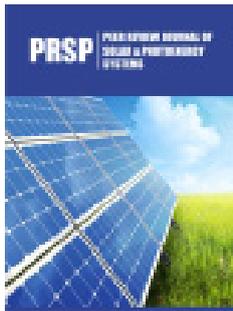


Principles and Applications of Solar Energy

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Submission: 📅 April 28, 2022

Published: 📅 July 27, 2022

Volume 2 - Issue 2

How to cite this article: Idowu David Ibrahim, Yasser Alayli. Principles and Applications of Solar Energy. Peer Rev J Sol Photoen Sys. 2(2). PRSP.000532. 2022.

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Introduction

Solar energy is the energy from the sun that falls on the earth's surface. Solar energy is created by the constant nuclear fusion reactions occurring deep within the sun. Nuclear fusion in the sun happens when protons (which are essentially the same as hydrogen atoms) collide and fuse under extreme temperature and pressure to create helium. This process emits a massive amount of energy (plus more protons), and in the core of the sun, this reaction is constantly happening, producing over 500 million tons of hydrogen atoms every second. The intensity of the energy is a result of the distance between the sun and the earth. The minimum intensity occurs in December (winter solstice) and the maximum in June (summer solstice) of each year. The distances between the sun and earth during the minimum and maximum intensity scenarios are respectively 1.471×10^{11} and 1.521×10^{11} meters. Therefore, the amount of solar radiation that the earth intercepts vary per time throughout the year depending on the earth-sun distance having an average of 1.496×10^{11} .

Solar energy can be regarded to be in the same form as electromagnetic radiation having wavelengths varying from approximately 0.3×10^{-6} to over 3×10^{-6} m, which tally with ultraviolet (less than 0.4×10^{-6} m), infrared (over 0.7×10^{-6} m) and visible (0.4×10^{-6} m and 0.7×10^{-6} m). This form of energy is predominantly concentrated in the visible wavelength and close to the infrared wavelength range. Incident solar radiation, also known as insolation, is calculated in irradiance or kW/m^2 . The average total amount of solar radiation striking the earth's surface, normal to the sun incident rays outside the earth's atmosphere, extra-terrestrial insolation and at an average earth-sun distance is known as the solar constant. This constant was recently measured to have a value of 1366.10 W/m^2 .

Solar energy is one of the most popular forms of renewable energy and the most exploited form of alternative and renewable energy. This energy can be used directly (for drying, cooking, water heating, space heating, etc.) or indirectly by converted into other forms of energy like electricity which can then be used for transportation, etc. Based on these, we look at practical applications of solar energy with a major focus on heat rather than light.

Application of Solar Energy

The sun is the main source of life on earth, and it is useful in many amazing ways. Two major forms of energy are created from the sun, namely heat and light. These forms of energy can be harnessed for several applications ranging from plant photosynthesis to electricity generation. Let's discuss in detail several and most common uses and benefits that are derivable from the sun.

Solar electricity

Electricity generation is among the solar energy applications, which have gained momentum in the last two decades. The cost of a solar panel is constantly declining, and people are becoming aware of the economic and environmental benefits associated with solar energy, thus, solar electricity is increasingly and continuously becoming accessible.

Solar water heating

The use of solar energy also extends beyond electrical power generation to water heating systems. Most residential and commercial buildings make use of solar energy to heat water as solutions to the energy crisis and environmental concerns globally. Solar water heating could be by evacuated tube, flat plate collector, parabolic trough collector, Heliostat field solar collector, linear Fresnel collector, etc. Another popular application of solar energy is heating swimming pools.

Solar heating of buildings

Typical uses of solar space heating systems include powering radiant floors or pairing with a forced hot air system to heat a home. solar space heaters are designed to use liquid or air as a means of harnessing sunlight and converting it into thermal energy. These solar thermal solutions can either be passive or active. The passive systems leverage natural convection to circulate heated liquid or air, while active solar heating systems use pumps to induce the circulation of heated water. Passive solar home design during winter takes into consideration the placement of windows and the selection of certain materials that can store energy and use it at a later stage in the building.

Solar ventilation

Solar ventilation solutions such as solar attic fans can reduce the burden of HVAC by cooling the building (residential or commercial) during the summer. This reduces the burden of gas-powered air conditioning systems, thus, making it a smart way of using solar energy.

Solar lighting

Solar lighting has become universal and can be found everywhere from home landscaping and security lights to road

signs and streetlights. Unlike standard outdoor lights, solar lighting is mostly wireless, easy to install and reduces reliance on the power utility-supplied at night.

Portable solar device

In the current technology age, phones and tablets are constantly with us and often run low on battery. Portable Solar Photovoltaic (PV) chargers can be used to keep our electric devices charged while on the go. Lightweight and water-resistant solar cells have been developed by researchers in Japan that will someday be sewed into clothing to power our devices.

Solar powered wearable tech

Several wearable techs are powered by solar energy; this is not something new in smart and portable electronics. Portable solar chargers can charge or power a wide range of electronics, from smartphones to smartwatches, cameras, tablets and much more.

Solar transportation

Solar-powered vehicles are becoming popular globally and an alternative to fossil fuels. The existing applications of solar energy in transportation include powering buses, trains, drones, and race cars. Most countries like China, USA, Germany, Italy, France, etc. have fully solar-powered cars already in use.

Solar cooking

The energy crisis in most developing countries has necessitated the use of solar energy for cooking. An example of a solar cooker is the flat plate box. This consists of a well-insulated wooden or metal box that is blackened from the inner side.

Conclusion

Solar energy is one of the most abundant renewable energy resources and it is freely available. The major applications of solar energy include solar electricity, solar water heating, solar heating of buildings, solar ventilation, solar lighting, solar transportation, solar ventilation, solar cooking, and many more. The advantages of solar energy include green energy, no pollution, abundantly available and absolutely free, and suitable for remote locations that are not connected to the main power grid. The use of solar energy will reduce carbon footprint and make the environment better.

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