

An Overview of Potential of Solar Energy and Its Future Prospects

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ABSTRACT: *Solar energy has huge potential in order to fulfill the energy need by the world. It has a promising future for fulfilling the demand of energy. Non-renewable energy sources such as oils and gases generated waste at large quantity that has adverse effect on the environment. Solar power comes under the renewable energy source that available in the nature in unlimited quantity. The production of the electricity is the primary application of the utilization of the solar energy. It doesn't produces carbon dioxide (CO₂) and other harmful gases that help in minimizing the air pollution. Many emerging as well as developed countries focused on the proper implementation of the technologies based on the solar energy. This review paper aimed to discuss about the likely of solar power and its aspects. In the future, the proper implementation of the solar energy in different sectors can reduce the pollution significantly resulting in healthier ecosystem.*

KEYWORDS: *Energy Resources, Renewable Energy, Solar Energy, Silicon, Semiconductor.*

INTRODUCTION

Nowadays, energy is the basic need of the society. It can be in the form of heat or electrical energy. The commercial technologies are usually based on the non-renewable energy sources. Most of the developed as well as developing countries are utilizes these resources for the production of energy in different forms. The production of the electrical energy is mostly based on the utilization of the non-renewable energy resources[1]. The main issue associated with non-renewable energy resources based commercial technologies is that it produces wastes at large scale, the emission of carbon dioxide (CO₂) and other harmful gases are the primary waste products that have heavy negative impact on the environment. Rapid growth in the level of the CO₂ in the atmosphere causes climate change and global warming due to which the temperature of the earth increases continuously. Not only human beings but also animals and birds are suffering from the various diseases due to the carbon emission in the environment[2].

In contrast, renewable energy (RE) sources consider as the best alternative of the energy generation technologies based on the non-renewable energy resources. There are mainly four kinds of the sustainable energy sources including solar power as well as wind power, wave power and biogas. Each energy resources have its own advantages and limitations. Apart from all renewable energy resources, solar power is an emerging sector that contribute huge likely for fulfilling the demand of the energy without damaging the environment. It doesn't produce any kind of harmful gases that has adverse effect on the environment. Every country of the world now looking at the renewable energy resources, more particularly to the solar energy because it requires less maintenance and more accessible to the isolated places such as rural areas. Some countries have established solar parks in order to generate electricity at large scale. Solar panels, solar cooker and heater based on the solar energy are the primary applications of the technology based on the solar energy[3]. There are various advantages offering by solar energy such as it helps to reduction of electricity bills, it provides the wide spectrum of applications and minimal maintenance charges. This review paper provides an overview of likely of solar power as well as its aspects including the various kinds of solar power-based advancements, limitations of solar energy followed by the benefits as well as challenges associated with solar power-based technologies. At last future prospects associated with solar energy will be discussed. The aim of this paper is to cover all the aspects associated with the technologies based on the solar energy so that the researchers who are working in this field can take good reference from here.

SOLAR ENERGY AND ITS STATUS GLOBALLY

In general, the radiation and heat produced by the sun is considered as solar energy. For producing the electrical energy from the solar power, the solar energy captured by the device and subsequently converts to the electrical energy. Generally, solar panels are utilized for the production of the electricity. These solar panels consist of multiple solar cells based on the semiconductor PN-junction. Currently, many countries including developed as well as developing nations are focused to established technologies based on the solar power for the production of the electrical energy. This technology still in the developing mode because it needs proper implementation policies and regulations as well as low efficiency is the major issue. The status of the consumption of different renewable energy resources in different years is shown in the Figure 1.

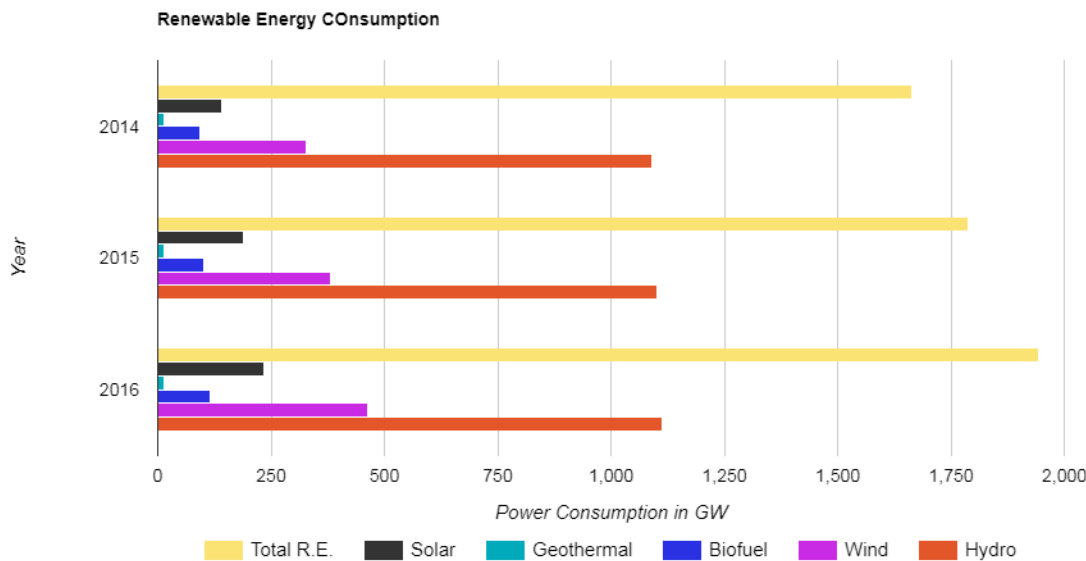


Figure 1: Status of Consumption of Different Renewable Energy Resources from 2014 to 2016[4].

It has been noticed that the production of electrical energy through the solar power is increasing continuously in many countries. Many countries from Europe, America and Asia, actively participate in the implementation of the solar energy in order to minimize the dependency on non-renewable energy resources. Since, most of the countries aware about the concern associated with the global warming and climate change due to the emission of the carbon dioxide (CO₂) and the other harmful gases. The capacity of the electricity generation based on the solar energy by different countries in 2015 is shown in the Figure 2.

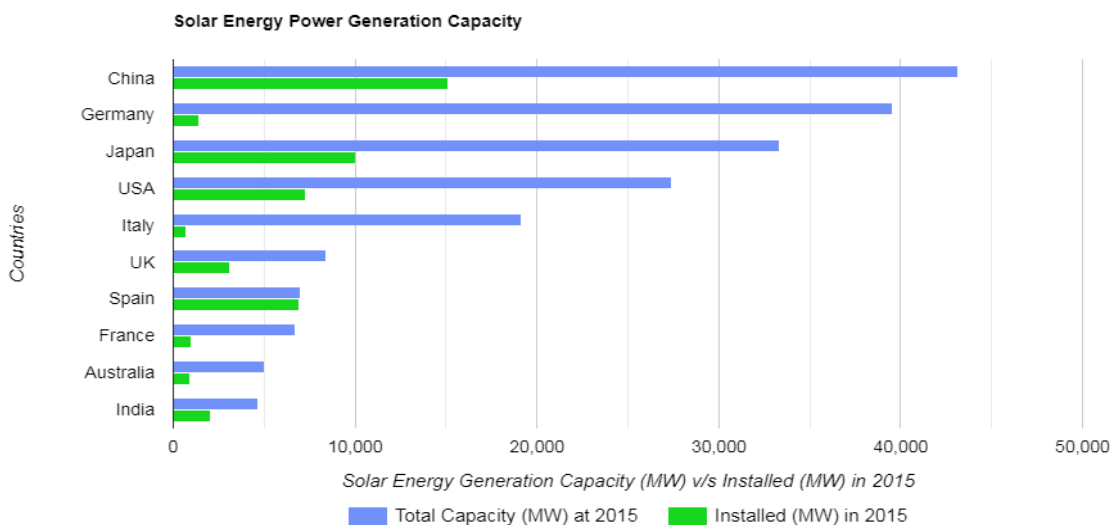


Figure 2: Status of the Solar Energy Power Generation Capacity v/s Installed in Different Countries in 2015[4]

TYPES OF SOLAR POWER BASED TECHNOLOGIES

The utilization of the solar power for the fulfilling the need of energy depends on the objective, in which form the solar energy needs to be consume. There are mainly two types of the technologies based on the solar energy (as shown in the Figure 3). In some cases the solar energy directly utilize to covert to another form of energy and in some cases processing is required in between.

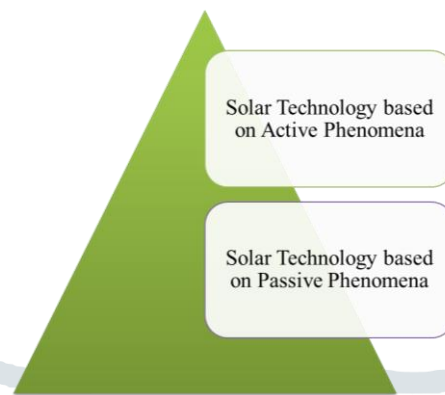


Figure 3: Schematic Illustration of the Types of Solar Energy Based Technologies.

1. Solar Technology based on Active Phenomena:

This solar energy based technology usually utilized the irradiated sun light in order to convert it in the form of energy, either electrical energy or heat energy by using the electrical or mechanical tools. Photovoltaic cells are the best example of the active solar cell technology. This is a semiconductor device that converts solar energy to the electrical energy. The schematic illustration of the photovoltaic cell is shown in the Figure 4.

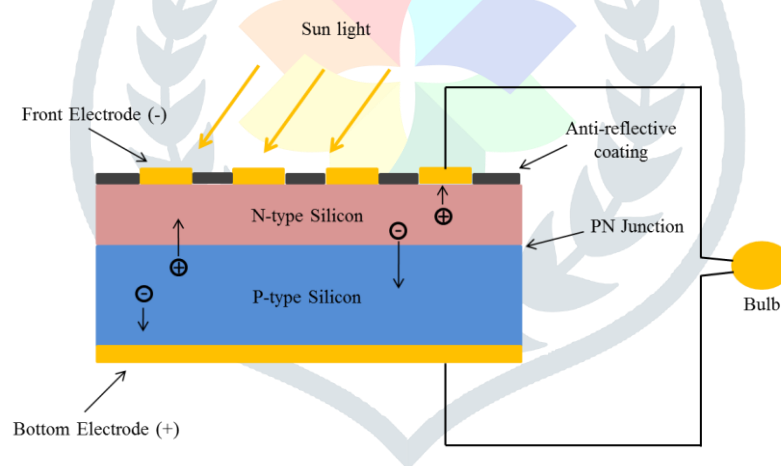


Figure 4: Schematic Representation of the Photovoltaic Cell for Producing Electricity from Solar Energy.

1.1 Working of the Photovoltaic (PV) Cell:

PV cell is a semiconductor device that consists of two extrinsic type semiconductor materials. Generally, silicon material is used for the fabrication of the PV cell. One material is n-type extrinsic material as well as another one is p-type extrinsic material. In the n-type semiconductor material, the mainstream current carriers are electrons as well as the minority current carriers are holes. When pentavalent impurity (for instance phosphorous in which five electrons are present in the outer most orbit) implant in the pure silicon material. Since silicon has four valences that is why all four valance electrons present in the silicon materials makes covalent bond with the four out of five valance electrons present in the phosphorous material The fifth electron that haven't participate in the bonding process is free to move but this electron loosely bonded with the parent material that is why it requires very less amount of energy in order to move freely from one place to the another place. The chemistry of the n-type silicon is shown in the Figure 5.

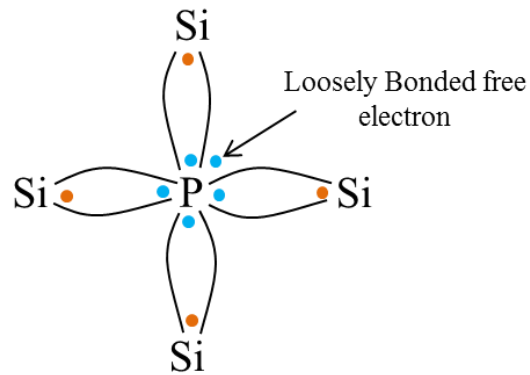


Figure 5: Schematic Illustration of the n-type Silicon Semiconductor Chemistry

On the other hand, in the p-type silicon material, a trivalent (for instance boron material that has three electrons in the outer most orbit) material implant in the pure silicon material due to which a hole is created that serves as a charge carrier. The mobility of the electron is higher than holes that is why electron carriers higher current. N-type semiconductor devices are faster than p-type semiconductor based devices. The chemistry of p-type extrinsic silicon semiconductor based material is shown in the Figure 6.

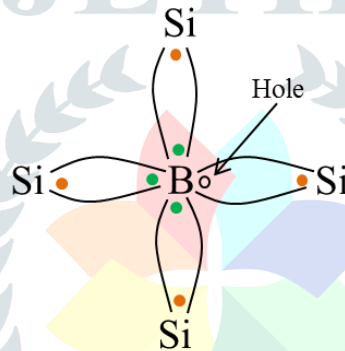


Figure 6: Schematic Representation of the p-type Silicon Semiconductor Chemistry

When both type semiconductors (i.e. n type and p type) bonded together and form PN junction, it creates a depletion layer (consist of covalent bonds and immobile ions) at the interface of the materials[5]. When sunlight falls on the PV cell subsequently large number of covalent bonds breaks due to the solar energy. When covalent bond breaks, hole and electron pairs are generated. These charge carriers moves to opposite terminal (i.e. in the case of holes, it move towards the negative terminal and electron moves towards the positive terminal) that leads to the current flow in the PV cells[6].

LIMITATIONS OF THE TECHNOLOGY BASED ON SOLAR ENERGY

Every technology has some limitations that make to utilize that technology in specific conditions. Solar energy also exhibits two main limitations that are listed in the Table 1. Some limitations are depends on the technological point of view that can be overcome by technical advancement. Another form of limitations depends on the specific natural conditions that have to be manage somehow because it can't be change.

Table 1: List of the Limitations Associated with the Solar Energy.

Limitation	Explanation
Dependency on Sun	Since solar energy comes from the sun that is why it greatly depending on presence of sun. In the bad weathers, solar energy based equipment or devices don't have any significant importance.
Area of Installation	Another limitation is about the area of installation. The solar energy based equipment and tools must install in the open area so that equipment or devices can easily receive maximum amount of sunlight so that the energy can be generated at optimum level.

MERITS AND DEMERITS OF TECHNOLOGY BASED ON SOLAR ENERGY

Since, solar energy is a renewable energy resource that is why it offers various advantages in the environment and health perspective. Apart from various benefits there are some disadvantages of the solar energy based technology that needs to be tackled for enhancing the implementation and productivity of the solar energy based technology. The merits of the solar energy are listed in the Table 2.

Table 2: List of Merits Associated with the Solar Energy Based Technology.

Merits	Explanations
Renewable Energy Resource	<ul style="list-style-type: none"> • Solar Energy comes under the renewable resource that cannot be run out for endless time • No emission of carbon dioxide (CO₂) or other harmful gases
Minimize the burden of Electricity bills	<ul style="list-style-type: none"> • It reduces the electricity bill significantly • It not just save electricity bill but also can serve as a medium of income if surplus energy transfer back to the system of grid
Wide Spectrum of Applications	<ul style="list-style-type: none"> • It can help to expand it area of applications in various fields including generation of heat as well as heat
Less maintenance required	<ul style="list-style-type: none"> • The technology based on the solar energy required very less maintenance resulting in reduction of maintenance charges significantly • The manufacturers of solar energy based systems offers 25-30 years warranty • Solar systems doesn't have complex mechanical parts that increases the reliability of the system
Development of Technology	<ul style="list-style-type: none"> • Solar energy based technology continuously growing that is why there

	is lot of scope of development of the technology that must be required any new technology for advancement in the productivity of the system
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The deployment of the solar power for the generation of the electrical power continuously increasing. Every country in the world is trying to shift getting the non-renewable energy resources to the resources based on renewable energy in the perspective of environmental conservation and improve the life of the humans as well as the animals. Renewable resource of solar energy based technology has many benefits as discussed above but there are some limitations that have to be overcome in order to enhance the deployment of the technology in effective manner. The solar energy based technology has some drawbacks also that have been discussed in the Table 3.

Table 3: List of Demerits Associated with the Solar Energy based Technology.

Demerits	Explanations
Expensive	Since the solar energy based technology is an emerging technology that is why the heavy financial investment is required at the beginning of the installation of the solar systems that makes this technology expensive that is why it is difficult for the poor people to use this technology
Dependency on weather conditions	Since, solar energy depends on the sun so in the bad weather conditions the efficiency has been decreased significantly. In rainy seasons or cloudy atmospheric conditions, this technology faces negligible effect of sunlight.
Cost of the storage of the solar energy is high	There are two ways by which solar energy based technology can be used. First one is that solar energy can be directly utilize or second one is that the solar energy stored in some batteries so that it can be used subsequently in the absence of sun in the day or at night.
Required large area	For the high production of the electricity by utilizing the solar energy, the solar panels or systems require large area of installation. Some countries make solar farms in open area so that electricity can be generated at large scale.
Linked with some pollution activities	There is no directly link between the emissions of the harmful gases or any other kind of pollution but for the transportation and installation of the solar systems utilizes heavy machineries and vehicles that increases chances of emission of carbon dioxide or other harmful gases to the atmosphere that can cause global warming and climate change.

FUTURE OF TECHNOLOGY BASED ON SOLAR ENERGY

Solar energy has huge potential to fulfill the demand of the electricity. It provides various benefits in terms of inexpensiveness, capacity, effectively as well as efficiency as compared to the other energy resources. Since, it

is available in the nature in unlimited quantity that makes solar energy is a promising energy resource for the future in order to fulfill the demand of the electricity. Currently, solar energy based technology utilizes the silicon technology for the development of the solar systems and devices. The researchers and scientists from all across the world trying to find new materials for enhancing the efficiency and productivity of solar power-based systems. Some researchers have been developed devices based on the 2D materials like the graphene as well as transition metal dichalcogenide materials. Since these materials offers exceptional electrical, optical and mechanical properties that is why it can implemented to develop next generation solar energy based systems with improved efficiency.

DISCUSSION

Commercial technologies for production of the electrical energy generally utilize the non-renewable energy resources such as fossil fuels and coal. But the most common drawback associated with the non-renewable energy resources is that it produces hazardous waste products as well as emits various greenhouse gases. In contrast, renewable energy resources are best alternative of the non-energy resources because these energy resources are environmental friendly and don't generate any kind of toxic wastes. Solar power is considered as the better renewable energy resources that have huge commercial benefits in terms of generation of electricity. PV system is best example of the solar system that produces electricity in clean manner. By giving an importance to the climate change issue, developed as well as developing countries now trying to shift from commercial technologies to the solar energy based technologies for the products of the electricity. USA, UK, Germany, Australia, China, Japan and India are the major countries that are focused on solar energy based electricity generation. Every technologies has some limitations and disadvantages apart from various benefits, like that solar energy based technologies also facing some challenges and limitation that has to be overcome for the improvement of the efficiency and productivity.

CONCLUSION

Solar energy based technologies are now matured and widely utilized all across the world for the generation of the electricity. Rapid growth in the technology development in the solar energy sector makes this technology more efficient and productive. At the beginning, the purchasing and installation cost was very high that is why it was difficult to use by the poor peoples. In recent years, the development in this sector make accessible to the general public. Energy generations industries are also shifting to the solar energy based technology and try to establish the large area solar farms for the production of the electricity at large scale. PV systems are the main equipment that are utilized for the generation of the electricity but these systems takes too much area for the installation, in this regard it is recommended for the future that new materials needs to be extensively researched for the fabrication of the PV cells so that efficiency and productivity can be improved as well as less area required for the installation of the PV systems.

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