Concentrated solar power

Concentrated Solar Power (CSP) takes the sun's energy and collects it through a series of arrays and then concentrates or focuses it on a location that is the center of the arrays. The energy at that central point becomes very hot, hot enough to melt many metals and to produce steam. Most notable of these arrays are the large installations of heliostats (mirrors), which track the Sun and reflect the radiant energy to a receiver on a tall tower. A very few smaller systems use Fresnel lenses or parabolic reflectors to concentrate the solar thermal energy. There are a lot of advantages of solar power.

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Concentrator Designs

Solar concentrator technologies comes in several forms:

- **Solar power towers** - are designed for large scale centralized grid applications. They are only a few prototypes in operation and they use parabolic mirrors to reflect the sun's radiation and then focus it on the power tower which is located in the center of the reflectors and elevated above the ground.
• **Dish Solar Concentrators** - are a smaller version of a power tower. A mirror array concentrates the sun's energy on the center of the concentrator. In the SES and SAIC systems this is where the gen-set or power generator is located. Their power range varies in relation to the size of the concentrator array but the SES/SAIC system generator about 20-40 kwh about enough to power 4-6 homes.

• **Solar Troughs** - Usually designed as part of a large scale centralized power system, however they do not rely on a centralized focus point as does the power tower and can be used for smaller scale applications.

• **High-Flux Solar Furnace** - Involves the concentration of to many times the normal intensity of the sun at the Earth's surface, creating very high temperatures enabling the molding of metals using energy directly from the sun.

A typical system may consist of a Sun tracker electro-mechanical system, a Thermal Energy Battery (sometimes called TES or Thermal Energy Storage), and an application, such as an absorption unit which can produce rotational horsepower.

## Heliostats

*From Heliostats edit*

A heliostat is a device that includes a mirror, usually a plane mirror, which turns so as to keep reflecting sunlight toward a predetermined target, compensating for the sun's apparent motions in the sky. The target may be a physical object, distant from the heliostat, or a direction in space. To do this, the reflective surface of the mirror is kept perpendicular to the bisector of the angle between the directions of the sun and the target as seen from the mirror. In almost every case, the target is stationary relative to the heliostat, so the light is reflected in a fixed direction.

The principal uses of heliostats are for daylighting (bringing daylight into a space that would otherwise be poorly illuminated), and in the generation of electricity in solar-thermal power stations. They are also occasionally used, or have been used in the past, in surveying, in astronomy and other sciences, to produce very high temperatures in solar furnaces, to improve illumination for agriculture, and to direct constant sunlight onto solar cookers. During the 19th Century, they were used by painters and other artists in order to provide constant, bright illumination of their subjects.

Heliostats should be distinguished from solar trackers or sun-trackers, which always point directly at the sun in the sky. However, some types of heliostat incorporate sun-trackers, together with additional components to bisect the sun-mirror-target angle.
What are its advantages and disadvantages of this technology as compared to Solar PV?

Solar PV is expensive and one reason it is expensive compared to other energy sources like oil is that you need a lot of PV panels that take up a lot of area to produce a certain amount of electricity. Concentrated solar though requires a much small footprint because it operates at a higher level of efficiency converting more of the sun per unit of collector into energy. However it is still not known for sure whether the cost of this technology will be competitive with PV solar much less petroleum or natural gas because this technology is still in the experimental stages. At the present time there is no capacity to mass produce the parts needed to make the SES solar concentrators so they are expensive to make. SES of course believes that once they have developed an economy of scale the cost will of constructing these arrays will go down dramatically.

The two major companies developing concentrating solar technology have used External combustion engines as the gen-set. However the versatility of the dish solar system allows for different gen-sets to be installed. The Nevada 1MW Solar Dish Engine Project too place at a UNLV test facility. Two dish solar competitors SAIC and SES were evaluated against each other. SES seemed to produce more power and performed well overall. However what was interesting was the concentrated solar/PV that was created with the use of triple junction solar cells. This hybrid has the potential to significantly increase cell capacity therefore dramatically improving power yield from cells reducing the number of cells needed to produce electricity. This though is still an experimental technology. Other possibilities involve the use of thermal-electric coupling or steam turbines.

Application Areas

Large scale solar development for centralized power solutions as SES proposes with its 1000 MW stirling generator facility is one option towards a renewable energy economy.

The Solar Power Village technology does fit this model and it also offers low-cost sterling engine solutions rather than high cost solutions put forward by SES. However SES's system may be more geared to produce electricity for sale to utilities than the Solar Power Village System. In one test performed by UNLV's solar research program SES's concentrator system outperformed SAIC's.

There are many other applications for industrial and human use of the latent heat stored in the TEB/TES
Why CSP?

Today's world suffers from an increasing dependence on fossil fuels, either for electricity production, transportation or reagent for the chemical industry. A technological revolution in hydrogen and electricity production is important to support the future needs and lead the world towards a better future. For that, technological and economical barriers have to be broken. Concentrated solar power (CSP) has been proving to be a valid means to start this revolution and produce electricity and hydrogen from completely renewable sources—water and the sun. Although solid steps should be taken to solve the current limitations and increase the technical and economical viability of these projects, there are conditions to begin this revolution using factual bridges from the current fossil technologies to renewable technologies.

Next steps

The most appropriate technology approaches are those focused on Distributed Power and/or District Power solutions and this primarily includes Dish and Trough solar Thermal systems. These systems are versatile, in that they can be used both in what are called distributed decentralized power systems and centralized, grid based or stand alone (off grid) applications (like the way most is generated today in large power plants at centralized locations).

Location

The world's first concentrated solar power tower (PS10) was built near Seville, Spain with construction beginning in 2004. The project today has 11 MW installed capacity, but the Spanish are aiming to increase installed capacity in the area to near 300 MW when other plants come online by the end of 2013.

The Ivanpah concentrated solar power plant in California's Mojave Desert is currently the world's largest such plant. The Ivanpah project has a planned installed capacity of 370 MW, although currently there are only 126 MW of installed capacity.

Solar power plants are preferred to be built in dry, arid regions of the world, which serve the dual purpose of maximizing solar insolation while protecting equipment from inclement weather. As with solar power in general, potential for CSP in the future is tremendous.

Solar CHP System Example

Solar insolation on Earth is tremendous and is more than capable of being a significant source of an energy portfolio. Consider that solar energy is responsible for plant growth, wind, waves, hydro-electric power, river power and direct conversion to electricity and for direct heat.
A major problem with CSP systems (and with any solar system) is matching load to supply. The storage of a hot liquid in the TEB, greatly in excess of the anticipated load over time, will allow for uninterrupted use. Critical backup should always be provided for hospitals, communication centers, and other essential services. The TEB can provide most of that backup, since heat can be generated and parsed into the TEB from a variety of sources (electric heat, liquid fueled heaters, geothermal heat, heat from biomass combustion). The supply of heat from the TEB allows for matching to a variable load. The use of solar radiance to heat the transfer liquid is the lowest cost source of energy, even considering the amortization of equipment and operational expenses. Distributed energy. The primary benefit is derived from the ability to size a system for a wide variety of different applications, loads, and locations. The Solar Furnace CHP System's electrical generation can operate in stand-alone mode or networked locally or nationally. A significant savings of energy lost over the transmission lines, due to heat radiation, can be realized by locating many smaller plants at the point of application and the avoidance of huge, centralized facilities.

Heat collection, storage and transfer. The use of a heat transfer liquid allows for two levels of heat. The collectors will be able, on a sunny day, to heat the liquid up to 600 degrees F. This liquid will be pumped to the TEB which is a large tank, heavily insulated and containing two heat exchangers. This tank can be made of many different materials, including temperature resistant concrete, ceramics, steel, aluminum, and other metals. The insulation will consist of a closed cell foam, made from soy, applied to the outside of the tank. The heat exchanger will be metal plate exchangers. Should one of the leaves of a plate exchanger fail, that exchanger can be unbolted and the failed plate replaced.

The tank takes its input from the solar collectors at the maximum temperature (not to exceed 600 degrees F), which incoming liquid heats the liquid in the TEB. A plate heat exchanger then parses that heat to the application. In doing so, the temperature of the liquid leaving the exchanger is regulated by a mixing valve which mixes the returning, colder fluid, with the outgoing hotter fluid, able to maintain the target temperature used by the application. Such mixing values are commercially available and can be linked to computer controls and remote sensors, switches, pumps and valves.

These units will are marketed to farms, greenhouse operations, dairies, food processing and packaging plants, industrial plants and institutions. The anticipated payback time will be between two and ten years.

References