1. Environmental Awareness in Energy & Environment Business

2. MHI’s Energy & Environment Strategies

3. Product Strategies
Green energy revolution is becoming the global mainstream.

All nations and regions place “social investment into energy and the environment” at the core of their economic-stimulus measures.

Forming a low-carbon social infrastructure is a challenge shared globally.

- 20% renewable energy by 2020
- Invest €105 billion into green economy
- Allocate €48 billion to environmental measures
- Invest more than €100 billion into offshore wind power generation; create 160,000 jobs
- Promote & 50 billion in investments into low-carbon sectors
- Planned investments totaling 4 trillion yuan (JPY 57 trillion)
- Environment market scale: JPY 120 trillion
- Create 2.8 million new jobs
- 40-fold expansion in photovoltaic power generation by 2030
- Introduce FIT (Feed-in Tariff) relating to photovoltaic power generation
- Obama’s “Green New Deal” policy
  - Invest US$150 billion into clean energy; create 5 million new jobs
  - Produce/launch 1 million PHEVs (Plug-in Hybrid Electric Vehicles)
  - Achieve 25% renewable energy rate
MHI possesses products and technologies that can respond to all of these demands. Applying its strengths in integration, it is adding speed to business expansion.
2. **MHI’s Energy & Environment Business Strategy**

**Apply integration strengths to achieve business expansion**

1. While putting strengths of existing businesses to good use, creation of next-generation businesses

   - GTCC, wind turbines, nuclear power, fertilizer plants, methanol plants, etc.
   - IGCC, CCS, solar (photovoltaic/heat), offshore wind turbines, EV related business, eco-houses, etc.

2. Expand business opportunities through comprehensive proposals of energy/environment-related products (policies)

   - Electricity provides in Iceland, Ukraine, Australia, United Kingdom, and others

3. Acceleration of global expansion (base network expansion, alliances)
2. MHI’s Energy & Environment Business Strategy

Application of Comprehensive Capabilities through Integration of Product Operations

**Power Systems**  
(power generation technology)

**Machinery & Steel Structures**  
(Chemical plants, CO₂ recovery technology, transportation system, etc.)

**Nuclear Power**  
(Nuclear power generation technology)

**Air-conditioning & Refrigeration**  
(Chillers, air-conditioners)

**Shipbuilding**  
(shipbuilding, marine technology)

**General Machinery & Special Vehicles**  
(Engines, turbochargers, forklift trucks)

Business Expansion through Integration

Sustainability Energy & Environment Strategic Planning Department

- IGCC+CCS
- Alternative fuel chains
- Lithium-ion batteries
- Eco-friendly houses
- Offshore wind turbines
- Eco-friendly town
- Nuclear power generation-use turbines
- Hat pumps
- Battery powered forklift trucks
- Eco-friendly ships
- US/EU-APWR

MHI Group

Ryoju Estate, MHI Bridge & Steel Structures Engineering, MJK, and etc.
Examples of Integration Merits

Development of new projects encompassing MHI product technologies

MHI technologies

- Nuclear power
  - Power plant facility
  - EPC capability
- IGCC+CCS
  - IGCC
  - CO₂ recovery
- Offshore wind turbines
  - Wind turbines
  - Marine
  - Large-size cranes
- Lithium-ion batteries
  - Batteries
  - Thin-film technology
  - Mass-production technology
- EV-related business
  - Batteries
  - Motors
  - Air-conditioning

Integration Effects

- Full use of capacities in equipment manufacturing capacity and in-house EPC
  - EPC: Engineering, Procurement, Construction
- Single responsibility in power generation technology and chemical process technology
  - IGCC: Integrated coal Gasification Combined Cycle
  - CCS: Carbon Dioxide Capture and Storage
- Wind turbine technology, marine technology, crane and bridge technology.
- Lithium-ion batteries, thin-film technology (paper printing), mass production technology (food machinery). One company possessing all technologies
- Technologies of energy, machinery and air-conditioning
3. Product Strategies

Enhancement of Thermal Efficiency

Completion of J-series development → Further enhancement of efficiency

① GTCC applying super high-temperature gas turbine (1,700 °C class)
② IGCC (Coal gasification)
③ GTCC + SOFC (Hybrid cycle)

IGCC: Integrated coal Gasification Combined Cycle
SOFC: Solid Oxide Fuel Cell
GTCC: Gas Turbine Combined Cycle
USC: Ultra Super Critical pressure Coal-fired plant
Global Expansion in Gas Turbine Business

- Development of J-series gas turbine completed
- Aiming for 30% market share through world’s most advanced technologies and 50-unit/yr production system

Future

Large-size gas turbine ordered [GW]

Share 30%

Temperature at turbine inlet (°C)

CC efficiency: 60%+
(World’s highest level)
3. Product Strategies

**CCS (Carbon dioxide Capture & Storage)**

**Fuel**
- High-efficiency IGCC

**CO₂ storage methods**
- **Ocean sequestration**
  - Stationary type (pipeline)
  - Mobile type

- **Geological storage**
  - In progress

**CO₂ storage methods**
- **Under consideration**
  - Depleted oil/gas field
  - Aquifers (land)
  - Aquifers (offshore)
  - EOR EGR

**CO₂ transportation** (pipeline, etc.)
- MHI’s high-pressure CO₂ compressor delivered to CCS plant in Algeria

**CO₂ Sequestration**
- Ocean sequestration & geological storage

**CO₂ storage methods**
- MHI’s CO₂ recovery plant – enables CO₂ recovery lower energy consumption

**Achieved 2,000 hrs continuous operation at Nakoso**

**In progress**
- CO₂ storage methods

3. Product Strategies

IGCC + CCS

Acquisition of EPC plant engineering management capability globally, and promotion of integrated solutions business

- Coal gasification
- CCS
- Power generation
- Heat recovery
- Power generation

Air separation  Gasification  Gas refinery  Gas turbine  HRSG  Steam turbine

All requisite elements possessed in-house

Company A

Company B

Company C
Licensing only

Company D
Licensing only

Achieved 2,000 hour continuous operation at Nakoso

Integration of multiple segments under Sustainability Energy & Environment Strategic Planning Department
Promote globalization in order to respond to the rapidly expanding global market for wind turbines

**Europe**
- Launch of design office in Germany
- WTG factory under planning, depending on future order trends
- Offshore wind turbines hitting stride: 33GW in UK, 30GW in Germany, etc.

**USA**
- Increased capacity at VienTek blade factory (1,200MW→1,600MW)
- WTG factory under planning

**MPSE (UK)**
- WTG factory under planning

**MPSE (Germany)**
- VienTek: blade production plant

**Nagasaki/Yokohama**
- Licensing to Ningsha Electric Power Group, etc.

**MPSA**
- WTG factory under planning

**3. Product Strategies**
3. Product Strategies

Development of Nuclear Power Generation Technology (1)

**US/EU-APWR**

- **Large light water reactor with the world’s largest output (1,700 MWe class)**

**US-APWR**
- Reactors chosen by Luminant in 2007 (2 units)
- US DC/COL application docketed

**EU-APWR**
- Conformance certification application to European Utilities Requirements

DC: Design certification
COL: Combine license

**Domestic newly constructing plants**

- **Domestic light water reactors**
  1. HEPCO Tomari No. 3 Reactor constructed (Latest 3rd generation reactor)
    Domestic 24th PWR
    Initial criticality in March this year expected to start operation in December
  2. JAPCO Tsuruga No. 3 and No. 4 Reactors
    (Domestic largest class APWR)
    Under safety review, expected to start operation in 2016 and 2017

**Future reactors**

- **Next generation light water reactors**
  Participate in the national project.

- **Fast breeder reactors (FBR)**
  Mitsubishi FBR Systems established (2007)
  Make Japanese technology adopted as a global standard.

**ATMEA1**

- **Globally compatible intermediate light water reactors (1,100 MWe class)**

  - A joint venture established with AREVA in 2007
  - Combine the world’s most advanced technologies of both companies.
  - Complete basic design and start sales promotion in 2009.

Source: “JAEA-Research 2006-042”, Fig. 2.1.1-4, p. 69 (2006)
Effective use of existing nuclear plants, steady pace of new installations and expansions, achievement of nuclear fuel cycle

Domestic light water reactor plants

- After-sales services for existing plants
- Tomari No. 3 Reactor and Tsuruga No. 3 and No. 4 Reactors
- Next-generation new plants

Overseas light water reactor plants

- US/EU-APWR
- ATMEAI
- Overseas after-sales services

Nuclear fuel cycle

- Reprocessing plant
- MOX fuel plant

Source: “JAEA-Research 2006-042”, Fig. 2.1.1-4, p. 69 (2006)
Development of Solar Thermal Gas Turbine

- Power generated by solar thermal gas turbine is more efficient than with photovoltaic cells.
- No water is required during power generation.

<table>
<thead>
<tr>
<th>Space requirement</th>
<th>200,000m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>About 110m</td>
</tr>
<tr>
<td>Max temp</td>
<td>850 – 900 °C</td>
</tr>
<tr>
<td>Turbine output</td>
<td>10MW</td>
</tr>
</tbody>
</table>

Target market for solar thermal power generation


Forecasts for annual demand for solar thermal power generation

Source: ESTIA and Greenpeace, Concentrating Solar Power Outlook 2009
Making comprehensive energy/environment policy proposals worldwide

Proposals formulated to match each country’s situation

- **Iceland**
  Proposal toward realization of zero-emission society

- **United Kingdom**
  Proposal for next-generation energy network

- **Ukraine**
  Energy infrastructure centered on coal-fired generation

- **Australia**
  Energy infrastructure centered on coal-fired generation
  Solar thermal project making effective use of coal
Zero Emissions in Iceland

Participating in Iceland’s zero-emissions plan with DME synthesis targeting EVs and fishing vessels

- **Renewable Energy**
  - Geotherma/hydorpower

- **Electricity**
  - Recycling of CO₂ emissions into refined DME
  - Aluminum smelting
  - H₂ production
  - Synthesized Fuel (DME)

- **Consumption**
  - Electric Vehicles
  - Fishing vessels (/SUV)

Use of recycled CO₂ fuel means CO₂ emissions from fishing vessels are not counted.

Use of DME in SUVs is also under consideration.

Fully controlled vegetable plant also to be proposed.
3. Product Strategies

Energy Infrastructure Rebuilding Scheme, Future Business Scope

Innovation in energy supply structure
- Higher efficiency from thermal power plant
- Higher efficiency from nuclear power plant
- Clean use of coal
- Coordination with existing power plant

Renewable energy expansion
- Power grid stabilization equipment
- Electric bus electricity storage by small-scale hydropower plant

Innovation in energy consumption structure
- "Eco Sky House" (Yokohama) home testing & verification
- Heat pump hot water supply & A/C
- Photovoltaic power use time differential by battery

Electricity storage technologies
- Smart power control
- Heat pump hot-water supply system
- Smart house as source of power generation

Smart grid concept
- Electric bus
- Battery station (Inner-city emergency power source)
- Industrial vehicles
- Review of urban transportation infrastructure
- EV penetration testing
- Parking

Energy Infrastructure Rebuilding Scheme, Future Business Scope

Our Technologies, Your Tomorrow
3. Product Strategies

Regional Supply and Regional Consumption Type Smart Community

Offshore wind turbine
Electricity storage
Wind turbines
Heat pumps
Smart control center
LRT
PV cells
EV, electric bus
EV related business (battery station)
Eco-house
Hydro power plant
Benefits of Smart Communities

Through use of renewable energy (wind, solar, hydro, etc.), harmonic co-existence with nature can be advanced.

Gas stations serve as stations for charging/swapping EV and electric bus batteries, resulting in reforms in business formats, including employment opportunities.

Preservation and recycling

By knowing the volume of mobile electricity storage of EVs, etc., affinity of grid and renewable energy is enhanced.

Promoting electrification of urban transport enables use as an emergency power source.

Comfort and convenience

Safety and security

3. Product Strategies
Energy conservation technologies come together to enable a major reduction in household energy consumption.

Key technology

- High thermal insulation
- Wind power generation system
- Solar ventilation (natural forced ventilation system using solar heat)
- New ventilation system
- Greening of roof/wall surfaces
- New tandem-type Photovoltaic cells
- Lithium-ion battery
- Hybrid system
- V2H EV charger port
- Heat-pump hot-water supply system
- Underfloor thermal storage system
- Organic EL illumination
- Rainwater utilization system
- New ventilation system
- Exterior wall blind + water mister
- Self-sufficiency: over 100%

Results in May 2009

Generated electricity
Electricity consumed

Energy conservation technologies come together to enable a major reduction in household energy consumption.
### Investments in Major Businesses and Expansion into New Businesses

<table>
<thead>
<tr>
<th>Item</th>
<th>Action, aim, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas turbines</td>
<td>Strengthening of production system at US factory and creation of jobs</td>
</tr>
<tr>
<td>Wind turbines (land)</td>
<td>Establishment of JV and factory in India growth market</td>
</tr>
<tr>
<td>Conventional thermal power plant</td>
<td>Promotion of new plants, achievement of 2 plants/yr structure</td>
</tr>
<tr>
<td>Nuclear power</td>
<td>Focus on fertilizer and methanol plants</td>
</tr>
<tr>
<td>Environment, chemical plants</td>
<td>Accelerated development of Chinese and emerging markets with start-up of factory in China</td>
</tr>
<tr>
<td>Forklift trucks</td>
<td>Expansion of global production capacity with start-up of factory in Thailand</td>
</tr>
<tr>
<td>Turbocharger</td>
<td>Enhancement of production capacity of Takasago Machinery Works</td>
</tr>
<tr>
<td>Centrifugal chillers</td>
<td></td>
</tr>
</tbody>
</table>

**Strengthening of existing businesses**

**Response to new businesses**

- IGCC (+CCS)
- Nuclear fuel cycle
- Lithium-ion battery
- Offshore wind turbines
- CO₂ recovery system
- Alternative fuels
- Eco-town, eco-house
- Hybrid forklift trucks

- Realization of commercial plants, strengthening of gasifier production facilities
- Reprocessing plants, MOX fuel plants, fast breeder reactors
- Launch of initiative targeting mass production
- Market expansion in Europe, etc. (max. 120GW by 2030)
- Key components for achieving 50% cut in CO₂ by 2050
- DME synthesis by coal gasification, etc.
- Application of comprehensive capabilities to propose solutions to national governments, etc.
- Lead the industry in energy saving and CO₂ reductions through world’s first commercialization
3. Product Strategies

Growth Targets of Major Businesses

The Company is pursuing business expansion through capex and other strengthening measures.

**Gas turbine**
- Acquisition of 30% market share through launch of J-series and 50-unit production system
- IGCC
  - Production System Expansion

**Nuclear power**
- Expansion of servicing, new plants and fuel cycle businesses, to achieve sales of JPY 600 billion after 10 yrs
- 2008 After 10yrs

**Wind power, solar and other renewable energy**
- Wind power: response to sharp market expansion especially in US, Europe
- Solar: consider production increase (40MW/yr) while monitoring market trends

**CO2 recovery system**
- Business opportunity expansion through technologies responding to social demand to reduce CO2

**Heat pumps**
- Market for electric A/C with hot/cold-water supply systems expanding sharply, especially in Europe. Targeting development of that market.

**EV-related business**
- Considering entering EV-related business, a key component for shedding reliance on fossil fuels and promoting switch to electricity

**Capex in energy/environment since 2006**

**EV, HEV, PHEV**

**Lithium-ion battery**

**Scale of European A/C market (JPY 100 million)**

**Scale of sales (GW)**

Capex: capital expenditure
Through merits and effects of integration, MHI is aiming for JPY 3 trillion in sales in the energy/environment field.

Integration effects

Examples of new projects by integration effects

- IGCC (+CCS) - After 2012
- Nuclear power (new construction, fuel cycle) - After 2012
- Lithium-ion battery - 2012~2015
- Offshore wind turbine - 2012~2015
- CO₂ recovery system - 2012~2015
- Alternative fuels - 2012~2015
- Eco-town, eco-house - ~2012
- Hybrid forklift trucks - 2009~
MITSUBISHI
HEAVY INDUSTRIES, LTD.

Our Technologies, Your Tomorrow