SGT5-8000H
SCC5-8000H 1S

Experience of Commercial Operation at Irsching 4

ANIMP-ATI, Sesto San Giovanni
26 June 2012

Massimo Gianfreda
- 8000H Overview
- Validation Status
- Summary
## Siemens Large Scale Gas Turbines:
### Product Portfolio for 50 Hz and 60 Hz

<table>
<thead>
<tr>
<th>Model</th>
<th>Output (MW)</th>
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<tbody>
<tr>
<td>SGT5-8000H</td>
<td>375</td>
</tr>
<tr>
<td>SGT5-4000F</td>
<td>292</td>
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<tr>
<td>SGT6-8000H</td>
<td>274</td>
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<tr>
<td>SGT6-5000F</td>
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<tr>
<td>SGT6-4000F</td>
<td>187</td>
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<td>SGT5-2000E</td>
<td>168</td>
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<tr>
<td>SGT6-2000E</td>
<td>113</td>
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</tbody>
</table>

Output in MW @ ISO conditions

**Fig. 3**

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### 8000H Program Overview

<table>
<thead>
<tr>
<th>Event Description</th>
<th>Date</th>
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</thead>
<tbody>
<tr>
<td>Program Launch – Concept Phase</td>
<td>01 Oct 2000</td>
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<tr>
<td>Gate 1: Product Strategy Release</td>
<td>21 Mar 2001</td>
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<tr>
<td>Gate 2: Start GT/CC Basic Design</td>
<td>05 Nov 2001</td>
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<tr>
<td>Gate 3: Product Release</td>
<td>17 Aug 2004</td>
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<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; 50Hz engine ex Works Berlin</td>
<td>30 Apr 2007</td>
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<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; Fire</td>
<td>20 Dec 2007</td>
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<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; Synchronization to grid</td>
<td>07 Mar 2008</td>
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<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; Base Load</td>
<td>24 Apr 2008</td>
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<td>End of 50Hz GT Test &amp; Validation Phase</td>
<td>28 Aug 2009</td>
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<tr>
<td>Gate 4: Series Release</td>
<td>22 Jun 2010</td>
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<tr>
<td>Combined Cycle Commissioning &amp; Testing</td>
<td>Jan – Jul 2011</td>
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<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; 60 Hz engine es works Berlin</td>
<td>Jan 2011</td>
</tr>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; Fire 60Hz engine (Berlin Test Facility - BTF)</td>
<td>Sept 2011</td>
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<tr>
<td>End of 60Hz Test &amp; Validation Phase</td>
<td>Jul 2012</td>
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</table>
The SGT-8000H concept uses proven features from Siemens and (former) Westinghouse engines and introduces new technology.
SGT5-8000H
Efficient & Flexible

Evolutionary 3D blading
- 4 stages of fast acting variable-pitch guide vanes (VGV) allowing for improved part load efficiency and high load transients

Proven rotor design
- (Hirth serration, central tie rod, internal cooling air passages) for world class fast (cold) start and hot restart capability

Advanced Can Annular combustion system
- > 60% combined cycle efficiency

3D Four stage turbine with advanced materials and thermal barrier coating
- High cycling capability due to fully internally air cooled turbine section

HCO for reduced clearance losses

Transient protection of clearances for reduced degradation with hydraulic clearance optimization (HCO) active clearance control

Designed for >60% efficiency in combined cycle and best in class operational flexibility

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TVC roll out/roll in capability

- Roll out/in capability of the turbine vane carrier enables exchange of stationary turbine hardware without rotor lift
- Sequence and tooling successfully tested during final assembly and prototype test

Removable turbine blades and vanes

- All blades removable w/o rotor lift
- Vane 1 and blade 1 removable w/o cover lift (access through combustion chamber)
- Blade 4 removable w/o cover lift (towards the exhaust end)

Removable compressor blades

- All rotating blades replaceable without rotor de-stack or lift.

Serviceability – a key design factor to assure optimized outage time and high availability

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Energy Sector
Possible heat extraction per GT Type in large CHP-CCPPs (Examples)

- SCC5-8000H 1S: 570 MW
- SCC5-4000F 1S: 430 MW
- SCC5-2000E (1x1): 230 MW
**SGT5-8000H / SCC5-8000H**

**Significant Increase of CC Efficiency**

- Increased PR + 0.2 %
- Increased TIT combined with cooling air reduction + 0.8 %
- Improved component efficiencies + 0.2 %
- Fuel Preheating of 215°C + 0.1 %
- Advanced water/steam cycle (600°C & 171 bar) + 0.4 %

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**Siemens 8000H significantly increases efficiency by up to 1.7%-pts. in combined cycle.**

**Without compromising plant flexibility!**

Fig. 9

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Energy Sector
**SGT-8000H**
**Direct scaling approach**

### Scaling rules

<table>
<thead>
<tr>
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<th>50Hz</th>
<th>to</th>
<th>60Hz</th>
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<tbody>
<tr>
<td>Speed</td>
<td>x</td>
<td>1.2</td>
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<tr>
<td>Dimensions</td>
<td>÷</td>
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<td>Power, Mass Flow</td>
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<tr>
<td>Stresses &amp; Temperatures</td>
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<tr>
<td>Efficiency</td>
<td>x</td>
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**Harmonized design features** allow validation experience transfer from 50 to 60 Hz
## Configuration and Performance Overview

<table>
<thead>
<tr>
<th>Configuration</th>
<th>50 Hz</th>
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<tr>
<td>SGT-PAC 8000H</td>
<td>375 MW</td>
<td>274 MW</td>
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<td>40 %</td>
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<td>SCC-PAC 8000H 1S</td>
<td>570 MW</td>
<td>410 MW</td>
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at ISO conditions

Fig. 11  ANIMP-ATI, Sesto San Giovanni, 26 June 2012
- 8000H Overview
- Validation Status
- Summary
8000H Program includes Comprehensive Validation and Testing Concept

Parts tests
- Casting blades & vanes
- Materials, coatings
- Manufacturing trials etc.
- Stress / Strain verification

Component tests
- Combustion system rig test
- Cover plate rig test
- Mock up

Systems tests
- Compressor test &
- Combustion system test
  at test bed Berlin

50Hz Prototype GT field validation

Prototype CC field operation

60Hz Prototype Validation

Siemens carried out the most comprehensive test program in the industry

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# Irsching 4, Project Overview

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

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<th>Year</th>
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<th>Q3</th>
<th>Q4</th>
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</table>

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

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Fig. 14

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Irsching 4, Phase II, Combined Cycle Extension
Installation Completed on Schedule

SCC5-8000H 1S

Single Shaft Power Train

Plant View, June 2011

Power Train View, June 2011

Plant in commercial operation since July 2011
Increased loading & acceleration rate reduces startup time
- Standard Loading: 25 Minutes to 375MW
- Fast Loading: 10 Minutes to 350 MW

Proven: GT Fast start-up capability due to internal air cooling concept
SGT5-8000H Validation Example: Performance/Emissions

Overall Engine stability limit well above commercial rating

387,1 MW

Fuel preheat on

Emissions met
Excellent serviceability proven on customer site boundaries
Reality Check: World Class Flexibility (Plant Hot Start)

Promised and Delivered!

Hot start capability: 540 MW in 30 min.
> ½ GW in ½ hour
Reality Check:
World Class Flexibility (Grid Code Compliance)

Load increase
64 MW (12%) in 10 s

CC load

Load decrease
250 MW (45%) in 6 s

Most stringent frequency response target overachieved

Island Operation target achieved.
We are prepared for the upcoming ENTSO-E network code

Promised and Delivered!

Fig. 20
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CCPP Irsching 4
Performance Data (net)
☑ Efficiency $\eta = 60.75\%$
☑ Power Output $P_n = 578\text{ MW}$

Promised and Delivered!

Fig. 21
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### SGT5-8000H / Irsching 4 Operational Status

![Image of power plant]

<table>
<thead>
<tr>
<th>Phase I</th>
<th>Phase II</th>
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<tbody>
<tr>
<td>GT Testing</td>
<td>CC Extension</td>
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<table>
<thead>
<tr>
<th>Starts</th>
<th>EOH</th>
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<tbody>
<tr>
<td>85</td>
<td>4365</td>
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<td>&gt;295</td>
<td>&gt;11,000</td>
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Status 2012-05-31

More than 380 starts & 15.500 EOH’s so far
SGT-8000H References

1x 5-8000H, Germany
>15,500 EOH

6x 6-8000H, USA
3x PAC 2013, 3x PAC2014

1x 6-8000H, South Korea
PAC 2013
### SGT-8000H References

<table>
<thead>
<tr>
<th>Count</th>
<th>Description</th>
<th>Location</th>
<th>Year</th>
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<tbody>
<tr>
<td>1</td>
<td>6-8000H, South Korea</td>
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<td>1</td>
<td>5-8000H, Germany</td>
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</table>
- 8000H Overview
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The SGT-8000H / SCC-8000H has proven:

H Class Performance >60%

beyond

F Class Flexibility

Thanks for your attention!