Analysis of Atmospheric Conditions on the Performance of Solar Energy System in MP

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***Abstract*—the most abundant and most environmentally friendly renewable energy source is solar power. For example, modern system may be used to generate power, provide light, and heat water for home as well as commercial and industrial purposes. Renewable energy is projected to meet a significant portion of the future needs in India. With solar energy being abundantly available in most part of the country, grid connected solar power plants are assuming increasing importance. Energy fed into grid by a solar power plant depends upon seasonal variation of the solar resources, system losses, and losses due to condition of the grid. This paper presents performance analysis of solar power plant installed in Madhya Pradesh. Daily and seasonal variation in the solar power plant output is shown using monitored data, the SPV generation in relation to load duration curve of substation is observed.**

***Index Terms*—Solar Energy, Atmospheric Condition, Madhya Pradesh, Power Plant, Renewable Energy.**

I. INTRODUCTION:

Solar energy is the largest renewable energy source on the earth. Therefore, solar photovoltaic (PV) energy conversion is potentially the largest and most widely used system as compared to other renewable energy technologies. It significantly reduces the negative environmental, economic, and health aspects of anthropogenic climate change through reductions of greenhouse gas emissions. Although PV energy system is becoming much more economically competitive with electricity from conventional sources in many countries, economic aspect is still the main barrier to exploitation of this source of energy while remaining within the necessary physical limits of life cycle carbon emissions. In this context, optimization of the electrical output on a per cost basis is important to speed up the diffusion of solar PV technologies [11].

II. SYSTEM FOR SOLAR POWE PLANT:

Solar power generation technologies can be broadly classified into two broad categories:

- **Solar Photovoltaic technologies**
- **Solar thermal power plants**

Solar Photovoltaic (SPV) technologies:

Photovoltaic converters are semiconductor devices that convert part of the incident solar radiation directly into electrical energy. The most common PV cells are made from single crystal silicon but there are many variations in cell material, design and methods of manufacture. Solar PV cells are available as crystalline silicon, amorphous silicon cells such as Cadmium Telluride (Cd-Te), Copper Indium diselenide, and copper indium gallium diselenide (CIGS), dye sensitised solar cells DSSC and other newer technologies such as silicon nano particle ink, carbon nanotube CNT and quantum dots. Crystalline silicon (c-Si) modules represent 85-90% of the global annual market today. C-Si modules are subdivided in two main categories: i) single crystalline (sc-Si) and ii) multi-crystalline (mc-Si) [12].

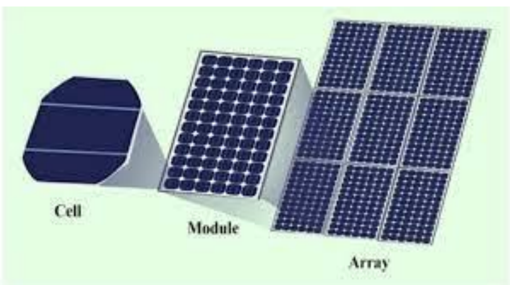

Fig: 1. Solar Photovoltaic (SPV) technologies

Solar thermal power plants:

Solar thermal power plants produce electricity by converting the solar radiation into high temperature heat using mirrors and reflectors. The collectors are referred to as the solar-field. This energy is used to heat a working fluid and produce steam. Steam is then used to rotate a turbine or power an engine to drive a generator and produce electricity. Solar thermal power plants are electricity generation plants that utilize energy from the Sun to heat a fluid to a high temperature.

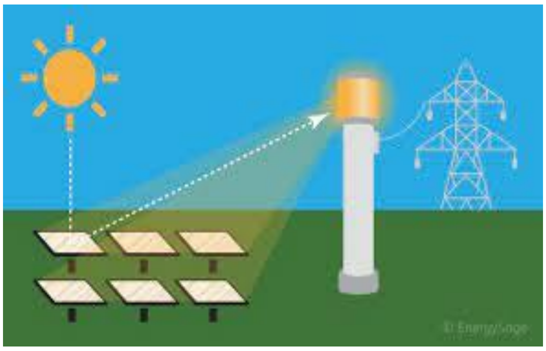

Fig: 2. solar thermal power plants

III. PERFORMANCE OF SOLAR POWER PLANTS:

The performance of solar power plants is best defined by the Capacity Utilization Factor (CUF), which is the ratio of the actual electricity output from the plant, to the maximum possible output during the year. The performance of the power plant system however depends on several Parameters including the site location, solar insolation levels, climatic conditions specially temperature, technical losses in cabling, module mismatch, soiling losses, transformer losses and the inverter losses [8].

There could also be losses due to grid unavailability and the module degradation through aging. Some of these are specified by the manufacturer, such as the dependence of power output on temperature, known as temperature coefficient.

The following factors are considered key performance indicators:

1. Radiation at the site
2. Losses in PV systems
3. Temperature and climatic conditions
4. Design parameters of the plant
5. Inverter efficiency

IV. DEFINITIONS AND TERMINOLOGY:

Beam Radiation – solar radiation received from the Sun without being scattered by the atmosphere and propagating along the line joining the receiving surface and the sun. It is also referred as direct radiation. It is measured by a pyrehiliometer [6].

***Diffuse Radiation* –** the solar radiation received from the Sun after its direction has been changed due to scattering by the atmosphere. It does not have a unique direction and also does not follow the fundamental principles of optics. It is measured by shading pyrenometer.

***Total Solar Radiation* –** the sum of beam and diffused radiation on a surface. The most common measurements of solar radiation is total radiation on a horizontal surface often referred to as 'global radiation' on the surface. It is measured by pyrenometer.

***Irradiance (W/m2)* –** the rate at which incident energy is incident on a surface of unit area. The symbol G is used to denote irradiation.

Irradiation (J/m2) – the incident energy per unit area on a surface, found by integration of irradiation over a specified time, usually an hour (I) or a day (H). Solar Constant - The solar constant is the amount of incoming solar radiation per unit area, measured at the outer surface of Earth's atmosphere, in a plane perpendicular to the rays

Direct Normal Insolation (DNI) - It is the direct component of the solar radiation incident normal to the collector; that is, the angle of incidence of solar radiation with the normal of the collector is zero throughout the day.

V. HOW VARYING WEATHER CONDITIONS CAN AFFECT THE PERFORMANCE OF SOLAR PV CELL:

Cloudy Environment:

Solar panels in overcast weather are less productive than on bright days since they rely on solar radiation to work. The amount of cloud cover affects the output of a solar panel on a cloudy day.

Cirrocumulus or thin sheet-like clouds, for example, may not harm solar panels. When it's overcast, even the most efficient solar panels lose 10 to 25 % of their efficiency.

Instead of seeming horrible, rainy days may really be rather pleasant. The panels' output might be impaired if they become dirty over time. The dirt may be washed away by rainwater, which reduces the need for upkeep [13].

Snowy Environment:

PV cells can be adversely affected by a high covering of snow, however even with a thin layer of snow; some sunlight can still reach the panels. The construction of a new roof is often done in such a way that snow just rolls off of it. The increased quantity of solar energy created by a snow-covered home is unexpected because of the snow's reflecting characteristics. Because of this, more radiation penetrates solar panels throughout the winter.

Extreme Temperatures:

It's a frequent belief that greater temperatures will make solar panels more efficient. This is not the case. Temperatures lower than 80 degrees Fahrenheit are better for solar panels. When the temperature goes above a specific level, the voltage drops. To put it another way, solar panels are more efficient when it's chilly and sunny outside.

Windy Environment:

Unfortunately, even though current panels can withstand gusts of up to 90 mph, poorly built panels may have a lower wind resistance than the more modern ones. Even if the system fails, the panels are rarely the limiting issue.

Problems with the racking system or the roof on which the solar panels are installed are frequently to blame. In windy situations, the panels may also be damaged by dust and other flying debris. The vast majority of solar panels, on the other hand, are built to resist even the most extreme weather conditions.

Lightning:

Damage or destruction of solar panels and inverters can occur as a result of lightning striking them. Direct lightning hits, for example, have the potential to melt the panels. Indirect lightning strikes, which are more common than direct strikes, can harm several components of the system. Lightning insurance may be a good idea if you reside in a region prone to lightning strikes.

To keep the solar power plant safe from lightning, Genus has installed a lightning arrestor. Despite adverse weather conditions, solar panels are becoming more durable and productive because to technological advancements. Clients must first learn about their own location before making any judgments about which panel to select.

VI. WHY IN MADHYA PRADESH?

1. Madhya Pradesh is one of the largest powers consuming States in India with a peak demand of nearly 8 GW and a peak deficit of close to 10 per cent.
2. Madhya Pradesh is a neighbor to both Rajasthan and Gujarat — States with the highest solar irradiation and the largest areas of arid lands. Offers good sites having potential of more than 5.5 to 5.8kWh/sq
3. The State’s demand for solar power is expected to rise to 400 MW by 2016
4. As per MPERC regulations 2008, RPO has been specified as 3.2% for cogeneration and other sources for FY-2019 -20 and 2020 -21.
5. Purchase of electricity from solar projects to form part of 3.2% subject to any amendments/ regulations of MPERC 10-year exemption in electricity fee, four per cent subsidy by the state government in the wheeling charges, banking of generated power and exemption as per rules in VAT and entry tax, among others.

VII. COMPARISON OF ATMOSPHERIC EFFECT OF SOLAR ENERGY SYSTEM:

S.N	Impacts–burdens	Alleviation techniques
01	Solar thermal heating Visual impact on buildings’ aesthetics	Adoption of standards and regulations for environmentally friendly design; Good installation practices; Improved integration of solar systems in buildings; Avoid siting of solar panels on buildings of historic interest or in conservation areas.
02	Routine & accidental releases of chemicals	Recycling of the used chemicals; Good practices—appropriate disposal.
03	Land use	Proper siting and design.
04	Photovoltaic power generation Land use: large areas are required for central systems.	Use in isolated and deserted areas; Avoidance of ecologically and archeologically sensitive areas; Integration in large commercial buildings (facades, roofs); Use as sound isolation in highways or near hospitals.
05	Visual intrusion—aesthetics	Careful design of systems; Integration in buildings as architectural elements;

		Use of panels in modern architecture instead of mirrors onto the facade of buildings.
06	Impact on ecosystems (applicable to large PV schemes).	Avoidance of sensitive ecosystems and areas of natural beauty, archaeo logical sites.
07	Use of toxic and flammable materials (during construction Of the modules).	Avoidance of release of potentially toxic and hazardous materials with the adoption Of existing safety regulations and good practice.

Table: 1. Comparison of Atmospheric Effect of Solar Energy System.

VIII. CONCLUSIONS:

Solar energy is the most plentiful renewable energy source accessible, and in most places of the world, its theoretical potential is much in excess of the present primary energy supply in such locations, physically speaking, Energy availability in rural and isolated areas, long-term energy security, and greenhouse gas abatement are all possible outcomes of solar energy system.

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