

# Energy Systems



GTCC Power Plant (Thailand)

## Current Status Assessment

<b>Strengths</b> <span style="font-size: 2em; color: white;">S</span>	<b>Gas &amp; Steam Power Systems</b>	<ul style="list-style-type: none"> <li>Systems offering world's highest levels of thermal efficiency and output</li> <li>Integrated system for gas turbine development, design, manufacture, verification and after-sales service</li> <li>Extensive product portfolio</li> <li>Combustion technology supporting diverse fuels such as hydrogen, ammonia coke oven gas (COG) and blast furnace gas (BFG)</li> <li>Integration capabilities combining cutting-edge decarbonization and other eco-friendly technologies</li> <li>Technological capabilities and systems enabling integrated verification from hydrogen production to power generation</li> </ul>
	<b>Nuclear Power Systems</b>	<ul style="list-style-type: none"> <li>World's only comprehensive nuclear power plant manufacturer capable of providing a one-stop service from development through design, manufacture, construction, and maintenance</li> <li>Encompassing not only light-water reactors but also the entire nuclear fuel cycle, including fuel manufacturing/reprocessing facilities and fast reactors</li> <li>World-highest level safety technologies and product quality, and ample track record as the leading company in domestic nuclear power</li> </ul>
	<b>Renewable Energy</b>	<ul style="list-style-type: none"> <li>Building wind power systems business in collaboration with partners</li> </ul>
	<b>Compressors</b>	<ul style="list-style-type: none"> <li>Extensive track record in chemical (ethylene and fertilizer) market</li> <li>Integrated production and quality control processes encompassing every step from optimal pairing of internally manufactured steam turbines and compressors to test operation</li> <li>Synergy with turbo-machinery technology of MHI Group</li> </ul>
	<b>Aero Engines</b>	<ul style="list-style-type: none"> <li>Technological capabilities in combustors and low-pressure turbines</li> <li>Robust coordination with manufacturers of aircraft engines</li> <li>Synergy with turbo-machinery technology of MHI Group</li> </ul>
	<b>Marine Machinery</b>	<ul style="list-style-type: none"> <li>High market share in MET turbocharger business for two-stroke marine engine segment</li> <li>Providing solution technology for energy saving and compliance with strengthened environmental regulations</li> <li>Wide-ranging customer network, both domestic and international</li> </ul>
<b>Weaknesses</b> <span style="font-size: 2em; color: white;">W</span>	<b>Gas &amp; Steam Power Systems</b>	<ul style="list-style-type: none"> <li>Imbalanced regional coverage at the global level</li> </ul>
	<b>Nuclear Power Systems</b>	<ul style="list-style-type: none"> <li>Little experience in global business</li> </ul>
	<b>Compressors</b>	<ul style="list-style-type: none"> <li>Low share of oil and gas market</li> </ul>
	<b>Aero Engines</b>	<ul style="list-style-type: none"> <li>High impact of the business strategies deployed by manufacturers of aircraft engines</li> </ul>
	<b>Marine Machinery</b>	<ul style="list-style-type: none"> <li>Limited scale of business and product portfolio</li> </ul>
<b>Opportunities</b> <span style="font-size: 2em; color: white;">O</span>	<b>Gas &amp; Steam Power Systems</b>	<ul style="list-style-type: none"> <li>Acceleration of global decarbonization movement and demand for highly efficient, clean electric power in response to environmental regulatory tightening</li> <li>Need for load adjustments in connection with growth in renewable energy</li> <li>Need for diversification of power generation methods and power generation fuels associated with strengthening of energy security</li> <li>Need for high-efficiency conversion and strengthening of resilience of existing power plants</li> </ul>
	<b>Nuclear Power Systems</b>	<ul style="list-style-type: none"> <li>Growing need for carbon-free, large-scale stable power sources and greater energy self-sufficiency (new and replacement facilities)</li> <li>Rising need for effective use of existing nuclear power plants (more plants being restarted, achievement of 60 years in operation)</li> <li>Increased need to supply equipment associated with plans for new equipment overseas</li> </ul>
	<b>Compressors</b>	<ul style="list-style-type: none"> <li>Replacement demand due to aging plants</li> <li>Growth in demand for CO<sub>2</sub> compressors for CCUS*1 and compressors for promising carbon-free fuels such as hydrogen and ammonia due to acceleration of Energy Transition</li> <li>Increase in energy demand due to high oil prices</li> </ul>
	<b>Aero Engines</b>	<ul style="list-style-type: none"> <li>Engine market expansion driven by growth in aircraft demand</li> </ul>
	<b>Marine Machinery</b>	<ul style="list-style-type: none"> <li>Increasing demands for new projects by acceleration of new initiatives for CO<sub>2</sub> reduction and zero GHG emissions in the maritime industries</li> </ul>
<b>Threats</b> <span style="font-size: 2em; color: white;">T</span>	<b>Gas &amp; Steam Power Systems</b>	<ul style="list-style-type: none"> <li>Further escalation of competition with international competitors</li> <li>Uncertainty of future energy portfolio</li> <li>Geopolitical risk caused by destabilization of the international situation</li> </ul>
	<b>Nuclear Power Systems</b>	<ul style="list-style-type: none"> <li>Escalating competition with other power sources</li> </ul>
	<b>Compressors</b>	<ul style="list-style-type: none"> <li>Escalating competition, rise of Chinese manufacturers</li> <li>Impact of industry restructuring and new chemical processes</li> </ul>
	<b>Aero Engines</b>	<ul style="list-style-type: none"> <li>Change of aircraft business model due to technological innovation</li> <li>Industry changes including supply chains after COVID-19</li> </ul>
	<b>Marine Machinery</b>	<ul style="list-style-type: none"> <li>Less business opportunity due to unfavorable domestic shipbuilding market conditions</li> </ul>

## Overview of FY2021 and Priority Strategies in the 2021 Medium-Term Business Plan

As the trend of decarbonization accelerates globally, we believe that MHI Group's GTCC\*2, nuclear power systems and biomass power systems will play an important role in the Energy Transition. Consolidated orders received were up year on year to ¥1,444.3 billion due to orders for new installations of GTCC, nuclear power systems and biomass power systems. Revenue totaled ¥1,651.0 billion, a year-on-year increase attributable largely to increased sales of GTCC and nuclear power systems. Although stable earnings were secured in GTCC and nuclear power systems, profit from business activities was ¥86.2 billion, an overall decrease due to recording a gain on sales of securities related to the offshore wind power systems business in the previous year.

MHI Group is working toward a carbon neutral society by implementing specific measures concerning the Energy Transition. In the gas & steam power systems business, we are developing hydrogen gas turbines to decarbonize existing infrastructure, and are steadily proceeding to perform verification aimed at commercialization by 2025, such as successfully conducting hydrogen combustion trials at the Takasago Machinery Works, and with large-frame gas turbines at a power plant in Georgia, U.S. In addition, we began establishing Takasago Hydrogen Park, which will be the world's first facility enabling integrated validation from hydrogen production to power generation. At the same time, as a measure for the transition phase, we will also engage in reduction of carbon emissions through improvement of efficiency of existing thermal power generation facilities and the combustion of biomass and ammonia.

In the nuclear power business, we are working with electric utilities to restart existing light-water reactor plants, installing severe accident management facilities and preparing for completion of a fuel cycle facility's construction.

In FY2021, we performed work on safety measures for Kansai Electric Power Mihama Unit 3 and contributed to the resumption of operations at a plant more than 40 years old for the first time in Japan, in addition to contributing to the completion of the severe accident management facilities at Shikoku Electric Power's Ikata Unit 3. We are also designing a next-generation light-water reactor that will bring to fruition some of the safest reactors in the world thanks to the deployment of revolutionary technologies. We are aiming for commercial operation by the mid-2030s. Additionally, we are developing future reactors (e.g., small modular light-water reactors, high temperature gas-cooled reactors, fast reactors, micro-reactors, nuclear fusion reactors) to be able to meet diverse needs for power sources in the future. In FY2021, MHI decided to cooperate with the development of the fast reactor (Sodium reactor) under development by U.S.-based TerraPower (whose largest investor is Bill Gates).

Lastly, we are building out our wind power systems business in collaboration with partners.

In the compressors business, we are proposing CO<sub>2</sub> compressors for CCUS and compressors for applications in hydrogen and ammonia supply chains. Furthermore, in the marine machinery business we participated in a global joint research project, focused on R&D activities of new technologies and engaged in the acceleration of decarbonization and the establishment of international rules in the maritime industry. Aero engines are expected to recover to the market size before COVID-19, and we will strengthen the cost competitiveness of the Nagasaki plant that began production in 2020. In response to growing energy demand and decarbonization, MHI Group has established a system for responding to market needs in a wide range of businesses.

## Business Initiatives in the 2021 Medium-Term Business Plan

<b>Gas &amp; Steam Power Systems</b>	<ul style="list-style-type: none"> <li>Develop and demonstrate hydrogen-fired gas turbines and other clean power products in pursuit of a decarbonized society</li> <li>Expand the number of gas turbine order bookings and improve profitability by reducing costs</li> <li>Expand advanced maintenance and innovation businesses</li> <li>Expand industrial businesses through energy solutions</li> </ul>
<b>Nuclear Power Systems</b>	<ul style="list-style-type: none"> <li>Provide support for the restart of domestic light-water reactor plants and the installation of severe accident management facilities, and strengthen service operations to contribute to stable supply and higher economic efficiency after restarting</li> <li>Support the completion of nuclear fuel reprocessing facilities, support maintenance work after completion, and achieve the nuclear fuel cycle domestically in Japan</li> <li>Decommission light-water reactor plants, and provide support for TEPCO's Fukushima Daiichi nuclear power plant</li> <li>Promote development of next-generation light-water reactors and future reactors (e.g., small modular light-water reactors, high temperature gas-cooled reactors, fast reactors, micro-reactors, nuclear fusion reactors) that will achieve some of the world's safest reactors thanks to the deployment of revolutionary technologies</li> </ul>
<b>Compressors</b>	<ul style="list-style-type: none"> <li>Expand operations by allocating more resources, including staff, to after-sales service</li> <li>Strengthen competitiveness in new construction projects; maintain stable order bookings in oil and gas sector and top market share in chemical sector</li> <li>Accelerate new-energy initiatives (ultra-high-tip-speed compressors for hydrogen sector, geared compressors for CCUS)</li> </ul>
<b>Aero Engines</b>	<ul style="list-style-type: none"> <li>Ramp up MRO*3 business's new model (PW1100G-JM) service operations and parts repair business</li> <li>Further strengthen internal production capabilities and cost competitiveness through integrated production of combustors at the Nagasaki plant</li> <li>Strengthen design and technological capabilities by deepening collaboration, including joint development programs, with aircraft engine makers</li> </ul>
<b>Marine Machinery</b>	<ul style="list-style-type: none"> <li>Participate in global R&amp;D partnerships together with the other major players in the maritime industry to accelerate the development of technology toward zero GHG emissions</li> <li>Expand MET turbocharger business (expand and maintain market share in the two-stroke engine market as a stable business and accelerate to penetrate the four-stroke engine market for further business expansion)</li> <li>Expand service business by strengthening global network</li> </ul>

\*1 CCUS: CO<sub>2</sub> Capture, Utilization, and Storage \*2 GTCC: Gas turbine combined cycle \*3 MRO: Maintenance, repair and overhaul