DESIGN AND DEVLOPMENT OF PORTABLE MICRO SOLAR POWER PLANT

Venkatesh Kulkarni[1], Mahesh Bhelave[2],Shravni Gurao[3],Rushikesh Shevane[4],Himanshu Waghmare[5],Sahil Chauhan[6], Prof.DR.S.R.Ikhar[7]

[123456]UG Student, Department of Mechanical Engineering KDK Collage of Engineering Nagpur, Maharashtra, India

[7]Professor, Department of Mechanical Engineering, KDK Collage of Engineering Nagpur, Maharashtra, India

Abstract

This paper is about design of portable micro solar power plant to generate electricity with means of solar energy. It has the potential to replace petrol generator, widely used by peddlers at night markets. Conventional generators are heavy, oily, have high maintenance and use fossil fuel to generate electricity. The solar generator can generate 200 Watts of electricity. This amount of power can supply up to 96 hours of electricity for the purpose of operating and running small electrical appliances. The power output is (alternating current) AC current using 150 Watts inverter with 200 Watts, sufficient enough to operate all commercial single phase electric appliances. Solar charge controller is used to maximize the charging rate and to protect the battery. The system has low maintenance as the batteries need to be changed every three to four years, which depends on the usage. The materials used to develop the solar generator are easily available at all local markets, thus the cost of developing the system and making it suitable for commercialization.

Keywords: photovoltaic, solar charge controller, inverter, battery, portable sheet metal box

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I. Introduction-

Due to the more apparent limitations of fossil fuels, solar energy is becoming more popular as the renewable energy source that could change the future. Solar energy is available in abundance and it does not cause harm to the environment with no greenhouse gas emissions. This solar power plant is portable can easily be transported [1]. Also, this device that could provide power for non-portable devices that could be useful. Examples of non-portable devices are an electric fan, a projector to watch movies, a computer printer, and a microwave oven for people who want to heat up their food quickly. This portable solar power plant can be operated at a fully charged condition of the battery. The portable solar power plant is rated 200W of 220V and 50Hz. It is expected that in this condition, it was favourable to carry load of the stipulated power. Loads of low power factors are not helpful since they produce spikes [1]. Overloading is not potent to provide zero change over time and the inverter had LEDs which indicates mains failure and battery discharge and system fault. This solar power source makes it possible to provide a clean reliable supply of alternative electricity free of sags or surges which could be found in the line voltage frequency.

II. Methodology-

The methodology is divided into 5 main phase:

2.1. Planning- The planning phase determines the expectation milestone and timeline for completion of project. This will ensure all activities will be done on schedule and development of the project is on time.

2.2 Research-The research phase is where all the information and study of the literature review for this project is done. The research phase includes finding information on SEGS, solar geometry, PV modules and experimentation on solar radiation.

2.3Analysis-The analysis phase is where the computation and theoretical analysis is done. This process includes finding the PV sizing, suitable PV module and load calculation.

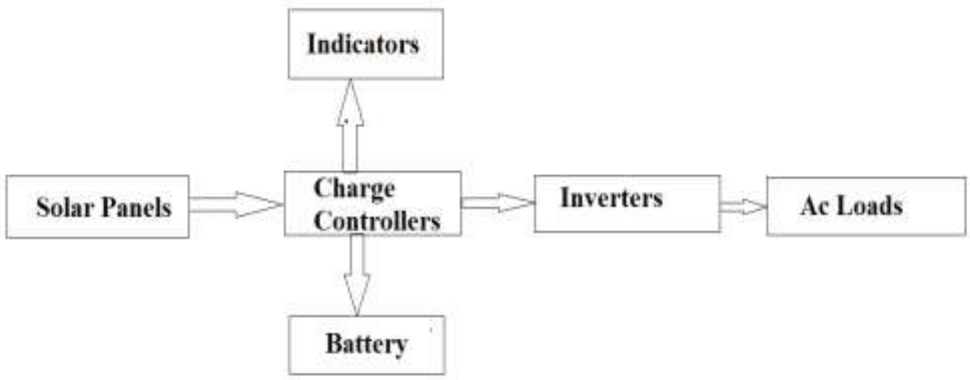
2.4-Design-The design phase determines the design of the prototype and its operational components. The selection of equipment for the prototype is also done during design phase.

2.5-Fabrigation and testing-In this, the prototype is constructed and tested. The testing process is to ensure the prototype is functional and optimum output is produced. During the testing process, improvement of the prototype is also made to ensure there are no failures and improvement has been made.

III. Working Principle-

Photovoltaic is the direct conversion from light into electricity at an atomic level. Some materials have a property known as the photoelectric effect; the material absorbs light photons and releases electrons. A panel is divided into cells, which are responsible for converting the energy of light into direct current (DC) electricity, which happens when the free released electrons are captured [4]. The use of a PV inverter is commonly used due to the need to stabilize the current, transforming from DC into alternating current (AC) before using it in a local grid. Figure shows illustrate PV cell's energy transformation. The operation of a PV cell Photovoltaic cells are made of specially treated semiconductor material that shares both metal and insulation properties to convert sunlight into electricity. The light that is absorbed by a semiconductor is transferred as energy to the electrons. This allows the electrons to flow freely through the material as an electric current. The direction of the electron flow is controlled by the positively and negatively charged electric fields in the photovoltaic cells. By extracting the current from the PV cell, the power produced by the solar cell can be used extrinsically.

Block Diagram -



(Block diagram for portable solar power plant)

IV. .Component Used-

4.1) Solar Panel-Solar panel is an indispensable component of this system. A solar panel is a device that is able to absorb sun rays and convert it into electrical energy precisely DC. The photovoltaic panel comprised of silicon crystals, which reacts with sun ray and under this process, converts the sun rays into electricity [4]. Multiple modules are used to produce more electricity and then any excess energy that was produced was stored in the batteries for use during the cloudy/ rainy weather.

Solar Panel Design Specification-

1) Two solar panel of 100 watts capacity each

2) Solar cell temperature-25^{0}c

3) Temperature reduction factor-85%

4) Dust reduction factor-93%

5) Solar panel dimension-42.3*66cm

(Solar Panel)

4.2) Battery-Batteries operate by converting chemical energy into electrical energy through electrochemical discharge reactions. Batteries have one or more cells, each containing a positive electrode, negative electrode, separator, and electrolyte. The maximum power available from a battery depends on its internal construction [5]. Here we are using lead acid battery. The advantages of this battery are it is recyclable, and has long service life. The battery can be operated at wide temperatures in between -40 degrees to 60 degrees Celsius.

Specification:-

1) The battery we are using is 12v 8 AH which is Lead acid battery.

2) The battery's dimension is 15*8.5*6 cm and weighing

3) Battery weight- 29 pounds, which was a good size in comparison to other batteries found while doing research.

(Battery)

4.3) Charge Controller- The charge controller is an electronic voltage regulator that was used to limit the rate at which electric current was being drawn in or out of the batteries. This charge controller turns off the charge when the battery reaches the optimum charging point and resume charge flow when it goes below certain level. This charge controller shows system operation parameters, battery status and protection from over discharge.

Microcontroller Specification-

1) It has a capacity of 250 watt because,

2) If the sun rays will increase the electric charge will exceed than 200 watt so we have taken charge controller having capacity of 250 watt.

(Charge Controller)

4.4) Inverter- The inverter convert the DC voltage produced by the solar panels (and from the energy stored in the batteries into A C voltage. We are using PWM inverter PWM inverter advantages include single panel power optimization, independent operation of each panel, plug-and play installation, improved installation and fire safety, and minimized costs with system design and stock minimization.

Inverter Specification:-

1) The inverter used here is of 250 watt because,

2) We are using this inverter because we are producing electricity up to 200 watt.

3) The inverter used with the PV power systems have peak efficiencies of 92-94% indicated by the manufacturer, but these again were measured under well- controlled conditions. Actual field conditions that usually resulted in the overall dc-to ac conversion efficiencies was about 88-92% as a reasonable compromise.

4.5) Copper wire and switches and sockets- A copper wire is a single electrical conductor made of copper. Multi-Strand Wires are a bunch of small wires that are bunched together to form a thick conductor. It can conduct electric load to 30 amp Copper is one of the most conductive materials of electricity available. It has a high corrosion resistance it helps in reducing the risk of deterioration and failure. A switch is an electrical component that can disconnect or connect the conducting path in an electrical circuit, interrupting the electric current or diverting it from one conductor to another. Sockets connect electric equipment to the alternating current (AC) .Here we are using Switches and sockets of 6 and 16 amp .16 amp switches and sockets are used to reduce voltage drop across each load 6amps switches and sockets will be used for inductive load.

4.6) Portable sheet metal box- For light weight and easy to handling sheet metal box and rotating wheel are preferable. The aluminum sheet metal box of size 58*33*33 cm having two compartments. One compartment for inverter, controller, indicator and AC load, where as another compartment for batteries. In this portable solar power plant there are 4 wheels of NYLON material with 360 degree rotational movement. The wheel diameter is 9cm and box having ground clearance of 11cm.

V. Design specifications

5.1) Inverter Sizing: Inverter rating=peak power * safety factor =4113*1.25 =5141.25~5150W Thus, the inverter rating 24V 5150W can be used for this system. Supposing the inverter efficiency is 0.9. The DC equivalent energy demand of AC load is given as: Eac load =Total AC load Wh per day/inverter efficiency =14632Wh/0.9 =16257.7778Wh electricity conversion.

5.2)Battery Bank Sizing: The energy need to store by battery bank is given as: Energy store=Energy load*D/MDoD Energy store=16260wh*4/0.5 Energy store=130080Wh The number of autonomy days is taken as 4 and the maximum allowable depth of discharges taken as 50%, due to remote standalone PV system.

5.3) charge controller sizing the solar charge controller is typically rated against Amperage and Voltage capacities. Select the solar charge controller to match the voltage of PV array and batteries and then identify which type of solar charge controller is right for your application. For the series charge controller, the sizing of controller depends on the total PV input current which is delivered to the controller and also depends on PV panel configuration (series or parallel configuration). According to standard practice, the sizing of solar charge controller is to take the short circuit current (Isc) of the PV array, and multiply it by 1.3 Solar charge controller rating = Total short-circuit current of PV array x 1.3.

VI. Conclusion-

The portable solar plant has the potential to replace petrol plant in future especially for lighting and running small electrical appliances. The power plant requires low maintenance cost as the battery needs to be changed once every three to four years. It is light weight and portable making it suitable for use at home or at street vendors at night and as backup energy supply. Photovoltaic power production has more significance as it is renewable energy source.

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