Business Briefing on Power Systems

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# Relationship Between Power Systems and Business Domains

|-----------------|-------------------|----------------------------------|---------------|-------------------------------------------|------------------|---------------------------------------|----------------------------------------|
| **Energy & Environment** | • Power companies  
  • Gas companies  
  • Resource companies (oil, chemicals, steel) | - GTCC  
  - Large-sized thermal power plants  
  - Nuclear energy | - Environmental plants  
  - Chemical plants | | | | |
| **Machinery, Equipment Systems** | • Core industries (steel, etc.)  
  • Automotive industry  
  • Logistics, etc. | - Stationary engines  
  - Compressors  
  - Metals machinery  
  - Crane & material handling systems | | | | | |
| **Transportation** | • Airlines (air)  
  • Shipping companies (sea)  
  • Railways (land), etc. | - Commercial Ships  
  - Transportation system | - Commercial aircraft | | | | |
| **Defense & Aerospace** | • Ministry of Defense (land, sea, air)  
  • JAXA | - Destroyers & submarines for the Ministry of Defense | - Defense aircraft  
  - Missiles  
  - Space Systems | | | | |
1. Review of FY2011 (Review of 2010 Mid-Term Business Plan)
2. Business Environment
3. Business Policy for Achieving the 2012 Mid-Term Business Plan
4. Product Portfolio
5. Enhancing Competitiveness by Developing Global Network
7. Future Technological Development (Offshore Wind Turbine, Lithium-Ion Rechargeable Battery, SOFC)
8. Marine Machinery and Engine Business
1. Review of FY2011 (Review of 2010 Mid-Term Business Plan)

2010 Business Plan Implemented Steadily

- **Boosted product technologies**
  - Introduced a state-of-the-art “J” series GT into the market, with order intakes for the turbines. Upgraded existing models.
  - Developed 7 MW-class hydraulic-drive, large offshore wind turbine.

- **Global expansion**
  - Commenced construction of rotor manufacturing facilities at GT manufacturing plant of Savannah Machinery Works in Georgia, the United States, to increase production capacity
  - Established Regional headquarters, Mitsubishi Power Systems India

- **Efficient use of EPC functions**
  - Established the Engineering Headquarters

Orders in FY2011

- **GTCC**
  - Orders for 10 state-of-the-art “J” series GTs in South Korea,
  - Turnkey order for Nong Saeng GTCC power plant (1,600MW) from Gulf JP NS Company, Ltd. in Thailand

- **Large-sized Coal-fired Thermal Power Plants**
  - Order for 3 units of supercritical-pressure power plant for Linkou Thermal Power Plant from Taiwan Power Company

- **Others**
  - Orders for 20 stationary engines for securing power sources in Japan

<table>
<thead>
<tr>
<th>Year</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orders for 10 state-of-the-art “J” series GTs</td>
<td>700</td>
<td>700</td>
<td>990</td>
<td>+290</td>
</tr>
<tr>
<td>Turnkey order for Nong Saeng GTCC power plant</td>
<td>700</td>
<td>700</td>
<td>990</td>
<td>+290</td>
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The outlook for the new nuclear power plants is uncertain. In the short term, environmental-friendly GTCC will grow as an alternative power source.

In Emerging countries, Stable demand for coal-fired thermal power due to the low coal price.

Globally, renewable energy market faces excess of supply and falling prices due to the reduction of governmental support (incentives) in developed countries. Large offshore wind turbine will be the solution.

Expand the thermal power business by strengthening the EPC network.

Continue investments in large offshore wind turbines.
2. Business Environment (2/2)

Price Trends of Natural Gas

- **North America**: Prices are kept low and the gas utilization has been increasing due to shale gas development.
- **Asia**: Prices have been rising with the energy diversification in emerging countries and moves to secure natural gas following the Great East Japan Earthquake. Highly efficient use of the gas is important.

   Strengthen GTCC business in response to needs in regional markets.

Competitive Environment

- Continuing Yen appreciation
- Intensified price competition due to new manufacturers from Asia

   Reduce currency rate fluctuation risk and cost reduction by expanding the global network.
   Secure advantage by improving efficiency and developing eco-friendly technologies.
3. Business Policy for Achieving the 2012 Mid-Term Business Plan

Aim to expand the business, which has remained at around 1 trillion yen, to 1.5 trillion yen by taking chance of changing business environment.

(1) Improve the ability to win orders through globalization.
   - Strengthen EPC, procurement, services, and sales bases by establishing the “Diamond Network.”
   - Improve the competitiveness of main equipment and increase production capacity with global production.

(2) Reform the operation of the product business.
   - GT: Accelerate development of strategic new models.
   - Boilers: Utilize LCC and shift to IGCC business in the future.
   - ST: Improve competitiveness through global procurement and production.
   - Marine Machinery and Engines: Increase market shares by MEET products.

(3) Develop new business and domain.
   - Offshore wind turbine, lithium-ion rechargeable battery, SOFC triple combined system

Order Intake Plan

Maintain 1 trillion yen level and aim for further increase

- Increase GTCC orders, responding to demand for the replacement of aging power plant in developed countries and the diversification of power sources in emerging countries.
- Continue getting orders for coal-fired thermal power in emerging countries, mainly in India and Southeast Asia.
- Increase competitiveness by accelerating the global expansion of EPC business.
4. Product Portfolio

A product portfolio developed in anticipation of the continuation of highly efficient use of thermal power plants and environmental considerations required in the future

<table>
<thead>
<tr>
<th>Energy</th>
<th>Natural Gas</th>
<th>Coal</th>
<th>Renewables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristics and Challenges</td>
<td>- A well-balanced power source with economic efficiency and environmental-friendliness</td>
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<td></td>
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<tr>
<td></td>
<td>- The competitive edge over other power sources changes rapidly due to fluctuations in prices.</td>
<td>- Coal is easy to procure and fuel is readily available at reasonable prices.</td>
<td>- Eco-friendly and CO2-free power source</td>
</tr>
<tr>
<td></td>
<td>- But coal emits more air pollutants than other power sources. Measures need to be taken to achieve zero emissions.</td>
<td></td>
<td>- Costs of power generation are high. Performance improvement and cost cutting are necessary.</td>
</tr>
<tr>
<td>Market Environment</td>
<td>- North America: The environment is conducive to the introduction of GTCC because the use of gas has been increasing with the development of shale gas.</td>
<td>- Developed countries: Construction of new facilities has been stagnant because they are subject to environmental regulations.</td>
<td>- Policies on offshore wind turbines are promoted in several countries.</td>
</tr>
<tr>
<td></td>
<td>- Asia: Pursuit of fuel efficiency reflecting rising gas prices following the earthquake</td>
<td>- Emerging countries: Coal is the main power source supporting economic growth in India, Southeast Asia, and elsewhere.</td>
<td>- Energy management technologies sought to achieve the low-carbon society in the future</td>
</tr>
<tr>
<td>Product Development Policy</td>
<td>- Development of high-efficiency, high-output GT</td>
<td>- Development of clean coal technologies (= USC, IGCC)</td>
<td>- Large offshore wind turbine</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Lithium-ion rechargeable battery</td>
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<td></td>
<td></td>
<td></td>
<td>- Geothermal (Development of longer blades)</td>
</tr>
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USC: Ultra Super Critical pressure Coal-fired plant
IGCC: Integrated coal Gasification Combined Cycle
Strengthen the capacity of thermal power projects worldwide by networking bases of power systems for comprehensive operation.

Manufacturing base of main equipment
Engineering base
Procurement base
Base for sales and services

MPSA: Mitsubishi Power Systems Americas, Inc
MPSE: Mitsubishi Power Systems Europe, Ltd
MPS-India: Mitsubishi Power Systems India Private Ltd
CBC: CBC Industrias Pesadas S.A.
MHIEV: MHI Engineering Vienna GmbH
LMB: L&T-MHI Boiler Pvt. Ltd.
LMTG: L&T-MHI Turbine Generator Pvt. Ltd.
MTS: MHI Technical Service Corporation
SMW: Savannah Machinery Works
Enhancing Competitiveness by Developing Global Network

5. Strategic Investments Made in FY 2011 for EPC Network

Global Design Base

Mitsubishi Power Systems India Private Ltd
Established in October 2011
- Engineering base for thermal power projects worldwide
- Get orders for GTCC and implement EPC in the domestic market in India.

EPC Base of Europe

MHI Engineering Vienna GmbH
Established in June 2011
- GTCC engineering base for the European market
- Procurement base in European region

Strengthen the EPC business further by securing global resources
5. Promoting Localization of Thermal Service

Improve customer services by strengthening *Diamond Service Network*.

### Americas
- MPSA
  - OSC (Orlando Service Center)
  - SMW (Savannah Machinery Works)
  - Houston Outage Resource Center

### Europe, Middle East, and Africa
- MPSE
  - LSC (Leeds Service Center)
  - Maintenance Partners

### Asia
- MHI
  - MPS-AP, MPS-T, MPS-I
  - MPS-India

**Strengthen the service business for the equipment we delivered by expanding the network.**

* : Fully owned base
● : Joint Venture
(Thermal Power Business: Natural Gas 1/2)

Large GTCC (Gas Turbine Combined Cycle)
Achieve over 30% of the global shares by developing cutting-edge technologies for large-sized GTs that meet the needs of regional markets.

East Asia and Southeast Asia

- Needs for highly-efficient GT have been growing due to the surging gas prices, which is advantageous for J-Series GT.
- World’s highest thermal efficiency performance in 2011: Thanks to the introduction of M501J with thermal efficiency exceeding 61%, MHI won orders for 10 units in South Korea, where demand has increased rapidly.
- Respond to customer needs with a lineup of high-efficiency GTs.

M501J / M701J / M701F5

<table>
<thead>
<tr>
<th>Model</th>
<th>CC Output</th>
<th>CC Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>M701F5</td>
<td>525 MW</td>
<td>61.0%</td>
</tr>
<tr>
<td>M501J</td>
<td>470 MW</td>
<td>61.5%</td>
</tr>
<tr>
<td>M701J</td>
<td>680 MW</td>
<td>61.7%</td>
</tr>
</tbody>
</table>

CC: Combined Cycle
North America Operational Flexibility and High-Output

GTCC has become the most economical power source given the fall in gas prices, reflecting shale gas development.

There has been growing demand for turbines with high flexibility given the need to cope with load-fluctuations by increased renewable energy installation.

M501GAC: Got order for 2 units from TransAlta, following orders for a total of 6 units from Dominion (VEPCO)

Demand for large GTCC for base-load power plants, as the alternative to aging large-sized coal-fired plants, have grown due to the emission control specified by the U.S. EPA.

New market for M501J

Orders for M501G in North America: 39 units
(Thermal Power Business: Clean Coal Technology)

**Large-Sized Coal-Fired Power Plants**

**High-quality plants at competitive prices**
- Increased orders, mainly in East Asia and Southeast Asia, where the economy has been growing, on the strength of high efficiency and high reliability
- Reduced costs by global design, procurement, and production network, and maintained price competitiveness against our competitors from China and South Korea.
- In India, where demand is strong, we localized our business by establishing JV with Larsen & Toubro, a leading local company.

**Coal Gasification Technology (IGCC)**

**Power source that materialize needs for Coal-utilization and Eco-friendly**
- Verified high reliability
  - More than 16,000 hours of operation (accumulated) of demonstration equipment at Nakoso IGCC of Clean Coal Power R&D Co., Ltd.
- Cost reduction toward commercialization

**September 2011:**
Got order for 3 units of supercritical-pressure power generation for Linkou Thermal Power Plant from Taiwan Power Company (2,400MW)

**Accelerated order intake for commercial-use units by developing markets in coal-rich regions, including China and North America**

**700MW Coal-Fired Thermal Power Plant**

**Clean Coal Power R&D Co., Ltd. (Nakoso IGCC)**
7. Future Technology Development (Offshore Wind Turbine)

Cost reduction is essential to materialize renewable energy

Large offshore wind turbines, which permit lower unit cost of power generation (cost reduction) with improved power generation efficiency enabled by large capacity and size, are promising.

Development Policy and Schedule

- Introduced a hydraulic power drive technology owned by a UK venture firm, Artemis Intelligent Power (acquired in 2010), to hydraulic drive trains for offshore wind turbines
- Under development of 7MW-class gearless offshore wind turbine

Development of Floating Wind Turbine

- Integrating our wind turbine technologies with our marine structure technologies
- Participation in the “Experimental Offshore Floating Wind Farm Projects” sponsored by METI of Japan, which started in FY2011

Offshore wind turbine plans are in progress, mainly in the UK and other European countries. They are also in progress in the United States, China, South Korea, and Japan.
7. Future Technology Development
(Lithium-ion Rechargeable Battery)

Enable diverse applications. Accelerate verification tests and commercialization efforts.

For Energy Storage Systems
- Emergency power supply
- Promotion of introduction of renewable energy
- Reduction of power demand at peak times

- Rack 100kW-class Energy Storage System
  - Found practical application as an emergency power supply system
  - Introduced to eco-friendly condominiums of Mitsui Fudosan Residential

- Container 100kW-class Energy Storage System
  - Introduced as a micro grid test facility to the Shimizu Institute of Technology of Shimizu Corporation

- Container-type MW-class Energy Storage System
  - Japan’s first large-capacity power storage system
  - Internal verification test for power stabilization application is under way.

For Vehicles
- Application to vehicles manufactured internally and ones from other manufacturers
- Verification tests under severer environmental conditions

- Hybrid Forklift
  - World’s first 4-ton hybrid forklift

- Demonstrative Driving of Electric Bus
  - Demonstrative driving in the City of Manitoba in Canada, where the environmental condition is severe, following Kyoto City, Aomori City, and Fukuoka City

- Racing EV
  - Going to provide high output batteries to a team which will participate in a hill climb race to be held in the United States
7. Future Technology Development (SOFC Triple Combined System)

Aim for further improvement in power generation efficiency with a triple combined system combining SOFC with GTCC

- **SOFC (Solid Oxide Fuel Cell)** = Highly-efficient fuel cell that operates at high temperatures
- The key technology for materializing a low-carbon society
  - Aim to provide a thermal power generation system with low cost of power generation and low CO\(_2\) emissions with a triple combined system combining SOFC and GTCC

**Status of SOFC Development**

- **FY2009**: Established world-leading technology by achieving power generation capacity of 229 kW and 52% power generation efficiency with a hybrid system combining two cycles: SOFC and micro gas turbine (MGT)
- **FY2012**: Will begin developing a triple combined system integrating three cycles: SOFC, GT, and ST

**Diagram**: System Flow of the triple combined system.

**Power generation efficiency**: Over 70% (LHV standard; transmitting end)
8. Marine Machinery and Engine Business (1/2)

IMO Emission Regulation

Rise in fuel prices associated with CO2 and sulfur content regulation

Promote MEET as a solution for environmental regulations and better fuel efficiency.

MERS: Mitsubishi Energy Recovery System

An energy-saving system that recovers from the exhaust gas of marine engines to optimize heat efficiency

MHI 90%

MET Hybrid Turbocharger

A compact hybrid turbocharger combining the functions of generator and motor, utilizing extra exhaust gas from marine engine

Top global market share for multi-functional turbochargers

Global market share for MET turbochargers

Global market share for MERS

The 1st unit delivered in FY2011

IMO: International Marine Organization
MEET: Mitsubishi Marine Energy & Environment Technical Solution-System

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Increase market share by expanding alliances in the growing markets, China and South Korea.

Licensees in China
- 2st engines (QMD)
- 2st engines (YMD)
- 2st engines (YP)
- Auxiliary boilers (Jiujiang Haitian)

Licensees in South Korea
- Turbochargers (Hyundai Heavy Industries, Doosan Engine, STX Metal)
- 2st engines (Hyundai Heavy Industries)
- Vessel steering gear (Yoowon Industries)
- Marine turbines (Hyundai Heavy Industries)
- Marine pumps (Hyundai Heavy Industries)
- Deck cranes
  - Deck machinery
  - Vessel steering gear (Jiangsu Masada)

QMD: Qingdao Qiyao Wartsila MHI Linshan Marine Diesel
YMD: Yichang Marine Diesel Engine
YP: Zhejiang Yungpu Heavy Machinery
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