Study of Grid tied Smart Solar Photovoltaic system: A review

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Abstract.A photovoltaic system is a device that is capable of converting the energy contained in photons. With the increasing concern about the global demand for Renewable Energy (RE) energy, it is very much important to reduce the cost of the whole solar photovoltaic (PV) system. Till now most of the solar photovoltaic (PV) systems are highly expensive. In this paper we have proposed study of a photovoltaic (PV) solar power system which can be operated by feeding the solar power to the national grid along with the residential load. An extensive literature review of solar PV systems with a special focus on grid-connected systems was conducted. A comparison of Grid connected and off grid system ha been carried out.

Index Terms: Photovoltaic system, tracking, Grid connected system, arrays**.**

1 INTRODUCTION

PV cells use semiconductor material to convert sunlight into electricity. The technology for doing so is very closely related to the solid-state technologies used to make transistors, diodes, and all of the other semiconductor devices that we use so many of these days. Grid-connected solar Photovoltaic (PV) systems use the direct conversion of sunlight into electricity which is fed directly into the electricity grid without storing it in batteries. This option, is generally carbon free or carbon neutral and as such does not emit greenhouse gases during its operation, since global warming and climate change are mostly caused by the release of carbon dioxide and other greenhouse gases into the atmosphere. Photovoltaic systems are solar energy supply systems that convert sunlight directly to electricity. The major component of a PV system is the solar panel which is formed by putting together several PV cells. Several PV cells forms a PV module, several modules form arrays and several arrays form panels. Fig .1 shows basic diagram of a cell, module & an array[6].

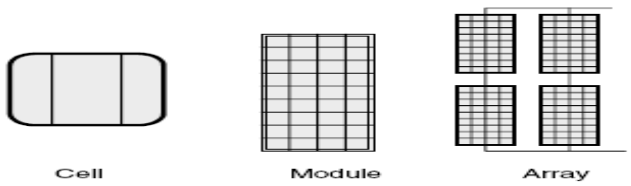

Fig 1. Photovoltaic cells, module and array

The modular nature of PV cells makes it possible for them to be used for a wide range of power applications ranging from a few mill watts in wrist watches and scientific calculators to several megawatts in central power stations. Solar cells are usually made of semiconductor materials such as silicon, gallium arsenide, cadmium telluride or copper indium dieseline. Solar cells come in two major forms based on the nature of the material used in their production [7]. The two main forms are crystalline solar cells and thin film solar cells. Mono crystalline and Polycrystalline cell are main types of thin film cells. Off-grid systems and Grid-connected systems are two main types of Solar Server Photovoltaic systems .Solar PV is presently the fastest growing power generation technology in the world. It is anticipated that photovoltaic (PV) systems will experience an enormous increase in decades to come. However, a successful integration of solar energy technologies into the existing energy structure depends on a detailed knowledge of the solar resource. This paper presents an improved and cost efficient way to synchronize the PV array output with the utility grid[5]. As a result, an individual solar PV system owner can acts as an electricity provider to the national power grid.

2 .THE SOLAR SPECTRUM

The surface of the sun emits radiant energy with spectral characteristics. When solar radiation passes through the atmosphere, some is absorbed by various constituents in the atmosphere, by the time it reaches the earth's surface the spectrum is significantly distorted. The amount of solar energy reaching the ground, as well as its spectral distribution, depends very much on how much atmosphere it has had to pass through to get there. The length of the path taken by the sun's rays through the atmosphere to reach a spot on the ground, divided by the path length corresponding to the sun directly overhead, is known as air mass ratio. Fig. 2 shows a graph of useable energy of photons[4].

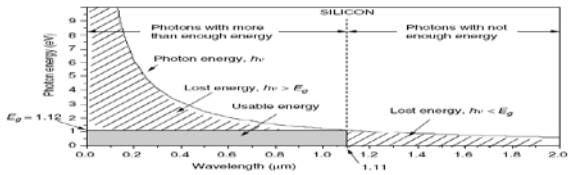

Fig 2 .Useable energy of photon

2.1 The Simplest Equivalent Circuit of a Photovoltaic Cell

Equivalent circuit model of a photovoltaic cell consists of a diode in parallel with an ideal current source as shown in Fig. 3. Current voltage graph is shown in Fig. 4.

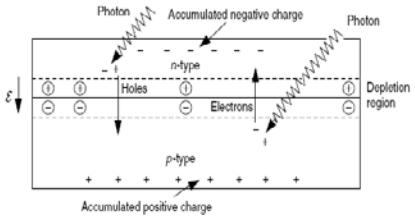

Fig. 3. Equivalent circuit of a PV cell

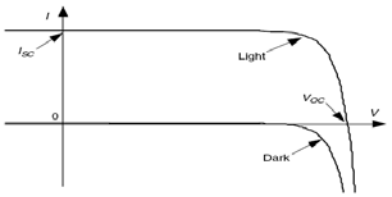

Fig. 4. Photovoltaic current–voltage graph for "dark" and "light"

3. Tracking Systems

Trackers are utilized to track the sun rays to catch highest Solar insolation at any time of the day So far, the assumption has been that the collector is permanently attached to a surface that doesn't move. In many circumstances, however, racks that allow the collector to track the movement of the sun across the sky are quite cost effective.Trackers are described as being either two-axis trackers, which track the sun both in azimuth and altitude angles so the collectors are always pointing directly at the sun, or single-axis trackers, which track only one angle or the other. Two axis and single axis tracking system is shown in Fig. 5 & Fig. 6 respectively.Calculating the beam plus diffuse insolation on a two-axis tracker is quite straightforward[3] .A polar mount has the axis of rotation facing south and tilted at an angle equal to the latitude

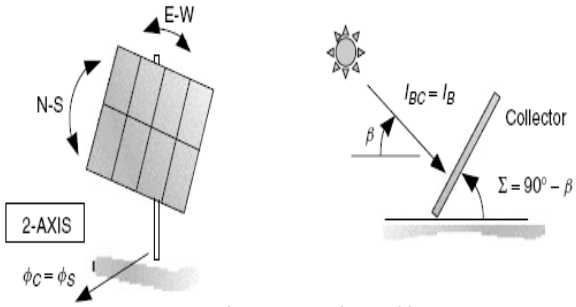

Fig. 5.Two axis tracking system

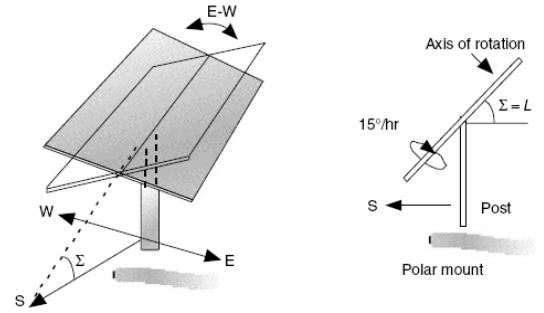

Fig. 6. A single-axis tracking mount with east–west tracking.

Single-axis tracking for photovoltaic's is almost always done with a mount having a manually adjustable tilt angle along a north-south axis, and a tracking mechanism that rotates the collector array from east-to-west, as shown above single-axis tracking mount with east–west tracking.

4. Conventional Off Grid and Grid Tied System

PV systems which are installed without being connected to the conventional grid line are called off grid systems and most of these systems make use of the large capacity battery as energy storage device. On the other hand grid tied systems are connected directly to the National grid.

4.1 Off-Grid Systems

Fig. 7 shows an off grid system. These PV systems are not connected to the public electricity grid. They require an energy storage system for the energy generated, solar energy is available during the day, but the lights in a stand-alone solar lighting system are used at night so the solar energy generated during the day must be stored for use at night. They are mostly used in areas where it is not possible to install an electricity supply from the main utility grid, or where this is not cost-effective. They are preferred in developing countries in remote areas are still frequently not supplied by an electrical grid. These systems are usually employed in the following applications; industrial applications such as telecommunications and traffic signs and remote habitations such as solar home systems and water pumping applications. A typical off-grid system comprises the following main components:

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• Solar PV Modules: These convert sunlight directly into electricity.
• Charge Controllers: Manage the charging and discharging of the batteries .
• Battery Bank: They Stores the energy generated by the PV modules.
• Inverter: It Converts the DC current generated by the solar PV modules to AC. .

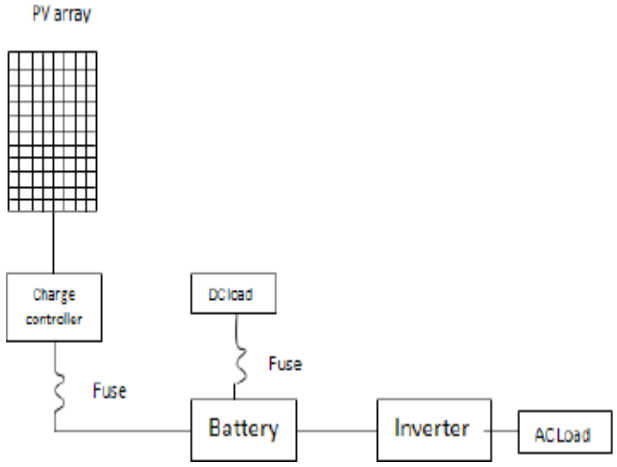

Fig. 7.Block diagram of off grid system

4.2 Grid-Connected PV Systems

Block diagram of a grid tied system is shown in Fig. 8. PV Grid-connected systems are connected to a large independent grid and feed power directly into the grid. These systems are generally employed in both decentralized grid-connected PV applications and centralized grid-connected PV applications [8] .Decentralized grid-connected PV applications include rooftop PV generators, where the PV systems are mounted on rooftops of buildings and building integrated system in which the PV systems are incorporated into the building[2] . In the case of residential or building mounted grid connected PV systems, the electricity demand of the building is met by the PV system and the excess is fed into the grid; their capacities are usually in the lower range of kilowatts .A typical grid-connected system comprises the following components:
• Solar PV Modules: these convert sunlight directly to electricity.
• Inverter: converts the DC current generated by the solar PV modules to AC current.
• Main disconnect/isolator Switch
• Utility Grid
Central grid-connected PV applications have capacities ranging from the higher kilowatts to the megawatt range.

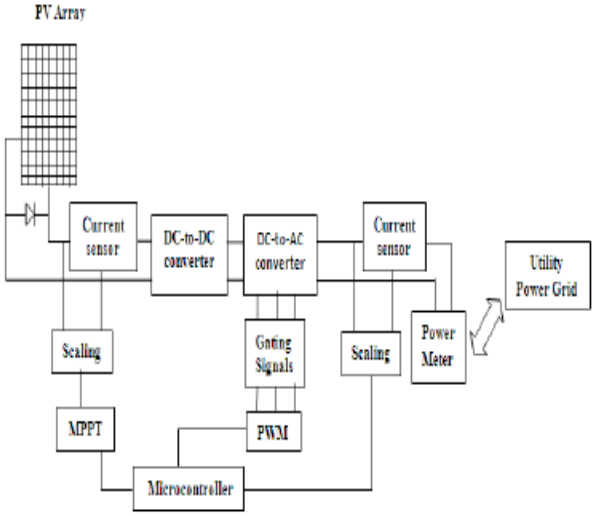

Fig. 8. Block diagram of grid tied PV system

5. Advantages of Grid Connected System

- Simple to install
- High efficiency
- Reliable
- Flexible

A grid-connected photovoltaic power system will reduce the power bill as it is possible to sell surplus electricity produced to the local electricity supplier. Grid-connected PV systems are comparatively easier to install as they do not require a battery system. Grid interconnection of photovoltaic (PV) power generation systems has the advantage of effective utilization of generated power because there are no storage losses involved. A photovoltaic power system is carbon negative over its lifespan, as any energy produced over and above that to build the panel initially offsets the need for burning fossil fuels. Even though the sun doesn't always shine, any installation gives a reasonably predictable average reduction in carbon consumption[1].

6. Limitations of the Grid Tied System

The grid-tied system without storage can't supply power during night or rainy day when sunlight is not sufficient. Again power output from certain renewable energy sources, like wind and solar, can be intermittent. Fluctuation in output can negatively affect power grid frequency, voltage, component performance, causing instability in the power generation system and inter-rupted service to the customers.

7. Conclusion

This system has been studied with a concept of micro photo voltaic power station. Still the solar PV system installation cost is not within an acceptable limit. Proper step should be taken to reduce the solar PV system cost. So that, the general electricity consumer can concentrates their attention in grid-tied PV system. So, in this paper we have shown an advanced grid-tied PV sys-tem which is suitable to produce more energy from renewable energy sources. Thus every photovoltaic system which is installed any where can be treated as a micro PV power station, no matter what ever the generation capacity of the plant.

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