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Ångturbiner – kommersiellt tillgängliga tekniker och framtida visioner och möjligheter

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Date 09 02 05

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- Kort om Siemens
- Siemens i korthet.ppt

- Siemens Energi Sektor, produktöversikt och intressanta energitrender
- Siemens Energi Sektor produktöversikt och intressanta Energitrender.ppt

Nya Siemens ångturbiner i Sverige

- Nya Siemens ångturbiner i Sverige.ppt

Ångturbiner – kommersiellt tillgängliga tekniker och framtida möjligheter

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- Kommersiellt tillgängliga turbiner
  - Solturbiner från Finspång
  - Solturbiner från Finspång.ppt
  - Mellanöverhettning
  - Reheat.ppt
  - Små ångturbiner med direktkopplad snabbgående generator
  - Ångturbin med direktkopplad snabbgående generator.ppt

Ångturbiner – kommersiellt tillgängliga tekniker och framtida möjligheter

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Turbinutveckling uppdelning:

- Intressanta visioner – pågående utveckling
  - Oljefria turbiner
  - Testrigg för magnetlager.ppt
    Ångturbiner med direktkopplad snabbgående generator
- Annan utveckling
  - Större Finspångturbiner
  - Mindre ångturbiner

Ångturbiner – kommersiellt tillgängliga tekniker och framtida möjligheter

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Ångturbiner med direktkopplad snabbgående generator

Bakgrund
Siemens undersökte för några är sedan möjligheten att få fram sådana turbogeneratorer (i området 5 – 15 MW) och fann att de besparingar som kunde göras genom att eliminera växeln, minska oljesystemet och förenkla bottenplattan för turbogeneratorn mer än väl ”åts upp” av de kostnadshöjningar men skulle få på den snabbgående generatorn och på frekvensomvandlingsutrustningen.

De pågår dock en utveckling både på snabbgående generatorer och på elektronikområdet. Sålunda bevakar vår utvecklingsavdelning vad som Pågår kontinuerligt.

Det är troligt att den nya tekniken så småningom blir konkurrenskraftig.

Ångturbiner – kommersiellt tillgängliga tekniker och framtida möjligheter

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Större Finspångsturbiner

På sikt räknar vi att kunna erbjuda

- Kondensturbiner i klassen 250 MW+ för gaskombikraftverk
- Flytta inloppsångdata bortom dagens 165 bar(a) / 585 oC för att passa bland annat nästa generation kombikraftverk och även större solkraftverk av typ central tower

Ångturbiner – kommersiellt tillgängliga tekniker och framtida möjligheter

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Mindre ångturbiner

Inom turbineffekt området 5 – 15 MW för enkla process- och fjärrvärme applikationer behöver vi skärpa vår konkurrenskraft. Sålunda jobbar vi på att få fram ett kostnadseffektivt ångturbinprogram inom detta storleksområde.

Dessa turbiner bygger på existerande grundkomponenter men med tillverkning i Indien.

Vi räknar att inom kort få börja att offerera dessa.


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Tack för uppmärksamheten


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Industrial Steam Turbines
Presentation Siemens E O SU

Active in three Sectors

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Industry	Energy	Healthcare	Cross-Sector activities
			
Automation and Drives	Power Generation	Medical Solutions	IT Solutions and Services
Industrial Solutions and Services	Power Transmission and Distribution		Siemens Financial Services
Siemens Building Technologies			
Transportation Systems			
OSRAM			

External sales of Sectors excluding Other Operations (as of September 30, 2007)

Global presence
Basis for competitiveness

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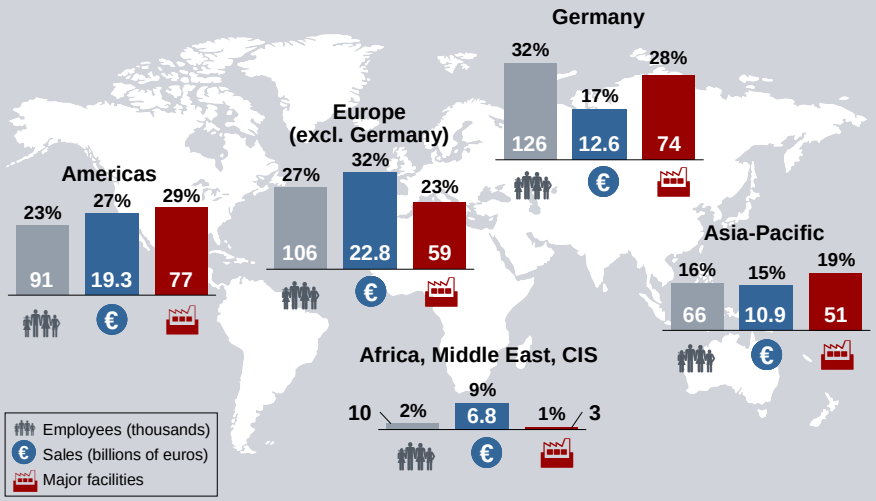
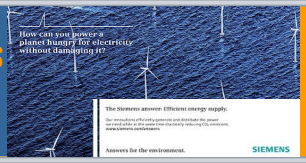


As of September 30, 2007

Sectors: Divisions and former Groups

SIEMENS

Sector	Divisions	Former Groups
Industry 	▪ Industry Automation ▪ Motion Control ▪ Building Technologies ▪ Osram ▪ Industry Solutions ▪ Mobility	▪ A&D ▪ I&S ▪ SBT ▪ Osram ▪ TS
Energy 	▪ Fossil Power Generation ▪ Renewable Energy ▪ Oil & Gas ▪ Service Rotating Equipment ▪ Power Transmission ▪ Power Distribution	▪ PG ▪ PTD
Healthcare 	▪ Imaging & IT ▪ Workflow & Solutions ▪ Diagnostics	▪ Med

Oil & Gas
Our history

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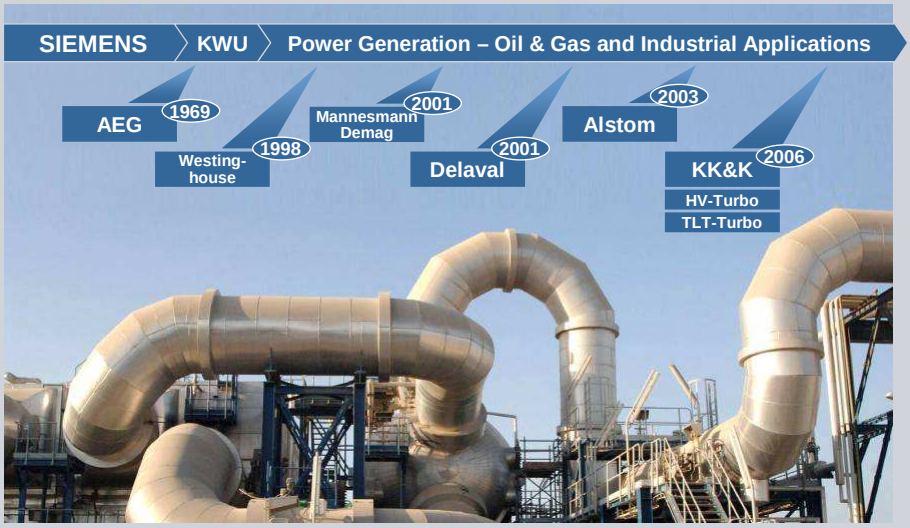

E O SU - regional presence in important markets
Locations

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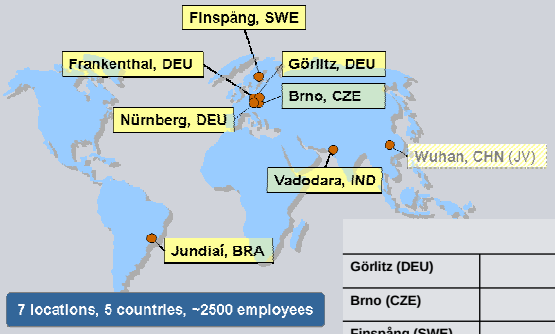

7 locations, 5 countries, ~2500 employees

Görlitz (DEU)		Headquarter. R&D and most central functions. Largest manufacturing site.
Brno (CZE)		Second largest site (formerly Alstom). Production splits with Görlitz for cost optimization.
Finspång (SWE)		Former Alstom production site. R&D, design, sales, manufacturing and service.
Frankenthal (DEU)		Acquisition of KK&K in Nov-06. Smaller steam turbines up to 10 MW.
Jundiaí (BRA)		Focus: South American markets. Moved in 2006 from Taubaté to the new site.
Nürnberg (DEU)		Engineering, project management, sales, manufacturing and service.
Vadodara (IND)		Focus: Indian Market. New factory inaugurated in Jan-07
Wuhan (CHN)		Joint Venture under negotiation

Broad range for 50- and 60-Hz-grids and drive application

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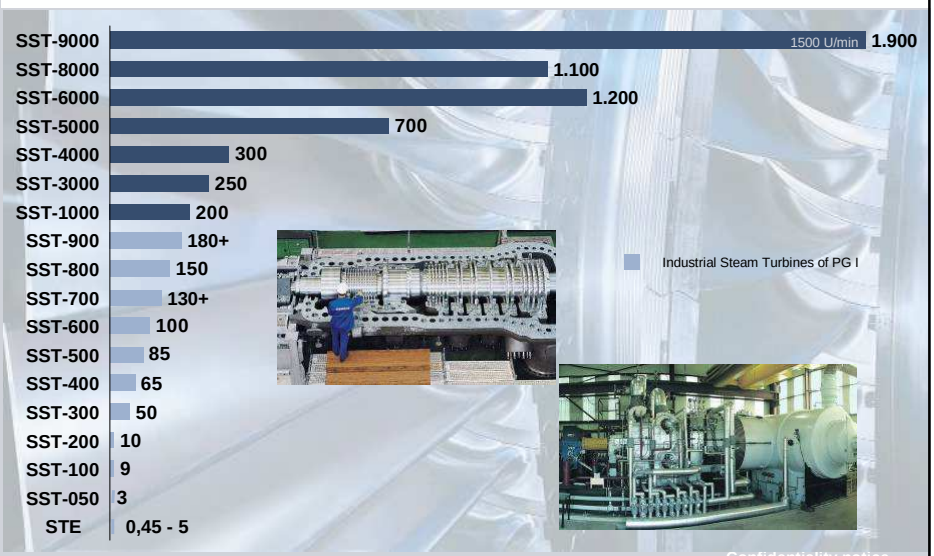

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Energy Sector

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Energy is an essential part of our daily lives

Energy supply in the future will place major challenges on the infrastructure

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Three global megatrends in the energy sector

Demographic dynamics

- **Population growth:** 7.5 bn in 2020 (+1.1 bn)
- **Power consumption:** +5.2% p.a. in emerging regions and 1.4% in developed world
- **Megacities** (>10 million): 22 new megacities in 2015

Resource scarcity

- **Geopolitics:** 70% of world oil and gas supplies only in a few countries
- **Fuel diversity:** 100% increase in oil prices over last 2 years accelerates shift to broader fuel mix

Environmental focus

- **Global emissions:** 40% increase in air pollution over past 20 years
- **Climate change:** Global warming limited to an average increase of 2 degrees Celsius

Renewables are gaining in importance – but fossil fuels will continue to be the mainstay

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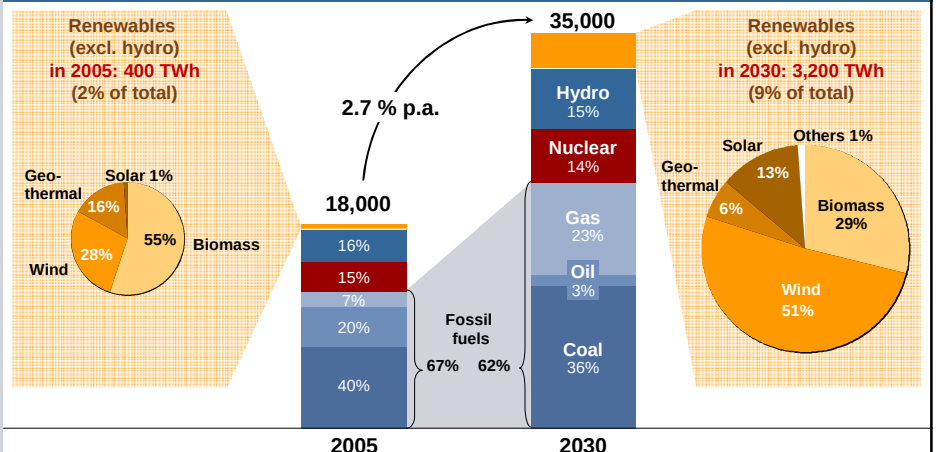
Power generation (in TWh[1])



Source: Siemens Energy Sector, GS4 base case 1) Terrawatt-hours

There are major regional differences in the growth of power demand

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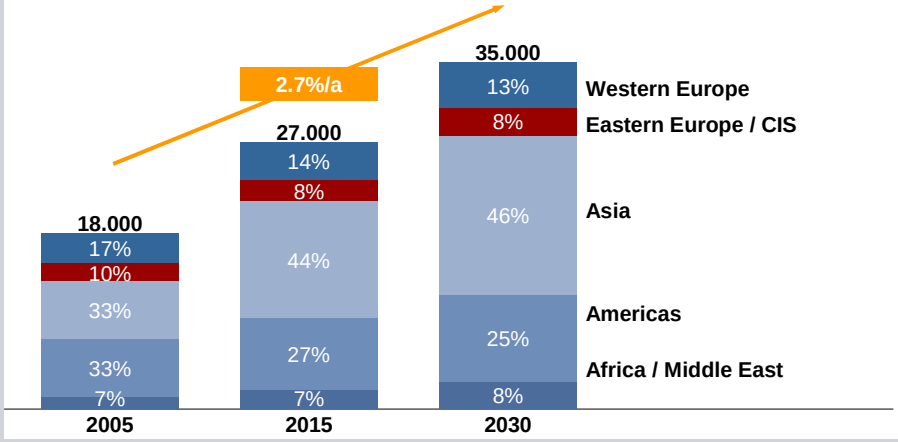
Development of power demand by region (in TWh[1)])



Source: Siemens Energy Sector, GS4 base case 1) Terrawatt-hours

Siemens Energy Sector – Answers for energy supply

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Energy products and solutions - in 6 Divisions

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Oil & Gas Division

Portfolio

- Gas turbines (< 50 MW)
- Steam turbines(≤ 200 MW)
- Compressors and compression solutions for the process industries
- Oil & gas solutions incl. power supply systems (Up-, Mid- and Downstream)
- Municipial and industrial power generation

Innovation highlight

- The ECO-II compressor is the only centrifugal compressor with gas-tight casing currently available.

CEO

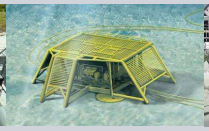
Dr. Frank Stieler

Employees

10,740 (fiscal 2007)

References

Siemens is the world market leader for compressors with extremely low intake temperatures like those required in LNG (liquefied natural gas) plants.

Broad range for 50- and 60-Hz-grids and drive application

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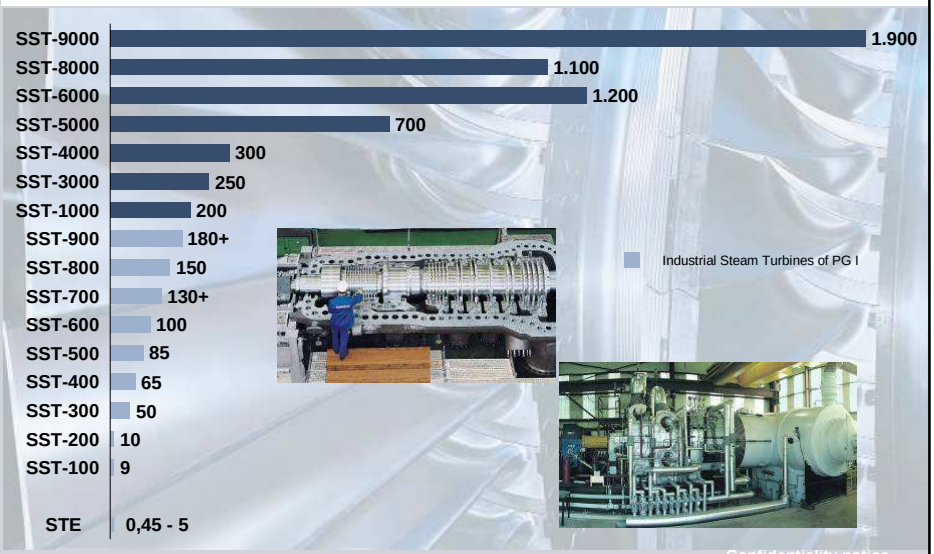

STE - Turbines
➔ Portfolio

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SST-050
up to 750 kW

SST-060
up to 5 000 kW

SST-110
up to 7 000 kW

SST-120
up to 10 000 kW

STE - Turbines
➔ Technical basic values

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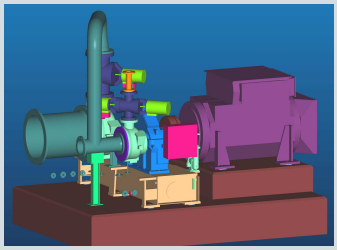
Live steam pressure:	3 – 131 bar_a
Live steam temperature:	dry sat. - 530℃
Exhaust steam pressure:	0,08 – 29 bar_a
Speed:	500 – 23 000 1/min
Power:	up to 10 000 kW

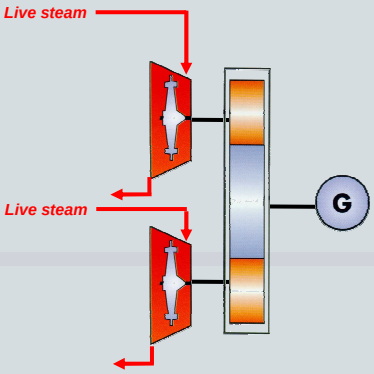
STE - Turbines
➔ Products & markets

SIEMENS

SST-110 (TWIN-type) ⇒ example

Power generation from biomass (Munksjö Paper)





Operating data:

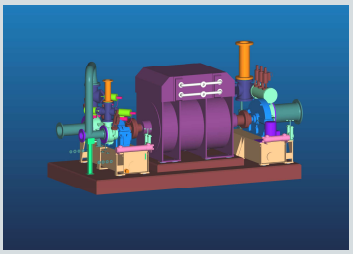
Live steam pressure:	36,0 bar a
Live steam temperature:	400℃
Condensing pressure:	10,0 / 4,0 bar a
Electrical output:	4 100 kWe

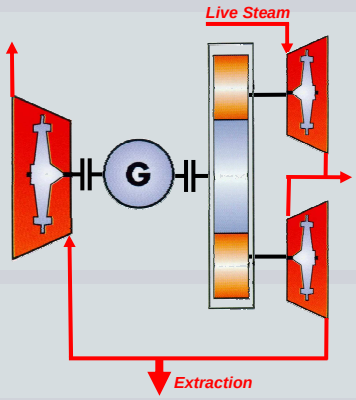
STE-Turbines
➔ Products & markets

SIEMENS

Tandem ⇒ example

Cogeneration (Kemira)

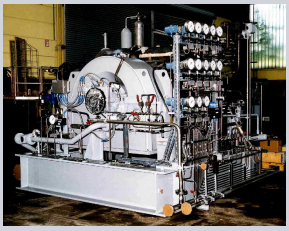




Operating data:

Live steam pressure:	46,0 bar a
Live steam temperature:	450°C
Back pressure:	26,0 / 6,0 / 0,7 bar a
Electrical output:	7 235 kWe

SST-200



General:
Geared or direct drive turbine suited to both generator and mechanical drives for standardized applications for industry and power generation

Technical Data:

Power output:	up to 10 MW
Inlet pressure:	80 bar / 1,160 psi
Inlet temperature:	480 ℃ / 896 ℉
Controlled extractions:	up to 16 bar / 232 psi
Exhaust pressure:	vacuum up to 10 bar / 145 psi
Rotational speed:	up to 14,600 rpm

Features:
- Backpressure / condensing type
- Package unit design
- Downward exhaust
- API - conforming
- Customized steam path
- High speed

SST-300

General:
Geared turbine for generator drive – compact and flexible design with a high degree of standardization for industry and power generation applications

Technical Data:

Power output:	up to 50 MW
Inlet pressure:	120 bar / 1,740 psi
Inlet temperature:	520 ℃ / 968 ℉
Double controlled extraction:	up to 16 bar / 232 psi
Exhaust pressure:	vacuum up to 16 bar / 232 psi
Rotational speed:	up to 12,000 rpm

Features:
- Backpressure / condensing type
- Package unit design
- Pre-engineered turbine modules, modular peripherals
- API-conforming
- Radial/axial exhaust
- Customized steam path

SST-400

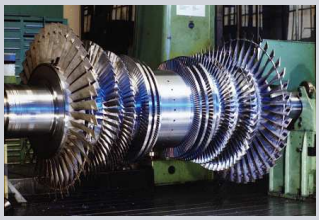
General:
Geared turbine for generator drive – compact and flexible design with a high degree of standardization for industry and power generation applications

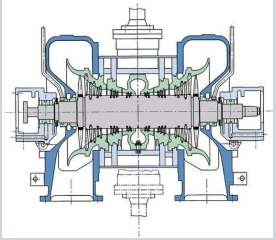
Technical Data:

Power output:	up to 65 MW
Inlet pressure:	120 bar / 1,740 psi
Inlet temperature:	520 ℃ / 968 ℉
Double controlled extraction:	up to 45 bar / 653 psi
Exhaust pressure:	vacuum up to 25 bar / 363 p
Rotational speed:	3000 – 8,000 rpm

Features:
- Backpressure / condensing type
- Semi-package unit design
- Pre-engineered turbine modules, modular peripherals
- Double extraction
- Radial/axial exhaust
- Customized steam path

SST-500





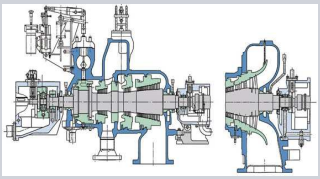
General:
Geared or direct drive turbine suited to both generator and mechanical drives to accommodate large volume flows; typical used as low pressure casing in two cylinder applications – tailor made applications for industry and power generation

Technical Data:

Power output:	up to 85 MW
Inlet pressure:	30 bar / 435 psi
Inlet temperature:	350℃ / 662℉
Rotational speed:	3,000 – 15,000 rpm

Features:
- Double-flow condensing turbine
- Standard turbine modules, modular peripherals
- Throttle controlled
- With or without uncontrolled extractions
- Highly customized design

SST-600



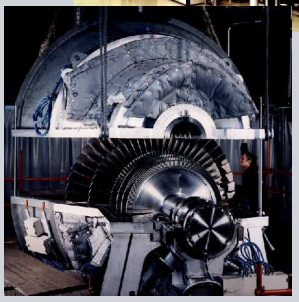
General:
Geared or direct drive turbine suited to both generator and mechanical drives; tailor-made applications for most complex processes in industry an power generation

Technical Data:

Power output:	up to 100 MW
Inlet pressure:	up to 140 bar / 2,031psi
Inlet temperature:	540 ℃ / 1,004 ℉
Double controlled extraction:	up to 45 bar / 653 psi
Exhaust pressure:	vacuum up to 55 bar / 798 psi
Rotational speed:	3,000 – 16,000 rpm

Features:
- Backpressure / condensing type
- Package unit design
- Inner casing for high inlet steam parameters
- Steam injection possible
- API-conforming

SST-700



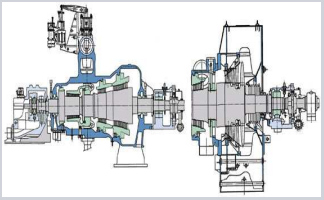
General:
Dual-casing turbine; consisting of geared HP module and LP, each module can be used independently or can be combined for optimal configuration – used for power generation applications, especially in combined cycle

Technical Data:

Power output:	up to 130 MW
Inlet pressure:	165 bar / 2393 psi
Inlet temperature:	585 ℃ / 1,085 ℉
Reheat temperature:	415 ℃ / 779 ℉
Exhaust pressure:	vacuum up to 40 bar / 580 psi
Rotational speed:	3,000 – 13,200 rpm

Features:.
- Backpressure / condensing type
- Parallel arrangement possible
- Customized steam path
- simple extraction in crossover pipe
- Axial/downward exhaust

SST-800



General
Direct drive turbine with reverse flow design for generator drive; tailor-made applications for most complex processes in industry and power generation

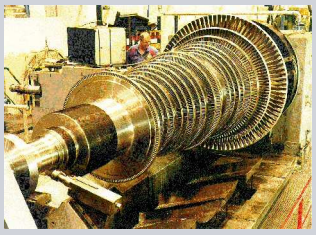
Technical Data:

Power output:	up to 150 MW
Inlet pressure:	140 bar / 2031 psi
Inlet temperature:	540 ℃ / 1,004 ℉
Double controlled extraction:	up to 40 bar / 580 psi
Exhaust pressure:	vacuum up to 14 bar / 203 psi
Rotational speed:	3000 / 3600 rpm

Features
- Backpressure / condensing type
- Package unit design
- Inner casing for high inlet steam parameters
- Steam induction possible
- Radial and axial exhaust

Our Turbine & Turboset Business SIEMENS

SST-900



General:
Single casing turbine for 2-pole-generators for power generation and industry; SST-900 RH – dual casing turbine for reheat applications

Technical Data:

Power output:	up to 180 MW
Inlet pressure:	165 bar / 2,393 psi (with reheat)
Inlet temperature:	585 ℃ / 1085 ℉ (with reheat)
Double controlled extraction:	up to 55 bar / 798 psi
Exhaust pressure:	vacuum up to 16 bar / 232 psi
Rotational speed:	3,000 / 3,600 rpm HP up to 13,200 rpm

Features:
- Backpressure / condensing type
- Pre-engineered turbine modules
- Customized steam path
- Axial/downward exhaust

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Renewable Energy Division

Portfolio
- Wind turbines (on- and offshore) and services
- Stake in Voith-Siemens Hydro (35%)

CEO
Dr. René Umlauft

Employees
3,290 (fiscal 2007)

Innovation highlight
- SWT-3.6-107 with a capacity of 3.6 MW, the world's most powerful series-produced wind power system for offshore applications

References
With the Siemens wind power systems installed since 2003 (combined capacity of 3300 MW) as much as 8 million t CO_2 can be saved annually. That is approximately equivalent to the emissions in Latvia.

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Energy Service Division

Portfolio
- Services for oil & gas and industrial applications
- Operating power plant services
- e.g. spare parts, long-term service agreements, maintenance and repairs, modernization and upgrades

CEO
Randy Zwirn

Employees
11,780 (fiscal 2007)

References
Servicing more than 550 GW of the Siemens fleet plus licensee.
Business operated through 48 regional offices worldwide with over 4,000 employees in field service.

Location in Sweden Finspång
- Offers service for both steam and gas turbines

Nya Siemens ångturbiner på den Svenska marknaden

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1.	Gävle	25 MW	SST600
2.	Östrand	74 MW	SST800
3.	Karlsborg	46 MW	SST600
4.	Gruvön	49 MW	SST600
5.	Skärblacka	50 MW	SST600
6.	Malmö	23 MW	MP10
7.	Väja	28 MW	SST300
8.	Sundsvall	19 MW	SST300
9.	Piteå	26 MW	SST300
10.	Obbola	25 MW	SST300
11.	Vallvik	28 MW	SST300
12.	Storuman	8 MW	SST300
13.	Övik	41 MW	SST600
14.	Aspa	21 MW	SST300
15.	Umeå	41 MW	SST600
16.	Igelsta	90 MW	SST800
17.	Kalmar	35 MW	SST600
18.	Mölndal	25 MW	SST600
19.	Norrköping	41 MW	SST600
20.	Billingsfors	4 MW	SST110
21.	Helsingborg Kemira	8 MW	SST120

Nya Siemens ångturbiner på den Svenska marknaden

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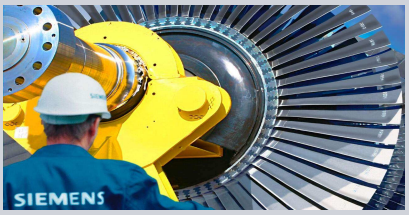
The Siemens Sunshine story

Short presentation of our solar powered steam turbine technology



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The History of Solar Power….

Imagine…….Solar Power existed in 1912

These huge parabolic solar collectors (~4 m in width) were built in Meadi, Egypt, a small farming community on the Nile River 25 km south of Cairo. They were developed by a Philadelphia inventor, business entrepreneur, and solar visionary named Frank Shuman. Each collector was ~70 m in length, and there were five of them in all. Each collector was fitted with a mechanical tracker which kept it automatically tilted properly toward the sun. The heat collected by these reflectors was used to produce steam which drove a series of large water pumps. Together they produced the equivalent of 55 horsepower. They were capable of pumping an astonishing 23 m3 of water per minute, bringing irrigation water to vast areas of arid desert land. All this in 1912...

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Present thermosolar technologies…

Parabolic Trough

Central Tower

Linear Fresnel Type

Stirling Dish Engine

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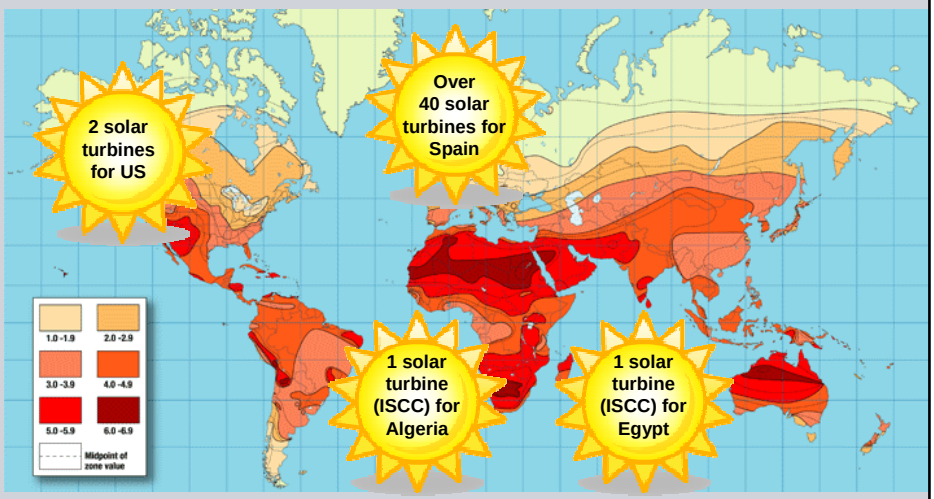
Siemens global solar market…



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Project facts for a typical Spanish solar plant

- Investment 260-300 million €
- Steam turbine only 5-8% of total investment
- Feed in tariff ~270€/MWh
- Solar Field approx 80 football fields in size (1200 x 1200 m)
- Thermal storage (molten salt) up to 6-7 hrs of full operation
- Nominal turbine output 50 MW
- Mirror area about 400 000 m^2

Solar Field	
Nominal Power (MW)	50
Thermal Inertia	30 min.
Solar Collector Assemblies	768
Aperture Area (m)	5 x 100
Collector Area (m^2)	470
Field Aperture (hectares)	35,72
Heat Transfer Fluid (HTF)	Therminol VP-1
HTF Volume (litros)	1.514.000
# of Metal Frames	9.120
# of Mirror Segments	182.400
# of Receiver Tubes	18.240
Total Tube Length (km)	72,96
Site Area (hectares)	162
Field Inlet Temperature (ºC)	350
Field Outlet Temperature (ºC)	395

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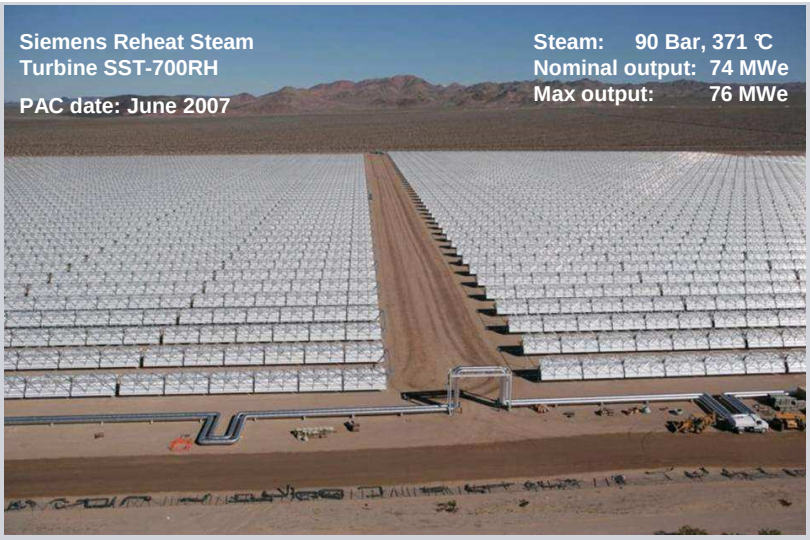
The first project since the -80'ies... Nevada Solar 1, Boulder City.



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Boulder City solar field under erection

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Boulder City, Site erection 2006

Andasol, Spain:
The first commercial European CSP project

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Andasol, Spain:
The first commercial European CSP project

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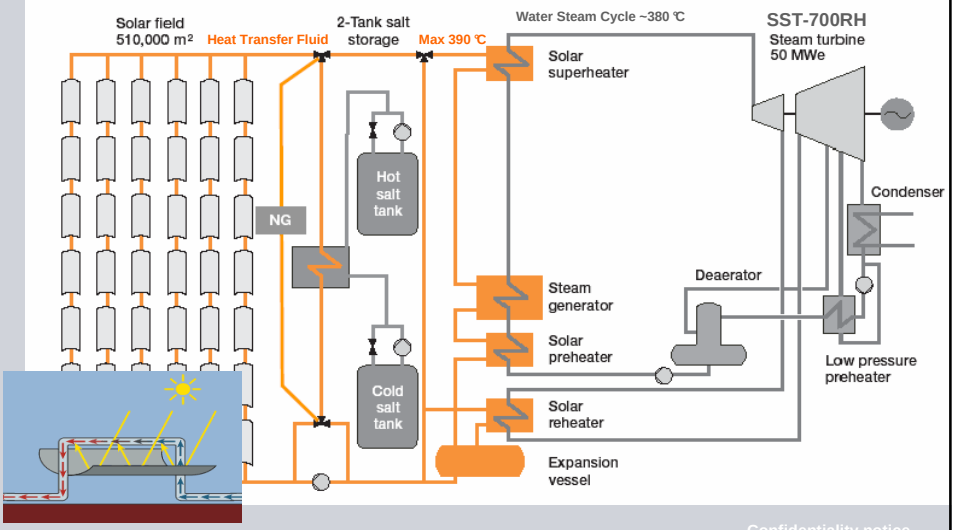
The Andasol Solar Cycle



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An ISCCS - cycle
(Integrated Solar Combined Cycle System)

Typical design for project Hassi R'Mel in Algeria for Abener (and Kuraymat in Egypt for Iberdrola)

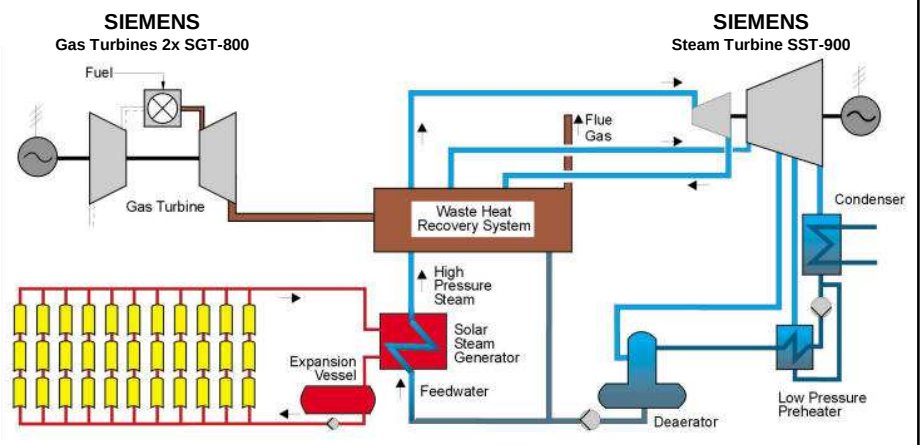

Figure by FLAGSOL GmbH 2008

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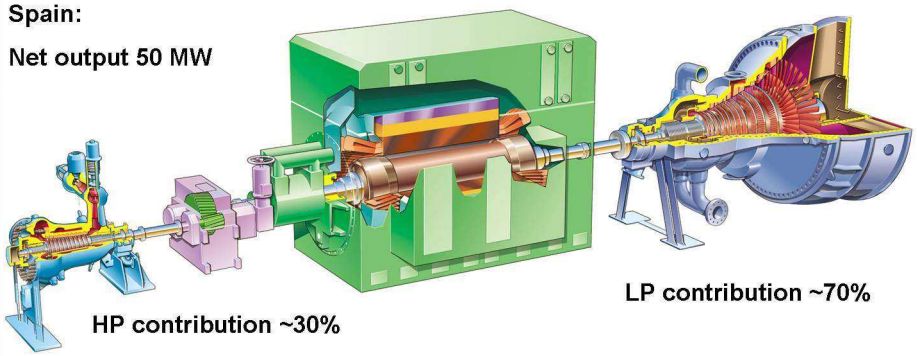
Siemens steam turbine solution for CSP plants

Spain:

Net output 50 MW



SST-700 HP/LP for Thermosolar Power Plants

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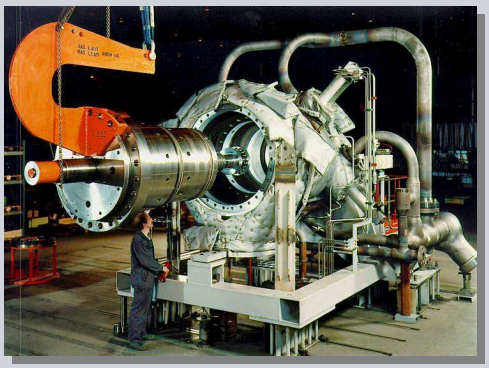
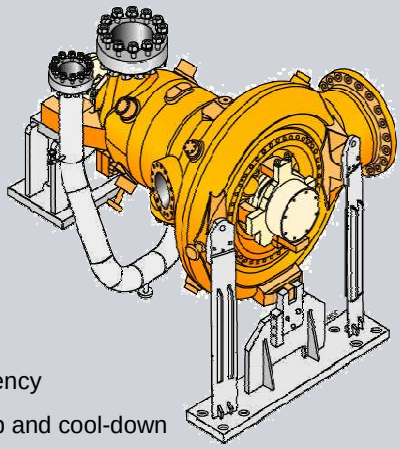
HP Turbine Steam turbine for CSP plants

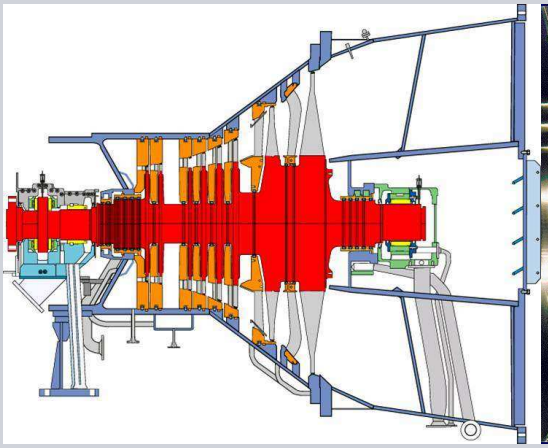


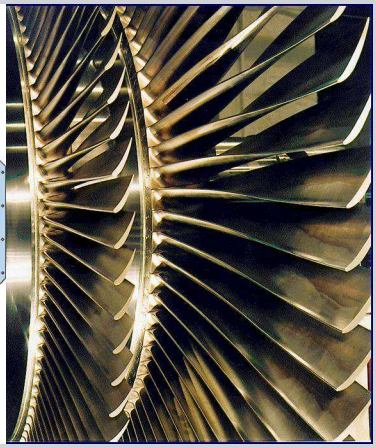


- High speed turbine ~8960 rpm for High Efficiency
- Thermoflexible barrel casing for quick start-up and cool-down
- Easy assembly and maintenance thanks to barrel design
- Initially a Marine turbine developed for ship propulsion

SIEMENS

LP Turbine Steam turbine for CSP plants





Direct Driven
3000 rpm

Exhaust
Axial connection to condenser

Last Stage Blades
Three fixed rows of standard blades

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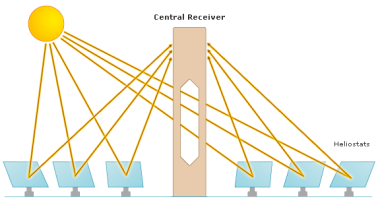
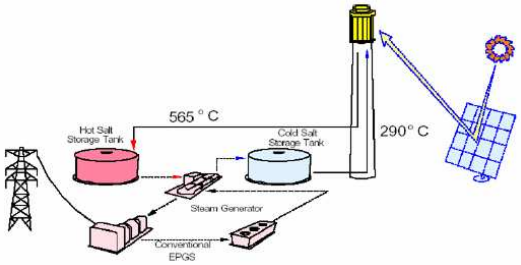
GEMASOLAR (SOLAR TRES) Spain: Molten Salt Solar Thermal Power Demonstration Plant



Siemens Reheat Steam Turbine SST-600RH

Steam: 105 bar, 540 ℃
Max output: 20,0 MWe

Expected PAC: August 2010



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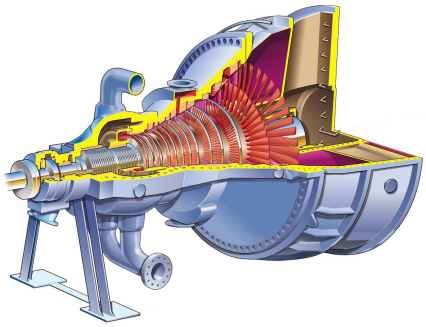
Siemens Steam Turbine SST-900 for Central Tower

Central Tower non-reheat turbine:

Single casing Steam Turbine type SST-900 with axial exhaust up to ~180 MWe



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Industrial steam turbines for mid-range reheat cycles

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Advantages of a reheat cycle

Heat is added at a higher average temperature than a non-reheat cycle, giving:

Improved cycle efficiency

- greater output for same heat input into HRSG
- less steam to condenser, therefore lower cooling water losses

Reduced turbine exhaust moisture

- increases efficiency
- minimizes erosion
- reheat cycle allows higher inlet pressure and/or lower exhaust pressure whilst limiting moisture to an acceptable level

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Example of efficiency improvements using reheat

	Non Reheat Cycle	Reheat Cycle
Inlet pressure, bara/psia	131/1,900	131/1,900
Inlet temperature, ℃/℉	540/1,004	566-566/ 1,050-1,050
Exhaust pressure, bara/psia	0.069/1.0	0.069/1.0
Exhaust moisture content	14.5%	7.5%
Mass flow to condenser	100%	87%
STG power output, MW	89.6	92.6 +3.35%
Total CC net power output, MW (using the same GTG)	Base	+3.25 +1.23%

Optimal design to meet customer needs

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Tough and efficient

- Robust mechanical design to cope with frequent starts and load changes
- Well proven turbomachinery

Optimal design

- Each turbine can be optimized for specific requirements
- HP optimized for small volume flow of high-pressure, high-temperature steam
- IP/LP optimized for large steam flow volumes at lower steam pressure

Variable configurations

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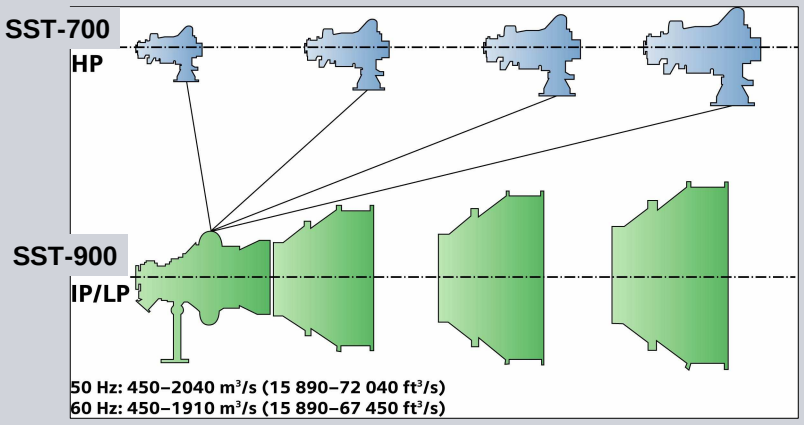
Four sizes of HP modules can be combined with six IP/LP modules to suit the desired outlet volume flow



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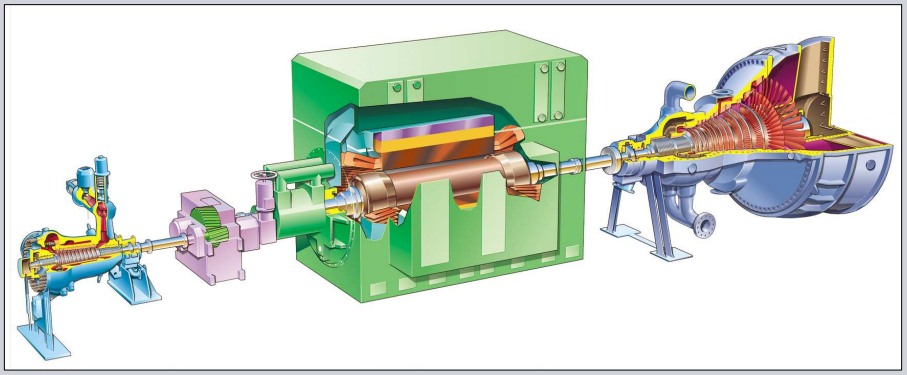
Dual End Drive Solution

The generator has dual end drive and is placed between the HP and the IP/LP turbines



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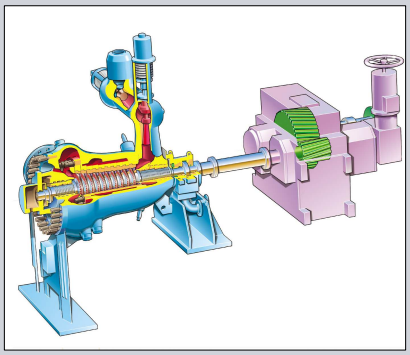
HP turbine

Accepts high-pressure, high-temperature steam
Ideal for small volume flows of HP steam
Geared barrel casing modules
Small and thermoflexible
Short bearing span
No horizontal casing flange



Technical data - Reheat applications

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	HP	IP/LP
Max inlet temperature, °C/°F	585/1085	565/1049
Max inlet pressure, bara/psia*	165/2390	40/580
Max inlet volume flow, m^3/s / ft^3/s	3.5/123	17/600
Max exhaust volume flow, m^3/s / ft^3/s	13.6/480	2040/72040
**at maximum temperature*		

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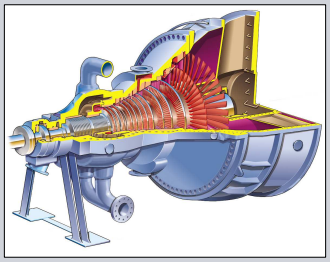
IP/LP turbine

Direct-drive
Reduced inlet pressure, high steam temperature
Horizontally split inner casing to protect outer casing from highest temperatures
Designed for maximum thermoflexibility
Inlet volute for even steam distribution and high efficiency
Rotor made from one solid forging for mechanical reliability



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Key features, summary

High reliability and availability
High performance
Easy installation
Easy maintenance
Tailor-made solutions

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References

Saltillo, Mexico
One 114 MW reheat unit in combined cycle with a W501F gas turbine. Inlet 148 bara/ 2150 psia, 565℃/1050℉, with reheat to 565℃/1050℉. Order spring 1999.

Laguna Park, USA
One 95 MW reheat unit in combined cycle with a GE 7FA gas turbine. Inlet 129 bar(a)/ 1871psia and 568℃/ 1054℉ Order March 2000.

Batesville, USA
Three 112.7 MW units in combined cycle with W501F gas turbines. Inlet data per unit 112.7 MW at 145 bar(a)/ 2103 psia and 561.3℃/1004 ℉. Order 1998.

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References

HP turbine
Some forty of these 22MW HP turbine modules have been delivered for standard combined cycle plant.
Inlet 165 bara/2400 psia, up to 585°C/1085°F.

Denver City, Texas, USA
One 172.3 MW reheat unit in combined cycle with two GE 7FA gas turbine (2 GTs on one STG), inlet data 107 bar(a)/ 1552 psia and 534°C/ 997°F

Kladno, Czech Republic
The IP/LP turbine module for one of two 135 MW fossil fired reheat units.
Inlet data124 bara/1800 psia, 538°C/1000°F.

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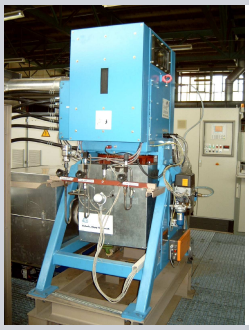
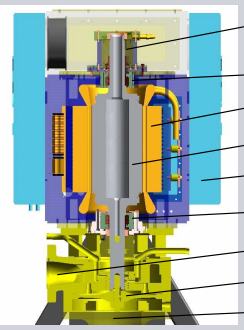
Små ångturbiner med direktkopplad snabbgående generator

Ångturbin med Generator testrigg





Permanent - magnetiserad Synkron- generator

Enstegs Axialturbin

TYekniska data:
Färskånga: 235°C / 17,5 bar $_A$
Mottryck: 1,5 … 4,5 bar$_A$
Ångflöde: 0 … 10 t/h

Turbogenerator:
Uteffekt: 0 … 500 kW$_{el}$
Varvtal: 16.000 … 20.000 min^{-1}

-

Små ångturbiner med direktkopplad snabbgående generator

SIEMENS

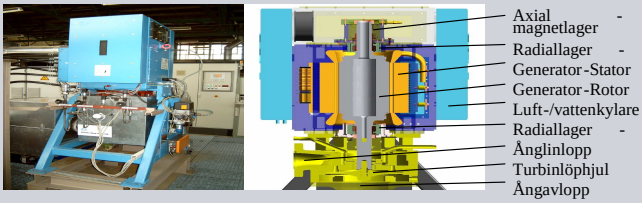
Projekt Bad Bibra Tyskland

STE*1 – Ångturbintyp

Maskin-Typ SST-020 (f.d. AFA 3,5)

Techniska data

Inlopptryck/temperatur.:	26 bara / 380℃ (minimal: 310℃)
Ångflöde:	3,8 t/h
Uteffekt:	239 kW el
Varvtal:	16.000 – 20.000 min^{-1} (Nominellt varvtal: 18.000 min^{-1})



*1 … STE – Siemens Turbomachinery Equipement GmbH, före detta AG Kühnle, Kopp & Kausch Frankenthal