Steam turbines for CSP plants

Industrial steam turbines

Answers for energy.

SIEMENS

Green power without carbon dioxide

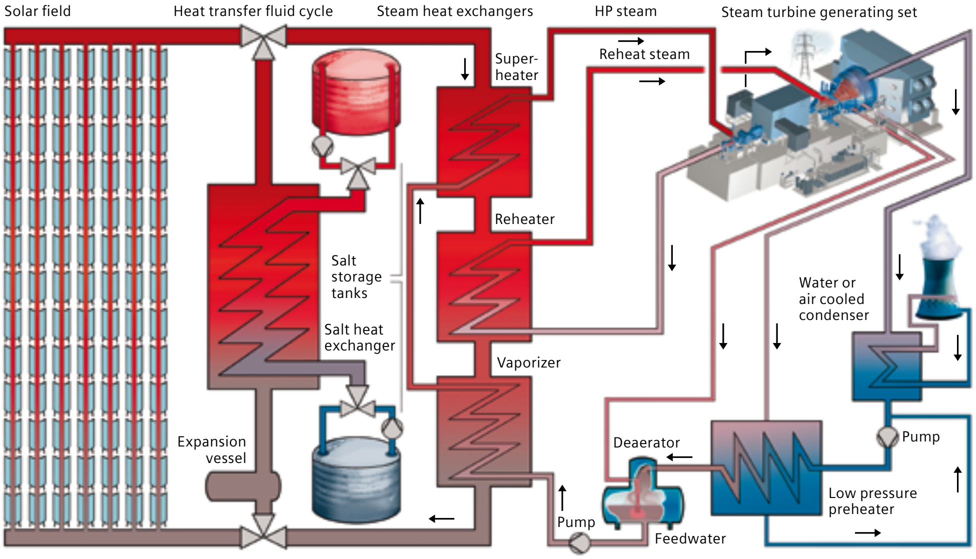
Sun power is a potentially inexhaustible source for energy production. The advantage of solar energy is that the fuel is both free and abundant. In the face of global warming, with energy policies calling for wide-scale use of renewable and sustainable technologies, solar projects are proving increasingly valuable in the reduction of fossil fuel energy use. Cost reduction forecasts implicate that CSP plants could be competitive with fossil fuel power stations in the near future.

Solar power technologies

Since the solar boom of the eighties in USA, solar thermal energy has been a proven technology. The most common type of plant is the parabolic trough collector, but alternative technologies are rapidly coming to the fore, such as Linear Fresnel collector plants with flat mirrors and central tower plants with slightly curved mirrors or heliostats. The basic principle is the same for all three plant technologies: Mirrors concentrate the incident solar radiation onto a receiver where it is converted into heat that is used to produce steam to drive a steam turbine. Heat storage systems like molten salt tanks provide for power supply even during unfavorable weather conditions or at night. They significantly increase the number of full-load operation hours with optimal steam turbine efficiency.

Turbines for all main CSP technologies

With its broad steam turbine portfolio, Siemens offers a range of turbines for different types of solar plants and all power outputs. The turbine technology fits all three common concentrated solar power (CSP) concepts. Siemens was the first steam turbine supplier to re-enter the CSP market in the 21st century, pioneering commercial solutions in the US and Spain. Today, Siemens is the world market leader in steam turbines for CSP plants, and has more than 20 years of experience with steam turbines for daily cycling. The SST-700 steam turbine in the US King City power plant is a good example of this.



Steam cycle of a concentrated solar power plant (parabolic trough type)

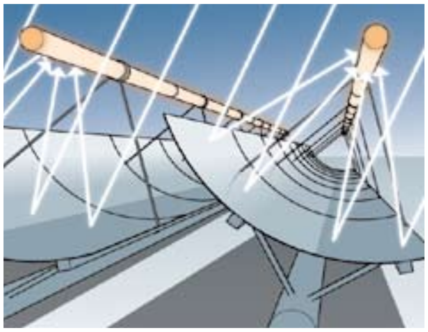
Parabolic trough technology

With operational experience of more than 20 years in commercial installations, the parabolic trough technology has proven its reliability, showing its impressive potential on a day-to-day basis. Extensive research efforts are now being made to replace the currently used thermal oil with molten salt or through direct steam generation to improve the efficiency of the parabolic trough technology.

Parabolic systems use trough-shaped mirrors to focus sunlight onto an absorber tube (receiver) placed in the trough's focal line. The troughs are designed to track the sun along one axis, predominantly north-south. The receivers contain a heat transfer fluid (e.g. synthetic thermal oil, molten salt) which is heated by the focused sunlight. It is circulated in these tubes and pumped through heat exchangers to produce steam.

The parabolic trough technology is currently the best proven and most used technology, even though the live steam parameters are lower than in solar power tower plants.

As of summer 2010, Siemens steam turbines are operating in eight parabolic trough CSP plants, while more than 30 turbines have been ordered for parabolic trough plants which are under construction or in planning.



NEVADA SOLAR ONE, Boulder City, Nevada, USA
Parabolic trough (Oil)
64 MW(e) nominal

The 64 MW solar power plant with solar trough technology has been in operation since 2007. It was built by Acciona Solar Power, a partially owned subsidiary of Spanish company Acciona Energy. Nevada Solar One uses 760 parabolic troughs, consisting of more than 180,000 mirrors, to concentrate the sun's rays onto receivers placed at the focal axis of the troughs. Thermal oil that heats up to 390°C flows through the receiver tubes and is used to produce steam to drive the steam turbine. The plant powers about 40,000 households.

Steam turbine: Siemens SST-700
Power output: up to 74 MW(e)
Inlet pressure: 90 bar / 1,305 psi
Inlet temperature: 371°C / 670°F

Nevada Solar One, completed in 2007, was the first CSP plant built in 17 years

ANDASOL 1 + 2, Granada, Spain
Parabolic trough (Oil)
50 MW(e) each

The two CSP plants are located in the Granada area, each covering a field of 1.95 km^2 of which the mirror field size is about 510,000 m^2. Both Andasol plants have a thermal storage system using molten salt to absorb part of the heat produced in the solar field during the day. This process almost doubles the number of operational hours per year at the solar thermal power plant. Andasol I went online in 2008, while Andasol II commenced its testing phase in 2009.

Steam turbine: 2 x Siemens SST-700
Power output: 2 x 50 MW(e)
Inlet pressure: 100 bar / 1,450 psi
Inlet temperature: 377°C / 711°F

Andasol 1 in southern Spain was the first parabolic trough plant that went online in Europe

Solar power tower / central receiver

The main advantage of solar power towers in comparison to line-focusing systems is the ability to provide high-temperature superheated steam, leading to higher power generation efficiencies. Another point is its flexibility when it comes to plant construction, because heliostats do not need to be sited on an even surface.

A circular array of flat heliostats (sun-tracking mirrors) concentrates sunlight on to a central receiver at the top of a tower. A heat transfer medium (water/steam, molten salt or air) in the receiver absorbs the thermal energy and transfers it into the steam cycle to generate superheated steam for the turbine.

The advantage over the parabolic trough or Fresnel collector concept is that the sunlight on the central receiver is focused to a smaller area, and the heat transfer medium does not have to be piped around the large solar field. This means that higher working fluid temperatures in the receiver (up to 1000°C) and better steam parameters are feasible, even supercritical steam is expected.

For central tower technologies, Siemens steam turbines can be operated in plants with all current heat transfer mediums like air, water/direct steam and molten salt.

Solar Power Tower (Air)
1.5 MW(e)

This northernmost solar power tower with its high-temperature air receiver has been built to demonstrate the technology of using air as a heat transfer medium despite its low heat transfer coefficient. The solar tower, about 60 m high and located in the city of Jülich in the northwest of Germany, went online in 2009. The pilot project was initiated with contributions from the German Aerospace Centre (DLR) and the Solar Institute in Jülich (SIJ). Plant construction and operation is accompanied by a research program to develop the high-temperature air receiver technology for much larger plants in the sunbelt countries of southern Europe or North Africa.

Steam turbine: Siemens SST-110
Power output: 1.6 MW(e)
Inlet pressure: 27 bar / 392 psi
Inlet temperature: 480° C / 896° F

The Jülich Solar Tower is a milestone to the commercialization of solar thermal power generation

IVANPAH SOLAR POWER COMPLEX, California, USA
Solar Power Tower (Water / Direct Steam)
3 plants, 392 MW(e) in total

BrightSource Energy, a privately owned energy company, is currently developing the Ivanpah Solar Energy Generating System in California's Mojave Desert. It will consist of three separate plants using tower technology and provide approximately 400 MW electricity to the US utilities PG&E and Southern California Edison. The first plant is scheduled to come online in mid-2012. The whole complex will generate enough electricity to power more than 140,000 homes.

Steam turbine: 3 x Siemens SST-900
Turbine data for the first plant:
Power output: 123 MW(e)
Inlet pressure: 160 bar / 2321 psi
Inlet temperature: 550° C / 1004° F

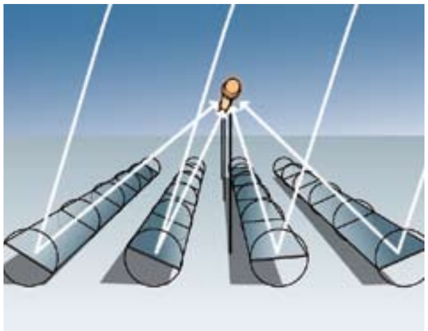
The Ivanpah plants will use BrightSource Energy's Luz Power Tower technology

Linear Fresnel

Simplified plant design, lower investment and operational costs are the main advantages of Linear Fresnel systems. The flat mirrors are cheaper and easier to produce than parabolic curved reflectors. Moreover, minimized structural costs, low wind loads, minimized internal energy losses, and lower maintenance costs could turn the Fresnel technology into a competitive alternative to parabolic troughs.

The Linear Fresnel technology uses long, flat or slightly curved mirrors to focus sunlight onto a linear receiver located at a common focal point of the reflectors. The receiver runs parallel to and above the reflectors and collects the heat to boil water in the tubes, generating high-pressure steam to power the steam turbine (water/direct steam generation, no need for heat exchangers). The reflectors make use of the Fresnel lens effect, which allows for a concentrating mirror with a large aperture and short focal length. This reduces the plant costs since sagged-glass parabolic reflectors are typically much more expensive.

Since the optical efficiency as well as the working temperatures are considerably lower than with other CSP concepts, saturated steam conditions have to be considered for this technology. Development is now heading from demonstration plants to bigger, commercialized projects.



PUERTO ERRADO 1 (PE1), Calasparra, Spain
Linear Fresnel (Water / Direct Steam)
1.4 MW(e)

The PE1 Linear Fresnel demonstration plant, developed by Novatec Biosol AG, commenced selling power to the Spanish grid in March 2009. The 1.4 MW Plant, located in Calasparra in the region of Murcia, Spain, has two rows of receivers, each with a length of 860 m, providing direct steam to the steam turbine. Each receiver uses 16 parallel lines of mirrors with a total surface of 18,662 m^2. A Ruth heat storage system, which utilizes hot water and saturated steam, is used for steam buffering. Construction of the utility-scale Linear Fresnel CSP plant Puerto Errado 2 (30 MW) started in April 2010.

Steam turbine: Siemens SST-120
Power output: 1.4 MW(e)
Inlet pressure: 55 bar / 798 psi
Inlet temperature: 270° C / 518° F (satured steam)

The PE1 plant demonstrates the efficiency and cost-effectiveness of the Fresnel technology

Steam turbines in CSP applications

CSP plants require steam turbines which are optimized for their complex and challenging cycle conditions. Bearing in mind that efficiency and total cost of ownership are key to any investment decision, Siemens incorporates its operational experience into extensive R&D and engineering activities to adapt the turbines to the specific requirements of the CSP technology. As market leader in industrial steam turbines, Siemens commands a comprehensive product portfolio for solar thermal plants, covering the full range from 1.5 MW to more than 250 MW.

The perfect configuration for CSP

In order to justify the investment cost for a CSP plant, which will not be run twenty-four hours per day, high demands for efficiency and increasing economic returns are imposed on the steam turbine used in the process.

Siemens has cooperated closely with leading solar thermal EPC companies, project developers and operators to develop and fine-tune their steam turbines for solar thermal applications. The highly efficient turbines enable a smaller solar mirror collector field with associated reduction in investment cost for generation of the required electrical power output. Alternatively, the surplus heat can be put into thermal storage to extend the production time for the plant.

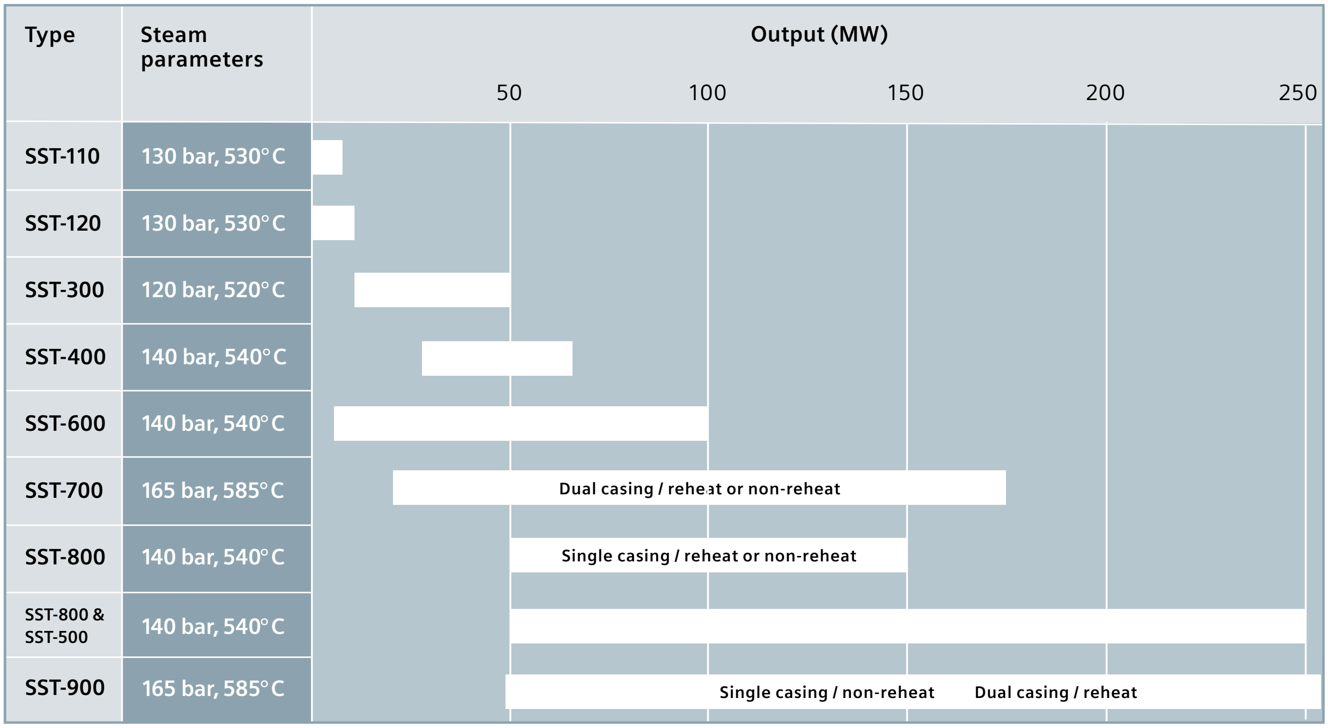
Installing the SST-700 low pressure steam turbine on the Boulder City site, Nevada, USA

Excellent daily start-up solutions

Day and night cycle often requires a large number of starts and fast daily startup capabilities from CSP steam turbines. When focusing on annual power production, the short start-up times of the turbines are of great benefit to the CSP plant owner. Daily cycling and temperature variations require special attention. Reheat solutions improve efficiency and reduce problems with erosion/corrosion and moisture in the LP turbine.

Siemens is able to deliver CSP steam turbines for all power outputs up to more than 250 MW. The turbines meet all customer requirements for economic installation and operation and provide excellent flexibility for all cycling conditions.

Power output for Siemens steam turbines suitable for CSP



Type	Steam parameters	Output (MW)
SST-110	130 bar, 530°C	
SST-120	130 bar, 530°C	
SST-300	120 bar, 520°C	
SST-400	140 bar, 540°C	
SST-600	140 bar, 540°C	
SST-700	165 bar, 585°C	Dual casing / reheat or non-reheat
SST-800	140 bar, 540°C	Single casing / reheat or non-reheat
SST-800 & SST-500	140 bar, 540°C	
SST-900	165 bar, 585°C	Single casing / non-reheat Dual casing / reheat

Siemens R&D activities

Together with EPC contractors and plant developers, Siemens is continuously developing new concepts for steam turbines for CSP applications. Siemens R&D activities focus on the increase in the internal steam turbine efficiency as well as on cycle efficiency enhancements of the steam turbine configuration e.g., double reheat configuration, supercritical steam parameters. Siemens CSP steam turbines have been optimized to handle a wide steam flow range because the solar energy intensity and the cycling conditions can vary according to the weather and time of day. The turbines are suitable for higher steam parameters and can be operated in non-reheat, single reheat and double reheat cycles. Due to their high flexibility and their outstanding efficiency, they fit for all main CSP technologies. Siemens is continuously reacting on new plant technology trends, e.g., the introduction of simpler solar field designs (e.g., Linear Fresnel) have led to changes in the steam parameters and accordingly to adjustments in the CSP steam turbines.

Main advantages of Siemens CSP steam turbines:

- Highly efficient, shortening the payback period of investments
- Designed for daily start-up and shutdown
- Rapid start-up times
- Daily cycling with low minimum load, enabling maximum running hours per day for plants without heat storage
- Shipped assembled for easy installation at site, reducing time and manpower
- Available in non-reheat, reheat and double-reheat solutions
- Available with axial or radial exhaust to decrease civil engineering investment
- Suitable for air- and water-cooled plants
- Tailored to customer requirements
- Coming from industrial background (robust and reliable design)

Integrated Solar Combined-Cycle Plants

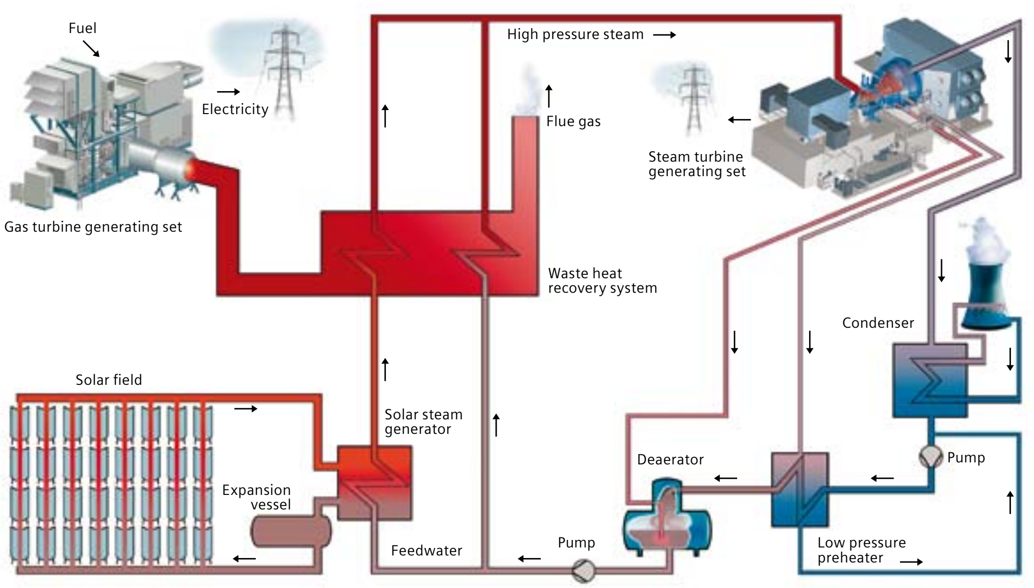
Apart from solar thermal power plants, Siemens solar steam turbines can be also used for hybrid plants like Integrated Solar Combined-Cycle (ISCC) systems. The heat generated by the solar field decreases the already low emissions of a combined cycle power plant and increases the efficiency even more.

Steam turbines for ISCC plants

For excellent performance and attractive emissions reductions, parabolic troughs can be effectively integrated with a conventional combined-cycle plant, as well as a steam-cycle plant.

This configuration is double effective. It not only minimizes the investment associated with the solar field by sharing components with the combined cycle, it also reduces the CO_2 emissions associated with a conventional plant. The integration maximizes operation efficiency even though solar energy intensity varies according to the weather and time of day.

The most used technical solution for ISCC plants is to oversize the steam turbine of the combined cycle plant. During solar operation, the gas turbine waste heat is used for preheating/superheating, while solar heat is used for steam generation to operate the turbine with an increased amount of steam. In this way, the capacity of the steam turbine can be increased by up to double the amount of a conventional combined cycle power plant. In hybrid cycle steam plants, the steam produced by the solar field is normally used to displace turbine extraction steam to the feedwater heaters.



Steam cycle of an ISCCS plant

KURAYMAT, Egypt
Integrated Solar Combined Cycle (ISCC) plant
126 MW(e)

The 126 MW ISCC plant, located about 90 km south of Cairo on the eastern side of the river Nile, is scheduled to start operation in autumn 2010. It will consist of a parabolic trough solar field capable of generating about 110 MW(th) of solar heat at a temperature of 400°C, one 74 MW(e) gas turbine and one single casing condensing Siemens SST-900 steam turbine with generator. Further enlargement of the solar field in the future is possible, and this would raise the plant capacity to around 150 MW.

Steam turbine: Siemens SST-900
Power output: 77 MW(e)
Inlet pressure: 92 bar / 1334 psi
Inlet temperature: 560°C / 1040°F

The Kuraymat ISCC plant will go online in autumn 2010

Comprehensive plant expertise

Siemens expertise includes high-efficiency receiver technology, complete plant know-how and proven repairs and maintenance solutions. We are able to offer about 70 percent of the components of a solar thermal power plant as well as EPC turnkey solutions in selected cases when this is valued by the customer.

Siemens delivers key components

With the acquisition of the solar thermal power company Solel Solar Systems and the cooperation with the Italian solar receiver specialist Archimede Solar Energy, Siemens is able able to offer high-efficiency receiver technology and comprehensive expertise in the planning, engineering and construction of solar fields.

In addition to the steam turbine and the solar receiver, Siemens is able to deliver the complete power block for CSP plants. It includes all components and solutions for the entire water/steam cycle.

In addition to the steam turbine package, the scope of supply includes the entire range of components from condensing systems to preheaters, evaporators and cooling systems as well as the entire electrical equipment, plant control systems, instrumentation, transformers, and switchgear.

All these components belong to traditional Siemens areas of expertise.

A truly global sales and service network as offered by Siemens gives the customer the benefit of security of investment, supply and after sales service.

From installation and commissioning, scheduled overhauls, on-site or factory repairs to spare parts, we are ready to serve you. Our global team of highly qualified service specialists is dedicated to provide fast and reliable support.

Selected turbine references in CSP

Siemens have sold more than 50 steam turbines for CSP plants using parabolic trough, solar power tower or Linear Fresnel technology to generate environmentally friendly electricity. The turbines are specially adapted to the solar-specific demands for a quick daily start-up and shutdown. The high technical efficiency is a prerequisite for operational cost-efficiency.

LEBRIJA 1, Lebrija, Spain
Parabolic trough (Oil)
49.9 MW(e)

Lebrija 1, located in southern Spain in the province of Seville, Andalusia, is a CSP plant predominantly manufactured with Siemens components: The solar field, including nearly 6,000 parabolic collectors, approximately 18,000 solar receivers, and more than 150,000 parabolic reflectors, was provided and installed by the solar thermal pioneer Solel, which was acquired by Siemens during the construction period. The power block was built by Valoriza, using a Siemens SST-700 reheat steam turbine. The plant will go online in 2011 and is expected to supply over 50,000 Spanish households with electricity.

Steam turbine: Siemens SST-700
Power output: up to 52 MW(e)
Inlet pressure: 104 bar / 1,508 psi
Inlet temperature: 377°C / 711°F

Lebrija 1 is the first CSP plant predominantly manufactured with Siemens components

GEMASOLAR, Fuentes de Andalucía, Spain
Solar power tower (Molten salt)
17 MW(e)

The Gemasolar project, formerly called Solar Tres, was developed by Torresol Energy, a joint venture between Sener and Masdar. Construction of the plant started in late 2008. Situated in the province of Seville, it consists of a 120 m high solar tower and a heliostat field of about 320,000 m^2. Gemasolar will be the world's first utility-grade solar power plant with a central tower that uses molten salt for the heat transfer between receiver and heat exchanger. Surplus heat is stored in the hot salt tank of a thermal storage system. Siemens supplied a SST-600 two-cylinder reheat steam turbine in 2009.

Steam turbine: Siemens SST-600
Power output: up to 19 MW(e)
Inlet pressure: 105 bar/1,523 psi
Inlet temperature: 542°C/1,008°F

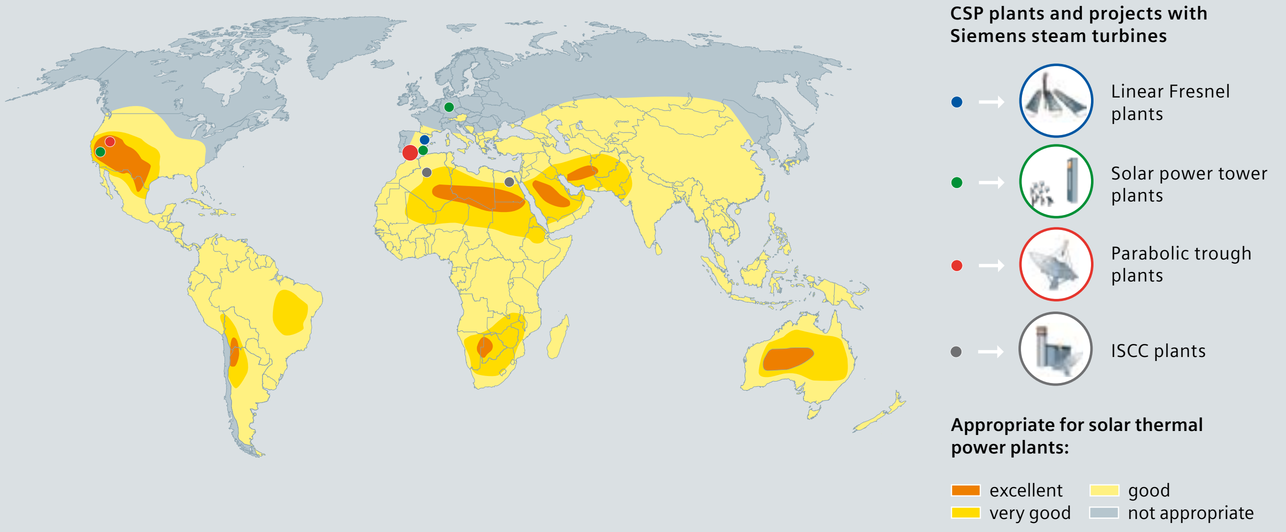
The Andalusian plant Gemasolar uses a Siemens SST-600 steam turbine

Siemens CSP experience

Customers can gain confidence in the reliability and bankability of new projects with Siemens, who have the largest number of steam turbine projects and references worldwide in solar thermal power plants with parabolic troughs, solar power tower and Linear Fresnel technology.

Siemens turbines power solar plants all over the world

Siemens industrial steam turbines for solar solutions are ordered by customers all over the world and provide energy at CSP plants in the US, Spain, Germany and Northern Africa.



Over twenty years of experience

One of the most challenging requirements for a CSP steam turbine is the daily start capability with short start-up times. In the power plant near King City, USA, a SST-700 has been running with almost daily starts and stops since 1988.

The experience from operation with that turbine is now the reference for the frequent start and stops that are common when operating a solar thermal power plant. Since June 2007, a 64 MW(e) SST-700 steam turbine is powering a solar thermal power plant in the U.S. – following the boom in the 1980s the first new solar thermal power plant for over 15 years. The turbine is deployed in the Nevada Solar One plant in Boulder City.

This order made Siemens a pioneer in steam turbines for solar thermal power plants. Since then, Siemens has continuously used its operating experience as feedback to adapt its broad steam turbine portfolio to the special demands of solar thermal power plants. Accumulated know how from the proven and successful SST-700 CSP product line was utilized in other steam turbine product lines. Life-cycle calculations of all critical parts have resulted in high-quality materials specially chosen for long and trouble-free operation. Additionally, casing design and blade root improvements have been made, and a low-mass rotor introduced.

To date, Siemens has sold more than 50 steam turbines for CSP plants. Over 80 percent of the Spanish parabolic trough-type CSP plants already or coming online are powered by Siemens turbines.

Future prospects

Market trends indicate that solar power will increase significantly in the future. The benefits of solar power are compelling: environmental protection, economic growth, job creation, diversity of fuel supply, technology transfer and innovation.

Solar thermal technology undoubtedly has a large global potential. Where there is sun there is heat, where there is heat, there is the possibility to produce power – clean and renewable power. Development is rapid, and a number of different solutions are coming to the fore. The proven high quality, reliability and flexibility of the Siemens industrial turbine range, as well as the early experience gained in the field, contributing to bankability, ensure that customer confidence is fully satisfied.

Siemens steam turbines for CSP

Siemens commands a comprehensive product portfolio for CSP plants, covering the full range from 1.5 MW to more than 250 MW. The following list presents the portfolio of Siemens steam turbine types and turbine combinations suitable for solar thermal applications. Siemens will always choose the best solution to meet the individual customer requirements.

SST-110

The SST-110 is a dual-casing steam turbine connected to a single gearbox that is coupled with the generator.

It can be used for high pressure/low pressure applications. For CSP applications, the SST-110 provides the highest possible cost efficiency and very high performance. The turbine supports the reduction of high heat gradients while providing a controlled extraction capability.

Technical Data**

Power output:
up to 7 MW

Inlet parameters:
130 bar / 1,885 psi
530° C / 985° F

SST-120

The SST-120 is a multi-casing steam turbine consisting of different turbine modules on each shaft end of the generator. The generator with its two shaft ends is placed between the low-pressure and high-pressure turbines, which can be used in parallel or serial steam flow arrangement. For CSP applications, the combination of the individual steam turbine modules provides very high flexibility and efficiency.

Technical Data**

Power output:
up to 10 MW

Inlet parameters:
130 bar / 1,885 psi
530° C / 985° F

SST-300

The SST-300 turbine for CSP is derived from the standardized single-casing SST-300 steam turbine concept with customized reaction blading and standardized LP condensing section.

The turbine is geared and has a nearly symmetrical casing with horizontal split, which allows short start-up times and quick load changes. The blading design guarantees high efficiency in CSP applications over a wide range of operation modes. This turbine concept copes well with CSP live steam parameters and supports both oil-heated trough and direct steam generation concepts for CSP plants.

Technical Data**

Power output:
up to 50 MW

Inlet parameters:
120 bar / 1740 psi
520° C / 970° F

SST-400

The SST-400 for CSP is derived from the standardized single-casing SST-400 steam turbine concept with customized reaction blading and standardized LP condensing section.

The turbine is geared and has a symmetrical casing with horizontal split, which allows short start-up times and quick load changes. The blading design guarantees high efficiency in CSP applications over a wide range of operation modes. The turbine design is focused on the high end of the geared concept. This turbine concept copes well with CSP live steam parameters and supports both oil-heated trough and direct steam generation concepts for CSP plants.

Technical Data**

Power output:
up to 65 MW

Inlet parameters:
140 bar / 2,030 psi
540° C / 1,005° F

*valid for CSP applications only; **max. technical data of product line, CSP-specific data dependent on application parameters

SST-600

For reheat and non-reheat applications

The SST-600 is a single or dual-casing turbine solution for 2- or 4-pole generators, which has been specially adapted to meet solar technology requirements such as tower applications. The reheat enhances overall solar power plant efficiency. The building block design allows an easy optimization of the turbines to meet the plant requirements. This configuration is most suitable for all applications with medium power output.

Technical Data[**]

Power output:
up to 100 MW

Inlet parameters:
up to 140 bar / 2,030 psi
540° C / 1,005° F

SST-700

For reheat and double reheat applications

The SST-700 is a dual-casing reheat turbine consisting of a geared HP module and direct-drive LP module. As an alternative to the HP turbine, a high pressure/intermediate pressure (HP/IP) turbine can be used, specially developed for CSP plants based on trough technology with moderate steam data. The reliable and well proven turbine is optimized for solar steam cycles.

The latest upgrade reflects feedback from the CSP plants already in operation and allows for improved start-up times and higher internal efficiency. The new design enables a double-reheat steam cycle, which further improves the plant efficiency.

Technical Data[*]

Power output:
up to 175 MW

Inlet parameters:
100 bar / 1,450 psi
400° C / 752° F

SST-800

For reheat and non-reheat applications

The SST-800 is a single-casing direct-drive turbine with reverse flow design for 2- or 4-pole generators, which has been optimized for CSP applications, in particular for plants with direct steam technology. The building block design allows an easy optimization of the turbines to meet the plant requirements. The latest optimization for the SST-800 allows a single-casing reheat solution for high efficiencies, which is also cost optimized specially for the solar market.

Technical Data[**]

Power output:
up to 150 MW

Inlet parameters:
140 bar / 2,030 psi
540° C / 1,005° F

Steam turbine combination

SST-800 & SST-500

For reheat applications

The SST-800 and SST-500 is a dual-casing reheat turbine concept consisting of a direct-drive single casing HP/IP module and direct-drive double flow LP module. The building block design allows an easy optimization of the turbines to meet the plant requirements. This configuration is most suitable for all applications with very high power output.

Technical Data[*]

Power output:
up to 250 MW

Inlet parameters:
up to 140 bar / 2,030 psi
540° C /1,005° F

SST-900

For reheat and non-reheat applications

The SST-900 is a single or dual-casing turbine for 2-pole generators. The dual casing solution, comprising one high pressure and one intermediate or low pressure module, is ideally suited for reheat applications, e.g., for large CSP plants. For ISCC plants, a single-casing high-pressure non-reheat SST-900 turbine is used, adapted to the demands of the combined cycle. It can be operated with any gas turbine, or in combination with one or more Siemens 47-MW SGT-800 gas turbines.

Technical Data[**]

Power output:
up to more than 250 MW

Inlet parameters:
165 bar / 2,395 psi
585° C / 1,085° F

*valid for CSP applications only; **max. technical data of product line, CSP-specific data dependent on application parameters

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