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A REVIEW ON SOLAR POWER PLANT AND ELECTRICITY IN INDIA

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ABSTRACT

A Solar Thermal Electricity generating system also known as Solar Thermal Power plant is an emerging renewable energy technology, where we generate the thermal energy by concentrating and converting the direct solar radiation at medium/high temperature (300ºC – 800ºC). The resulting thermal energy is then used in a thermodynamic cycle to produce electricity, by running a heat engine, which turns a generator to make electricity. Solar thermal power is currently paving the way for the most cost-effective solar technology on a large scale and is heading to establish a cleaner, pollution free and secured future. Photovoltaic **(**PV**)** and solar thermal technologies are two main ways of generating energy from the sun, which is considered the inexhaustible source of energy**.** PV converts sunlight directly into electricity whereas in Solar thermal technology, heat from the sun's rays is concentrated to heat a fluid, whose steam powers a generator that produces electricity. It is similar to the way fossil fuel-burning power plants work except that the steam is produced by the collected heat rather than from the combustion of fossil fuels. In order to generate electricity, five major varieties of solar thermal technologies used are:

* Parabolic Trough Solar Electric Generating System (SEGS).
* Central Receiver Power Plant.
* Solar Chimney Power Plant.
* Dish Sterling System.
* Solar Pond Power Plant.

Most parts of India, Asia experiences a clear sunny weather for about 250 to 300 days a year, because of its location in the equatorial sun belt of the earth, receiving fairly large amount of radiation as compared to many parts of the world especially Japan, Europe and the US where development and deployment of solar technologies is maximum. Whether accompanied with this benefit or not, usually we have to concentrate the solar radiation in order to compensate for the attenuation of solar radiation in its way to earth's surface, which results in from 63,2 GW/m2 at

the Sun to 1 kW/m2 at Earth´s surface. The higher the concentration, the higher the temperatures we can achieve when converting solar radiation into thermal energy.

Keywords: Solar radiation, Solar Electric Generating System (SEGS), hybrid systems, attenuation

1. INTRODUCTION

The National Solar Mission is a major initiative of the Government of India and State Governments to promote ecologically sustainable growth while addressing India's energy security challenge. It will also constitute a major contribution by India to the global effort to meet the challenges of climate change.In launching India's National Action Plan on Climate Change on June 30, 2008, the Prime Minister of India, Dr. Manmohan Singh stated.Our vision is to make India's economic development energy-efficient. Over a period of time, we must pioneer a graduated shift from economic activity based on fossil fuels to one based on non-fossil fuels and from reliance on non-renewable and depleting sources of energy to renewable sources of energy. In this strategy, the sun occupies centre-stage, as it should, being literally the original source of all energy. We will pool our scientific, technical and managerial talents, with sufficient financial resources, to develop solar energy as a source of abundant energy to power our economy and to transform the lives of our people. Our success in this endeavour will change the face of India. It would also enable India to help change the destinies of people around the world."

2. SOLAR THERMAL POWER PLANTS

Solar thermal power plants produce electricity by converting the solar radiation into high temperature heat using mirrors and reflectors. The collectors are referred to as the solar-field. This energy is used to heat a working fluid and produce steam. Steam is then used to rotate a turbine or power an engine to drive a generator and produce electricity

All CSP plants are based on four basic essential systems which are collector, receiver (absorber), transport/storage and power conversion. Parabolic Trough, Solar towers, Parabolic Dishes and Linear Fresnel Reflectors are the four main technologies that are commercially available today. The details are given below:

Fig. 1: Solar Thermal Technologies

3) SOLAR TOWERS

A circular array of heliostats concentrates sunlight on to a central receiver mounted at the top of a tower. The heliostats tack the sun on two axes. The central receiver can achieve very high concentrations of solar irradiation thus resulting in extremely high temperature for the operating fluid. A heat-transfer medium in this central receiver absorbs the highly concentrated radiation reflected by the heliostats and converts it into thermal energy, which is used to generate superheated steam for the turbine through the Rankin cycle. Breton cycle systems are also under testing because of the higher efficiencies. Spain has several solar tower systems operating or under construction, up to 20 MW capacity

4) PERFORMANCE OF SOLAR POWER PLANTS

The performance of solar power plants is best defined by the Capacity Utilization Factor (CUF) , which is the ratio of the actual electricity output from the plant, to the maximum possible output during the year. The estimated output from the solar power plant depends on the design parameters and can be calculated , using standard softwares. But since there are several variables which contribute to the final output from a plant, the CUF varies over a wide range. These could be on account of poor selection /quality of panels, derating of modules at higher temperatures, other design parameters like ohmic loss, atmospheric factors such as prolonged cloud cover and mist.

It is essential therefore to list the various factors that contribute to plant output variation. The performance of the power plant however depends on several parameters including the site location, solar insolation levels, climatic conditions specially temperature, technical losses in cabling, module mismatch , soiling losses, MPPT losses, transformer losses and the inverter losses. There could also be losses due to grid unavailability and the module degradation through aging. Some of these are specified by the manufacturer, such as the dependence of power output on temperature, known as temperature coefficient. The following factors are considered key performance indicators:

5) GENERAL INFORMATION: WHAT ARE THE ENERGY TRENDS IN INDIA

To better understand the current situation in India and the future of the renewable energies market, it is important to look at the trends in energy consumption, growth of the current grid, and the availability of transportation and equipment used there. Since thermal generation is based on burning coal or oil, increases in CO2 emissions, which damage the environment and affect global warming, accompany this growth. As the graph below shows, it also increases the dependence on imports, which will continue into the future unless the policy changes.

6 ENERGY CONSUMPTION AND PRODUCTION UP TO 2005

Since the 1980's, and still currently, India has encountered a negative balance in overall energy consumption and production. This has resulted in the need to purchase energy from outside the country to supply and fulfil the needs of the entire country. As we will demonstrate later, the Government is more sensitive to renewable energy potential and has started to put reforms and projects, incentives and legislation in place to convince investors and companies to make the shift. These will be discussed in a later section.

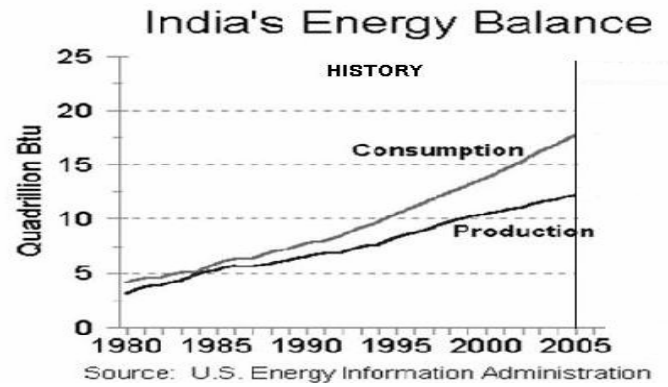

figure 2:enerjy balance

India has had a negative Energy Balance for decades, which has forced the purchase of energy from outside the country.

7) PARABOLIC TROUGH SOLAR ELECTRIC GENERATING SYSTEM

Although many solar technologies have been demonstrated, parabolic trough solar thermal electric power plant technology proves to be one of the major renewable energy success stories of the last two decades. Among all the solar energy systems, parabolic troughs are one of the lowest cost solar electric power options available today and have significant potential for further cost reduction.For example, nine parabolic trough plants, totaling over 350 MWe of electric generation, have been in daily operation in the California Mojave Desert for up to 18 years. These plants provide enough solar electricity to meet the residential needs of a city with 250,000 people. They have demonstrated excellent availabilities and have reliably delivered power to help California to meet its peak electric loads, especially during the California energy crisis of 2000-2001 (near 100% availability during solar hours). Although parabolic trough technology is the least cost solar power option, it is still more than twice as expensive as power from conventional fossil fueled power plants at today's fossil energy prices in the United States.

8) SOLAR CHIMNEY POWER PLANT

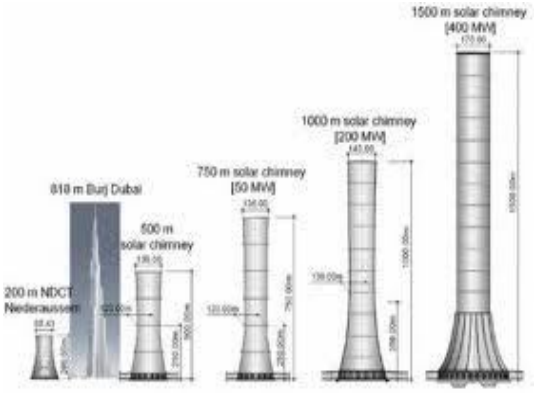

figure 3:solar chimney

Basically solar chimney power plant is the combination of solar and wind energy, in which solar energy is used to heat the air and making air less dense, moves up with particular velocity and rotates the wind turbine. Ambient air is drawn into the glass collector. This is warmed by solar energy and rises up the chimney. The current of rising warm air drives a turbine and the turbine is set at the base of chimney and dr ives the elect r ical generator

The Solar Chimney Power Plant (SCPP) is part of the solar thermal group of indirect solar conversion technologies i.e. involving more than one transformation to reach a usable form.

More specifically, a natural phenomenon concerning the utilization of the thermal solar energy involves the earth surface heating and consequently the adjacent air heating by the sun light. This warm air expands causing an upward buoyancy force promoting the flow of air that composes the earth atmosphere. The amount of energy available due to the upward buoyancy force associated with the planet revolution is so vast that can generate catastrophic tropical cyclones with disastrous consequences. Thus, the SCPP is a device developed with the purpose to take advantage of such buoyancy streams converting them into electricity. For that, a greenhouse the collector is used to improve the air heating process, a tall tube the chimney promotes the connection between the warm air nearby the surface and the fresh air present in higher atmosphere layers and a system to convert the kinetic energy into electricity

9) SOLAR MANUFACTURING IN INDIA

One of the Mission objectives is to take a global leadership role in solar manufacturing (across the value chain) of leading edge solar technologies and target a 4-5 GW equivalent of installed capacity by 2020, including setting up of dedicated manufacturing capacities for poly silicon material to annually make about 2 GW capacity of solar cells. India already has PV module manufacturing capacity of about 700 MW, which is expected to increase in the next few years. The present indigenous capacity to manufacture silicon material is very low, however, some plants are likely to be set up soon in public and private sector. Currently, there is no

indigenous capacity/capability for solar thermal power projects; therefore new facilities will be required to manufacture concentrator collectors, receivers and other
components to meet the demand for solar thermal power plants.

10) ADVANTAGES

Solar thermal electric powe collectors provides a practical, scalable solution to one of the greatest challenges of our times.

- It can provide reliable, night and day electric power at market prices without carbon emissions.
- It has availability that closely matches human energy requirements by hour and by season
- It uses less land than coal mining and transport.
- It is quick to implement.
- It is available widely around the planet, not just in a few countries.
- It has enormous primary
- A potential advantage of solar thermal systems is the ability to produce electricity when sunlight is weak or unavailable by storing solar heat in the form of molten salt.

CONCLUSIONS

Solar Photovoltaic and thermal power plants will play an important role in the overall energy supply. The grid parity is likely to be achieved around 2017-2020.
Solar radiation data is available from several sources including satellite simulations. The data collection and simulation is a complex procedure and can have inaccuracies varying from 3 to 20%. The most reliable data is ground measured with accurate instruments.The performance (Capacity utilization factor) CUF depends on several factors including the solar radiation, temperature, air velocity apart from the module type and quality, angle of tilt(or tracking), design parameters to avoid cable losses and efficiencies of inverters and transformers. There are some inherent losses which can be reduced through proper designing but not completely avoided. Thin film modules will perform better than the crystalline modules in high temperature zones. The estimated capacity factor varies from 16 to 20% in various parts of the country. At most locations in Rajasthan and Gujrat it is around 20%. In overall most of the places it is around 19% .In some places where the CUF is around 18%, it is advisable to increase to 19% by adding 50 KWp of modules for every MW of capacity to compensate for the inherent losses in the system. This will require an additional investment of Rs.40 to 45 Lakhs per MW. The modules show degradation in power output through years of operation. It is observed that quality modules is very important in determining the extent of degradation. The improvements in technology and quality assurance have reduced this degradation considerably. Several manufacturers are proposing extended warranties although with a safety of margins. Based on the results of past studies and trends, one can fairly assume degradation of maximum 0.5% per year from 3rd year

of deployment. This can also be compensated by addition of 5 KW of modules per year from 4th year to 24th year of operation requiring an expenditure of Rs.4 to 4.5 lakhs per year at current market rates. It would be desirable to monitor the solar plant installations and build up database for future work. It is also recommended to carry out a detailed study for several locations with active involvement of IMD database

REFERENCES

1://www.nrel.gov/docs/fy03osti/34186.pdf [accessed 30 march 2012]
2. www.solarpaces.org
3) Ausra, Inc.,2007, An Introduction to Solar Thermal Electric Power, Available from:ausra.com/pdfs/SolarThermal101_final [accessed 30 march 2012]
4. Solar Thermal Energy an industry report, Available from: www.solar thermal.com/solarth
5. Banerjee, R., Overview of Concentrating Solar Thermal Power, Available from: www.ese.iitb.ac.in/activities/solarpower/CSPoverview [accessed 30 march 2012].
6. WWW.wikipedia.orgmarch 2012]
7 ps of India http://www.mapsofindia.com
8 tp://mospi.nic.in/mospi_energy_stat.htm