May 27, 2008

MITSUBISHI HEAVY INDUSTRIES, LTD.

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General Manager,
Power Systems Headquarters
Global Primary Energy Consumption Forecasts by Region
Growing Energy Demand in Asia, Centering on China and India

Global CO₂ emission forecasts

- **Global emissions without actions to control CO₂**
  - Global: 2005 - 10.3 billion tons, 2030 - 16.5 billion tons (Up 60%)
  - Asia: 2005 - 3.2 billion tons, 2030 - 6.5 billion tons (Up 100%)

Source: IEEJ 2007 data

- **Global emissions in 2004**
  - CO₂ emissions: 24.6 billion tons
  - CO₂ concentration: 377 ppm

Source: data prepared by quoting IPCC forecasts

- **Global CO₂ emission forecast**
  - 2005: 10.3 billion tons
  - 2030: 16.5 billion tons (Up 60%)

- **Advanced countries**
  - 33 billion tons
  - Stabilized at 550 ppm

- **Developing countries**
  - 74 billion tons
  - Stabilized at 480 ppm

- **Eastern Europe** + former Soviet Union
  - 117 billion tons
  - Emissions in 2005 to become 50% of the current level

- **CO₂ emissions (100 million ton)**
  - 0, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1,000, 1,100, 1,200

- **Global CO₂ emissions**
  - 0, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1,000, 1,100, 1,200

- **Years**
  - 1959, 1975, 2000, 2025, 2050, 2075, 2100

- **Decrease**
  - 2005 - 2030

- **Average annual growth rate**
  - 1980-2005: 1.9%
  - 2005-2030: 1.9%
  - 2045-2050: 1.0%
  - 2050-2060: 1.0%
  - 2060-2070: 1.0%
  - 2070-2080: 1.0%
  - 2080-2090: 1.0%
  - 2090-2100: 1.0%

- **Regions**
  - North America
  - Oceania
  - Africa
  - Central/South America
  - Middle East
  - OECD members in Europe
  - Non-OECD members in Europe
  - Asia

- **Emissions in 2005**
  - 2004 data
  - CO₂ emissions: 24.6 billion tons
  - CO₂ concentration: 377 ppm

Source: IEEJ 2007 data

• Demand for GT and GTCC predicted to grow steadily at a rate of around 50GW/year.
• Demand for conventional thermal power generation facilities will decline because of the CO₂ emissions issue. Nuclear power generation facilities will replace them over the long term.
• In renewable energy, demands for wind turbines and photovoltaic power generation facilities are expected to expand rapidly.
Activities for Efficient Energy Use and CO₂ Reduction

- Promotion of energy-saving actions
  - Reduction in fossil fuel use
- Clean coal technology
  - Coal use as an oil substitute
- CO₂ capture and storage
- Greater use of nuclear power and renewable energy
- Greater use of carbon-free electricity

Annual CO₂ emissions worldwide

Forecasts (without further actions to control emissions)

Present 2020 2030 2040 2050

Annual CO₂ emissions worldwide for “halving CO₂ emissions in 2050”
# MHI Portfolio for Power Generation

## Technology Overview

<table>
<thead>
<tr>
<th>Coal-fired thermal power</th>
<th>Nuclear Energy</th>
<th>GTCC</th>
<th>Wind turbines</th>
<th>Photovoltaic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focused on existing technologies</td>
<td>Low CO₂ emissions</td>
<td>Relatively small environmental load</td>
<td>Low CO₂ emissions</td>
<td>Low CO₂ emissions</td>
</tr>
<tr>
<td>Stability in fuel supply</td>
<td>Relatively short construction period</td>
<td>Grid restriction</td>
<td>Short construction period</td>
<td>Short construction period</td>
</tr>
<tr>
<td>High CO₂ emissions</td>
<td>Public acceptance</td>
<td>Site restrictions</td>
<td>Public acceptance</td>
<td>Public acceptance</td>
</tr>
<tr>
<td>CCS Feasibility</td>
<td>Long construction period and rise in material cost</td>
<td>Need for subsidies</td>
<td>Long construction period and rise in material cost</td>
<td>Long construction period and rise in material cost</td>
</tr>
<tr>
<td>Business assessment</td>
<td>Secure of inexpensive fuels</td>
<td>Emergence of new technologies</td>
<td>Need for subsidies</td>
<td>Need for subsidies</td>
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<tr>
<td>Technology transfer to China and India</td>
<td>Orders in the United States</td>
<td>Production increase, anticipating demand</td>
<td>Production increase for the U.S. market</td>
<td>Development of proprietary thin-film technologies</td>
</tr>
<tr>
<td>Verification of IGCC technology</td>
<td>Production increase for the U.S. market</td>
<td>Cooperation with Chinese and South Korean manufacturers</td>
<td>Development of offshore wind turbines</td>
<td>Mass production achievement and production increase</td>
</tr>
<tr>
<td>MHI activity</td>
<td>Development of 1700ºC class gas turbine</td>
<td>Development of offshore wind turbines</td>
<td>Development of offshore wind turbines</td>
<td>Development of offshore wind turbines</td>
</tr>
</tbody>
</table>

## External factors

Government policies for global warming, surge in fuel price, soaring construction material price, electricity demand (business conditions) and technical innovations.

The degree of contribution by each power generation method in fulfilling electricity demand remain unclear.

## MHI’s strengths

- Business operations based on proprietary technologies and management dedicated to operation of products to satisfy electricity demand
- Company-wide responses to changes in external factors (resource optimization)
### Greatly expanding business scale leveraging growing global efforts against global warming

Expanding the scale and revenue of the business by accelerating the change from conventional thermal power to natural energy (Accelerating the development of major products, bolstering production capacity)

#### Breakdown of production (sales)

<table>
<thead>
<tr>
<th>Year</th>
<th>Others</th>
<th>Conventional</th>
<th>Natural energies</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>[95]</td>
<td>[350]</td>
<td>[160]</td>
</tr>
</tbody>
</table>

Numbers in brackets are indexes (100 for 2007)

<table>
<thead>
<tr>
<th>2007</th>
<th>2010</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishing a 30-unit/year production system</td>
<td>Building a 36-50 unit/year production system</td>
<td>The base load as a key business; responding to coal gasification</td>
</tr>
<tr>
<td>Developing an ultrahigh-temperature (1700°C) gas turbine</td>
<td>Bolstering the after-sales services system</td>
<td>Secure short-term revenue by responding to the rapid expansion of the market.</td>
</tr>
<tr>
<td>Establishing a 1,600MW production capacity</td>
<td>Establishing a 2,600MW production capacity</td>
<td>Increase market share through technologies and alliances. Expand after-sales service.</td>
</tr>
<tr>
<td>Developing offshore wind turbines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Establishing a 130MW production capacity</td>
<td>Considering a structure for additional production</td>
<td></td>
</tr>
<tr>
<td>Domestic demonstration equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Developing facilities to produce commercial equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Realizing overseas commercial plants</td>
<td></td>
<td></td>
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</tbody>
</table>

**IGCC**: Integrated Coal Gasification Combined Cycle
Global GTCC Operations: Activities Since 2007

- Viridian M701F begins operation in Ireland in 2007
- Order received from NUON in the Netherlands for 3 M701F GTCC systems
- Order received from IUD in Hungary for M701D BFG-burning GTCC
- Order received from WDEPC in Egypt for four M701F units
- M701F begins operation at RPC Ratchaburi in Thailand in 2008
- M701F begins operation at Kawasaki Thermal Power Plant of Tokyo Electric Power in 2007
- M501G begins operation at PGE in the United States in 2007
- Order received from Georgia Power in the United States for six M501G GT units
- Order received from IUD in Hungary for M701D BFG-burning GTCC
- Order received from PLN in Indonesia for three M701F units
- Order received from Alinta in Australia for one M701DA GT unit
- M251 begins operation at Lianyuan Iron & Steel in China in 2007
- M501F begins operation at Anshan Iron & Steel in China in 2007
- M501G begins operation at Datang plant of Taiwan Power in 2007
- M501G begins operation at ARAMCO in Saudi Arabia in 2007
- M501F begins operation at Qianwan Power Plant in China in 2007
- Order received from Korea Western Power KDHC for two M501G units and two M501F units
- M701F begins operation at POSCO in South Korea in 2007
- Order received from TGK-4 in Russia for one M701F GT unit
- Order received from NWPC in Egypt for four M701F units
- M701F begins operation at Genesis in New Zealand in 2007
- Order received from Taiyuan Iron & Steel in China for two M251 units
- M701G2 begins operation in line 1 of Kawasaki Thermal Power Plant of Tokyo Electric Power in 2007
- M501G begins operation at San Isidro II in Chile in 2008

- Achieving the target share of 20%

- Series of orders received from advanced countries in North America, Europe and others for 1500°C-class G units
- Expansion of blast furnace gas-fired GTCC from China to Europe
- Launch of marketing activities in licensed markets
- Launch of business activities in Russia and other new markets
- Expansion of the maintenance business following successive operational launch of delivered units

Average share for the past three years
- MHI, 8%
- Siemens, 29%
- Alstom, 11%
- GE, 46%
- Others, 6%
Long-Term Plan for Increasing the Efficiency of Thermal Power Generation

Aiming to increase the efficiency of thermal power generation

(i) Ultrahigh-Temperature Gas Turbine (1700 ºC)

(ii) IGCC (Coal Gasification)

(iii) GTCC + SOFC (Hybrid Cycle)

(iv) Advanced Cycles
   - Carbon Capture
   - Nuclear Gas Turbine (PBMR)

IGCC: Integrated Gasification Combined Cycle
SOFC: Solid Oxide Fuel Cell

USC: Ultra Super critical pressure Coal-fired plant
PBMR: Pebble Bed Modular Reactor
Development of 1700°C-class Gas Turbine (National Project)

- Completion of component development (2004 to 2008)
- Application of component technology (2008 to 2011)
- Target of efficiency: 62% LHV or higher

**Schedule for 1700°C GT development**

<table>
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<tr>
<th>2005</th>
<th>2010</th>
<th>2015 -</th>
</tr>
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- Application starts with existing low-risk 1500°C units (in 2007)

When 1700°C GTCC power generation ratio is raised to 30%, annual CO₂ emissions by Japan fall approximately 3%
Clean Coal Technology

<IGCC>

Demonstration plant at Nakoso in Japan

Features of MHI IGCC
(1) Air-blown gasification
(2) Dry coal feed
(3) Water wall structure
(4) Low-calorie gas firing GT

Approx. 11% reduction in CO₂ emission, compared with BTG.

Construction Launch: Aug. 2004
Demonstration Run: Sep. 2007～
IGCC with CO₂ Capture

➢ Coal gas is separated into CO₂ and H₂.
➢ Separated CO₂ is captured and stored underground.
➢ H₂-based gas after CO₂ capture is burned with a gas turbine for generating electricity.

System integration including CO₂ capture is performed by the entire Mitsubishi Group, and verification is conducted at feasible locations in Japan and abroad.
Clean Coal Technology

**<BFG*-firing GTCC>**

- Ironworks
- Blast oven
- Coal
- Coke oven

Approx. 22% reduction in CO2 emission, compared with BTG.

Full view of 300MW plant

- Number of delivered units
- Total plant output (MW)


Output

Units
Wind Turbine Business

Market growth will continue in North America in the immediate future. MHI will expand operations in markets centering on North America.

Wind turbine market forecasts

Supply record in USA

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Wind Turbine Business

The 2.4 MW model has been in great demand. MHI has been expanding production capacity.

Outline of 2.4MW model

<table>
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<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
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<tr>
<td>Rated output</td>
<td>2.4MW</td>
</tr>
<tr>
<td>Rotor diameter</td>
<td>92m/95m</td>
</tr>
<tr>
<td>Hub height</td>
<td>70m/80m</td>
</tr>
<tr>
<td>Pitch control</td>
<td>Individual pitch control</td>
</tr>
<tr>
<td>Yaw control</td>
<td>Active control</td>
</tr>
<tr>
<td>Sales performance</td>
<td>Orders received for more than 1,000 units</td>
</tr>
</tbody>
</table>
Development of Offshore Wind Turbines

- Installation of offshore wind turbines is expected to grow to take advantage of favorable wind conditions. Fundamental technologies are being developed in Japan and other countries.
- MHI is the world’s only manufacturer involved in both the wind turbine and shipbuilding (marine structure) businesses. MHI will leverage its overall technological capabilities to deliver world-class offshore wind turbines.

Offshore wind turbines in Europe (mounted on towers stood from the ocean floor: other companies)

Example of offshore wind turbines mounted on a floating platform (Tokyo University)

Coastal area [Mounted on a floating platform]
Thin-film solar cells have gathered a lot of attention recently as a competitively-priced technology.

The market is expanding at an annual rate of 30-40%. Crystalline PV have been dominant, but thin-film PV have gathered a lot of attention with their competitive prices and significant potential for further efficiency improvement in the future.

Focusing on thin-film PV ahead of competitors, MHI has begun to introduce new microcrystalline tandem PV to the market.

Outline of microcrystalline tandem solar cells

- Large size (1.4m x 1.1m)
- High conversion efficiency (up 30% from prior MHI cells)
- Silicon use reduced to approx. 1/100 compared with crystalline cells
Demand is expanding in the European and other markets.

PV supply record in Europe (through 2007)

<Total supply to Europe> 39,655kW

<Germany> 29,629kW
Major large-scale PV plants
- Waltenhofen
  400kW
  (2004)

<France> 80kW

<Italy> 440kW

<Greece> 80kW

<Spain> 9,426kW
Major large-scale PV plants
- Toledo
  1,400kW
  (2007)
New PV has been in great demand, and production capacity expansion is being considered. Execute the investment needed to raise the thin-film PV share to approximately 10%.
The Power Systems Headquarters are performing important roles in energy conversion technologies. In addition to wind turbines and photovoltaic power generation, the Headquarters are focusing on new technologies in such fields as IGCC and lithium batteries.
# Roadmap for Next-Generation Technologies

<table>
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<tr>
<th>Item</th>
<th>2008</th>
<th>2010</th>
<th>2015</th>
<th>2020</th>
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<td>IGCC</td>
<td></td>
<td>Establishment of facilities for producing commercial models</td>
<td>Commercialization</td>
<td></td>
</tr>
<tr>
<td>Seawater desalination</td>
<td>FS</td>
<td></td>
<td>Operational expansion</td>
<td></td>
</tr>
<tr>
<td>Lithium batteries</td>
<td></td>
<td>Construction of pre-mass production plants and sample shipment</td>
<td>Pre-mass production</td>
<td>Commercialization</td>
</tr>
<tr>
<td>Fuel cells</td>
<td>Development</td>
<td>Manufacture of test models</td>
<td>Pre-mass production</td>
<td>Commercialization</td>
</tr>
<tr>
<td>Offshore wind turbines</td>
<td>Design</td>
<td>Manufacture and installation</td>
<td>Verification test</td>
<td>Production of commercial models</td>
</tr>
<tr>
<td>Wave power</td>
<td>Technological development</td>
<td>Test models</td>
<td>Test production of pre-mass production models and long-term verification</td>
<td>Commercialization</td>
</tr>
<tr>
<td>Solar power</td>
<td>Development</td>
<td>Verification and market cultivation</td>
<td>Long-term testing at verification facilities and market expansion</td>
<td>Commercialization</td>
</tr>
<tr>
<td>Next-generation cells</td>
<td>Development</td>
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</tr>
</tbody>
</table>
MPS: Enhancing Global business Structure with Three Bases (MPSs)
Providing Environmentally-friendly Power Generation Facilities and Technologies to China and India

- **Dongfang Group**
  - Natural gas-burning large gas turbine technologies
  - Compared with coal-burning thermal power generation facilities, CO₂ emissions are reduced by approximately 50%.

- **Ningxia Electric Power Group**
  - 1000-kw generating wind turbine technologies
  - Power generating technologies that emit no CO₂

- **Mitsubishi Heavy Industries Dongfang Gas Turbine (JV)**
  - Hot parts technology for natural gas-burning large gas turbines
  - Compared with coal-burning thermal power generation facilities, CO₂ emissions are reduced by approximately 50%.

- **Harbin Group**
  - Supercritical and ultra-supercritical thermal power generation technologies
  - Compared with conventional coal-burning thermal power generation facilities, CO₂ emissions are reduced by approximately 5%.

- **L&T-MHI Turbine Generators Private Ltd.(JV)**
  - Supercritical and ultra-supercritical steam turbine technologies
  - Compared with conventional coal-burning thermal power generation facilities, CO₂ emissions are reduced by approximately 5%.

- **L&T-MHI Boilers Private Ltd.(JV)**
  - Supercritical and ultra-supercritical boiler technologies
  - Compared with conventional coal-burning thermal power generation facilities, CO₂ emissions are reduced by approximately 5%.