Hitachi Challenge for low CO₂ Coal-Fired Power Generations

March 2012

Contents

1. Introduction of Hitachi Group
2. Hitachi Thermal Power Business
3. USC Power Plant Experience
4. IGCC & CCS Technologies
1. Introduction of Hitachi Group
1.1 Hitachi Global Product portfolio

- Information & Telecommunication Systems
- Power Systems
- Industrial Systems
- Construction Machinery
- Electronic Devices
- Digital Media & Consumer Products
- Components & Devices
- Material & Components
- Financial Service
- Others

Revenue 93B€ (2010)
1.2 Business Areas

- Industrial, Transportation and Urban Development Systems
  - Eco-cities
  - Construction machinery
  - Water treatment
  - Elevators and escalators
  - Green mobility
  - Healthcare

- Information and Telecommunication Systems
  - Cloud computing
  - Consulting
  - Data centers
  - Storage

- Power Systems
  - Energy (Thermal, nuclear, renewable)
  - Smart grids

- Materials & Key Devices
1.3 Global Operations

For power plant business:
Hitachi Power Europe GmbH
HPE - Duisburg, Germany

Europe
142 companies
11,056 employees
$10 billion sales (9%)

China
133 companies
61,840 employees
$12 billion sales (11%)

Asia (incl. China)
275 companies
107,647 employees
$21 billion sales (19%)

Japan
404 companies
260,677 employees
$65 billion sales (59%)

North America
78 companies
14,867 employees
$10 billion sales (9%)

Hitachi Europe Ltd.
Hitachi (China) Ltd.
Hitachi Asia Ltd.
Hitachi America Ltd.
Hitachi Ltd.

Other Areas
45 companies
5,882 employees
$5 billion sales (4%)

41% of net sales (consolidated) are overseas
2. Hitachi Thermal Power Business
2-1 Business Overview (Power Systems Company)

Thermal Power Business
- Coal-fired thermal power plants
- IGCC
- Steam turbines and power generators (TG)
- Boilers and AQCS
- Gas turbines

Nuclear Power Business
- Boiling water reactor nuclear power plants (ABWR, ESBWR)
- Preventive maintenance, nuclear fuel cycle, etc.

<Major equipment of nuclear power plants>
- Reactor pressure vessel
- Reactor equipment
- Main Control Room Panel

<Major equipment of coal-fired thermal power plants>
- Steam turbines and power generators (TG)
- Boilers and AQCS
- IGCC: Integrated Gasification Combined Cycle

FY2010 consolidated revenues ¥813.2 billion

60%
20%
20%

Power Distribution, Renewable Energy and Other Businesses
- Wind power generation systems
- Solar power generation systems
- Proton beam therapy system
- Hydroelectric power generation systems, drive systems, smart grids, power semiconductors, etc.

IGCC: Integrated Gasification Combined Cycle
ABWR: Advanced Boiling Water Reactor
ESBWR: Economic and Simplified Boiling Water Reactor

Copyright © 2012, Hitachi, Ltd., All rights reserved.
2-2 Global Activity of Thermal Power Business (1)

**Integrated supply of BTG + AQCS ⇒ Optimize entire plants**

<table>
<thead>
<tr>
<th>Boilers (B)</th>
<th>Turbines (T)</th>
<th>Generators (G)</th>
<th>AQCS DeNOx Systems</th>
<th>Precipitators</th>
<th>DeSOx</th>
<th>CCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

### Steam turbines and power generators (TG)

- Highly efficient and reliable
- Achieved **world's highest level efficiency** with the new No. 2 unit of Isogo Thermal Power Plant for Electric Power Development Co., Ltd.

*Steam condition: 25MPa 600°C/620°C*

### Boilers (B)

- **Highly efficient combustion:** Low NOx/CO₂ emissions, high economical efficiency
- Compatible with various coal types:
  - Can use low grade coal
- **Top share Hitachi 20%**

**Source:** McCoy Reports 2010 (Excluding China and India)

### AQCS

- **Integrated system (DeNOx reactor, precipitator, desulfurizer)**
- High-performance DeNOx catalyst: In-house development and production system

**DeNOx Catalyst Share Top share Hitachi 26%**

**Source:** Hitachi estimate

---

Copyright © 2012, Hitachi, Ltd., All rights reserved.
Step up global development of highly efficient coal-fired thermal power business

Europe, South Africa

- Hitachi Power Europe GmbH
  - Maasvlakte (Under construction) B [1,100 MW]

- Hitachi Works
  - Moorburg (Under construction) B [820 MW x 2]

- Hitachi Works
  - Wilhelmshaven (Under construction) BTG [790 MW]

- Rotterdam (Under construction) BTG [790 MW]

- Medupi-1 - 6 (Under construction) B [800 MW x 6]

- Kusile-1- 6 (Under construction) B [800 MW x 6]

Asia

- Babcock-Hitachi K.K. Kure Branch
  - TEPCO/Hitachinaka 2 (Trial operations) BTG [495 MW]

- South Korea/yonhung Thermal Power Plant No. 5 and 6 units (Preparing for construction) TG [870 MW x 2]

- South Korea/Dangjin Power Plant.
  - No. 9 and 10 units (Preparing for construction) B [1,000 MW x 2]

- Medupi-1 - 6 (Under construction) B [800 MW x 6]

- Kusile-1- 6 (Under construction) B [800 MW x 6]

- TEPCO/Hitachinaka 2 (Under construction) BTG [1,000 MW]

- South Korea/Yonghung Thermal Power Plant No. 5 and 6 units (Preparing for construction) TG [870 MW x 2]

- South Korea/Dangjin Power Plant.
  - No. 9 and 10 units (Preparing for construction) B [1,000 MW x 2]

Americas

- Hitachi Power Systems America, Ltd.
  - Keephills-3 (Trial operations) BTG [900 MW]

- Duke Energy (Under construction) B [900 MW]

- Rotterdam (Under construction) BTG [790 MW]

- Wilhelmshaven (Under construction) BTG [790 MW]

- Medupi-1 - 6 (Under construction) B [800 MW x 6]

- Kusile-1- 6 (Under construction) B [800 MW x 6]

29 plants under construction mainly in industrialized nations [24.8 GW]

[FY2010 orders]

- TEPCO/Hitachinaka 2 (Under construction) BTG [1,000 MW]

- South Korea/yonhung Thermal Power Plant No. 5 and 6 units (Preparing for construction) TG [870 MW x 2]

- South Korea/Dangjin Power Plant.
  - No. 9 and 10 units (Preparing for construction) B [1,000 MW x 2]

Revenues

- FY2010: ¥460 billion
- FY2015 target: ¥650 billion

B: Boilers, TG: Steam turbines and generators
3. USC Power Plant Experience
3.1 Improvement of Steam Conditions

Japan since 1995

- Hitachi-Naka #1 (1000MW)
- Isogo #2 (600MW)
- Tachibana Wan #2 (1050MW)
- Haramachi #2 (1000MW)
- Matsuura #2 (1000MW)
- Nanao-Ohta #1 (500MW)
- Shinchi #1 (1000MW)
- Noshiro #1 (600MW)
- Hekinan #2 (700MW)
- Bexbach 1 (750MW)

Germany, Lignite

- Moorburg (800MW)
- Moorburg (750MW)
- Walsum (550 - 600 MW)
- Neurath F/G (1100 MW)
- Datteln (1100 MW)
- RKW NRW (550 - 600 MW)
- Moorburg (800 MW)
- Moorburg (670 MW)
- Niederauβem K (1000 MW)

Germany, Bituminous coal

- Boxberg R (900 MW)
- Boxberg (900 MW)
- Schkopau (2 x 400 MW)
- Lippendorf (2 x 930 MW)

SH Outlet Pressure [bar]

180 220 240 260 280 300 380

SH Outlet Temperature [°C]

540 560 580 600 620 700

Higher Efficiency

Copyright © 2012, Hitachi, Ltd., All rights reserved.
3.2 Effect of Efficiency on CO2 Reduction

**Efficiency Improvement**

<table>
<thead>
<tr>
<th>Pressure (MPa)</th>
<th>Temperature (°C)</th>
<th>Efficiency Improvement (Relative %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.7</td>
<td>538/538</td>
<td>5%</td>
</tr>
<tr>
<td>24.1</td>
<td>566/566</td>
<td>7%</td>
</tr>
<tr>
<td>25.0</td>
<td>600/600</td>
<td></td>
</tr>
</tbody>
</table>

**Reduction of CO2 Emission**

<table>
<thead>
<tr>
<th>Pressure (MPa)</th>
<th>Temperature (°C)</th>
<th>CO2/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.7</td>
<td>538/538</td>
<td>900</td>
</tr>
<tr>
<td>24.1</td>
<td>566/566</td>
<td>800</td>
</tr>
<tr>
<td>25.0</td>
<td>600/600</td>
<td>700</td>
</tr>
</tbody>
</table>

Copyright © 2012, Hitachi, Ltd., All rights reserved.
### EPDC

**Tachibananawan Unit 2**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boiler Type</strong></td>
<td>Once-Through, Benson</td>
</tr>
<tr>
<td><strong>Generator Output</strong></td>
<td>1,050MW</td>
</tr>
<tr>
<td><strong>Main Steam Flow</strong></td>
<td>3,000 t/h</td>
</tr>
<tr>
<td><strong>Steam Conditions</strong></td>
<td>25.9MPa / 605°C / 613°C</td>
</tr>
<tr>
<td><strong>Fuel</strong></td>
<td>Imported Bit.</td>
</tr>
<tr>
<td><strong>Commercial Operation</strong></td>
<td>Dec. 2000</td>
</tr>
</tbody>
</table>

### Tokyo Electric Power Co., Ltd

**Hitachi Naka Unit 1**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boiler Type</strong></td>
<td>Once-Through, Benson</td>
</tr>
<tr>
<td><strong>Generator Output</strong></td>
<td>1,000MW</td>
</tr>
<tr>
<td><strong>Main Steam Flow</strong></td>
<td>2,870 t/h</td>
</tr>
<tr>
<td><strong>Steam Conditions</strong></td>
<td>25.4MPa / 604°C / 602°C</td>
</tr>
<tr>
<td><strong>Fuel</strong></td>
<td>Bit &amp; Sub-bit Blend</td>
</tr>
<tr>
<td><strong>Commercial Operation</strong></td>
<td>Dec. 2003</td>
</tr>
</tbody>
</table>
3.4 USC Lignite Fired Boiler in Germany (HPE)

Neurath F + G (BoA II)

- 2 x 1100 MWel / 2 x 2898 t/h
- Benson® Steam generator
- Garzweiler/Hambach Lignite
- Design parameter:
  - SH: 600 °C / 292 bar a
  - RH: 605 °C / 56 bar a
- Boiler height 170 m
- Commissioning: started 2011
3.5 USC Lignite Fired Boiler in Germany (HPE)

**Boxberg R  670 MW**

- **High pressure part**
  - Steam rating: 1760 t/h
  - Allowable working pressure (gauge): 315 bar*
  - SH-Outlet temperature: 600 °C

- **Reheater**
  - Allowable working pressure (gauge): 72 bar*
  - RH-Outlet temperature: 610 °C

- **Boiler height:** 135 m
- **Commissioning started:** 2011

* Operational pressure: 286 bar, 52 bar

---

**24 RS®-Burners „all-wall“ firing**
3.6 Design Features of future Lignite Boiler (HPE)

Features

- High Reliability & High Availability
- Innovative Lignite Firing Technology
- High Efficiency from Full Load to Partial Load
- Flexible and Easy Operation, Easy maintenance

Low Slagging and Fouling Potential

Minimize Temperature Unbalance at Furnace outlet with Spiral Water Wall

Low NOx firing in “All-wall” arrangement with RS®-burners

High-stem Temperature with 600 deg C class

Prevent Erosion Potential

Steam Temperature Control by spray attemperator

High Load Change Rate

Copyright © 2012, Hitachi, Ltd., All rights reserved.