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Scope and Application of Solar Thermal Energy in India

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ABSTRACT: ***There are two types of energy sources and these are renewable (coal, petroleum, natural gas) and non-renewable. Solar energy has received a lot of interest in past decades as a simple and cost-effective sustainable power source for producing electricity. This article addresses the history of solar thermal energy in India, the Solar Heat Power Production Program in India, the benefits and drawbacks of solar thermal energy, and focusing solar power (CSP). Solar energy is a local sustainable power source that might help to minimize reliant on fossil fuels Solar energy is a versatile and environmentally responsible solution., as well as nation power stability, at a time when the world economy's long-term sustainability is threatened by dwindling global fossil fuel supply. Solar energy may be used in two different ways: solar photovoltaic and solar thermal. In this research, we look at how solar thermal energy may be used to generate electricity in India.***

KEYWORDS: ***Annual, Fuels, Generation , Solar energy, Thermal***

1. INTRODUCTION

Energy is seen as a vital component of economic development and a fundamental engine of economic development (L. Kumar et al., 2019). The shortage of fossil fuels, as well as the associated environmental problems, has underlined the necessity for alternate responsible power supply options centered on sustainable energy resources. Solar thermal power generating technologies, also referred as Solar Thermal

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Electricity (STE) generating processes, are unique renewable energy techniques with the potential to become a viable electrical development option in the future. (L. Kumar et al., 2019). This essay examines the technical potential of India, their present state, and potential and obstacles in establishing solar thermal power plants.

India is situated in the earth's equatorial solar belt, getting an abundance of radiant energy from the sun(Qerimi et al., 2020). The India Meteorology Service operates a nationwide infrastructure of irradiation sensors that monitor solar energy as well as the length of daily sunshine. Clear, bright weather may be found in most regions of India 250 to 300 days each year. Annual global radiation ranges between 1600 and 2200 kWh/m^2, which is equivalent to the tropical and sub-tropical areas' radiation(Wu & Butt, 2020).

The annual equal power possible is at 6,000 million GWh. Differing sections of the nation have different degrees of sun radiation(Sánchez-Barroso et al., 2020). Although Rajasthan, northern Gujarat, and parts of Ladakh receive the most annual global radiation, Andhra Pradesh, Maharashtra, and Madhya Pradesh also receive a significant amount of radiation when compared to many other parts of the world, particularly Japan, Europe, and the United States, where solar technology development and deployment is at its peak(Dheep & Sreekumar, 2018).

1.1 Solar thermal power generation Programme in India:

In Gwalpahari, the Ministry of New and Renewal Energy (MNRE) built India's 1st Solar Thermal Power Plant with a capability of 50 kW, Gurgaon, in 1989, using parabolic trough collector technology (line focusing)(Dheep & Sreekumar, 2018). The plant was commissioned in 1989 and ran until 1990, when it was shut down due to a shortage of spares. The facility is being resurrected thanks to the creation of elements like mirrors and a tracking system, among other things(Chang et al., 2016). The Rajasthan government has planned and approved the construction of a 140MW solar thermal power plant at Mathania. The GEF has approved a $40 million grant for the 140MW Hybrid Solar Combination Cycles Electricity Plant development, which combines a 35MW solar power

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technology and a 105MW traditional energy element. The German government has agreed to fund the project **through a soft advance of DM 116.8 billion and a profitable credit of DM 133.2 million**(Pelda et al., 2020). In Rajasthan's northern area, an industrial generating facility founded on Solar Ladder technologies were also examined. The plan called for the project to be executed in five phases. The power output in the first stage will be 1.75MW, increasing to 35MW, 70MW, 126.3MW, and 200MW in successive phases. The planetary chimney's initial height of 300 meters will be eventually expanded to 1000 meters(Fan et al., 2020).

The cost of power generated by this plant is projected to be Rs. 2.25 per kilowatt-hour. However, the project was shelved owing to security concerns and other factors. In the 1990s, BHEL Limited, an Indian power equipment manufacturer, As part of the project, they built a solar dish-based power plant of the Ministry of Nonconventional Energy Sources' research and development program. The US government contributed to the project's funding. In this plant, six dishes were employed(Gautam & Saini, 2020).

1.2 Advantages of solar thermal energy:

- *No Fuel Cost:*

Solar Heat Power, unlike most alternative sustainable power source, does not want any fuels. Compared to other fossil fuels, this is a huge benefit, whose prices are rising at a rapid pace year after year. Electricity costs are rising far faster than ordinary inflation in most regions of the globe(Kabeel & El-Said, 2015). With fossil fuel energy, price shocks owing to increased fuel prices are a huge danger these days.

- *Consistent, 24-hour power:*

Solar Thermal Energy can create power 24 hours a day, seven days a week. Solar thermal generating plants use melted salt and various substances to store energy, making this feasible(“Design of Solar Tracking System for Capturing Maximum Amount of Solar Energy,” 2019). Solar PV and wind energy, for example, are intermittent sources of renewable energy(S. Kumar & Singh, 2020). The electrical supply is more consistent and dependable.

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- *No Pollution and Global Warming Effects:*

One of the most significant benefits of solar thermal energy is that it does not produce pollution(Goel & Sharma, 2017). It should be noted that Solar Heating Energy Technology has a cost because of the machinery required to build and deliver it.

- *by Existing manufacturing Base:*

Solar Thermal Energy, unlike new technologies like CIGs Panels, employs equipment like sun thermal reflectors and rotors, which are produced in huge numbers at cheap price by the current Industry Base and need no substantial technology or materials modifications.

1.3disadvantage of solar thermal energy:

- *elevated Costs:*

Solar Heat Power prices at minimum Euro 3.5 per kilowatt and has been relatively stable over the last 3 to 4 years. These rates, however, are unreasonably high, because Solar PV currently prices Euro 2.5/watt and, even if moderate projections are right, will decrease by 5% in the following ten years, making it half the price of Solar Heating Technologies by 2020 (Syed et al., 2021).

- Concentrated solar power **(*CSP) is probable to developed obsolete in the future:***

With everyday reports of new advancements in components and techniques in PV technology, solar power became a hotspot of innovation. Oerlikon has unveiled a new radial a-Si Innovation, whereas CIGs players claim to have improved efficiency. Chinese solar companies have dominated the market because to their While a plethora of global behemoths including Posco, Korea, Korea, Sharp, GE, and TSMC have pledged to decrease costs even more.

- Water Issue:

Solar Heating Plant utilize a lot of freshwater, which is a problem in arid places. When non-water cooling is employed, the expense of CSP installations is too high. While it

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has been recommended that sea water be used, it is unclear if this strategy can be adopted since it would mean placing plants quite near to the shore.

- *Environmental and Cultural issue:*

The usage of enormous arrays of mirrors has been found to have a severe impact on desert animals, placing vulnerable species at risk. Developer in California have already reduced the height of plant facilities and paid cash to remove animals as a result of this issue.

- *Size and Location Restrictions:*

Sun Thermal Energy can only be constructed in areas with abundant solar radiation. They are generally erected in deserts and need a big amount of land. This implies they can't be built in densely populated regions. Solar Thermal Energy can also only be developed on big scales of at least 50 MW to be cost effective. Solar PV, on the other hand, is available in as little as 5 watts.

- Long Gestation Time Leads to Cost Overruns:

The development of a concentrating Permission, money, drilling, and other variables could potentially require 5-7 years to complete a solar heat energy station. Construction of a modest wind farm takes six months, whereas a solar PV plant takes three years.

1.4 Concentrating solar power(CSP):

Using different mirror/reflector and receiver combinations, Concentrated sun power (CSP) plants generate electricity by transforming solar energy's infrared component into elevated heat. The heat is then transferred to a typical generator. The plants are separated into two sections: one collects solar radiation and transforms it to heat, while the other converts heat energy to electricity. CSP devices employ the elevated heat from concentrated solar collectors to generate traditional engines and turbines. Collector, receiver, transit, and power converter are the four primary components in all CSP devices. The four CSP technologies listed below have either attained or are nearing commercialisation.

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- Trough Parabolic

Curved mirrors essence the sun's energy onto a receiver tube that runs along the middle of the trough in parabolic trough systems. A high-temperature heat transfer fluid absorbs the sun's energy in the receiver tube and heats water and produces steam by passing through a heat exchanger at temperatures of 750°F or higher. To create electricity, the steam powers a traditional steam turbine power plant. Hundreds of parallel rows of troughs linked as a series of loops are positioned on a north-south axis so the troughs may follow the sun from east to west in a typical solar collector field. People collector modules variety in tallness from 15-20 feet to 300-450 feet.

- Compressed Lined Fresnel Indicator:

The Compressed Linear Fresnel Indicator is built on concave troughs systems, however it uses long parallel rows of less costly flat mirrors instead. The sun's light is directed onto elevated receiver, which is constructed up of a network of tubes that allow water to flow through them. The focused sun boils the water, producing high vapor that might be utilized in power stations and other industrial steaming uses.

- Power tower:

A central receiver system is used in power tower systems, allowing for higher operating temperatures and consequently better efficiency. The sun is tracked along two axes by computer-controlled mirrors (called heliostats), which concentrate solar radiation on a mouthpiece at the highest of a high tower. The concentrated energy is utilized to create vapor and power a central power generator by heating a transfer fluid to above 1,000 degrees Fahrenheit. These projects can readily and cost-effectively include energy storage, enabling for 24-hour power production.

- Dish-Engine:

A parabolic dish's surface is covered with mirrors, which focus A receiver situated at the focus area receives sunlight. A dish-engine system, distinct additional CSP systems that use condensation to generate power via a turbine, uses a circulating liquid like gas

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warmed to 1,200° F in the reception to drive an engines. Every dish revolves on 2 blades to footpath the sun.

1.5 Barriers in solar thermal energy:

- Technical Obstacles:

Battery, inverter, and various systems elements, such as air conditioners, are in limited supply. The inefficiency of PV systems is a major source of worry. Thin film systems have an efficiency of 4–12%, whereas crystal PVs have a % efficacy. Moreover, the mercury used in CdTe is toxic, and tellurium is a very rare element. The demand for PV has outstripped the supply of silicon.

- Institutional Obstacles:

A significant communications gap occurs among multiple governmental agencies, organizations, stakeholders, and ministries, providing a barrier to the deployment of solar and renewable energy. Some Indian states, including as Haryana, Jaipur, Punjab, and Uttrakhand, have created a single-window project clearance and approval procedure for the implementation of RESs. However, this technique takes a long time to implement and its usefulness is debatable.

- Barriers to Investigation and Expansion:

The lower efficiency of PV systems in the implementation of solar energy technologies is the consequence of poor R&D effort. The absence of R&D activity is mostly owing to a lack of funding, Organizations for research and development, as well as a coordinated goal-driven effort of local and global organization . In India, rather than significant R&D activity, technology replication is going undertaken.

- Infrastructure on the Ground:

Another impediment is a lack of infrastructure. In order to use solar energy technology in rural regions, more infrastructure is necessary. Solar power plants are being built in

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distant locales, necessitating the construction of extra transmission lines to transfer energy to other locations.

1. DISCUSSION

The gathering of the sun's heat for human use is known as solar thermal energy. Photovoltaic (PV) power, on the other hand, turns a part of the sun's electromagnetic energy into electrons and electricity directly. Because the sun's heat may be collected and transmitted in a medium, and that stored energy can subsequently be utilized for purposes like as heating and cooling a house, boiling water, cooking food, or making electricity, solar thermal offers a greater variety of applications than PV. The first two applications, as well as energy generation, are typically suited for residential usage, although the latter is usually done on a commercial scale.

Solar heat power is employed for reduced boiling, chilling, and venting; mid-temperature sun thermally power is utilized for cookery, warm heaters, and various mid-heat activities; and elevated solar thermally radiation is utilized to generate electricity. There are a multitude of techniques to concentrate the sun's heat to produce electricity within the greater spectrum of creating electricity, such as using a heat exchangers to superheat liquid or an inert to drive a power generator, or utilizing an Engine to create energy.

Sun energy was directed on a pipe loaded with coolant, water, or synthetic oil by the first large-scale solar heat energy plants using a mirror-faced reflecting parabolic trough. The sun's heat is reflected back into the tube, heating the water within. A heat exchanger is used to circulate the heated liquid. The heated liquid converts water to pressure steam, which drives a turbine and generates power.

To improve their output, the pipes are encircled by evacuated glass vials, which helps them digest more heat power and precludes them from reradiating it. Troughs are usually north to south in orientation and follow the sun's movement throughout the day. Excess heat is stored in amazingly tanks stuffed with brine or graphite (both excellent

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heat storage materials) and then used to keep turbines rotating all night to maximize the quantity of electricity generated.

2. CONCLUSION

The gathering of the sun's warmth for person utilize is known as solar thermal energy. Photovoltaic (PV) power, on the other hand, direct conversion of a portion of the sun's magnetic radiation into protons and current Single of the greatest essential bases of sustainable biomass energy is biomass generation is concentrated solar thermal. A concentrated solar thermal development akin to the current wind power take-off is envisaged in the next years. Recent economic stimulus measures being discussed in nations such as Spain will allow the concentrating solar thermal industry to take its initial steps forward.

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