Asian Journal of Research in Social Sciences and Humanities
ISSN: 2249-7315 Vol. 11, Issue 11, November 2021 SJIF 2021 = 8.037
A peer reviewed journal

A SOLAR ENERGY REVIEW AND ITS DIVERSE APPLICATIONS

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DOI: 10.5958/2249-7315.2021.00262.8

ABSTRACT

Solar energy, often known as solar thermal energy, is a kind of thermal energy that may be collected utilizing a number of sophisticated emerging technologies, including photovoltaic's and solar thermal energy. Traditional energy harvesting techniques depend on nonrenewable energy sources, which have a major negative environmental effect since they emit a range of harmful and toxic chemicals. Solar energy is one of the most promising and finest nonrenewable energy options available. It may be used as a primary energy source as well as for secondary energy production such as electricity and steam. Solar energy has two major benefits: it is inexpensive and generates less pollution. Solar energy is extensively utilized to generate electricity, which is a major use of solar energy. The purpose of this review essay was to give a high-level overview of solar energy and its possible applications. Solar energy has the potential to help fulfill the energy needs of a rising population in the future in a more effective way.

KEYWORDS: *Conventional Energy, Electricity, Photovoltaic Cell, Renewable Energy, Solar Energy.*

1. INTRODUCTION

Nonrenewable resources are natural resources that do not regenerate at the same rate as they are used. There are just a few left. Fossil fuels such as oil, natural gas, and coal are examples of nonrenewable resources. Humans destroy these substances' reserves on a regular basis, but new supplies take millennia to generate. These nonrenewable resources help power plants by enabling them to generate more energy on demand. These energy resources are utilized in two ways: I to create primary energy resources like gasoline and diesel, which are directly used in vehicles, and (ii) to create secondary energy resources like electricity and steam, which are generated using coal and petroleum products. We have already utilized 60% of non-renewable energy storage capacity, which means that further excessive use of non-renewable energy resources may lead to future energy instability. Aside from this, one of the most serious disadvantages of non-renewable energy sources is the emission of harmful and toxic gases. The discharge of these gases into the atmosphere has a negative impact on the environment. Rising levels of nitrous oxide (NOx), carbon dioxide (CO2), carbon monoxide (CO), and sulphur dioxide (SO2) contribute to climate change and global warming (SO2)(1–3).

To solve such issues, renewable energy resources are being investigated on a greater scale. The lack of toxic gases and other harmful contaminants, as well as the availability of renewable energy sources, are significant advantages. Some of the most common renewable energy sources are wind energy, solar energy, geothermal energy, and hydropower. Renewable energy sources have the advantage of having an infinite supply over time, but their availability at any one moment is limited. The sun, for example, rises every day, but when it is overcast, its ability to generate energy is limited. Another disadvantage is that power plant operators are unable to increase renewable energy production when people use more electricity, such as when many people are using air conditioners at the same time on a hot day(4–7).

Among all renewable energy sources, solar energy is one of the most promising for consumption. Solar radiation, which includes infrared, radio waves, UV rays, and gamma rays, among other things, is how the sun's energy reaches the earth. Heat is the most common type of energy emitted by the sun, and it may be utilized for a number of reasons. Solar energy may be used as both a primary and secondary source of energy for the production of electrical energy and steam. Solar-powered power plants are especially useful in rural and other distant locations because they reduce the burden on transmission and distribution lines. One of the most potential applications for addressing the growing need for energy among the world's growing population is power generation. Solar power plants are currently being constructed in both developed and developing nations in order to produce electricity in a more environmentally friendly way. Apart from the many advantages, solar-powered energy production has a number of drawbacks and difficulties. Some of the most common challenges are weather dependency, low efficiency, and a high initial setup cost. These challenges must be addressed in order to progress this technology(8–11). This review article looked at solar energy and its associated components, such as materials, applications, and future prospects. This article will compare and explain how solar energy is better to other renewable energy sources, as well as look at other renewable energy alternatives. The comprehensive study of solar energy will assist scholars in grasping the fundamentals of solar energy.

1.1 Solar Energy:

Solar energy is a kind of thermal energy produced by the sun. The main source of thermal energy is the fusion process that occurs on the sun's surface. Because of the many disadvantages associated with non-renewable energy sources, the usage of solar energy has grown during the last two decades. The high amounts of harmful gas emissions into the environment, such as SO2, NOx, and CO, are one of the main drawbacks of nonrenewable energy sources. These gases lead to increasing air pollution, which has led to a host of problems such as climate change and global warming. In order to address such problems, renewable energy has been considered as one of the most promising alternatives to non-renewable energy sources. Solar energy is a renewable source of energy that will never run out of supply(3,12,13).

Solar energy from the Sun is dispersed equally in all directions, while other planets, such as Earth, get solar energy from the Sun at different intensities. The distance between the sun and the planet, as well as the planet's atmospheric conditions, determine the intensity of solar energy. The different layers of gases and particles that each planet possesses influence the sun's strength. The power density of solar energy received on Earth is modest, ranging from 0 to 1.2 kW/m2. Given the significance of solar energy, a number of facilities have been built in recent years in a variety of countries to produce more electricity(14–16).

Solar energy may be utilized in two ways: as a primary energy source, which can be used directly for a range of purposes; and as a secondary energy source, which can be used indirectly for a number of applications. Solar energy may be used directly for cooking and water heating, as well as (b) for the production of secondary energy resources, which are energy resources that are produced from primary energy resources or converted from primary energy resources to secondary energy resources. For example, electricity and steam are two of the most common secondary energy sources. Electricity production is one of the best uses of solar energy, as well as one of the most promising. Solar energy-based power production is especially advantageous in rural and isolated areas. It helps in the local generation of power, resulting in a reduction in energy transmission and distribution. It also contributes to the growth of local infrastructure(4,17,18).

1.2. Applications of Solar Energy:

Renewable energy resources may be used as primary energy resources as well as for the production of secondary energy resources by converting themselves to energy resources. Solar energy resources, like other renewable energy sources, have a broad range of applications and may be used to meet a variety of energy requirements. The following are some examples of solar energy applications:

1.2.1. Generation of Solar Electricity:

Photovoltaic cells may convert solar energy into electricity or vice versa. A photovoltaic cell is an energy conversion device that converts photons from sunshine into electricity directly. Semiconductors absorb solar photons and produce high-energy free electrons. When subjected to an electric field, these high-energy free electrons flow out of the semiconductor and do meaningful work. A p-n junction of materials with differing electrical characteristics produces the electric field in solar cells. Several manufacturing methods are used to make these cells as efficient as feasible. To create cell modules, these cells are stacked in a parallel or series configuration(6,19,20).

1.2.2. Solar Collector:

A solar collector is a device that collects and/or concentrates solar energy from the Sun. These devices are often used for active solar heating and allow for personal water heating. Due to the fact that they are exposed to a variety of weather conditions, these collectors are typically placed on the roof and must be very robust. These solar collectors may be used instead of a water heater to heat water in the house, perhaps saving money in the long term. A large number of these collectors may be put together in an array and used to produce electricity in solar thermal power plants or in homes. Each collection class has a unique set of advantages that may be utilized depending on the situation. Some are inexpensive and easy to maintain, while others are more expensive and need more maintenance yet offer excellent efficiency. Depending on the need, the best solar heat collectors may be selected from a wide range of solar heat collectors.

1.2.2.1. Types of Solar Collectors:

Solar collectors come in a variety of shapes and sizes, but they always follow the same basic design principles. In general, some substance is used to gather and focus solar energy so that it may be utilized to heat water. Some of the solar collectors are as follows:

- Flat Plate Collectors
- Evacuated Tube Collectors
- Line Focus Collectors
- Point Focus Collectors

1.2.3. Solar Cooker:

A solar cooker is a kind of solar cooker that uses the sun to cook. The solar cooker works on the idea that the sun heats the pot in which the food is cooked. By turning light energy into heat energy, the pot gets warmed up. Concave mirrors are utilized in these kinds of cookers because they reflect sunlight into a single focus point. The sun's rays are concentrated by the mirror onto a receiver, such as a frying pan. UV light rays enter a solar cooker and are converted to longer infrared light rays, which cannot escape. When food is exposed to infrared radiation, water, fat, and protein molecules vibrate energetically and heat up. The process of light energy interacting with the receiver material and turning light to heat is known as conduction. Using heat-conducting and heat-retaining materials, we may maximize this transition. Solar cookers are divided into two categories(6).

1.2.4. Solar Water Heating:

A solar water heating system consists of a blackened flat plate metal collector with accompanying metal tubing pointing in the general direction of the sun. A transparent glass cover sits above the plate collector, with a layer of thermal insulation underneath it. On cloudy days, a conduit links the collector's metal tubing to an insulated tank that keeps the hot water warm. Solar radiation is collected by the collector, which subsequently transfers the heat to the water flowing down the tube, either by gravity or with the help of a pump. The hot water is sent to the storage tank through a metal tube. This kind of water heating system is used in hotels, guest houses, tourist bungalows, hospitals, canteens, as well as residential and industrial units.

1.2.5. Solar cells:

Photovoltaic (or solar) technology is a type of semiconductor device that uses solar radiation to generate electricity. It is a pn-junction based semiconductor device composed of two types of extrinsic semiconductor materials: n-type and p-type semiconductor materials. A pentavalent impurity is added to the pure semiconductor material to create the n-type semiconductor material. The materials with the five valence electrons in the outermost orbit are known as pentavalent impurities. Phosphorous and antimony are two of the most frequent pentavalent impurities.When pentavalent impurity is added to silicon, for example, all valence electrons form covalent bonds with the neighboring four valance electrons of the pentavalent impurity, resulting in the formation of n-type silicon.

Following the establishment of covalent connection between the impurity atom and the pure material atom, a fifth electron remains unattached to the parent impurity atom and is weakly bound. By giving the atom a little amount of energy, these fifth electrons can be freed.Because the excess fifth electrons increase the amount of free charge carriers in the material, electrons are the majority charge carriers in n-type semiconductors, whereas holes are the minority charge carriers. A trivalent impurity is added to pure semiconductor material to create p-type semiconductor material. The doping process is the addition of an impurity to a pure semiconductor material.The three electrons in the outermost orbit are found in trivalent impurities. When a trivalent impurity is introduced to a pure semiconductor material, a vacancy is produced with a positive charge equal to the electron's charge magnitude. These vacancies are commonly referred to as holes, and they serve as charge carriers by accepting electrons.Because electrons have a higher mobility than holes, electrons provide more current. Charge carrier mobility in the germanium material is greater than that of silicon, resulting in better conductivity.

2. DISCUSSION

Academics have been very interested in renewable energy in recent years since it is regarded as the most feasible alternative to non-renewable energy sources such as coal, natural gas, and nuclear power. Nonrenewable energy sources emit a large amount of harmful gases and other toxic pollutants, all of which have a detrimental effect on the environment. The most serious issue associated with nonrenewable energy resources is air pollution. Air pollution causes a slew of problems, including climate change and global warming. Renewable energy resources, on the other hand, are natural green resources that are abundant in nature. Solar energy is considered one of the most promising renewable energy resources for electricity generation among all renewable energy resources. Solar energy has been used to generate electricity on a larger scale in recent years. Solar cells, solar power plants, solar heat collectors, solar cooking, and solar water heating are some of the most popular solar energy uses. Solar energy may be used directly in certain situations, and it can also be used to generate other energy resources such as electricity and steam. Many industrialized and developing nations have built solar power facilities in recent years to

meet the increasing demand for energy.

3. CONCLUSION

Solar energy is one of the most promising energy options for meeting the growing need for energy. Solar energy offers a number of benefits over nonrenewable energy sources, including availability and the lack of harmful gas emissions. Solar energy can be used without causing environmental damage. In recent years, many power generation companies have been paying close attention to it in order to shift their reliance from non-renewable energy sources to solar power. Despite its many benefits, solar energy has a number of drawbacks, including a high initial cost, weather dependence, and low efficiency, to name a few. Because sunshine is not accessible in inclement weather or at night, an extra storage system is needed, resulting in a high initial cost for a solar energy-based system. To address these issues, it is suggested that the government provide a suitable framework for the creation of renewable energy-based systems so that costs may be reduced, as well as encourage R&D in this area so that progress can be made on a regular basis.

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