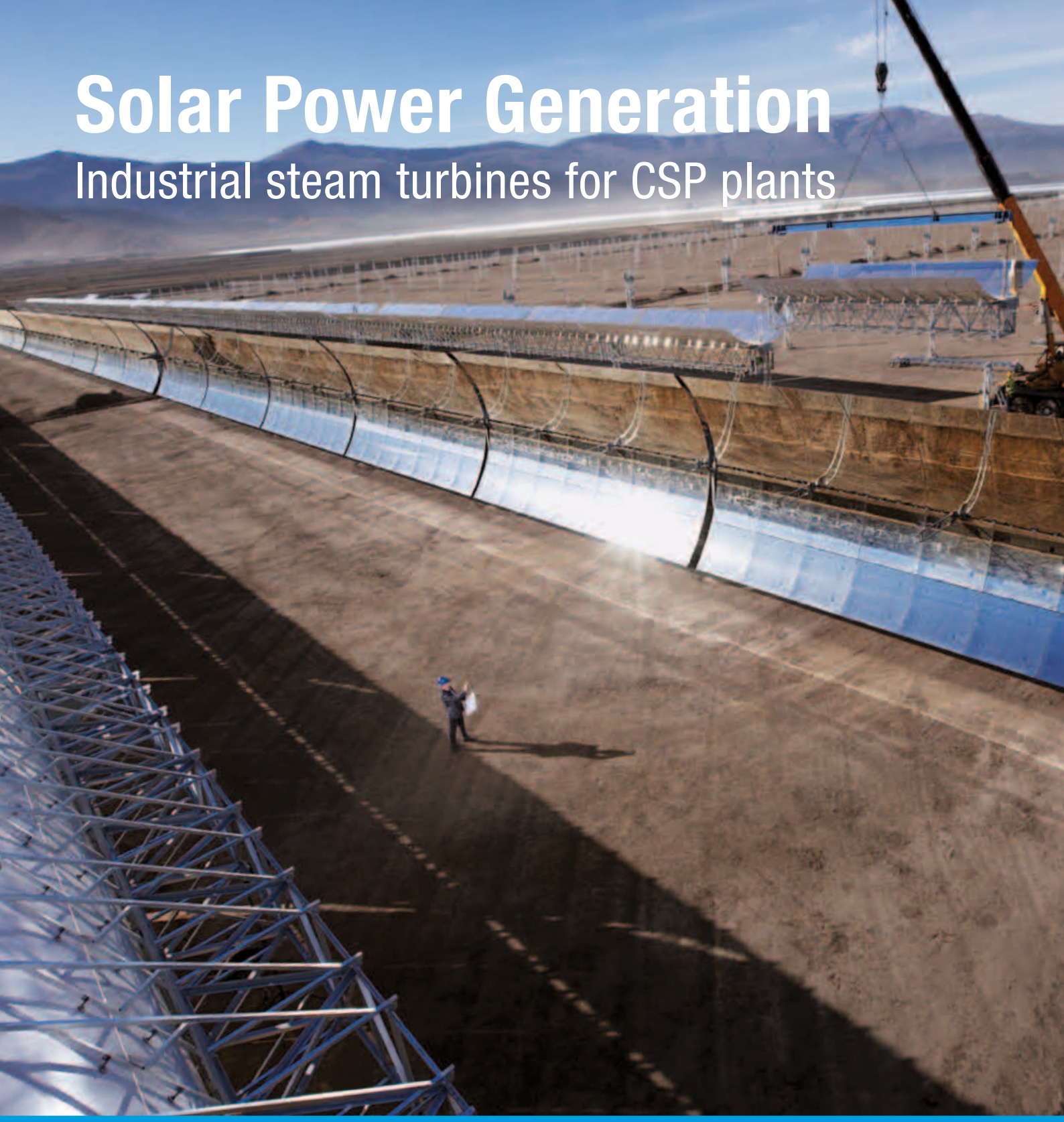
Solar Power Generation

Industrial steam turbines for CSP plants

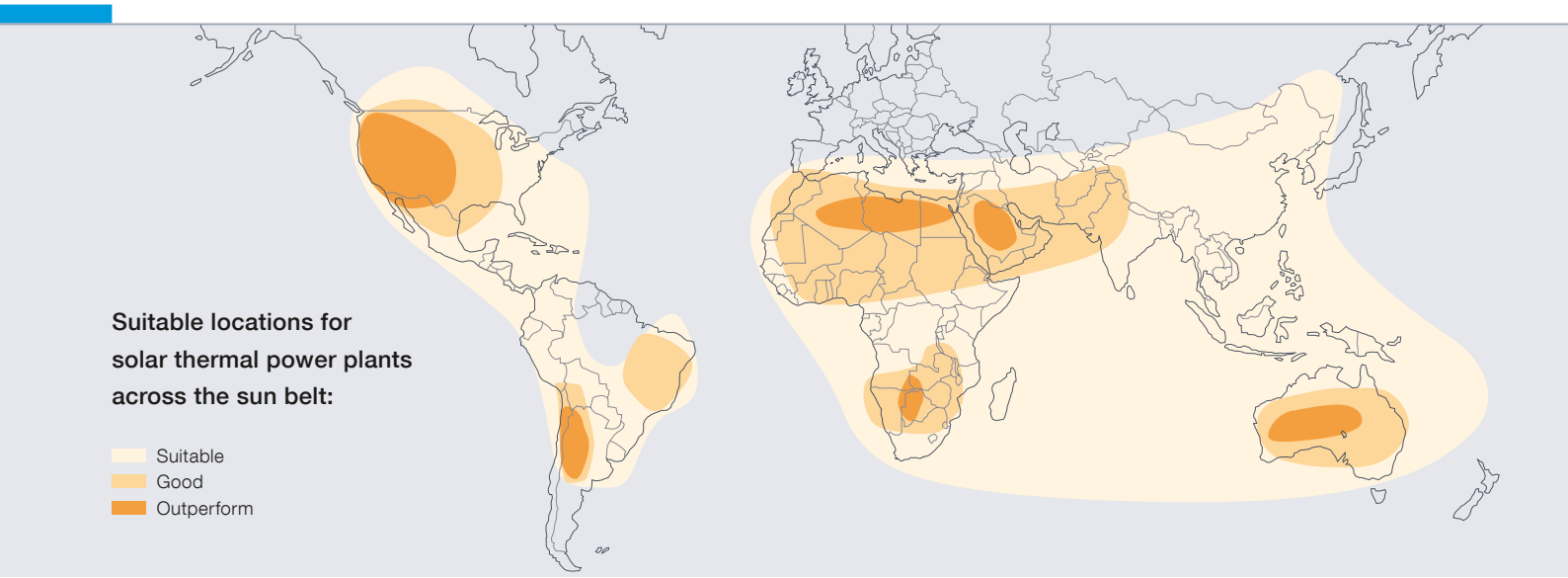


Engineering the Future – since 1758.

MAN Diesel & Turbo

Solar Power Generation – Future Energy Today

Steam turbines in concentrated solar power plants



World energy consumption is forecasted to grow significantly over the next decades. Solar thermal power plants built around the sun belt provide a sustainable, environmentally responsible solution – covering a portion of the increasing energy demands. Therefore, new commercial-scale solar thermal power plants have been reinvigorated in recent years. Several gigawatts are in both the planning and construction phases.

Although various collector technologies are available, the general principle is similar. Solar energy is focused by mirrors to heat a receiver medium to about 400 °C (750 °F). Via this fluid, steam is generated to drive a steam turbine generator set. Based upon the installed capacity and supported by diverse plant concepts, including the integration of high-temperature heat storage facilities and hybrid concepts with co-firing configurations, parabolic through and tower technology have matured to provide a highly reliable operation and improved overall plant efficiency.
Steam turbines employed in CSP plants need to match the application specific demands including a large number of starts, rapid start-up capabilities as well as re-heat options for maximum performance.

With the highest available efficiency in the market, the extremely reliable MAN Diesel & Turbo steam turbines provide the ideal solution for all solar thermal power plants.

Typical design features

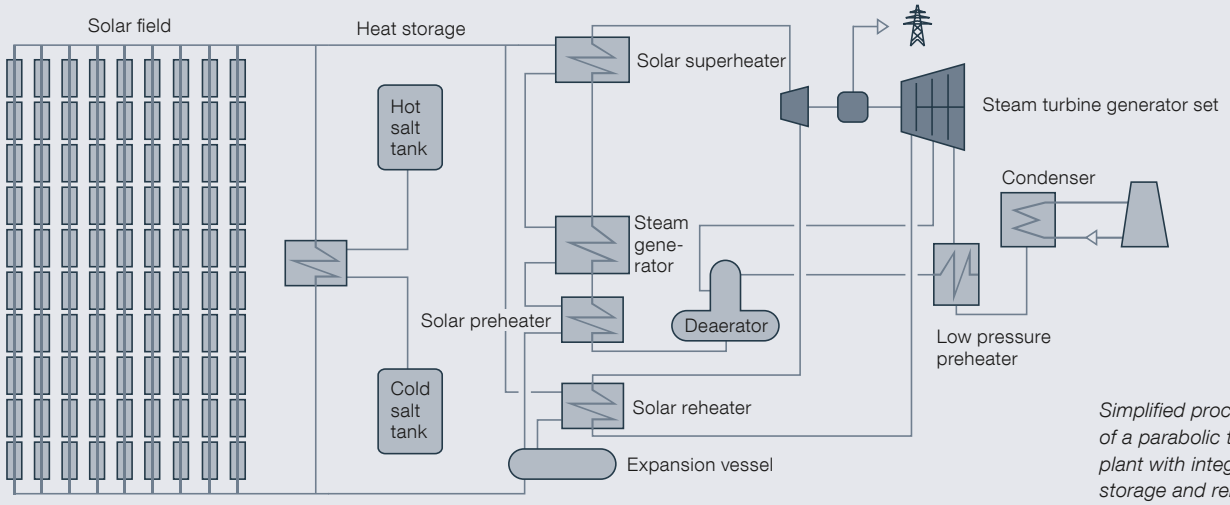
- Axial exhaust arrangement
- Dual or single casing design
- Highly efficient reaction-type blading
- Modular design options
- Sophisticated turbine control system
- Advanced construction materials
- Water- or air-cooled condenser

Design advantages

- Adaptable to highest CSP inlet steam parameters
- Flexible, tailor-made solutions
- High reliability and availability
- Maximum level of efficiency
- Low maintenance cost
- Reheat and non-reheat turbines
- Short start-up time
- Robust design (transient conditions)

MAN Diesel & Turbo Steam Turbines

Advanced technology – Highest efficiency



Simplified process scheme of a parabolic through power plant with integrated heat storage and reheat turbine

Andasol 3

Project description

The Andasol power plants are the first parabolic through power plants in Europe. Located in the southern Spanish province of Andalusia, the 2 km^2 Andasol 3 plant is equipped with thermal storage facilities, providing an additional 8 hours of plant operation in times of decreasing solar radiation or after sunset.

Turbine description

The 50 MW, highly efficient dual-casing reheat turbine supplied by MAN Diesel & Turbo is directly connected to the generator in the low-pressure section and via a gear in the high pressure section. The operator will thus produce about 165 GWh of environmentally-friendly electricity for about 150,000 people, reducing carbon dioxide emissions by 150,000 tons every year.

MAN Diesel & Turbo exclusive ability to tailor a highly efficient, reliable and cost effective steam turbine secured the order.

Shams 1

Project description

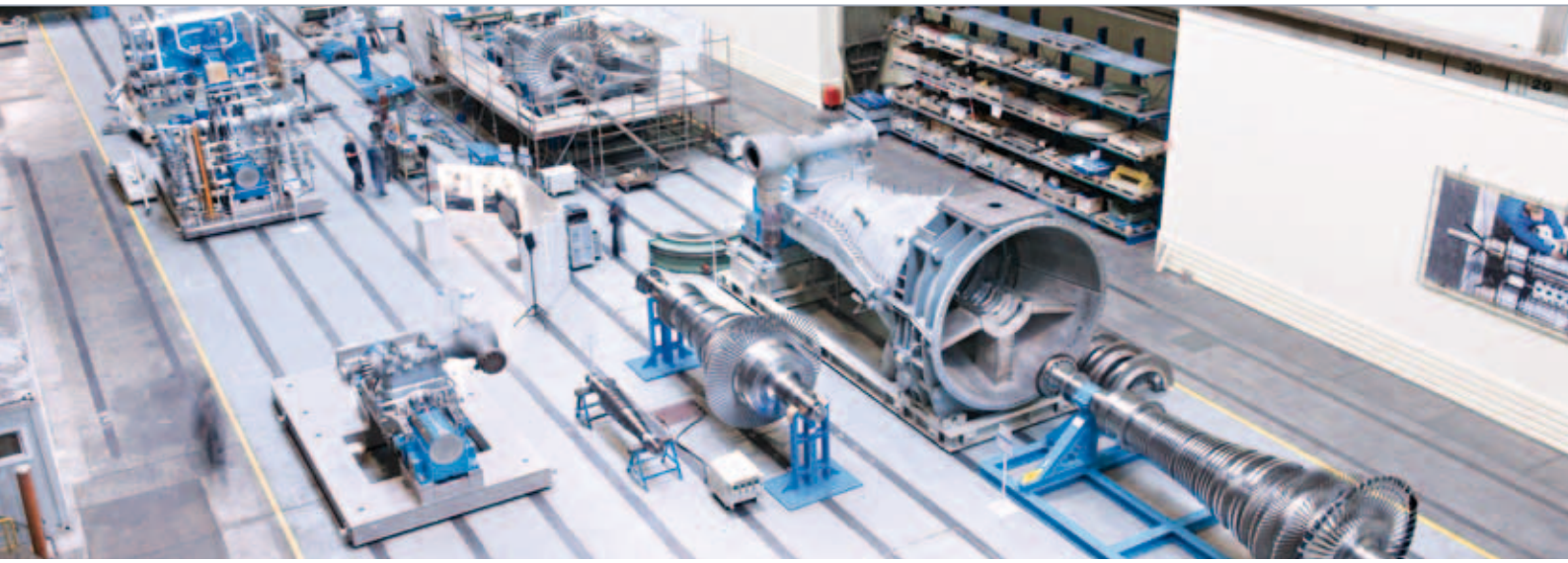
Shams 1 is the first Concentrated Solar Power (CSP) project implemented in the United Arab Emirates. The 2.5 km^2 plant using mature parabolic through technology is located in Abu Dhabi and will directly supply renewable electric power into the national grid.

Turbine description

The 125 MW steam turbine supplied by MAN Diesel & Turbo is the largest single casing turbine ever built for solar thermal power plants. It is designed as a highly efficient single-casing condensing steam turbine with constant power output above 100 MW. The inlet steam has a pressure of about 120 bar and a temperature of about 540 °C, while the exhaust steam is air-cooled due to the limited availability of water in the region. The plant will save approx. 175,000 tons of CO_2 emissions per year compared to conventional thermal power stations.

Technical Data

Steam turbine overview



Special Purpose Steam Turbines for Mechanical Drives and Power Generation (2-160 MW)

	Power range	Max. steam inlet
Standard	2-160 MW	130 bar (1,885 psi), 540 °C (1,004 °F)
Low pressure turbines	5-90 MW	1-20 bar (max. 290 psi), saturated steam
Fixed frame sizes (mechanical drive)	4-15 MW	90 bar (1,305 psi), 500 °C (932 °F)
Air turbines (CAES)	25-90 MW	130 bar (1,885 psi), 540 °C (1,004 °F)

MARC® Steam Turbines for Power Generation (2-40 MW, non-API)

	Power range	Max. steam inlet
MARC® 1	2-3.5 MW	60 bar (870 psi), 450 °C (842 °F)
MARC® 2	4-10 MW	90 bar (1,305 psi), 520 °C (968 °F)
MARC® 4	10-20 MW	120 bar (1,740 psi), 520 °C (968 °F)
MARC® 6	15-40 MW	120 bar (1,740 psi), 530 °C (986 °F)

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