

# Power Systems Business Plan

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Mitsubishi Heavy Industries, LTD

1. Business Overview
2. 2018 Medium-Term Business Plan
3. Vision of Power Systems in the Future
4. Individual Business Strategies
5. Power Systems – Mission Statement:  
“POWER & ENERGY SOLUTION PROVIDER”

# 1. Business Overview

1-1. FY 2017 Sales Overview

1-2. FY2017 Major Projects

## 2. 2018 Medium-Term Business Plan

## 3. Vision of Power Systems in the Future

## 4. Individual Business Strategies

## 5. Power Systems – Mission Statement:

“POWER & ENERGY SOLUTION PROVIDER”

# 1-1. FY 2017 Sales Overview

## Renewable Energy

### Offshore Wind Turbines\*



- Power Generation Pumps
- Chemical Plant Pumps
- Water Jet Pumps



## Nuclear Power

- Pressurized Water Reactors (PWR)
- Nuclear Fuel Cycle



Pressurized Water Reactors



Rokkasho Reprocessing Facility

## Marine Machinery

- MET Turbochargers
- Marine Boiler & Turbine



MET Turbochargers

## Gas / Coal / Geothermal

- Gas Turbine Combined Cycle (GTCC)
- Clean coal, IGCC
- Aero-derivative Gas Turbines
- Geothermal Power Generation
- Environmental Plants
- Organic Rankine Cycle Systems



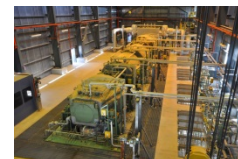
Gas Turbines (GT)



Integrated coal Gasification Combined Cycle (IGCC)

## Compressors

- For Chemical Plants
- For Power Plants
- For Oil & Gas Applications

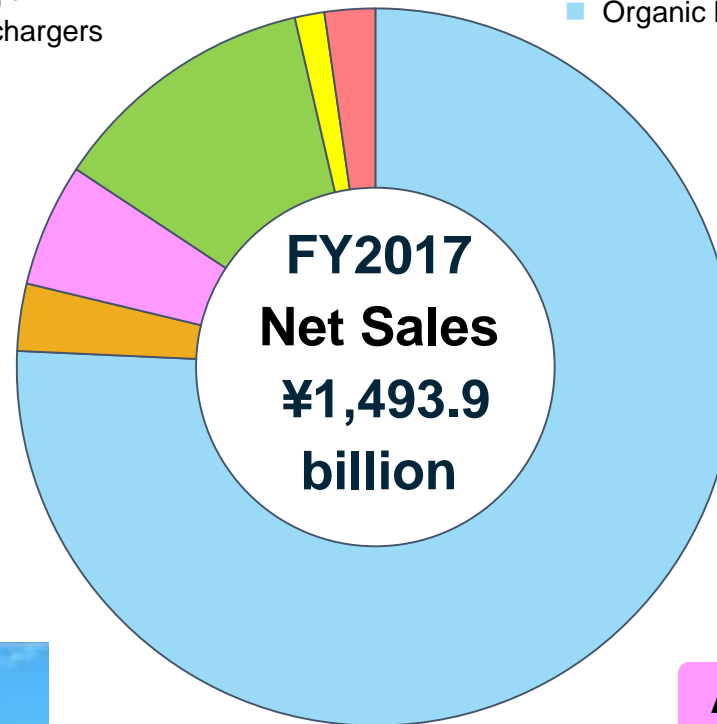


## Aero Engines



V2500

Photo courtesy of Japanese Aero Engines Corporation



\* MHI Vestas Offshore Wind (MVOW), which operates offshore wind power generation facilities, is not included in the graph because it is an affiliate accounted for by the equity method.

# 1-2. FY2017 Major Projects

## Highly Efficient Gas Turbines

### Thailand

Received order of Advanced GTCC



### Poland

Received order of Advanced GTCC



GTCC: Gas Turbine Combine Cycle    SOFC: Solid-Oxide Fuel Cell    MGT: Micro Gas Turbine

## Environmentally Friendly Technologies

### Serbia

Received order of world's largest flue gas desulfurization (FGD) system



## Fuel-Efficient Aircraft Engines

Next-generation aircraft engine for MRJ

Mitsubishi Heavy Industries Aero Engines assembles first unit



## Zero Emission Power

### Japan

Received first order of a SOFC-MGT hybrid system for industrial-use distributed power



### Germany

Received order for 31 units of V164-8.0MW offshore wind turbines  
(Order received by MVOW)



## 1. Business Overview

## 2. 2018 Medium-Term Business Plan

- 2-1. Review of 2015 Medium-Term Business Plan
- 2-2. 2018 Medium-Term Business Plan
- 2-3. Turbomachinery Synergies
- 2-4. Power & Energy Solution Business

## 3. Vision of Power Systems in the Future

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# 2-1. Review of 2015 Medium-Term Business Plan

## Challenges in FY2015 Medium-Term Business Plan

- Orders received & Net sales: Rapid market change in power business
- Operating income: Imbalance between business scale and fixed costs

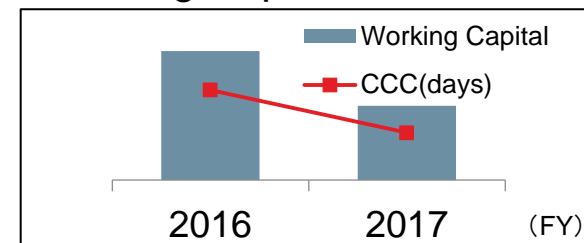
## Achievements of 2015 Medium-Term Business Plan

- Launch of power & energy solution business
- Creating synergies among turbo machinery businesses
- Improved financial foundation (reduced working capital, shortened CCC)

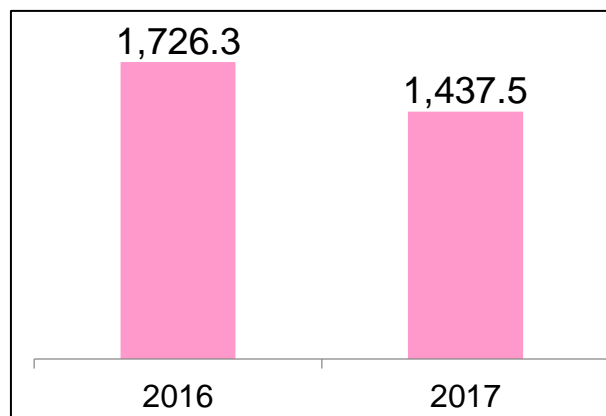
## Opportunities

- New business development by power & energy solutions coexisting with growing renewable energy
- Efforts of synergies among turbo machinery businesses
- Continue to pursue PMI activities while steadily executing the many projects on hand.

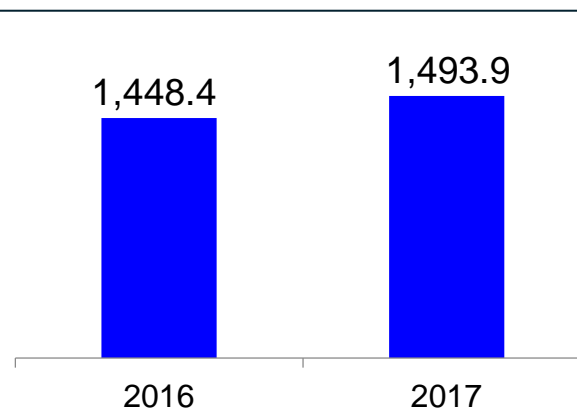
### Working Capital & CCC



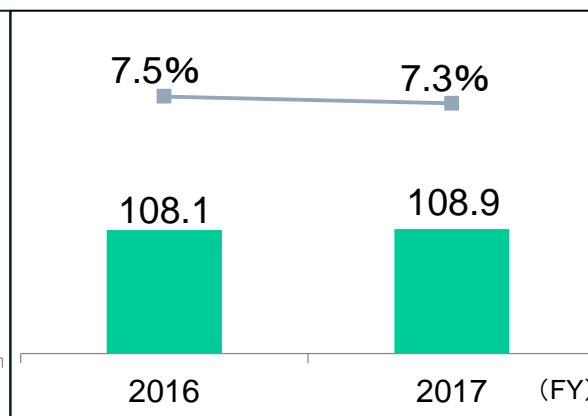
### Orders received



### Net sales



### Operating income (In billion yen)



PMI: Post Merger Integration    CCC: Cash Conversion Cycle



## 2-2. 2018 Medium-Term Business Plan (1/2)

### Targets

Gas / Coal / Geothermal

Compressors

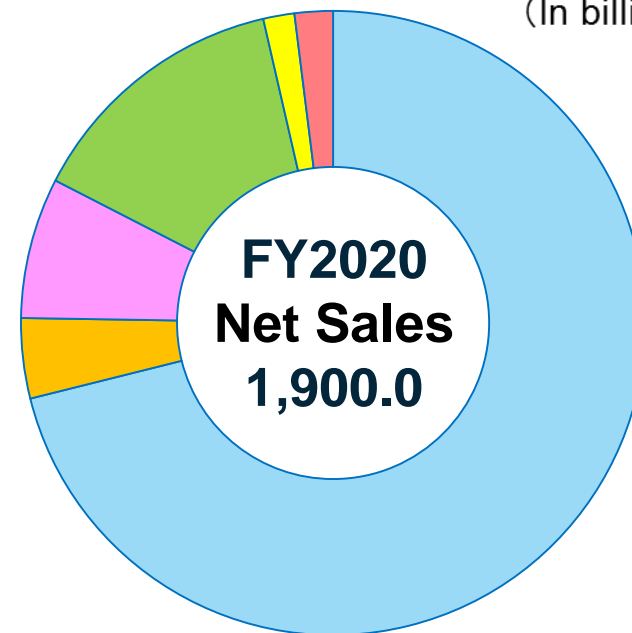
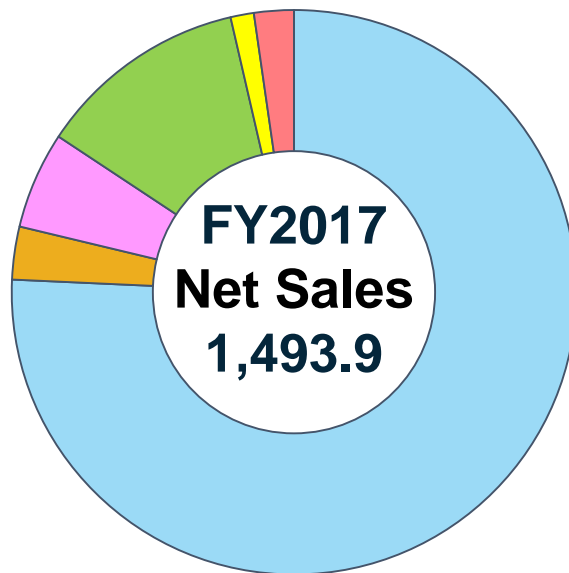
Aero Engines

Nuclear Power

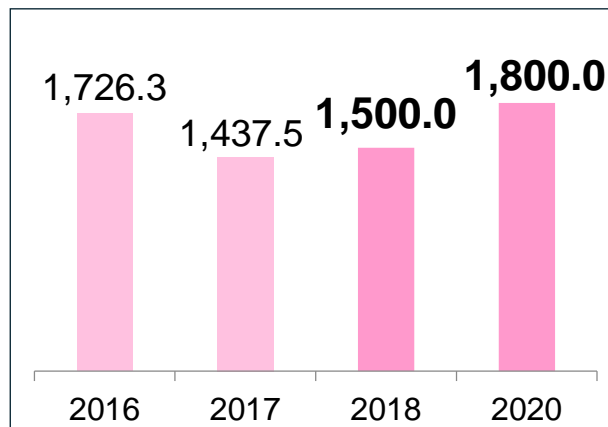
Renewable Energy

Marine Machinery

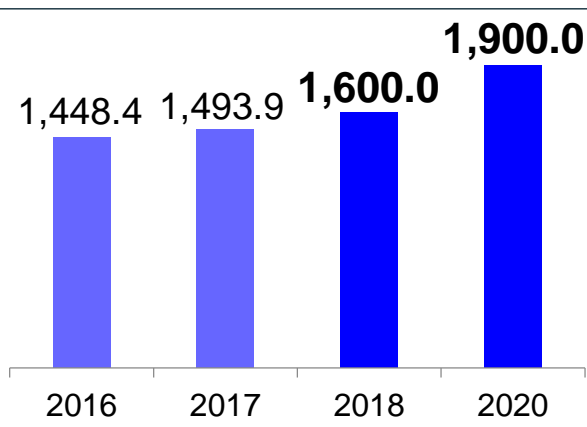
(In billion yen)



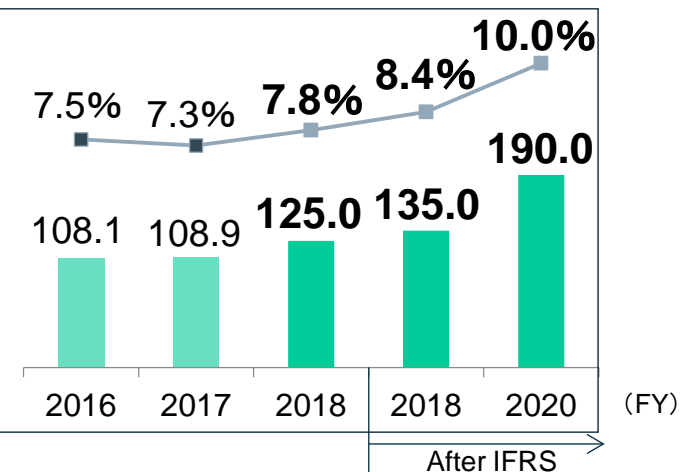
Orders received



Net sales



Operating income / EBIT





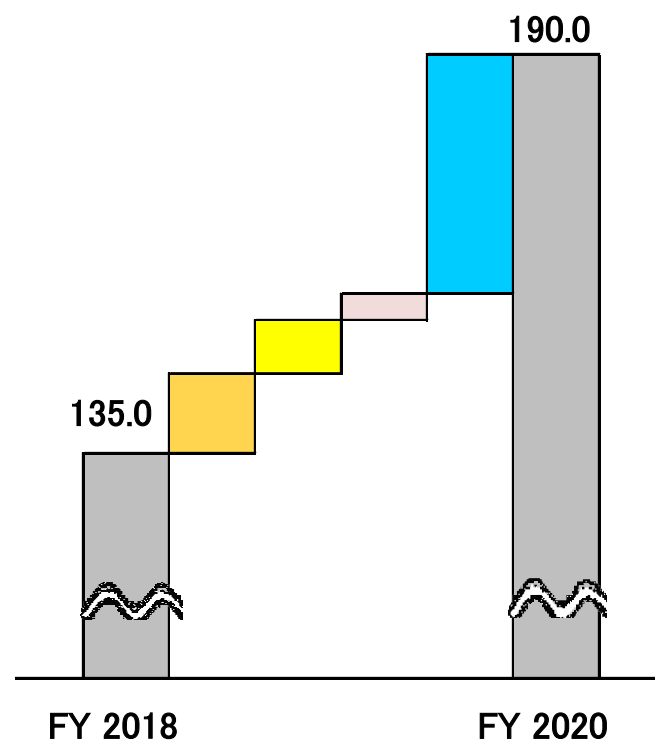
## 2-2. 2018 Medium-Term Business Plan (2/2)

### Initiatives for Achieving Earnings Targets

Gas/Goal/ Geothermal Power	<ul style="list-style-type: none"> <li>• Efficient execution and profit improvement for order backlog</li> <li>• Expand services business                             <ul style="list-style-type: none"> <li>-Improvement work for existing facilities (e.g. reduce carbon emissions, higher efficiency)</li> <li>-Digitalization, -Optimize O&amp;M, etc.</li> </ul> </li> <li>• Reorganization of domestic &amp; overseas bases through PMI</li> </ul>
Nuclear Power	<ul style="list-style-type: none"> <li>• Promote and ensure safety of construction and compliance with new domestic regulatory requirements.</li> <li>• Carry out various maintenance works after restart</li> <li>• Support completion of nuclear fuel cycle process facilities</li> <li>• Support stabilization of Fukushima Nuclear Power Plant</li> <li>• Strengthen risk management for overseas projects</li> </ul>
Aero Engines	<ul style="list-style-type: none"> <li>• Expand business volume in response to robust commercial aircraft demand</li> <li>• Promote the engine overhaul and repair business</li> </ul>
Renewable Energy (MVOW, Pumps, etc.)	<ul style="list-style-type: none"> <li>• Strengthen competitiveness in response to the expansion of the offshore wind turbine market</li> </ul>
Others (Compressors, Turbomachinery Synergies, Power & Energy Solution Business, etc.)	<ul style="list-style-type: none"> <li>• Increase orders for new compressors and services in preparation of an upturn in the oil &amp; gas market</li> <li>• Promote synergies within a broad range of MHI group turbo machinery technologies</li> <li>• Develop unique businesses within the Power &amp; Energy Solution Business function</li> </ul>

### Earnings Targets

(In billion yen)



Note: Impact of IFRS conversion is negligible.

O&M: Operation & Maintenance

## 2-3. Turbomachinery Synergies

Expanding natural gas production and applications  
for a low-carbon society

Mitsubishi Heavy Industries  
Compressor Corporation

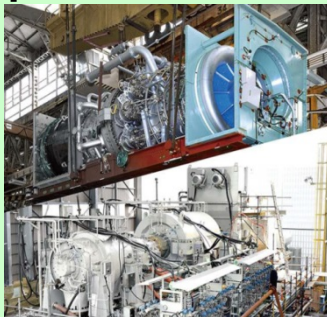
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MHPS

||

LNG production  
solutions

H-100 GT-driven LNG  
compressor train



Oil & gas related  
products business

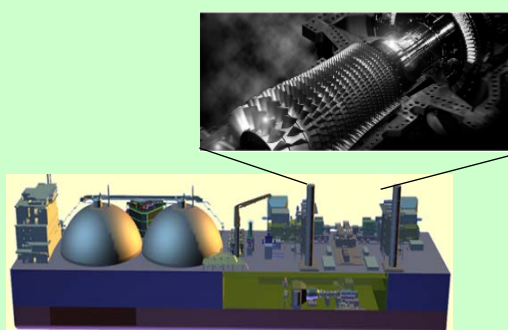
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MHPS

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LNG to Power

Power ship equipped with  
H-25 GTs



Uptake of renewable energies

MHPS

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Mitsubishi Heavy Industries  
Aero Engines, Ltd.

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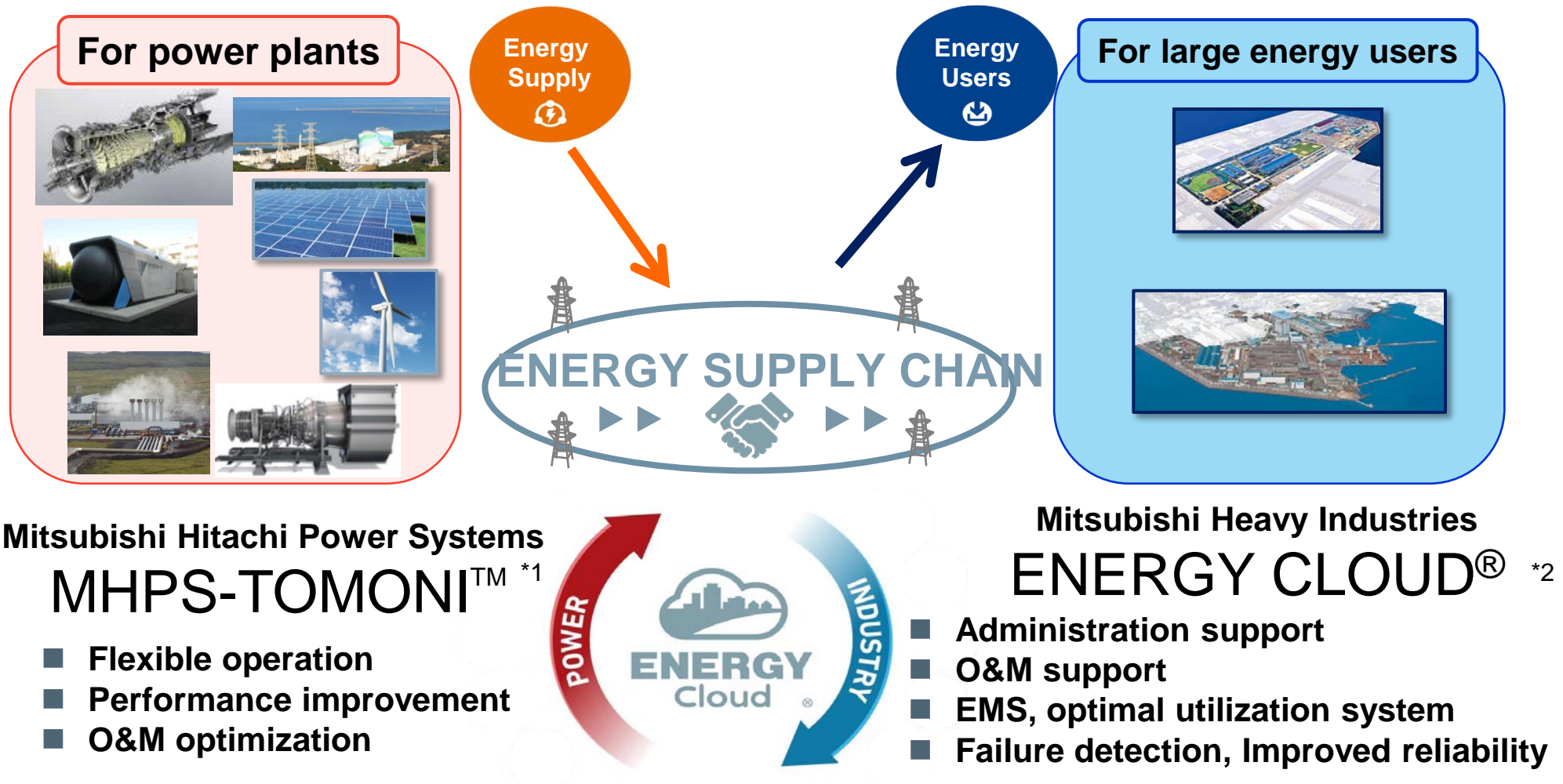
Flexible power  
generation to support  
renewable energies

Aero-derivative GTs



MHPS: Mitsubishi Hitachi Power Systems, Ltd.

### Comprehensive Management System Utilizing AI/IoT



\*1 MHPS-TOMONI™ is a trademark of Mitsubishi Hitachi Power Systems Ltd.

\*2 ENERGY CLOUD® and related logomarks are registered trademarks of Mitsubishi Heavy Industries, Ltd. In Japan.

EMS: Energy Management System

# 1. Business Overview

# 2. 2018 Medium-Term Business Plan

# 3. Vision of Power Systems in the Future

## 3-1. MHI FUTURE STREAM

## 3-2. Power Systems – Mission Statement

## 3-3. Challenges of Expanding Renewable Energy Use

## 3-4. Power Systems Strategies Toward a Carbon-Free Society

## 3-5. Future Energy Infrastructure

## 3-6. Solutions for Achieving “+2°C Scenario” for Climate Change

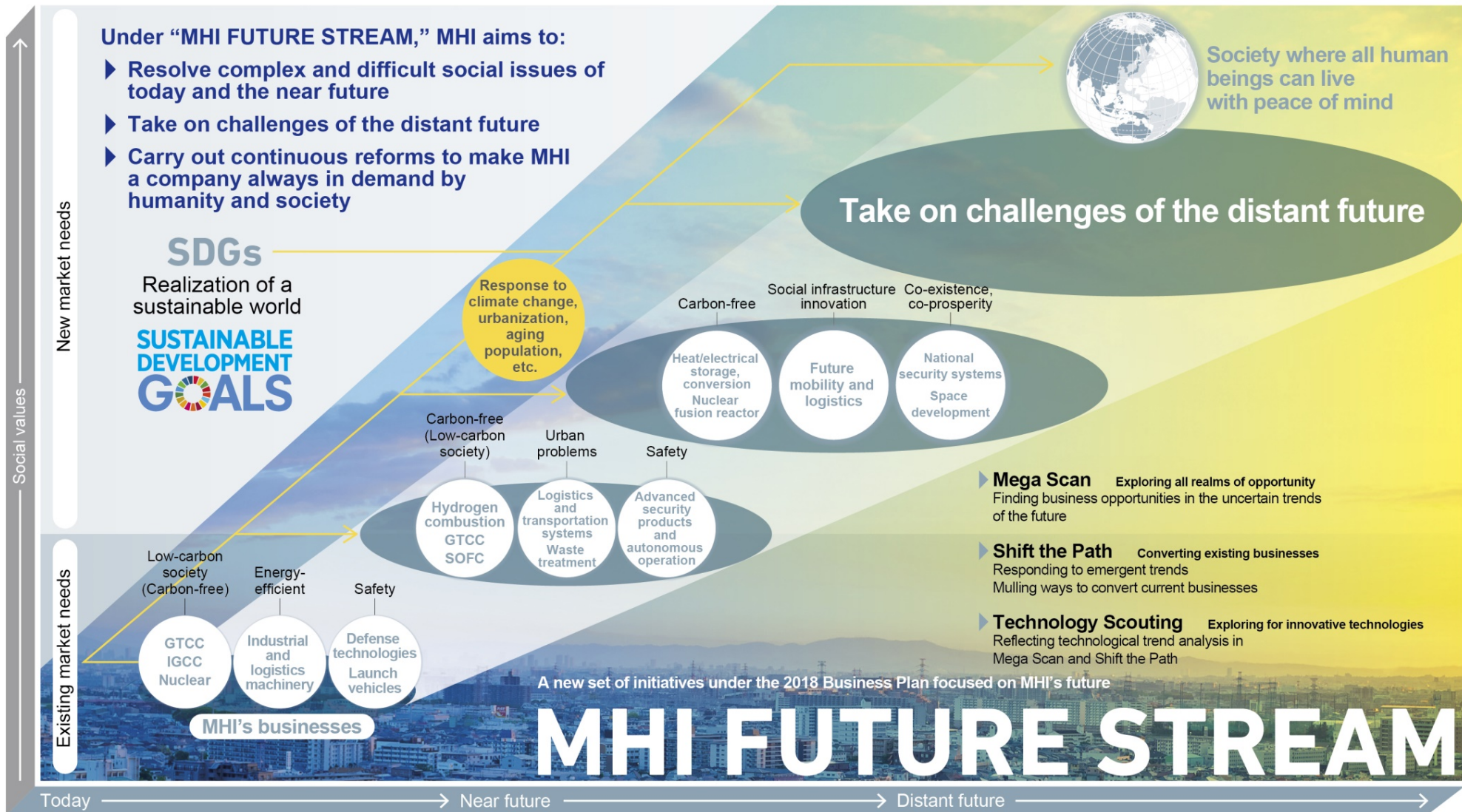
# 4. Individual Business Strategies

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# 3-1. MHI FUTURE STREAM



**Why?**

Provide stable clean energy solutions for a sustainable society

**What ?**

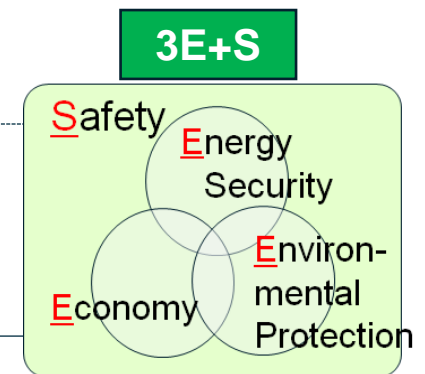
Provide decarbonizing solutions (low carbon / zero emissions)

**How ?**

Focus strategy around 3E+S in the future  
(2030s, 2040s, and 2050s)

**Who ?**

MHI Power Systems can provide advanced technologies & integrate multiple solutions



**MHI as a “POWER & ENERGY SOLUTIONS PROVIDER” of the future**

### 3-3. Challenges of Expanding Renewable Energy Use(1/2)

While wider use of renewable energy is essential, a stable backup power supply is also indispensable

**Australia: Wide-reaching power outage results in suspension of major resource operations and disruptions to public transportation.**

- In September 2016, a severe storm hit the state of South Australia and a large power outage occurred (wind power-generated electric power, which accounts for about half of the state's electricity supply, was cut off and lines from neighboring states were also interrupted).

1. A storm damages power transmission lines

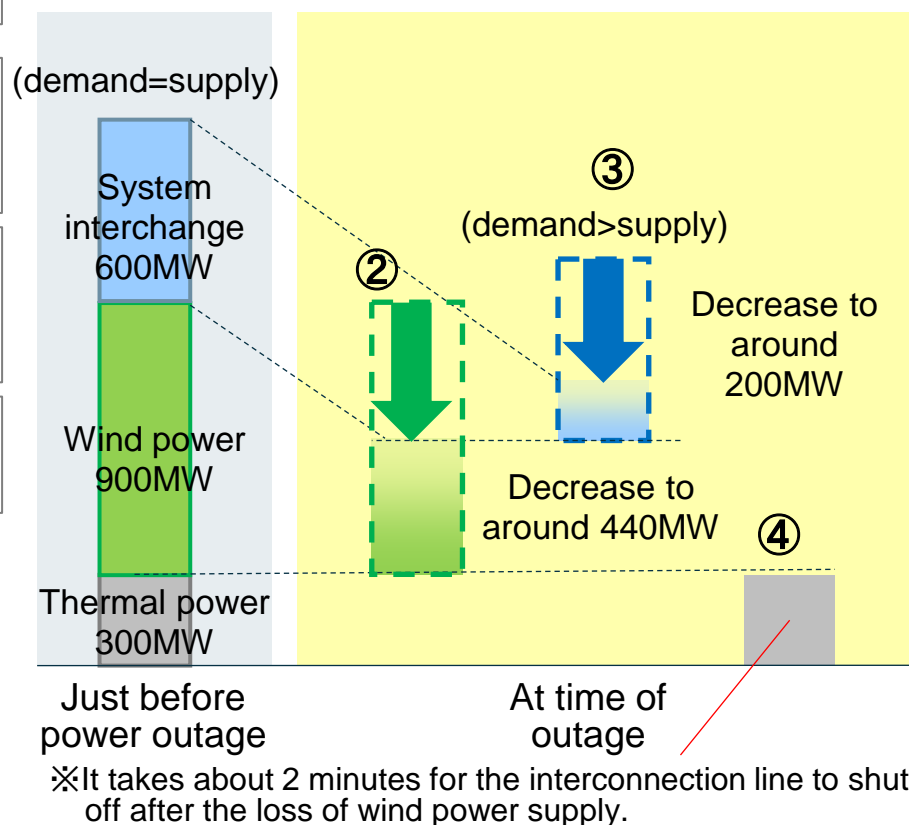
2. Unable to flexibly adjust power output due to minimum utility frequency requirements.  
Wind-generated power equivalent to 460MW is automatically cut off from the grid.

3. Attempts are made to offset the decrease in wind power generation with system interchanges, but the degree of power loss is too great and results in an automatic shutoff of lines to neighboring states (to ensure operation of those grids).

4. Attempts to use gas-fired thermal power to make up for the loss of electricity from wind power generation and from the grid could not be carried out in time.



Wind power generation accounts for about 50% of electricity supply; stable backup power supply is insufficient.  
→→Balance between renewable energy and backup power supply is crucial.



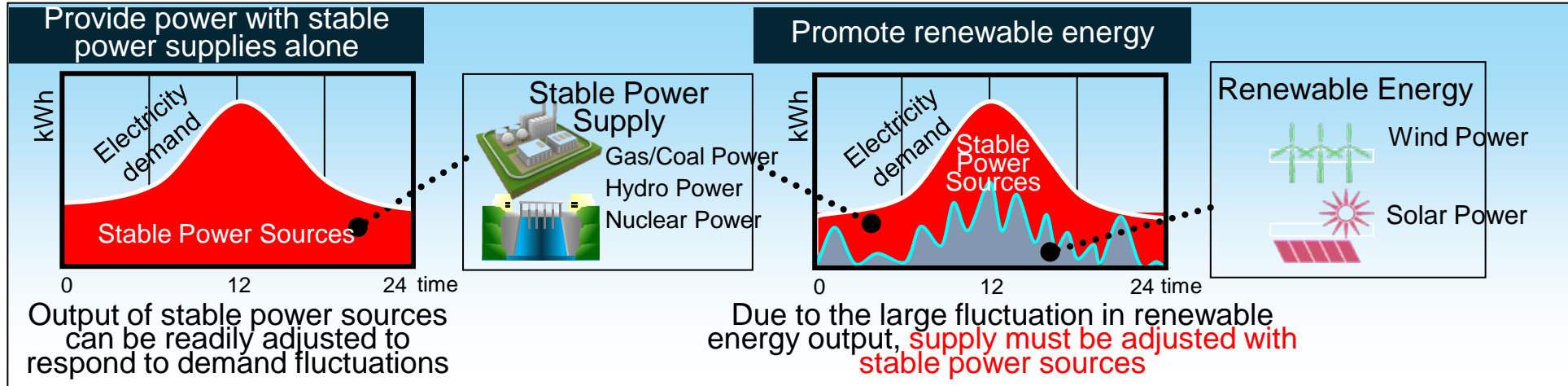


# 3-3. Challenges of Expanding Renewable Energy Use (2/2)

## — time constraints, uneven regional distribution

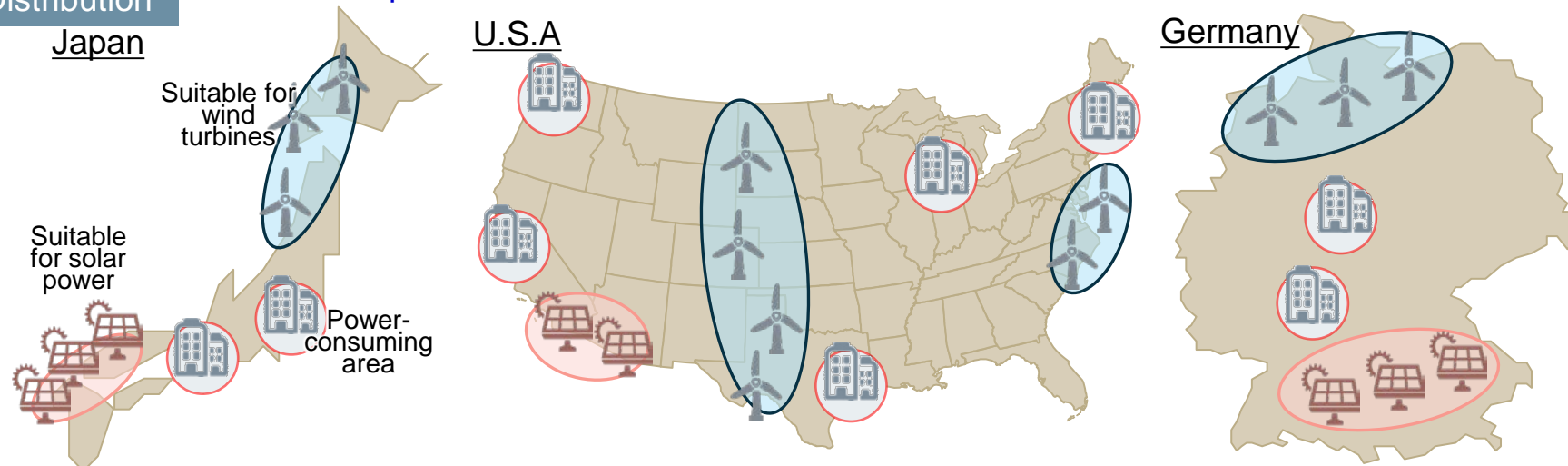
### Time Constraints

Compensate for imbalance between renewable energy output fluctuations and power demand with more enhanced and flexible operation of thermal power and other stable power sources



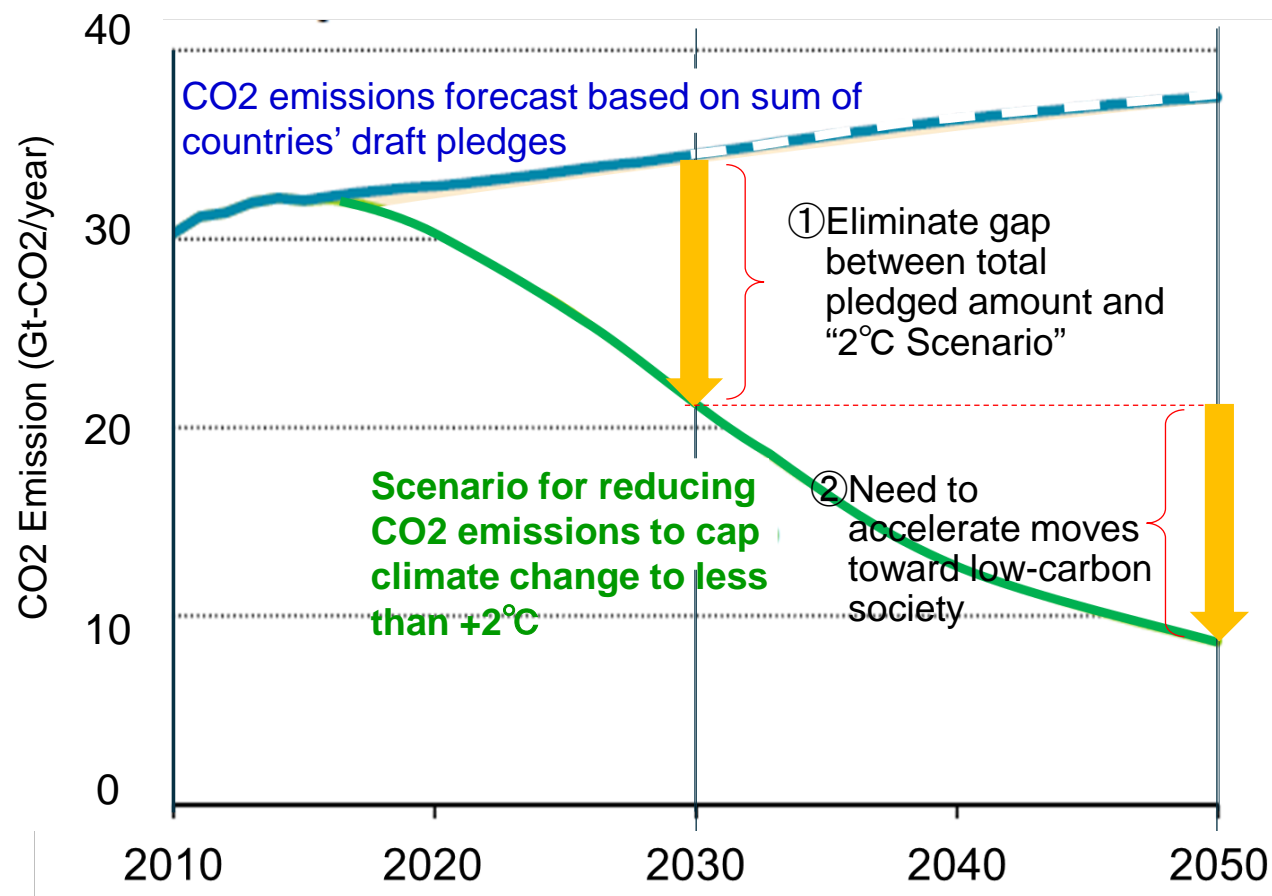
### Uneven Regional Distribution

High volume power-consuming areas that are distant from renewable energy fields require stable sources of power of a fixed scale



### 3-4. Power Systems Strategies Toward a Carbon-Free Society (1/2)

#### Challenges of Paris Agreement, Capping Climate Change at less than +2°C



To achieve the goals of the Paris Agreement, the following are needed in addition to more widespread use of renewable energy:

- Promotion of highly **energy-efficient** equipment and systems
- **CCS and CCUS** plants for recycling CO2 produced as emissions
- **Fuel conversion** toward using lower-carbon fuels

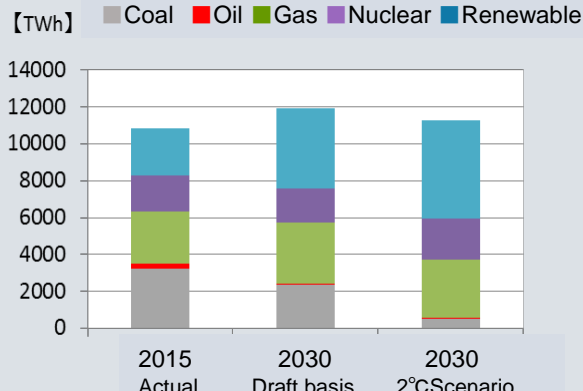
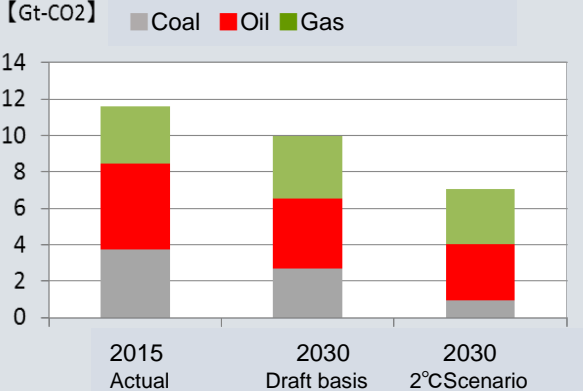
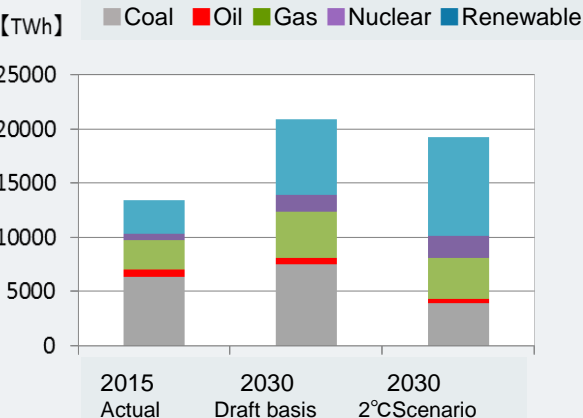
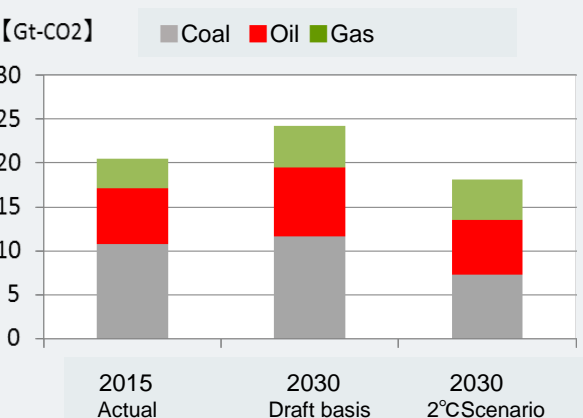
Need for integration of sophisticated power generation equipment and systems with a wide range of technologies

CCS: Carbon dioxide Capture Storage  
CCUS: Carbon dioxide Capture, Utilization and Storage

(Reference: IEA World Energy Outlook 2017)

# 3-4. Power Systems Strategies Toward a Carbon-Free Society (2/2)

## Regional initiatives to Achieve Paris Agreement → Combination of Renewable Energy and Low-Carbon Power Supply (gas/nuclear energy)

Area	Power consumption volume	Industrial CO2 emissions volume (from fossil fuels)	Solutions
Developed Country (OECD)	<p>● Power consumption volume: <u>stable</u></p>  <p>【TWh】</p> <p>2015 Actual 2030 Draft basis 2030 2°C Scenario</p> <p>Legend: Coal (Grey), Oil (Red), Gas (Green), Nuclear (Purple), Renewable (Blue)</p>	<p>● Sharp reduction needed to achieve 2°C Scenario</p>  <p>【Gt-CO2】</p> <p>2015 Actual 2030 Draft basis 2030 2°C Scenario</p> <p>Legend: Coal (Grey), Oil (Red), Gas (Green)</p>	<p><u>Promote shift in energy mix to low-carbon power supplies:</u></p> <ul style="list-style-type: none"> <li>● Aggressive adoption of renewable energy</li> <li>● Coexistence with low-carbon power sources</li> <li>● Offer CO2-free power systems</li> </ul> <p><u>Promote energy efficiency improvement with energy management</u></p> <ul style="list-style-type: none"> <li>● Fuel economy engines</li> <li>● ENERGY CLOUD</li> <li>● CCS/CCUS plants</li> </ul>
Emerging Country	<p>● Power consumption volume: <u>increase</u></p>  <p>【TWh】</p> <p>2015 Actual 2030 Draft basis 2030 2°C Scenario</p> <p>Legend: Coal (Grey), Oil (Red), Gas (Green), Nuclear (Purple), Renewable (Blue)</p>	<p>● Maintain CO2 emission volume at current level</p>  <p>【Gt-CO2】</p> <p>2015 Actual 2030 Draft basis 2030 2°C Scenario</p> <p>Legend: Coal (Grey), Oil (Red), Gas (Green)</p>	<p><u>Respond to increasing power demand and low-carbonization</u></p> <ul style="list-style-type: none"> <li>● Provide highly efficient facilities powered by clean energy</li> <li>● Renovate existing facilities to cut carbon emissions, promote fuel conversion</li> <li>● Promote wider adoption of renewable energy</li> </ul> <p><u>Promote energy efficiency improvement with energy management</u></p> <ul style="list-style-type: none"> <li>● ENERGY CLOUD</li> <li>● CCS/CCUS plants</li> </ul>

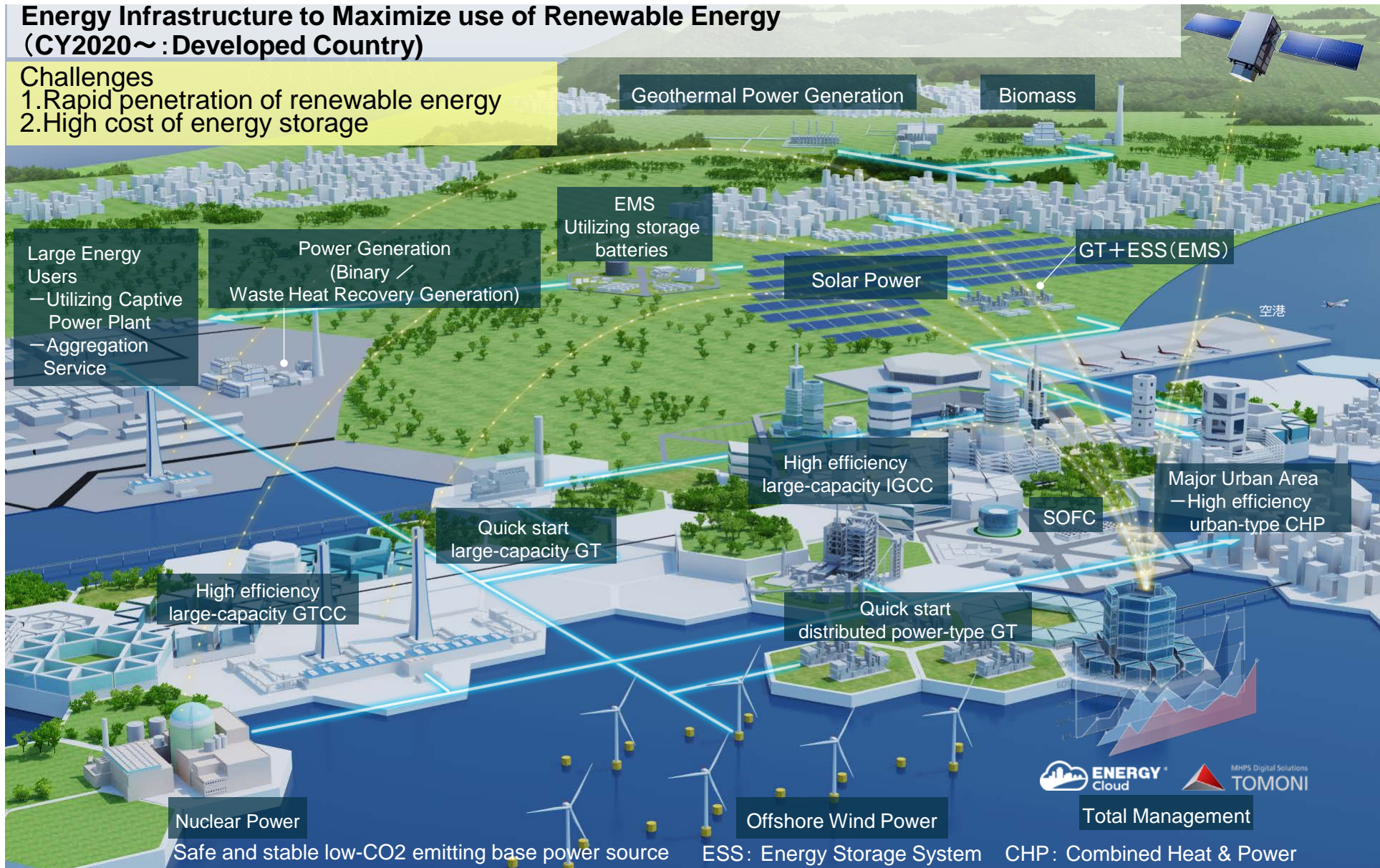


# 3-5. Future Energy Infrastructure (1/3)

## Energy Infrastructure to Maximize use of Renewable Energy (CY2020~ : Developed Country)

### Challenges

1. Rapid penetration of renewable energy
2. High cost of energy storage



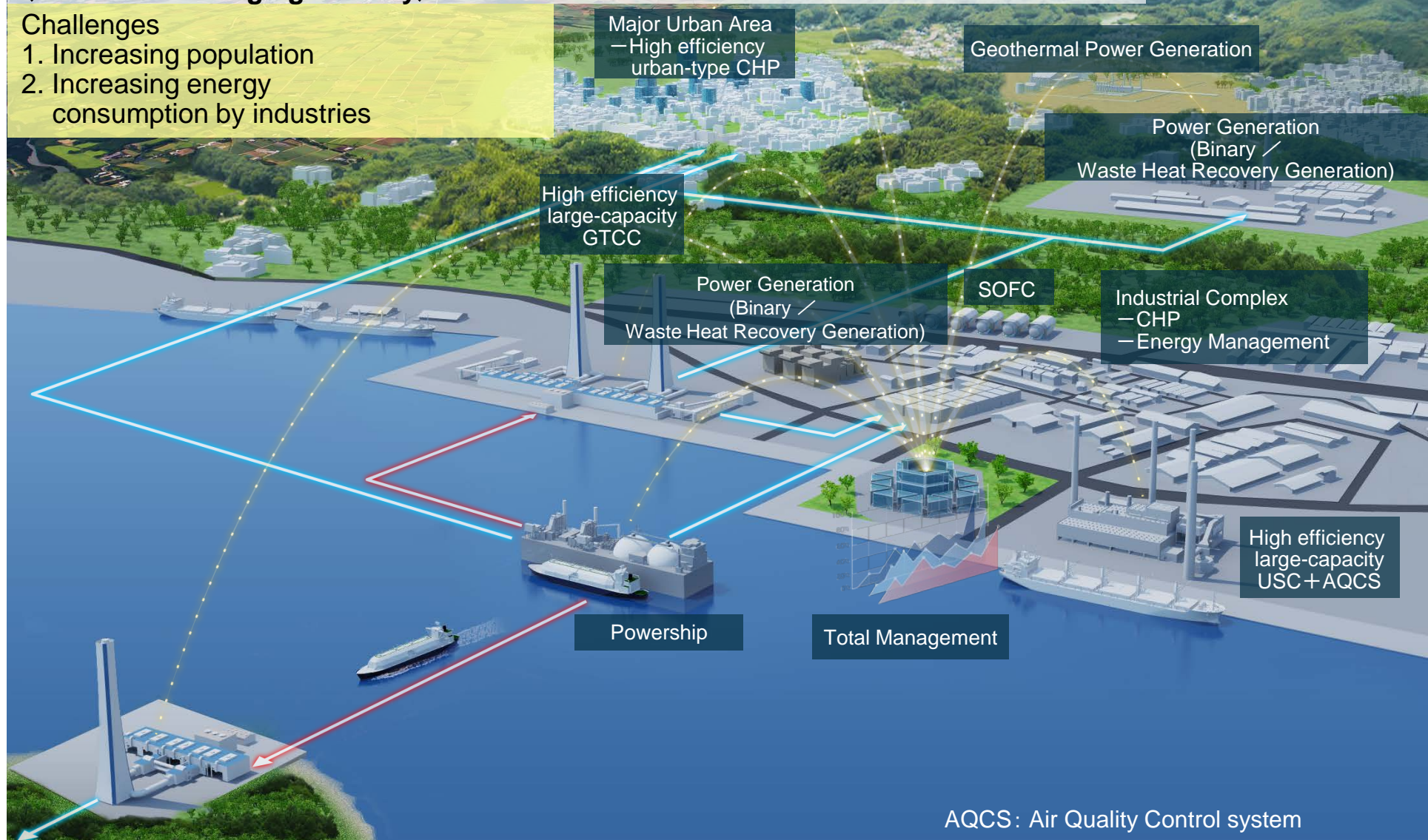


### 3-5. Future Energy Infrastructure (2/3)

#### Economical and Small Low-Environmental Impact Energy Infrastructure (CY2020~ : Emerging Country)

##### Challenges

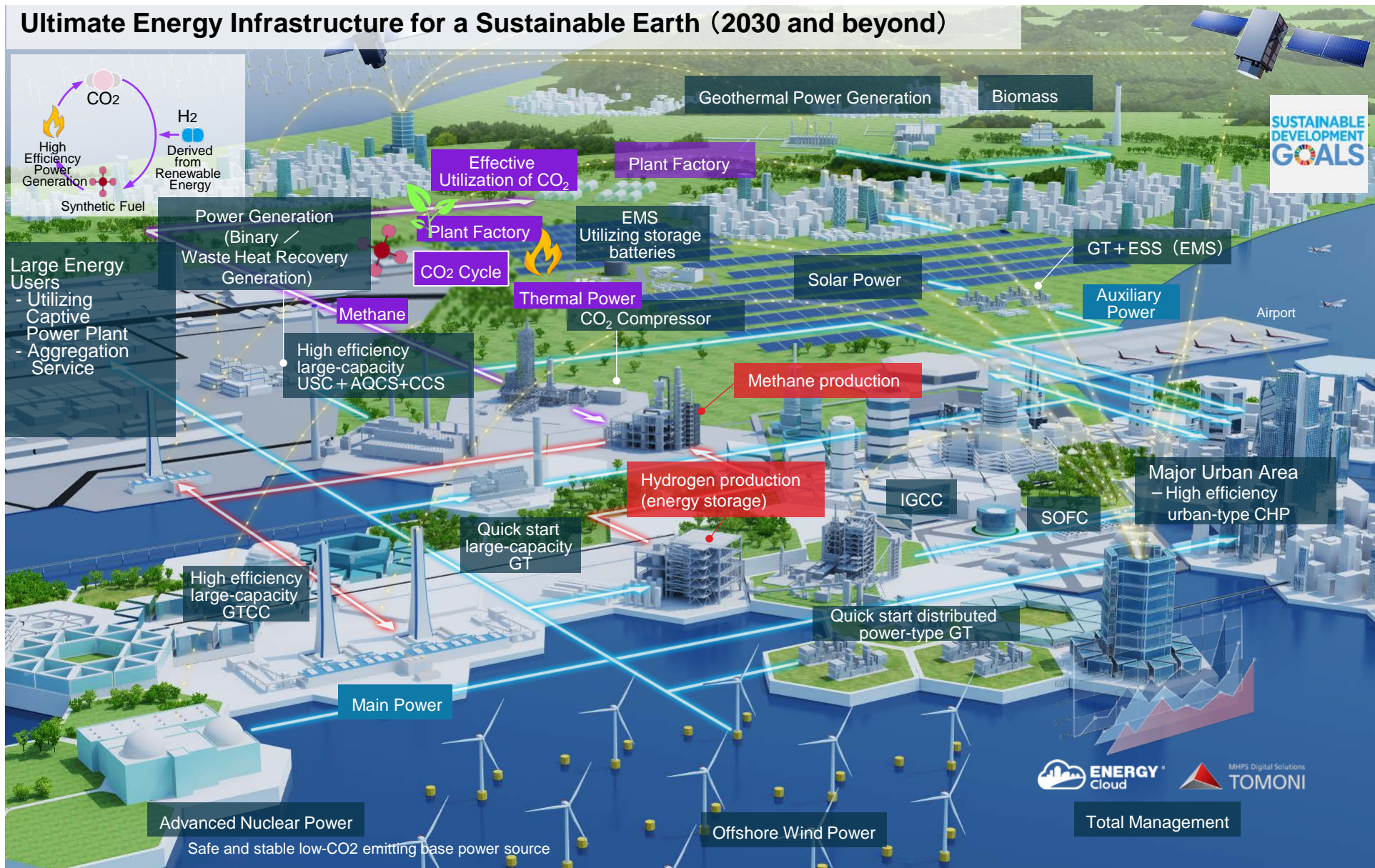
1. Increasing population
2. Increasing energy consumption by industries





# 3-5. Future Energy Infrastructure (3/3)

## Ultimate Energy Infrastructure for a Sustainable Earth (2030 and beyond)

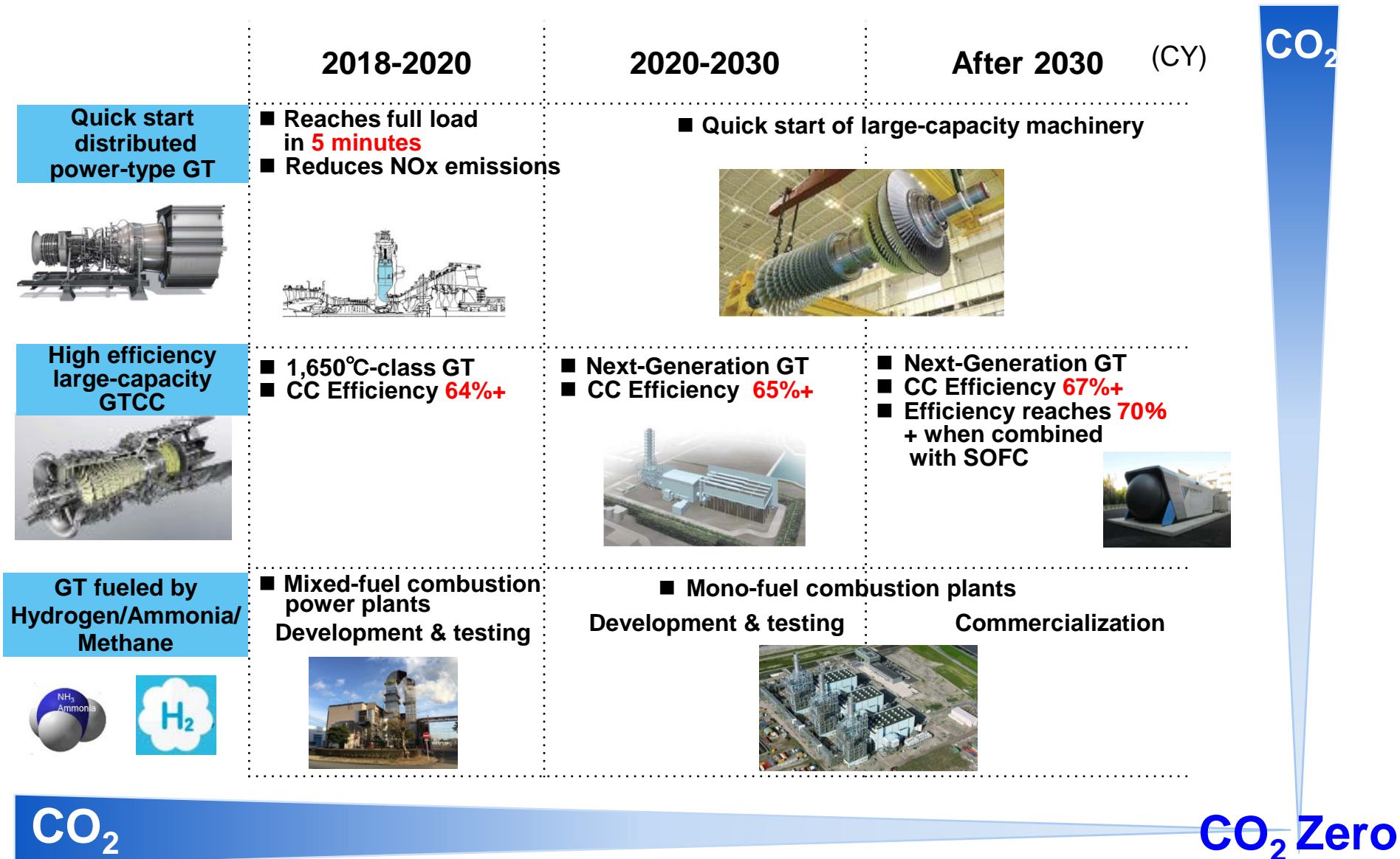


### 3-6. Solutions for Achieving “+2°C Scenario” for Climate Change (1/3)



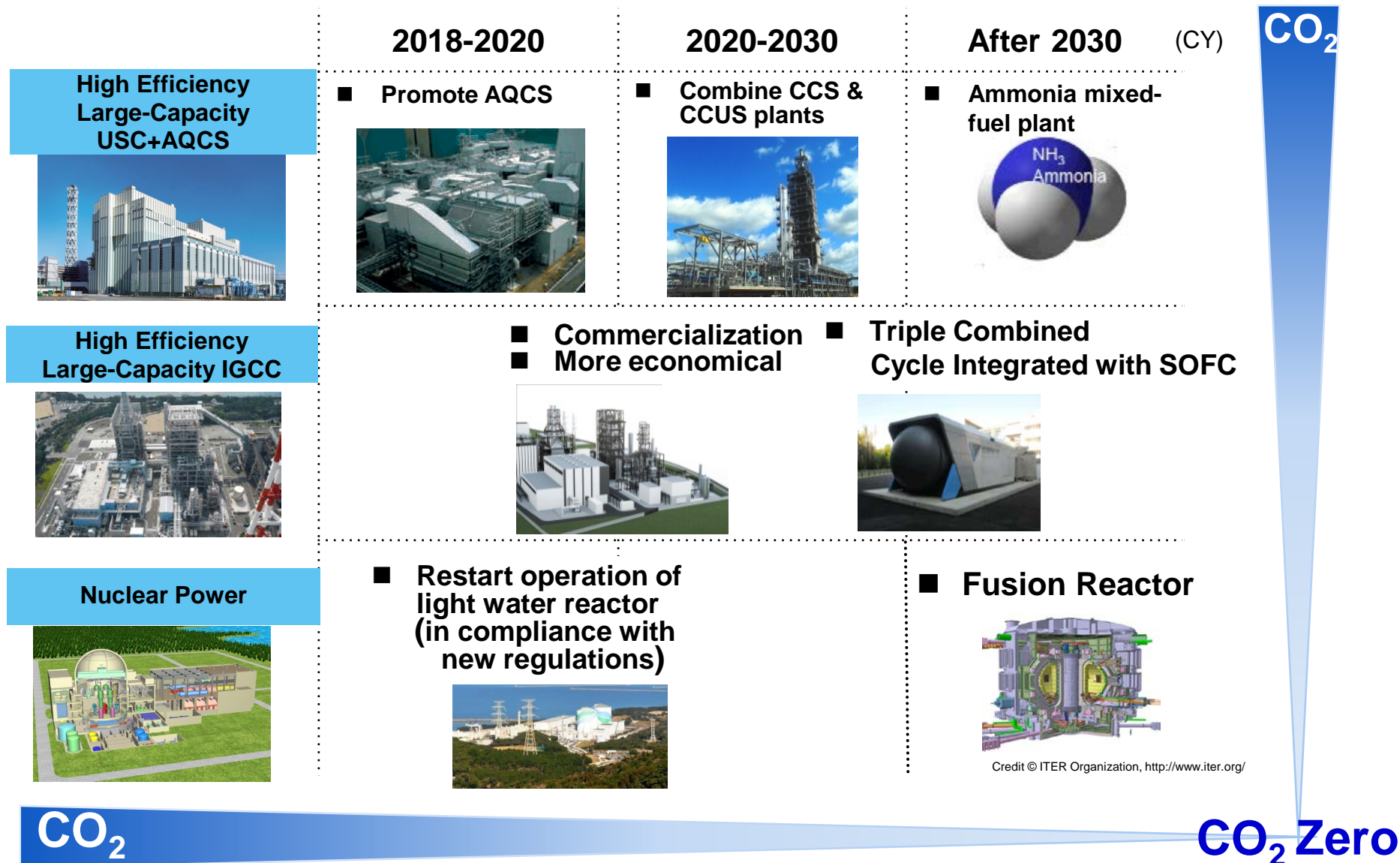


### 3-6. Solutions for Achieving “+2°C Scenario” for Climate Change (2/3)



GT: Gas Turbine CC: Combined Cycle

### 3-6. Solutions for Achieving “+2°C Scenario” for Climate Change (3/3)



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  - 4-1. Mitsubishi Hitachi Power Systems
  - 4-2. Nuclear Energy Systems
  - 4-3. Mitsubishi Heavy Industries Compressor
  - 4-4. Mitsubishi Heavy Industries Aero Engines
  - 4-5. Mitsubishi Heavy Industries Marine Machinery & Equipment (MET Turbochargers)
  - 4-6. Mitsubishi Vestas Offshore Wind (Offshore Wind Turbine)
5. Power Systems – Mission Statement:  
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# 4-1. Mitsubishi Hitachi Power Systems

## Circumstances

- Market for new coal-fired power plants is shrinking due to sharp increase in environmental awareness and growing use of renewable energy
- Firm need for low environmental impact gas-fired power as a stable source of power supply

## Challenges

- Adapt business structure to respond to changes in the circumstances (products, services, management systems and resources)



## Solutions

- Promote and enhance functionality of clean energy products toward realizing a low-carbon/carbon-free society
- Provide solution services by utilizing the newest digital/software technologies
- Expand business sphere with effective utilization of technologies and resources
- Optimize management systems and resource allocation in line with expansion of business sphere and transition to new structure

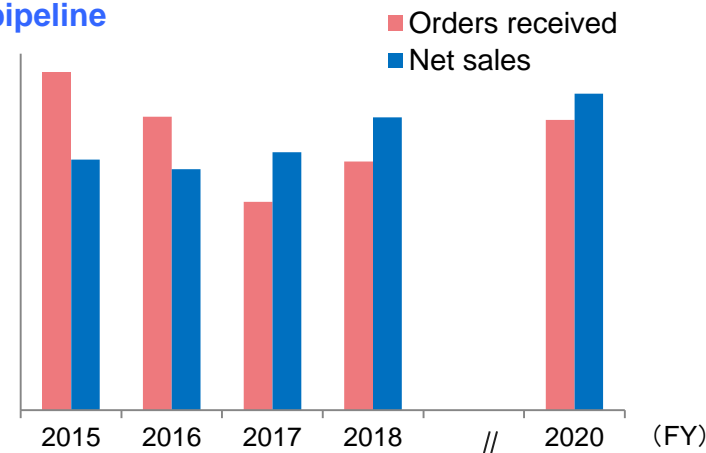
## Scale of market for new gas/coal power plants



Source: FY2015-2017(actual) Mc Coy Power Report; figures after 2018 are our forecasts.

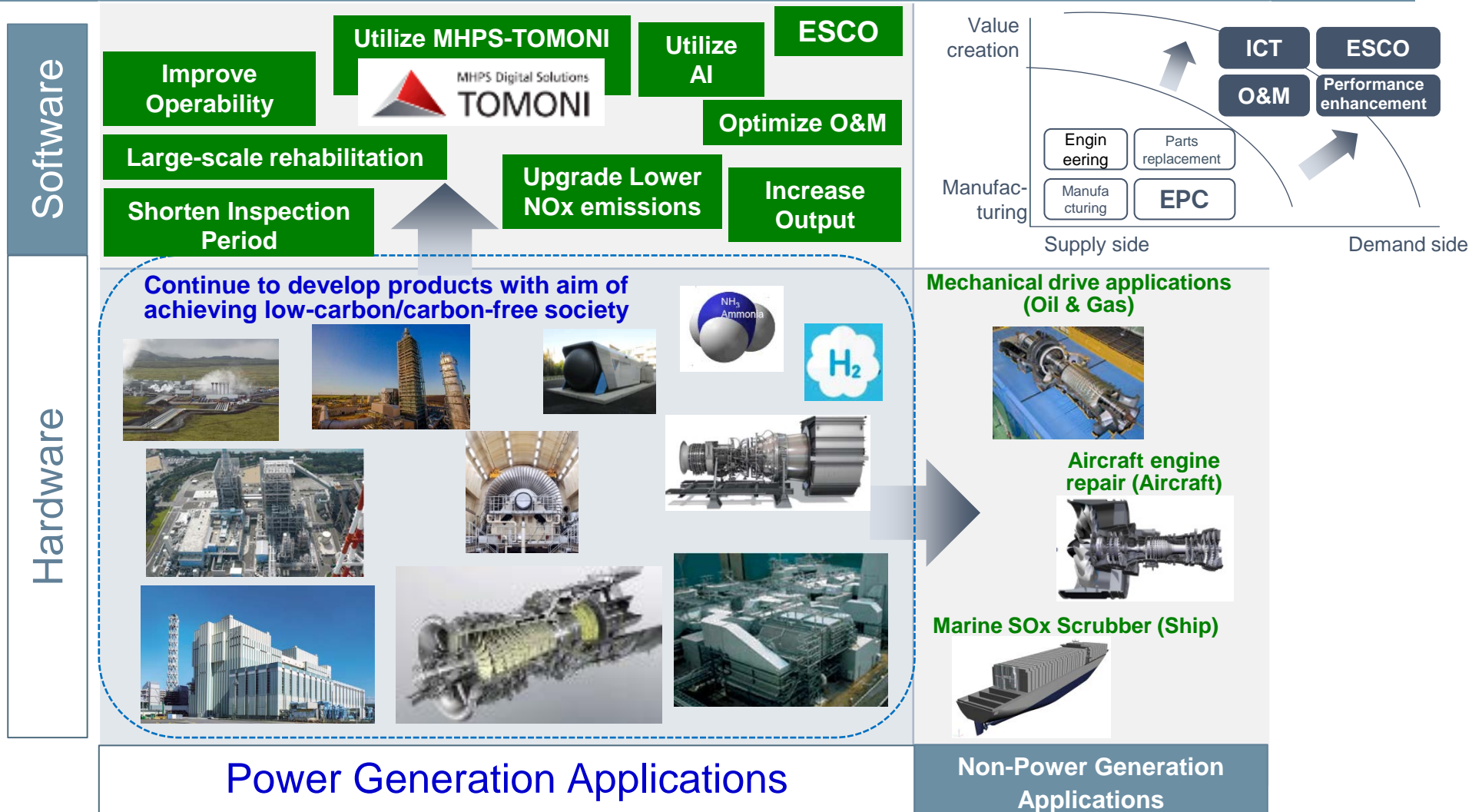
## Orders & Net Sales

**Scale of sales growing as orders are already in the pipeline**



# 4-1. Mitsubishi Hitachi Power Systems

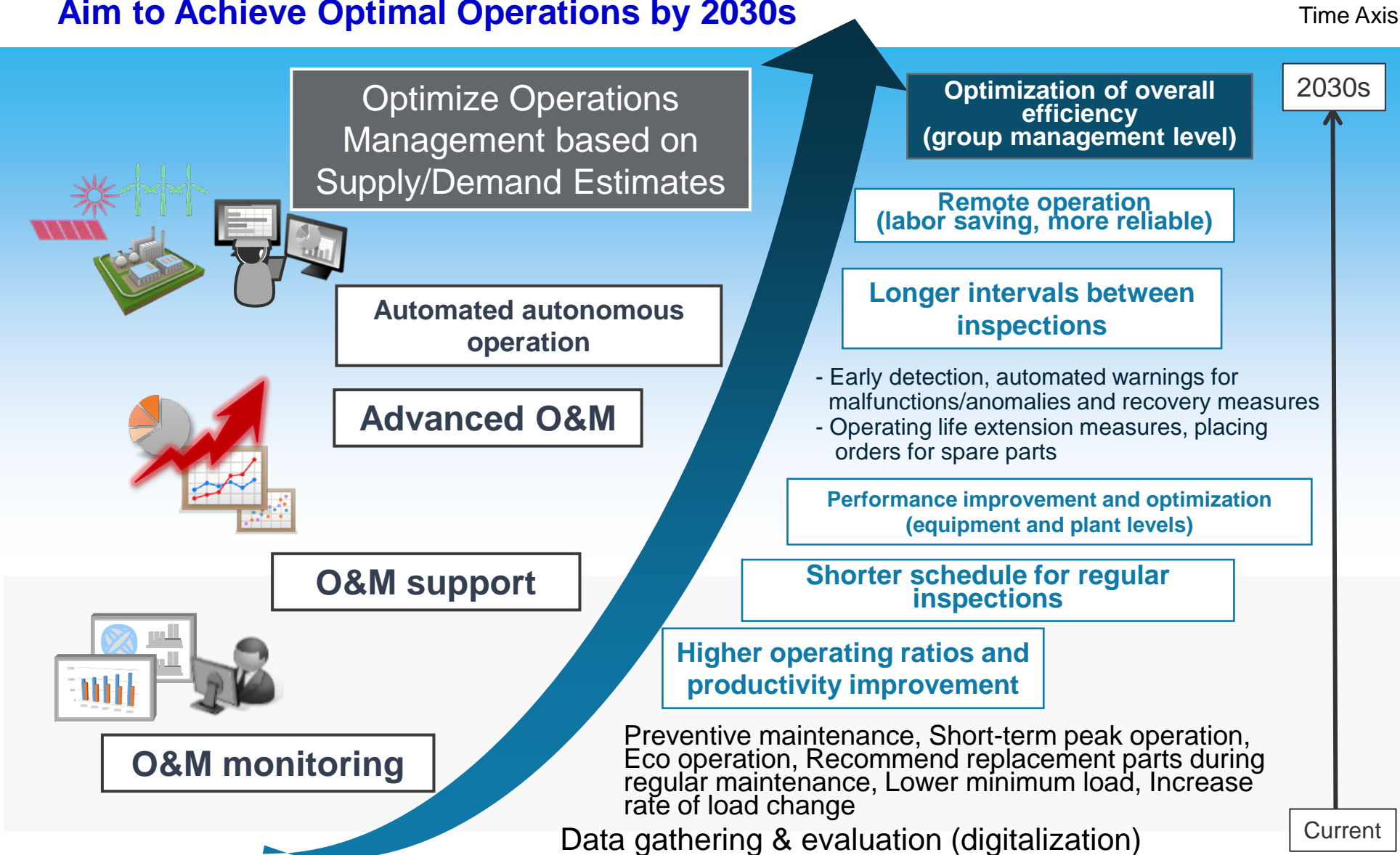
Respond to changes in the circumstances by expanding the business sphere and by adapting the new business structure



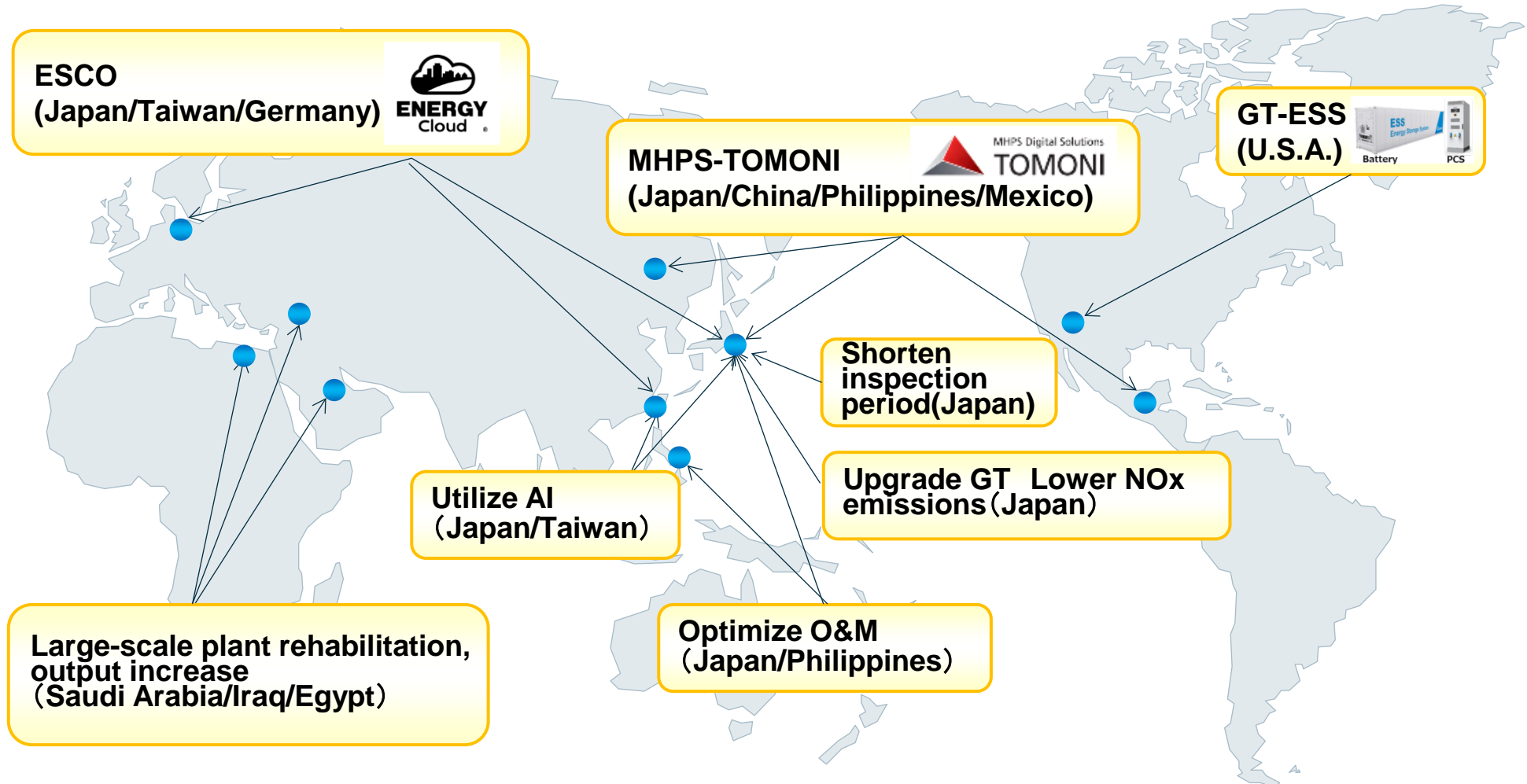
ESCO: Energy Service Company



## Aim to Achieve Optimal Operations by 2030s



**Transition from Product Manufacturing to Value Creation**  
**Work Together with our Customers to Provide Solutions with Value for our Customers**



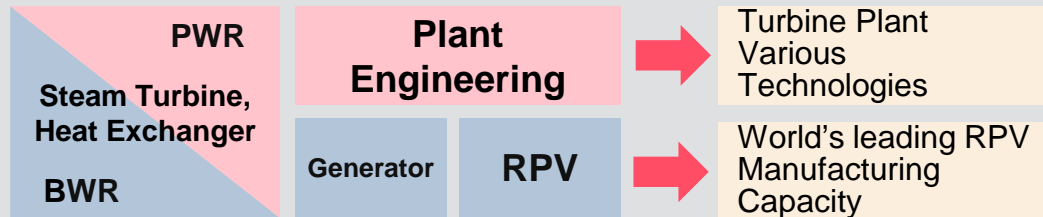


# 4-1. Mitsubishi Hitachi Power Systems

## Nuclear Turbine, Generator, Reactor Pressure Vessel (1/2)



### Major Product Technologies



### Leading-edge technology

#### 74 inch blade

Performance results  
of leading systems

Performance and  
reliability verification  
technologies



74 inch blade



World's largest High Speed  
Balance (HSB)

### Japanese market

#### 【Strengthen expansion of after-sales services】

- **Support plant restarts**
- **Increase reliability** (extend lifespan, improve performance)  
(20~22% power supply configuration by 2030)

### Overseas market

#### 【Approach regions seeing expansion in demand】

- **Supply turbines to countries where demand is growing**  
(China, India, etc. )
- **Respond to rebuilding demand in developed countries**

PWR: Pressurized Water Reactors BWR: Boiling Water Reactors RPV: Reactor Pressure Vessel ST: Steam Turbine Gen.: Generator

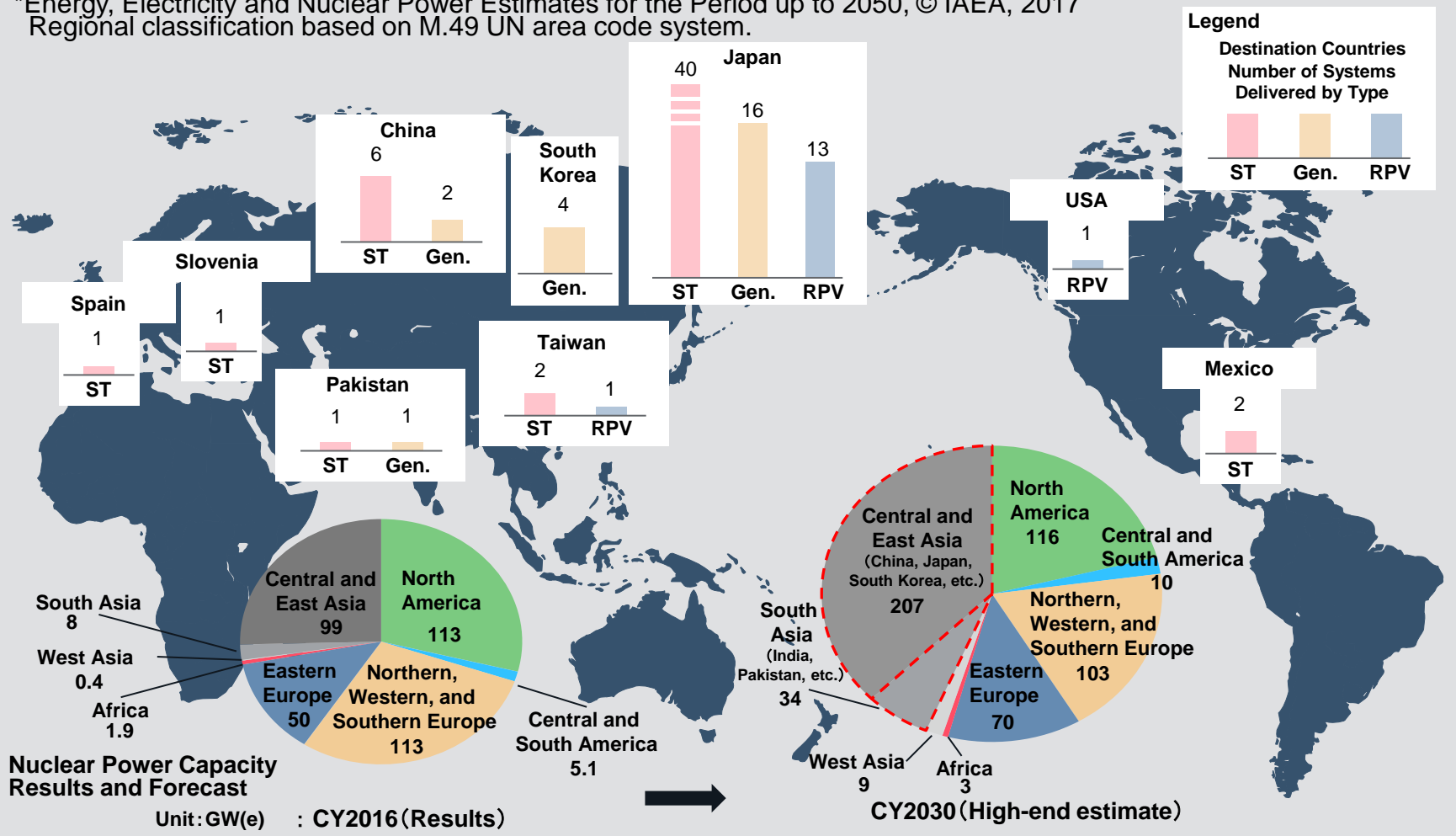
# 4-1. Mitsubishi Hitachi Power Systems

## Nuclear Turbine, Generator, Reactor Pressure Vessel (2/2)

The company's performance history and market trends \*

Extensive record of delivering systems to customers for over 40 years

\*Energy, Electricity and Nuclear Power Estimates for the Period up to 2050, © IAEA, 2017  
Regional classification based on M.49 UN area code system.



RPV: Reactor Pressure Vessel ST: Steam Turbine Gen.: Generator

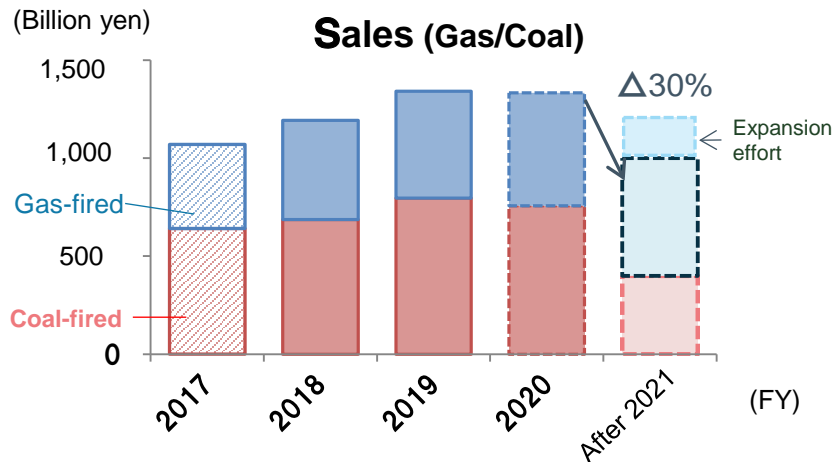
# 4-1. Mitsubishi Hitachi Power Systems

## Restructuring of Coal Power Systems Business

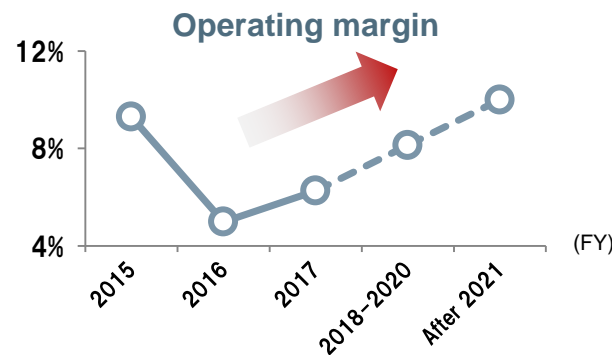


Promote structural shift to increase added value and to be ready for scale-down of coal-fired power systems business from 2021

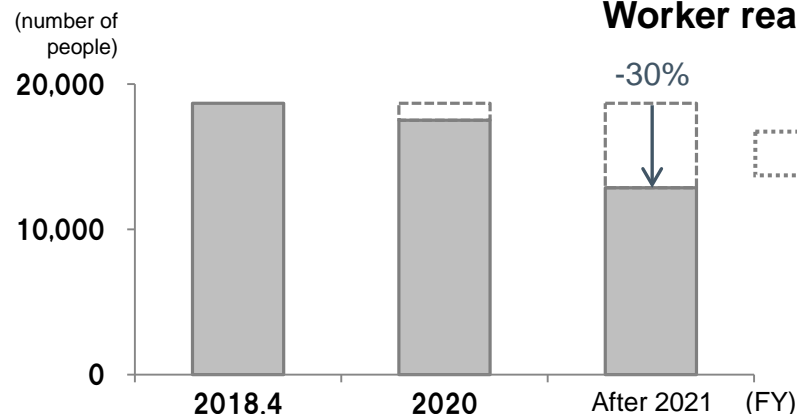
Study the 2018 Medium-Term Business Plan to implement necessary initiatives



Efficiently complete projects / improve earnings



- Reduce fixed costs
- Improve business management efficiency
- Utilize digital technologies
  - Plant automation
  - Utilize AI to pass on technical skills
  - Digital marketing



Domestic	Natural attrition + hiring restraint	-5%
	Reallocation, job changes	-15%
Overseas	Company / works reorganization*	-10%

(\* Mainly Boiler / Steam Turbine)

- Reallocation resources to growth businesses
- Focus on gas-fired power, renewable energy, digital/solutions businesses

## 4-2. Nuclear Energy Systems (1/2)

### Circumstances

- Domestic: Positioned as key base load power supply
- Overseas: Nuclear power generation needs increasing, especially in emerging countries

### Challenges

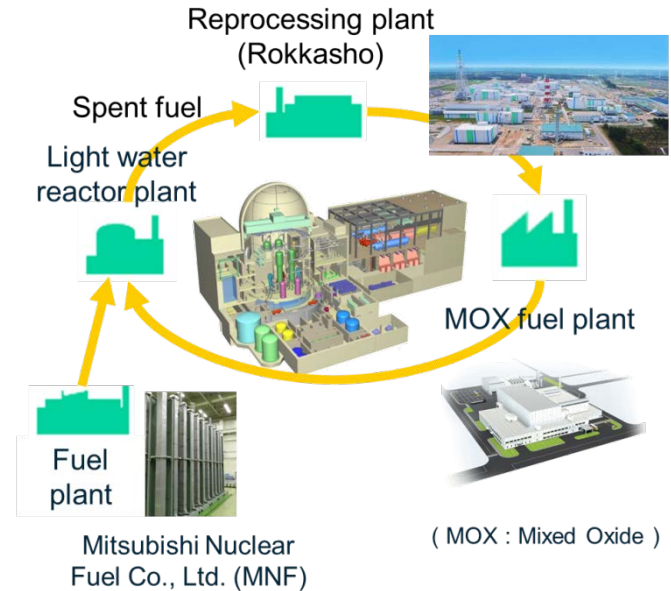
- Seek for world's highest level of safety
- Strengthen product competitiveness (cooperation with French companies, etc.)
- Make steady progress of maintaining and enhancing skilled nuclear technology



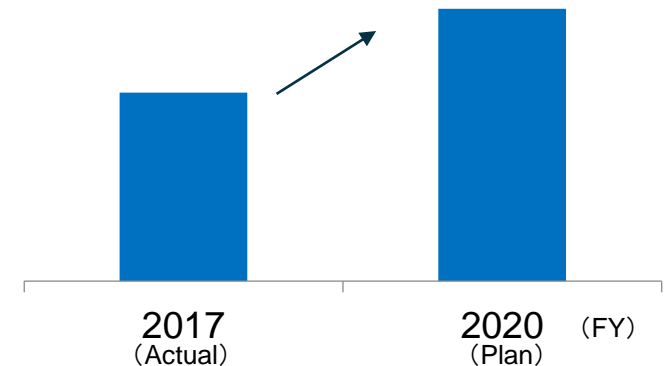
### Solutions

- Promote initiatives for conforming to new domestic regulation
  - Support preparation on waiting nuclear power plants restarting and large-scale renewal projects
  - Support successful completion of construction of nuclear fuel cycle facilities
- Support stabilization of Fukushima Daiichi Nuclear Plants (development of remote-controlled robots, etc.)
- Strengthen risk management for overseas projects (Sinop project in Turkey)
- Strengthen alliances with Orano and Framatome by investment

### Responding to all processes in nuclear energy cycle



### Net Sales



## 4-2. Nuclear Energy Systems (2/2)

### 2018 Medium-Term Business Plan (FY2018-FY2020)

### Medium to Long Term Business Outlook (CY2021-2030s)

#### Pursuing new business sphere

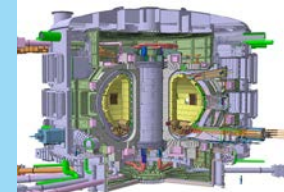
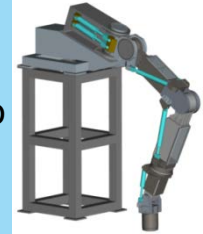
Make steady progress of maintaining and enhancing skilled nuclear technology in preparation for coming carbon –free society



- Promote initiatives for conforming to new regulations  
(severe accident management facilities, etc.)
- Develop large-scale renewal projects
- Support successful completion of construction of nuclear fuel cycle facilities



- Make efforts for new plants, including Sinop project in Turkey
- Prepare for removal of fuel debris from Fukushima Daiichi Nuclear Plant
- Contribute to intermediate storage facilities for spent fuel
- Commitment to decommissioning projects into full scale activities
- Promote R & D for fast reactor and fusion technology
- Promote strategic maintenance planning for 60 years operation  
(continual attention to safety, improve reliability)
- Deepen collaboration between Japan and France



Credit © ITER Organization, <http://www.iter.org/>

## 4-3. Mitsubishi Heavy Industries Compressor (Compressor)

### Circumstances

- Moderate recovery in plant construction demand since late 2017 as oil price stabilized
- Intensified Competition among players in oligopolistic market

### Challenges

- Strengthen the business base to survive global competition
- Strengthen service business offerings

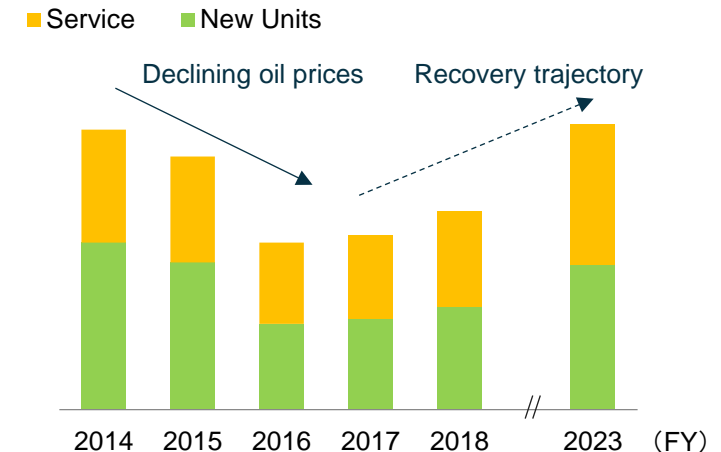


### Solutions

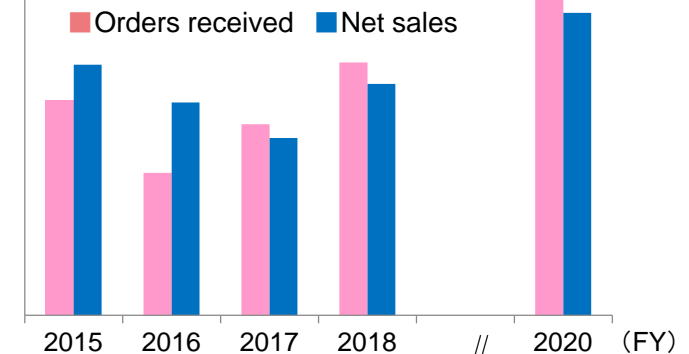
- Tie-up offering with MHPS gas turbine to expand sales of compressor trains in Oil & Gas market
- Strengthen cost competitiveness and shorten delivery times to maintain top share in petrochemical market
  - Optimize procurement process
  - Improve manufacturing process (casing: cast steel → steel plate)
- Expand service business
  - Strengthen service bases (US, Saudi Arabia, South Korea, Russia)
  - Strengthen IT, online services (remote monitoring)



### Market scale of compressor business



### Orders & Net sales





## 4-4. Mitsubishi Heavy Industries Aero Engines (Aero Engines)

### Circumstances

- Growing market sustained by robust aircraft demand
- Further growth of engine MRO market

### Challenges

- Response to continuous production increase
- Expand business scope



### Solutions

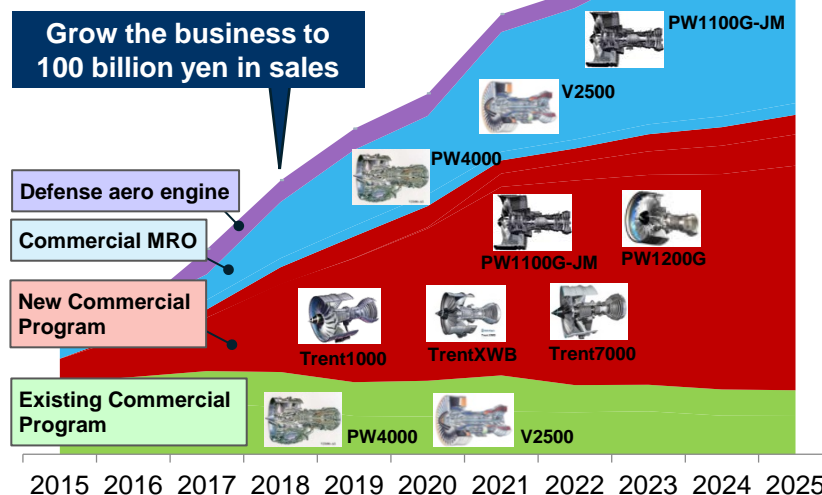
- Mobilize resources available in the business domain
- AI/IoT initiatives for smart factories and Advancing in SCM
- Expands capability/resources for MRO and part repairs (GTF engine MRO, repair technology development)
- Enhance contribution in development programs thru cooperation to customer value (P&W, RR)

MRO: Maintenance, Repair & Overhaul    SCM: Supply Chain Management  
P&W: Pratt & Whitney    RR: Rolls-Royce    GTF: Geared Turbo Fan

### Business scope (Net sales)

200 billion yen of sales in sight

Grow the business to  
100 billion yen in sales



### Smiling Curve of Aero Engines business

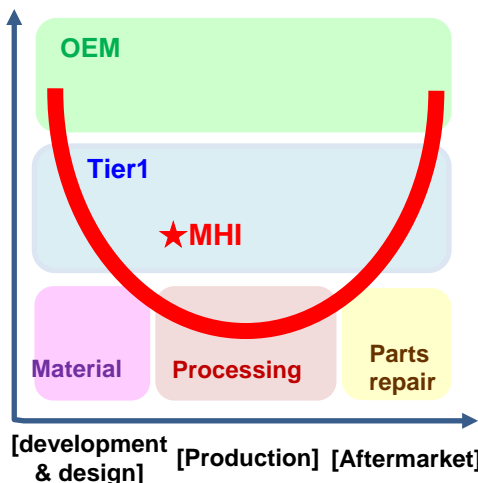


Photo courtesy of Japanese Aero Engines Corporation



## 4-5. Mitsubishi Heavy Industries Marine Machinery & Equipment (MET Turbochargers)

### Circumstances

- New shipbuilding market recovering since bottoming in 2016
- Stable market growth continuing for stationary engine segment

### Challenges

- Maintaining market share of products for marine engines
- Step up pace for making inroads to new areas (turbochargers for power generation and mechanical drive engine applications)



### Solutions

- To maintain market share while new shipbuilding market recovers, introduce a successor model of the large air flow-type turbocharger for low-speed marine engines
- Develop and release new models for power generation and mechanical drive engine applications (low cost, high compression ratio)
- Optimizing turbocharger design with the aim of having customers adopt them as their standard specifications (area indicated by red dashed line in exhibit to the right)

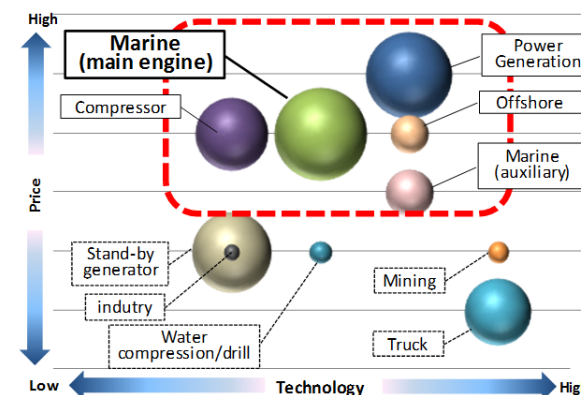
Marine Turbocharger  
(MET-MB)



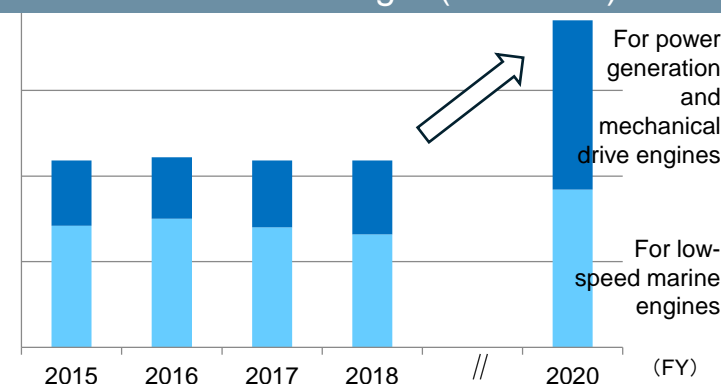
Turbochargers for power generation and mechanical drive engines (MET-SRC)



### Market structure & Target



### MET Turbocharger (Net sales)



MET: Mitsubishi Exhaust gas Turbocharger

## 4-6. MHI Vestas Offshore Wind (Offshore Wind Turbine)

### Circumstances

- Growing renewable energy becomes a prominent resource of electricity
- European market continuing to grow, and US, Taiwan, and Japan markets are expected to be emerging (around 4~6GW/year)
- The second largest share of offshore wind turbine market (cumulative market share)

### Challenges

- Respond to market growth and strengthen competitiveness
- Further improve economic performance
- Adjust for the variable renewable energy



### Solutions

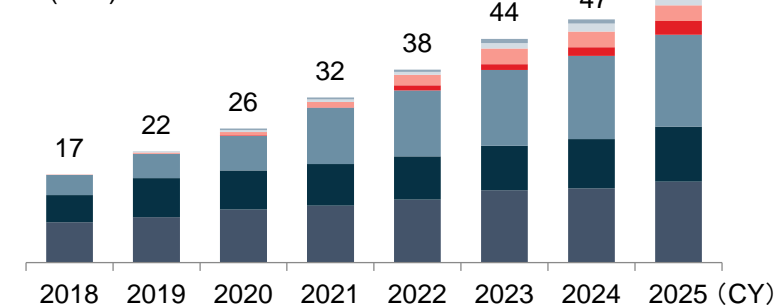
- Respond to market growth by strengthening mass-production systems
- Introduce the world's largest turbine, output 9.5MW, to the market (install in 2019)
- Add on higher value by combining with flexible power sources (e.g. small GT)



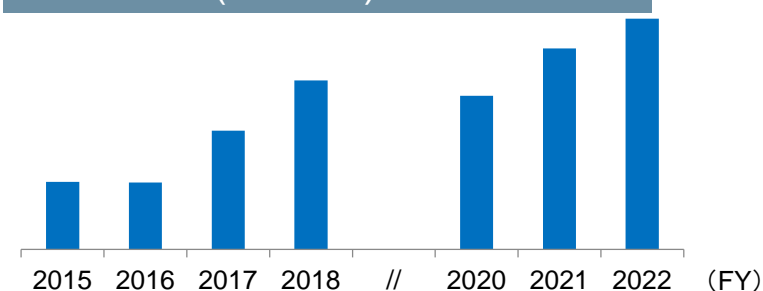
### Offshore Wind Turbine Market

(Survey by research institutes)

■ U. K. ■ Germany ■ European countries ■ U.S.A. ■ Korea ■ Taiwan ■ Japan  
(GW)



### Net sales (MVOW)



1. Business Overview
2. 2018 Medium-Term Business Plan
3. Vision of Power Systems in the Future
4. Individual Business Strategies
- 5. Power Systems – Mission Statement:  
“POWER & ENERGY SOLUTION PROVIDER”**



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