AT THE FOREFRONT OF INNOVATION

Concentrated solar power: mission accomplished for SENER

SENER Grupo de Ingeniería is now the leading company in the **development of innovative solutions** according to the number of **projects it has in progress.**

In this page: **SENERtrough, the parabolic trough collector system developed by SENER, lighter and easier to install.** ***In the next page:*** **construction works at Gemasolar plant, the first in the world with tower technology and molten salts storage system.**

The engineering projects in the field of Concentrated Solar Power (CSP), successfully carried out by SENER Ingeniería y Sistemas, add up to a total of 15, which will have a total installed power of 1 GWe once construction has finished. Among these are the three innovative plants of Torresol Energy, a company incorporated by SENER as a joint venture with Masdar, to promote large CSP plants around the world, allowing SENER to exploit its own technology.

Since the end of 2005, when it started its first large commercial project, Andasol-1, the major innovations of SENER, which have helped its plants maximize their efficiency, have enabled the company to secure a considerable portfolio of contracts, and are now being adopted by leading competitors. For example, the molten salt storage system that SENER installs in all the plants it develops, with parabolic trough or tower technology, has revolutionized the CSP market, and leading competitors are beginning to look into adopting similar systems. The thermal storage system allows plants using SENER technology to continue producing electricity at night or during cloudy weather, turning a renewable source like solar energy into a dispatchable energy, capable of supplying electricity in line with demand, unlike other technologies such as wind power, which has no storage option.

SENER recently won the engineering and construction contract for the solar arrays of three new CSP plants. These are ASTE 1 A and ASTE 1 B, located in Ciudad Real, and Termosolar Soluz Guzmán, in Córdoba, all in Spain. The three plants, using parabolic trough collector technologies with a power of 50 MW each, could be operational by the end of 2012. These three new contracts bring SENER up to a total of 15 thermosolar plants throughout Spain, five of which are currently operational. These plans will have a total installed power of 1 GWe once construction has finished, making SENER the leader in terms of the number of projects. Two of them, Andasol-1 and Gemasolar, have been true milestones for the CSP industry.

In this page: optimized thermal storage system in the Power Block of La Florida plant, owned by SAMCA, with three salt-oil heat exchangers. *In the next page, above:* heliostats in Gemasolar plant, owned by Torresol Enegy. *Below:* general view of the Valle 1 and Valle 2 plants, also owned by Torresol Energy and build, as EPC contract, by SENER.

A story of R&D

Few companies can boast such a long history of research and development in CSP technology. SENER, a high-tech company with innovation as its main distinguishing feature, which lists facing up to new challenges as one of its driving forces, was soon attracted to the opportunities for development to be found in a new form of power: concentrated solar power, capable of generating high-power electricity and thus of becoming an alternative to large conventional power plants. As early as the 1980s, the company had started to develop solar technology, including the first heliostats, but it did not get involved with the first CSP plant project, Solar Tres, until 2001. This was an experimental plant with a central tower and heliostat design, in collaboration with the companies Ghersa, Boeing and Nexant. SENER eventually became the project leader. Solar Tres allowed the company to conduct a thorough study of the real opportunities found in the solar power industry, and to make an investment in R&D that would lead to the first large-scale technological developments in CSP.

By 2005, SENER had sufficiently matured its research in thermosolar power to be able to undertake its first commercial project, the Andasol-1 plant. Owned by ACS, developed in a joint venture with Cobra, SENER carried out the engineering, construction, commissioning and commercial operation monitoring of the plant. This plant used parabolic trough technology, which was already efficiently used in the USA and had gained popularity in the thermosolar market. SENER added a molten salt storage system to this plant, thus extending its operating period by up to 8 hours without solar radiation. Connected to the grid at the end of 2008, it set a global milestone as the first commercial plant with storage capacity. The fulfilling experience with Andasol-1 gave SENER the opportunity to undertake other similar projects, winning 15 contracts in only six years.

Gemasolar is another global milestone, as the first commercial plant with central tower and heliostat array technology to include a thermal storage system. With a turbine of less than 20 MW, its production will be similar to that of a 50 MW parabolic trough plant without thermal storage. Overall, Gemasolar will supply clean, safe energy to 25,000 homes and reduce CO_2 emissions by more than 30,000 tones a year. Studies conducted by SENER have confirmed that this technology will be the most cost-effective, since it has a simple design which is still capable of generating electricity with greater efficiency and higher thermal storage capacity than parabolic trough technology. SENER has invested heavily in this plant, in which it also has a 60% stake through Torresol Energy. However, it will definitely bring returns in the medium term: when its comes into operation in 2011, Gemasolar will be an international reference and a starting point in the cost-cutting strategy of the thermosolar power industry; commercial operation of this plant will prove the efficiency of tower technology with molten salts receiver, paving the way for other similar plants around the world, which will enable industrial production like we see today with parabolic trough technology.

The talent of an experienced team

This innovative effort is key in explaining the leading position of SENER, as summarized in its competitiveness. SENER has been developing pioneering plants since the 1980s, which has afforded it a remarkable technological advantage over its competitors. Furthermore, this ability to think ahead has enabled the company to train experts in the field of CSP: engineers from various disciplines, who have seen solar projects through from initial design to commissioning, also responsible for following up their operation, and who today continue to work

NEW RESPONSIBILITIES, NEW MARKETS. The progress of the company has not gone unnoticed by its customers, who have gradually entrusted more tasks to the SENER engineering team over the last six years. Today, the company is involved in every phase of its projects, from initial design to commissioning and maintenance. It has also grown internationally, thanks to the good results its projects have obtained in Spain. Thus, in the USA, where it has an office dealing mainly with the promotion of solar projects, the company is working on two CSP projects, and in Abu Dhabi it has started to design two central tower plants with storage system. In addition, it has begun to study a variety of CSP projects in countries such as India, South Africa, Australia and Mexico. Since the start, SENER's goal is to lead projects around the world in the field of concentrated solar power: SENER Ingeniería y Sistemas is looking for opportunities beyond the domestic market; and Torresol Energy has this same objective as one of its founding goals, with the mission of promoting large solar plants around the world, especially in the so-called 'solar belt': Southern Europe, Northern Africa, the Middle East and the Southwestern USA.

at SENER. This highly qualified team is key for identifying improvements in CSP developments, which the company has gradually applied in each project, in a constant progression. Its developments therefore comprise computer programs for managing and operating solar plants, such as its SENSOL software, which has gradually incorporated new applications in subsequent versions; its collector design, the SENERtrough system, which enables notable savings in installation and maintenance costs; its salt storage system, which is constantly looking for ways to increase its efficiency –for instance, SENER is currently undertaking the construction of a prototype that removes one of the tanks from the circuit, resulting in a single-tank system, which would allow considerable cost savings-; and other improvements in power island installation, maintenance and operation... the engineers are constantly improving their skills. As for tower technology, with the first commercial project still in construction, SENER has already started planning a second generation, with a new layout of the solar field, capable of more efficient plant management.

With its sights set on the future, the company is still devoting a considerable number of working hours to research and development. In this way, SENER is making the most of its multi-discipline nature, as a company working in the sectors of Aerospace, Power and Process, Civil Engineering and Architecture and Marine Engineering, with access to experts in every discipline, applying innovations in all these fields to solar technology. On the other hand, the company Torresol Energy has plans to set up research centers at each one of its plants for testing prototypes at the actual plant. Furthermore, SENER engineers frequently collaborate with technology centers, such as the Plataforma Solar de Almería, belonging to the CIEMAT (Ministry of Industry), universities, technology centres such as the Technological Corporation of Andalusia, The Andalusian Technology Centre for Renewable Energies or institutions such as the Basque Energy Board (EVE), through innovative projects.

This innovative effort is key in explaining the **leading position of SENER**, that has already 15 CSP plants under development.

The main goal of all the research and development efforts by SENER Ingeniería y Sistemas as well as Torresol Energy is to achieve significant reductions in the cost of generating this type of electricity, in order to make it a true alternative to conventional power, both financially competitive and sustainable.

In this regard, the two companies share the same ideas as their parent group, SENER Grupo de Ingeniería: to offer the most advanced technological solutions in the fields where it is possible to develop innovations and where the talent of SENER, which is the sum of the talent of its professionals, can contribute to improving society as a whole.