a PV system based on providing adequate energy to meet the load during the period with the highest average daily load and lowest solar insolation on the surface.

*1)* Investigation month is January 2017, 6 h
*2)* Assume PV array temperature derate average of 15% daily requirement.
*3)* Assume inverter losses at 10% of daily requirement.
*4)* Assume fuses/disconnect losses at 1%.
*5)* Assume wiring losses at 3%.
*6)* Assume battery losses at 25%.
*7)* Total system losses are then 0.85*.099*.97*0.75= 55%.
*8)* Adjusted system load requirement = 200 Ah/day/0.55 =363.636 Ah/day.

To select the PV module for use in design (the module derating factor is usually 80-90%) is for a rated peak current of 3.55A and a rated peak voltage of 16.9V at 300 W .Thus applied Eq. (3) and (4),

The number of parallel modules = the adjusted load Ah requirement / (module peak current output*peak sun-hours.) (3)

= 363.636 Ah / 3.55 A * 6 h

= 17.1.

Meaning, 17 modules of 300 W in parallel.

The number of series modules = nominal system voltage/ (module peak voltage output*voltage temperature derate) (4)

= 12 V/ (16.9 V* 85%) = 0.84.

Meaning, 1 module of 300 W in series PV module will be needed.

### *D. Numerical energy sizing of the PV-System*

According to[17] the output energy of PV ($E_{PV}$ )array can be given by :

$$E_{PV} = A_{PV} \times E_{sun} \times \eta_{PV}(t) \times \eta_{inv} \times \eta_{wire} \quad (5)$$

where $A_{PV}$ is area of the PV module in ($m^2$) , $E_{sun}$ is the hourly solar energy ($Wh/m^2$), $\eta_{PV}$ , $\eta_{inv}$ , and $\eta_{wire}$ represents the efficiency of the PV,inverter and wire respectively .

Also, energy storage capacity of the battery can be calculated using the following relation according to [18] :

$$E_{bat} = d_O \left(\frac{E_{tot}}{8760}\right) \frac{1}{\eta_{batt}} \cdot \frac{1}{DOD_L} = d_O \frac{E_h}{\eta_{batt}} \cdot \frac{1}{DOD_L} \quad (6)$$

where $d_O$ is the typical hours of energy autonomy, $E_{tot}$ is the annual energy of the load, $\eta_{batt}$ is the energy transformation efficiency , $DOD_L$ is the maximum depth of discharge, and $E_h$ is the average hourly energy of the load.

The relationship between the battery nominal output and input with power of the PV (i.e. $P_{bat\_in}$, $P_{bat\_out}$ and $P_{PV}$ ) can be obtain using:

$$P_{bat\_in} = \gamma . P_{bat\_out} \leq P_{PV} \quad (7)$$

where $\gamma$ is represented the ratio of charge and discharge periods as well as the energy transformation efficiency in the battery .According to[18] gives the range of $\gamma$ to be 1.5- 3.

Thus, when the battery is in used the peak power percentage of the load that battery should cover can be represented known the capacity factor of the load and the power efficiency as following:

$$P_{bat\_out} = \tau . \frac{E_h}{CF_{load}} . \frac{1}{\eta_p} \quad (8)$$

where $\tau$ the peak power percentage of the load the battery should cover, $CF_{load}$ is the capacity factor and $\eta_p$ is the power efficiency. To round it up by bring in the relationship between the depth of charge (DOD) and the state of charge of the battery to give us the summary and understanding of the load on the battery.

$$SOC = 1 - \frac{Q}{C} \quad , \quad 0 \leq SOC \leq 1 \quad (9)$$

and

$$DOD = 1 - SOC \quad (10)$$

where Q is the battery charge and C is the nominal battery Capacity.

Finally the maximum and minimum SOC of the battery can be calculated as following:

$$SOC_{min} = SOC_{max}(1 - DOD) \quad (11)$$

This minimum SOC need to be watched in other for the battery to be properly perform in accordance with it specification. To prevent the system from abnormal situation and to assist the battery and the whole system we proposed an intelligent system to checkmate the system function and operation.

## III. PROPOSED INTELLIGENT POWER MANAGEMENT (IPM)

To assist in order to balance and checkmate the load we proposed IPM to assist the battery and encourage people to embrace renewable energy. Since many studies and worlds surveys are putting interest to increase the efficiency of any appliance in the reasonable price. We believe that the IPM proposed will be of good quality with avoidable price. The proposed IPM has the ability to switch off and on the appliances in the housed base on the condition of the battery in order to prevent the battery from discharge to the level of no –return. Unlike other smarts or loads management that based their objective on the cost and peak load management. The system will use following criteria to control the system, the number of loads i.e. the total power of the loads, the time of the day, the owner's comfort, and the level of the charge on the battery i.e. SOC accordance with Eq.(11) . In off-grid power management like ours, the system consists of two control level: The input control and output control.The charge control/monitor serves as input control from the battery to monitor the state of charge (SOC) from renewable energy sources from the battery; the function is to avoid over-discharging.While the output control constitutes the prediction control of the load to measure the current of individual appliances to decide which one to put off based on battery level through an inverter to avoid zero power output and prevent low discharge of the battery. The algorithm for the system as following steps:

*A.* *Step A:* The system power management algorithm begins with basic information about the appliances in the house:

*1)* Total consumption of all appliance says Fan, TV set, Radio Set, Lighting in the house in Watts
*2)* Schedule of the appliances into low or high consumption in accordance with their consumption at the perticular tim
*3)* Time of the day (Morning, Night)
*4)* The appliances priority will be set from leaning
*5)* Battery state of charge (SOC) level at a particular time.

Step B: The system using the algorithm to checks for battery level SOC, the level of consumption of individual appliances and priority of each appliance at that particular time. For battery level, the indicator will show the level of the battery and amount of load it can carry. For consumption level, the algorithm we use current measurement to check the low or high consumption appliances. The decision to switches OFF/ON can now base on the priority at the particular time when the battery falls to certain SOC level

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887*
*Volume 6 Issue III, March 2018- Available at www.ijraset.com*

in order to adjust the load on it,.The whole system then goes through the decision-making process to ensure that all the criteria are meet before appropriate appliances can be switched OFF to meet the capacity of the battery. Since there is now total isolation from the PV or charges due to little power from the utility, the battery is expected to charge back or remain on the level until is a chargeback to a higher level where all the appliances can go back to ON state

TABLE IV (a): Load Priority Setting for decision making for Morning (4.00 a.m. -12.00 noon)

| Appliances | Usage/Watt | Initial | final | Duration/Hour | Priority/rank |
|---|---|---|---|---|---|
| Light | 30 | 5.30 | 6.30 | 1 | 1 |
| Security light | 60 | 4.00 | 6.30 | 2.5 | 2 |
| Radio | 40 | 6.00 | 7.00 | 1 | 3 |
| Lap Top | 60 | 5.00 | 6.00 | 1 | 4 |
| Charge point | 60 | 5.30 | 7.00 | 1.5 | 5 |
| Ds-TV/TV | 75 | 6.30 | 7.00 | 0.5 | 6 |
| | | | | | |

TABLE IV (b): Load Priority Setting for decision making for Evening (12.00 noon -4.00 a.m.)

| Appliances | Usage/Watt | Initial | final | Duration/Hour | Priority/rank |
|---|---|---|---|---|---|
| Ds-TV/TV | 75 | 6.00 | 10.00 | 4 | 1 |
| Charge point | 60 | 5.30 | 10.00 | 4.5 | 2 |
| Lap Top | 120 | 7.00 | 10.00 | 3 | 3 |
| Radio | 40 | 6.00 | 8.00 | 2 | 4 |
| Fan | 100 | 6.00 | 7.00 | 1 | 5 |
| Security light | 60 | 7.00 | 4.00 | 2.5 | 6 |
| Washing Machine | 500 | 7.00 | 8.00 | 1 | 7 |
| Total | 950 | | | | |

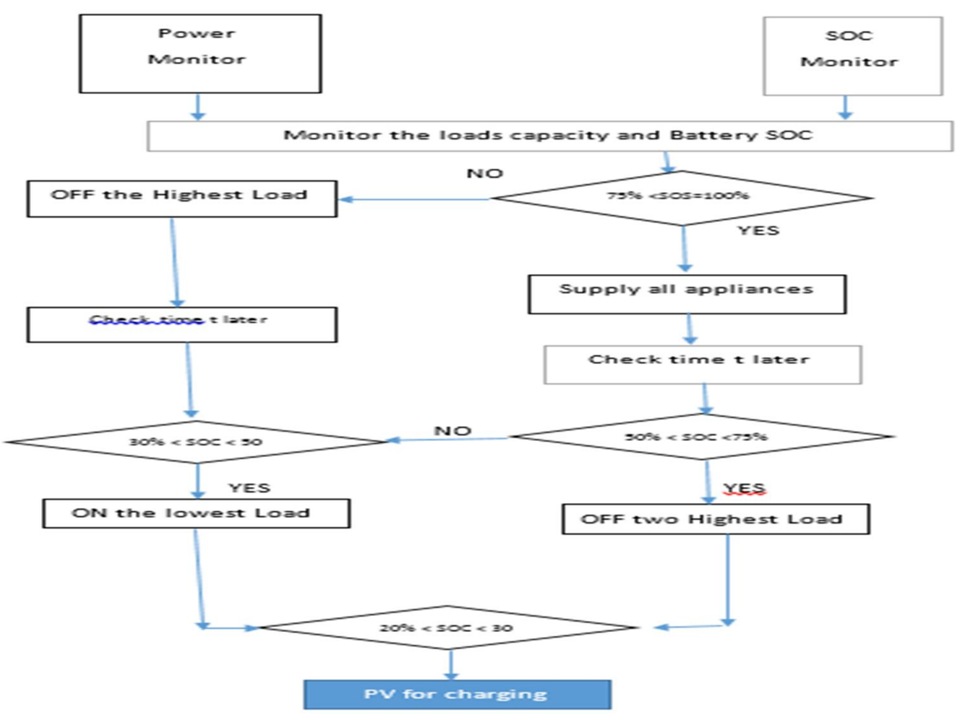



Fig.2 .Flow Chart of the Intelligent Power Management (IPM).

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887*
*Volume 6 Issue III, March 2018- Available at www.ijraset.com*

The battery monitor will send the amount of charge on the battery to the control device unit time to time in form of state of charge (SOC) as in fig.2. Well, the ability to accurately ascertain the state of charge is basic requirement for correct operation and thus maximum battery endurance. Control device unit receives the message and look at the past usage pattern of the components at that particular time and try to reschedule them in order of priority to minimize the output power in proportional to the available power on the system i.e. SOC.The control unit will decide to cut the highest load with less priority at that time.Meaning, the owner comfort is put into consideration. In this way, the system will able to manage the available charge on the battery at that particular time until the charges or voltage increase. Whenever an increase in charge again the system go back accordingly, without disturbing the owner comfort. Able to achieve this, the system will be useful to encourage the user to embrace the renewable energy and contribute to a reduction in $CO_2$ to the atmosphere from other sources energy.

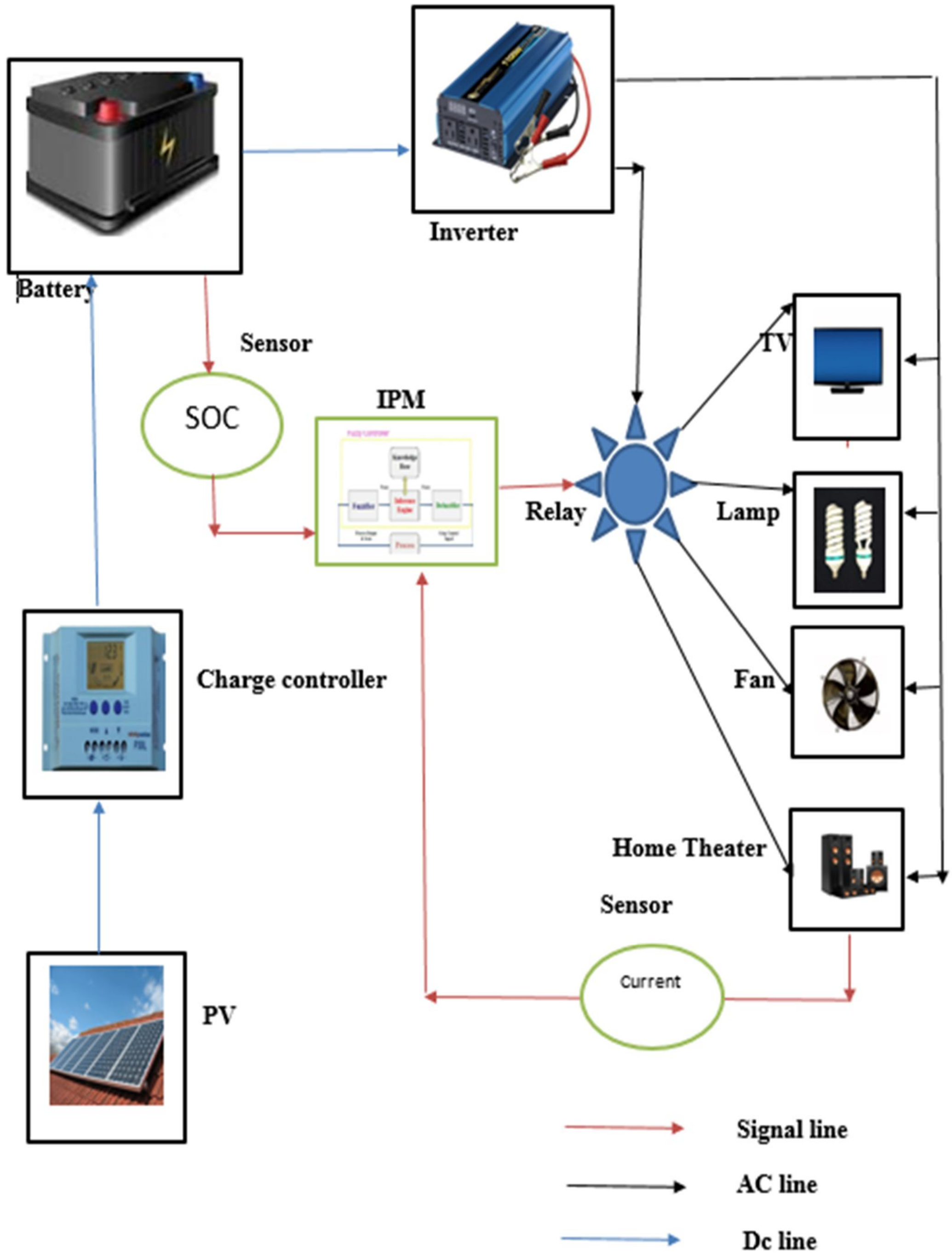



Fig 3: Pictorial of Intelligent Power Management

## IV. RESULT AND DISCUSSION

The main goal is to investigate the cause of problems for most installed standalone PV system in some of the selected houses in Ibadan. Because until now the battery has been seen as the most risk-prone component in off-grid systems. We investigate through contact and questioner, to calculate loads of individual houses as in Table III below. This largely be attributed to inaccurate battery management. To avoid deep discharge of batteries is our goal in order to prolong their battery's life. Lead acid battery has 50 to 80% DOD range for proper performance .Because, the deeper a battery's discharge, the shorter the expected lifetime. There is optimal value to stop discharging the battery in order to ensure the deep discharge does not occur. The best solution is to propose the system that will self-monitor the loads so that the battery will be prevented from go below a threshold level. The battery life improvement as part of our target and ways of encouraging people to embrace renewable energy. And from our results, we confirm that most of the user are just installed without proper documentation or rules for the installation and the best to help is to introduce monitoring system (IPM) that will not cost much and control the whole system for them as shown in Fig.3.

Table III. Result.

| Components | Case study | Condition | Calculations |
|---|---|---|---|
| Inverter | 1000 W | Continuous<br>Plus Surge | 2,400 W<br>3,500 W |
| Battery | 100 Ah | Daily<br>+3 days Autonomy | 200 Ah<br>6,000 Ah |
| PV -array | 300 W | 17 in Parallel<br>1 in Series | 300 W<br>300 W |

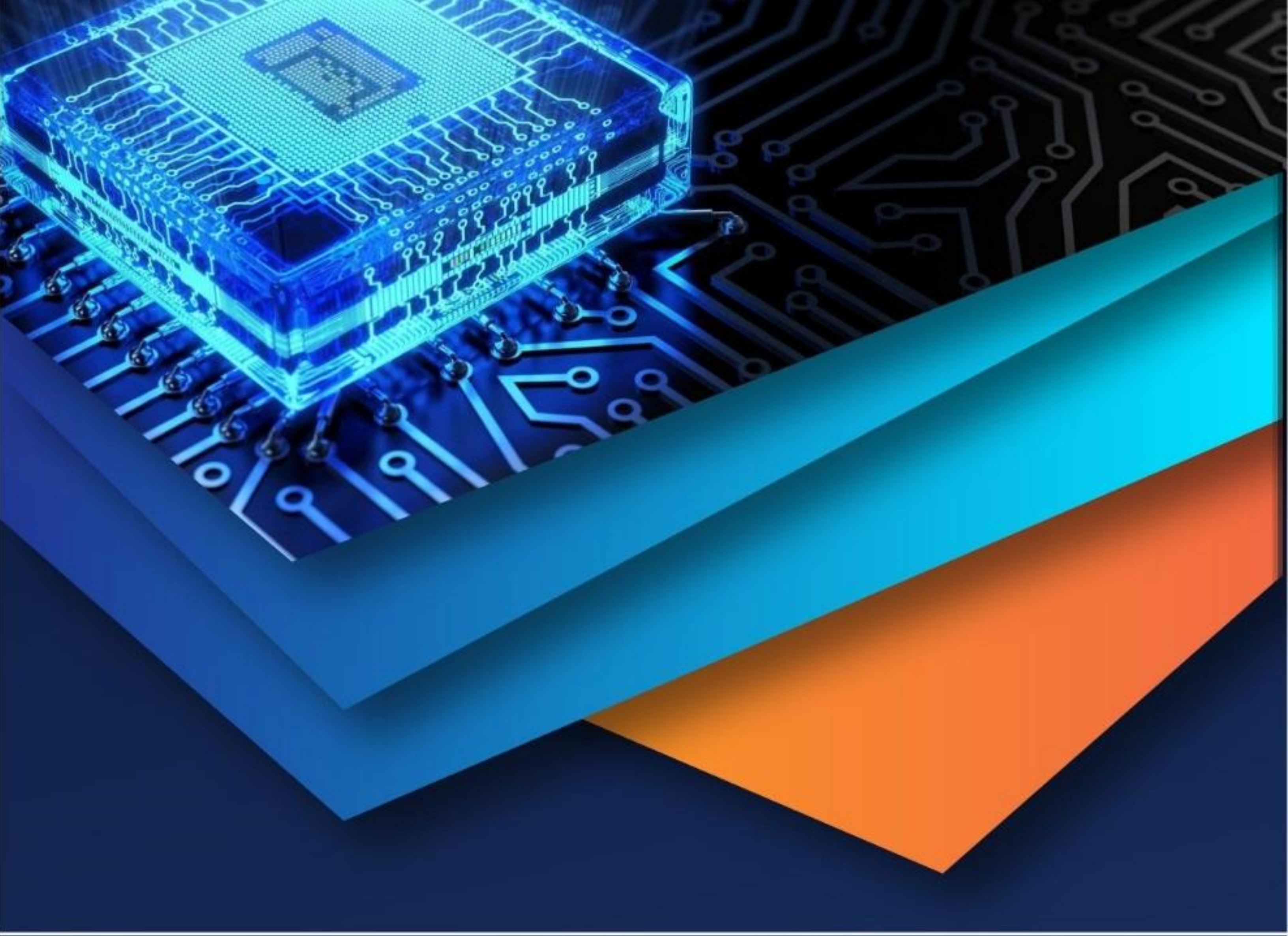
## V. CONCLUSION

Many factors contribute to the useful life of a battery cell in a given application. These include depth of discharge, discharge rate, cell temperature, charging regime etc. From the look of things, it shows that both battery and inverter are suffered most from those components constitute the PV –system installed .The owner always complaining of running down of their batteries and from the calculations, it shows that they are not followed proper requirement for PV- installation. Then we can suggest and proposed intelligent power management that can manage the appliances and able to keep the total household power demand below or balances with the amount of charge or capacity of the battery at a particular time. Because, if the battery management system is not working accurately, the whole system operation will have to replace the batteries at relatively early stage .Once a battery selected to meet a given load, the power demanded by the load will determine the depth and rate of discharge, are one of those factors that influences life prediction of the battery. The system also will be able to take into account load priority and owners comfort. Both the owner and the system will benefit differently, owner comfort will not be affected and economically the owner will have longer serving power. To the part of the system, the system will have longer operating power without been stress and overload unnecessarily and also battery life will be significantly extended with the control. The project will be a benefit to both owner and the system to work within the requirement of the system.

## REFERENCES

[1] Senjyu, T., et al., A hybrid power system using alternative energy facilities in isolated island. IEEE Transactions on energ
[2] Patra, S., et al., Power quality assessment in 3-Φ grid connected PV system with single and dual stage circuits. International Journal of Electrical Power & Energy Systems, 2016. **75**: p. 275-288.
[3] Parlak, K.Ş., PV array reconfiguration method under partial shading conditions. International Journal of Electrical Power & Energy Systems, 2014. **63**: p. 713-721
[4] Zeifman, M., C. Akers, and K. Roth. Nonintrusive appliance load monitoring (NIALM) for energy control in residential buildings. in International Conference on Energy Efficiency in Domestic Appliances and Lighting (EEDAL), Copenhagen. 2011
[5] Dergiades, T. and L. Tsoulfidis, Revisiting residential demand for electricity in Greece: new evidence from the ARDL approach to cointegration analysis. Empirical Economics, 2011. **41**(2): p. 511-531.
[6] Lujano-Rojas, J.M., et al., Optimum residential load management strategy for real time pricing (RTP) demand response programs. Energy Policy, 2012. **45**: p. 671-679.
[7] Ahmed, M.S., et al., Real time optimal schedule controller for home energy management system using new binary backtracking search algorithm. Energy and Buildings, 2017. **138**: p. 215-227.
[8] Molderink, A., et al., Management and control of domestic smart grid technology. IEEE transactions on Smart Grid, 2010. **1**(2): p. 109-119.

[9] Pedrasa, M.A.A., T.D. Spooner, and I.F. MacGill, Coordinated scheduling of residential distributed energy resources to optimize smart home energy services. IEEE Transactions on Smart Grid, 2010. **1**(2): p. 134-143.
[10] Bugaje, I., Renewable energy for sustainable development in Africa: a review. Renewable and Sustainable Energy Reviews, 2006. **10**(6): p. 603-612.
[11] Safaai, N.S.M., et al., Projection of CO2 emissions in Malaysia. Environmental Progress & Sustainable Energy, 2011. **30**(4): p. 658-665
[12] Ford, R. and C. Church, Reducing Domestic Energy Consumption Through Behaviour Modification. 2009: Citeseer
[13] Maharjan, S., et al., Demand response management in the smart grid in a large population regime. IEEE Transactions on Smart Grid, 2016. **7**(1): p. 189-199.
[14] Wei, T., et al. Battery management and application for energy-efficient buildings. in Design Automation Conference (DAC), 2014 51st ACM/EDAC/IEEE. 2014. IEEE.
[15] Gesing, F., The New Global Covenant of Mayors for Climate & Energy and the Politics of Municipal Climate Data. 2017.
[16] Chiasson, J. and B. Vairamohan. Estimating the state of charge of a battery. in American Control Conference, 2003. Proceedings of the 2003. 2003. IEEE.
[17] Kazem, H.A., T. Khatib, and K. Sopian, Sizing of a standalone photovoltaic/battery system at minimum cost for remote housing electrification in Sohar, Oman. Energy and Buildings, 2013. **61**: p. 108-115.
[18] Kaldellis, J., D. Zafirakis, and E. Kondili, Optimum sizing of photovoltaic-energy storage systems for autonomous small islands. International journal of electrical power & energy systems, 2010. **32**(1): p. 24-36.




10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429


# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY