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Article in *Journal of Advanced Research in Dynamical and Control Systems* · July 2020

DOI: 10.5373/JARDCS/V12SP7/20202439

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# Prevalent Glitches in Generation of Solar Power Using PV Panels - An Indian Scenario

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**Abstract---** There is a promising opportunity for the sustainable growth of solar power in our nation. The distinctive energy from sun received by the earth for one year is only about five thousand trillion kilowatt-hour. It is perceived that mainstream of those areas get 4-7 kWh/m<sup>2</sup> for every 24 hours. The accessible solar energy can be pragmatically used to warm system/space heating and even to structure electrical energy by means of solar-thermal and solar-photovoltaics. Besides, there is a massive prospective to proliferate the photovoltaic power in our country. The admiring quality of solar is that it can as well be manufactured as distributed power, which agrees for adding on to the standing capacity within a short extent of time. Electrifying the rural regions can be well implemented via solar distributed power and it is applied for heating and cooling of villages, communities, townships and metropolitan areas in addition to the supply of electricity. The solar is ultimately safer than other modes of generating electrical power. Rather, even a tiny portion of collected solar energy may feasibly oblige the needs of the entire nation though it allude to concrete intricacies. Thermal power manufacturing is widely applied in the present-day Indian condition using coal as base material because of its economic aspects. By the long-term and persistent research work and introduction of new-fangled skills, solar energy can be produced at considerably minimum cost. This paper projects the principal challenges/barricades in attaining solar power in India, predominantly through photovoltaics, which could help as a valuable guidance for the solar engineers and lay concrete on the way of fetching the solar electric power and other applications appropriately.

**Keywords---** Photovoltaic, Solar Electrification, Rural Electrification, Thermal Power Generation, Challenges, Distributed Power.

## I. Introduction

The fluctuating way of life with prompt industrial development has made electrical energy a crucial and vital service over the centuries [1]. In the course of the most recent decades, growing expenses of electricity with collective demand and diminishing fossil fuel reserves have elevated several concerns for strategy makers, stakeholders, and clients. Furthermore, existing system of supply carries out a challenge of carbon imprint because of its requirement on coal, oil and gas for generating electric energy. To get rid of this concern, the strategical planners across the globe have been considering for some viable and realistic sources of alternate energy for producing and supplying the electric power/energy [2]. The varied options include hydro, geothermal, tidal, wind, biogas, biomass, solar etc. Still, solar energy is preferred as a better option as per the preceding studies since it is spontaneously available and clean [3]. Various decision makers have formed a favourable atmosphere for solar and wind based schemes and hence there is an appreciable response from clients [4]. This literature highlights the progress of electricity production through solar scheme, which may be grid linked and grid isolated.

The progress of solar energy is noteworthy because of industrial developments with subsequent decrease in cost and subsidiary strategies introduced by the Indian government to cultivate and use unpolluted and renewable energy. The existing trends either emphasizes on the Concentrated Solar Power (CSP) or PV systems at a large scale feeding to power grids [5]. The quick spreading out of market supplying solar power/energy is mainly because of the instability of conventional fuel charges, ecological hazards involved with the fossil fuels and the associated greenhouse gas effects.

**A. Solar Photovoltaic Systems**

The solar-photovoltaic are also termed as PV or solar cells. These devices are made of semiconductors and they change heat energy of sun or solar radiation as electric energy. A PV structure comprises of group of photovoltaic cells arranged as a module along with peripheral components [6]. According to the installation style, these plants may be categorized as stand-alone model and grid linked model. In the former, the plants are not usually associated to regular grids of electricity and they serve loads of small magnitude like street lighting or they are meant for fulfilling the needs of rural houses where the grid is not near. In the latter, the plant is immediately connected to the existing grid nearby after converting the DC generated power into AC through suitable inverters [7]. Usually, the PV installations are assigned by the maximum power, which is known as peak watt (Wp) [8]. Based on the locality and the number of houses served, four different ranges can be specified Viz. Small (3 kWp, up to 5 kWp), Medium (5 kWp, up to 100 kWp), Big (100 kWp, up to 1MWp) and Huge (1 MWp to 50 MWp). The chief components of PV plants include the following:

1. PV modules for fabricating electric energy by means of the energy of sun
2. Inverters to alter the DC power into AC
3. Battery to stockpile the energy,
4. Transformer to vary the voltage to adjustable transmission/distribution level
5. Utility meter for turning back between solar and regular supply
6. Charge controller to regulate the degree of charging and to guard the batteries from surplus charging.

**B. Use of Renewable Energy – Projected**

The international renewable energy agency (IREA) has made a rigorous investigation with respect to alternate energy prospect in our nation. As per the report produced by them during the year 2017, it is seen that there is 36% electric power requirement for several segments out of which, 11% may be contributed by Solar PV. The Fig.1 shows the IREA analysis on renewable energy. It also suggests for smooth incorporation of renewable energy to grid. The apparent delay in setting up of renewable energy is mainly due to the huge investment cost in establishing infrastructure and rolling charges. It points out to ascertain main concern on dispatch of alternate energy. It simply means that the power from entire renewable mode of power should be made grid-tied despite of differences in the size of the scheme and the magnitude of load served. This necessitates the power obtained through all PV should be made grid connected resolving the challenging issues.

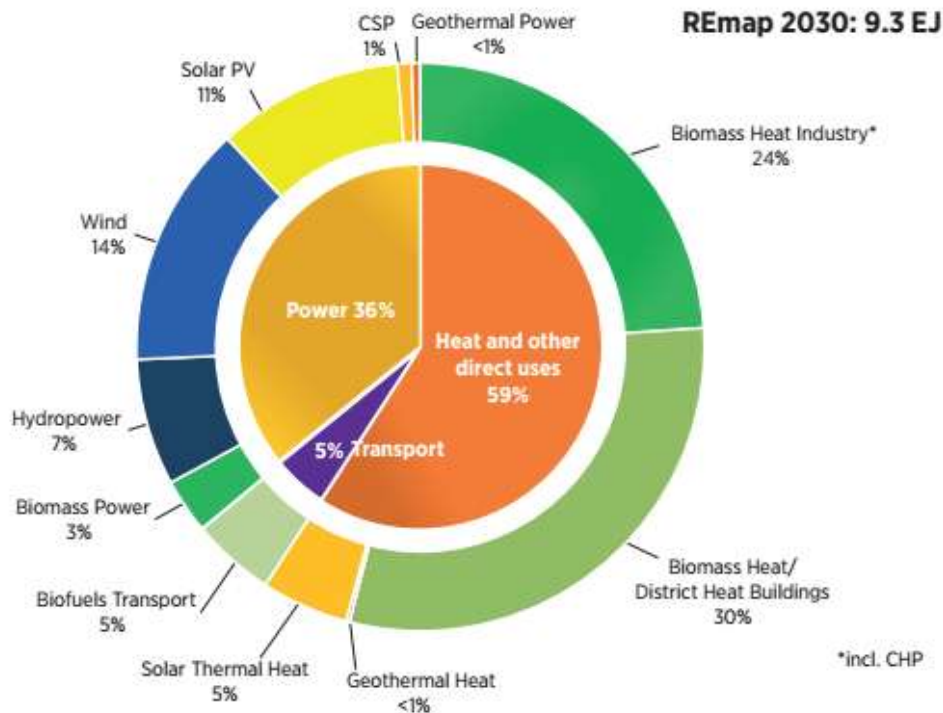


Fig. 1: Use of Renewable Energy for Different Sectors for Various Needs as per IREA Analysis

**C. Potential of Solar Energy in India**

India has got highest privilege to harvest solar energy. In a year, the nation gets bright sun for about 250 to 300 days due to its topography. In addition, it receives an average radiation of 200000 kW/sq. km per hour.

The quantity of accessible solar energy over a period with regard to the native climatic settings is a crucial input for selecting the ideal site/locality, machinery and dimensions of a specific solar energy scheme. Viability studies and procedural calculations of a solar energy scheme usually require energy resource valuation. Highly truthful on-site observations/readings of solar radiation offer the least ambiguity about the data relating energy resource and gives conceivable energy profit. This kind of measurements are accomplished by means of an eminent observation station for monitoring solar radiation measuring three significant constituents of solar radiation viz. direct normal irradiance, global horizontal irradiance and diffuse horizontal irradiance [9].

The Fig.2 shows the Direct Normal and Global Horizontal Irradiance on an average per year across India, which has been recorded by National Renewable Energy Laboratory (NREL) for a period of 10 consecutive years.

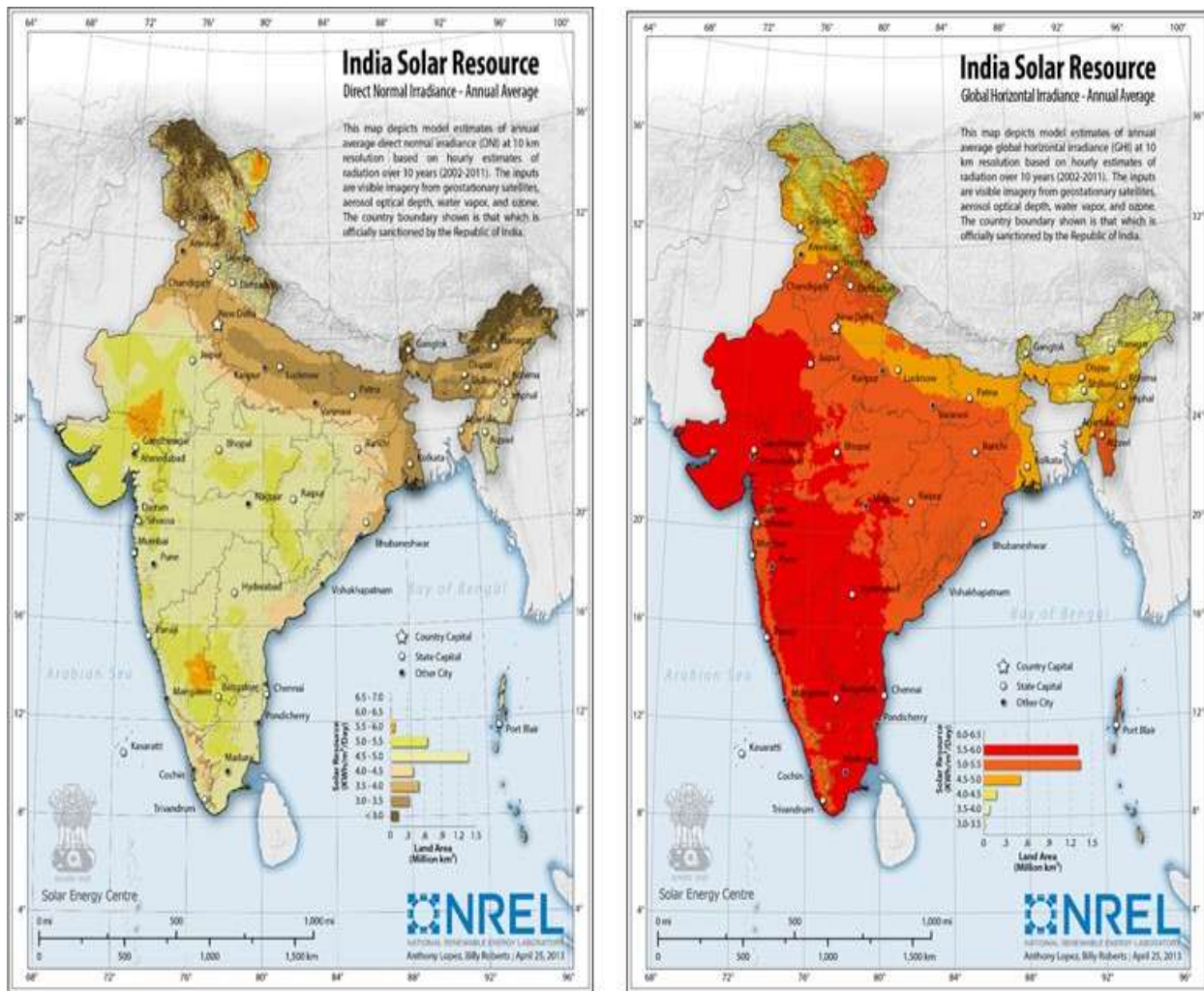


Fig. 2: DNI and GHI Map of INDIA (2002 – 2011) as Recorded by NREL

**D. Varieties in Solar PV**

There are two popular connections available with photovoltaic energy protection namely, the stand-alone or captive PV scheme and Grid-tied Schemes. The former consists of individual cell usually with a specification of 12V with a power rating of 50 or 100 W. These cells would be arrayed to form a panel, as per the requirement [10]. They receive solar radiation throughout the day to produce electricity and stores energy using rechargeable batteries to power the loads during nighttime. They are very much apt for use in remote and rural areas where access to grid

power is cumbersome. In medium scale, they may be utilized as rooftop panels. The main complication with these systems are experienced with the charge controller and storage batteries [11].

The latter have panels invariably connected to an inverter system so that normal AC loads are fed with output of inverter during the daytime itself. The panels are connected to regular grid through inverters during nighttime [12].

During favorable conditions, i.e. at the time of hot summer these panels produce electrical energy in excess than that required to serve the load. In such cases, the power can be supplied to grid. Thus, the power flow in grid-tied PV is bidirectional. The complication in this type of scheme is not with batteries but with inverters [13].

**E. Performance Failure of Solar PV Modules**

Even if substantial solar energy is extracted through PV, there exist some failures in the modules. The performance of PV cells is judged through the factor called Performance Ratio (PR). It is reported that there are significant power losses in the existing modules because of which the PR is reduced approximately by 15 to 20 % [14-15]. The major reasons for this letdown may be due to corrosion, hot-spots, faulty encapsulation, dust amassing, and incomplete shade, and mistakes in the connectivity of electric or mechanical circuits [16-18]. The various PV units are generally connected in a string in series. Thus, even a breakdown of a single unit may create power loss in the whole string. Also, immediate attention if not given to rectify the fault of such unit, it can speed up the weakening of PV units. To avoid such kind of failures a proper monitoring scheme has to be made. The performance have been measured by measuring the temperature, V-I characteristics etc. For the measurements many type of connections have been reported in the literatures. Yet, the intensity of monitoring is to be enhanced [19]. An electronic arrangement containing a monitoring circuit for individual PV module and a unit of control for regulating the whole system has been proposed. As the monitoring unit is attached parallel to the individual module, the functioning of modules is not affected. In addition, the use of power line communication that connects the control unit to monitoring unit reduces the number of connecting wires [20]. Another investigation states that the outdoor scrutiny will not give much exactness due to vague test environment. It suggests self-reliance algorithm to determine short-circuit current in outdoor by including many outdoor conditions with an experimental set-up, which helps to obtain precise analysis just similar to indoor precision results [21].

**F. Complications in Solar PV**

**Economic Issues**

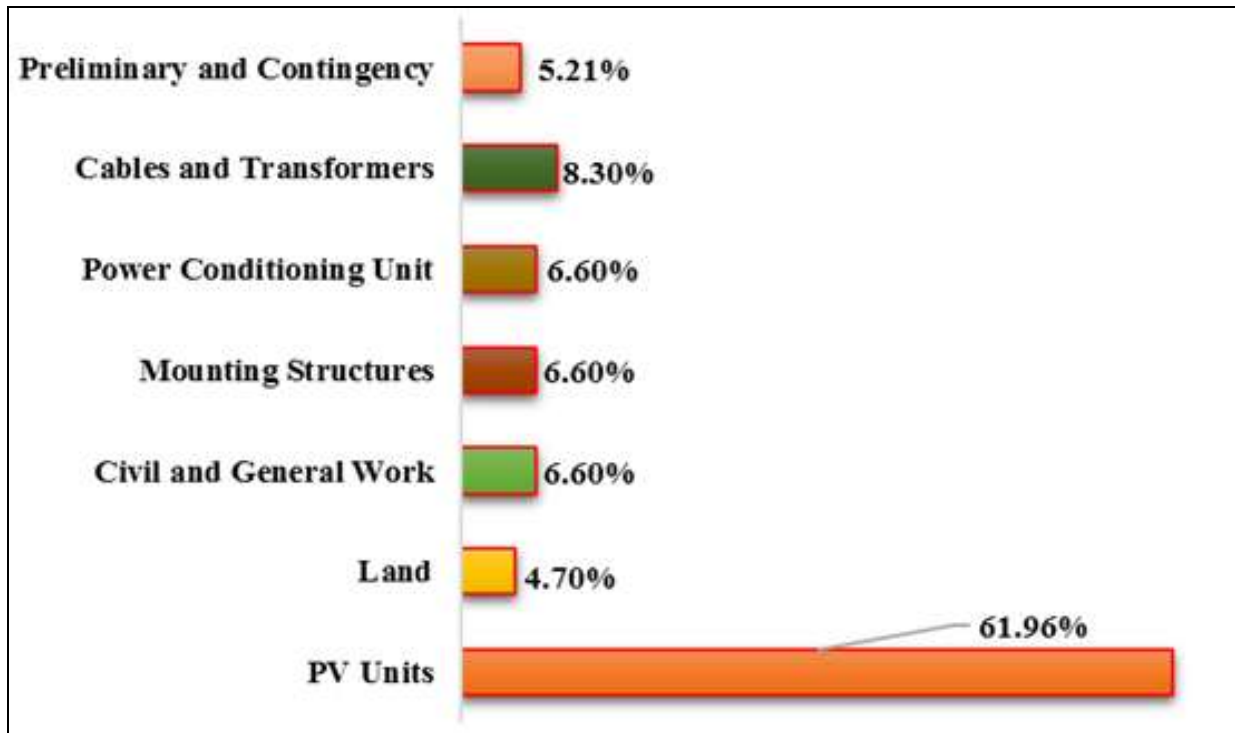


Fig. 3: Percentage EPC Cost /MW for Various Modules of Solar PV

The modules in a solar PV arrangement comprises of solar PV unit, inverter section, assemblies and Balance of System (BoS) which may be off-grid encompassing storage batteries or grid-interacting scheme. The assurance for life span of Solar PV units is 25 years in general and functions even after the assured period generating 80% of its actual appraised rating. The inverter section is usually works for 10 to 25 years. From the prevailing studies and data, it is assumed that because of BoS and reduction in cost of setting up, the Solar PV unit prices have come down in recent past [22-25].

For this reason, new models are evolved in the market. The principal cost (Rs./Wp) is decided through the maximum-watt, Wp and stands as a measure of installed capacity. It may be either dependent on the amount utilized for module and inverter or based on the whole capacity of installation [26]. The complete Engineering Procurement Construction (EPC) cost for the solar system as per the studies through government agencies in depicted in Fig.3.

### **Technical Issues**

The amount invested on large solar PV plants, rooftop panels are very high and they are meant for particular period of service. Unfortunately, they could not sometime yield the expected performance and further their lifetime is getting reduced because of technical difficulties. Irrespective of type of solar panels, some problems are quite common. Many literatures have reported a detailed experimentation. Most of them cover the issues regarding storage system with conventional batteries [27], Charge controllers designated to prevent the batteries from over-charging [28], tracking methodologies [29] that assist in reaping highest solar power, and the overvoltage problems and inverter control methodologies [30]. This section briefly points on recent researches covering the a fore mentioned issues. Table I describes the recent investigations pertaining to solar PV.

### **G. Government Initiatives & Developments**

The development of energy sector is not only satisfying the needs of citizens of India but also plays a vital role in upholding the economic growth of India. In line with this, government of India has taken valuable measures on improving the electric power generation. It has provided a lot of subsidies and benefits for the part takers those supply energy and invites foreign investments for improving the growth of renewable energy. Few schemes related to solar PV are listed below:

1. The Ministry of New and Renewable Energy (MNRE) has unambiguously offered custom and excise duty reimbursements to the solar rooftop division, leading to reduced setting-up cost.
2. A solar park 'Shakti Sthala' had been pitched in Karnataka in March 2018, which is the largest solar park across the globe. The capital investment of this scheme is Rs 16,500 crore.
3. Solar segment in India attracted an investment of about 9.8 billion US dollars in the year 2018.
4. India installed 1 MW of solar capacity every hour in 2018.
5. The Private Equity (PE) funds in India's wind and solar power have greater than before and found to be improved by 47% in 2017.
6. Solar capacity has augmented by 8 times for the past 4 years. The additional renewable energy capacity is 11.788 GW in the FY 2017-2018.
7. National Solar Mission (NSM), launched in 2010, had set a goal for expansion and setting out of 20 GW solar power within the year 2022. It has now been sanctioned for a target of 100 GW.
8. The solar power tariff has come down to Rs 4.50 per unit of electricity from Rs 5.50 per unit.
9. Government helps for the setup of 1000 MW of Grid linked Solar PV Venture by with Viability Gap Funding.

As per the official report of government of India a total cumulative capacity of 19584.15 MW of grid linked solar PV has been installed as on 28 February 2018. In the same period, standalone/captive solar PV plants of a total of 181901.4 kWp has been developed with various load ranging from home lighting to water pumps for irrigation. The given report is applicable for 36 states of our nation. The government looks for private players to invest on solar power projects so as to put the plants in operation in the near future. The incentives are even common for an individual who installs solar plant of minimum 1 kW capacity. The solar parks of total capacity of 23,404 MW has been launched across the country. The maximum capacity per state is contributed by Gujarat with a capacity of 6200 MW followed by the states of Rajasthan, Andhra Pradesh, Madhya Pradesh, Karnataka, and Maharashtra with overall capacity of 4331 MW, 4160 MW, 2750 MW, 2000 MW, and 1950 MW respectively.

Table I: Recent Researches on Technical Issues Related to Solar PV

S. No.	Author(s)	Point of concern	Observation and Remarks
1	Gurung and Qiao [31]	Storage integrated PV battery	Three important technical factors viz. energy density, efficiency, and stability, to further advancement of integrated PV-battery systems are deliberated.
			Main emphasis must be on the improvement of new strategies that integrates high-capacity, competent, and firm materials, highlighting the demo of real-world feasibility of such combined PV-battery systems.
			Upcoming determinations ought to validate the integrated scheme to satisfy the real-time applications like sensors and electronics oriented network. These requests possess explicit needs of consuming average and peak power, which in turn governs the style and sizes of the integrated scheme to power the load proficiently. This may better prove the real sustainability of the inherently integrated PV-battery schemes.
2	Gupta et al.[32]	Solar charge controller	In the areas, which are still not accessible to provide, electrical connectivity to grid can be supplied with photovoltaic power through solar-powered micro-grid system. However, it necessitates for wide range of variable voltages and hence an adaptable charge controller becomes mandatory.
			A novel DC-DC fly back converter is designed for using any voltage level and charges a regular 12 V battery. This battery is even suitable for panel of 48 V rating. Moreover, the I <sup>2</sup> R loss in the controller is reduced largely as this considerably contributes to the system loss. The said controller is designed for charging a battery of rating 7.2 AH using a charging current of 500 mA.
3	Ahtesham ul Haque [33]	Power-point Tracking	The PV arrays possess non-linear characteristics leading to poor outcome. Hence, it becomes important to harvest highest power from the PV array by means of power tracking schemes (MPPT). The most widely applied scheme for tracking high power is Perturb and Observe method.
			The characteristics of tracking arrangement is dynamic with respect to varying climatic settings. This is mainly because of sudden variation in the radiating energy from sun and restricted shading by the presence of clouds. Thus, it becomes imperative to analyze the tracking schemes with regard to real-time radiation and varying load conditions.
			The regular tracking methodology has been altered to govern the control circuitry of DC-DC converter. Initially the conditions are predicted in a simulation environment by means of PSIM.
			To check the real-time effects, a prototype has been modelled and to account for varying irradiation, an artificial light setting has been developed. The comparative results are promising and the new scheme helped in achieving better steady-state output.
4	Han et al. [34]	Over-voltage problem due to high penetration of PV cells	Day by day, the distributed power system is gaining popularity, which uses PV generators. The rate of PV penetration is also high and it may impose a serious over-voltage issue on the grid because of the power flowing in the reverse direction.
			This may be addressed by employing controlled/regulated reactive power with the help of PV inverter. More specifically, the inverter linked to PV unit may produce reactive power to normalize the voltage at point of common coupling. A pulse-width modulation scheme may be employed to appropriately control the voltage at the output.
			The reactive power absorption is accomplished by means of PV inverter that has been tested using PSCAD simulation environment.

## II. Conclusion

Rising the usage of renewable energy makes a vibrant part in nation's development. Paying utmost attention to such expansion supports in solving the mounting challenge of demand for energy and improve the safety and multiplicity of energy supplies. Seeing the impending capability of solar energy in India, more exertions should be made to reap it. Yet, the prevailing solar plants and solar corridors gratify the needs to some extent, resolving the complications will even enhance and shape the system. This paper, stippled the diverse schemes in actuality, economic and technical restraints still existing in the solar PV. Furthermore, the strategies, encouragements, and subsidies offered by the Indian government are also presented. Thus, the integrated PV system can be sculpted to satisfy the demands by unravelling the concerns prevalent in storing batteries, charge-controlling mechanisms, tracing huge power, approaches to control the inverter, repairs and up keeping, etc.

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