A Review on Solar Thermal Power Plant

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Abstract— India has more scope in building and operating solar thermal power plants on the megawatt scale. The present scenario of energy used in India is only 1% of the total energy produced in India. Many industries generate solar energy directly with the use of photovoltaic cells, they not using Solar Thermal Power Plant for this purpose, in large commercial concentrating Solar Thermal Power Plant generate electricity at a normal/reasonable cost for more than 16 years and, some of the new technologies of these type of power plant as soon erected. This paper compares the difference between the Solar Power Plant and Thermal Power Plant, providing a short description of how they work and what is the future impact of this technology.

Keywords: Power Generation, CST, Photovoltaic Cells, Solar Thermal, Solar Powers, STPP, Abengoa

I. INTRODUCTION

The Prime minister of India launched the mission i.e. called Jawaharlal Nehru National Solar Mission in January 2010 to create an allowing policy framework for the deployment of 20,000 MW of solar power by 2022. The mission of this project is to achieve 15 million square meters solar thermal collector areas by 2017 and 20 million by 2022 and to set up 20 million solar lighting systems for rural areas by 2022. To fulfilled and achieve these ambitious targets, the government has come out with the several and needs of incentives to accelerate the growth of the photovoltaic (PV) and thermal conversion of solar energy in the country to generate energy from the Sun. One of the important aims and mission of this project is to inhibit the commercial deployment of solar energy is its cost and to aim that bringing down the costs as rapidly as possible[1].

In 2010, IIT Bombay, a top institute in Mumbai, decided to create a test facility which would help in gaining experience in design, operation, and maintenance of large scale solar thermal power plant. This project is to provide help in facilitating research development in the solar industry in India. The 5MW power was divided into two power plants of different technologies and i.e. Parabolic trough and linear Fresnel reflector technology. Parabolic trough solar field has capacity of 3MW was built by Abengoa. Abengoa (MCE: ABG. B) applies modern technology solutions for sustainability in the energy and environment sectors, generating electricity from renewable resources, converting biomass into biofuels and producing drinking water from seawater.

The 3MW solar thermal parabolic trough field built by Abengoa is the first parabolic trough power plant in India.

This power plant needs to equipped with controllers to track the position of the sun on a real-time basis and optimize energy absorption.

The project was named as "National Solar Thermal Power Testing", Simulation and Research facility. In this power plant, the energy which is generated is renewable energy, because in this power plant we take "solar" as a boiler instead of coal, diesel or other types of fuels. In this power plant, the more energy is generated in a sunny area like Rajasthan, Sahara desert the part of the earth where the sun's radiation comes first and direct to the surface of the earth. This power plant not based on photo effect but generate the electricity with the help of sunlight. India's current capacity to install the power plant 135401.63 MW. Nowadays there is a shortage of peak power of about 10% overall shortage is 7.5%. In India "National Solar Thermal Power Plant" is located, designed and commissioned by Gurgaon near New Delhi, by IIT Bombay as a part of the consulting project.[2]

II. LITERATURE REVIEW:-

This is about the development of a small capacity power generation unit by using solar energy. Solar power plants are desirable to meet the rising electricity demand and at the same time to take caution of the condense fossil resources and to reduce global CO2 emissions. In the past few years, it has become obvious that fossil fuels are fast consumed. At the same time, the world's population is reaching 7 billion. Therefore, the total world energy world consumption is expected to expand by 49% from 1.449*10^11 MWh in 2007 to 2.1637*10^11 MWh in 2035 as per International Energy Organization 2010. [3]

This study focused mainly east countries to implementing and researching on the CSCS(Concentrating Solar Collector Systems) for many applications, during the last thirteen years.

There are the technologies that are performed in this power plant and that is are as follows,

The first one and the unique one technology is theAbengoa Selection, in this technology, Abengoa earned the distinction of being a key player in this sector due to its pioneering projects throughout the world. Abengoa has consolidated its international presence as a leader in concentrated solar power plant construction. At the time when this pilot plant was in the demand stage, Abengoa's included assets that the technological parabolic trough plants, Solnova 1, Solnova 3 and Solnova 4, all with a capacity of 50 MW and a solar field of 390 collectors of each, were being constructed. After that when this technology settled then apart from this in Spain, Abengoa was already having a capacity of 20 MW. The Abengoa work with the Indian government to pave the wave for CSP technology, IIT Bombay chose the utilize the experience and to know that how Abengoa's capabilities to plan and execute this pilot plant for demonstrating this world, the capabilities of India to build such plants.[4]

III. THE DESCRIPTION OF PARABOLIC TROUGH SYSTEM:-

This technology based on the mirrors by which we collect the radiation on sunlight to generate the electricity. The parabolic trough system is the solar collector field is an HTF heating system with parabolic trough collector assemblies arranged in a linear system. As we know that every technology has its 2 aspects advantages and disadvantages. As far as we saw the number of different types of solar collector designs that use the energy of the sun to heat water.

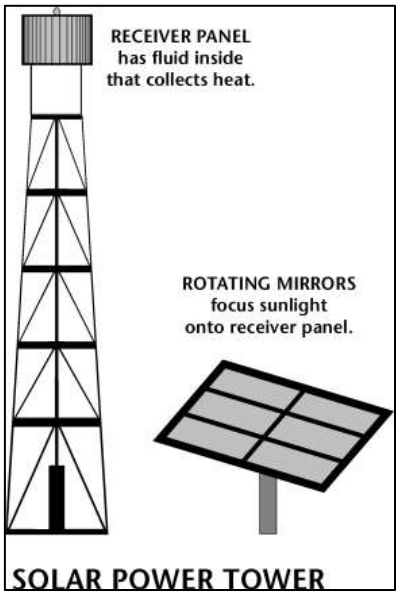
But in order to generate higher temperatures with good efficiency, a solar collector in the form of a Parabolic trough reflector may be required. The parabolic trough reflector is a solar thermal energy collector designed to capture the sun's direct solar radiation over a large surface area and focus, or more generally "concentrate it" onto a small focal point area increasing the solar energy received by more than a factor of two which means more overall heat per square meter of trough. This solar collector must be designed as like that all the incoming sunlight reflects off the surface of the collector and arrives at the same focal point no matter what part of the collector the sunlight hits first.[5]

Parabolic Trough System

The next technologies used i.e

1) Solar Tower Power System:-

In this technology power towers(also known as "central tower" power plant or"heliostate"power plant).These design to capture and focus the sun's thermal energy witth thousands tracking mirrors called "heliostats".Within the eceiver the concentrated sunlight heats molten salt to over 1000 degree F(538 degree C).The steam drives a standard turbine to generate electricity.Solar power tower convert sunshine into clean electricity.A heat transfer fluid heated in the receiver is worn to produce steam,which,in turn,is worn in a standard turbine-generator to produce electricity,prior power towers such as the solar is the one plant worns steam as the thermal transfer fluid.Current power towers such as Solar Two worn molten nitrate salt.Nitrate salt is worn because of its upper-level heat transfer and energy cache capabilities.The change of solar one to solar two need a new molten-salt heat convey system and a new control system.This includes the receiver,heating cache,piping, and a steam generator.The solar one heliostat field,the tower,and the turbine or generator required only nominal modifications.



There is the fluid used in this power plant and i.e Molten salt. Because of the thermal capacity of this salt is very high that's why this salt is being used in this power plant. There is a variety of fluid were present and get tested for this system to transport the sun's heat, including water, oil, air and sodium, before molten salt was selected as best. Molten salt is used in solar power tower systems because it is liquid at atmosphere pressure, it provides an maximum efficiency, low-cost medium in which to store thermal energy, its operating temperatures are compatible with todays high pressure and high-temperature steam turbines, and it is non-flammable and non-toxic. It is also used for heat transfer fluid in the chemical and metals industries as a heat-transport fluid.

The benefits of Solar Thermal Towers is Like all solar technologies ,solar power towers are fueled by sunshine and do not release greenhouse. This type of technology is better then the Solar electric technologies in their ability of efficiently store energy and dispatch electricity to the grid when needed, even at night or during the cloudy weather.

The environmental impact of this Solar Power Towers are, No hazardous gaseous or liquid emissions are released during operation of the Solar Power Tower Plant. If a salt tip over occurs, the salt will store at a very low temperature in order preserve it before significant contamination of the soil occurs. Salt is picked with the shovel and can be recycled if necessary. If there is any hybridized with the conventional fossil plant, emissions will be released from the non-solar portion of the plant.[6]

The other one technology which is use in this power plant is

1) Solar Dish/Engine System:-

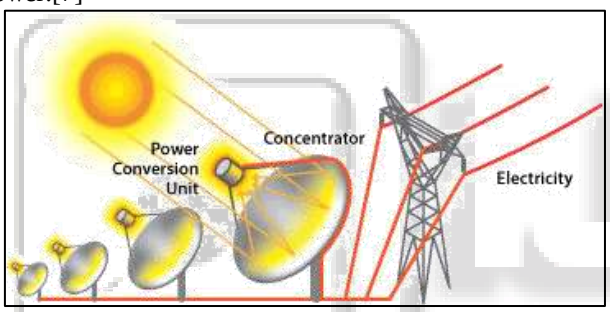
This is the technology in which a parabolic dish of mirrors to direct and concentrate sunlight onto a central engine that produces electricity. The dish/engine system is a concentrating solar power (CSP) technology that build compact amounts of electricity than further CSP technologies typically in the range of 3 to 25 kilowatts-but is favourable for modular use. The major part of this system is solar concentrator and the power transformation unit.

2) Solar Concentrator:-

The solar concentrator, or dish, assemble the solar energy coming by a direct route from the sun. The resulting beam of concentrated sunlight is reflected onto a thermal receiver that collects the solar heat. It is mounted on a structure that tracks the sun continuously throughout the day to reflect the highest percentage of sunlight possible onto the thermal receiver.

3) Power Conversion Unit:-

In this system the power conversion unit includes the thermal receiver and the engine/generator. The thermal receiver between the dish and the engine/generator. It absorbs the intensive beams of solar energy. It converts the heat, and transfer the heat to the engine/generator. It is the bank of fluid of hydrogen or helium -that typically is the heat transfer medium and also the working fluid for the engine.The engine or generator system is the sub-station that takes the heat from the thermal receiver and uses it to produce thermal to electric energy conversion.The most common type of engine is used in this systems is Stirling engine.This stirling engine used for heated the fluid to move the pistons and create mechanical power.The mechanical work,in the form of the rotation of the engine's crankshaft,drives a generator and produces electrical power.[7]



Solar dish/engine system

4) The next technology is named as (CLFR) that stands for Compact Linear Fresnel Reflector:-

The compact linear Fresnel reflector also referred to as a concentrating linear Fresnel reflector, is a specific type of linear Fresnel reflector technology.

The first linear reflector solar power system was developed in ITALY in 1961 by Giovanni Francia of the university of Genoa.

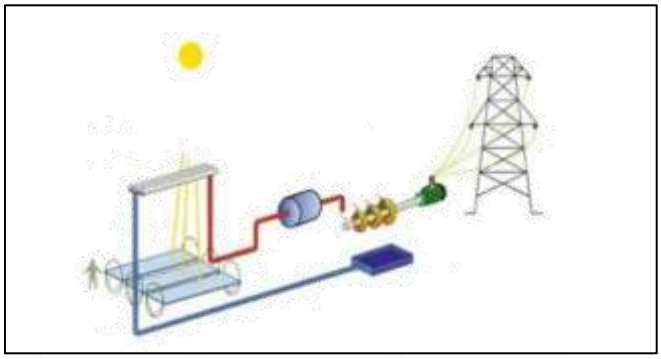
Linear Fresnel reflectors are use long, thin segments of mirrors to focus sunlight onto fixed absorber located at a common focal point of the reflectors.

These are the mirrors are capable of concentrating the sun's energy to approximately 30 times its normal intensity.

This concentrated energy is convey the fluid then goes by a heat exchanger to power a steam generator.

They are named as a Fresnel reflector(LFR) technology. The fluid then goes convey a heat exchanger to power a steam generator. As opposed to traditional LFR's the CLFR utilizes multiple absorbers within the vicinity of the mirrors.[8]

The constructional view of the Compact Linear Fresnel Reflector



And at last here the technology which take a part as it is said that as a backup for the Solar Thermal Power Plant (Enclosed Trough System)

The Glass point solar has introduced the Enclosed Trough Solar once-through steam generator (OTSG) that addresses these challenges and additionally meets the requirements for the EQR application. The Enclosed Trough represents an entirely new approach to the design and construction of concentrating solar collectors. The Enclosed Trough is protected by a glass-skinned structure, essentially a simplified agriculture greenhouse, the subject plant has a solar field footprint of 17,280 m sq. with a peak output of over 7 MW thermal.

The greenhouse protects the components from the element that can be negatively impact system reliability and efficiency. It has light weight curved, solar reflecting mirror.

Water is pumped through the pipes (stationary steel pipes) and boiled to generate steam when sun radiation is applied.[9]

IV. CONCLUSION OF THIS POWER PLANT:

Solar thermal power generation presents a unique opportunity among the renewable technologies and for future too. It is well-understood, prototypes and commercial power plants of this sort exist. It is affordable in those locations where lots of sunlight are present. It has extremely low carbon dioxide footprint. Designs of water is very low the existing areas without access to a lot of cooling water.[10] In the face of Global warming ,rising fuel costs and an ever-growing demand for energy needs are expected to increase by nearly the equivalent of 335 million barrels of oil per day, mostly for electricity. By concentrating solar energy with reflective materials and converting it into electricity, modern solar thermal power plants, if adopted today as an indispensable part of energy to more than 100 million people in the next 20 years. All from one big renewable resource: THE SUN.

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