A Review on Impact of Solar Irradiation on Performance of PV System

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Abstract- In this paper, the impact of the non-uniform irradiance on the performance of the photovoltaic system and the characteristics of the photovoltaic system has been studied. India is considering renewable energy resources like solar and wind as alternative for future energy needs. To accommodate this target solar photovoltaic system is being widely used all over the country. There are various technical and non-technical challenges in the installation and operation of the photovoltaic system. The performance of a photovoltaic module is mostly affected by array configuration, irradiance, and module temperature. For a safe and better life of all human beings on this planet new, clean and renewable sources of energy and related technologies are being sought, developed and implemented worldwide. It is most important to understand the relationship between these effects and output parameters of the photovoltaic system. As the solar irradiance is not uniform throughout the year at every location, so it is important to study the behavior of a photovoltaic system during non-uniform conditions. This paper incorporates the impact of the four major parameters such as isolation, temperature, partial shading and tilt angle.

I. INTRODUCTION

Among solar, wind, rain, tides, waves and geothermal heat sources of renewable energy, solar energy utilization is growing fastest due to its advantage of requirement of less time and space for installation and thus provides highest annual return on investment in industries as well residential. Solar energy is one of the green energy sources which can play an important role in the program of reducing green house gas emissions. Although, the PV technology is expensive, it is receiving strong encouragement through various incentive programs globally. As a result, large scale solar farms are being connected to the grid. Transmission grids worldwide are presently facing challenges in integrating such large scale renewable systems (wind farms and solar farms) due to their limited power transmission capacity. Today, we are mostly dependent on non-renewable energy that have been and will continue to be a major cause of pollution and other environmental degradation. Finding the sustainable alternative is becoming increasingly urgent because of these problems and the dwindling supply of petroleum. Perhaps, the greatest challenge is in devising a sustainable future, which relies on integration and control of renewable energy sources in grid distributed generation. After hydro and wind power, Solar Photo Voltaic is third most important renewable energy sources in terms of globally installed capacity.

Solar Photovoltaic is a system which uses solar panels for converting solar energy to electrical energy .These solar panels consist of photovoltaic cells (also sometimes called as solar cells).PV cell is similar to a PN junction diode .PV (photo voltaic) cells are made up of semiconductor materials which exhibit the photovoltaic effect by virtue of which solar energy is converted into direct current electrical energy. Photovoltaic effect is a phenomenon in which electrons are excited into a higher state of energy by photons of light due to which these electrons act as a charge carrier for the flow of current. Properly chosen renewable power sources will considerably reduce the need for fossil fuel leading to an increase in the sustainability of power supply. At the same time, conventional power source aids the renewable sources in hard environmental condition, which improves the reliability of the electrical system. Renewable energy sources are environment friendly and produce little carbon emission to the atmosphere thus by promoting the use of renewable sources like wind, solar, micro hydro global warming could be reduced. With the spurt in the use of renewable energy resources, PV power generation is being employed in many applications. Some operating conditions result in non-uniform irradiance of PV array, such as shadows, clouds, dirt, debris, different tilt and orientation. If several cell in series PV module are mismatched due to non-uniform irradiance, these cell will limit the output current of the normal cells, this leads to the decrease of the output power even generate hot spot and cause damage to the cells.

Nowadays, renewable energy is getting very much concern in various applications. So far there are many types of renewable sources. Out of which solar energy is gaining more attention. Earlier a single junction solar cell was used. But today multi-junction solar cell is being employed in many areas. This has further extended the uses of photo-voltaic systems. The most important thing to keep in mind while working with the solar modules is its efficiency that can be maximized using various MPPT techniques. The various MPPT techniques are perturbation and observer, incremental conductance, etc. Each of the techniques is granted with merits and demerits. Despite of various merits of PV system, it has demerits also. One of them is the low out-put power which can be further boosted by using a converter. But the out-put of the converter will be DC which can be further converted to an AC by using a suitable inverter. Then this AC power can be utilized in many fields especially in induction motor drives.

Nowadays, solar energy is one of the promising sources of energy that is gaining a lot of attention worldwide. Owing to its high efficiency, eco-friendly behavior, low maintenance, etc it is bridging gap between supply and demand very rapidly.

With increase in temperature the output voltage of the PV module decreases because of p-n junction voltage temperature dependence. PV array which is exposed to the uniform solar irradiance shows the non-linear *P-V* characteristic. Nevertheless, the P-V characteristic becomes more complex with multiple maximum power points (MPP) when the array is operated under partially shaded condition. PV arrays are used in many terrestrial applications. It exhibits a non-linear I-V characteristic which electrical energy production is depending on typical conditions such as solar irradiance and temperature**.** The performance of a PV array is affected by temperature, solar isolation, shading, and array configuration. Often, the PV arrays get shadowed, completely or partially, by the passing clouds, neighboring buildings and towers, trees, and utility and telephone poles. The situation is of particular interest in case of large PV installations such as those used in distributed power generation schemes. Under partially shaded conditions, the PV characteristics get more complex with multiple peaks. Yet, it is very important to understand and predict them in order to extract the maximum possible power. It is clear that output or the performance of the PV system change with change in various technical and non technical parameters. So, this motivation leads to the basis of this thesis in which the impact of various parameters is considered and analyze using MATLAB and fuzzy toolbox, and the corresponding output is presented in graphical and tabular form. PV system is such a system which is capable of converting sunlight to electricity. It is the basic device of PV system. A semiconductor diode whose PN junction is exposed to light is a photovoltaic cell. Such cells are composed of thin layer of thin or bulk silicon film connected to electrical terminals. PN junction is formed by doping one of the sides of silicon layer.

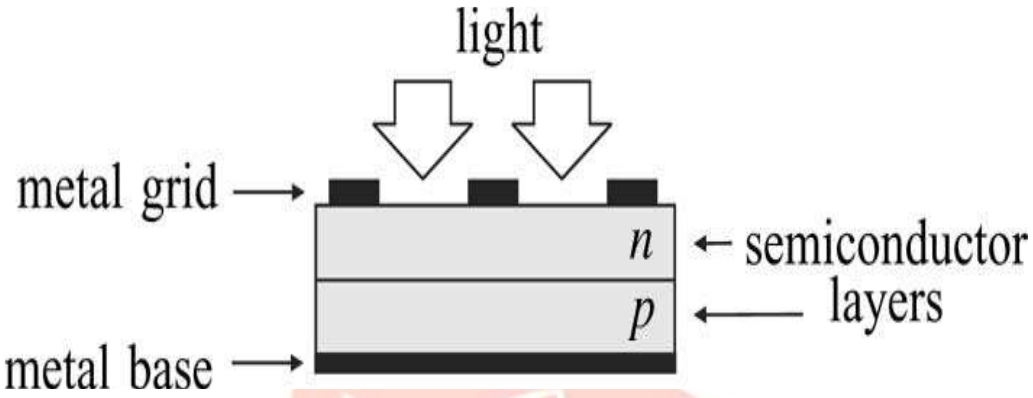

Figure1: Physical structure of a PV cell.

If the cell is short-circuited, charge carriers are generated by incidence of light which in turn originates electric current. Charge generation is possible only when energy of incident photon is sufficient enough to detach the covalent electrons of semiconductor. It is based on two factors viz. Semiconductor material and wavelength of incident light. The Absorption capacity of solar radiations and generation of free carriers at pn junction play a main role in pv phenomenon.

II. LITERATURE SURVEY

[1] This paper, improve the conversion efficiency and other performance parameters to reduce the cost of commercial solar cells and modules. The secondary goal is to significantly improve manufacturing yields while reducing the energy consumption and manufacturing costs and reducing the impurities and defects. This is achieved by improving our fundamental understanding of the basic physics of PV cells. The continuing development efforts to produce more efficient low-cost cells have resulted in various types of PV technologies available in the market today in terms of the conversion efficiency and the module cost.

[2] This paper is based on two diode model. To reduce the computational time, the input parameters are reduced as the values of series and parallel resistance are estimated by iteration method. The results obtained through simulation have been compared with the datasheets of the manufacturer for the final validation. It has been found that the simulation waveforms are in conformity with the waveforms obtained through the manufacturer data sheets.

[3] This paper is based on one diode model with unique step-by-step procedure for the simulation of photovoltaic module. It has been found that the mathematical modeling procedure helps in the closer understanding of I-V and P-V characteristics of PV module.

[4] Discussed about the modeling of one diode which is based on solar radiation and temperature of the system. The results obtained through the simulation have been compared with the data sheets of the manufacturer for final validation. It has been found that the simulation waveforms are in conformity with the waveforms obtained through the manufacturer data sheets

[5] Discussed about the 120W PV array simulation based on the two diode model. These models are implemented in the MATLAB through programming using a flowchart. The results obtained through simulation have been compared with the datasheets of the manufacturer for the final validation. It has been found that the simulation waveforms are in conformity with the waveforms obtained through the manufacturer data sheets.

[6] MPPT control rules are created based on a prediction line that associates the MPP and the optimum current. One of its parameter (voltage coefficient) should be acquired through the hill-climbing method, which makes it commercially impractical.

[7] Extend the previous analog RCC technique to the digital domain for MPP tracking. The proposed digital implementation is less expensive, more flexible, and more robust. Similar to analog RCC method, the inductive and capacitive parasitic components may have a significant impact on the ability of RCC to drive the system toward the true MPPT.

[8] Proposed analysis of pv hydro isolated power systems. The analysis in this paper is done by using mat lab /Simulink. The simulation results it is found that pv Hydro-Battery energy storage system performs efficiently under different dynamic conditions, maintaining voltage & frequency within the limits.

[9] This paper introduces a generalized multi-dimension diode PV model which can be used to select the most suitable dimension for a particular PV cell technology. The results confirm that the single diode PV model is suitable for the multi-crystalline and mono-crystalline PV modules. For the thin film PV module, a multi-dimension diode PV model is required to achieve a low modeling error.

III. CONCLUSION

In this paper, features and characteristics of photovoltaic systems have been studied and also discussed the impact of the non-uniform irradiance on the performance of the PV system. This paper presents the behavior of a photovoltaic system during non-uniform conditions. This paper includes the impact of the four major parameters such as isolation, temperature, partial shading and tilt angle.

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