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Uninterrupted Electricity Generation from Hybrid Solar Power System

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Abstract: one of the primary needs of the society is to obtain uninterrupted power supply. In this work the design of 5 KW hybrid solar systems is presented. Solar system is hybrid in the sense that power from the grid and solar energy is used simultaneously to operate the load. Grid inverters are designed to operate only during time when power is available from the sun. In our designed solar system the advantage is to harness maximum energy from the sun even in absence of power from the grid. The proposed work was funded by Total Engineering quality improvement program (TEQIP)
Keywords: Solar energy, grid inverter, Battery Bank, inverter, Solar plates.

1. INTRODUCTION

Abundant solar energy is available[1]. The requirement of the day is to harness maximum solar energy from the sun. In solar system solar cells are concerned to convert light in to electricity. Generated electricity by solar cells is DC in nature which is dependent on the cell structure and technology used to fabricate the cell [2-4]. Most of the devices in houses are operated by AC current. So an inverter is required to convert DC supply from the cells into AC supply. Grid inverter is directly used to convert DC supply from the solar cell into AC supply and to feed the grid with surplus electricity generated from the solar cells for further use. Grid inverters are connected to grid to couple extra generated power from the solar system so they will couple the generated solar power to grid even during the time when grid supply is not available. This provides dangerous environment for person working on grid during planned shutdown of electricity. So to avoid miss happening grid inverters are required not to feed the grid during power failure from the grid. In this work we had designed a solar system which has the capacity to convert DC power from the cell into AC power, Couple the extra power from the solar cell to the grid and to generate the electricity from the grid inverter even during the time of grid failure to operate the load. The above mentioned aims are obtained by using a simple inverter, battery bank and a automatic changeover Switch in addition to grid inverter. The advantages of above mentioned solar system design is to provide uninterrupted power supply and to harness maximum available energy from the sun. Organization of this paper is such that Section 1 provides the information regarding the need and components required for designing the Hybrid solar system. Section II describes the methodology of designing the solar system. Section III. Explains the circuit diagram of designed hybrid solar system of 5 KW capacities. Conclusion is presented in section IV. References are presented in section V.

II. DESIGNING SOLAR SYSTEM

A solar PV system design basically includes four steps

- First step in Designing Solar System is Load estimation and calculation.
- A system voltage depending on the available inverter voltage is selected for all the components of the system (inverter, battery bank, array etc).
- Third step is the estimation of battery bank for the system.
- Final step is the estimation of number of PV panels.

Load calculation is dependent on the Wattage and the time duration of the appliances used. In this work Hybrid solar system is designed to operate 5KWH load.

Batteries are used for the purpose of storing energy. Batteries are calibrated in terms of ampere-hour (Ah) which describes how much electricity they can store. If a battery delivers 1 A of current continuously for 100 hours its rating is 100 Ah. If a battery delivers 10 A continuously for 10 hours, it also has rating of 100 Ah. While selecting the battery the voltage and the ampere-hour rating of the system must be known. For use in houses the voltage of available battery is either 12 V or 24 V. The size in ampere-hours is decided by the load of used appliances. The capacity of available battery is either C20 or C10 which indicates the discharging time of battery. Backup time of battery is dependent on the voltage rating, ampere hour rating and capacity of load. Depth of discharge is the other important factor of the battery to be considered. It indicates the maximum possible discharge from the battery.

It can be concluded that sizing of battery will depend upon

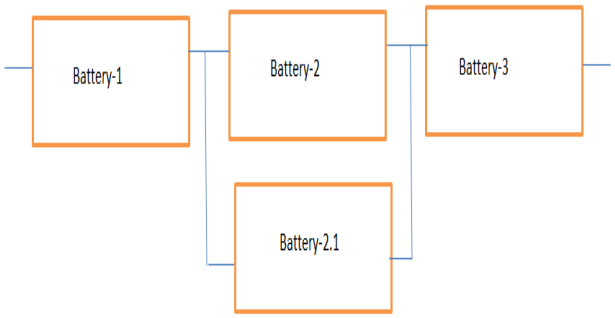
- The total energy that the battery bank must supply.
- Maximum depth of discharge
- System voltage

- Back up time required by Battery.
- Discharging time of Battery.

Steps used to decide the battery size calculation are as

- Step 1. For each appliance calculate the required watt-hours per day and then obtain the total watt-hours per day for all appliances.
- Step 2. Multiply the total appliance watt-hours per day by the number of days for which backup is required.
- Step 3. The required ampere hour capacity of the battery can be estimated by dividing the battery voltage.

If required capacity of battery is not achievable by using a single battery batteries can be connected in series or in parallel to obtain the desired capacity as shown in Fig(1) with the condition that overall system voltage do not change.



Fig(1)
(Batteries connected in series and in parallel)

Final step in designing Solar system is estimation of number of solar panels. Panel manufacturers specify their panel's capacity by the watts of power that they will produce when the sun is at its peak. This is called panel peak watts. The peak power produced from the panel not only depends on the size of the panel but is also dependent on the brightness of the sunlight striking the panel. A power generation factor of 3.43 is used in India. Which means that total generated watt hours from the solar panel per day is equal to multiplication of power generation factor with panel peak watts.

Steps involved to decide the number of panels required are as

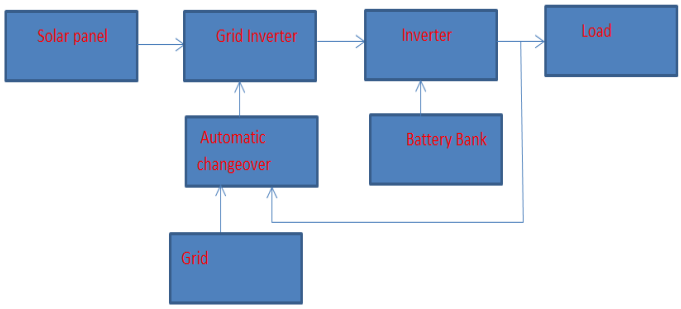
- Step 1. Calculate the total watt-hours needed per day for all used appliance.
- Step 2. Multiply the total appliance watt-hours per day by 1.3 to incorporate the efficiencies of panels.
- Step 3. Divide the total obtained watt-hours by a generator factor of 3.43.
- Step 4. Divide the result obtained in step 3. By the available peak watts from the panel. This gives the number of panels required.

It is also important to choose inverter of proper sizing. In order to choose the inverter of proper sizing steps involved are

- Calculate the total connected load to PV panel system. Let it is X.
- Inverter are available with rating of Y,Z Etc
- Choose inverter with capacity such that Y>X.

III. DESIGNED HYBRID SYSTEM

Block diagram of designed hybrid system for uninterrupted power supply is as shown in Fig (2).

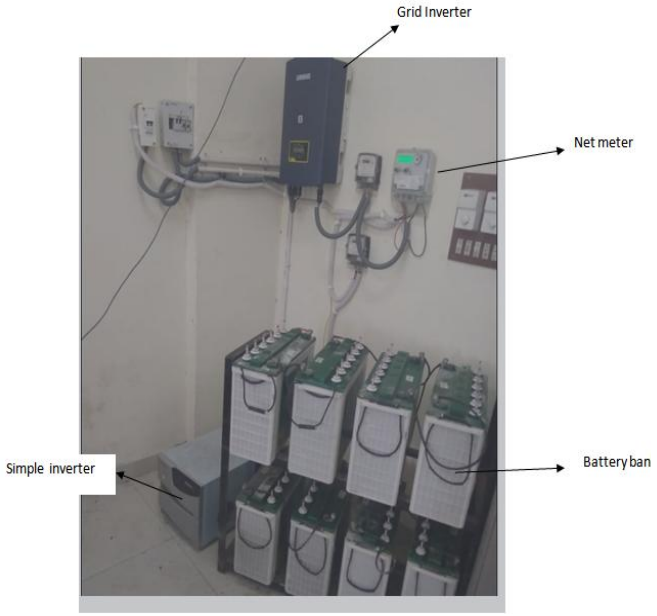


Fig(2) (Design of Hybrid System)

This system is designed to operate a load of 4 KW which includes one AC of nearly 1.2 KW, 35 fans of 1.75 KW and 20 tube lights of capacity 1 KW. Inverter is of 5KW capacity with 96 Volt as system voltage. Eight batteries each of 12V voltage rating are connected in series to provide system voltage of 96V. Grid inverter of capacity 5 KW is connected to PV array on one side. When AC power supply is available on one of inputs of grid inverter it converts DC power from the solar panel to the AC supply. AC power supply from the grid inverter is utilized by the load and by the battery bank through inverter. AC power supply is fed to grid inverter through automatic changeover. Automatic changeover switch is used to select AC power available either from the grid or from the output of inverter. When power from the mains is not available output of inverter is used to provide the desired AC supply to the grid inverter. Sets of solar panel each of 48 V system voltage are connected in parallel to provide energy to grid inverter. The structure of designed hybrid system is as shown in Fig(3) and Fig(4).

Fig(3) (Installed solar pannel)

Each Solar plate is of poly crystalline Silicon with rectangular shape having capacity of 250 watts and 24 Volts and efficiency of more than 13%. When two solar panels are connected in series they provide system voltage of 48 volts. Solar panels are further connected in parallel to improve the current rating. Output from two set of solar panels are directly connected to inputs of grid inverter. Grid Inverter is of 5KW capacity with single phase operating voltage of 230V. Inverter efficiency is more than 95%. Maximum input DC power to inverter is 5000W. Grid inverter is further connected with the mains on one side and load on the other side. When AC power is available from mains grid inverter converts DC power from the panel to AC power. Load is supplied power first from the solar panel any additional power required by the load is provided by grid. Further extra power generated is coupled to the grid. Output of grid inverter which is AC is coupled the inverter before connecting with the load. Inverter is also connected to battery bank to provide energy to load when power from grid or solar power is not available. Individual battery is of 12V capacity with 150AH rating. Eight batteries are connected in series to provide an overall system voltage of 96V. Two Energy meters are connected to measure electricity generated by solar system and to measure the total energy consumed by the load.



Fig(3)
(Installed components of solar system)

Utmost care should be taken while working with solar panel, Battery Bank and inverters. During sun shine a very high power is generated from the solar panel and moreover this is DC power. All installations of solar panels should be done without connecting the panels. It is preferable to install battery banks in ventilated locations. A lot of energy is wasted while transmission of power from solar panels to inverter. So length of wire used and material of wire should be chosen to avoid or to minimize the transmission losses.

IV. CONCLUSION

A hybrid solar system of 5 KW capacities is designed to provide uninterrupted power supply. During day time Energy from the solar panel is utilized to operate the load. Extra energy generated by solar panel is fed to grid. During day time when grid supply is not available output from the inverter derives the grid inverter which intern derives the load. During night either grid supply or energy stored in battery bank is used to derive the load.

V. References

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