Solar power and its practical implications : A literature review

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Abstract : Solar energy conversion is being frequently used to create heat and power. This paper discusses how solar energy is used in the real world. Solar thermal has been discovered to be gaining a lot of traction in industrial applications. Solar thermal energy can be used to create power, process chemicals, or even heat your home. Food, non-metallic, textile, building, chemical, and even business-related industries can all benefit from it. Solar electricity, on the other hand, is widely used in the telecommunications, agricultural, water desalination, and construction industries to power lights, pumps, engines, fans, freezers, and water heaters. So, we are presenting a literature review in our study to throw in-depth knowledge about our subject.

Keywords : Solar energy, Industrial Applications, Literature Review

Introduction

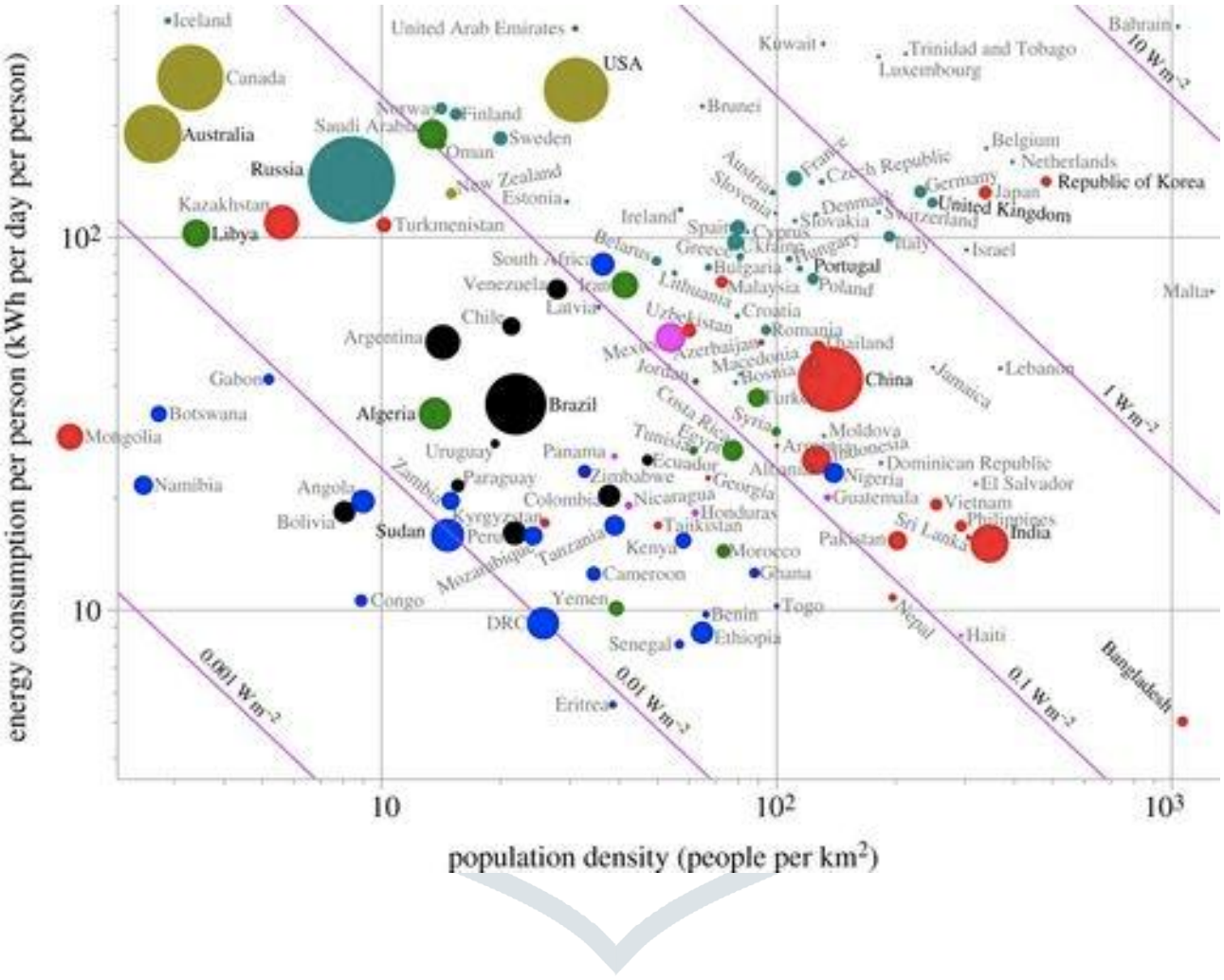
As a key foundation for economic progress and society's development, global energy consumption has been steadily increasing **(Chakrabortty and Bose, 2017)**. Solar radiation is an important component of a variety of renewable energy sources. It is the primary and continuous input variable from the virtually limitless sun. Fresh water and energy are the two primary resources that provide the foundations for all human activities in order to maintain an acceptable and high quality of life. These two resources are intertwined in a complex way. Water power was, in fact, the primary source of energy during the early civilisations. Solar energy is the oldest source, and it is the foundation for practically all fossil and renewable energy sources.

Solar energy is predicted to play a large role in the future, particularly in poor countries, but it also has potential in industrialised countries. To create necessary thermal energy, nearly all industrial energy networks and systems are partially or completely reliant on the combustion of fossil fuels. According to the distribution of energy consumption, approximately 13% of thermal industrial applications require low temperatures thermal energy up to 100°C, 27% require high temperatures thermal energy up to 200°C **(Kalogirou, 2012)**, and the remaining applications require high temperatures in the steel, glass, and ceramic industries **(Schnitzer, Christoph, Gwehenberger and Minimizing, 2007)**.

The horizontal axis represents a country's population density, and the vertical axis represents its energy consumption per person, measured in kWh per day per person. (1 kWh = 40 W; 'energy consumption' here refers to total primary

energy consumption, which includes solid, liquid, and gaseous fuels for power, transportation, heating, and industrial.) Each point in Figure 1 has an area corresponding to the country's size. Both axes are logarithmic, with nations on the right having population densities more than 100 times higher than countries on the left, and countries on the top consuming around 100 times more per capita than countries on the bottom.

Figure 1 : Energy consumption per person



The majority of energy produced around the world is derived from fossil fuels, which result in the production of environmentally harmful carbon dioxide and the depletion of fossil fuel resources.

Literature Review

Most common applications for solar thermal energy used in industry are the SWHs, solar dryers, space heating and cooling systems and water desalination. Using solar energy to generate thermal energy for industrial processes not only reduces dependency on fossil fuel resources but also minimizes greenhouse emissions such as CO2, SO2, NOx **(Schnitzer, Christoph, Gwehenberger and Minimizing, 2007)**. Nevertheless, there are

some challenges for merging solar heat into a wide variety of industrial processes like periodic, dilute and variable nature of solar radiation **(Schnitzer, Christoph, Gwehenberger and Minimizing, 2007)**.

Solar energy may create heat for a range of industrial uses, including water desalination, increased oil recovery, food processing, chemical synthesis, and mineral processing, to name a few. This high energy consumption contributes significantly to operating costs. Many businesses are utilising the potential of renewable energy by installing solar panels on their factory and warehouse rooftops to reduce energy expenditures. These institutions can generate their own power on-site for free by installing a solar system.

Solar energy in manufacturing industry

For a variety of reasons, manufacturing enterprises are good locations for solar system installations. To begin with, these companies usually operate out of pretty large plants with enormous roofs. These broad, flat areas are ideal for erecting a huge number of solar panels. This open space allows businesses to install longer strings, which absorb more sunshine and create more electricity.

Furthermore, manufacturing plants are typically placed in industrial parks and other regions outside of city centres, away from densely packed skyscrapers. Because these enormous plants are located far from tall buildings, they avoid problems created by massive structures looming over solar panels while still providing shade. This means that a solar PV system on a manufacturing plant is more likely to benefit from long periods of uninterrupted sunlight streaming down and generating a large amount of energy, speeding up the return on investment.

In areas where there is no existing power line, photovoltaic (PV) water pumping systems may be the most cost-effective water pumping solution. They're ideal for grazing businesses that need to give water to far-flung pastures. Simple PV power systems run pumps directly when the sun shines, so they're at their most efficient during the hot summer months when they're most needed. Batteries are typically not required because the water is stored in tanks or pumped to fields and used during the day. Batteries, inverters, and tracking mounts to follow the sun may be included in larger pumping systems **(EREC, 2002; NYSERDA, 2009).**

Solar panels can be installed not only on the rooftops of manufacturing companies, but also in parking lots and other carports for a large number of employees. Manufacturers can take advantage of space that otherwise would not add anything to the company's overall worth other than providing a place for employees to park their cars while they work by placing a layer of solar panels over the enormous width of a parking lot. Installing a solar-powered carport is a terrific method to take advantage of solar-generated electricity. Furthermore,

providing employees with a shaded parking spot eliminates the need for them to leave work and travel.

One of the oldest and most commonly used applications of solar energy is drying crops and grains in the sun. Allowing crops to dry naturally in the field or spreading grain and fruit out in the sun after harvesting are the simplest and least expensive methods. These methods have the disadvantage of exposing crops and grains to damage from birds, rodents, wind, and rain, as well as contamination from wind-blown dust and dirt. Solar dryers that are more advanced than open air technologies safeguard grain and fruit, reduce losses, dry faster and more uniformly, and generate a higher-quality product **(EREC, 2002; UCS, 2009).**

Solar energy in food industry

Because the treatment and storage processes of food items are relatively robust, the food industry provides ideal circumstances for solar heat usage. Solar heat is also used in scalding, sterilizing (vegetables, meat, and fish), cleaning, pre-cooking, can sealing, cooling, and refrigeration in the food preservation industry. The authors **(Nandi and Rupanjana, 2007)** presented a case study of solar thermal applications in India's energy-intensive food industry. The sweat meat industry affects the country's economy as well as its traditional culture. Diesel fuel is used in the traditional systems.

According to recent studies, while post-consumer food waste accounts for the biggest overall losses in affluent economies, food wastes are substantially higher in developing countries at the immediate post-harvest stages, and perishable food wastage is higher in both industrialized and developing economies. Food losses at various processing phases in a generic food supply chain are quantified and displayed in Table 1 **(Parfitt et al. 2010)**.

Solar energy in agriculture industry

Solar energy can be used in agriculture to save money, increase self-reliance, and reduce pollution in a variety of ways. Solar heat collectors can be used to dry crops as well as to heat homes, livestock barns, and greenhouses. Solar water heaters can heat water for dairy farms, pens, and houses. PV water pumping devices are effective in most regions without access to power. These systems also give water to far-flung pastures. Simple PV systems are often intended to provide water where it is needed when the sun shines.Solar storage batteries aren't needed in these situations since farmers store the water in tanks or pump it directly to the fields. Larger systems, on the other hand, can make use of tracking mounts, storage channels, and inverters. Farmers that construct a large-scale PV system don't have to undertake any maintenance because the power is consistent. Irrigation, livestock water supply, pond aeration, and a variety of other applications are all possible with these systems.

Despite the mature and promising potential for solar photovoltaic (PV) technology to reduce global reliance on fossil fuels, large-scale PV development faces a number of challenges, including land use conflict **(Calvert and Mabee, 2015; Adeh et al., 2019)** and social resistance **(Wüstenhagen et al., 2007; Sovacool, 2009; Batel, et al., 2013).**

Livestock and dairy businesses require different amounts of space and water heating. Cattle and poultry are raised in enclosed facilities by modern farmers. As a result, temperature and air quality control are critical in such structures. The farmer must replenish air on a regular basis to remove moisture, dust, and hazardous odors.

Furthermore, heating such huge spaces necessitates a significant quantity of energy. By using a well-designed solar energy system, the air can be heated even before it enters the structure. Additional ventilation can also be provided by the system.

Solar Transportation

Aside from industrial demand for electricity, the transportation industry is a major energy consumer in the country. Road and rail transportation have grown rapidly in recent years as important pillars of passenger mobility and freight transport. This trend suggests a rise in energy consumption, particularly electricity, as a result of improved energy efficiency and lower carbon emissions, but also exacerbates the power supply-demand gap. Increased solar power generation has been widely implemented in their own suitable locations for road and rail transportation in recent years, attracting a lot of attention as a source of additional power.

According to the International Energy Agency (IEA), the transportation sector accounts for 29% of worldwide final energy usage **(International Energy Agency, 2019 and Resources for the Future, 2020)**, a figure that has climbed dramatically in recent decades. The need for road and rail transportation is driving the significant growth in energy consumption. Furthermore, solar-powered mobility has been identified as a promising strategy for the long-term and collaborative development of both the energy and transportation sectors.

Table 1 reapersents some other applications of solar energy. The area has been studied before and we have also cited the most authentic articles of the industry.

Table 1 : Some other applications of solar power

S. No	Reference	Year	Application Discussed
1	Glueckstern (1995)	1995	Potential uses of solar energy for seawater desalination

2	Wagner (1997)	1997	Large lead/acid batteries
3	Kumar and Rosen (2011)	2011	Solar powered air-heating systems
4	Jelle et al. (2012)	2012	Building integrated photovoltaics
5	Zhang et al. (2013)	2013	Concentrated solar power plants
6	Vignaroobana et al. (2014)	2014	Hastelloys in molten metal-chloride heat-transfer fluids
7	Mukrimin (2015)	2015	Solar power and application methods

Conclusions

This report discussed the applications, advances, and forecasts of solar energy in industry. It was highlighted how utilizing solar energy can increase product quality and quantity while lowering greenhouse gas emissions. Both solar thermal and photovoltaic systems have been shown to be suitable for a variety of industrial process applications. The overall efficiency of the system, however, is dependent on correct system integration and solar collector design. Finally, it has been proven that a collaborative approach can not only help to further the evolution of a low-carbon, green, and sustainable development, but also considerably boost the use of renewable energy for energy transformations.

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