Power Systems Business Operation

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Power Systems Headquarters

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## 1. Overview of 2008 Business Plan and Current Measures

### Summary of 2008 Business Plan

- **Orders:**
  Orders decreased due to the slow recovery of demand and suspension of the wind turbine business stemming from the USITC’s* initial determination (business resumed after the USITC’s final determination) (*US International Trade Commission).

- **Sales/Profits:**
  Overcoming tougher competition and the stronger yen stemming from the recession.

- **Principal Measures/Achievements:**
  - Next-generation GTCC: Completed development of J-series gas turbines, which KEPCO has decided to adopt.
  - Demonstration of new coal-utilization technology: Nakoso IGCC demonstration plant has achieved over 8,000 hours cumulative operation.

### Current Measures

- Pursuing further cost competitiveness
  - Expanding procurement and local production in China, United States, India, etc.
- Reducing fixed costs
2. Business Environment and Overview of 2010 Business Plan

Business Environment

- Next-generation energy project have not progressed due to uncertain GHG policies and future trend of fuel price (No clear direction for “Energy Shift”)

Overview of 2010 Business Plan

- Expanding business by localization in promising markets
- Reinforcing the service business network
- Product development in growth fields (high-efficient thermal power, natural energy, secondary batteries, etc.)

Product breakdown (sales)

- 2009=100

<table>
<thead>
<tr>
<th>Year</th>
<th>New business and other</th>
<th>Natural energy</th>
<th>Coal utilization</th>
<th>GTCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
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<td></td>
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<tr>
<td>2010</td>
<td>[90]</td>
<td>[102]</td>
<td>[94]</td>
<td>[110]</td>
</tr>
<tr>
<td>2012</td>
<td>[122]</td>
<td>[144]</td>
<td>[140]</td>
<td>[146]</td>
</tr>
<tr>
<td>2014</td>
<td>[148]</td>
<td>[144]</td>
<td>[235]</td>
<td>[146]</td>
</tr>
</tbody>
</table>

Impact of difficult economy

Synergy of environment-related investments and economic recovery

- Responding by increasing production of wind turbines
- Promoting clean coal technology (coal-gasification)
- Expand market share with competitiveness in J-series gas turbines
3. Trends in Power Systems Market

**Industrial countries (North America, Europe, Japan)**
- Will continue to CO₂-free renewable energy (wind turbine)
- Replaced to high-efficiency GTCC from aging coal-fired power plant (North America: Mining shale gas and tight sand gas)
- Main energy will change depending on fuel prices, construction cost and governmental environmental policies

**Emerging countries (BRICs, Southeast Asia, Middle East, etc.)**
- Growth has also remained firm after the financial crisis and orders continue to be placed.
- Cumulative installed capacity of emerging countries will comprise 50% of the global installed capacity by 2030.
- India: Conventional coal-fired power plant will remain the mainstream.
- Southeast Asia, etc.: Will continue to place GTCC orders at a high level.
- China: Will increase nuclear and GTCC and study IGCC

![Graph showing trends in power systems market](image)
4. Approach in Emerging Countries (1/3)

China

- Mitsubishi Heavy Industries BFG Gas Turbine Services (Nanjing) (Subsidiary/BFG-fired gas turbine service)
- Hangzhou Steam Turbine (Partner/gas turbine manufacturing)
- Ningxia Electric Power Group (Partner/wind turbine manufacturing)
- Dongfang Turbine (Partner/gas turbine manufacturing)
- Nanjing TianLing Energy Technology (JV/BFG-fired GTCC engineering)
- MHI Shenyang Pump Engineering (JV/thermal-power pump engineering)
- Halbin Group (Partner/boiler, thermal-power turbine, and nuclear turbine manufacturing)

Partners' orders (Cumulative total of past five years)

<table>
<thead>
<tr>
<th>Product</th>
<th>Order scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas turbine</td>
<td>2 GW</td>
</tr>
<tr>
<td>Steam turbine</td>
<td>31 GW</td>
</tr>
<tr>
<td>Boiler</td>
<td>28 GW</td>
</tr>
</tbody>
</table>

- Deeping partnership with local partners
- Boosting orders
4. Approach in Emerging Countries (2/3)

India

- L&T JV
  - LMB*: (JV/Boiler manufacturing)
  - LMTG*: (JV/Turbine manufacturing)

- JAYPEE
  - 660x2 MW (Boiler, ST)

- MAHAGENCO
  - 660x3 MW (Boiler, ST)

- Krishnapatnam
  - 800x2 MW (ST)

- MHI-India Engineering Center
  - (Subsidiary/GTCC Engineering)

- The number of supercritical pressure coal-fired power plants increased rapidly
- Joint ventures with L&T established
  - Boiler production capacity: 4 GW/year
  - Turbine production capacity: 4 GW/year
- Deploying steady business activities
  - Orders for 660-800 MW boilers (5 units) and turbines (7 units)
- Expanding engineering centers

Thermal power market in India

* LMB: L&T-MHI Boilers Private Limited
  LMTG: L&T-MHI Turbine Generators Private Limited
## 4. Approach in Emerging Countries (3/3)

### Brazil

**CBC**  
(Subsidiary/boiler manufacture)

**Overview of CBC**  
- Acquired from THYSSEN in 1963  
- Number of employees: Approx. 900  
- Products  
  - Manufacture of boilers, heat exchangers, pressure vessel, environmental equipment, etc.

- Electrical demand is set to increase ahead of the 2016 Olympics.  
- New offshore oilfield has been discovered and associated gases are being produced (promising for GTCC and gas engine)  
- Petrobras, an oil and gas utility is planning large-scale investment projects.

- Developing new markets centering on CBC

### Russia and CIS

**Kyiv Representative Office**  
Komsomolsk M701Fx1 (GT)

**Krasnodar**  
M701Fx1 (GTCC)

**Navoi**  
M701Fx1 (GTCC)

- Demand for replacement of aging thermal power plants

- Representative office set up in Kyiv, Ukraine for business operation (GTCC-based CHP, gas engine, coal-fired power plant)

- Recent orders:  
  - Russia: Krasnodar GTCC  
  - Uzbekistan: Navoi GTCC  
  - Ukraine: Komsomolsk GT
5. Approach for Partnerships, Local Production and Overseas Procurement

- Reinforcing SCM: Collaborating with new suppliers
- Supporting domestic suppliers’ overseas business
- Hedging exchange risk

- MPS-Americas
  - Combustor Plant for Gas Turbines
- MPS-Europe
  - MPSA
    - Nacelle Plant for Wind
  - L&T MHI JV
    - Turbine Plant
    - Boiler Plant
- Halbin Group
- MPS-AP
  - Engineering center
  - JV in Guangzhou
    - Hot gas path parts Plant for Gas Turbines
- VienTek
  - Blade Plant for Wind
- CBC
  - Boiler Plant
- Doosan Heavy Industries & Construction
- Ningxia Electric Power Group
- Hangzhou Steam Turbine
- Dongfang Gas Turbine
- Nanjing TianLing Energy Technology
6. Expanding Service Business

Establishment of **Diamond Service Network** for sales expansion

- Deploying the know-how from our domestic service business
- Offering a global quality service and global business models
- Promoting localized operation in Americas, Europe, and Asia

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**Establishment of key service infrastructure completed**

**Continue localization**

Develop as key business segment for Power Systems

<table>
<thead>
<tr>
<th>Year</th>
<th>Sales Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td></td>
</tr>
<tr>
<td>Future</td>
<td>Double</td>
</tr>
</tbody>
</table>

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**Effective localized operation**

**Further business expansion**
## 7. Product Development in Growing Fields

### Continuous technology development for high environmental and economic performance

<table>
<thead>
<tr>
<th>High-efficicncy Gas Turbine</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>J series gas turbine</td>
<td></td>
</tr>
<tr>
<td>World-leading, high-efficiency low NOx technology</td>
<td>Comprehensive technologies in power systems, aerospace, and ships</td>
</tr>
<tr>
<td></td>
<td>High capacity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lithium-ion Secondary Battery</th>
<th>IGCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>For grid systems</td>
<td>Air-blowing gasification</td>
</tr>
<tr>
<td>Research achievement with electric utilities</td>
<td>Technology for low-grade coal utilization</td>
</tr>
<tr>
<td>Laminated large-capacity model</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Geothermal</th>
<th>MEET for Ships</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geothermal pioneering technology</td>
<td>Highly efficient and eco-friendly technology</td>
</tr>
<tr>
<td>World’s largest market share</td>
<td>High reliability for ships</td>
</tr>
<tr>
<td></td>
<td>Incorporating eco-friendly technologies from land power systems products</td>
</tr>
</tbody>
</table>
High-Efficiency Gas Turbine

New-generation Gas Turbine J-series released from Japan

- Over 60% combined efficiency
- 50% reduction in CO₂ emissions compared with conventional coal-fired power plants
- Adapted as 1st unit (M5101J x 6 units) at KEPCO Himeji Power Station #2

Contributing to 25% reduction in CO₂ emissions in Japan by replacement with a high-efficiency gas-fired power plant

Utilization of unconventional natural gas is expanding and gas price expected to remain stable in the medium and long term

- North America, China, etc.

Business discussion are underway with domestic and overseas leading electric utilities

Schedule of 1st unit

<table>
<thead>
<tr>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing at plant</td>
<td>Onsite construction</td>
<td>Starting operation in October</td>
<td></td>
</tr>
</tbody>
</table>
Wind

Constructing a wind turbine assemble plant

Ranked 4th (*) in deliveries (installation) for fiscal 2009: plant for assembling wind turbine facilities in the State of Arkansas
(* Source: AWEA)
- Start plant construction within 2010 (Initial number of employees: 300)
- Start production from the second half of 2011.

Production capacity: 600MW/year
(250 units of the 2.4MW turbine)

US International Trade Commission (USITC's final determination)

January 8: USITC's final determination: MHI’s not in violation of the Tariff Act
⇒ Resuming business in the United States
May 20: File complaints against GE in the United States
Patent infringement
(Federal District Court of Middle District of State of Florida)
Damages suit for violation of the Antitrust Law and illegal act
(Federal District Court of West District of State of Arkansas)

Offshore wind turbine development

- Promoting 5-7 MW class large-capacity wind turbine development (with subsidies from the British government)
  Aming to get an order for the Offshore Wind Turbine Round 3 Project of Britain (from 2015: 32 GW)

[Britain's Offshore Wind Turbine Round 3 Project] (Nine areas)

- Plans to participate in a NEDO national project for TEPCO
  Promoting offshore wind turbine demonstration in Japan (From 2011: Choshi offshore)
- Potential for offshore wind capacity: 68 GW
  (Reference: total installed capacity in Japan is approx. 270 GW)
  Employment boosting effects in associated fields in Japan
  (Principal wind turbine units, components, steel, submarine transmission wires, ship building, ocean civil engineering, port and harbor development, etc.)
Lithium-Ion Secondary Battery

- MHI has built a mass-production demonstration plant to enter into the lithium-ion secondary battery business field.
- MHI will apply them to vehicles, such as forklifts, and to energy storage systems that stabilize renewable energy, anticipating market expansion, by utilizing the experience of in-house products.

For Vehicles
Application example: 4 to 5 t diesel engine-powered hybrid forklifts

For Energy Storage Systems
Application example: micro grid systems for island in Kyushu Electric Power's project

Mass production demonstration plant (image)
- Nagasaki Shipyard in Nagasaki Prefecture
- Annual production: 66 MWh
- Start production in the autumn of 2010

Features of MHI’s lithium-ion secondary batteries
- Large-capacity of square lamination
World-leading class unit cell capacity (50 Ah/P140 type)

- High output
Materialize high output characteristic (3350 W: 2400 W/kg)

- Safety structure
- Designing own components after taking their performance and safety into account
- Cleared safety examinations such as UN test

1. Product Development in Growing Fields

MHI will apply them to vehicles, such as forklifts, and to energy storage systems that stabilize renewable energy, anticipating market expansion, by utilizing the experience of in-house products.

- Studying on commercial mass-production hopefully from 2011
- Improving merchantability by applying to MHI’s products

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Hazardous material test on a UN recommendation
Demonstrating high reliability to advance into the stages of commercialization and overseas deployment

- Cumulative operation hours: Over 8,000 hours
- Availability*: Over 90%  *Not including planned suspension

Features of MHI’s IGCC and coal gasifier

- Air-blowing IGCC with world-leading efficiency
- High-efficiency 2-stage entrained bed gasification fitting for low-grade coal, gas, liquid fuel, and chemical raw material production

Example of commercial project
ZeroGen Project in Australia (IGCC commercial plant + CCS demonstration)

- Type of coal: Australian bituminous coal
- Generating-end output: 530 MW
- Gasified system: Dry coal feed, air-blowing
- Gas turbine: M701G2 GT (1 on 1)
- CO₂ recovery rate: 65%
- CO₂ captured amount: 2-3 million t/year

Clean Coal Utilization Technology
7. Product Development in Growing Fields

Geothermal

Features of Geothermal Power Plant

- Inexhaustible and independent of the weather (stable supply)
- Eco friendly energy with low CO₂ emissions

Ranked first in the world (2000 to 2009)
(Our cumulative orders: over 100 units)

Creating a market as a pioneer of geothermal power

Contributing to the energy solution in geothermal resource countries

Further actions to retain leadership in the market

- Expanding collaboration with local partners
- Developing new turbines

McCoy Power Report 2000-2009

Record of geothermal orders:
2,231 MW

Iceland Nos. 3 and 4 units of Hellisheidi Power Plan

Iceland Nesjavellir Power Plant

Iceland
Marine Engine Business

Against tighter environmental control and soaring fuel prices, MHI will start marine solution business in functional combination with MHI’s marine engines and equipment.

- Project MEET (Mitsubishi Marine Energy & Environmental Technical Solution-System)

- Tighter environmental control
  - The International Maritime Organization (IMO) plans to impose strict environmental control in designated ocean areas (NOx: 80% reduction from 2016 and SOx: 98% reduction from 2015).
  - CO₂ emission control are inevitable since the CO₂ emission of marine engines in the ocean (870 million tons/year) exceeds Germany’s emissions (769 million tons/year).

- Soaring fuel oil price

Fuel oil price forecast

- CO₂ emission trading system is expected to start around 2013.
- SOx control is set to start around 2020

US$/ton

0 500 1000 1500
2010 2015 2020 2025 2030

C-Heavy oil  A-Heavy oil  CO₂ surcharge