IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Recent Trends in Solar Photovoltaics with Implementation of MATLAB/ Simulink

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Abstract:Sources of energy have been decreasing and becoming exhausted in recent years. Solar Photovoltaic (PV) systems are utilized in place of this because of their free availability, renewability, and low running costs. However, limitations like as poor efficiency and reliance on weather conditions can be solved by employing maximum power point tracking (MPPT) algorithms and efficient converters to generate the greatest power output. PV arrays, MPPT algorithms, and converters are all modeled and analyzed using MATLAB/Simuiink. Recent research advancements in PV arrays, various MPPT algorithms, and numerous efficient Converters are described in this study. The purpose of this study is to provide an overview of current research developments in the market of solar photovoltaic systems.

Index Terms**Environmental Effects, MPPT, Materials, Simulation.**

I. INTRODUCTION

Energy is important to current culture. Energy consumption per capita can be used as a measure of progress. The United States, Canada, and a few European countries have the highest numbers. Energy consumption is decreasing in industrialized and developing countries. Even the social progress index has a reasonable relationship with energy use. As a result, energy has become synonymous with development and social advancement. Programs for energy generation are never able to meet the targets established by development plans. On the other hand, generating energy from traditional sources has its own set of issues, such as air pollution and environmental risks. Furthermore, traditional power generation technologies rely on fossil fuels like coal and oil. Slow chemical changes lasting millions of years generated both coal and oil in nature. Their supply is finite.[9]

The majority of developing countries have shifted their focus to non-conventional, renewable energy sources. Solar energy harvesting is at the forefront of these endeavours. This is due to its abundance, inexhaustibility, and lack of pollution. With the discovery of the photoelectric effect, science has solved the energy dilemma. We don't need to go elsewhere for energy as long as the sun shines. Converting science into technology is the issue that needs to be addressed. The amount of solar energy received by the globe is far greater than what we require. Inadequacies in the conversion devices are to blame for the limitations. The quantity of solar energy that reaches the planet, for example, is 1.75 1017 W, far more than is required for civilisation. With a 10 percent efficiency, solar radiation falling on only 0.1 percent of the earth's surface can meet the entire world's energy needs. 1 In terms of photovoltaic (PV) conversion, it is estimated that "our energy need can be met by covering only 0.4 percent of the earth's surface with photovoltaic (PV) panels with a 15 percent efficiency. From 2 megawatts to megawatts. If interplanetary solar energy is 1367 W/m2 (the value when the Earth–Sun distance is 1 AU), direct sunlight at the Earth's surface when the Sun is at its zenith is about 1050 W/m2, but the total quantity (direct and indirect from the atmosphere) striking the ground is around 1120 W/m2. There is a direct transformation in photovoltaics that converts sunlight into electricity without the use of any moving components. It is a vast source of energy. The PV components are simple to construct, and it is the only system that can produce output ranging from micro- to megawatts."[10]

II. SOLAR CELL MANUFACTURING MATERIALS:

The materials used in the formation and development of solar cells are another important component that influences their efficiency and cost-effectiveness. "Crystalline silicon PV cells are the most prevalent solar cells used in commercially available solar panels, accounting for more than 85 percent of world PV cell market sales in 2011," according to the Department of Energy. Laboratory energy conversion efficiency for crystalline silicon PV cells are over 25% for single-crystal cells and over 20% for multicrystalline cells" (Department of

Energy). In terms of energy conversion efficiency, crystalline silicon cells are neither superior nor inferior, but there are other aspects to consider when deciding which materials to utilise in a solar cell, particularly when marketing to consumers outside the United States.[14]

The second most abundant material in the Earth's crust is crystalline silicon, which is separated into two purities: monocrystalline silicon and polycrystalline silicon. "The more pure silicon is," says Mathias Maehlum, an energy and environmental engineer.

The most common material used in solar cells is crystalline silicon. Crystalline silicon cells have a life expectancy of over 25 years without degeneration, making them excellent for industrial solar power generation. It has the highest energy conversion efficiency of all the currently mass-produced panels, up to 22%. Crystalline silicon is coated with substances like silicon nitride or titanium dioxide to boost efficiency even more by minimising reflected light.[17]

The more exactly aligned the silicon molecules are, the better the solar cell's conversion of solar radiation to electricity will be" (Maehlum, 2015). Monocrystalline silicon typically has a 5% better efficiency than polycrystalline silicon, but at a higher cost. Monocrystalline silicon is more expensive to create than polycrystalline silicon because it has a more precisely aligned molecular structure, but it is a more viable alternative to fossil fuels.

Silicon that lacks a crystalline structure is known as amorphous silicon. It's used to make a thin-film solar cell, which can be found in small solar panels like those seen on calculators or in solar panels used to power private homes. Vapour deposition of silicon in a very thin film (about 1m) onto a metal or glass frame is used to make the cells. Due to deterioration of the material when first exposed to sunlight, amorphous silicon solar panels only have a 7 percent efficiency

In recent years, gallium arsenide (GaAs) has gained in prominence as a solar panel semiconductor. Gallium and arsenic are mixed together in this chemical. It works well as a semiconductor and yields a lot of energy for a small amount of material. It has a 1.49 eV bandgap, which is higher than silicon. However, there are two major disadvantages: first, gallium is more scarce than gold and hence more expensive, and second, arsenic is poisonous, posing a safety risk when producing solar cells.[5]

III. PHOTOVOLTAIC (PV) GROWTH

The PV business has experienced strong growth over the last few years, and estimates indicate that this trend will continue. According to a recent analysis from the Fraunhofer Institute for Solar Energy Systems (ISE), global PV installations grew at a compound annual growth rate of 40% between 2010 and 2016, making it a very fast-growing market.

Europe continues to lead the way in terms of overall PV installations, accounting for 33% of the world total in 2016, with China accounting for 26%. Germany, in particular, has embraced the technology, accounting for 13% of global PV energy yield in 2016 and producing 7% of their national energy need through solar energy.

Over the last 25 years, a substantial reduction in the cost of installation has been a primary element driving the rise of global solar energy production. The cost of a typical roof-mount PV system in Germany has dropped from 14,000 €/kWp in 1990 to 1,270 €/kWp in 2016.

The cost reduction has been noticed all around the world, and it is mostly attributable to advances in material efficiency and pricing.

IV. THE UPCOMING DIFFICULTIES:

As the use of solar energy grows around the world, there will be a greater demand for improved efficiency and lower costs. Thankfully, several novel materials are showing signs of promise. Solar cells made on thin-film metal halide perovskites now have a solar cell efficiency of 22.7 percent, and work is underway to improve cell stability. Perovskite solar panels appear to be the material of the future since they have the potential to be less expensive and lighter than silicon. Perovskites and silicon cells have been joined in recent research at MIT and Stanford, resulting in a hybrid that is efficient and perhaps less expensive than typical silicon-only panels. At the moment, several firms are forming to manufacture and sell perovskite-silicon tandem cells, so keep an eye on this arena.[21,22]

V. CONNECTION OF SOLAR PV SYSTEM

Solar Photovoltaic Modules come in sizes ranging from 3 WP to 300 WP. However, we frequently require electricity in the kW to MW range. We need to link N-number of modules in series and parallel to get such a significant power.

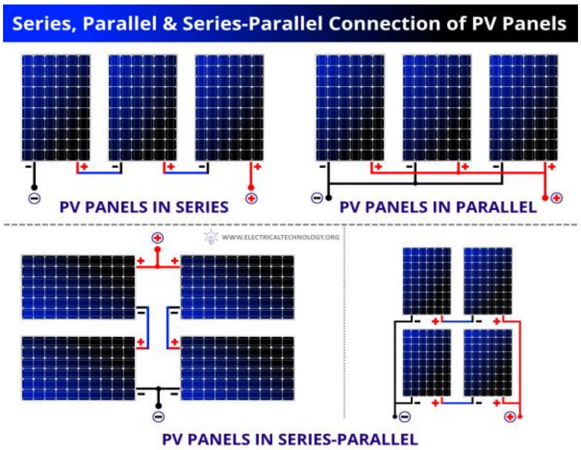

Fig 1 series/parallel connection of solar cell

N-number of PV modules are linked in parallel to enhance the current. The term "Solar Photovoltaic Array" or "PV Module Array" refers to a series and parallel connection of modules. The diagram below displays a solar PV module array coupled in a series-parallel manner.

A power plant's system voltage can sometimes be substantially greater than a single PV module can provide. To supply the needed voltage level, N-number of PV modules are linked in series. PV modules are connected in series in the same way that N-number of cells in a module are connected to achieve the desired voltage level. PV panels are linked in series as seen in the diagram below.[13]

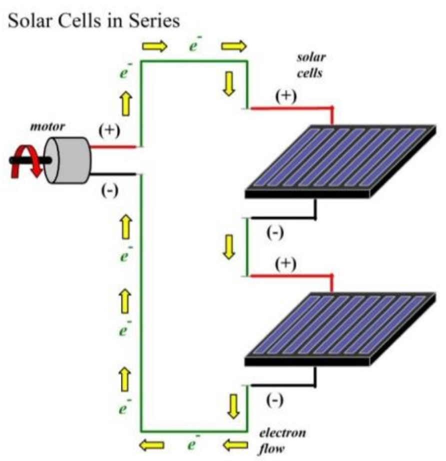

Fig 2 Series connected solar cell

VI. SIMULATION OF SERIES CONNECTED SOLAR CELL & RESULTS

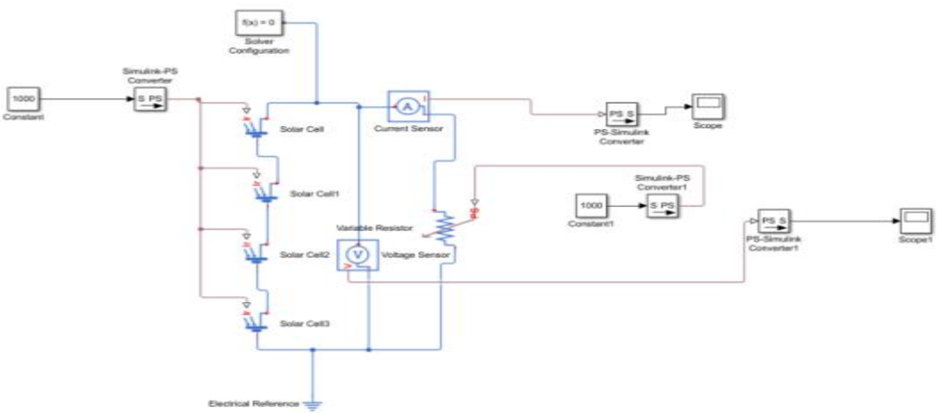

Fig 3 Simulation of solar cells

The Idea presented here describe with the help of MATLAB Simulink. The given circuit was simulated using toolbox sim power system in the simulink and this operation of proposed work done. The solar cell circuit as per our requirement defined in the given fig.() and made in simulink to simulate the condition of PV array.

This simulink model give the output for different parameters of Voc, Isc, Rsc and irradiance the wave form shown in fibg below. The solar cell is a basic block for obtaining PV system it produces about 1W of power. For getting high power cells are connected in series and parallel circuits on a panel. The equivalent circuit characteristic of PV module are generally represented by I-V and P-V curves.

Result shows the I-V and P-V character tics under varying irradiance with constant temperature here the solar irradiance changes with values of 1000, ,100 W/m2 while temperature keeps constant at 25 oc.

Fig 4 simulation result at 100watt irradiance respect to voltage

Fig 5 Simulation Result 100watt irradiance respect to current

When we change the parameters of voltage and current then we see that irradiance also change though this simulation result it is clearly shown that by value of cell temperature we can simulate the parameters at different whether condition. Fig given below shows the results for other conditions of solar cell.

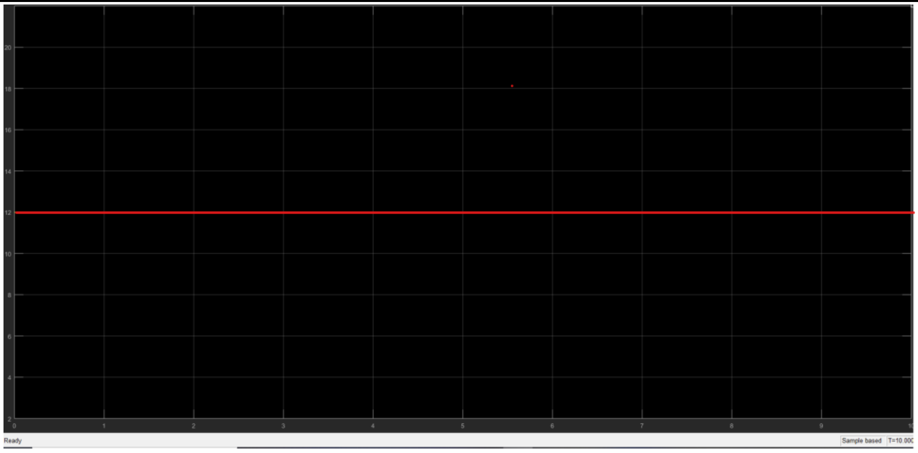

Fig 6 simulation result at 1000watt irradiance respect to voltage

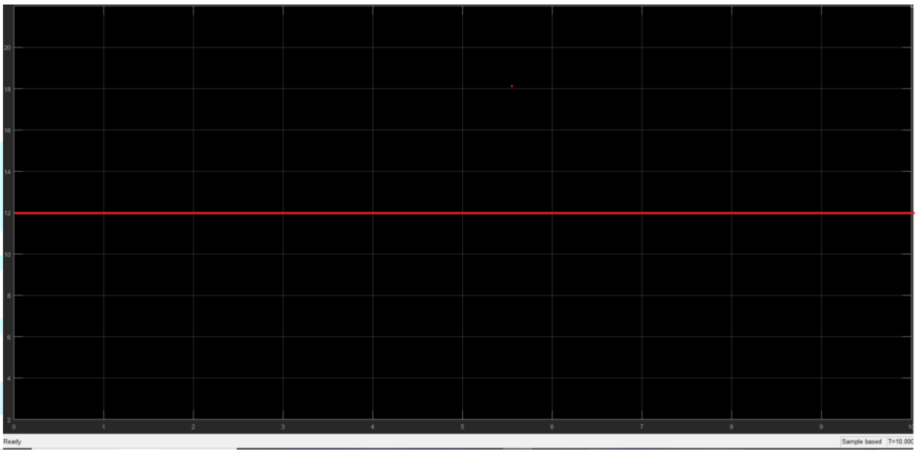

Fig 7 simulation result at 1000watt irradiance respect to current

VII. CONCLUSION

PV research has been spurred for many years by the potential environmental and political benefits of integrating renewable energy, and PV electricity is now becoming the economical alternative for utilities providers. This is an intriguing opportunity to expand PV characterization studies and develop a comprehensive understanding of PV performance and reliability from modules to atoms. PV systems benefit from multi-scale characterization since it allows for a better understanding and targeted improvement. where complementary methodologies are required to discover performance implications originating from specific device layers, components, faults, interfaces, additives, and so on. Additional increases in chemical sensitivity combined with high spatial resolution would be advantageous to the community in further understanding structure-function links between micro/nanoscale composition and semiconductor performance. It's also crucial to make these characterization capabilities more accessible to a broader range of non-specialists in order to achieve a broad understanding through additional statistics. Furthermore, continuing to create non-traditional and outdoor-compatible equipment is critical for lowering the cost of PV electricity while meeting the needs of new users through a variety of materials and technologies.

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