Plant Optimization through Integrated Design

Update on H Class technology from Siemens

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South Asia

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Siemens Energy Solutions CCPP’s – Leading questions…

1. How to cope with the **increasing energy demand**, increase **profitability** and save the environment?

2. How can different **load profiles** be compensated by rapid availability of CCPP’s?

3. How can CCPP’s provide **grid support** and **stable operation** in case of **grid incidents**?
What I would like to talk about today...

- Siemens Energy Solutions product portfolio
- Our plant design philosophy to meet major market drivers
- Dangjin 3 – Asia’s most efficient plant
- Service Concept
- Operational experience
- Conclusions
Siemens Gas Turbines for 50Hz and 60Hz markets

**Large-scale Gas Turbines**
- SGT5-8000H: 375 MW
- SGT5-4000F: 295 MW
- SGT5-2000E: 172 MW
- SGT6-8000H: 274 MW
- SGT6-5000F: 232 MW
- SGT6-2000E: 112 MW

**Industrial Gas Turbines**
- SGT-800: 47/50 MW
- SGT-750: 36 MW
- SGT-700: 31 MW
- SGT-600: 25 MW
- SGT-500: 19 MW
- SGT-400: 13 MW
- SGT-300: 8 MW
- SGT-200: 7 MW
- SGT-100: 5 MW

Output in MW @ ISO conditions
Pre-engineered power plant solutions available as Simple (SSC) or Combined Cycle (SCC)

H-Class
Pioneering & Proven

F-Class
Flexible & Reliable

E-Class
Robust & Durable

SCC5-8000H
SCC5-4000F
SSC5-2000E

SCC6-8000H
SCC6-5000F
SSC6-2000E

50 Hz
60 Hz

We deliver tailor-made power plants based on proven standards
Gas fired power plants
Power output ranges in standard configurations

50 Hz
- 1140 MW SCC5-8000H 2x1
- 862 MW SCC5-4000F 2x1
- 570 MW SCC5-8000H 1S
- 512 MW SCC5-2000E 2x1
- 341 MW SCC5-4000F 1S
- 253 MW SCC5-2000E 1x1
- 295 MW SSC5-4000F
- 172 MW SSC5-2000E

60 Hz
- 820 MW SCC6-8000H 2x1
- 690 MW SCC6-5000F 2x1
- 410 MW SCC6-8000H 1S
- 345 MW SCC6-5000F 1x1
- 342 MW SCC6-2000E 2x1
- 171 MW SCC6-2000E 1x1
- 232 MW SSC6-5000F
- 112 MW SSC6-2000E

All values: ISO base rating
### SCC-8000H series
Performance and configuration overview

<table>
<thead>
<tr>
<th>Configuration</th>
<th>50 Hz</th>
<th>60 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGT-PAC 8000H</td>
<td>375 MW</td>
<td>274 MW</td>
</tr>
<tr>
<td></td>
<td>40 %</td>
<td>40 %</td>
</tr>
<tr>
<td>SCC-8000H 1S</td>
<td>570 MW</td>
<td>410 MW</td>
</tr>
<tr>
<td>SCC-8000H 1x1</td>
<td>&gt; 60 %</td>
<td>&gt; 60 %</td>
</tr>
<tr>
<td>SCC-8000H 2x1</td>
<td>1.145 MW</td>
<td>824 MW</td>
</tr>
<tr>
<td></td>
<td>&gt; 60 %</td>
<td>&gt; 60 %</td>
</tr>
<tr>
<td>SCC-8000H 3x1</td>
<td>- -</td>
<td>1.236 MW</td>
</tr>
<tr>
<td></td>
<td>- -</td>
<td>&gt; 60 %</td>
</tr>
</tbody>
</table>
SCC-8000H – supporting the Customer requirements…

Highest efficiency

Efficiency

Grid support

Power on demand

GuD Kraftwerk Irscning 4
Leistungsdaten (netto)
Wirkungsgrad \( \eta = 60.75 \% \)
Elektr. Leistung \( P_e = 578 \text{ MW} \)

Frequent load changes between 15 MW/min – 35 MW/min at stable live steam temperature

Load increase 64 MW (12%) in 10 s
Load decrease 250 MW (45%) in 6 s
Frequency simulation ±300 mHz

Plant load increase 12% within 10 s
Decoading by 45% followed in 6 s
Stable behavior of plant

New Delhi, May 5-7, 2014
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Power plant solutions as an outcome of an integrated approach

**Optimization Criteria**
- Thermal stress optimization
- Load Ramp
- Start-up readiness

**Integrated Plant design**

**Market Boundaries**
- Flexibility
- Environment
- Profitability

**FACY enables the world’s fastest start-up times without additional life time consumption**
Dangjin 3 (former Bugok 3) – South Korea
SCC6-8000H 1S
SCC6-8000H 1S – Dangjin 3
Proven H-class using advanced cycle technology
HRSG design

Ulrich Hartmann (Irsching #4, Germany)
600°C steam parameter @ SH and RH section

- Live steam temp.: 600 °C
- Reheat temp: 600 °C

Dangjin 3 (South Korea)
585°C steam parameter with T91 material @ SH and RH section

- Live steam temp.: 585 °C
- Reheat temp: 585 °C

Siemens is the only company with a 600 °C HRSG in operation. HRSG solution for 600 °C according ASME design available
Dangjin 3 – A globally optimized and integrated design based on a compact low level arrangement
Danjing 3 – Environmental, Health and Safety (EHS) performance sets a benchmark…

LTAFR Development Status as of November 2012

Mio Man-hours

<table>
<thead>
<tr>
<th>Year</th>
<th>Mio Man-hours</th>
<th>LTAFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>17</td>
<td>0.52</td>
</tr>
<tr>
<td>2005</td>
<td>11</td>
<td>0.20</td>
</tr>
<tr>
<td>2006</td>
<td>27</td>
<td>0.15</td>
</tr>
<tr>
<td>2007</td>
<td>59</td>
<td>0.14</td>
</tr>
<tr>
<td>2008</td>
<td>67</td>
<td>0.20</td>
</tr>
<tr>
<td>2009</td>
<td>45</td>
<td>0.17</td>
</tr>
<tr>
<td>2010</td>
<td>32</td>
<td>0.13</td>
</tr>
<tr>
<td>2011</td>
<td>29</td>
<td>0.09</td>
</tr>
<tr>
<td>2012</td>
<td>50</td>
<td>0.07</td>
</tr>
</tbody>
</table>

LTA = Lost Time Accident  \[ \text{LTAFR} = \frac{\text{LTA} \times 100,000}{\text{Man-hours worked}} \]

Dangjin 3 (2013)  Man hours: 1,470 Mio  LTAFR: 0.07

… confirming overall Siemens Energy Solutions project execution excellence
We are your most trusted partner offering cutting edge integrated solutions at highest quality

Beyond 60% efficiency: Dangjin – the most efficient fossil power plant in Asia

“"We want to become the leading power producing company in Asia. And we want to continue our partnership with Siemens""

"Using top quality components and software, Siemens engineered an outstanding power plant solution""

Wan-Kyoung Lee
President and CEO  GS EPS Co. Ltd
Seoul Korea
8000H Maintainability

The SGTX-8000H core engine was designed for easy and fast maintenance

- All rotating blades, including compressor, are replaceable without a rotor lift.

- Row 1 Turbine Blades/Vanes/Ring Segments & Row 4 Blades can be replaced with or without cover lift.

Vane 1 Removal

Turbine Blade 4 Removal

Diagram
8000H Maintainability

The SGTX-8000H core engine was designed for easy and fast maintenance

- Roll out/in capability of the turbine vane carrier enables exchange of stationary turbine hardware without rotor lift.

- Roll out/in capability also allows for optional assembled spare vane carrier exchange concept which further reduces outage durations.
8000H Maintainability

The Major Inspection concept allows access to all necessary components!
28 GTs under contract; 9 units in commercial operation
The SGT-8000H has achieved more than 1300 starts & 66,000 EOH
SCC-8000H will accumulate > 250,000 EOH until 2015

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>Launch – Concept Phase</td>
</tr>
<tr>
<td>2007</td>
<td>1st Fire – Beginning of Validation Phase</td>
</tr>
<tr>
<td>2009</td>
<td>End of 50 Hz GT Test &amp; Validation Phase and Extension to Combined Cycle</td>
</tr>
<tr>
<td>2011</td>
<td>Combined Cycle Commissioning, Testing and Commercial Operation Ulrich Hartmann</td>
</tr>
<tr>
<td>2013</td>
<td>Proven Technology in Commercial Operation</td>
</tr>
<tr>
<td>2015</td>
<td>Extensive Operational Experience</td>
</tr>
</tbody>
</table>

Pioneering technology is proven.
Siemens Energy Solutions is your most trusted partner offering cutting edge integrated solutions at highest quality

1. **SCC-8000H** power plant series is based on **proven technology** and is the result of a **fully integrated approach**.

2. World class performance & operational flexibility as well as **highest plant reliability / availability**.

3. Asia’s first H-class and **most efficient** power plant **Dangjin 3** achieved commercial operation ahead of schedule.

4. **Dangjin 3** impressively demonstrates Siemens Energy Solutions **project execution excellence** and **highest quality standards**.

5. **Consequently** the customer will continue the **trustful partnership** with Siemens.
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