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Solar Energy as Renewable Energy Systems: Perspective and Challenges in Indian Context

Dr. Neeta Saxena
Assistant Professor
Amity University Madhya Pradesh, Gwalior

Abstract: *Energy has always been a most important part of day to day of human life, it is essential for economic and social development of a nation, however fossil flues is the major case of air pollution and climate change. Improving efficiency of energy and de-linking economic development from energy consumption is essential for sustainable development of nation. Energy is required for all the economic activities, supply of energy required for both intermediate product as well as final consumption. The implementation of technologies incorporates with modelling and strategies use to improve energy system gives appropriate amount of energy. At each stage of energy flow technologies are involve with different conversion. In Indian context it is a tropical country, where sunshine is available for longer hours per day and in great intensity. Solar energy, therefore, has great potential as future energy source. Solar Energy is a clean renewable resource with zero emission. With recent developments, solar energy systems are easily available for industrial and domestic use with the added advantage of minimum maintenance. Solar energy could be made financially feasible with government tax incentives and rebates. Most of the developed countries are switching over to solar energy as one of the prime renewable energy source. This study need to find out how the efficiency of photovoltaic cells can be calculated and describe the strategies to improve efficiency of PV cells.*

Key Words: Solar Energy, Efficiency, PV Cells.

Introduction: India is seen as a developing nation however, it is developing at a pace that isn't coordinated by numerous others. We have encountered huge financial development. in any case, the reality remains that our development is obliged by vitality supply and accessibility. Despite the fact that we have seen a moving increment in a introduced limit expansion, from scarcely around 1,350 MW at the season of autonomy (1947) to around 160,000 MW today, more than 90,000 MW of new age limit is required in the following seven years. The increasing appetite for energy that has developed in the recent past has been further complicated by rapidly diminishing conventional sources, like oil and coal. To additionally add to the issues of the expanded request and obliged supply, there are not kidding inquiries regarding seeking after a petroleum product drove development system, particularly with regards to ecological concerns. The test confronting a creating country, for example, our own is to meet our expanding vitality needs while limiting the harm to nature.

There is a pressing need to pick up the pace the development of advanced clean energy technologies in order to address the global challenges of energy security, climate change and sustainable development. Solar Photovoltaic is a key technology option to appreciate the shift to a decarbonised energy supply and is projected to emerge as an attractive alternate electricity source in the future.

Solar power generating systems assimilate daylight and change over it into power that we can utilize. Consistently, the sun sends around 42 trillion kilocalories of vitality to the Earth. On the off chance that we could change over 100% of this sun oriented vitality into power, we could make one year of energy for the whole planet in a single hour. Solar energy is the most powerful of all sustainable power source assets.

India is situated in the equatorial sun belt of the earth, consequently getting inexhaustible luminous energy from the sun. The India Meteorological Department (IMD) keeps up an across the country system of radiation stations which measure sun powered radiation and furthermore the day by day span of daylight. In many parts of India, the clearly identifiable radiant climate is experienced 250 to 300 days a year. The yearly worldwide radiation shifts from 1600 to 2200 kWh/ sq.m. which is similar to radiation got in the tropical and subtropical

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areas. The equal energy potential is around 6,000 million GWh of energy for each year. The most astounding yearly worldwide radiation is gotten in Rajasthan and northern Gujarat. In Rajasthan, expansive regions of land are desolate and inadequately populated, making these territories reasonable as areas for huge focal power stations in light of sunlight based energy.

The National Solar Mission: The Sun is the ultimate source of energy**.** The National Action Plan on Climate Change in June 2008 recognized the improvement of solar energy advancements in the nation as a need thing to be sought after as a National Mission. In November 2009, the Government of India endorsed the Jawaharlal Nehru National Solar Mission. This is a one of a kind and aspiring transformational target that plans to set up India as a worldwide pioneer in solar energy by making the strategy conditions for its dispersion the nation over, as fast as would be prudent. The Mission means to empower 20,000 MW of solar energy to be sent in India by 2022 by giving an empowering approach structure. By utilizing local and remote speculations, this structure will encourage and give the establishment to the private area to partake wholeheartedly and to participate in innovative work (R&D), assembling and arrangement, making this segment universally focused. This is the biggest and the most yearning system of its kind any place on the world. The Mission is innovation nonpartisan, permitting mechanical advancement and economic situations to decide innovation victors. The Mission isn't only an exertion at producing framework associated power. Or maybe, two of its real destinations are to empower R&D and support development, along these lines encouraging framework equality in the cost of sun based power, and to build up India as the worldwide centre point for solar manufacturing. This is what makes it a uniquely ambitious and game-changing programme.

Technology for Solar power plants:

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

•Solar Photovoltaic technologies

•Solar thermal power plants

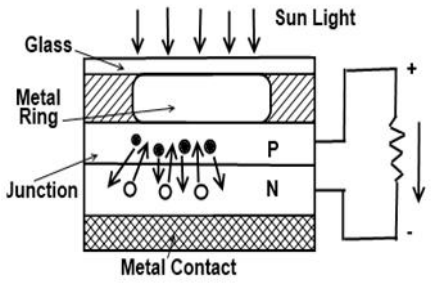
A solar cell, or photovoltaic cell, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon. It is a form of photoelectric cell, defined as a device whose electrical characteristics, such as current, voltage, or resistance, vary when exposed to light. Solar cells are the building blocks of photovoltaic modules, otherwise known as solar panels.

The operation of a photovoltaic (PV) cell requires three basic attributes:

- The absorption of light, generating either electron-hole pairs or exactions.
- The separation of charge carriers of opposite types.
- The separate extraction of those carriers to an external circuit.

Construction-

It essentially consists of a silicon PN junction diode with a glass window on top surface layer of P material is made extremely thin so, that incident light photon’s may easily reach the PN junction.



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Working of solar cell

1) Solar cell works under the principle of photovoltaic effect-when light is incident on 'P-N' junction a potential gets developed across the junction, this potential is capable of driving a current through the circuit.

2) Hence light energy is getting converted to electrical energy.

3) Here electrons absorb photons having energy greater than the band gap energy hence they can make transition from the valence band to the conduction band & hence contributes current.

4) The wavelength of light is given by the relation, $Eg=h=hc/\lambda=1.24$

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.

Wafer-based c-Si		Thin Films		
Mono-Si	Multi-Si	a-Si; a-Si/µc-Si	CdTe	CIS/CIGS
15-20%	15-17%	6-9%	9-11%	10-12%

Table 1: Commercial efficiencies of photovoltaic modules

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).

Thin films currently account for 10% to 15% of global PV module sales. They are subdivided into three main families: i) amorphous (a-Si) and micromorph silicon (a-Si/µc-Si), ii) Cadmium-Telluride (CdTe), and iii) Copper-Indium-Diselenide (CIS) and Copper-Indium-Gallium-Diselenide (CIGS). Emerging technologies encompass advanced thin films and organic cells. The latter are about to enter the market via niche applications. Concentrator technologies (CPV) use an optical concentrator system which focuses solar radiation onto a small high-efficiency cell. CPV technology is currently being tested in pilot applications.

The above technologies are mainly used on roof tops of commercial and residential buildings, and as large scale grid connected power plants. For optimum output, larger installations use tracking devices which change the orientation of the panels to correspond with the trajectory of the sun to focus sunlight directly onto the panels.

Measuring PV Efficiency: Efficiency in photovoltaic solar panels is measured by the ability of a panel to convert sunlight into usable energy for human consumption. In general, a typical efficiency level of PV panels ranges between 12-16%, though recent technological improvements suggest we will soon be talking of efficiencies in the range well above 20%. Knowing the efficiency of a panel is important in order to choose the correct panels for your photovoltaic system. For smaller roofs, more efficient panels are necessary, due to space constraints. The panel efficiency determines the power output of a panel per unit of area. The maximum efficiency of a solar photovoltaic cell is given by the following equation:

$$\mu_{max}\text{ (Maximum efficiency)} = \frac{P_m \quad (M \qquad p \quad o \quad)}{E\,(I \qquad r \qquad fl \quad)*A(A \quad o \; c \qquad)}$$

The incident radiation flux could better be described as the amount of sunlight that hits the earth's surface in W/m^2.

Performance evaluation of Solar 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.

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The assessed yield from the sun oriented control plant relies upon the outline parameters and can be computed, utilizing standard programming projects. Be that as it may, since there are a few factors which add to the last yield from a plant, the CUF differs over a wide range. These could be because of poor choice/nature of boards, derating of modules at higher temperatures, other plan parameters like ohmic loss, climatic factors, for example, delayed cloud cover and fog.

It is essential therefore to list the various factors that contribute to plant output variation. The performance of the power plant however depends on several parameters including parameters including the site area, sunlight based insulations levels, climatic conditions mainly temperature, specialized losses in cabling, module mismatch, dirtying losses, MPPT losses, transformer losses and the inverter losses. There could likewise be losses because of grid inaccessibility and the module debasement 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:

- Radiation at the site
- Losses in PV systems
- Temperature and climatic conditions
- Design parameters of the plant
- Inverter efficiency Module Degradation due to aging

Current Trend in Indian Solar Energy Sector: Solar Power has so far played an almost non-existent role in the Indian energy sector. The grid connected capacity(all PV) in now India stands at 481.48 MW. However, The market is set to grow extensively in the next ten years, driven mainly by rising power demand and prices for fossil fuels, the ambitious National Solar Mission (NSM), Various state level initiatives, renewable energy quotas including solar energy quotas for utilities as well as by falling international technology costs.

Encouraging the spread of solar Power generation (both CSP And PV) And aiming for grid –parity (currently at around RS.5/kWh) by 2022 and parity with Coal power generation (currently at Around RS.4/kWh) by2030, Is a key element In India's comprehensive, Long term Energy strategy. Keeping in view the solar annual insolation, solar power could therefore easily address India's long term power requirements. However, it has to be cost-competitive. As Of December 2011, Solar power generation in India Costs around RS.10/kWh, or over 2.5 Times as much as power from coal. Importantly, it is crucial that the industry receives the right policy support to ensure that projects are executed and performed up to the mark. Jawaharlal Nehru National Solar Mission (JNNSM) will be carried out in three phases and aims to do the following: to create a policy framework for deployment of 20,000 MW by 2022; to add 1,000 MW of grid solar power by 2013, and another 3,000 MW by 2017. The target for 2017 may be higher based on the availability of international finance and technology transfer. The scheme also aims at strengthening indigenous manufacturing capability, and achieving 15 million sq. meters solar thermal collector area by 2017 and 20 million by 2022. One of the steps to achieve this will be to make solar heaters mandatory by incorporating byelaws in the National Building Code. Deployment of 20 million solar lighting systems for rural areas by 2022 is also part of the scheme.

Future growth challenges and limitations of solar in India: The solar industry's structure will rapidly evolve as solar reaches grid parity with conventional power. Solar will be seen more as a viable energy source, not just as an alternative to other renewable sources but also to a significant proportion of conventional grid power. The testing and refinement of off-grid and rooftop solar models in the seed phase will help lead to the explosive growth of this segment in the growth phase. Global prices for photovoltaic (PV) modules are dropping, reducing the overall cost of generating solar power. In India, this led to a steep decline in the winning bids for JNNSM projects. With average prices of 15 to 17 percents per kilowatt hour (kWh), solar costs in India are already among the worlds lowest. According to one estimates, the combination of electricity demand growth, fossil fuel cost and availability challenges, and supportive environmental regulations could increase solar power capacity to more than 50 GW by 2022. In order for the India solar

energy sector to report substantial growth, the following steps are recommended basing on the analysis of the information collected in this study:

- Careful Implementation of On-Grid Application.
- Development of Mini Grids that are Localized.
- Emphasis on R&D activities by setting up research centres and financing the initiatives.
- Closer industry government corporation should be built.
- Government should improve the current financing structure, arrangements and models in order to encourage the use of PV products and spur industry growth.
- Consumer awareness regarding solar power should be improved including its usage and economics.

Conclusion: The fossil fuels presently meet the all global energy needs to some extent. These Fossil Fuels need replacement by renewable energy sources in the view of their depletion rates and emission legislation. The usage of renewable energy sources can cut the pollutant emissions into the atmosphere. The sun is about 1.4 million km in diameter and 150 million km from the earth. It is close to 5500°C at its surface and emits radiation at a rate of 3.8 × 1023kW. This power is due to nuclear fusion reactions near itscore going to continue for several billion years. Exploration of solar energy plays a vital role in developed and developing countries like India where the energy problem is very serious, despite of discoveries of oil and gas off the west coast. Importance of crude oil continuous to increase and the price paid for all other expenditure. India being a master in the sector of solar energy needs more development. Installation of Photo Voltaic (PV) systems solely for remote sites has expanded to include rural economic development. A major benefit of solar thermal power is that it has little adversative environmental impact, with none of the polluting emissions or safety concerns associated with conventional generation technologies.

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