Concentrated solar power

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Abstract*—Nowadays Power has become most important thing for the living purpose. We all need power (like electricity or fuel) for our day to day life. One of our dream is to produce clean power with low cost. In this paper, we have taken sun as main source to produce clean power, since sunrays are free and hence cost of main source becomes free of cost. Concentrated solar power systems are used to generate solar power in small area by using mirrors and lenses. They are so arranged in the small area to concentrate a large area of sunlight, or solar thermal energy. Electricity is generated when the concentrated light is converted to heat, which drives a heat engine (usually a steam turbine) connected to an electrical power generator or powers a Thermo-chemical reaction. Concentrated solar power is the way that produces power in a reasonable cost.*

***Keywords*—solar, concentrated, CSP, thermodynamic, research.**

I. INTRODUCTION

Concentrating Solar Power (CSP), which is also referred as solar thermal power, uses mirrors to concentrate the sun's rays to heat a fluid that is then used to generate electricity by using conventional steam turbines. There are three CSP generation technologies: parabolic trough, solar tower, and dish engine. **Parabolic trough** is the most commonly used technologies which uses curved mirrors with single-axis tracking to concentrate sunlight on a receiver tube or collection element that contains a heat which transfer fluid, such as synthetic oil, molten salt or steam. The heated fluid is swept through a heat exchanger to generate steam, which then is passed to a turbine to move and generate electricity.

CSP **tower** systems employ a field of mirrors to concentrate sunlight on a receiver at the top of a tower. Tower systems typically gain high temperatures while operating, which permits increased energy storage. **Dish engine** systems use parabolic reflectors that concentrate solar energy on a receiver located at the focal point of the reflector. The receiver includes a Sterling engine or small gas turbine that generates electricity.

Unlike photovoltaic installations, solar thermal facilities can accumulate energy in molten salt or other medium, allowing it to transmit energy to the grid even after the sunset. Solar thermal power needs about 3 to 8 acres per MW of installed capacity, depending on the technology and amount of thermal storage.

II. TYPES OF SYSTEMS

Unlike solar (photovoltaic) cells, which capture light to generate electricity, concentrating solar power systems produce electricity with heat. Concentrating solar collectors use mirrors and lenses to concentrate and focus sunlight onto a thermal receiver, similar to a boiler tube. The receiver assimilates and converts sunlight into heat. The heat is then transported to a steam generator or engine where it is converted into electricity.

There are basically three main types of concentrating solar power systems viz: dish/engine systems, parabolic troughs and central receiver systems. These technologies can be used to generate electricity for various applications, varying from remote power systems as small as a few kilowatts (kW) up to grid-connected applications of 200-350 megawatts (MW) or more. A concentrating solar power system that generates 350 MW of electricity dislodges the energy equivalent of 2.3 million barrels of oil. There are three solar thermal power systems currently being developed by United States: power towers, parabolic troughs and dish/engine systems. Because these technologies involve a thermal intercessor, they can be effortlessly hybridized with fossil fuel and in some cases adapted to use thermal storage. The primary advantage of hybridization and thermal storage is that this technologies can provide moveable power and operate during time intervals when solar energy is unavailable. Hybridization and thermal storage can enhance the economic value of the electricity generated and reduce its average cost.

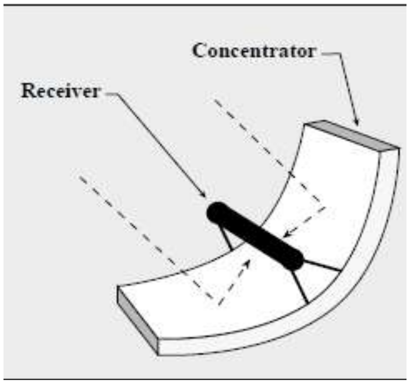

FIG. 1.Trough Systems

2.1 Trough Systems

These solar collectors use mirrored parabolic troughs to focus the sun's energy to a fluid-carrying receiver tube located at the focal point of a parabolically curved trough reflector (see Fig.1 above). The energy from the sun is delivered to the tube heats oil flowing through the tube, and the heat energy is then used to produce electricity in a conventional steam generator. Many troughs placed in parallel rows are called a "collector field." The troughs in the field are all aligned along a north- south axis so they can track the sun from east to west, ensuring that the sun rays are continuously focused on the receiver pipes. Individual trough systems currently can generate about 80 MW of electricity. Trough designs can include thermal storage-setting aside the heat transfer fluid in its hot phase-allowing for electricity generation for a couple of hours in the evening. Currently, all parabolic trough plants are "hybrids", which means that they use fossil fuels in addition to the solar output during periods of low solar radiation. Typically, a natural gas-fired heat or a gas steam boiler/re-heater is used. Troughs also can be fused with existing coal-fired plants.

2.2 Dish Systems

Dish systems use dish-shaped parabolic mirrors as reflectors to focus the sun's rays on the receiver, which is mounted above the dish at the dish center. A dish/engine system is a standalone unit composed primarily of a collector, a receiver, and an engine (see Fig.2 below). It works by collecting and concentrating the sun's energy with a dish- shaped surface on a receiver that absorbs the energy and transfers it to the engine. The engine then converts that energy to heat. The heat is then converted to mechanical power, in a manner similar to conventional engines, by compressing the working fluid when it is cold, heating the compressed working fluid, and then expanding it through a turbine or with a piston due to which mechanical power is produced. An electric generator or alternator converts mechanical power into electrical power.

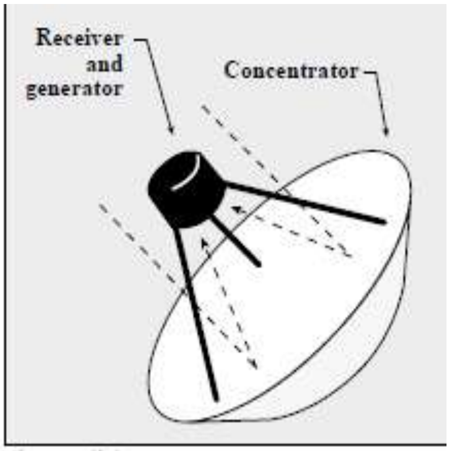

FIG.2.Dish Systems

Dish/engine systems use dual-axis collectors to spot the sun. The ideal concentrator shape is parabolic which is created either by a single reflective surface or multiple reflectors, or facets. Many options exist for receiver and engine type, including Stirling cycle, micro turbine, and concentrating photovoltaic modules. Each dish produces 5 to 50 kW of electricity and can be used separately or linked together to increase generating capacity. A250 kW plant composed of ten 25 kW dish/engine systems requires less than an acre of land.

2.3 Central Receiver Systems

Central receivers (or power towers) use thousands of individual sun-tracking mirrors called "heliostats" to reflect solar energy onto a receiver located on top of a tall tower. The receiver collects the sun's heat in a heat-transfer fluid (molten salt) that flows through the receiver. The salt's heat energy is then used to make steam to generate electricity in a conventional steam generator, located at the foot of the tower. The molten salt storage system maintains heat efficiently, so it can be stored for couple of hours or even days before being used to generate electricity. Therefore, a central receiver system is consists of five main components: heliostats, receiver, heat transport and exchange, thermal storage, and controls (see Fig. 3).

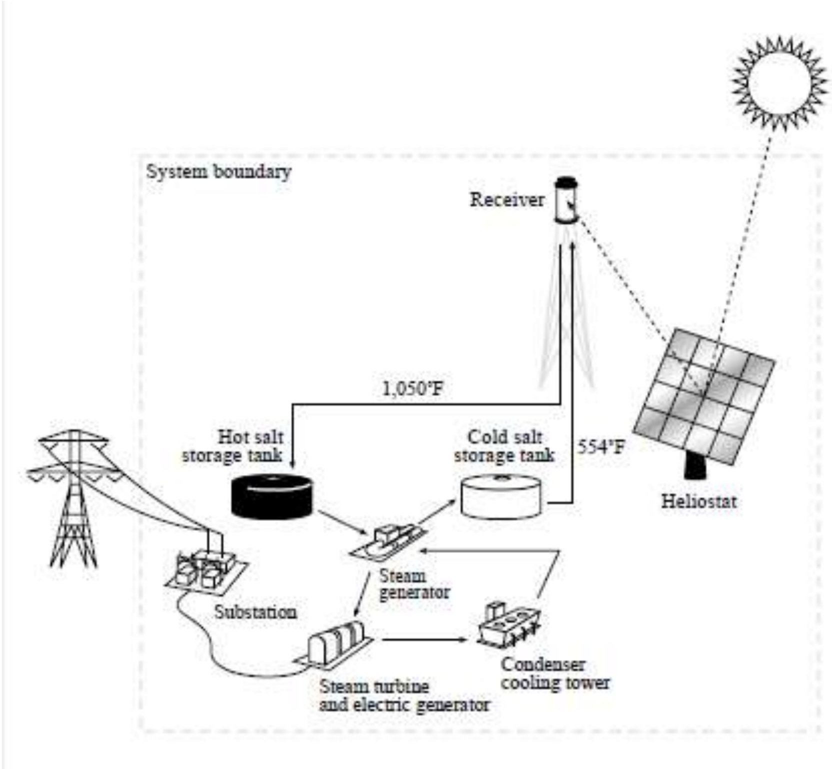

FIG. 3. Solar Two power tower system

2.4 Solar One, Two, "Tres"

Solar Two, a demonstration power tower located in the Mojave Desert which can produce about 10 MW of electricity.

In this central receiver system, thousands of sun-tracking mirrors called heliostats reflect sunlight onto the receiver. Molten salt at 554ºF (290ºC) is driven from a cold storage tank through the receiver where it is heated to about 1,050ºF (565ºC). The heated salt moves on to the hot storage tank. When power is needed from the plant, the hot salt is driven to a generator that produces steam. The steam activates a turbine/generator system that creates electricity. From the steam generator, the salt is returned to the cold storage tank, where it stored is and can be eventually reheated in the receiver.

By using thermal storage, power tower plants can potentially work for 65% of the year without any need for a back-up fuel source. Without energy storage, solar technologies like this are have a finite limit up to annual capacity factors near 25%. The power tower's ability to operate for extended periods of time on stored solar energy separates it from other renewable energy technologies.

Solar Two demonstrated how nitrate salt (molten salt) could be used as the heat transfer fluid in the receiver and as the heat storage media as well. At Solar Two, the molten nitrate salt reached about 1,050°F (565°C) in the receiver and then navigated to a storage tank, which had a capacity of 3 hours of storage. Solar Two demonstrated how solar energy can be stored efficiently and economically as heat in tanks of molten salt so that power can be produced even when the sun isn't shining. It also promoted commercial interest in power towers. Two of the project's key industry partners have been pursuing commercial solar power tower plant opportunities in Spain. Solar energy surcharges and other incentives under review in Spain create an attractive market opportunity, providing the economic incentives which are needed to reduce the initial high cost and risk of commercializing a new technology. The Spanish project, called "Solar Tres" or Solar Three, will hopefully use all the proven molten-salt technology of Solar Two, which is scaled up by a factor of three. Although Solar Two was a demonstration project, Solar Tres will be operated by industry as a long-term power production project. This utility-scale solar power could be a prime source of clean energy worldwide, offsetting as much as 4 million metric tons of carbon equivalent through 2010.

III. FUTURE CHALLENGES

Solar technology has made huge technological and cost improvements, but more research and development remains to be done to make it cost-competitive with fossil fuels. Costs can be reduced by increasing demand for this technology over the globe, as well as through improved component design and advanced systems.

Concentrating solar power technologies currently offer the lowest-cost solar electricity for large-scale power generation (10MW-electric and above). Current technologies cost around $3 per watt or 12¢ per kilowatt-hour (kWh) of solar power. New innovative hybrid systems that blend large concentrating solar power plants with conventional natural gas combined cycle or coal plants can reduce costs to $1.5 per watt and steer the cost of solar power below 8¢ per kWh. Advancements in the technology and the use of low-cost thermal storage will permit future concentrating solar power plants to work for more hours during the day and shift solar power generation to evening hours. Future advances are expected to allow solar power to be generated for 4¢ to 5¢ per kWh in the next few decades.

Researchers are developing low cost solar concentrators, high-efficiency engine/generators, and high performance receivers. The aim is to further develop the technology to increase acceptance of the systems and help the systems penetrate growing domestic and international energy markets.

IV. FUTURE OPPORTUNITIES

Developing countries in Asia, Africa, and Latin America where half the population at present is without electricity and sunlight is usual abundant which represents the biggest and fastest growing market for power producing technologies. A number of projects are developed in India,

Egypt, Morocco, and Mexico. In addition, independent power producers are in the early stages of design and development for potential parabolic trough power projects in Greece (Crete) and Spain. If successful, these projects could open the Ndoor for additional project opportunities in these and other developing countries.

The southwestern U.S. can use of these systems. Because the Southwest gets a good amount of sunlight which is twice as much sunlight as the rest of the country, many southwestern states (California, Nevada, Arizona, and New Mexico) are exploring the use of concentrating solar power, especially for use in public utilities.

V. CONCLUSION

One of the best advantage of concentrating solar energy systems is their close resemblance to most power plants. Concentrating solar power technologies use most of the same technologies and equipment used by conventional power plants; they simply fillin the concentrating power of the sun for the combustion of fossil fuels to provide energy for conversion to electricity.

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