SGT5-8000H / Irsching 4

Siemens H class gas turbine
Pioneering efficiency with world class flexibility

W. Fischer
Program Director 8000H
19.05.2011, Irsching
## Evolution of Siemens Combined Cycle Technology

<table>
<thead>
<tr>
<th>Year</th>
<th>Technology</th>
<th>CCPP</th>
<th>Performance</th>
<th>Temperature</th>
<th>Pressure</th>
<th>CC Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>SGT5-2000E</td>
<td>∼50%</td>
<td>Killingholme (2x1)</td>
<td>525 °C / 80 bar</td>
<td>2PR-non RH</td>
<td>≥50%</td>
</tr>
<tr>
<td>1996</td>
<td>SGT5-4000F</td>
<td>&gt;56%</td>
<td>Didcot B (2x1)</td>
<td>540 °C / 110 bar</td>
<td>3PR-RH</td>
<td>&gt;56%</td>
</tr>
<tr>
<td>2007</td>
<td>SGT5-4000F</td>
<td>&gt;58,5%</td>
<td>Mainz (1x1)</td>
<td>565 °C / 125 bar</td>
<td>3PR-RH</td>
<td>&gt;58%</td>
</tr>
<tr>
<td>2011</td>
<td>SGT5-8000H</td>
<td>&gt;60%</td>
<td>Irsching 4 (1S)</td>
<td>600 °C / 170 bar</td>
<td>3PR-RH, Benson</td>
<td>&gt;60%</td>
</tr>
<tr>
<td>~2015</td>
<td>SGT5-8000H</td>
<td>&gt;61,5%</td>
<td>SCC5-8000H (1S)</td>
<td>t.b.d.</td>
<td>&gt;61%</td>
<td></td>
</tr>
</tbody>
</table>

* at ISO conditions

~10 % points increase in efficiency over approx. 20 years

Future
8000H Program Overview

Gate 2: Start GT/CC Basic Design 05. Nov. 2001

1st 50Hz engine ex Works Berlin 30. April 2007
1st Synchronization to grid 07. March 2008
End of 50Hz GT Test & Validation Phase 28. August 2009

Gate 4: Series Release 22. June 2010
Combining Cycle Commissioning & Testing Jan. – July 2011

1st 60 Hz engine es works Berlin January 2011
1st fire 60Hz engine (Berlin Test Facility - BTF) July 2011
End of 60Hz Test & Validation Phase March 2012
The world’s most powerful gas turbine – proven efficiency and output

375 MW GT
570 MW CC
40% GT efficiency
> 60% CC efficiency

GT: Gas Turbine
CC: Combined Cycle

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**SGT5-8000H / SCC5-8000H 1S**

**Advanced Single Shaft Combined Cycle System**

- Increased Pressure Ratio
- Increased Turb. Inlet Temperature combined with cooling air reduction
- Improved component efficiencies
- Fuel Preheating of 215°C
- Advanced water/steam cycle (600°C & 171 bar)
- Reduced pressure losses (HRSG, piping)

Siemens H-class significantly increases efficiency by ~ 1.7%-pts. in combined cycle without compromising plant flexibility
Irsching 4, Project Overview

Overall schedule from Contract to Combined Cycle extension and Commercial Operation (PAC)

- **Phase 1**
  - SGT5-8000H open cycle
- **Field Validation**
  - SGT5-8000H 18 months
- **Phase 2**
  - Combined Cycle extension
- **Reference Plant**
  - SCC5-8000H 1S

Timeline:
- **2005**: Open Cycle
- **2006**: Validation 8000H
- **2009**: PAC
- **2010**: Combined Cycle

Feedback from 4000F Single Shaft cold and warm conditions Modularization / Harmonization
SGT5-8000H
Simple Cycle Start-up

Fast start-up capability due to air cooling concept
- Increased loading & acceleration rate reduces startup time
- Standard Loading: 25 Minutes to 375MW
- Fast Loading: 10 Minutes to 350 MW

![Graph showing Normal Startup and Startup w/ fast loading with output (% Load) and speed (RPM) on the y-axis and time (seconds) on the x-axis. The graph illustrates the time taken to reach 350 MW in 10 minutes and 375 MW in 25 minutes, as well as the acceleration time to reach 350 MW.](image)
Performance and Emissions validated already during Phase I

Overall Engine stability limit well above commercial rating of 375 MW

387,1 MW

Fuel preheat on

Emissions met
Irsching 4, Phase I (2008 / 2009)
Successful validation as basis for market introduction

✓ 1st fire achieved on schedule
✓ Stable and reliable ignition from 1st start
✓ Base load within 9 days of operation from 1st synchronisation
✓ Overall engine integrity and stability confirmed
✓ Engine Performance overachieved
✓ 3 months / 1500 hrs Endurance Testing conducted

Validation program completed on track: overall stability, vibrations, performance, emissions and operational flexibility fully confirmed.
Irsching 4, Phase II, Combined Cycle Extension
Advanced SST5-5000 Steam Turbine

Integrated Single Shaft Train

Combined HP / IP and dual flow LP

SST5-5000
Most advanced and flexible combined HP/ IP Steam Turbine

Steam Conditions:
HP: 171 bar, 600°C
IP: 35 bar, 600°C

- Short start-up times
- Forced Cooling
- Daily start / shut down
- Highest efficiency
  - 3DV-blading design
  - State-of-Art sealing technology
- Outstanding Reliability / Availability

![Graph showing load percentage over time](chart.png)

Load (%) vs. Time (cold start 150°C rotor temp)
Most advanced Low Pressure (LP) Design
2nd Generation Ti- Last Stage Blade (LSB)

- Largest full-speed LSB used to support lowest condenser backpressure
- Outstanding experience in Titanium technology for LP design
- Intensive R & D as well as comprehensive Validation efforts over years

Model Turbine at University of Stuttgart

Last Stage, Full Scale Shop Test

LP Rotor during installation at Irsching 4

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Latest gas turbine technology, combining advanced performance with operational flexibility

Customer Needs

- Advanced thermal performance
- Operational flexibility (fast start-ups and high part load performance)
- High availability
- Reduced Life Cycle Costs

Innovative Solution

- “On-board” Air Cooling (no external cooling systems)
- Based on proven Siemens design principles
- Design for serviceability

Validation and Implementation

- Integrity and Performance validated before series release
- Comprehensive Validation in a Siemens controlled environment
- 3,000 points of measurement

SGT5-8000H: developed in response to customer needs, based on latest advanced technology and fully validated before commercial market launch.