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Investigating the Future of Solar Energy Application and its Benefits in the Mechanical Engineering Field

RESEARCH

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Abstract

Solar energy is typically used directly, either by converting it to electricity using photovoltaic solar cells or by creating and absorbing heat using thermal cells. Excess solar energy reaches the Earth's surface and disperses throughout the globe, generating localized heating on the rotating surface, which drives weather patterns and ocean currents.

Solar offers an important advantage because the solar energy is predicted to be available for the next five billion years, making it nearly limitless. It is worth mentioning that, unlike fossil fuels, which require millions of years to replenish, solar electricity is available on a daily basis and offers a clear, if overly easy, alternative.

Organic materials have some advantages for solar photovoltaic cells due to lower production costs and environmental friendliness. According to the classic solar cell, electricity cannot be generated without sun radiation. However, in the near future, power will be generated at night without the need for sunlight, according to the anti-solar cell concept.

The study methodology used the descriptive analytical method mainly by documenting a group of previous studies that were highly relied upon in this research, as they were discussed and analyzed. This was done in

order to achieve the main objectives of the research, which revolve around:

1. Studying the future of solar energy applications.

2. To investigate the importance of these applications in the field of mechanical engineering.

Keywords: (solar energy, mechanical engineering, renewable resources, electricity)

1. Introduction

Solar energy and its derivatives are the solution and driving force behind all of the energy it has access to and will continue to utilize in the near future. While nuclear energy has a position in our energy portfolio, it will take some time before it can substitute current projects, and even then, it will most likely do so in ways we have yet to recognize or accept (Sumedha R.G, 2020).

Rhodes (2010) confirmed that regardless of whether it is renewable or non-renewable, all of the present energy are used comes from the sun. Wind, as well as current solar and thermal cells, are all renewables that rely on the direct effects of the sun.

Obviously, if it is considerably offset non-renewables, it must be increased our usage of solar energy through these renewables (Sumedha R.G, 2020). The direct use of solar energy should thus be a critical component of any strategy for offsetting the use of fossil fuels in order to generate clean, renewable power. However, in its current forms, it is frequently unreliable due to the way it is used, particularly because the existing methods rely solely on nature. With all of the volatility inherent with solar, producing consistent, reliable, and hence economical power can be tough (Rajput, 2017).

Among the most distinguishing characteristics of solar power is the impossibility of anyone other than highly organized and well-funded power firms to deliver electricity into a power system (Rhodes, 2010). Localized sources, such as houses, businesses, and even communities, can generate additional energy sources. Unfortunately, most moderately sized grids are incapable of handling huge supplemental sources and are even less likely to be capable of integrating, smoothing, filtering, and synchronizing these additional nodes (David, 2019).

As a result, the grid will require significant upgrade planning and control to accommodate changes in energy sources, as well as the addition of grid-level power storage to balance out unexpected and unanticipated power inputs (Sumedha R.G, 2020).

Annually, around 1.524 x 1012 gigatonne of energy from the Sun strike the Earth's surface. Humans, on the other hand, consume 2.38 x 107 gigatonne-hours, or around 0.0016 percent of the total energy produced by the Sun and transmitted to the Earth (Maddileti, 2019).

This solar energy is frequently utilized directly by turning it into electricity with photovoltaic solar cells or by producing and capturing heat with thermal cells. Excess solar energy that reaches the Earth's surface disperses over the globe, causing localized heating on the rotating surface, which drives weather patterns and ocean currents (Thannikkatt, 2013).

Solar has a significant advantage because the sun's energy is expected to be available for the next five billion years, making it virtually unlimited. It is worth noting that whereas fossil fuels require millions of years to replenish, solar electricity is available on a daily basis and is a clear, but excessively simple, alternative (Shaikh, 2017).

The question then becomes whether it is available in sufficient quantities to meet localized needs and whether it can be managed to deal with storage and distribution issues caused by the diurnal cycle (Rhodes, 2010). Furthermore, while the overall energy available from the Sun is enormous, it is scattered across the entire world; thus, catching it in ways that are sufficient for specialized needs has yet to be addressed or even contemplated for the future needs of the globe as humankind continues to modernize (Rajput, 2017). The primary goal of this research is to investigate the future of solar energy applications. As well, determine its benefits in the mechanical engineering field.

1.1 Problem Statement and Questions

This section of the research identifies the research problem and the primary research questions that will be addressed using the theoretical framework of research:

1.1.1 Problem Statement

When it comes to solar energy technology, its use and efficiency are limited due to its intermittent and variable qualities. Hybrid solar systems are commonly applied in rural and mountainous areas that are remote from large power lines. Solar energy cannot deliver a constant and stable active power output due to its randomness and diversity. In general, because the distribution of natural resources is determined by the culture of the individual community, this solar energy will not be adaptable everywhere in the far future (David, 2019).

Shaikh (2017) asserted that significant contributions are taken to enormous innovation in the solar energy area in order to achieve high efficiency while emitting less pollution. The usage of crystalline silicon for generating solar cells can be costly in the solar energy area due to the expense of extraction and manufacturing procedures. As a result, organic materials will be included as novel materials for the construction of solar cells in the future.

The use of organic materials for solar photovoltaic cells has some advantages due to lower production costs and environmental friendliness. Electricity cannot be generated without sun radiation, according to the classic solar cell. However, under the anti-solar cell concept, power will be created at night without the need for sunlight in the near future (Maddileti, 2019).

1.1.2 Research Questions

The following are the study's questions, which clarify what this research attempts to answer:

1. What effect does solar energy have on the field of mechanical engineering? What are the benefits of using solar energy on mechanical engineering?
2. What are the applications used for solar powered vehicles?
3. What is the future of solar energy applications predicted to be?

1.2 Research Significance

This section of the study offers theoretical and practical implications that are supposed to assist the readers:

Because smart materials comprised qualitative developments in practical research as well as theoretical research, a comprehensive examination of the literature and published research was undertaken in this study. Smart materials technology has been used in a variety of fields, including construction engineering, textile manufacturing, electronics manufacturing, and biomedical engineering. Yet, it has been noticed that some disciplines have not invested or have used smart materials' distinctive qualities and functions sparingly in developing their industry.

Renewable sources that originates from the wind, the sun, geothermal energy, and other non-renewable sources. This study focuses on solar energy by identifying its current and future applications, improving the efficiency of solar energy and photovoltaic cells by altering the optical properties of smart materials technologies, identifying key opportunities, and recommending a future strategy for wind turbine technology and actuators. In addition to determining the benefit of solar energy applications in the field of mechanical engineering, as it is required to use it to improve energy savings in various climates.

1.3 Research Objectives

This research mainly involves investigating the Future of Solar Energy applications and their Benefits in the Mechanical Engineering Field. While the primary goals of the research are as follows:

- Investigating the effect that solar energy have on the field of mechanical engineering. Besides, discussing the benefits of using solar energy on mechanical engineering.
- Studying the applications used for solar powered vehicles.
- Investigating the future of solar energy applications predicted to be.

2. Literature Review

This literature review provides a critical examination of the research arguments presented in numerous scholarly articles on the topic of the current study. The selected academic work sheds light on the study of the future of solar energy applications and benefits in the field of mechanical engineering.

2.1 Solar Energy

Kabir (2017) justified that it has been known that fossil fuels such as coal, oil, and natural gas are now the primary sources of energy on a worldwide scale. Because of the three reasons listed below, it is appropriate to employ naturally accessible renewable energy in the form of solar energy to replace fossil fuel energy. (a) With the advancement of science and technology, as well as the ever-rising global population, overall energy consumption is increasing on a daily basis. (b) Fuel supplies are diminishing. Fossil fuels are quickly decreasing around the planet, and (c) when burned, fossil fuels generate greenhouse gases that contribute considerably to global warming.

Importantly, over the previous two or three surprise decades, practically all developed/developing countries have continued to pursue frenzied research in order to make the most of solar energy through diverse processes such as thermal processes and photovoltaic processes (Rhodes, 2010). In India, for example, various research organizations are actively engaged in exploring the efficient use of solar energy through a range of methods. Solar energy is the light and heat released by the sun, which has been harnessed by man since ancient times through a variety of ever-evolving technology (Jäger, 2014).

Solar energy techniques include the use of thermal energy from the sun, whether for direct heating or as part of a mechanical conversion process for generating electricity through photovoltaic phenomena (David, 2019). As well as architectural designs that rely on the exploitation of solar energy, which are techniques that can contribute in addressing some of the world's most important issues today (Rajput, 2017).

Solar radiation is responsible for the majority of the renewable energy sources present on Earth's surface, as well as secondary energy sources such as wind energy, wave energy, hydropower, and biomass. It is worth mentioning that have been only consumed a small portion of the available solar energy in our lifetime. Heat engines or photovoltaic inverters generate electrical energy from solar energy (Sumedha R.G, 2020).

Once solar energy has been transformed into electrical energy, only human ingenuity can determine how it is used. Solar energy is used in a variety of applications, including heating and cooling systems during architectural designs that rely on solar energy, drinkable water during distillation and disinfection, the use of sunshine, water heating, solar cooking, and high temperatures for industrial uses (Abbood, 2019).

Solar technologies are classified as either passive solar energy systems or active solar energy systems based on how sunlight is captured, converted, moreover, delivered. The employment of photovoltaic panels and the solar thermal collector, along with mechanical and electrical equipment, to transform sunlight into other useful forms of energy is one example of a technology that relies on the exploitation of positive solar energy (David, 2019).

In the upper atmosphere, the planet receives 174 petawatts of incoming solar energy (solar radiation). About 30% of this radiation is reflected back into space, with the remainder absorbed by clouds, oceans, and landmasses. The majority of the solar light spectrum on Earth's surface is dispersed in the visible and near-infrared ranges, with a tiny percentage scattered in the ultraviolet range (Thannikkatt, 2013).

The amount of solar energy that reaches the Earth's surface is so vast that it is roughly twice as much as what would be gotten from all of Earth's energy sources combined, such as coal, petroleum, and natural gas, in one year (Rajput, 2017). The table of energy sources will show that solar, wind, or biomass energy will be sufficient to meet all of our energy needs. However, increased use of biomass energy has a negative influence on global warming and has significantly increased food costs because of the exploitation of forests and crops for biofuel production. Because wind and solar energy are renewable energy sources, they have brought additional concerns (Shaikh, 2017).

2.2 The Applications of Solar Energy

Sumedha R.G (2020) asserted that solar energy mostly refers to the practical application of solar radiation. Except for tidal and geothermal energy, all renewable energy sources obtain their energy from the sun.

Solar technology can be either passive or active, depending on how sunlight is captured, processed, and dispersed. Photovoltaic panels, pumps, and fans are used in positive solar technology to convert sunshine into other usable kinds of energy. As a result, they are regarded as secondary sources to meet the demand for large amounts of energy (Jäger, 2014). According to (Guney, 2016), the most important applications of solar energy are:

2.2.1 Civil and Architectural Engineering

Since the dawn of architectural history, sunlight has had an impact on building design. The Greeks and Chinese, who built their structures to the south to gather light and warmth, first used the advanced urban and architectural planning approaches that rely on the use of solar energy. The construction of buildings with a low surface area to volume ratio, selective shade (overhanging areas of buildings), and thermal mass is a typical feature of passive solar architecture planning

When these features are accessible to suit the surroundings and local climate, they can result in well-lit areas with a medium temperature range. The residence of the Greek philosopher Socrates, known as Megaron, is a typical example of passive solar architecture designs. Modern solar architecture designs employ computer designs that mix solar air conditioning/ventilation/solar heating/heating and day lighting/solar lighting systems into an integrated solar energy architectural design.

Painting buildings and roads white and planting plants are simple ways to mitigate the heat island effect. Using these strategies, the Towards Temperate Communities theoretical program in Los Angeles demonstrated that metropolitan temperatures might be reduced by around 3°C at a cost of US$1 billion, and provided an estimate of the programs' total annual profit potential. By lowering temperatures, these earnings are expected to be around US$530 million, because of cutting the costs of utilizing air-conditioning units and saving the state's healthcare costs.

2.2.2 Growing plants and orchards

Those interested with agricultural growth want to enhance the usage of solar energy in order to boost the production of farmed plants. Some approaches, such as timing the planting seasons, adjusting the orientation of the rows of grown plants, regulating the heights between rows, and combining different plant species, can increase crop production. While sunlight is a plentiful source of energy, others argue that solar energy is especially important for agriculture.

During the Little Ice Age, when crops were scarce, English and French farmers built clusters of tall fruit trees to maximize the quantity of solar energy collected. By preserving the fruit in a warm medium, these trees act as thermal masses and improve the rate of fruit ripening. Originally, these trees were built perpendicular to the ground and facing south, but they were tilted over time to make best use of sunlight. Nicolas Vaccio de Doilier proposed using a contraption that could revolve on an axis to follow the sun's rays in 1699.

Aside from agricultural cultivation, solar energy is used in agriculture to power water pumping devices, dry crops, incubate chicks, and dry chicken excrement. Solar panels' energy was employed to manufacture fruit juices in the contemporary age. Greenhouses turn sunshine into heat, allowing all crops to be grown year round and crops and plants that cannot grow in the local climate to be grown (in an enclosed setting).

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2.2.3 Water heating

Sunlight is used to heat water in solar heating systems. Solar heating systems can supply 60-70 percent of the hot water required in dwellings in geographic depressions (below 40 degrees) with temperatures as high as 60 degrees Celsius. The most prevalent forms of solar water heaters are evacuated tubes (44%) and flat plates (34%), which are frequently used to heat water in residences. as well as unglazed plastic panels (21%), which are mostly used to heat swimming pool water.

2.2.4 Heating, cooling and ventilation

Heating, cooling, and air conditioning systems account for 30% (4.65 kW) of energy used in workplaces and approximately 50% (10.1 kW) of energy used in residential structures in the United States. Some of this energy can be countered by using solar heating, cooling, and ventilation systems.

A solar chimney (or thermal chimney in this context) is a passive solar ventilation system that consists of a vertical shaft connected to the inside and outside of a structure. When the temperature of the chimney rises, the air inside the building is heated, causing an upward stream of air to rise and be replaced by cooler air. The use of thermal mass materials and polished surfaces that simulate the operation of a greenhouse can improve chimney outcomes.

2.2.5 Water treatment

To make salty and brackish water drinkable, solar distillation is utilized. Arab chemists were the first to apply this approach in the sixteenth century. In the Chilean mining town of Las Salinas, the first big solar distillation project was established in 1872. Solar stills are available in single-slope, double-deck (greenhouse-like), vertical, conical, reverse absorbent, and multi-effect designs. These devices can function in an active, passive, or hybrid manner.

The World Health Organization suggests using solar energy to disinfect water as a simple approach for cleaning water in households and storing it safely. It is worth noting that over two million individuals in underdeveloped nations to treat their everyday drinking water use solar water disinfection.

2.2.6 Electricity generation

Photovoltaic (PV) converters, the Concentrating Solar Process (CSP), and a variety of other experimental approaches can convert direct sunshine into power. Photovoltaic inverters are typically used to power small and medium-sized appliances, ranging from a calculator powered by a single sun cell to off-grid residences powered by a solar cell array.

Solar energy, as a renewable energy source, necessitates a backup supply, which can be partially wind energy. This assistance is typically provided by batteries, but devices typically utilize hydroelectric energy stored by pumping. The University of Kassel's Institute of Solar Energy Generation Technology is testing a virtual power plant linked to an energy storage system, where energy can be generated from solar energy, wind energy, organic gas, and pumped-storage hydroelectricity to provide enough energy for continuous use; thus, the project is entirely reliant on renewable resources.

2.2.7 Solar powered vehicles

Since the 1980s, the development of a solar-powered car has been a prominent aim in engineering. The World Solar Challenge, held twice a year, is a global competition for solar-powered cars in which teams from colleges and organizations compete to travel 3,021 kilometers (1.877 miles) across Australia from Darwin to Adelaide. Some cars use solar panels to get more energy, such as for air conditioning and maintaining a cool atmosphere inside the car, which saves fuel usage. In 1975, the first solar-powered watercraft was developed in England. Passenger boats outfitted with photovoltaic panels first appeared in 1995, and they are now widely used.

The Sunrise, an unmanned aircraft, became the first solar-powered aircraft to fly in 1974. The Solar Razer was the first aircraft to fly with solar energy on April 29, 1979, with a fully controlled and staffed crew. The Josmar Albatross "solar-powered aircraft" made the first piloted flight using purely photovoltaic electricity in 1980.

A solar balloon is a black balloon filled with normal air that, when exposed to sunlight, heats up and expands, generating an upward thrust, similar to an artificially heated air-filled balloon. Some solar balloons are large enough to carry a person, however they are only available in recreational equipment stores because to their high surface area to net weight ratio.

Solar powered spacecraft are a type of spaceship propelled by narrow mirrors that take advantage of the sun's radiant energy pressure. Solar-powered ships, unlike missiles, do not require refueling. Although the ship's upward thrust is feeble in comparison to that of rockets, it will continue to climb as long as the sun shines on it and can reach great speeds in space.

The Missile Extrusion Division of the United States Department of Defense has signed a contract with the US armament contractor "Lockheed Martin" to create a high-altitude aircraft to supplement the ballistic missile defense system. These motorized blimps outperform solar-powered aircraft because they do not require a steady supply of energy to stay aloft, and a considerable portion of their outside surface is highly exposed to the sun.

3. The Future of Solar Energy

Today, there is 227 GW of total solar PV capacity built around the world, which supplies around 1% of global energy needs. Solar energy has the potential to become a substantial source of energy for some localized areas, with many countries expecting to enhance their solar production over the next 25 years (Jamshidi, 2017). While the rise of solar energy has created new opportunities, there are some challenges that must be addressed. To begin with, solar energy is highly unpredictable because the sun does not always shine every day or all day (Kabir, 2017).

While some of these concerns can be addressed by the modernization of electrical grid infrastructure and the implementation of grid-level power storage devices, these advancements would require a major financial and technological investment on the part of utility companies around the world. Most of these issues ignore the current solar capture systems' life expectancy, maintenance, and replacement costs, as well as the environmental impact of their ultimate disposal and recycling (ibid)

Global manufacture of solar panels will eventually reduce costs while increasing efficiency and dependability, but this assumes that the materials required for present production as well as production of more sophisticated versions would be readily and affordably available (Jamshidi, 2017).

4. Conclusion and Recommendations

Traditional solar energy power generating is widely regarded as unsustainable in the end because to inability cases and low power efficiency. As a result, more inventions are being introduced over the world. The most critical innovation alternative is nighttime electricity generating. Solar energy technologies, based on present technology, are in a condition to deliver adequate energy to rising energy needs, and when compared to nonrenewable technologies.

As a result, innovation is a critical aspect in the solar energy sector's development in order to maximize efficiency. As a result, this article delivers unique concepts and future perspectives on solar energy technology. Finally, innovation is a panacea for solar energy technology in terms of properly meeting future expanding energy demand.

The supply of solar energy will continue to affect the power system as the trend for increasing usage of renewable energy expands. When solar energy provides much less than the typical daily production, utilities must immediately boost the amount of energy produced from traditional energy sources. If there is insufficient electricity provided to the grid to fulfill demand, some areas may experience blackouts. In the event that renewable energies fall short of demand, these backup power facilities must always be operational.

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