Renewable Energies Business Presentation Meeting

October 17, 2006
Power Systems Headquarters
1. Position of Power Systems Segment in MHI

FY2005 Actual

- Power Systems Segment: 25%
- Consolidated net sales: 2.8 trillion yen

FY2008 (Business Plan for FY2006)

- Power Systems Segment: 29%
- Consolidated net sales: 3.0 trillion yen
2. Power Systems Headquarters – Business Policy

**Concentrate on growth areas**

... Concentrate resources on GTCC and renewable energy-related products (wind turbines, solar cells, etc.).

**Raise profitability**

... Expand sales of highly profitable products. Expand service/maintenance business.

**Change product strategy**

... Shift emphasis from generally available products to those using MHI’s unique, cutting-edge technologies (air-blown IGCC, BFG-fired GTCC, thin film amorphous silicon (a-Si) type solar cells, and high-temperature gas turbines)

GTCC ; Gas Turbine Combined Cycle,
IGCC ; Integrated coal Gasification Combined Cycle

BFG ; Blast Furnace Gas
3. Composition of Products and Their Contribution to Sales/Income

- Non-consolidated net sales
  - FY'05-FY'06 Average: 100
  - FY'07-FY'08 Average: 136 (+36)

- Other (+4)
  - Large conventional power plant, industrial use, marine machinery, etc.

- GTCC (+20)

- Renewable energies (+12)

- FY'05-FY'06 Average: 100
  - FY'07-FY'08 Average: 157 (+57)

- Ordinary income
  - FY'05-FY'06 Average: 100
  - FY'07-FY'08 Average: 157 (+57)

- Other (+9)
  - Large conventional power plant, industrial use, marine machinery, etc.

- GTCC (+27)

- Renewable energies (+21)
4. Power Systems Headquarters – Capital Investment Plans

...(In index figures) ...

Major capital investment projects ahead:

- Facilities to produce gas turbine hot parts
- Plant to produce microcrystalline tandem solar modules (additional plant enlargement being considered)
- Wind turbines production facilities
- Facilities to produce gas turbine/steam turbine main bodies

<table>
<thead>
<tr>
<th>FY’03-FY’05 Average (Actual)</th>
<th>FY’06-FY’08 Average (Target)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>220% (120%)</td>
</tr>
<tr>
<td>GTCC (130%)</td>
<td>Other (540%)</td>
</tr>
<tr>
<td>Renewable energies (190%)</td>
<td></td>
</tr>
</tbody>
</table>
5-1. Power Systems Headquarters – Products Portfolio (1/2)

MHI’s position in the market

Opportunities for MHI

Growth areas with aggressive investment

- Wind turbines
  - Respond to the market’s rapid expansion and secure short-term profit.

- GTCC Gas engines
  - Take a lead with MHI’s technological superiority. Increase market share by expanding alliances.

- Solar cells
  - Make investments as large in scale as those in the electronics industry in order to achieve growth.

- IGCC

Areas to be maintained with stable growth

- Large conventional power plant, Industrial conventional, Marine machinery
  - Mature businesses generating stable income and forming the basis of the Headquarters’ business.

- Large Conventional

Maturity phases

- Many entrants in the market
- Intensified competition to lead to selection
- Survivors to enjoy profit

Current products

Next large-scale products
5-2 . Power Systems Headquarters – Products Portfolio (2/2)

Market size and market share

(amount of investment and profitability

Size of circle corresponds to size of sales.)

Profitability

Size of circle corresponds to size of sales.)

Market size
(Trillions of yen)
6. Long-term Projection of Global Demand for Primary Energies

- Other Renewable
- Solar Thermal Heating
- Solar Power
- Wind Power
- Biomass
- Hydro Power
- Nuclear Power
- Gas
- Coal
- Oil

40% to be produced from natural energies

Reference: solarwirtschaft.de
7. Trends in Global Demand for Power Generation Systems for New Installation

**GTCC**

- **Actual** and **Projection**
- Expanding 5GW/year mainly in SE Asia and Middle East

**Wind turbines**

**Large conventional power plant**

- Increase to 30GW levels.

**Solar power**
8. Expand GTCC Business

Production of gas turbines (projection)

- Production capacity of 30 units currently being established through capital investment.
- Produce 30-plus GTs by enhancing collaboration with other companies.

<table>
<thead>
<tr>
<th>Year</th>
<th>GTs Produced</th>
<th>GTs in Stock Orders</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY’06</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>FY’07</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>FY’08</td>
<td>30</td>
<td>40~</td>
</tr>
<tr>
<td>FY’09</td>
<td>40~</td>
<td>40~</td>
</tr>
</tbody>
</table>
9. Progress in Construction of A New Plant for Production of Gas Turbine Hot Parts (Takasago Machinery Works)

- Raise production capacity of hot parts ~
- Construct a new plant

Operation to start in March 2007.
Amount of investment: Approx. ¥8bn

- Blades plant (under construction)
- Combustor Basket plant (under construction)

MHI is considering additional investments to respond to future demand in 2008 and thereafter.
10. Expand GTC Business

- Increase production of hot parts

MHI plans to achieve production increase target set for 2010 ahead of schedule in order to supply hot parts to alliance makers (in numbers besides 30 units produced).

**Turbine Blades**

- Construction of a new plant (Takasago Machinery Works)
- Utilization of OSC**, etc.
- Further capital investments (under consideration)
- To be supplied to alliance makers

![Production capacity chart](chart.png)

* Presented in index figures with production capacity in 2005 as 100.

** Orlando Service Center** (Service Plant of MPSA)

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11. Expand Service/Maintenance Business

(In index figures)

Efforts to achieve the ratio of sales from service/maintenance business to total sales of 40% [Achieve higher customer satisfaction]

1. Expand markets of MHI products; make entries in a wider range of markets of peers’ products. Establish a global network to respond to rapidly increasing LTSAs and service/maintenance business that is facing increasing sophistication and intensifying competition.
   (1) Expand services operations overseas (A service company for BFG-fired GT in China, etc.)
   (2) Collaborate with overseas manufacturers.
   (3) Provide rehabilitation service of peer-made boilers and turbines.

2. Make entry into O&M market
12. Expand BFG-fired Gas Turbines Business

- MHI is receiving a growing number of orders by leveraging its unique technology.

MHI maintains almost dominant market share in BFG-fired GTCCs. Going forward, MHI will leverage its unique technological superiority to win more orders from Chinese and other markets.

Order trends for BFG-fired GT

<table>
<thead>
<tr>
<th>Period</th>
<th>Number of units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivered '82-'06</td>
<td>13</td>
</tr>
<tr>
<td>Under production '06-'08</td>
<td>11</td>
</tr>
<tr>
<td>Orders (projection) '07-'09</td>
<td>7</td>
</tr>
</tbody>
</table>

World’s largest BFG-fired GTCC (using M701F)
Kimitsu Cooperative Thermal Power Company, Inc. (Operation started in 2004)

Orders received from:
- Japan: 8 units
- China: 12 units
- Eastern Europe, etc.: 4 units
- India and Europe: Sales activity under way
13. Trends in Global Wind Turbines Market

- Global market is expected to continue expansion (11GW in 2005, 25GW in 2010, and 40GW in 2015).
- Currently, Europe accounts for approx 73% of the global market. North American and Asian (China and India) markets are expected to expand sharply.
14. Market Share of Mitsubishi Wind Turbines

- In 2002, MHI launched MWT-1000A on the market. In 2005, MHI accounted for 2.0% (233MW/ranked 10th) in terms of global market share (7% and 3rd in the U.S., 57% and top market share in Japan).

![Pie chart showing top 10 suppliers in 2005](source: BTM Consult ApS - March 2006)
## Growth of North American Wind Turbines Market

### Annual increase in MW

**– Basic scenario (2006〜2010)**

- **Canada**: 4,150, 4,590, 4,670, 4,920, 5,140
- **U.S.**: 3,400, 3,600, 3,600, 3,800, 4,000

### Annual increase in MW

**– Low growth scenario (2006〜2010)**

- **Canada**: 3,800, 4,000, 4,200, 4,400, 4,500
- **U.S.**: 3,200, 3,800, 800, 1,200, 2,000

### Annual increase in MW – High growth scenario

- **U.S.**: 3,800, 4,000, 4,200, 4,400, 4,500
- **Canada**: 4,100, 4,400, 4,400, 4,500

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16. Trends in Market Prices of Wind Turbines and Production Plans for Mitsubishi Wind Turbines

- Market prices of wind turbines started to rise in 2004. Currently, the market is the “seller’s market” to the levels unseen before.
- MHI will expand production bases for Mitsubishi wind turbines to increase production to over 1000MW in 2008.

**Trends in prices of wind turbines**

(Price per output (kW) with the figure in 2004 as 100)

- Target profit margin: 10%

**Production plans for Mitsubishi wind turbines (MW)**

- Yokohama Plant
- Nagasaki Plant

- 2004: 1208 MW
- 2005: 671 MW
- 2006: 381 MW
- 2007: 671 MW
- 2008: 1208 MW
17. Plans to Expand Wind Turbines Plants

(Production of nacelles at Nagasaki Plant)

- Dedicate the Nagasaki Plant, the main wind turbines plant, to production of 2.4MW models and increase production capacity from: 480MW to 650MW +
18. Production of Nacelles at Yokohama Plant (Honmoku Plant)

- Leverage a large space at Yokohama Plant (production facilities for steel structures and bridges at Honmoku Plant to be converted) and port facilities.
- Start production in October to produce nacelles at two plants (in Yokohama and Nagasaki).
- Start establishing a supply chain in the Kanto area following the completion of a new nacelle production plant.

- Secure production capacity at Yokohama Plant as high (650MW) as at Nagasaki Plant.
19. Production of Nacelles at Yokohama Dockyard & Machinery Works (Honmoku Plant)

Yokohama Plant (in Honmoku)
20. Expansion of Blade Production Plant (VIENTEK)

Capacity expansion at the Mexico plant (VIENTEK) to increase production of wind turbine blades for 2.4MW machines marketed in the core U.S. market.
(Capacity expansion at the Nagasaki Plant to increase production of wind turbine blades for the Japanese market.)

Blade production capacity: up from current 400MW to 1200MW+. 

VIENTEK plant: blade shipment
Blade production line
21-1. History of Developing Mitsubishi Wind Turbines

- **Mitsubishi Nagasaki Test Machine**: 40 kW
- **Kyushu Electric Power Okino-erabu Island**: 300 kW
- **Squirrel cage induction motor**
- **Tohoku Electric Power Tappi WP**: 275 kW, 300 kW
- **Wound induction motor**
- **Winkra-Energy, Germany**: 450 kW
- **Synchronous motor**
- **NEDO Tappi WP**: 500 kW
- **Mitsubishi Hokusandocho**: 600 kW
- **Muroran-city, 1000 kW**
- **Tohoku Electric Power Tappi WP**: 300 kW
- **Okinawa New Energy Development Gushikawa**: 1950 kW
- **Hotel New Awaji 2000 kW**
- **Wound induction motor**
- **Foot Creek, USA**: 600 kW
- **2006 Yokohama city (Demo model)**: 2400 kW

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21-2. Delivery of Mitsubishi Wind Turbines

Delivered: 2,077 units / Total output: 1,295MW

First model

As of End/FY2005
(Operation started as of March 2006)
22. Mitsubishi Wind Turbines - Outline

**MWT62/1.0**

- **Operation**
  - Rated Output: 1000 kW
  -Rotor Diameter: 61.4 meters
  - Hub Height: 69/60 meters

- **Market launch in 2003**

**MWT92/2.4, MWT95/2.4**

- **Operation**
  - Rated Output: 2400 kW
  - Rotor Diameter: 92/95 meters
  - Hub Height: 70/80 meters

- **Market launch in 2008**

- **Power Regulation**: Full Span Pitch Control

- **Wind Class**: IEC Class IIA
23. Yokohama 2.4 MW Demo Model

Performing a thorough examination of performance and reliability by using a demo model of large-sized wind turbine at the Yokohama Plant (in Kanazawa)

Rated Output: 2.4MW
Rotor Diameter: 92m
IEC Class IIA

Test: lightning damage to wind turbine blade (demo model; Apr 2, 2006). 63 coulomb measured. No problem detected.

Assembly of nacelle (Nagasaki plant)
24. Mitsubishi Wind Turbines in the U.S.

**Total 1,850MW 2,475 units** (sales as of May 2006)

**Oregon Area**
- Condon: 600kW x 83 units
- Combine Hills: 1000kW x 41 units
  - Total 90.8MW 124 units

**Tehachapi California Area**
- Toyowest: 250kW x 20 units
- Mojave ‘89: 275kW x 340 units
- Mojave ‘90: 275kW x 300 units
- Mojave ‘99: 275kW x 30 units
- Morwind: 300kW x 29 units
- Mogul: 500kW x 8 units
- OASIS: 1000kW x 60 units
  - Total 280MW 787 units

**Palm Springs California Area**
- Mountain View: 600kW x 74 units
- Mountain View: 600kW x 37 units
  - Total 66.6MW 111 units

**Wyoming Area**
- Foot Creek: 600kW x 69 units
- Foot Creek: 600kW x 3 units
- Foot Creek: 600kW x 28 units
- Rock River: 1000kW x 50 units
  - Total 110MW 150 units

**Tahoe Area**
- Toyowest: 250kW x 20 units
- Mojavé: 275kW x 340 units
- Mojavé: 275kW x 300 units
- Mojavé: 275kW x 30 units
- Morwind: 300kW x 29 units
- Mogul: 500kW x 8 units
- OASIS: 1000kW x 60 units
  - Total 280MW 787 units

**MPS Los Angeles Office**
- (Wind Business Group)

**Undisclosed**
- Project A: 1000kW x 38 units
- Project B: 1000kW x 90 units
- Project C: 1000kW x 45 units
- Project D: 1000kW x 135 units
- Project E: 1000kW x 160 units
- Project F: 1000kW x 250 units
- Project G: 1000kW x 80 units
  - Total 798MW 798 units

**Iowa Area**
- Iowa: 1000kW x 50 units
  - Total 50MW 50 units

**Texas/New Mexico/Arizona Area**
- White Deer: 1000kW x 80 units
- Brazos: 1000kW x 160 units
- Caprock: 1000kW x 80 units
- San Juan Mesa: 1000kW x 120 units
- Steel Park: 1000kW x 15 units
  - Total 455MW 455 units

**Red color: MWT62/1.0**
25. Mitsubishi Wind Turbines in the U.S.

MWT-250 x 300 unit 1990
Dia. 28m x T.Height 30m

MWT-57 60 Units Operations in Dec. ‘04

MWT-62 160 Units Operated began Dec. ‘03
26. Development of Offshore Wind Turbines

• Installation of offshore wind turbines is expected to grow to take advantage of favorable wind conditions. Fundamental technologies are under development in Japan and abroad.
• MHI is the only group in the world that engages in both the wind turbine and shipbuilding (marine structure) businesses. MHI will leverage its overall technological capabilities to deliver world-class offshore wind turbines.

Source
http://www.middelgrunden.dk

Example of offshore wind turbines mounted on a floating platform (Tokyo University)
27. Solar Cells - Business Environment

As of 2005, MHI ranked 20th in the global solar cell market. MHI will increase production to join the world’s top 5 companies by 2010 as a leading thin-film solar cell maker.
28. MHI’s Production Capacity and Sales Outlook

Volumes of purchase by existing MHI customers are expected to increase sharply. These customers have requested MHI to increase supply volumes rapidly and significantly.
29. Trends in Production and Cost

Module cost is expected to decrease sharply as production increases.
## 30. Comparison of Solar Cells

<table>
<thead>
<tr>
<th>Cross Section</th>
<th>Crystalline</th>
<th>Amorphous</th>
<th>Tandem</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image1" alt="Crystalline Diagram" /></td>
<td><img src="image2" alt="Amorphous Diagram" /></td>
<td><img src="image3" alt="Tandem Diagram" /></td>
</tr>
<tr>
<td>Cost ratio</td>
<td>100%</td>
<td>90%</td>
<td>80%</td>
</tr>
<tr>
<td>Cell efficiency</td>
<td>14~17%</td>
<td>7~8%</td>
<td>11~12%</td>
</tr>
<tr>
<td>Annual Power Generation (Thermal Coefficient)</td>
<td>100%</td>
<td>110%</td>
<td>105%</td>
</tr>
<tr>
<td>Volume of silicon &amp; Cost</td>
<td><img src="image4" alt="Graph" /></td>
<td><img src="image5" alt="Graph" /></td>
<td><img src="image6" alt="Graph" /></td>
</tr>
<tr>
<td>EPT= Energy Annual Power Generation</td>
<td><img src="image7" alt="Graph" /></td>
<td><img src="image8" alt="Graph" /></td>
<td><img src="image9" alt="Graph" /></td>
</tr>
</tbody>
</table>
31. Road Map on Solar Cells for NEDO

Microcrystalline tandem solar cells to replace crystalline solar cells

Lowering system prices is key to diffusion of solar cells. Accordingly, mass production of solar cells using thin-film silicon technology or composites is attracting attention as a substitute for crystalline solar cells. In particular, MHI’s proprietary technologies (for production of high-speed, large-area films) are highly valued by NEDO and peers.

< Development timetable for highly-productive thin film silicon solar cells >
32. Rendering of the New Plant

A new plant for production of microcrystalline tandem solar modules with annual production of approx. 40MW to be constructed adjacent to the amorphous solar cell production plant (capex: approx. ¥10bn).

New products to be launched in April 2007.

Rendering of the new plant for production of microcrystalline tandem solar modules (steel framed, two-story building with dimension of 150m(W)x50m(D)x15m(H))
33. Production Facility for Microcrystalline Tandem Solar Cells

The plasma CVD production line, the central part of a microcrystalline tandem solar cell production facility, has an efficient and compact structure based on MHI’s expertise in amorphous solar cells.
34. Technologies Differentiating MHI from Peers in Production of Thin-film Si Solar Cells

- **Size of substrate**
  - MHI: 1.1m × 1.4m
  - Company B: 0.56m × 0.93m
  - Company A: 0.46m × 0.91m

- **Film production speed**
  - MHI: [2.0 nm/s]
  - Company B: [2.0 nm/s]
  - Company A: [1.0 nm/s]

- **Efficiency**
  - MHI: 10%
  - Company B: 8%
  - Company A: 5%

- **Operating rate**
  - MHI: 90%
  - Company B: 6%
  - Company A: 15%

**Productivity (cost)**
- MHI: 100%
- Company A: 16%
- Company B: 6%

Based on same production yield per film production chamber

- Large area, high speed, high quality
- Plasma CVD

- Self cleaning

---

- **Peers:** Placing too much focus on efficiency improvement (system development entrusted to equipment makers)
- **MHI:** As an equipment maker, MHI works to improve the full scope of technologies for cost reduction. (MHI's proprietary technology)

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35. Large Scale Solar Power Generation System

<Facilities outline>
- Name of plant: Buttenwiesen PV Plant, Germany
- Output: 1,000kWp
- Number of panels: 10,000 (amorphous solar modules made by MHI)
36. Characteristics of MACH-30G

- Achieved world’s highest level electric efficiency and low NOx levels.
- High reliability (developed based on the KU30 series (over 400 units were ordered))
- Seamless customer support package (from planning maintenance and after service)

MACH-30G  Main specifications /50Hz (in brackets 60Hz)

<table>
<thead>
<tr>
<th></th>
<th>8MACH-30G</th>
<th>12MACH-30G</th>
<th>14MACH-30G</th>
<th>16MACH-30G</th>
<th>18MACH-30G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cylinders</td>
<td>8</td>
<td>12</td>
<td>14</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>Cylinder bore × piston stroke mm</td>
<td>300×380</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of revolutions</td>
<td>min⁻¹</td>
<td>750(720 )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated output (at power generation end)</td>
<td>kW</td>
<td>2,550 (2,450)</td>
<td>3,800 (3,650)</td>
<td>4,450 (4,250 )</td>
<td>5,100 ( 4,900)</td>
</tr>
<tr>
<td>NOx</td>
<td>ppm</td>
<td>200 or less : converted to O2=0%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
37. Efficiency of MACH-30G

![Graph showing electric efficiency at generator end (%) vs. output for diesel, conventional gas engine, and MACH gas engine.](image-url)
MACH-30G - Awards and Market Share

Agency for Natural Resources and Energy (ANRE) Director-General’s Prize of Japan (2002)

MACH-30G was awarded in the 23rd Energy Saving Machinery and Equipment Awards in the field of power generation engines for its high performance including significant improvement in efficiency and reduction in NOx/CO2/PM (Particulate matter) and other pollutants.

JGA’s Technical Award (2003)

Awarded by the Japan Gas Association (JGA) for achieving high efficiency, high operating performance and high environmental performance in the area of gas fueled machinery and equipment.

Japanese market share of gas engines (3.5～7.5MW class) (FY2001 (when MACH was launched) ～FY2005)

Others: 190MW (20%)

MACH: 720MW (80%)
39. MACH-30G - Orders Received

![Graph showing orders received for MACH-30G units from 2001 to 2006.](image)
40. Overview of MACH-30G (Example)

Customer: Sodegaura Power Station, Nippon Steel Corporation  18MACH-30G × 10Units
41. IGCC (Integrated Coal Gasification Combined Cycle)

Air Blown IGCC is the Best System for Power Generation

1. Features

1. More than 10% lower CO₂ Emission Intensity than latest USC conventional coal fired plant by Higher Plant Efficiency with Air-blown IGCC.
2. Fuel Flexibility for high moisture Low Rank Coal like PRB Coal.
3. Higher Reliability with Waterwall Structure based on mature boiler experiences.
4. Much Experiences in Low calorific gas firing G/T.

2. 250MW-class Demonstration Plant

IGCC: Integrated coal Gasification Combined Cycle
Power River Basin (PRB) coal: a low rank coal with higher moisture content and lower heating value, but available at low cost because of its plentiful reserves.
3. IGCC projects in the U.S.

EPACT (Energy Policy Act; signed in Aug 2005) set measures including subsidies, tax incentives for investments, etc.
→ Triggering IGCC projects across the U.S.

4. Commercial Plant Performance

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>250MW Demo. Plant</th>
<th>Commercial Plant (60Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Output</td>
<td>MW</td>
<td>250</td>
<td>500</td>
</tr>
<tr>
<td>Design Coal</td>
<td>Bituminous Coal</td>
<td>Bituminous Coal</td>
<td></td>
</tr>
<tr>
<td>Gasifier</td>
<td>Air-blown Dry coal feed</td>
<td>Air-blown Dry coal feed</td>
<td></td>
</tr>
<tr>
<td>Gas Clean-up</td>
<td>Wet Clean-up</td>
<td>Wet Clean-up</td>
<td></td>
</tr>
<tr>
<td>Gas Turbine</td>
<td>M701DA</td>
<td>M501G</td>
<td></td>
</tr>
<tr>
<td>Net Plant Efficiency</td>
<td>%,HHV</td>
<td>40.5</td>
<td>46</td>
</tr>
<tr>
<td>Emission SOx</td>
<td>ppm</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>(16%O2) NOx</td>
<td>ppm</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>PM</td>
<td>mg/Nm³</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

Mitsubishi IGCC ready for Commercial plants in Japan and the U.S.
43. MHI’s Efforts to Develop Fuel Cells

**SOFC** (solid oxide fuel cells)

- **Tubular type SOFC**
  - Jointly developed with J-Power

- **MOLB-type SOFC**
  - Jointly developed with Chubu Electric Power
  - MOLB (MO-no-Block Layer Built)

**NEDO technology development project**
(2004 - 2007)

- Development of “Combined System” with levels of 200kW
- Mid-sized dispersed type power sources;
  Replacement for large-sized thermal power generation

**Cogeneration system**
- for Japan Pavilion
- for Electric Power Pavilion

**Project of experimental study in Aichi World Expo 2005**
(March - September)

**PEFC** (polymer-electrolyte fuel cell)

- **PEFC for mobile applications**
- **PEFC for “Urashima”, deep sea cruising**
  - AUV developed by JAMSTEC

As an autonomous underwater vehicle (AUV), Urashima recorded the world’s longest continuous cruising of 317km in February 2005.
44. SOFC Combined-Cycle Power Generation System

Efficiency and Road Map

- **SOFC Combined-Cycle**
- **LNG SOFC C/C**
- **LNG C/C**
- **C/C (1700 MW class)**
- **IGFC**
- **USC (coal)**
- **IGCC**
- **Combined-Cycle**

**Efficiency at power generation end**

- **USC (coal)**: Efficiency 45%-LHV
- **IGCC**: Efficiency 50%-LHV (Efficiency with output of 350kW class: 55%-LHV)
- **LNG C/C**: Efficiency 55%-LHV
- **C/C (1700 MW class)**: Efficiency 60%-LHV
- **IGFC**: Efficiency 70%-LHV

**Year**

- 1990
- 1995
- 2000
- 2005
- 2010
- 2015
- 2020

**IGFC**: Integrated Gasification SOFC Combined Cycle

**IGCC**: Integrated Gasification Combined Cycle

**USC**: Ultra Super critical pressure Coal-fired plant

Power Generation plant for Utility (output several 100 MW)
## 45. Road Map for Lithium Rechargeable Batteries

### Phases of development
- Raise performance of batteries
- Reduce cost
- Develop mass production technology

### Stationary batteries
- Stationary battery cells
- Stationary module batteries
- Power storage system
- Unit w/100kWh

### Electricity storage business; R&D on use of natural energies

### Graph
- Power density (W/kg)
- Energy density (Wh/kg)
- For HEV
- For PEV
- MHI stationary batteries (Developed in 1998)
- MHI stationary batteries (Developed in 2005)
- MHI batteries for mobile applications (Developed in 2001)
- Data of batteries developed by peers

### Timeline
- 2006
- 2007
- 2008
- 2009

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46. Estimation of Fuel Cell Prices

- Test production facilities (current facilities)
  - Production capacity: For approx. 60 EVs/year

- Pre-mass-production facilities
  - Production capacity: For approx. 2,000 EVs/year
  - Reduce production cost; reduce materials cost

- Initial-phase mass production facilities
  - Production capacity: For approx. 8,000 EVs/year

- Full-scale mass production facilities
  - Production capacity: For 16,000 EVs/year
  - Reduce materials cost
47. Future of Power Generation

- GT C7 C
- Future of Power Generation
- System (CC)
- Battery