

TECHNICAL REPORT ON STEP BY STEP INSTALLATION OF SOLAR ENERGY AND ITS MAINTENANCE

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ABSTRACT

This technical paper describes solar energy and Its Maintenance. Solar Energy is refers to as the energy from the sun; the conversion of the sunlight into electricity gives you Solar power. It allows any user with necessary receiving components to receive the sun for its utilization by using photovoltaic (PV). Photovoltaic convert light into an electric current and this current can be converted into alternating current (AC) using an inverter and also stored using a well arranged batteries for use in homes for illumination and for appliances at home. This technical paper will discuss in details the necessary steps to be taken for proper installation and maintenance of solar energy.

Key words:

Solar module/PV, battery, charge controller, inverter and installation.

1.0 INTRODUCTION

Solar energy in recent years has attracted more attention to people due to inefficiency and unavailability of power for different use in homes and industries. It is a well known fact that the world is facing a major threat of

fast exhaustion of the fossil fuel reserves like in Nigeria where our source of energy is from natural gas and water [1]. There has been general outcry against lack of constant power supply to help our industries and home appliances. This has brought about the urgent need to explore other means of power generation such as solar energy. Research has been into the development of reliable and strong systems to harness energy from nonconventional energy resources. Solar power source have experienced a tremendous rapid growth in the past ten years and is Pollution free source of abundant power. This paper lists the basic components needed for installation of solar energy at homes; this includes the solar panels (PV modules), Charge controller, Battery, Inverter, Connecting wires. [2]

2.0 COMPONENTS OF A SOLAR POWER

Solar design and installation is absolute easy thing one can do but with proper knowledge, training and skill with some money to purchase the equipments. Some of the components you need for installation of solar energy are listed below:

- Solar system

- Solar panels (photovoltaic PV modules)
- Charge controller
- Battery
- Inverter
- connecting wires
- Appliances (like Bulb, TV, Fan etc)

1) The Solar system

Solar System can be defined as the Sun and everything that orbits the Sun which also include the planets and their satellites. It can also be called a group of celestial bodies orbiting another star. In this paper, solar system refers to the system that includes Earth and the Sun. Solar energy is the energy from the sun. It comes to us in form of light and heat. Nigeria receives about 4.851×10^{12} KWh of energy from sun daily, 1.804×10^{15} KWh annually and the country has average solar insolation of about $5.535 \text{KWh/m}^2/\text{day}$ which will effectively be used for solar power installation, and will bring about total change in power system failure in the country.[3]

2) Solar panels (photovoltaic PV modules)

A solar cell or photovoltaic cell can be defined as a device that converts light directly into electricity by the photovoltaic effect. Solar Photovoltaic systems generate electricity directly using sunlight. Solar thermal systems actively or passively collect, transport, and utilize solar energy to generate heat. The generation of voltage across the p-n junction in a semiconductor due to the absorption of light radiation is

called photovoltaic effect. The Devices based on this effect is called photovoltaic device.

The solar panel converts the solar energy (energy from the sun) to electricity which charges the battery. For more effective use, more than one solar panel are electrically connected to form array for the purpose of collecting a good amount of sun to charge the battery which will be capable of supplying a home the amount of electricity needed. Solar panel connections are done in two different ways for efficient useful work.[4]

The two ways of connecting solar PV are as follows:

- Series connections.
- Parallel connections.

2.1) Series connection

Series connection simply is connecting solar panel positive terminals to negative terminals of another. It gives output voltage equals the sum total of the voltage of the entire module in the string and the output current equals the equivalent of the current for a single solar. In series connection all the currents are equal while the voltages are the sum of individual voltages.

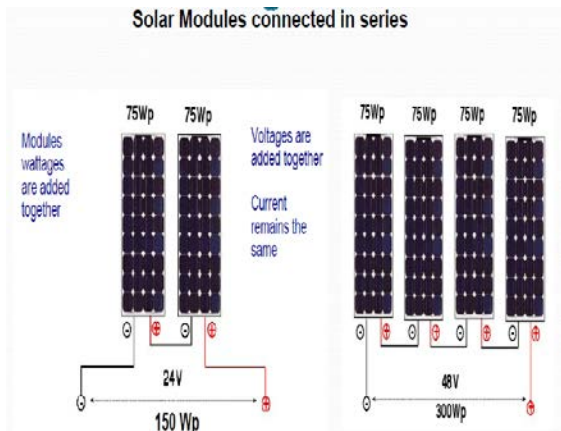


Fig 1a: Series connection of solar module

By Series connecting, the voltage equals the sum of those panels, being in series, the amperage is equal.[4]

2.2) Parallel connection

Parallel connection simply is connecting the solar panel positive terminals to positive terminals of next and negative terminals to negative terminals of next. When using this type of connection, your voltage remains the same but your amperage is the total sum of the panels being used. That is to say, it gives output voltage equals the equivalent voltage of a single solar panel in the string and the output current equals the sum total of all the current of the solar panel in the string.

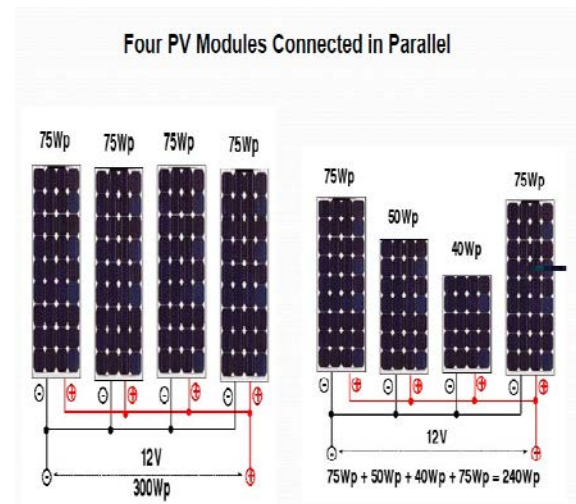


Fig 1b: Parallel connection of solar module

By parallel connected solar panel gives more current (amperage) the sum of individual currents, the voltage is equals.[4]

3) Charge Controller

Charge controller ensures is used to charge your batteries, it ensures that the battery is not over-charged or over-discharged; it stops receiving from the solar panel when the battery is fully charged and switches off every DC load connected to it when the battery is discharged to the minimum level. These charge controllers regulate the charging of your batteries because they are programmed. The quality of these programs determines the lifespan of your batteries. This is the reason only quality charge controllers should be used, because batteries are the most expensive part of any solar system installation. DC loads are taken directly from the charge controller. The procedure for selecting Charge controller is by determining the operating voltage of the PV array and the current, i.e. the charge

controller must be sized to handle maximum current and voltage produced by the solar PV array.[5]

4) Battery

Battery stores the electrical charge produced by the solar panel during the day. It helps the output of the solar panel when it cannot supply enough electricity to the system. Batteries are a major cost of any solar system and are the most friable component in the solar system. Battery should have sufficient Amp hour storage to supply the needed power during the cloudy weather. Batteries can be either shallow cycle discharge (for automobiles) or deep cycle discharge (for PV system).

A shallow-cycle batteries discharge only between 10% and 20% of their Ah capacity/day discharging beyond this point without recharging shortens the battery life.

Deep-cycle batteries are designed to allow a discharge of 60% to 80% of its Ah capacity. A battery discharged at a rate of 1 amp will have a higher Ah capacity than a battery discharged at a rate of 4 amps. A battery which can deliver 1 amp for **100 hours has a capacity of 100Ah @ C100**. The same battery may only deliver 4 amps for **20 hours**. Then its capacity is 80Ah @ **C20**. **C100** means discharged over 100 hours, **C20** means discharged over 20 hours. Batteries are connected in series and parallel.[6]

5) Inverter

This is what will turn the 12 volt DC current into 110-120 volts AC current for use in powering your household electrical devices.

An inverter is device that changes direct current (DC) from the battery to alternating current (AC) to be used for AC appliances. The battery provides DC voltage to the inverter, and the inverter converts the DC voltage to normal AC voltage. The output of a solar PV system can be either DC or AC depending on the type of electrical load it is meant to power. If it is used to power a DC load, then there is no need for an inverter. However inverter is required when the electrical load is AC. One can choose to go for solar inverter; solar inverters have some special functions with the photovoltaic arrays like maximum power point tracking and anti-islanding protection. There are two types of inverters which include modified sine wave and pure sine wave inverters. Note: the size of the inverter should be around three times what you plan to use it for, this is because the consumer products do not always use the best components and this is a way to ensure your unit will last longer than when you purchase an undervalued unit and push it to burn out.

Before you buy an inverter you need to take cognizes of the following:

- i. The maximum load; the rating is larger than wattage of all the ac loads to be run at any one time
- ii. The maximum surge; Inverter is designed to surge if motors will be connected.
- iii. The output voltage
- iv. The input battery voltage requirements[7]

6) Connecting Wires

They are used to connect one component to the other. The generated electricity (electric current) flows through them to the load. The recommended size of cables is 2.5mm.

3.0 THE STEP BY STEP INSTALLATION OF SOLAR ENERGY

Solar power plant installation is very easy. But before the actual work begins, the most important issues that you must have done are to know the total electricity consumption for the household, this can be done by taking a physical view of all the appliances to check their power ratings to know the capacity of all the system components and the total number of panels, batteries and the capacity of charge controller and the appropriate inverter needed. Now the components are conveyed to the site a day before the actual installation. The stages in the installation include

1. Arrange the photovoltaic PV modules:

After bringing out the PV with the ratings behind the panel, the information you will see is the maximum wattage, voltage, and amperes. After that, wire the panel according to the required need but I prefer the parallel connection (the voltages remain the same while the currents is added). Then mount the PV on the rooftop of the building with a few inch gap and parallel to the surface of the roof. Solar PV can also be mounted on the ground. The solar array is usually best placed in perpendicular to the sun's rays, which change continuously over the course of the day and season. The most suitably location and inclination for a PV

mounting is east front and slope of 30-40°. [8]

2. Charge controller: The next thing to do after the setting up the solar PV array is to connect the charge controller (which you know is to ensure that the battery is not over-charged or over-discharged) directly from the output terminals of the solar PV using lighter gage wires. Note: DC loads can be directly connected to the charge controller. After the connection, we move to next step which is connecting the battery. [4]

3. Battery: The batteries are properly connected either in series or parallel connection depending on your need, and then connect the battery to the charge controller at the port selected/indicated for it in solar charge controller. The next thing to connect is the inverter. [4]

4. Inverter: The next setup is the inverter, as we discussed above the inverter converts the DC supply from the solar PV into the battery to AC supply in order to power our AC loads. Connect the battery terminal to the inverter with 2.5mm cable. Finally, from the inverter you connect to the external load in the house. The rating of the inverter should be the same with rating of the PV array. [4]

4.0 MAINTENANCE OF SOLAR PV SYSTEMS

Solar panels have no moving parts, and therefore no potential points of mechanical failure. Therefore properly installed PV system requires very little maintenance. After the installation of solar system for household use, best maintenance practice is to inspect the equipment especially batteries

and modules, to make sure all electrical contacts are tight. We can keep the solar PV operational through two maintenance techniques which include the preventive and corrective maintenance. Let us look at maintenance of the different components of the solar system which include:

1. Solar PV Maintenance

You should wash the PV array, during the cool of the day, when there is a noticeable buildup of dust and dirt. Periodically inspect the system to make sure all wirings and supports are intact. Furthermore, check for tree growth that has shaded your modules and also check for birds' nests in your modules and junction boxes. Review the output of the system annually (assuming the array is clean) to see if the performance of the system is close to the previous year's reading. Do not scratch the glass casing of the module.[9]

2. Battery Maintenance

Battery is very important component in the solar system; therefore proper care should be taken. For long life, battery should be cleaned monthly; the electrolyte level should be checked and kept in a high state of charge. When cleaning batteries, beware of the battery acid and do not short the terminals. Carry the battery outside when cleaning to avoid spilling acid, keep plenty of water nearby to rinse spills.[9]

3. Charge controller malfunction

Charge controller will be will go bad if the battery voltage exceeds the appropriate set voltage for the type of battery used, and also the batteries are bubbling severely causing a lot of moisture accumulation on the battery

tops. Charge controller can go badly if the battery bank capacity is not up to the rate.[9]

4) Some of the general precaution/maintenance to be carried on the system include:

4.1) observe the tightness of screws on all connector strips, controls; switches, etc. make sure that they are well chewed. This is mostly important for old or exposed wire.

4.2) look at the junction boxes to make sure that insects have not build house there, and also make sure they are watertight when exposed to the environment.

4.3) inspect switches to make sure they are in good operating manner

4.4) inspect the fuses to ensure no one is blown. If blown, find the cause and replace or repair with a new one of the same size.

4.5) inspect the indicator lamps on the charge controller. The solar charge controller indicator should be ON when the sun is up. If is not ON. Check to see if batteries are being charged. Check whether the other LED indicator lamps are working (that is battery full and low voltage).

4.6) Check grounding wires to make sure they are still intact.[9]

5.0 CONCLUSION

In the present work a Solar PV Energy System was implemented. A portion of the energy requirement for a private house, farm house, a small company, an educational institution depending on the need at the site where used has been supplied with the

electricity generated from the solar power. It reduces the dependence on one single source and has increased the reliability. Apparently, we can improve the efficiency of the system with an individual interest mode of generation. Photovoltaic systems are cost-effective, pollution-free and maintenance-free. They could be deployed in remote locations where conventional power is not readily available.

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