A Comprehensive Study on Use of Solar Energy Technologies

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ABSTRACT: ***In recent years, the usage of solar energy has risen to new heights. Its motivating force is the ongoing quest for an alternate power source owing to the projected shortage of fossil fuels. As the price of fossil fuels continues to climb, it is becoming more popular. The sun provides more energy to the globe in a single hour than humans utilize globally in a year. Global climate changes and rising energy demand, along with constant advancements in renewable energy technology, are creating new prospects for renewable energy use. Solar energy is the most plentiful, unlimited, and clean renewable energy supply currently available. Its usage has shown to be the most cost-effective, as most systems in individual applications only require a few kilowatts of power. The current state of solar thermal technology is reviewed in this study. This work discusses existing design performance assessments, mathematical simulation design, and manufacturing of novel designs with recommended enhancements.***

KEYWORDS: ***Energy, Energy Sources, Fossil Fuel, Solar Energy, Space Heating.***

1. INTRODUCTION

Aside from wind power, solar thermal power is one of the most plentiful renewable energy sources accessible. Around 80% of the world's energy consumption comes from traditional sources. Energy substitution became less important as a result of the discovery of nuclear energy in mid-20th century, which would be ten to twenty times more efficient than fossil fuels. Nevertheless, nuclear energy does have certain drawbacks. In fusion reactors, uranium and thorium ores are used, both of which are regarded fossil fuels. Nuclear reactors, on the other hand, are now only used for large-scale power generation. Its best energy source for cooking, heating, and small-scale uses remains renewable energy. So long as humans are able to survive on the planet without the use of fossil fuels. There are a number of CO_2 free energy options that are promising to replace fossil fuels. Renewably generated energy provided only 1.8 percent to the world's total energy consumption in 2008[1], [2].

The risks of their utilization include the fact that they are all susceptible to severe weather conditions or human actions. It's predicted that the global demand for fossil fuels, starting with oil, would surpass yearly supply over the next two decades. Oil and gas shortages can potentially trigger international economic and political crises and wars. Burning fossil fuels releases toxic pollutants such as carbon dioxide, nitrogen oxides and aerosol particles that have a negative impact on the local, global, and changing ecosystem as a whole. In 2030, the trend is expected to increase by 2 percent. 2006 and 2040 energy consumption patterns worldwide by industry, based on a variety of sources of energy [3]. A large portion of energy is consumed by industry and hence plays an important role in industrial growth. Globally, it accounts for more than 40% of all energy use. Companies no longer use fossil fuels in the industrial sector due to rising pricing for conventional fuels and environmental concerns[4].

Through the utilization of renewable energy-based technologies in industry, greenhouse gas emissions may be dramatically decreased. It is therefore necessary to switch away from old power sources and adopt new technologies in the industrial sector. Fig. 1, Illustrates the demand of solar energy globally starting from year 2006 to 2030, which suggests that demand is goes on increasing up to year 2030. Heat is transferred from the air or water by means of using solar collectors to enhance the efficiency of solar thermal systems. Every single collector, on the other hand, has a distinct purpose. Examples include flat-plate collectors, focusing and heat concentrated solar collectors, two-axes tracking collectibles, and stationary and one photovoltaic cells, all of which are well-suited to coolants.

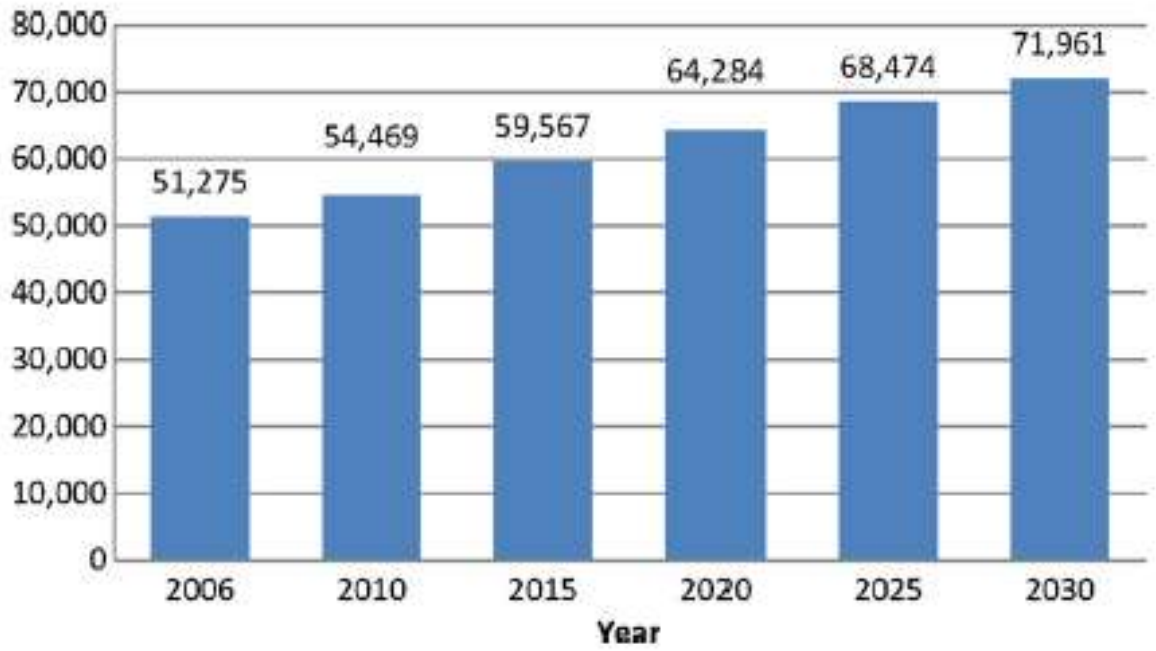

Fig. 1: Illustrates the demand of solar energy globally starting from year 2006 to 2030, which suggests that demand is goes on increasing up to year 2030 [5]

Solar power, out of all the renewable energy sources, has garnered the most attention as the most promising alternative for industrial use. Solar energy is abundant, free, and pollution-free. Solar collectors, sun trackers, and huge mirrors have all been used in the past to harvest solar energy for industrial reasons. Solar thermal and photovoltaic applications are the two primary types of solar energy used in industry[6]. There are several uses for hot water and steam include drying and dehydrating operations, preheating, concentration, pasteurization, sterilization, and washing. Most typical uses include hot water, steam, drying, dehydrate, concentration, pasteurization, sterilization, washing, cleaning, subatomic particles, industrial space heating, food, plastics, the building industry, the manufacturing sector, and even business issues, among many others. Engineers are increasingly focusing on solar energy applications because of worldwide energy shortages and concerns about adverse environmental consequences[7].

As a result, it is imperative that we continue to look for efficient and cost-effective ways to absorb, store, and transform solar energy into useable energy[8]. There is no systematic study of solar energy uses in industrial facilities in the literature. On the whole, this assessment should be highly beneficial for industrial energy users as well as policymakers and investigation institutions. Electricity, heat, gas, water, or coal are the major sources of power for the system's operation. In a system, a manufacturing company is the element that performs the manufacturing process. Subsystems such as pressure/vacuum/temperature solenoids, valves, and switches are powered by energy in this section of the system. It is possible to use solar energy systems either as a power source or directly in a manufacturing process. Many issues have arisen as a result of the world's population expansion, especially in developing countries. Currently, one-fourth of the world's population does not have access to enough clean water.

The map of the world's population distribution since 1950 and projections up to 2050 As can be seen, the world's majority of people live in Asia and Africa. Dehydration technology is therefore more important in these areas. In order to deal with water shortages and overcome the constraints of available water resources, the water desalination business has emerged. From brackish or sea water, it can create usable clean water. Conventional desalination technologies, often known as supply side approaches, have a negative impact on the environment and disrupt ecosystems. Aside from that, they take a lot of energy to function properly. So-called solar stills, which are tiny tubs implanted in lifeboats, can harness sun energy to desalinate seawater. In rural and secluded locations, on small islands, and on large ships with no connection to the grid, solar stills are ideal. As a result, solar energy is more cost-effective and technically superior than conventional diesel-powered reverse osmosis systems. However, this approach requires a large initial investment, a large surface area, containing heavy and sensitivity to the weather conditions, while being incredibly straightforward.

Therefore, its use in huge production facilities is limited. Fig. 2 illustrates the process of converting sea water in to drinking water using solar heat as primary source of power.

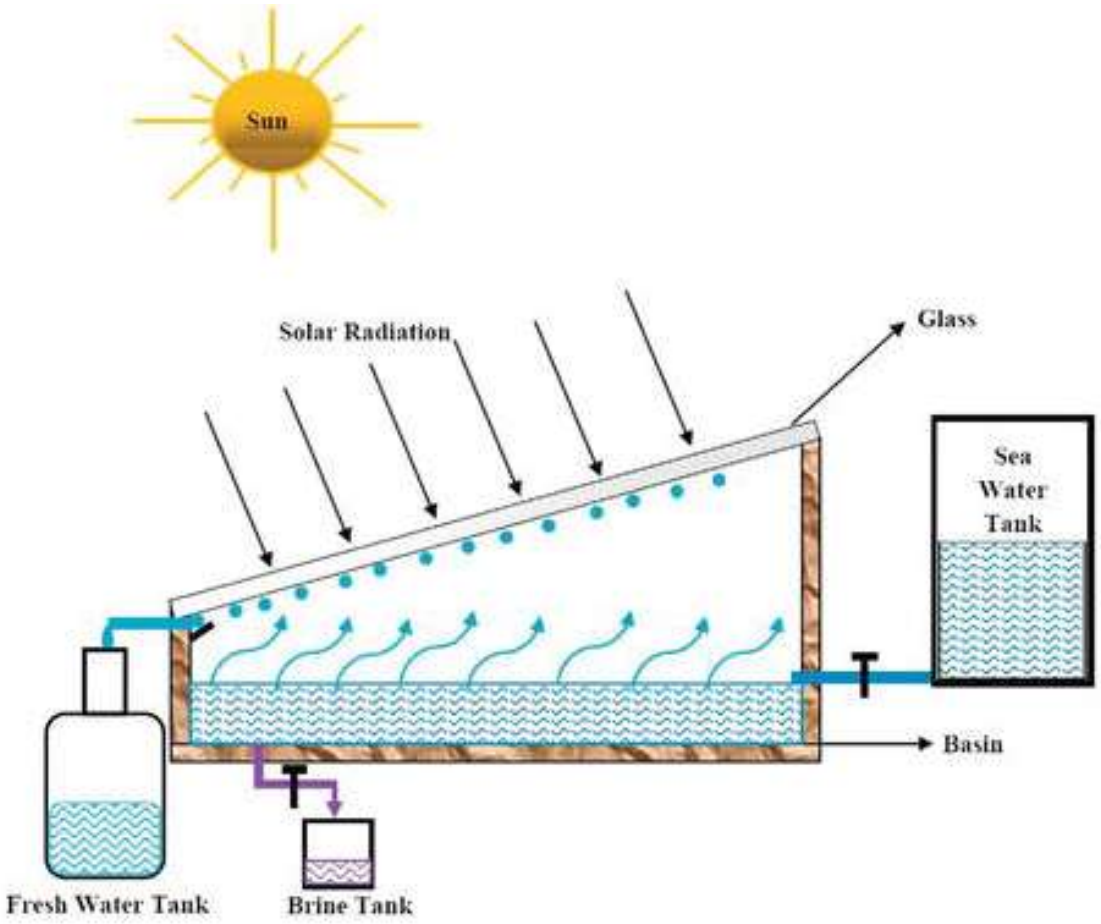

Fig. 2: Illustrates the process of converting sea water in to drinking water using solar heat as primary source of power[9]

2. DISCUSSION

2.1 Use of solar in food industry:

In the food sector, solar heat is a viable option since the treatment and storage methods for food items are quite robust. Non-concentrating solar collectors used in the food sector in Germany were studied. As a result of system study, the system's efficiency is equivalent to that of sand solar space heating systems. Laundry and cleaning; sterilization; pasteurization; drying; cooking; hydrolyzing; distillation; extraction; and polymerization may all be done using solar thermal at medium temperatures. In the brewing sector, thermal energy accounts for around 70% of the total energy use. Besides scalding, sterilization of vegetables, meat and fish, cleaning, pre-cooking, can sealing, chilling and refrigeration, food preservation businesses also utilize solar heat. For their different process activities, the dairy industry may also make full use of solar energy.

They generally work seven days a week, without taking a day off. As a result, solar systems in this sort of enterprise can be regarded highly cost effective. For pasteurization, sterilization, and even drying milk to make powder, dairy businesses rely on thermal energy. In the dairy industry, high-constant-energy equipment with a long running time of up to 8000 hours per year is required A temperature range of 120–180 C is used to dry the milk and whey. The use of solar energy in dairy industry has been shown in Fig. 3.

Fig. 3: Illustrates the use of solar panels in food processing industry, panels used here are installed in milk processing unit.

2.2 Use of solar in buildings:

In terms of global energy consumption, the building sector and its allied industries are the second-largest energy consumers. In China, the construction sector accounts for 27.8% of the overall energy demand, whereas in Europe, residential and commercial structures account for 40% of the energy budget. Solar energy is currently frequently used in the construction industry, either directly or indirectly. The use of solar energy in construction and industry may have a positive impact on the environment and the economy. The use of solar thermal energy in buildings is the most frequent and extensive use of solar thermal energy, not just in Europe, but also across the world. Smaller requests for single-family homes and medium-sized applications for multi-family dwellings, social facilities, and commercial structures might be classified under this category. For example, household hot water, space heating or combination, when combining both, and cooling or low temperatures for swimming pools might be classified as applications. A popular use of sun heat exchangers is for district heating in single-family homes, which constitutes the biggest proportion of solar thermal technology sales globally. Thermal energy storage for single-family homes is well-established and has been on the marketplace for over 30 years. The use of catchers for domestic hot water production in single-family homes is the most prevalent use in the concentrated solar market.

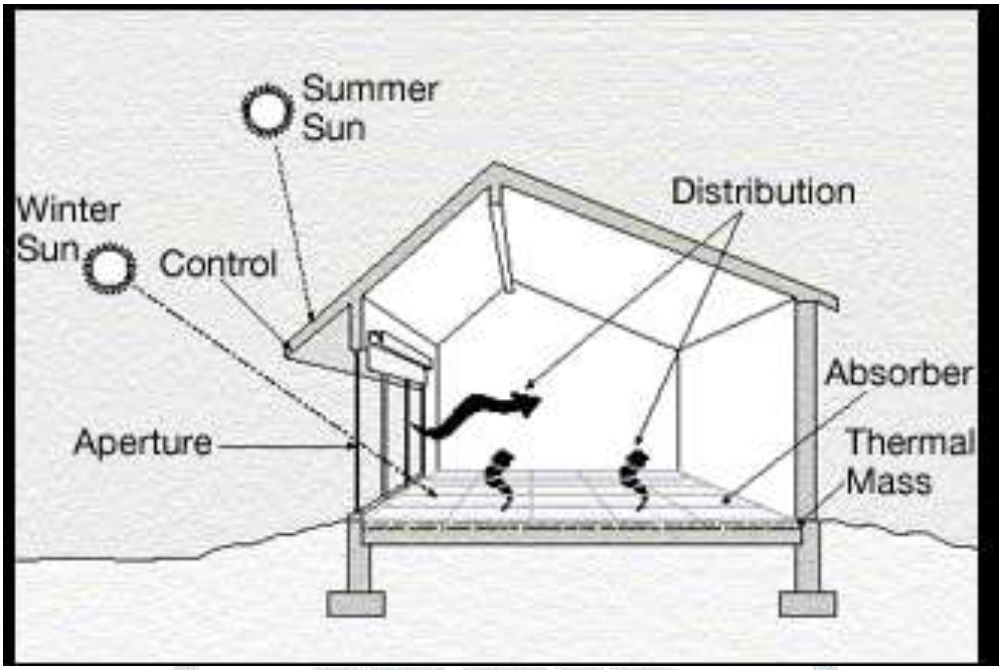

Fig. 4: Illustrates the phenomena of solar heating in a domestic layout explaining different thermal mechanism used in it.

If anyone to get the most out of your solar-integrated buildings, they should be facing south. Throughout the day, the glass windows and trombe walls gather sunlight, which heats the structures. It would appear that proper ventilation is required in such buildings, as the absorbed heat must be dispersed throughout the whole structure. In a demonstration project, solar energy is used to heat a building with trombe wall technology for natural ventilation. Cost-effective and long-lasting solar heating solutions have been discovered for buildings**.** Fig. 4, Illustrates the phenomena of solar heating in a domestic layout explaining different thermal mechanism used in it.

2.3 Use of solar in refrigeration industry:

There has been an increase in demand for air conditioning systems due to rising living and working standards as well as rapid urbanization, unpleasant outdoor pollutions, and more inexpensive air conditioners. There is a direct correlation between demand for air cooling and demand for electrical power. It is because of this that power stations fulfil their peak load on summertime, which leads to power outages According to statistics, the number of air conditioning systems in European people has grown five-fold in the previous 20 years. Thermal power from a solar-driven heat piping system is used to drive a standard vapor compression device Rankine cycle. A outstanding solar storage tank could be incorporated. As a result of physical or chemical attraction between different atoms, the refrigeration effect is achieved by sorption refrigeration. It is only possible with a sorption system to convert heat energy directly into cooling power. As a result of this, the refrigerant has a lower boiling point than the sorbent. Fig. 5, Illustrates the refrigeration system working on solar energy that include component similar to conventional vapor compression refrigeration system.

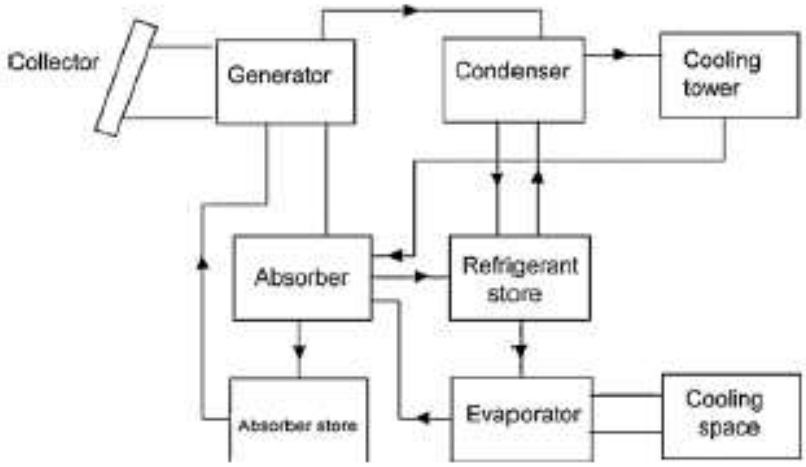

Fig. 5: Illustrates the refrigeration system working on solar energy, that include component similar to conventional vapor compression refrigeration system[10].

3. CONCLUSION AND IMPLICATION

This article discusses the applications, advancements, and projections of solar energy in the industrial sector. In addition to decreasing greenhouse gas emissions, solar energy usage may enhance product quality and quantity. Solar thermal and photovoltaic systems have been shown to be appropriate for a variety of industrial processes. However, the total efficiency of the system is dependent on the right integration of systems and the suitable design of the solar collectors, respectively. We conducted a thorough literature review of the most important technologies in the field of solar thermal energy. As a consequence of the evaluation, we may either improve the performance of the current system or design a new system that is more innovative and produces better results than the current one. As a result, the study identifies the areas in solar thermal technology where additional research is needed.

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