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An Analysis of Usage of Solar Energy in Industries

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ABSTRACT: Solar energy conversion is now extensively utilized to create heat and power. According to a comparative analysis on global energy consumption published by the International Energy Agency (IEA), solar array installations will provide approximately 45 percent of global energy demand in 2050. Solar thermal has been discovered to be gaining a lot of traction in industrial applications. Solar thermal energy may be used to produce power, process chemicals, or even heat your home. Food, non-metallic, textile, construction, chemical, and even business-related sectors may all benefit from it. Solar energy, on the other hand, is widely used in the telecommunications, agricultural, water desalination, and construction industries to power lights, pumps, motors, fans, freezers, and water heaters. It is critical to use solar energy for a range of purposes and to offer energy solutions. Modifying the energy percentage improves energy stability, increases energy sustainability, reduces conversion, and therefore improves system efficiency. The goal of this research was to investigate into how solar energy systems are used in industrial applications and which industrial applications are more compatible with solar energy systems.

KEYWORDS: Energy, Heat, Industry, Solar, Thermal.

1. INTRODUCTION

Due to the significant rise in energy consumption in recent decades, energy usage has become a major issue. Furthermore, environmental problems associated with traditional energy supplies, such as climate change and global warming, are pushing us to seek for alternate energy sources. According to World Health Organization (WHO) data, direct and indirect impacts of climate change because the deaths of 160,000 people per year, with the rate expected to double by 2020. Natural catastrophes such as floods, droughts, and dramatic fluctuations in atmospheric temperature are all caused by climate change. Furthermore, certain illnesses, such as malaria, hunger, and diarrhoea, have become epidemics in society. One of the catastrophes was recorded in 2003, when it struck European nations, killing 20,000 people and causing $10 billion in damages in the agriculture sector [1]. Conventional energy sources now account for almost 80% of worldwide energy use.

The urgent need to replace energy sources was postponed in tandem with the discovery of nuclear energy in the mid-twentieth century, which would outperform fossil fuels by ten to twenty times. However, there are certain drawbacks to using nuclear power as a source of energy. Nuclear fusion, for example, exposes uranium and thorium ores, both of which are considered fossil fuels. Furthermore, nuclear power facilities are presently only accessible for large-scale electricity production. As a result, renewable energy remains the greatest option for cooking, heating, and small-scale applications. It is the source of energy that allows humanity to continue to exist on the planet without relying on fossil fuels. Solar, wind, biomass, hydropower, and tidal energy are all potential CO_2-free options. Despite widespread knowledge of the benefits of renewable energy, renewable energy accounted for just approximately 1.5

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percent of global energy consumption in 2006. In, the trend is expected to increase to 1.8 percent [2].

Because a large portion of energy is utilized in industrial processes, the significance of energy in industrial growth is critical. It now accounts for more than half of all global energy use. The industrial sector's supplied energy is used in four main areas: construction, agriculture, mining, and manufacturing. The industrial sector's energy consumption, savings, and emission analyses for electrical motors, compressed air, and boilers were addressed in, and it was discovered that this industry consumes a significant amount of energy [3].

Enterprises are no longer enticed to utilize fossil fuels in the industrial sector due to fast increases in conventional fuel costs and environmental concerns. The adoption of renewable energy-based technologies in industry may substantially decrease greenhouse gas emissions. As a result, conventional energy sources should be replaced with renewable energy sources, and new technologies must be created and implemented in enterprises. Solar power, out of all the renewable energy sources, has gotten the most attention as the most promising choice for industrial use. Solar energy is abundant, free, and pure, and it produces no noise or pollution in the environment. Many efforts have been made thus far to harvest solar energy using solar collectors, sun trackers, and massive mirrors in order to use it for industrial uses. In the industrial world, there are two types of solar energy applications: solar thermal and photovoltaic. Hot water, steam, drying and dehydration processes, preheating, concentration, pasteurization, sterilization, washing, cleaning, chemical reactions, industrial space heating, food, plastic, construction, textile sector, and even commercial issues are some of the most frequent uses [4].

1.1. Integration of Solar Energy into Industrial Systems:

Power supply, manufacturing plant, energy recovery, and cooling systems are the four major components of a typical industrial energy system. The energy required for the system to function is provided by the power source, which is mostly made up of electrical energy, heat, gas, steam, or coal. The production plant is a component of the system that manages the manufacturing process. This section uses energy to power subsystems, pressure/vacuum/temperature solenoids, valves, and switches. Solar energy systems may be used as a power source or directly to power a process.

1.2. Solar Thermal Energy:

Solar thermal may be defined as the conversion of solar irradiance into heat. Solar thermal is the most cost-effective option among renewable energy technologies. Solar collectors and concentrators are often used to collect solar radiation, store it, and utilize it to heat air or water in residential, commercial, or industrial facilities [5]. The location, type of collector, working fluid (to calculate necessary storage volume), and system size and storage volume (to establish heat exchanger size and load) are all variables to consider for particular applications. However, it should be remembered that solar energy is not accessible 24 hours a day for certain purposes.

Additional measures should be given in such situations to collect solar irradiation on sunny days, store it in an embedded phase transition, and release it in a regulated way under severe conditions. Solar collectors are used to heat the air or water as the medium of heat transfer to improve the efficiency of solar thermal systems. Each collection, on the other hand, is devoted to a particular application. Flat-plate collectors, for example, are well-suited to low-temperature applications, while concentrating and sun-tracking parabolic trough collectors (PTC) are well-suited to high-temperature applications in which the system can achieve temperatures of more than 250°C with high efficiency. In power generation, two axes tracking collectors are used, one stationary (non-tracking) and the other moving (tracking). Moveable collectors, in comparison to other collectors, have a greater maintenance cost [6]. A concentration ration is also provided, which is defined as the aperture area divided by the receiver/absorber area of each kind of collection. Solar thermal energy costs range between 0.015 and 0.028 C£/kWh, depending on the original investment and the kind of solar collectors employed. Solar thermal systems with wide collecting fields are more cost effective on a big scale. When compared to many tiny plants, they need less initial investment; nevertheless, the collector cost is greater [7].

1.3. Thermal Energy For Industrial Processes:

To produce critical thermal energy, almost all industrial energy networks and systems are partly or completely reliant on the combustion of fossil fuels. According to the distribution of energy consumption, about 13% of thermal industrial applications require low temperatures thermal energy up to 100°C, 27% require high temperatures thermal energy up to 200°C, and the remaining applications require high temperatures in the steel, glass, and ceramic industries [8].

Many industrial processes use heat at temperatures ranging from 80 to 240 degrees Celsius. Solar thermal energy has tremendous uses at low, medium, and medium-high temperature ranges, according to industrial energy analysis. Almost every industrial operation necessitates the use of heat in some form. Heating accounts for almost 15% of the final energy consumption in the industrial sector in southern European nations. SWHs, solar dryers, space heating and cooling systems, and water desalination are the most frequent industrial uses for solar thermal energy. Many industrial applications utilize solar as an input power source for heat engines. Stirling engines may operate with any kind of external heat source. They are very dependable, have a basic design and construction, are simple to use, and are cost efficient. The efficiency of such mechanical devices, however, are very modest. When compared to external combustion engines, they are more efficient and emit less pollutants. Solar irradiation may be used to produce heat for Stirling engines, lowering their cost and complexity while improving their efficiency. Solar-powered Stirling engines would be cost-effective if they were mass-produced in large quantities [9].

The most cost-effective option is to generate solar energy for industrial applications utilizing Stirling engines rated at 1–100 kW. On a Stirling cycle, compressed fluids such as air, hydrogen, helium, nitrogen, or steam are used. Stirling engines may be used in a variety of applications that need quiet operation, such as systems with many fuel sources, a suitable cooling source, low speed, steady power output, and a slow rate of changing output power. Solar energy is used to produce thermal energy for industrial operations, which lowers reliance on fossil fuels while also lowering greenhouse gas emissions such as CO_2, SO_2, and NOx.

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However, due to the periodic, dilute, and changeable character of solar radiation, there are certain difficulties in integrating solar heat into a broad range of industrial processes [10].

1.3.1. Solar water heating (SWH):

In both the residential and industrial sectors, solar water heating accounts for the bulk of solar thermal applications. They are thought to be the most cost-effective of all the options. There are presently accessible solar thermal technologies. SWH systems are currently marketed and well-established in a number of nations across the globe. The use of SWHs has grown at a 30 percent yearly growth rate since 1980. Solar collectors and a storage area are typically seen in SWHs. It is based on the density difference between hot and cold water, or thermo syphon. Because of their simple and compact construction, combined collector/storage SWHs are more popular in colder regions. Batch solar collectors are better at accounting for sun radiation restrictions in the afternoon and night time.

The once-through systems and the recirculating water heaters are the two major types of SWHs. Cleaning processes in the food sector often use once-through technology. As a result of the pollutants present in the used water, it is not permitted to circulate again in the system. Domestic SWHs are quite similar to recirculating water heaters. Hot water (low-pressure steam) or pressured steam are often used in industrial heat demand applications to provide the heat needed for system functioning. Because of its availability, thermal capacity, storage ease, and cheap cost, water is often used as the flowing fluid in thermal applications. Nonetheless, when greater pressure is needed, the cost of the storage system skyrockets. The system must be pressurized at temperatures over 100°C. Mineral oils are utilized in medium temperature (over 100°C) applications. However, increased prices, a proclivity for cracking, and oxidation are just a few of the problems that come with such systems.

1.3.2. Steam generation using solar systems:

In sterilizing and desalination evaporator supplies, low-temperature steam is often utilized. PTCs (parabolic trough collectors) are high-efficiency collectors that are frequently used to produce steam in high-temperature applications. PTCs produce steam using three different methods: steam-flash, direct or in situ, and unfired-boiler. The steam-flash technique generates steam by flashing pressured hot water in a separate vessel. To produce steam in an in situ technique, there is a two-phase flow in the collector receiver. Steam is produced in an unfired-boiler system via heat exchange in an unfired boiler. A heat medium fluid passes through the collector in this design. On keep the water from boiling, the system applied pressure to it. The pressurized water passes through the solar collector before being discharged into a flash vessel. The feed water supply keeps the water level in the flash vessel at a consistent level.

1.3.3. Solar drying and dehydration systems:

Solar drying and dehydration systems utilize solar irradiance to heat the air either as the primary source of energy or as a complement. Solar dryers use the sun's irradiation for drying and dehydration processes in industries including bricks, plants, fruits, coffee, wood, textiles, leather, green malt, and sewage sludge, whereas conventional drying systems use fossil fuels. They are divided into two groups: high temperature dryers and low temperature dryers. Almost

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all high-temperature dryers require fossil fuels or electricity to heat them, while low-temperature dryers may utilize either fossil fuels or solar energy.

Solar thermal energy at low temperatures is also suitable for preheating processes. Solar dryers, on the other hand, are divided into two categories depending on the technique of air flow generation: natural circulation (passive) and forced-convection (active) solar dryers. Passive solar dryers, in general, rely on solar energy, which is plentiful in the environment. As a result, in the agricultural sector in underdeveloped nations, this approach is often referred to as the only commercially accessible method. They may be divided into two types: exposed to the sun and natural-circulation solar-energy crop drying. Open-to-sun passive drying methods are extensively used in developing nations, particularly those with tropical climates. They dry the crops in two ways: in the field or in situ, by spreading them on the ground or on any vertical or horizontal plate exposed to sunlight.

Sun energy is used with electricity or fossil fuels to produce power for pumps and motors that circulate air in active solar drying systems. Solar energy is the sole source of heat in this kind of solar dryer. This technique is utilized in commercial drying applications on a big scale. This kind of technology may decrease energy usage while also regulating drying conditions. For the direct drying procedure, high-temperature sun heaters are utilized. The fossil-fuel fuelled dehydrator, on the other hand, is used to raise the air flow temperature to the required level in medium and low temperature systems. The latter is referred to as a "hybrid solar dryer." It eliminates the impacts of the solar collector's variable energy production at night or when the sun's irradiation is low. Solar active dryers are often utilized in high-temperature drying procedures that need constant air flow.

2. DISCUSSION

The world's energy consumption is rapidly increasing as a result of population growth and technological advances. For future energy demand, it is thus critical to choose a dependable, cost-effective, and eternal renewable energy source. Solar energy, like other renewable energy sources, is a promising and readily accessible source of energy for addressing long-term problems in the energy crisis. Because of the increasing need for energy, the solar business is rapidly growing all over the globe, despite the fact that the main energy source, fossil fuel, is finite and alternative sources are costly.

It has become an instrument for improving developing nations' economic position and sustaining the lives of many disadvantaged people since it is now cost efficient as a result of years of active research to speed up its growth. In comparison to other renewable energy sources, the solar sector would undoubtedly be the greatest choice for future energy demand since it is better in terms of availability, cost effectiveness, accessibility, capacity, and efficiency. As a result, this paper discusses the importance of the solar industry, as well as its fundamental concepts, the global energy scenario, highlights of research done to upgrade the solar industry, its potential applications, and barriers to a better solar industry in the future in order to resolve the energy crisis.

3. CONCLUSION

This study discussed the applications, advancements, and predictions of solar energy in industry. It was addressed how using solar energy may enhance product quality and quantity while lowering greenhouse gas emissions. Both solar thermal and photovoltaic systems have been shown to be appropriate for a variety of industrial process applications. The total efficiency of the system, however, is dependent on correct system integration and solar collector design. Solar energy systems may be used as a source of electricity or directly applied to a process. Because stationary collectors are used, large-scale solar thermal systems with huge collector fields are economically feasible. Furthermore, as compared to tiny plants, they need a lower initial investment.

The feasibility of integrating solar energy systems into conventional applications is determined by the energy systems used by businesses, as well as a study of heating and cooling demand and benefits over current technologies. Solar PV systems are dependable alternatives that should be regarded as a cutting-edge power source in construction, industrial industries, and water desalination systems. When these systems are used in distant areas where there is no connection to a public grid, they have a better economic future.

Other technical and economic factors like as wear and tear, beginning and operating expenses, economic incentives, PV module price declines, and oil price increases should not be overlooked. Solar energy systems must be considered by designers, engineers, architects, service engineers, and material suppliers as a sustainable energy development. Furthermore, government and community policies may play an important role in encouraging the household and industrial sectors to adopt new technology.

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