MOLTEN SALT HEAT STORAGE SYSTEM

Gaining ground in solar technology

The engineering company has become a reference in the sector due to its **innovations in thermosolar plants.**

SENER has positioned itself as a leader in the solar power industry thanks to its continuous progress with innovating technology. Its efforts have focussed in particular on the development of numerous solutions, from components to control software and complete systems, for concentrated solar power plants, with several dozen megawatts of installed power and the capacity to supply entire towns.

Of all the engineering developments, the main difference in the thermosolar plants built by SENER stems from the molten salt heat storage system, used in Cylindrical-Parabolic Plants (CPP) and central tower receiver plants with a heliostat array. Thanks to their storage capacity, these plants can continue producing power throughout the night using the same heat from the sun. These are, without a doubt, the plants of the future.

Operation of the system

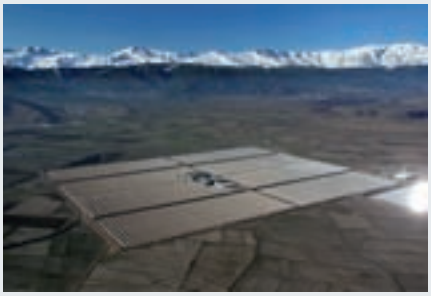
Concentrated solar power uses direct solar radiation, with a system of mirrors to concentrate sun rays on a point which contains a flowing fluid that heats up. This heat is then used to generate steam, which drives a turbine. In central tower plants, the heliostats (flat mirrors) reflect solar radiation onto a receiver located at the top of a tower in which the fluid is flowing.

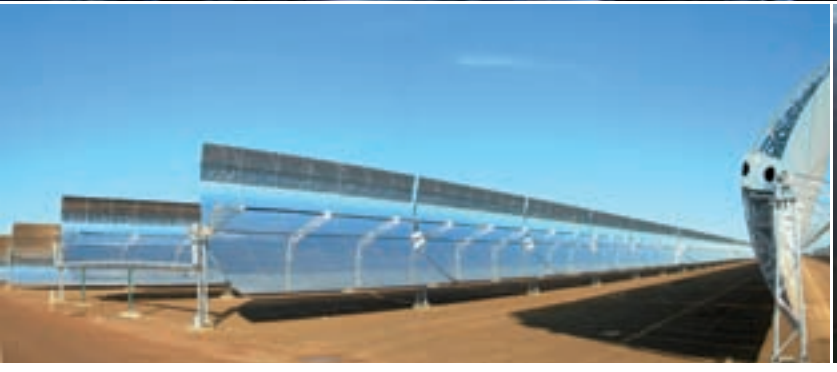
On the other hand, in cylindrical-parabolic collector plants, cylindrical mirrors concentrate the radiation on a central tube in which the fluid is flowing.

At SENER plants, in addition to generating steam, these hot fluids are also used to store excess heat in tanks of molten nitrate salts. In the tower plants, the salts are used directly as a heat absorption fluid: they flow from the cold tank, by means of a pump, to the receiver at the top of the tower, where they are heated to a temperature of 565 °C, after which they descend to the heat exchanger where they generate steam. When excess energy is received, i.e. when the received heat radiation is more than enough to cover the demand of the turbine, a part of these salts is stored in a hot tank, allowing it to be used at times with low solar radiation, when the plant does not receive enough heat to generate steam directly. The stored

TWELVE PROJECTS IN PROGRESS

SENER is building twelve thermosolar plants with molten salt heat storage systems across Spain. Three of these plants are already in operation, and the engineering firm is responsible for all the technology they use. Some of these plants are true international milestones: Andasol 1, using cylindrical-parabolic collectors, in Granada, was the first thermosolar plant in the world to use a molten salt heat storage system in commercial operation. Connected to the grid at the end of 2008, the fulfilling experience of its construction, commissioning and commercial operation has enabled SENER to undertake ten other similar projects using the same technology. Also notable is Gemasolar, the first commercial plant in the world to use central tower receiver technology with a heat storage system. Promoted by Torresol Energy, it will enter operation in 2011 and SENER is hoping it will become an international reference, a starting point in the strategy to reduce costs in the thermosolar power sector.





Above, on the left: **molten salts tank in the cylindrical-parabolic plant Andasol 1.**
Above, on the right: **molten salts tank in the central tower plant Gemasolar, that is being built in Seville.**
Below, on the left: **SENERtrough system, patented by the company, that SENER currently installs in all its CPP projects.**
Below, on the rigth: **Extresol 1 aerial view, located in Badajoz (Spain), a project where SENER has carried out the 100% of the engineering works.**
Left page: **Andasol 1 solar plant, in Granada (Spain), a turnkey project developed by SENER in joint venture with ACS-Cobra.**

salts can then supply this heat and continue generating steam.

A similar system is used in CPP plants, with the difference that oil is used as the fluid for absorbing heat radiation. Once heated, this oil is transferred to a heat exchanger, either to generate the steam required to drive the turbines directly, or to heat molten salts at times with excess energy, and to store the heat in a hot tank that allows the plant to continue generating electricity even when the sun is not shining. At these plants, the molten salts are stored at a lower temperature than in central tower plants, since the absorption fluid, in this case the oil, reaches lower temperatures than the salts when they are heated directly in the central tower receiver. For this reason, their capacity to get advantage of the thermal storage system is also lower.

Benefits of heat storage

A common feature of all solar power plants is their dependence on solar radiation for the generation of electricity, which is subject to considerable fluctuations according to the position of the sun in the sky throughout the day and throughout the year, as well as cloud cover. These fluctuations are sometimes directly responsible for sudden load variations in the turbine, which is the element that transforms the heat energy from the solar array into electric power. Generally speaking, in a CPP plant, the turbine receives double the input power in the summer compared with the winter and, on days with considerable cloud cover, the turbine is subjected to sudden bursts that shorten its useful life.

The use of a heat storage system, which makes it possible to continue producing electricity with no sunshine, considerably reduces these load variations. This also guarantees a continuous supply of electricity, overcoming intermittences, and flexibly adapts the supply to the demand, one of the main weaknesses of certain renewable technologies. Furthermore, due to this system the turbine efficiency increases.

The engineering firm, which has innovation as one of its founding values, is continuing to improve its technology with every single project. Its goal is to turn solar power into a true alternative that can compete with conventional power sources. As a result of this, these solar power plants, which can uninterruptedly produce clean, inexhaustible power, may define the medium-term outlook for solar power worldwide.