Power Systems
Business Plan

Kentaro HOSOMI
Executive Vice President,
President and CEO of Power Systems

July 12, 2019
Mitsubishi Heavy Industries, Ltd.
1. Business Overview
   1-1. Sales Overview
   1-2. Management Structure
   1-3. FY2018 Major Topics

2. 2018 Medium-Term Business Plan Progress Status
   2-1. Outlook
   2-2. Review of FY2018
   2-3. 2018 Medium-Term Business Plan Strategies and Measures
   2-4. Individual Business Strategies
       1. Clean Gas Power
       2. Steam Power
       3. Nuclear Power
       4. Compressors
       5. Aero Engines
       6. Marine Machinery
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3. Looking to The Future beyond 2020 - What is our sustainable business ?
   3-1. Global Power Market Trends
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4. Summary
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4. Summary
1-1. Sales Overview

Renewable Energy
- Offshore wind turbines*
- Power plant generation pumps
- Chemical plant pumps
- Water jet propulsion systems

Nuclear Power
- Pressurized water reactors (PWR)
- Nuclear fuel cycle facilities

Marine Machinery
- MET Turbochargers
- Marine boilers & Steam turbines

Clean Gas / Steam Power
- Gas turbine combined cycle (GTCC) systems
- Clean coal and integrated coal gasification combined cycle (IGCC) systems
- Aero-derivative gas turbines
- Geothermal power plants
- Environmental plants
- Organic Rankine Cycle (ORC) systems

Compressors
- For chemical plants
- For power plants
- For oil & gas applications

Aero Engines
- For chemical plants
- For power plants
- For oil & gas applications

FY2018 Revenue
¥1,525.1 billion

* MHI Vestas Offshore Wind (MVOW), which handles operations in offshore wind power generation facilities, is not factored into the sales figure because it is an equity-method affiliate.
1-3. FY2018 Major Topics

**JAC-Series Gas Turbines**
Orders received: Thailand: 8 units  US: 2 units

**Heavy-Duty Gas Turbines**
No.1 global market share (41%) in 100 MW and above class*

**Offshore Wind Turbines**
Order received for 100 units of V164-9.5 MW from Moray East, UK

**H-100 Gas Turbine and Compressor Modular Package**
Received technical qualification by oil majors

**Flue Gas Desulfurization (FGD) Systems**
No.1 global market share (61%)*

**MET Turbochargers for Diesel Engines**
Introduced small, lightweight, high-efficiency models into market

**Aero Engines**
Completed assembly of first domestically produced unit of new PW1200G for MRJ/SpaceJet

* According to data compiled by McCoy Power Reports
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4. Summary
2-1. Outlook

- Achieve 10% profit margin in FY2020 by fulfilling backlogged orders and optimizing resources, including reducing fixed costs and total assets

### Revenue

<table>
<thead>
<tr>
<th>Segment</th>
<th>FY2017</th>
<th>FY2018</th>
<th>FY2019</th>
<th>FY2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean Gas / Steam Power</td>
<td>1,482.4</td>
<td>1,525.1</td>
<td>1,650.0</td>
<td>1,900.0</td>
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<tr>
<td>Marine machinery</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renewable energy</td>
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<td></td>
</tr>
<tr>
<td>Nuclear power</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aero engines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Orders Received

<table>
<thead>
<tr>
<th>Year</th>
<th>FY2017</th>
<th>FY2018</th>
<th>FY2019</th>
<th>FY2020</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,437.5</td>
<td>1,426.5</td>
<td>1,600.0</td>
<td>1,800.0</td>
</tr>
</tbody>
</table>

### Profit from business activities

<table>
<thead>
<tr>
<th>Year</th>
<th>FY2017</th>
<th>FY2018</th>
<th>FY2019</th>
<th>FY2020</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>87.6</td>
<td>132.8</td>
<td>140.0</td>
<td>190.0</td>
</tr>
<tr>
<td>Profit</td>
<td>5.9%</td>
<td>8.7%</td>
<td>8.5%</td>
<td>10.0%</td>
</tr>
</tbody>
</table>
2-2. Review of FY2018

<table>
<thead>
<tr>
<th></th>
<th>FY2017</th>
<th>FY2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orders received</td>
<td>1,437.5</td>
<td>1,426.5</td>
</tr>
<tr>
<td>Revenue</td>
<td>1,482.4</td>
<td>1,525.1</td>
</tr>
</tbody>
</table>

**FY2018 Results**

- **Maintained business plan (Order, Sales, profit) by recovering from the cancellation of a coal-fired project in Japan**
  - Increases in service business, compressors, etc.
  - Profit margin improved on squeezing and efficient management of assets

- **Secured No.1 market share in medium/heavy-duty gas turbines in a competitive market**

- **MVOW's market share expanded in growing offshore wind turbine market**

- **Order backlog reduced with good progress in constructing new plants**
  - Strategies to improve profitability:
    - Further expansion of service business
    - Increase share in growing products
    - Launch new businesses and solutions business
    - Accelerate structure conversion of steam power business (factory reorganization and resources shift)

* Figures for offshore wind turbines are shown for reference purposes only. These operations are handled by MHI Vestas Offshore Wind (MVOW), an equity-method affiliate.
Measures for achieving 10% profit margin: expand service business, scale up growth products, optimize resources

Business profit
(In billion yen)

Expand service business
- Establish new bases, expand business scope (renovate and enhance functions of products to reduce environmental load, including products of other manufacturers)
- Propose solutions to improve equipment operability
- Respond to demand for higher safety and quality

Expand growth products
- Expand profit from business activities in expanding markets: compressors, aero engines, offshore wind turbines, etc.

Optimize resources
- Improve productivity through factory digitalization, etc.
- Shift resources into growth areas

FY2018: 132.8 billion yen
FY2019: 140.0 billion yen
FY2020: 190.0 billion yen

Expand service business: + 35 billion yen
Expand growth products: + 15 billion yen
Strengthen the business foundation by expanding the service business and increasing share in growth products

Service business expansion

Solutions business
- Gas / Steam Power
  - JAC Series gas turbines, low-emission solutions, additional installations of environmental systems
- Nuclear power
  - Comprehensive support for restarting domestic plants, installing severe accident management facilities
- Marine machinery
  - Provide solutions for tightening SOx regulations

Environmental solutions

Market expansion
- Aero engines
  - Expansion of MRO* business
- Compressors
  - Improvement and expansion of service network

Expand service business through business growth

Business expansion of growth products
- Clean Gas / Steam Power
  - Expand business in small/medium gas turbines (for driving compressors for LNG main engines, rapid start-up models)
  - Establish mass production ability of SOFC
- Compressors
  - Expand sales to US gas processing compressors (strengthen MCO-I)
- Aero engines
  - Expand and improve ability to manufacture parts for A320neo (PW1100G-JM)
- Marine machinery
  - Expand market share in turbochargers for four-stroke marine engines
- Offshore wind turbines
  - Strengthen mass production ability; enter US, Taiwan and Japan markets

* MRO: Maintenance Repair and Overhaul
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2-4-1. Clean Gas Power

Business Environment

- Solid market expected over medium to long term with expansion of the LNG market
- Realizing a low carbon society together with renewable energies
- Eventual shift to a carbon-free society

Expand market share in Heavy duty gas turbines

Heavy-duty gas turbines

Results: Orders increased: 6 units in FY2017 → 13 units in FY2018
  - JAC series achieved 64% efficiency (70% CO₂ reduction), 27 orders / LOI received

Strategy: Technology development to further reduce environmental load
  - Efficiency improvement, higher temperatures technology application
  - Product development responding to low-carbon society (hydrogen-powered gas turbine, etc.)

Small/medium scale gas turbines

Results: Orders increased: 2 units in FY2017 → 18 units in FY2018
  - Distributed generation systems, cogeneration (H Series)
  - Mobile trailer system: (aero-derivative MOBILE PAC®, Easy installation and startups.)

Strategy: Sales expansion with multiple applications
  - Renewable adjusted flexible operation, distributed generation, compressor driven, floating power generation facilities

Solutions services

Results: Taiwan PJ  Renovation of existing plant
  (Low NOx, efficiency and output improvement, plant optimization with MHPS-TOMONI)

Egypt PJ: Renovation of existing plant
  (Efficiency and output improvement, reliability enhancement for long term operations.)

Source: 2015-18 results : McCoy Power Reports 2018
From 2019 (adjusted to order placement basis)

Scale of Market for New Gas-fired Power Plants (GW/year)

<table>
<thead>
<tr>
<th>Year</th>
<th>Solid through medium/long term</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>16</td>
<td>50</td>
</tr>
<tr>
<td>17</td>
<td>60</td>
</tr>
<tr>
<td>18</td>
<td>70</td>
</tr>
<tr>
<td>19</td>
<td>80</td>
</tr>
<tr>
<td>20</td>
<td>90</td>
</tr>
<tr>
<td>21-25</td>
<td>100</td>
</tr>
<tr>
<td>26-30</td>
<td>110</td>
</tr>
</tbody>
</table>

Source: World Energy Outlook 2018, and MHPS data

In 1,000 MW class (Approx. 1.7 million households), reduces CO2 equivalent to 3 million vehicles
New build market for coal plants is shrinking. Global trend toward low-carbon and carbon-free societies.

Demand still remains for emerging countries with energy security needs.

Strong demand for modernizing existing plants reducing CO2 and other environmental emissions.

Increased interest in Biomass and Geothermal as renewable energies.

### Breakdown of global power generation (TWh)

- **Renewables**
- **Nuclear**
- **Gas**
- **Coal & Oil**

Existing coal-fired plants will continue to serve as key generation asset. Need to convert these into “low-carbon” plants.

### Steam Power business outlook (Revenue)

- **New installations**
- **Service**

Decrease in New installation opportunities.

Continuous high demand in Service business.

Source: IEA World Energy Outlook 2018
2-4-2. Steam Power (2/2)

- Adjusting to market trend (fixed cost reduction / reorganization shifting to services)
- Solution based business responding to low-carbon society

### Results and Strategies

**Optimize resources for post 2021**

[PMI progress at MHPS]

- Domestic: Steam turbines → consolidation to Hitachi Works
  - Boilers → Nagasaki and Kure Works unified operation
- Overseas: Reorganization adjusting to business scale
  - (Downsize in China, Europe, Australia, etc.)

**[Shifting resources]**

- Shifting to services.
- Reallocating to other MHI Group businesses
- Optimizing manpower through shift to digital factories

**Provide solutions for low-carbon market**

- Expand AQCS business (2018 No.1 global market share in FGD)
- Cutting-edge technologies (IGCC, high-efficiency USC, CCS/CCUS)
  - and environmental solutions (AQCS, FGD)
  - (Boiler rehabilitation life extension, steam turbine efficiency improvement, environmental systems additions, etc.)
- AI / IoT solutions (MHPS-TOMONI)
  - (O&M cost reduction and fuel cost reduction through operation optimization,
    longer inspection intervals, reduction in manpower through remote monitoring services,
    supporting optimized O&M resources.)

MHPS Personnel

```
Feb 2014 (MHPS launch)  Δ16%
Apr 2019                  Δ30%
After 2021
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2-4-3. Nuclear Power

- Nuclear power is evaluated globally as an important base load power source as it can contribute to reduce CO2 emissions.
- In order to assure the long-term and continuous operation of nuclear power plants, establishing the nuclear fuel cycle is strongly desired.

As a leading company in the nuclear power industry in Japan, MHI is helping solve energy issues by maintaining and developing outstanding technologies of our own that will respond to long-term needs.

1) **Light water reactor O&M Service**
   - Steady implementation to comply with new regulations
   - Supporting the early completion of severe accident management facilities
   - Expanding maintenance work to enable safe and stable operation for 60 years

2) **Nuclear fuel cycle**
   - Supporting on schedule completion of reprocessing facilities and MOX fuel plants
   - Proposing maintenance work to enable safe operation after completion (collaboration with Orano)

3) **New-build and future reactors**
   - Developing new reactors with enhanced safety for upcoming new-build projects
   - Developing future reactors such as fast reactor, small-modular reactor, high temperature gas cooled reactor

4) ** Decommissioning initiatives**
   - Supporting the decommissioning of light water reactors using technologies as a plant supplier
   - Focusing on technology development for core debris removal from Fukushima Daiichi plant to enable stabilization

**Results and Strategies**

- Nuclear power is evaluated globally as an important base load power source as it can contribute to reduce CO2 emissions.
- In order to assure the long-term and continuous operation of nuclear power plants, establishing the nuclear fuel cycle is strongly desired.

**Business Environment**

**Business Scale (Revenue)**

<table>
<thead>
<tr>
<th>Year (FY)</th>
<th>Revenue (In billion yen)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>0</td>
</tr>
<tr>
<td>2018</td>
<td>200</td>
</tr>
<tr>
<td>2019</td>
<td>200</td>
</tr>
<tr>
<td>2020</td>
<td>220</td>
</tr>
</tbody>
</table>

MOX: Mixed OXide fuel
2-4-4. Compressors

**Business Environment**

- Market scale will sustain expansion through the long term. In FY2018, investments were brisk especially in the field of ethylene
- Maintaining the top market share in petrochemicals

**Results and Strategies**

- In the promising oil & gas market, expand compressor train sales by collaborating with MHPS gas turbines
- To respond quickly to US demand for gas processing plants, currently investigating introducing test stand into our US shop and building a fully integrated local production system
- Expand service business
  - Expand and improve service bases (Americas, Middle East, Asia)
  - Strengthen solutions business response (remote monitoring)

**Market Scale of Compressor Business**

- Service
- New installation

**Business Scale (Order / Revenue)**

(In billion yen)

<table>
<thead>
<tr>
<th>Year</th>
<th>Order</th>
<th>Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY2016</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY2017</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY2018</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY2019</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY2020</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>FY2021</td>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>
2-4-5. Aero Engines

**Business Environment**

- Growth market sustained by robust aircraft demand. Over next 20 years, demand for approx. 83,000 engines (¥130 trillion)
- Broad participation in new fuel-efficient, low-noise engine business (PW1100G, Trent, etc.), contributing to reducing environmental load
- MRO business to become ever more brisk, driving market expansion

**Results and Strategies**

- Strengthen facilities and personnel in response to business expansion
  - Mobilizing Groupwide resources,
    - Increase production of parts
    - Launch MRO business for PW1100G-JM installed in A320neo
- Expand business areas utilizing technological synergies within MHI group
  - Expand participation in development through deeper collaboration with OEMs (P&W, RR)
  - Expand business areas further by establishing and commercializing parts repair technologies

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**Market Scale and Growth Potential**

Over next 20 years, demand for approx. 83,000 engines totaling ¥130 trillion

- Large engines (44%)
- Medium-size engines
- Small engines (38%)
- RJ engines
- Turboprop engines

**Business scale (Revenue)**

To exceed ¥100 billion in 2019
¥300 billion within sight by 2040

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MRO: Maintenance Repair & Overhaul  QCD: Quality, Cost, Delivery
OEM: Original Equipment Manufacturer  P&W: Pratt & Whitney
RR: Rolls-Royce

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2-4-6. Marine Machinery

**Business Environment**

- New shipbuilding market recovering since bottoming out in 2016
- Maritime environmental regulations (SOx, CO2) tightening
- Engine market for turbochargers growing steadily

**Results and Strategies**

- Develop new types of turbochargers* to expand business.
  Capture new customers in Europe and China.
- In service business, orders are robust for boiler fuel conversion work responding to tightened SOx emissions regulations.
- Together with customers, currently using digital technologies to develop new technologies for substantially reducing CO2 emissions. Focus on applying other area products and technologies to marine machinery, with sales support. (SOx scrubbers, gas fuel supply systems, deck machinery, water jets, etc.)

* Features of new turbochargers:
  1) **MET-MB II** (axial-flow turbocharger for 2-stroke engines)
     Turbocharger downsized by increasing air flow volume (+16%)
  2) **MET-ER** (radial turbocharger for 4-stroke engines)
     Compact size and fewer parts (-30%)
     High pressure ratio response and high response

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**Turbocharger Market Structure and Targets**

**MET-MB II**

**MET-ER**

**Business scale (Revenue)**

(In billion yen)

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Turbochargers</td>
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<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Marine machinery</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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</tbody>
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2-4-7. Offshore Wind Turbines

**Business Environment**
- Offshore wind turbine market growing faster than anticipated
- Market expected to expand from current focus on Europe first to North America, then Asia (Taiwan, Japan, India, Vietnam, etc.) and other regions (approx. 4-6GW/year)
- Entered offshore wind market in April 2014 upon establishing MVOW with Vestas
- Market share increasing steadily; order backlog and preferred supplier as of FY2018-end totaled 8.7GW

**Results and Strategies**
- Respond to market expansion by strengthening mass-production systems
  - Launch world's largest turbine: V174-9.5MW
  - Establishing bases and developing markets in Japan, Taiwan, US
  - Strengthen support from MHI
    1) Engineering support (production, control, development, etc.)
    2) Support development in US, Asia

**Offshore Wind Turbine Market (excluding China)**

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
</tr>
</thead>
<tbody>
<tr>
<td>GW/year</td>
<td>3.2</td>
<td>3.2</td>
<td>3.0</td>
<td>3.7</td>
<td>4.1</td>
<td>6.8</td>
<td>7.2</td>
<td>6.8</td>
<td>9.5</td>
<td>9.7</td>
<td>11.5</td>
</tr>
</tbody>
</table>

**Revenue and Market Share**

- **Business scale projected to expand significantly**
  - (work volume secured through FY2021)
- Average annual growth rate of over 30%
- Share forecast FY2017-FY2021: 12% to 26%
- Share forecast FY2021-FY2026: 9% to 38%

Source: Wood Mackenzie (installation basis/year)
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3-1. Global Power Market Trends (1/2)

- Power demand will continue to grow worldwide. (2016: 24,919 TWh → 2030: 33,510 TWh)
  - [US/Europe] Carbon-free → Electrification
  - [Southeast Asia] Power demand increase driven by economic growth
- Generation method
  - Share of renewable energy will increase worldwide, gas and nuclear remain solid
  - [US/Europe] Coal retiring
  - [Southeast Asia] Coal remaining one of major power sources

Source: World Energy Outlook 2018
3-1. Global Power Market Trends (2/2)

Although power demand will grow worldwide and renewables will increase, there is a limit to responding to today’s demand with renewables alone.

Gas will play a key role as a backup power source complementing renewables, and nuclear as a baseload source.

### Power Breakdown (%)

- **Generation volume / Total generation**
  - Nuclear: 10%
  - Gas: 52%
  - Coal & oil: 25%
  - Renewables: 25%

### Generation Volume, Average Capacity Factor

<table>
<thead>
<tr>
<th>Year</th>
<th>Generation Volume</th>
<th>2016</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar</td>
<td></td>
<td>12%</td>
<td>13%</td>
</tr>
<tr>
<td>Wind</td>
<td></td>
<td>23%</td>
<td>30%</td>
</tr>
<tr>
<td>Coal</td>
<td></td>
<td>48%</td>
<td>37%</td>
</tr>
<tr>
<td>Gas</td>
<td></td>
<td>34%</td>
<td>30%</td>
</tr>
<tr>
<td>Nuclear</td>
<td></td>
<td>74%</td>
<td>76%</td>
</tr>
</tbody>
</table>

### Plant Capacity / Avg Annual Power

- **Plant capacity / avg annual power**
  - 2016: 1.0
  - 2030: 3.0

### Increase in Power Rate (Industrial) in Germany with Introduction of Renewables

- **Power cost**
- **Renewables fee**
- **Tax, etc.**
- **Renewable ratio**

As ratio of renewable energy usage, which has a low capacity factor, increases, facilities to meet power needs (kW) become excessively necessary. (Challenges: rising power rates, power excess, etc.)

Expanding demand for technologies to sustain renewable power generation: load adjustment, baseload power supply, etc.

Source: From WEO2018
3-2. Long-Term Business Strategies (1/2) Initiatives toward Achieving SDGs

- Realize sustainable society by providing balanced energy infrastructure

**Supply side solutions**

**Stable supply of affordable and less CO2 emissions power source**
Increase efficiency and improve operability as baseload power supply

- High-efficiency GTCC X
- IGCC
- Nuclear
- Hydrogen gas turbine
- CCS/CCUS
- Future reactors (high-speed, compact, high-temperature gas)

Combination with renewable energy, support technologies

- Offshore wind turbine
- Rapid start-up gas turbine
- ESS/Energy Storage
- ORC

**Key Index Approach**

**Providing well-balanced, high-quality energy infrastructure**

**Demand side solutions**

**Improve productivity and lower energy consumption and costs**

- Improve factory productivity
  - Achieve visibility and energy saving
  - Sign detection
- Demand side management
  - DR/VPP
  - Utility packages
  - EMS
- Reduce environmental load and utility costs
  - O&M, asset management
  - Overall optimization
  - Infrastructure adoption

**Technology strength**

- X

**AI strength**

- X

**Workplace strength**


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3-2. Long-Term Business Strategies (2/2) Sample of New Domain Initiatives

- Propose “high-quality energy infrastructure” which realizes sustainable urban development from the planning stage, using the Key Index Approach (QoEn)

**Society**
- Employment per GDP
- Health, Education
- Public sector efficiency ratio
- Electricity usage Etc.

**Economy**
- Power rates, Demand
- Network stability
- Digitalization
- R&D investment Etc.

**Environment**
- CO₂ emissions
- Energy consumption
- Renewable energy ratio
- Recycling ratio Etc.

QoEn and related logos are filed for trademark registration.

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**Case 1**
Area targeting expanded use of renewables
- Large-scale offshore wind turbines
- Renewable energy + backup power supply (gas turbine, ESS)

**Case 2**
Area targeting effective use of resources
- High-efficiency, large-capacity GTCC

**Case 3**
Area targeting simultaneous economic growth and clean environment
- High-efficiency thermal + CCS

**Case 4**
Area lacking resources
- Innovative new type of nuclear reactor

Indication of direction of high-quality energy infrastructure
“Quality of Energy”

Eco: Economic indicator  En: Environmental indicator  So: Social indicator
Contents

1. Business Overview
   1-1. Sales Overview
   1-2. Management Structure
   1-3. FY2018 Major Topics

2. 2018 Medium-Term Business Plan Progress Status
   2-1. Outlook
   2-2. Review of FY2018
   2-3. 2018 Medium-Term Business Plan Strategies and Measures
   2-4. Individual Business Strategies
      1. Clean Gas Power
      2. Steam Power
      3. Nuclear Power
      4. Compressors
      5. Aero Engines
      6. Marine Machinery
      7. Offshore Wind Turbines

3. Looking to The Future beyond 2020 - What is our sustainable business?
   3-1. Global Power Market Trends
   3-2. Long-Range Business Strategies

4. Summary
4. Summary

Proposal, planning & enhancement of total energy solutions along with needs of each area

Technologies & services
supporting society with renewable energies
Nuclear Power  Hydrogen-powered GT IGCC CCS/CCUS  Offshore wind turbine
Energy Cloud  MHPS-TOMONI

Sustainability
Supply balanced energy infrastructures
Check of effects & monitoring
Sustainable society
Reference Materials

Nuclear Power Business
1) Light Water Reactor O&M Service Initiatives
2) Initiatives for Nuclear Fuel Cycle Activities
3) Initiatives for New-built and Future Reactors
4) Decommissioning Initiatives
1) Light Water Reactor O&M Service Initiatives

- Compliance with new regulatory standards for PWR plants is proceeding smoothly, with 9 units already restarted
- Installing severe accident management facilities for restarted plants and maintenance work to enable 60 years of operation are moving steadily forward
  ⇒ In the case of severe accident management facilities, MHI supports power companies, considering/promoting process shortening
- To achieve stable energy supply in Japan, BWR plant restarts are also recognized necessary
  ⇒ In response to the requests from BWR utilities, MHI is providing supports in available area based on the experience in PWR plants
- Also respond to component export projects, to maintain our technological capabilities
2) Initiatives for Nuclear Fuel Cycle Activities

- To reduce excess plutonium and maintain the nuclear fuel cycle, on time completion of Rokkasho Reprocessing Plant (RRP) and MOX Fuel Fabrication Plant (J-MOX) are necessary.
- As a core company of both projects, taking the lead in supporting Japan Nuclear Fuel Ltd. (JNFL).
- Applying knowledge of Orano (France), into which MHI has invested, proposing extended maintenance programs that will contribute to stable operation after completion.

### Examples of requirements of new regulations

1) New emergency response headquarters
   - Conceptual rendering

2) Cooling tower tornado-resistant measure
   - Protective net

<table>
<thead>
<tr>
<th>Year</th>
<th>RRP</th>
<th>J-MOX</th>
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<tbody>
<tr>
<td>2018</td>
<td>Work for compliance with new regulations</td>
<td>Work for compliance with new regulations</td>
</tr>
<tr>
<td>2019</td>
<td>▼ Completion (1st half of FY2021)</td>
<td></td>
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<tr>
<td>2020</td>
<td>Inspection / Repair / Operation support</td>
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<td>2021</td>
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<td>2022</td>
<td>Inspection / Repair / Operation support</td>
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<td>2023</td>
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<tr>
<td>2024</td>
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</table>
3) Initiatives for New-build and Future Reactors

- Started developing a new concept in order to realize enhanced safety for new-build light water reactors
- Accelerate to develop the design of innovative future reactors* such as fast reactor, small-modular reactor and high-temperature gas-cooled reactor
- For overseas markets, collaborate with EDF of France in consideration of its economical feasibility

* Project supported by METI. 2019 "Innovative Nuclear Technology Development Support Projects Responding to Social Needs"  
EDF: Électricité de France (French power company)
4) Decommissioning Initiatives

- For the decommissioning of light water reactors, supporting the utilities in the areas where MHI has advantages as a plant supplier
- MHI is already undertaking first phase of work for the decommissioning PWR plants
- Providing proactive support for stabilization of Fukushima Daiichi, even though they differ from PWR plant facilities
  (To remove debris—a critical challenge—plans call for phased implementation on small scale using a method conceived by MHI)

**Light water reactor decommissioning**
Sampling inside reactor vessel

**Fukushima Daiichi decommissioning**
Debris removal method and equipment

**Horizontal access method**
Enables access to debris from shortest distance

**Debris removal robot arm tester**
As a member of IRID, under development as a project financed by METI for decommissioning and handling contaminated water. One proposal (prototype) for equipment to be used after removal scale has expanded.