IOSR Journal of Engineering (IOSR JEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
PP 06-12

Study of Solar Pv (Photovoltaic) System

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Abstract: *The major purpose of this study to know a solar photovoltaic system. In this study we get aware with the Energy is a Global demand to use and the resources may be renewable or non-renewable. There is demand and requirement to use renewable resources as an energy source. New technologies are opening up new opportunities for utilization of renewable energy resources. Most abundant, inexhaustible and clean of all the renewable energy resources till date is the solar energy. There are some limitations that as in all renewable energy sources, solar energy has intermittency issues; not shining at night but also during daytime there may be cloudy or rainy weather and Solar energy panels require additional equipment (inverters) to convert direct electricity (DC) to alternating electricity (AC) in order to be used on the power network. In this paper we discussed on history of PV system, different components, advantages, disadvantages, and its application.*
Keywords: *PV, Electricity generation, Alternate current, Direct current.*

I. Introduction

A photovoltaic (PV) system is a power system design to supply useable solar power by means of photo voltaic. A photo voltaic system, also solar PV power system, or PV system, is a power system design to supply useable solar power by means of photo voltaic. Arrangement of several components, a solar inverter to change the electric current from DC to AC, as well as mounting, cabling, including solar panels to absorb and convert sunlight into electricity and other electrical accessories to set a working system. It may also use a solar tracking system to improve the system's overall performance and include an integrated battery solution, as prices for storage devices are expected to decline as balance of system (BOS). Moreover, PV systems convert light directly into electricity and shouldn't be confused with other technologies, such as concentrated solar power or solar thermal, used for heating and cooling.

II. History of PV

In the 1860s, Willoughby Smith was an electrician who tested underwater telegraph lines for faults using a material called selenium. By chance, he discovered that electricity travelled through selenium very well when it was in light, but it didn't if the selenium was in darkness. In the late 1870s, William Adams and Richard Day was two American scientists, became interested in this. They soon discovered that the sun's energy creates a flow of electricity in selenium. Then in the early 1880s Charles Fritts invented the first PV cell by putting a layer of selenium on a metal plate and coating it with gold leaf, by placing in the sunlight, this cell made even more electricity but not enough to be useful.

III. Components of PV system

Fig 1. Components of PV system

Components of PV system are:
1.Solar array 2.Mounting 3. Cabling 4.Tracker 5. Inverter 6.Battery 7.Monitoring and metering

1. Solar Array

Solar arrays begin with a single solar energy cell known as a photovoltaic cell. “Photo” essentially means light, and “voltaic” refers to voltage, which is a unit of potential electrical energy. So combination of these two terms, the word photovoltaic encompasses the conversion of light energy to an electrical current. For its simplicity, you can refer to photovoltaic cells as solar cells. You’ll need many solar cells to convert the right amount of sunlight to electricity to provide enough power to your home. Since a single solar cell only generates a relatively small electrical current, when you connect several solar cells together, you create a solar panel, sometimes called a solar module. As per the National Renewable Energy Laboratory (NREL), the typical solar panel consists of approximately 40 solar cells.

You can create a solar array by combining several solar panels,. According to NREL, the average home requires and array of between 10 and 20 solar panels to provide enough electricity to be viable. Certainly, there are many factors that affect how many solar panels your home will need, including which region of the country you call home.

Fig 2. Solar Array

2. Mounting

Classifications of mounting system where modules are assembled into arrays are ground mount, roof mount or pole mount. The modules are mounted on the rack and for solar parks a large rack is mounted on the ground, and for buildings, many different racks have been devised for pitched roofs. For flat roofs, racks, bins and building integrated solutions are used. Solar panel racks mounted on top of poles can be stationary or moving, you observe trackers below. Side-of- mounting raises what would otherwise be a ground mounted array above weed shadows and livestock, and may satisfy electrical code requirements regarding inaccessibility of exposed wiring. To increases performance, pole mounted panels are open to more cooling air on their underside. A rack which does not follow the sun from left to right may allow to adjust seasonally up or down.

Fig 3. Mounting

3. Cabling

To become resistant against UV radiation and extremely high temperature fluctuations due to their outdoor usage, solar cables are specifically designed and are generally unaffected by the weather. A number of standards specify the usage of electrical wiring in PV systems, such as the IEC 60364 by the International Electro technical Commission, in section 712 "Solar photovoltaic (PV) power supply systems", the British Standard BS 7671, incorporating regulations relating to micro generation and photovoltaic systems, and the US UL4703 standard, in subject 4703 "Photovoltaic Wire".

4. Tracker

Throughout the day a solar tracking system tilts a solar panel. The panel is either aimed directly at the sun or the brightest area of a partly clouded sky depending on the type of tracking system. Trackers greatly enhance early morning and late afternoon performance, increasing the total amount of power produced by a system by about 20–25% for a single axis tracker and about 30% or more for a dual axis tracker, depending on latitude. Trackers are effective in regions that receive a large portion of sunlight directly. In diffuse light (i.e. under cloud or fog), tracking has little or no value. Because most concentrated photovoltaic systems are very sensitive to the sunlight's angle, tracking systems allow them to produce useful power for more than a brief period each day.

Fig 4. Tracker

Tracking systems improve performance for two main reasons. First, solar panel receives more light on its surface when it is perpendicular to the sunlight, than if it were angled. Second, direct light is used more efficiently than angled light. To improve solar panel efficiency for direct and angled light a special Anti-reflective coatings can be made, somewhat reducing the benefit of tracking.

To optimize the performance trackers and sensors are often seen as optional, but tracking systems can increase viable output by up to 45%.PV arrays that approach or exceed one megawatt often use solar trackers. It is the fact that most of the world is not on the equator, and that the sun sets in the evening, the correct measure of solar power is insulation – the average number of kilowatt-hours per square meter per day. For the weather and latitudes of the United States and Europe, typical insolation ranges from 2.26 kWh/m²/day to 5.61 kWh/m²/day in the sunniest regions in northern climates.

The energy gained by using tracking systems can outweigh the added complexity (trackers can increase efficiency by 30% or more) for large systems. For very large systems, the added maintenance of tracking is a substantial detriment. For flat panel and low-concentration photovoltaic systems, tracking is not required. Necessity of this is for high-concentration photovoltaic systems, dual axis tracking. Trackers become a less attractive option when solar panel prices drop.

5. Inverter

To deliver alternating current (AC) systems designed, such as grid-connected applications need an inverter to convert the direct current (DC) from the solar modules to AC. String inverter (left), generation meter, and AC disconnect (right). A string of solar panels built a solar inverter. At each solar panel a solar micro-inverter is connected in some installations. To enable maintenance and for safety reasons a circuit breaker is provided both on the AC and DC side. An electricity meter into the public grid is connected through AC output. To determines the total DC watts the number of modules in the system generated by the solar array; however, the inverter ultimately governs the amount of AC watts that can be distributed for consumption. For example, a PV system comprising 11 kilowatts DC (kWDC) worth of PV modules, paired with one 10-kilowatt AC (kWAC) inverter, will be limited to the inverter's output of 10 kW.

To get the maximum possible power from the photovoltaic array, maximum power point tracking (MPPT) is a technique that grid connected inverters used. In order to do so, the inverter's MPPT system digitally samples the solar arrays ever changing power output and applies the proper resistance to find the optimal maximum power point.

To immediately shuts down the inverter preventing it from generating AC power there is a Anti-islanding protection mechanism when the connection to the load no longer exists. This happens, for example, in the case of a blackout. Without this protection, the supply line would become an "island" with power surrounded by a "sea" of unpowered lines, as the solar array continues to deliver DC power during the power outage. to utility For workers islanding is a hazard, who may not realize that an AC circuit is still powered, and it may prevent automatic re-connection of devices.

Fig 5. Inverter

6. Battery

Batteries used for grid-storage also stabilize the electrical grid by leveling out maximum loads, and play an important role in a smart grid, as they can charge during periods of less demand and feed their stored energy into the grid when demand is more. Common battery technologies used in today's PV systems include the valve regulated lead-acid battery– a modified version of the conventional lead–acid battery, nickel–cadmium and lithium-ion batteries. Lead-acid batteries have lower energy density and a shorter lifetime compared to the other types. However they are currently the predominant technology used in small-scale, residential PV systems, due to their high reliability, low self-discharge as well as low investment and maintenance costs. To prevent damage from overcharging, PV systems with an integrated battery solution also need a charge controller, as the varying voltage and current from the solar array requires constant adjustment.

7. Monitoring and metering

Some systems use two meters, many meters accumulate bidirectional, but a unidirectional meter (with detent) will not accumulate energy from any resultant feed into the grid. To provide transmission lines and generation capacity, Grid operators historically have needed. Now they need to also provide storage.

Fig. 6. A Canadian electricity meter

The two variables a grid operator has are storing electricity for when it is needed, or transmitting it to where it is needed. It can be automatically shut down, although in practice all inverters maintain voltage regulation and stop supplying power if the load is inadequate. For supplying reactive power which can be advantageous in matching load requirements the three-phase inverters have the unique option. To detect breakdown and optimize their operation Photovoltaic systems need to be monitored . Depending on the output of the installation and its nature there are several photovoltaic monitoring strategies . To dedicated to supervision only or offer additional functions monitoring tools can be used. Battery charge controllers and individual inverters and may include monitoring using manufacturer specific protocols and software. For revenue metering purposes, energy metering of an inverter may be of limited accuracy and not suitable . A third-party data acquisition system can monitor multiple inverters, using the inverter manufacturer's protocols, and also acquire weather-related information. To measure the total energy production of a PV array system, independent smart meters may be used. To estimate total insolation for comparison, separate measures such as satellite image analysis or a solar radiation meter (a pyrometer) can be used.

IV. Advantages of PV System

- PV panels provide clean – green energy.
- There are no harmful greenhouse gas emissions during electricity generation with PV panels thus solar PV is environmentally friendly.
- Solar energy is energy supplied by nature – it is thus free and abundant.
- Solar energy can be made available almost anywhere there is sunlight.
- Solar energy is especially appropriate for smart energy networks with distributed power generation – DPG is indeed the next generation power network structure.
- Solar Panels cost is currently on a fast reducing track and is expected to continue reducing for the next years – consequently solar PV panels has indeed a highly adjhopeful future both for economical viability and environmental sustainability.
- Photovoltaic panels, through photoelectric phenomenon, produce electricity in a direct electricity generation way.
- Operating and maintenance costs for PV panels are considered to be low, almost negligible, compared to costs of other renewable energy systems
- PV panels have no mechanically moving parts, except in cases of –sun-tracking mechanical bases; consequently they have far less breakages or require less maintenance than other renewable energy systems (e.g. wind turbines)
- PV panels are totally silent, producing no noise at all; consequently, they are a perfect solution for urban areas and for residential applications (see solar panels for home)
- Because solar energy coincides with energy needs for cooling PV panels can provide an effective solution to energy demand peaks – especially in hot summer months where energy demand is high.
- Though solar energy panels' prices have seen a drastic reduction in the past years, and are still falling, nonetheless, solar photovoltaic panels are one of major renewable energy systems that are promoted through government subsidy funding (FITs, tax credits etc.); thus financial incentive for PV panels make solar energy panels an attractive investment alternative.
- Residential solar panels are easy to install on rooftops or on the ground without any interference to residential lifestyle.

V. Disadvantages of PV System

- As in all renewable energy sources, solar energy has intermittency issues; not shining at night but also during daytime there may be cloudy or rainy weather.
- Consequently, intermittency and unpredictability of solar energy makes solar energy panels less reliable a solution.
- Solar energy panels require additional equipment (inverters) to convert direct electricity (DC) to alternating electricity (AC) in order to be used on the power network.
- For a continuous supply of electric power, especially for on-grid connections, Photovoltaic panels require not only Inverters but also storage batteries; thus increasing the investment cost for PV panels considerably
- In case of land-mounted PV panel installations, they require relatively large areas for deployment; usually the land space is committed for this purpose for a period of 15-20 years – or even longer.
- Solar panels efficiency levels are relatively low (between 14%-25%) compared to the efficiency levels of other renewable energy systems.
- Though PV panels have no considerable maintenance or operating costs, they are fragile and can be damaged relatively easily; additional insurance costs are therefore of ultimate importance to safeguard a PV investment.

VI. Importance of PV system

- Electricity is essential to every society and economy in our world. With growing populations and expanding economies the need for electricity is increasing worldwide. Unfortunately much of the world's electricity generation depends upon burning fossil fuels. In the 20th century the use of fossil fuels increased by ten times. Fossils fuels now provide about 90% Of the world's commercial energy needs. Much of the world's transportation also depends on fossil fuels. These uses of fossil fuels have helped increase the worldwide emission of greenhouse gases. There is a shift taking place around the world to reduce greenhouse gas emissions in the production of electricity. Some power companies and governments are beginning to introduce renewable energy sources to

- Replace fossil fuels in the production of electricity. Electricity generated by PV systems is one of these renewable energies and it does not produce greenhouse gases. In addition to this, oil and gas reserves that are easy to access are becoming harder to find. As these fuels become more expensive, other kinds of fuels will become increasingly important. Because solar energy is clean, safe and renewable, it is being used more than ever before. As more research into PV technology is done, new kinds of PV systems should become less expensive, more efficient, and used in new ways. These changes will mean PV technology becomes more widely used.

VII. Application of PV system

For irrigation in agriculture as a power source, it can first be used. In health care solar panels can be used to refrigerate medical supplies. It can also be used for infrastructure. PV modules are used in photovoltaic systems and include a large variety of electric devices:

- Photovoltaic power stations
- Solar vehicles
- Rooftop solar PV systems
- Standalone PV systems
- Solar hybrid power systems
- Concentrated photovoltaic
- Solar planes
- Solar-pumped lasers

Fig 7. Rooftop solar PV systems

VIII. Types of PV system

1) Grid connected PV
a) Large scale production (without Battery)
b) With battery (smart grid concept)2) Off grid PV system
c) With battery (e.g. for houses and industries)
d) Without battery (PV water pump)
3) Hybrid PV system
a) Wind PV Hybrid system
b) PV diesel hybrid system
4) PV base utilities

- Solar land, solar mobile charger etc.

IX. Conclusion

- It is best to use for electricity generation.
- It is a best technique to utilize renewable energy.
- It's a benefit to optimize the consumption of energy.

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