

Environmental and Social Impact Assessment of Large-Scale Solar Energy Projects

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Abstract-*The solar energy system converts solar energy into electrical energy, either directly through the use of photovoltaic panels or indirectly through the use of concentrated solar power. Solar energy is the most essential source of energy, and it has continued to gain popularity globally. Solar energy has recently experienced massive growth as a result of both technological advancements that have reduced costs and government policies that support the development and use of renewable energy sources. This is because there is an increasing demand for clean, environmentally friendly energy sources. This chapter largely tackles solar energy and covers its innovations, advancements, and prospects for the future. Energy resources can be divided into non-renewable and renewable energy sources. People are focused on using renewable energy resources to generate energy because of certain negative environmental effects like air pollution, climate change, and the depletion of natural resources. One of the most talked-about sources of sustainable energy is solar energy. The current chapter gives a general summary of the world's solar energy capacity, its classification, and advantages, and contains crucial methods for enhancing their usability, dependability, and affordability.*

Keyword-*Solar energy, Photovoltaic (PV) panels, Concentrated solar power (CSP), Renewable energy, Sustainability, Clean energy, Environmental benefits, Technological advancements*

I.INTRODUCTION

Nowadays, due to the decreasing amount of renewable energy resources, the last ten years become more important for per watt cost of solar energy device. It is definitely set to become economical in the coming years and growing as better technology in terms of both cost and applications. Everyday earth receives sunlight above (1366W approx.) This is an unlimited source of energy which is available at no cost. The major benefit of solar energy over other conventional power generators is that the sunlight can be directly converted into solar energy with the use of smallest photovoltaic (PV) solar cells. There have been a large amount of research activities to combine the Sun's energy process by developing solar cells/panels/module with high converting form. the most advantages of solar energy is that it is free reachable to common people and available in large

quantities of supply compared to that of the price of various fossil fuels and oils in the past ten years. Moreover, solar energy requires considerably lower manpower expenses over conventional energy production technology

The most plentiful source of energy on planet is likely solar energy. Solar energy is the term used to describe solar radiations that are used to produce heat and electricity. Solar energy is a renewable resource; thus, it will never run out. Because of this, we are free to experiment and determine how to use it most effectively and efficiently. Sunlight and heat are captured and transformed into several types of energy. One of the renewable energies is solar energy, which is the transformation of solar energy. Most of the sunlight is converted to visible light and infrared radiation once it has passed through the atmosphere of the earth. These energies are transformed into electricity using solar cell panels. Due to the limitations and effects of non-renewable energy sources, people must pay attention to renewable energy sources. The increasing need for power in developing nations as a result of global warming, greenhouse gas emissions, shifting oil costs, and other factors requires innovative approaches. Therefore, the direction of energy development and the current energy structure have a significant impact on renewable energy. Solar energy, a sort of renewable energy resource, has seen vast-scale development and extensive applications as a result of limits on energy transportation

Solar energy often offers several advantages over fossil fuels like coal and oil since it cleans the air, emits fewer greenhouse gases, and can be produced again during our lives

The world's current situation has led to a rise in global electricity usage. Researchers have therefore concentrated on creating solar energy technologies to achieve a high degree of efficiency with a low investment cost and reduced environmental contamination

In order to achieve high efficiency with little environmental contamination, researchers are

making significant contributions to innovation in the solar energy area. Due to the price of the extraction and manufacturing processes, using crystalline silicon for the creation of solar cells can be expensive in the field of solar energy. Consequently, new materials for solar cell construction will include organic components in the future

Organic materials are more environmentally friendly and have lower production costs, thus they can be used to make solar photovoltaic cells. According to the conventional solar cell, electricity cannot be produced without sun radiation. However, in the near future, power will be produced at night without sunlight thanks to the anti-solar cell concept

Therefore, briefly explore the advancement and future of solar energy technology in this review study. Many other potential applications for solar energy in both household and commercial settings have been studied. Through intense research and development programmes, the prospects for others who are not yet commercially viable are also improving. Environmental effects are a result of all energy generation and transmission methods Traditional producing options can harm the air, climate, water, land, wildlife, and ecosystem as well as raise unsafe radiation levels, as is evident from their consequences. Renewable technologies offer a solution to a number of social and environmental problems and are substantially safer than fossil and nuclear energy

Solar power technology outperforms the potential of other renewable energy sources like wind and biomass-derived energy by several orders of magnitude Additionally, solar energy has a number of benefits that appeal to people in different parts of the world, such as lowering greenhouse gas emissions, stabilising degraded land, increasing energy independence, creating jobs, accelerating rural electrification, and raising living standards in developing nations

Amount of energy in the form of heat and radiations called solar energy. It is radiant light and heat from sun that is natural source of energy using a range of ever changing and developing of technology such as solar thermal energy, solar architecture, solar heating, molten salt power plant and artificial photosynthesis. The large magnitude of solar power available makes highly appealing source of electricity. 30% (approx.) solar radiation is back to space while the rest is absorbed by ocean, clouds and land masses

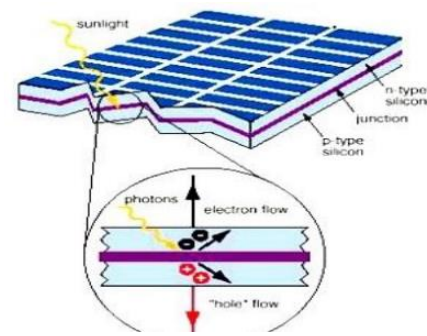


Fig 1: Model of solar panel

II.WORKING OF SOLAR ENERGY

PV cells Convert Sunlight to Direct Current (DC) electricity. Charge Controller work as control the power from solar panel which reverse back to solar panel get cause of panel damage. Battery System act as storage of electric power is used when sunlight not available (i.e. night).From this system connected to inverter for convert Direct Current (DC) into Alternating Current (AC).

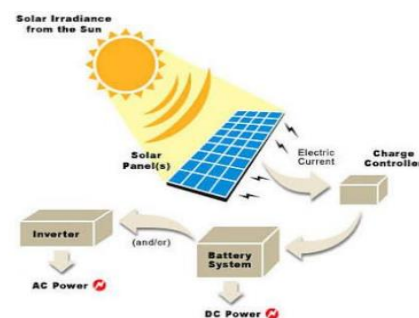


Fig 2: Working model of solar cell

Solar Cell (Photovoltaic Cell) The cells converted solar radiation directly into electricity. It consists various kinds of semiconductor materials. It has two types: positive charge and negative charge shown on fig.1.This cell technology are used to design solar cells with low cost as well as high conversion efficiency. When the cell absorbed photons from sunlight, electrons are knocked free from silicon atoms and are drawn off by a grid of metal conductors, pressure a flow of electric direct current. Solar cell PV made up of many chemicals.

Photovoltaic Module A PV module consists of solar cell circuits sealed in an environmentally protective laminate and are the fundament building blocks of PV system. Generally sizes from 60W to 170W. Usually a number of PV modules are arranged in series and parallel to meet the energy requirement

Photovoltaic Panel It includes one or more PV modules assembled as a pre-wired, field installable unit. In this panel PV cell is series connections. Solar panels are made up of individual PV cells connected together.

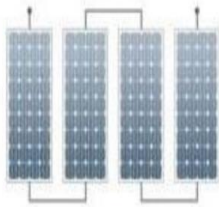


Fig 3: Photovoltaic Array

It is contained of several amount of PV cells in series and parallel connections. Series connections are responsible for increasing the voltage of the module whereas the parallel connection is responsible for increasing the current in the array. It generates maximum 180W in full sunshine. Large the total surface area of the area of the array, more solar electricity it will produce.

IV.ENVIRONMENTAL IMPACT ASSESSMENT OF SOLAR ENERGY

- The possible environmental effects of solar energy might differ greatly depending on the technology [20]. These effects are connected to the use of land and the destruction of habitat, the use of water, and the creation of hazardous products.
- Depending on their location, larger utility-scale solar projects can result in difficulties with habitat loss and land degradation. Water is needed for solar thermal concentration plants to cool down. These plants also need more water because it is necessary to maintain the reflectors.
- The manufacture of solar cells involves the usage of several hazardous substances. The majority of those substances are utilised to polish and clean the semiconductor surface. Compared to conventional silicon photovoltaic cells, thin-film photovoltaic cells use a variety of more harmful substances.
- Global warming emissions occur during operation. However, other phases of the solar life cycle are also connected with emissions [21]. It covers production, material transportation, installation, upkeep, decommissioning, and deconstruction. 6. The innovations of solar energy technology: Electricity cannot be produced after sunset, according to conventional solar cells. According to the anti-solar cell theory, solar cells might be used to produce electricity at night [20]. The anti-solar cell theory

considers the earth to be a heat source and accounts for the night sky using advanced radiative cooling and radiative photovoltaic concepts [22]. Thermo-radiative cells operate on the same basic principles as traditional photovoltaics. Random photon absorption by the cell equals random emission from the cell when a p-n junction enters thermal equilibrium with its surroundings in the dark, and the Fermi level through the semiconductor remains constant. When the p-n junction is hotter than its surroundings, the device tries to cool by expelling more energy than it absorbs. The temperature remains constant when a thermal reservoir is connected to the cell. A reverse bias voltage is created across the junction when the enhanced emission lowers the carrier concentration below its equilibrium level, separating the hole and electron Fermi levels in the opposite manner [23]. When an electron and hole pair recombine but are not balanced by photon absorption, an additional electron and hole are supplied via the contacts to make up for the missing pair. When a cell is connected to a load in this case, there is a current flow [24]. The main distinction between a thermo-radiative PV cell and a conventional PV cell is

- The current flows counter to its natural flow.
- The voltage created has a reversed sign as well. The optical rectenna concept has been proposed as an alternative to conventional semi-conductor photovoltaic. A rectenna is a high-frequency rectifier system made up of an antenna that collects electromagnetic radiation and a diode that converts it into DC electricity. Concentrated photovoltaic (CPV) technology is a recent development in solar power technology [25].

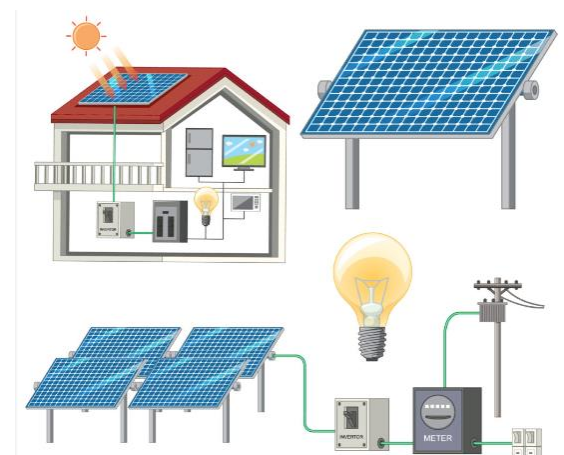


Fig 7 : Grid connected solar cell

- Self-cooling panels: A crucial component of how solar panels work is continuous exposure to the sun's

beams. However, severe temperatures cause the majority of panels to perform less effectively. Some researchers have developed a method to enable panels to cool themselves in order to overcome this overheating issue and ensure that they can continue to work at their best even in the hottest temperatures. Basically, the bottom of a standard solar panel has a gel sheet attached to it. This gel absorbs the night time airborne water vapour [29]. The water is then evaporated during the day as a result of the solar panel producing too much heat. The solar panel will cool off as a result of water evaporation, just like when you splash water on your skin on a hot summer day.

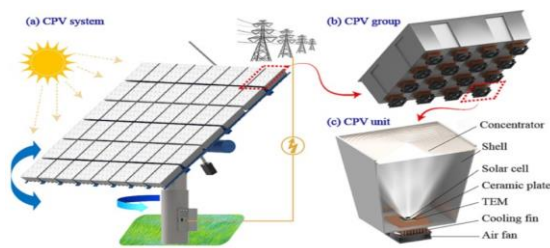


Fig 8: Conceptual schematic of the self-cooling concentrated photovoltaic system

- Innovation in materials: The search for innovative components and photovoltaic cell arrangements that can improve the performance of current solar panel technology is never-ending. Perovskites, a class of semiconductors, is one example of such a substance [30]. They have the potential to be the key element in solar cells of the future. These new cells won't just be more affordable; they'll also likely be far more effective than current cells. The fact that the solar power sector is researching specific forms of synthetic perovskites is important in this regard. The type of resources extracted from the earth are not a factor in their supply because they are made in laboratories [31]. They will therefore be less expensive.

- Solar straight from space: The effort to create a technology that transmits solar energy directly from space to earth is in full force. American researchers made the first attempt in this direction by launching a tiny photovoltaic module. This experiment tries to examine how solar energy is transformed into microwaves [32]. The panel features a layer intended to collect the blue light spectrum of the sun's beams, which is conceivable in the atmosphere of space, according to a clever detail the researcher has made public. Technology, production, and methods for solar electricity are constantly changing. The industry can only maintain its momentum and bring in the era of renewable energy

in this way. The fact that there are always fascinating new innovations taking place in the solar energy sector is a wonderful thing.

- Solar panels: Anyone wishing to save money and the environment at the same time can consider solar panels as a fantastic energy source. Solar panels can be purchased for a fair price and are an investment that will save the buyer money for at least two decades.



Fig 9: Solar panels

More and more companies are investing in solar panels in an effort to cut costs. Solar panels have been around for a while, but because to advancements in solar energy, they are now affordable for everyone, providing power to those who have never had access to it before.

- Portable solar: For safety, affordability, and efficiency, developing nations and regions that are recovering from catastrophic occurrences like floods and earthquakes are turning to alternative energy sources like solar energy. Agencies like the Red Cross and the United Nations have invested millions of dollars in portable solar panels that can light and illuminate their disaster relief crews. Kits are provided with mobile solar power systems so that aid personnel can gather and store energy. In the near future, entrepreneurs will use solar-powered 3D printers to provide vital medical supplies to disaster-affected areas.



Fig 10: Portable solar

- Grid batteries: The other difficulty that sustainable solar energy has is energy storage technology, in addition to the high cost of solar equipment. The development of solar energy technology depends on energy storage, which is also what gave rise to the

current development of grid batteries. Compared to other cells, these batteries are more effective at storing solar energy.



Fig 11: Grid batteries

Combining grid batteries and solar technology is the best approach to ensure a consistent electricity supply that is less expensive than fossil fuels. Solar panels can be shared with neighbours at a price that is less expensive than purchasing other forms of energy by those whose roofs aren't suitable for PV panels. 7. Ways to improve the efficiency of solar energy: Solar energy is currently used widely in a number of businesses because to its infinite reserves, universal accessibility, cleanliness, and many other advantages. The solar cell's efficiency is a crucial factor. Following are some crucial suggestions for increasing the effectiveness of solar electricity.

- Increasing the solar panel's conversion efficiency - Solar panels are the key element in turning solar energy into electricity. In recent years, scientists have been developing novel solar panel technologies. As the most current advancement in solar panels in recent years, the Nano solar panel shows a new side to development. The solar light and solar panel are vertical and have an automatic tracking system. Due to the sunlight's shifting angle, the solar cell's generating capability will alter over time. By implementing an autonomous tracking system, the generating capacity can be increased [38].
- Create two independent devices by dividing the collecting and transformation portions. The collector is one of them; it is used to increase solar energy by sequentially collecting solar energy.
- A different converter transforms light energy into electrical energy. These mirrors were used to create this collector. The converter transforms thermal energy into electrical energy, resulting in a thousand times greater generating capacity than a standard solar panel.
- The best invention in solar cell technology is the solar tree idea because there isn't enough room to place the solar panel due to the rapid increase in

human population nowadays. To generate effectively, this solar tree needs very little room. The solar tree may therefore be the most appropriate for the modern world. One of the best ways to fulfil future energy demand is through solar energy

- Lower the start-up costs
- Get a flexible solar cell and have less of an influence on the environment.
- Capable of producing power during the day.
- In high-temperature zones, concentrated solar technology may produce power much more effectively than conventional solar technology. According to the present findings, solar energy technologies are unable to supply enough energy to fulfill the world's steadily growing energy needs while minimizing their negative impacts on the environment and human health [46]. To overcome the aforementioned issues and achieve higher efficiency, similar to non-renewable technologies like nuclear and fossil-based energy, innovation and upgrades are required. 9. Environmental Impact Assessment
- Environmental impacts from photovoltaic power generation: When in use, photovoltaic systems are often considered to have a minimally harmful impact on the environment because they don't create any noise or chemical pollutants. It is one of the most practical renewable energy technologies to employ as an alternative to the current building cladding materials in urban areas [47].
- Land use: Specific elements determine how land usage affects natural ecosystems. The geography of the landscape, the area of the PV system's coverage area, the type of land, the distance from sensitive ecosystems or scenic areas, and the biodiversity all have an impact on how land use affects natural ecosystems. Construction activities including earthmoving and transport movements are likely to have an impact on the environment and change the landscape during this phase [48]. Additionally, the installation of a PV system on formerly arable land runs the risk of destroying the biodiversity, soil productivity, the area covered by the system, the kind of the land, and the distance from delicate ecosystems and picturesque areas. Construction-related activities like earthmoving and transport movements are likely to have an impact on the environment and change the landscape. Additionally, it is possible to ruin portions of productive soil by placing a PV system on formerly arable land.

➤ Visual impacts: The kind of the scheme and the PV systems' surroundings have a significant impact on visual intrusion. It goes without saying that the aesthetic impact of installing a PV system close to a scenic place would be very high [49]. Comparing modern buildings to historic or culturally significant buildings, there may be a favourable visual influence in the case of modules integrated into building facades. Optimum architectural solutions to lessen potential effects on building aesthetics and visual aesthetic. Design and proper location of big PV installations. PV modules are assembled in large-scale systems using colour. To reduce the negative effects on the environment caused by the manufacture of PV cells, a number of factors need to be researched: The potential for cell layers to become thinner; the concentrator PV technology' full potential; Possibilities for more effective material use; Better and safer materials; Efficiency of module recycling technique.

➤ Air pollution: According to life cycle analyses, the manufacturing process of the system, especially when it comes to the production of power, has a significant impact on how environmentally friendly it is [50]. Modern PV systems may directly offer clean electricity that is perfectly matched to the building's demand when they are structurally integrated into buildings. In urban settings, they can also support day illumination, shadow management, and ventilation. Mirrors can be replaced with PV panels on a building's front. PV systems also help to foster a climate where additional energysaving measures can be promoted by building promoters, owners, and users. PV energy services are especially evident in situations when only small amounts of power are needed, such as in rural electrification applications, and where consumers can directly benefit from the extraordinarily high reliability of having their own PV generator. Installing a PV generator is typically less expensive in the first scenario than extending the main grid over significant distances.

➤ Noise intrusion: There won't be much noise, as with all construction-related activities. Additionally, there will be certain employment advantages throughout the construction period and, more so for big projects, during the operational phase. It is important to urge manufacturers to create systems that are simple to recycle. The majority of environmental effects are brought on by batteries because of their heavy metal content and limited lifespan, according to a life cycle analysis of batteries for freestanding PV systems. Furthermore,

its creation requires a significant quantity of energy and raw resources. A module-recycling programme can make things better in this case.

- Environmental impacts from solar thermal electricity: The possible environmental implications of such a concept have not been thoroughly examined due to the limited use of ST power. Even if some emissions do happen at other points in their life cycles, they are much smaller than the emissions when the system's activity stops. Materials' manufacture and processing. Construction, Land use, Ecosystem, flora and fauna, Visual impact, Water resources, Health and safety, Social impacts

CONCLUSION

Most of the people are aware about non-renewable energy resources. Solar energy has become increase more popular due to their economic benefits. By on Battery Backup, Solar Energy can even provide Electricity 24x7, even on cloudy days and at night. This also used with inter-grid System with Continuously Power supply. It has more benefits compared to other forms of energy like fossils fuels and petroleum deposits. It is an alternative which is promise and consistent to meet the high energy demand. Research on solar cell and solar energy is promise has a future worldwide.

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