

# Power Systems

The Power Systems domain is supporting power supply throughout the world by offering a variety of energy solutions, including clean gas power, which realizes high energy efficiency and helps reduce environmental load; nuclear power, which contributes to reducing CO<sub>2</sub> emissions and can be used as a base load power source; flue gas desulfurization plants, which significantly reduce air pollution; and offshore wind turbines and thermal power, which utilize renewable energies. Also, we have been proposing compressor trains integrated with gas turbines to create turbomachinery synergies in the oil and gas market. Amid demands from the global society to shift to low-carbon and carbon-free energy, we aim to realize a sustainable society while addressing social and economic needs, which differ in each area of the world.

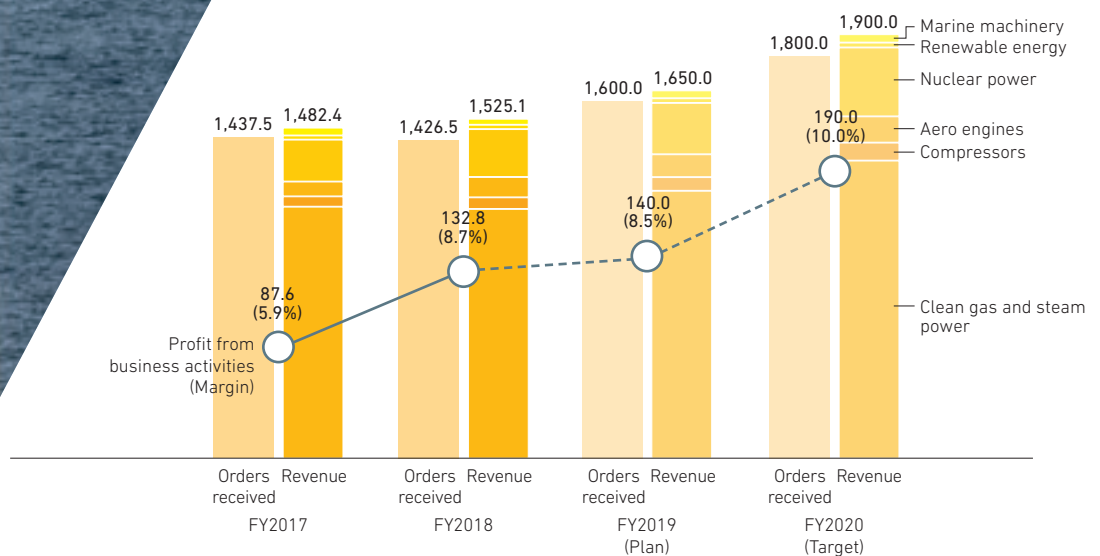


Main SDGs contributed to



## Operating Performance

(Billions of yen)



## Business Environment and Addressing Social Issues

MHI believes that global electric power demand will expand even further as electrification progresses, due to phenomena such as economic development in emerging countries and the penetration of electric vehicles. At the same time, global warming is expected to spur movement toward low-carbon and carbon-free energy. Geographic, economic, and social conditions differ depending on country and region, so it is important to realize a balanced energy supply that corresponds to these diverse needs. The introduction of renewable energy, such as wind power, has been expanding continuously. Simultaneously, we can see growing needs for supply and demand load regulation systems and energy storage systems that secure stabilized electric power and address requirements for efficiency improvement and lower generating costs.

## Areas of Focus under the 2018 Medium-Term Business Plan

We will work to expand after-sales services that meet demand for improving economic performance and reducing the environmental load. For example, we have been engaging in renovation of existing heavy-duty gas turbine plants for efficiency improvement, or for reducing NOx emissions by adding air quality control systems (AQCS). We are also working to respond to new domestic regulations on nuclear power and steadily promote and enhance the safety of construction work aimed at preventing major accidents related to nuclear power. For marine machinery, we will focus on construction geared toward switching over fuel sources to respond to SOx regulations. Additionally, to capitalize on the expanding market scale, we will enhance the MRO\*<sup>1</sup> business for aero engines and our compressor service network. In these ways, we will aim to establish a virtuous cycle in which the profit that we gain through these efforts will be invested in products in growth fields, such as small- to medium-sized gas turbines, compressors for gas processing plants, and manufacturing components for aero engines, in addition to expanding after-sales services for such products.

\*1 Maintenance, Repair, and Overhaul

## Business Opportunities in the Near Future

The world's energy consumption is forecast to grow 30% or more over a 15-year period, from 24,919 TWh in 2016 to 33,510 TWh by 2030.\*<sup>2</sup> In terms of the global power mix, the percentage of renewable energy used in Europe and the Americas is doubling, while the use of coal-fired power is declining. However, the use of gas-fired thermal power and nuclear power is expected to remain at a steady level. Meanwhile, in Southeast Asia, the rising demand for power is being met with renewable energy, gas, and coal-fired power. Although the use of renewable energy will continue to grow going forward, there is a limit to how much this energy source can meet demand for power on its own. Accordingly, steam power will continue to play a key role as a renewable adjusted flexible operation, and also nuclear power will remain an important base load energy source.

\*2 Source: World Energy Outlook 2018

## Development of Key Technologies and Creation of Synergies

It is MHI Group's continued aim to reach the Sustainable Development Goals (SDGs). As the introduction of renewable energy progresses, we will contribute to society by providing a balanced energy infrastructure. To that end, we will develop products and offer solutions that contribute to a stable power supply, including hydrogen-powered gas turbines, light-water reactors that enhance safety, and innovative next-generation reactors. Additionally, to support the future need for introducing energy infrastructure, we are working together with a university in Australia to develop the key index approach "QoEn™." This index approach will aim to offer proposals related to a quantitative vision for high-quality energy infrastructure from the planning stage of projects such as urban development.

QoEn™ is a registered trademark of Mitsubishi Heavy Industries, Ltd.

Strengths	S	Clean Gas and Steam Power	<ul style="list-style-type: none"> <li>• Systems offering world's highest levels of thermal efficiency and output</li> <li>• A full range of output levels, from small and medium-sized to large</li> <li>• Cutting-edge low-carbon and eco-friendly technologies (IGCC, highly efficient USC,*<sup>1</sup> CCS/CCUS,*<sup>2</sup> AQCS,*<sup>3</sup> and FGD*<sup>4</sup>)</li> </ul>
		Nuclear Power	<ul style="list-style-type: none"> <li>• Highest levels in the world in safety technologies and product quality</li> </ul>
		Renewable Energy	<ul style="list-style-type: none"> <li>• Extensive track record in offshore wind turbines (second-largest share of the world market) and launch of a 10 MW offshore wind turbine with world's highest output (MVOW*<sup>5</sup>)</li> </ul>
		Aero Engines	<ul style="list-style-type: none"> <li>• Combustor and low-pressure turbine manufacturing techniques amassed over many years</li> </ul>
		Compressors	<ul style="list-style-type: none"> <li>• Top share of the market in the petrochemical field</li> </ul>
		Marine Machinery	<ul style="list-style-type: none"> <li>• Flexible customization and the ability to provide solutions</li> </ul>
		Turbomachinery Synergies	<ul style="list-style-type: none"> <li>• Mutual use of technologies, human resources, and facilities</li> <li>Gas turbines, aero engines, aero-derivative gas turbines (PWPS*<sup>6</sup>), compressors, pumps, MET turbochargers, Organic Rankine Cycle (Turboden)</li> </ul>
<p><small>*1 Ultra super critical *2 Carbon capture and storage/carbon capture utilization and storage *3 Air quality control systems *4 Flue gas desulfurization *5 MHI Vestas Offshore Wind *6 PW power systems</small></p>			

Weaknesses	W	Clean Gas and Steam Power	<ul style="list-style-type: none"> <li>• Development of service businesses</li> </ul>
		Nuclear Power	<ul style="list-style-type: none"> <li>• Little experience in constructing new plants overseas</li> </ul>
		Renewable Energy	<ul style="list-style-type: none"> <li>• Overspecializing in offshore wind turbines, thereby not being able to produce enough renewable energy to meet lively demand</li> </ul>
		Aero Engines	<ul style="list-style-type: none"> <li>• Market led by European and U.S. engine manufacturers</li> </ul>
		Compressors	<ul style="list-style-type: none"> <li>• Track record in the oil and gas market</li> </ul>
		Marine Machinery	<ul style="list-style-type: none"> <li>• Global network</li> </ul>

Opportunities	O	Clean Gas and Steam Power	<ul style="list-style-type: none"> <li>• Need for high-efficiency, green power generation in line with increasingly stringent environmental regulations</li> <li>• Need for supply and demand adjustments in accordance with the expansion of renewable energy</li> </ul>
		Nuclear Power	<ul style="list-style-type: none"> <li>• Introduction of new plants in anticipation of upcoming carbon-free societies</li> </ul>
		Renewable Energy	<ul style="list-style-type: none"> <li>• Expanding offshore wind turbine market (Europe, North America, Japan, Taiwan, etc.)</li> </ul>
		Aero Engines	<ul style="list-style-type: none"> <li>• Sustained growth in the aircraft market</li> </ul>
		Compressors	<ul style="list-style-type: none"> <li>• Increasingly vigorous oil and gas markets</li> </ul>
		Marine Machinery	<ul style="list-style-type: none"> <li>• Strengthened environmental regulations</li> </ul>

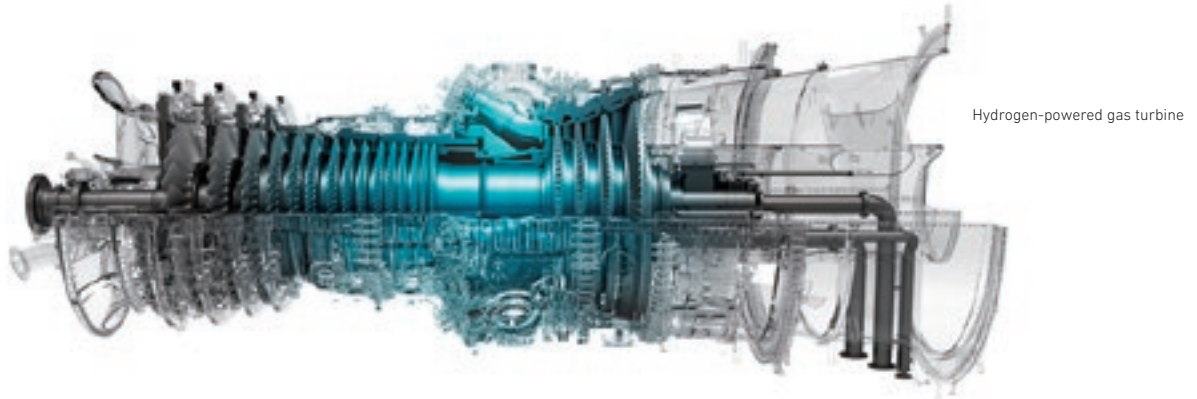
Threats	T	Clean Gas and Steam Power	<ul style="list-style-type: none"> <li>• Increasingly stringent competition with overseas companies</li> </ul>
		Nuclear Power	<ul style="list-style-type: none"> <li>• Trend away from nuclear power generation</li> </ul>
		Renewable Energy	<ul style="list-style-type: none"> <li>• Increased pressure to lower prices of offshore wind turbines, rise in the number of competitors</li> </ul>
		Aero Engines	<ul style="list-style-type: none"> <li>• Aircraft component business changing due to technological innovation</li> </ul>
		Compressors	<ul style="list-style-type: none"> <li>• Increasingly severe competition in the oil and gas market</li> </ul>
		Marine Machinery	<ul style="list-style-type: none"> <li>• Creation of massive shipbuilding companies through M&amp;A in China and South Korea</li> </ul>

## Strategies

Clean Gas and Steam Power	<ul style="list-style-type: none"> <li>• Develop technology to further reduce environmental load (efficiency improvement technology application of heavy-duty gas turbines, hydrogen-powered gas turbines and AQCS, etc.)</li> <li>• Expand sales of small- to medium-sized gas turbines with multiple applications</li> <li>• Expand service solutions business (renovation of existing plants, strengthening of solution proposals through AI/IoT, etc.)</li> <li>• Improve management efficiency through the continuous implementation of post-merger integration (Optimize resources)</li> </ul>
Nuclear Power	<ul style="list-style-type: none"> <li>• Steadily promote a response to new domestic regulations on nuclear power, provide support for severe accident management facilities</li> <li>• Implement maintenance work after the restart of operations</li> <li>• Provide support for completion of the construction of nuclear fuel cycle facilities</li> <li>• Support measures for the decommissioning of light-water reactors leveraging the technologies as a plant supplier, support the stabilization of the Fukushima Daiichi Nuclear Power Plant</li> <li>• Develop new reactors with enhanced safety for upcoming new-build projects, develop future reactors (fast reactors, small-modular reactors, high temperature gas cooled reactors)</li> </ul>
Renewable Energy	<ul style="list-style-type: none"> <li>• Strengthen mass production systems in response to the expanding offshore wind turbine market</li> </ul>
Aero Engines	<ul style="list-style-type: none"> <li>• Expand business scale to meet robust demand for commercial aircraft</li> <li>• Expand MRO business</li> </ul>
Compressors	<ul style="list-style-type: none"> <li>• Expand sales of compressor trains in the oil and gas market</li> <li>• Expand and improve service bases, strengthen solutions business response (remote monitoring)</li> </ul>
Marine Machinery	<ul style="list-style-type: none"> <li>• Develop new types of turbochargers to expand business, capture new customers in Europe and China</li> </ul>

## Structural Transition in Energy Businesses

While responding to the steam power market, where demand to lower environmental load is increasing, we will strengthen our product development for clean gas power generation, which is expected to expand, with a focus on the shift to a low-carbon society. We will also work to expand our solution services utilizing AI and IoT.



Hydrogen-powered gas turbine

We anticipate that steam power generation will continue to serve as a means for responding to the fluctuating load of renewable energy, which continues to grow. We also believe that nuclear power will continue to be utilized as a base load power. Accordingly, these types of energy will likely continue to be a necessary part of power generation in the low-carbon society of the future. MHI Group will aim for growth over the medium to long term by completing the structural transition of its energy businesses.

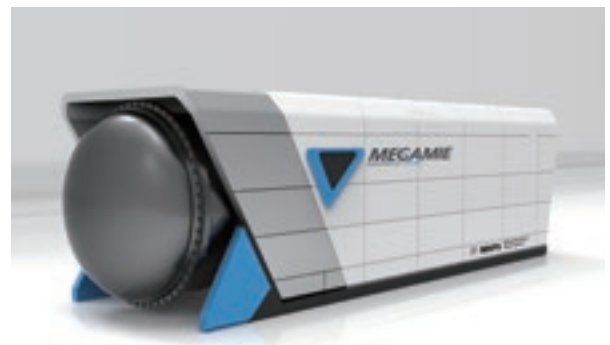
We have achieved the No.1 global market share in heavy-duty gas turbines in fiscal 2018, and we will strive to further increase our share by introducing products with the world's best efficiency. At the same time, we will develop next-generation products as well as hydrogen-powered gas turbines, which do not emit CO<sub>2</sub>. For medium-sized gas turbines, we will increase sales of products for multiple applications, such as renewable adjusted flexible operation, distributed power generation, and compressor-driven operations. We will also strive to gain the ability to mass-produce solid oxide fuel cells (SOFC).

Furthermore, we will expand our after-sales services that strive to improve the operation of existing facilities. We will also reinforce our total solutions that meet needs for improving economic

performance from the perspective of both supply and demand and reducing the environmental load. These solutions include energy-saving proposals utilizing AI and IoT: ENERGY CLOUD®, which offers factory management know-how covering from operation to maintenance; and MHPS-TOMONI®, which enhances the performance of power plants and improves operational efficiency.

In terms of renewable energy, we will move forward with the development of the 10 MW offshore wind turbine, which represents the world's highest output, at MVOW, a joint venture in Denmark.

For realizing a society with well-balanced energy, MHI Group will promote coexistence within society and support renewable energy through our clean products and services.



Solid oxide fuel cells (SOFC)

ENERGY CLOUD® is a registered trademark of Mitsubishi Heavy Industries, Ltd.  
MHPS-TOMONI® is a registered trademark of Mitsubishi Hitachi Power Systems, Ltd.