GTCC
Gas Turbine Combined Cycle
Power Plants
OUR PLANET IS CALLING FOR AFFORDABLE, SUSTAINABLE, HIGHLY RELIABLE AND CLEAN POWER. TOGETHER WE CAN ACHIEVE IT.

Power grows when we all work together.

There is a strong demand for energy decarbonization in the world today. One in ten people is forced to live without reliable access to electricity, while global demand for power continues to grow. Mitsubishi Power addresses such needs by providing stable, highly reliable, and clean energy solutions.

Mitsubishi Power, a power solutions brand of Mitsubishi Heavy Industries based on a long history of product development and supply for more than a century, has been dedicated to designing, manufacturing, verifying, engineering, installing and providing services for a wide range of proprietary power generation systems.

One of our products is gas turbine combined cycle (GTCC) power plants, which provides incredibly efficient electric power while reducing CO₂ emissions.

We also provide next-generation power systems, such as integrated coal gasification combined cycle (IGCC) power plants, steam power plants, geothermal power plants, air quality control systems (AQCS) and intelligent solutions TOMONI™.

Mitsubishi Power combines cutting-edge technology with deep experience to deliver innovative, integrated solutions that help to realize a carbon neutral world, improve the quality of life and ensure a safer world.
Clean, high-efficiency power

Gas turbine combined cycle (GTCC) power plants use natural gas to deliver one of the cleanest and most efficient forms of power. Plants employing Mitsubishi Power’s cutting edge J-series gas turbines are 20% more efficient than conventional coal-fired power plants and have attained the world’s highest level of efficiency of more than 64%. What’s more, the system’s high efficiency reduces CO2 emissions by about 50%. Mitsubishi Power installed the first combined cycle power plant for a Japanese power company in 1971. Since then, we have installed numerous units for various customers who depend on Mitsubishi Power not only for the supply and installation of power plants, but also a wide range of ongoing services including inspections, maintenance and intelligent solutions TOMONi™.

What makes GTCC the most suitable choice?

The key advantages of GTCC thermal power plants

High level of thermal efficiency

In comparison with steam power plants, which offer a thermal efficiency of about 40%, combined cycle power plants deliver a thermal efficiency of about 60% (both figures are based on lower heating values).

Less impact on the natural environment

- Less carbon dioxide (CO2)
- Less Nitrogen oxides (NOx) and sulfur oxides (SOx)
- Less high-temperature wastewater
- Less water consumption compared to coal generators

Clean, high-efficiency power

World-class Highest Efficiency

More than 64% (LHV)

Wide Output Range

30-1,285 MW
(1 on 1 / 2 on 1 / 3 on 1)

Combined Cycle Power Plants

Verification Testing

Mitsubishi Power On-grid Facility

CO2 Emission

About 50% Lower

Compared with those of Coal-fired thermal power generation
How Mitsubishi Power helped deliver low-emission GTCC power to Oklahoma

In 2014, Mitsubishi Power signed a contract to supply a natural gas powered M501J Gas Turbine, Steam Turbine and associated electric generators to the Grand River Dam Authority (GRDA). The power generation equipment was designed for the GRDA’s new Unit #3 power generation facility in Chouteau, Oklahoma, USA. Also, as part of the project, GRDA signed a 25-year long term service agreement with Mitsubishi Power.

Manufactured at Mitsubishi Power’s main US production facility in Savannah, Georgia, this project was delivered on schedule as the first order for a state-of-the-art J-type gas turbine for the US market. Only two days after it achieved successful First Fire on March 14, 2017, it synchronized to the grid to deliver electricity for GRDA.

First 60 Hz plant to achieve 62% efficiency

The Oklahoma plant is the first 60 Hz plant in the world to achieve an efficiency of 62%. During the smooth startup process, the M501J turbine exceeded its performance guarantee and GRDA was selling power to the grid ahead of schedule.

First Fire was well ahead of schedule

“It has been my privilege to work with the technology team assembled to create Unit 3 at the Grand River Energy Center,” said Charles J. Barney, Executive Vice President of GRDA.

“These partners all shared our vision to set a new standard for efficiency and reliability. Each partner contributed their best engineers and constructors, and I congratulate them on their exceptional accomplishment. This ultra-efficient electric generator is now integrated with our hydro and wind generation, and will help assure that GRDA customers have low-cost, clean and reliable electricity for many decades,” said Mr. Barney.

Because Mitsubishi Power is focused on GTCC power solutions that reduce environmental burdens, this project is another example of how Mitsubishi Power GTCC technology is playing a key role in preserving the planet by lowering CO2 emissions.
Gas Turbines

Raising the world’s standards for capacity and efficiency

Mitsubishi Power gas turbines made with cutting-edge technology

Small and medium capacity gas turbines (41 MW to 116 MW)

H-25-series
H-100-series

Large capacity gas turbines (114 MW to 574 MW)

For 60 Hz
• M501J-series
• M501G-series
• M501F-series
• M501D-series

For 50 Hz
• M701J-series
• M701F-series
• M701G-series
• M701D-series

Aero-Derivative Gas Turbines (30 MW to 140 MW)

• FT8® MOBILEPAC®
• FT8® SWIFTPAC®
• FT4000® SWIFTPAC®

Powering the world with a full range of gas turbines

To meet the power demands of industries and societies around the world, Mitsubishi Power produces a wide range of gas turbines from the 30 MW to the 574 MW class for power generation and industrial use. These turbines drive the development and supply of highly-efficient, clean energy around the world. In fact, Mitsubishi Power has delivered more than 1,600 gas turbines to customers in more than 50 countries worldwide.

Gas Turbine and Combined Cycle Output

Thermal Efficiency of Combined Cycle Systems
High-capacity gas turbines for power generation incorporating cutting-edge technologies

J-series gas turbines build on the proven G-series design with advanced technologies developed as part of a Japanese government’s national project to develop a class of gas turbines that have a turbine inlet temperature (TIT) of 1,700°C. The J-series, with a TIT of 1,600°C is well on its way to meeting the Project’s goal.

Compressor

Advanced 3D design techniques were used to improve the performance and reduce the shockwave loss in the intermediate and final stages. This concept was evaluated using 3D computational fluid dynamics (CFD) software and verified using a full-scale, high-speed research compressor. In addition to variable inlet guide vanes used to modulate air flow, J-series gas turbines are equipped with three variable vanes at the front stages of the compressor. The four stages operate together to modulate the gas turbine air flow, in order to maintain a relatively high exhaust temperature (at part load) for improved bottoming cycle efficiency.

Combustor

The J-series combustor is based on the proven steam cooling system used in G-series gas turbines. The turbine inlet temperature of 1,600°C (2,912°F) is 100°C (180°F) higher than the G-series. We were also able to maintain emissions to levels equivalent to the G-series.

This was accomplished through the use of low-NOx technologies including optimization of the local flame temperature in the combustion zone, and by improving the combustion nozzle to produce a more homogeneous mixture of fuel and air. The advanced JAC-series with air-cooled combustors enhances operational flexibility by eliminating the need for steam cooling in the bottoming cycle.

Turbine

The blades of turbine rows 1 to 4 are cooled by compressor bleed air, which is cooled by an external air cooler. The vanes of turbine rows 1 to 4 are also air cooled, with row 1 vane cooled by compressor discharge air, and the remaining vane rows are cooled by compressor intermediate stage bleed respectively. The cooling structure was improved for the G-series turbine, and again for the J-series.

The application of high-performance film cooling, developed as part of the Japanese Government’s National Project, further offsets the temperature increase.

The metal temperature is maintained at the same level as the J-series by utilizing the 1,700°C technology developed in the Japanese National Project. The 100°C (180°F) temperature increase from the G-series to the J-series is offset in part by an advanced thermal barrier coating (TBC).

Development of the air-cooled JAC-series

The JAC-series gas turbines use air cooling for combustors instead of steam cooling. With performance equivalent to the J-series gas turbines, they produce a high level of flexibility including a shorter start-up time.

Advantages of the JAC-series

While the flow path of the compressor and the turbine has the same shape as that of the J-series, the JAC-series has a cooling structure for the blades and vanes of the turbine, which is optimized according to the air-cooled combustor. The combustor uses the air cooling system that has proven its effectiveness and reliability in the GAC-series. JAC-series turbines also feature the low-NOx technology used in the J-Series.

The latest models in the J-series and the JAC-series gas turbines. In combined cycle operation, the JAC-series achieves power generation efficiency of more than 64%.

Enhanced air cooling system

Air extracted from the combustion casing in the compressor outlet is cooled using an external cooler. It is then pressurized by an enhanced air compressor and returned to the combustor casing to cool the combustor.

The air cooling system, already verified at Mitsubishi Power’s T-Point validation facility, has the following features:

- Exhaust heat from the external cooler is recovered in the bottoming cycle in a system that offers excellent efficiency.
- The combustor cooling mechanism is optimized to produce cooling performance equivalent to that of steam cooling.
- This system starts up faster than the steam cooling system.
Gas turbines for power generation to accommodate diverse fuels

In 1991, Mitsubishi Power developed the M501F-series gas turbines for 60 Hz power generation. The following year, it developed the M701F-series for 50 Hz power generation with similar design features. Since then, Mitsubishi Power has continued to improve the design of F-series gas turbines. While introducing advanced elemental and material technologies, verified by the G-series’ proven track record, the F-series attains continuous performance enhancement.

Compressor
Variable inlet guide vanes ensure operational stability at start-up and enhanced performance at partial load in combined cycle operation.

Combustor
A premixing low-NOx combustor is composed of one pilot burner surrounded by eight main burners. The compressor has an air bypass mechanism that enables regulation of the fuel-air ratio in the combustion region.

Turbine
The rotating blades on the first two stages are free-standing, while the third and fourth stages are integral shroud blades. Stationary vanes are supported by blade rings that are independent at individual stages to prevent turbine casings from being affected by thermal expansion.

In February 1997, the first M501G gas turbine with a TiT of 1,500°C entered commercial operation. This series features the use of steam for cooling combustors. The GAC-series, which is the current mainstay model, uses the latest air-cooled combustor technology in place of conventional steam-cooled combustors, using compressor discharge air for cooling combustors to add operational flexibility by eliminating the need for steam for cooling from the bottoming cycle.

Compressor
The GAC uses the existing proven G-series compressor. The advanced airfoil designs were incorporated to support a large volume, high efficiency and higher pressure ratio. Variable inlet guide vanes operate to modulate the gas turbine air flow to maintain relatively high exhaust temperatures (at part load) for improved bottoming cycle efficiency.

Combustor
The M501GAC has 16 annular combustor cans. The combustor is an ultra-low-NOx design with a single pilot nozzle for diffusion firing surrounded by eight nozzles for premixing firing. Innovations such as an air-cooled, dry-low-NOx combustor and the latest blade technology have been incorporated into the GAC following stringent element and operational model tests.

Turbine
The G-series employs a 3D aerodynamic design in a four-stage axial-reaction turbine. Directionally solidified (DS) materials with thermal barrier coating (TBC) are applied to the first two stages and the first three stages are air-cooled. The turbine blade rows to 3 are cooled by the compressor bleed air, which is cooled by the external air cooler. The vanes of turbine rows 1 to 3 are also air cooled, with the vanes of row 1 cooled by compressor discharge air. The remaining rows of vanes are cooled by intermediate-stage compressor bleed respectively. The first and second stages on the turbine rotor are free-standing. The third and fourth stages use integral shrouds. Each row of vane segments is supported in a separate blade ring, which is keyed and supported to permit radial and axial thermal response independent of possible external cylinder distortions.
**Shared Features of the J-, F-, and G-series**

**Designs backed with 40 years of experience**
The J, F and G-series incorporate basic design features and concepts developed over 40 years of experience, such as cold-end generator drive, single shaft rotor construction and axial exhaust.

**Gas turbines that are easy on the natural environment**
- Most efficient use of fossil fuel resources
- Low NOx, CO, UHC and VOC emissions

**Overall design**
First deployed in the early 1970s, these gas turbines are based on over 40 years of proven experience. The main features are:

- The compressor shaft end drive reduces the effect of thermal expansion on alignment and eliminates the need for a flexible coupling (cold-end generator drive).
- The rotor has a two-bearing structure to support the compressor and turbine ends.
- An axial flow exhaust structure is used to optimize the combined-cycle plant layout.
- Horizontally split casings facilitate field removal of the blades with the rotor in place.

**Flexible configurations**
Based on our sophisticated combined cycle plant technology and diverse product applications, we not only offer our customers multi-shaft arrangements such as a 2 on 1 configuration, but also a 1 on 1 configuration with the gas turbine, steam turbine and generator connected on the same shaft.

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**Aero-Derivative Gas Turbine Package**
Mitsubishi Power supplies aero-derivative and industrial gas turbines. Having installed more than 550* industrial gas turbines in over 50 countries worldwide, we pride ourselves in our expertise in gas turbine repairs and overhauls. Our portfolio offers competitive, efficient and flexible products generating from 30 to 140 MW of power.

- FT8®, FT4000®

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* FT8®, FT4000®
Advantages of the H-25-series
- Heavy duty structure: A highly reliable design focused on ease of maintenance and long-term continuous operation.
- High efficiency: Exceptional performance in various power generation cycles (simple, combined and co-generation).
- Package: Easy to transport and install.

Advantages of the H-100-series
- Heavy duty design: A heavy and highly reliable structure focused on ease of maintenance and long-term continuous operation.
- High efficiency: Exceptional performance in various power generation cycles (simple, combined and co-generation).
- Packaging: Easy to transport and install.
- The series is applicable not only for power generation but also for mechanical drives.

The world’s largest high-efficiency two-shaft gas turbines
Developed as the world’s largest high efficiency two-shaft gas turbines, the H-100-series was designed for utility and industrial customers in both 50 Hz and 60 Hz markets. The first unit went into commercial operation in 2010. Mitsubishi Power is always seeking to improve the design of the H-100-series gas turbines by incorporating advanced elemental and material technologies proven by H-25-series’ performance.

For co-generation plants
<table>
<thead>
<tr>
<th>Item</th>
<th>H-25</th>
<th>H-100</th>
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</thead>
<tbody>
<tr>
<td>Power Output</td>
<td>112.3 MW</td>
<td>182.5 MW</td>
</tr>
<tr>
<td>Overall Efficiency</td>
<td>More than 60%</td>
<td>More than 50%</td>
</tr>
</tbody>
</table>

System Configuration
- Fuel: Natural gas, gas fuel, syngas, light oil, kerosene and bio-ethanol.
- Package: Easy to transport and install.

Mechanical drive applications
H-100-series gas turbines are suitable for mechanical drive applications, especially for driving compressors in LNG plants.

Features
- H-100-series models are suitable for 4 to 6 million tons per annum (MTPA) class LNG plants.
- Variable speed operation.
- Start-up with a fully loaded compressor.
- No helper motor or variable frequency driver (VFD) required.
- High nitrogen (N₂ fuel) applicability.
- Start-up with a fully loaded compressor.
- Variable speed operation.
Solutions for Power Augmentation
Mitsubishi Power provides solutions for increasing output for existing GTCC units. We offer a wide lineup of services for increasing power including water/steam injection, fogging, inlet air cooling systems such as chillers, changing the maximum IGV opening degree to increase working air, and compressor upgrades. We analyze economic and climatic conditions of each power plant and provide the best solution to meet the diverse needs of the market.

Solutions for Improving Availability
Services to improve power plant availability include:
- Shortening outage duration with maintenance-friendly product design
- Highly reliable products by applying the latest technology
- Maintenance optimization such as extended outage intervals by diagnostic analysis of operating conditions
- Early detection of signs of trouble by using intelligent solutions TOMONI® to reduce forced outages

Solutions for Improving Plant Operability
With the increase in renewable energy, further flexibility is required in gas turbine operation for power generation. Mitsubishi Power provides services that meet market needs, such as reducing start-up time, improving load change rate, optimizing shutdown and restart times, and enabling turnaround to operate at lower loads while improving emissions. We are also developing options that meet diverse market needs such as thermal efficiency improvements during low load operation to meet power demand and reduce power generation costs. We provide solutions that further improve operability such as a twin-shaft gas turbine that achieves a load change rate of 25% per minute.

Solutions for Decarbonization
Mitsubishi Power is creating a future that works for people and the planet by developing innovative power generation technology and solutions to enable the decarbonization of energy and deliver reliable power everywhere. To help achieve decarbonization, we will provide conversion of existing units to hydrogen or ammonia fired gas turbines with minimal modifications.


Solutions for Improving Thermal Efficiency
The latest J-series gas turbine technology is utilized in upgrades for F- and G-series gas turbines to improve thermal efficiency and increase power output of existing plants by replacing turbine and compressor components. We also offer upgrades for the H-25 series of small/medium gas turbines for thermal efficiency improvement with the latest components.

TOMONI™ Analytics and Performance Center
Our operation and maintenance experts work around the clock to monitor and support the operational status of plants around the world in real time. 365 days a year, 24 hours a day. By detecting signs of anomalies and diagnosing performance degradation based on ever-changing operation data as well as constant collaboration with customers, we provide optimal advice according to various situations to prevent problems and maximize availability.

Services Utilizing Advanced Technologies
The latest gas turbine models developed by Mitsubishi Power are equipped with a variety of advanced technologies, including component technologies developed in a Japanese national project to develop next-generation gas turbines. By applying these technologies to existing machines, we provide an upgrade service to improve performance, maintainability, reliability, and operability of existing plants. Since it is essential as a gas turbine manufacturer to be able to utilize the knowledge gained from our extensive operational experience with actual machines, we continue to work on technological developments that meet customer needs.

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Long Term Service Agreements (LTSA) for Gas Turbines
Mitsubishi Power provides comprehensive solutions to meet diverse customer needs to ensure high availability and reliability of gas turbines. Our LTSA-based solutions focus on efficient operation of power plants while minimizing maintenance costs, planning of maintenance programs and outages, supply and repair of parts, dispatch of technical advisors, TOMONI™ HUBs, and more.

Key Support Areas of Mitsubishi Power LTSA
- Short-term and long-term maintenance planning support for maximizing plant utilization and optimizing operation and maintenance costs
- Packaging of maintenance items to spread maintenance costs over time for customer budget optimization
- Reliable parts supply and technical support from expert engineers
- Utilizing remote monitoring services and data diagnosis using intelligent solutions TOMONI™ to optimize plant operations including fuel conversion, load changes, maintenance interval extensions, and more
- Solutions for business risks such as decreased demand, unexpected plant outages, and exchange rate fluctuations

Providing Services Throughout the Plant Life Cycle
Mitsubishi Power provides optimal services to meet the changing needs of customers throughout the plant life cycle.

<table>
<thead>
<tr>
<th>Performance and environmental improvement</th>
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</thead>
<tbody>
<tr>
<td>• Thermal efficiency improvement</td>
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<tr>
<td>• Power Augmentation</td>
</tr>
<tr>
<td>• CO2/NOx reduction</td>
</tr>
<tr>
<td>• Fuel conversion</td>
</tr>
<tr>
<td>• Steam power plant gas turbine replacement (repowering)</td>
</tr>
<tr>
<td>• Life extension</td>
</tr>
<tr>
<td>• Preventive maintenance, training, and operational support</td>
</tr>
</tbody>
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Long Term Service Agreements (LTSA)

<table>
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<tr>
<th>Start of operation</th>
<th>10 years</th>
<th>20 years</th>
<th>30 years</th>
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<tbody>
<tr>
<td>Life extension</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>improvement</td>
<td></td>
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</table>

Preventive maintenance, training, and operational support
TOMONI™, a suite of intelligent solutions use advanced analytics and are driven by customer collaboration to deliver powerful financial and environmental advantages including decarbonization.

TOMONI, a Japanese word meaning “together with,” reflects the emphasis Mitsubishi Power places on collaborating with customers to solve their unique challenges. Mitsubishi Power works together with customers, partners and society to deploy solutions that support the decarbonization of energy and deliver reliable power everywhere.

Features of TOMONI

- TOMONI is composed of three solution categories. O&M Optimization, Performance Improvement, and Flexible Operation. The combination of these categories allows us to deliver optimal solutions.
- From utility to industry power plant, TOMONI is applicable to a wide variety of power plants.
- TOMONI is able to customize for a variety systems such as cloud and edge computing as well as customer’s existing platforms.
- Combining with AI technology and Mitsubishi Power’s knowledges accumulated over the long history has enabled to develop solutions to optimize the operation of the power plant to meet customer’s demand.

Roadmap for TOMONI

Autonomous Operation of Power Plants.

- Advanced operation and maintenance
  - Minimize maintenance costs, improvement reliability
  - Combine AI technologies and our continue accumulated knowledges to assist O&M
  - AI identifies problems instantaneously and plant’s operational plan

- Remote monitoring / status visualization
  - Leverage IoT for remote monitoring, diagnostic applications
  - Detect abnormal cases, offer solutions
  - Provide high performance solutions through digitization of information

- Autonomous Operation
  - Optimize operations in response to changes (in environment)
  - Real-time diagnosis of power plant, automatic optimization with simulation technologies using high precision AI application (Digital Twin)

Comprehensive capabilities from Development to Manufacturing

Mitsubishi Power is the only solution provider in Japan that handles the entire production process from development, design, manufacturing, construction and commissioning to after-sales. For thermal power plants requiring advanced technology and reliability, we capitalize on our comprehensive approach to play a major role.

Validation facility

T-point at Mitsubishi Power’s Takasago Works

Purpose

- To validate gas turbine technologies newly applied to achieve higher efficiency, allow operations at elevated temperatures, and reduce NOx.
- To validate the reliability through long-term commercial operations of the highly efficient and environmentally friendly combined-cycle power generation.

History

The unit 1 power plant (T-point) equipped with the M501G-series gas turbine and performance and reliability tests were conducted since 1997, and long-term validation tests had been successfully completed. Then, in February 2011, the gas turbine was replaced with the M501J-series and the commissioning was completed safely in the same year. In 2015, the unit was upgraded to forced air-cooling system. The unit 2 power plant (T-point 2) upgraded and replaced T-point, started commercial operation in July 2020 with its cutting edge M501JAC-series gas turbine.

Validation of Next Generation Combined Cycle Power Generation

With its combination of gas turbine and steam turbine, T-point 2 is cutting edge combined cycle power plant validation facility. By developing next-generation technologies and validating them in T-point 2 GTC facilities, Mitsubishi Power helps its customers worldwide attain a stable electricity supply. Long term demonstration of off-site plant control at T-point 2 is conducted from the Mitsubishi Power Takasago TOMONI HUB (Analytics and Performance Center). Validation operations are run to increase the reliability of the entire plant including the main equipment such as turbines as well as auxiliary equipment such as pumps and fans. In addition, various applications of a suite of intelligent solutions TOMONI™, that serve to shorten start-up time and automatically optimize operation parameters are installed in T-point 2. Mitsubishi Power will also be training its AI applications, allowing T-point 2 to eventually become the world’s first autonomous combined cycle power plant.

<table>
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<tr>
<th>Item</th>
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<th>T-point 2</th>
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<td>Target Inlet Temperature</td>
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<td>1,645°C</td>
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<tr>
<td>Year Operation Started</td>
<td>1997</td>
<td>2011 (replacement date)</td>
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Notes: TOMONI is a trademark of Mitsubishi Heavy Industries, Ltd. in the United States and other countries. (Trademark registration has been applied for)
### Performance

#### Simple Cycle Specs

<table>
<thead>
<tr>
<th>ISG Base Rating (kW)</th>
<th>LM2500 Max Rate (kW)</th>
<th>Efficiency (% LHV)</th>
<th>Pressure Ratio (psi)</th>
<th>Turbine Speed (rpm)</th>
<th>Exhaust Flow (kg/s)</th>
<th>Exhaust Temp (ºC)</th>
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<tbody>
<tr>
<td>60 Hz</td>
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<td>17.9</td>
<td>7,200</td>
<td>114</td>
<td>549</td>
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<tr>
<td>60 Hz</td>
<td>61,800</td>
<td>36.2</td>
<td>17.9</td>
<td>7,200</td>
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<td>549</td>
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<tr>
<td>M701DA</td>
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<td>M801DA</td>
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<td>744</td>
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#### Mechanical Drive Specs

<table>
<thead>
<tr>
<th>ISG Base Rating (kW)</th>
<th>LM2500 Max Rate (kW)</th>
<th>Efficiency (% LHV)</th>
<th>Pressure Ratio (psi)</th>
<th>Turbine Speed (rpm)</th>
<th>Exhaust Flow (kg/s)</th>
<th>Exhaust Temp (ºC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 Hz</td>
<td>144,350</td>
<td>38.9</td>
<td>18.4</td>
<td>3,600</td>
<td>293</td>
<td>534</td>
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<tr>
<td>60 Hz</td>
<td>146,780</td>
<td>38.9</td>
<td>20.1</td>
<td>3,000</td>
<td>315</td>
<td>552</td>
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</tbody>
</table>

#### Aero-Derivative Gas Turbine Specs

<table>
<thead>
<tr>
<th>ISG Base Rating (kW)</th>
<th>LM2500 Max Rate (kW)</th>
<th>Efficiency (% LHV)</th>
<th>Pressure Ratio (psi)</th>
<th>Turbine Speed (rpm)</th>
<th>Exhaust Flow (kg/s)</th>
<th>Exhaust Temp (ºC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 Hz</td>
<td>28,528</td>
<td>36.7</td>
<td>3,000</td>
<td>92</td>
<td>696</td>
<td></td>
</tr>
<tr>
<td>FT6</td>
<td>70,194</td>
<td>40.4</td>
<td>3,000</td>
<td>183</td>
<td>431</td>
<td></td>
</tr>
<tr>
<td>FT6000/²</td>
<td>140,500</td>
<td>40.5</td>
<td>3,000</td>
<td>367</td>
<td>431</td>
<td></td>
</tr>
<tr>
<td>50 Hz</td>
<td>30,961</td>
<td>36.7</td>
<td>3,600</td>
<td>92</td>
<td>691</td>
<td></td>
</tr>
<tr>
<td>FT6</td>
<td>71,928</td>
<td>41.5</td>
<td>3,600</td>
<td>183</td>
<td>431</td>
<td></td>
</tr>
<tr>
<td>FT6000/²</td>
<td>144,243</td>
<td>41.6</td>
<td>3,600</td>
<td>367</td>
<td>431</td>
<td></td>
</tr>
</tbody>
</table>

### Combined Cycle Specs

<table>
<thead>
<tr>
<th>Plant Output (MW)</th>
<th>LHV Heat Rate (kJ/kWh)</th>
<th>Plant Efficiency (%)</th>
<th>Gas Turbine Power (MW)</th>
<th>Steam Turbine Power (MW)</th>
<th>Number &amp; Type Gas Turbine</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPCP21H-25</td>
<td>60,100</td>
<td>4,647</td>
<td>3,197</td>
<td>56.0</td>
<td>39,400</td>
</tr>
<tr>
<td>MPCP21H-25</td>
<td>72,400</td>
<td>4,656</td>
<td>3,261</td>
<td>56.5</td>
<td>79,200</td>
</tr>
<tr>
<td>60 Hz</td>
<td>171,000</td>
<td>4,272</td>
<td>3,916</td>
<td>57.4</td>
<td>112,700</td>
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<tr>
<td>MPCP21H-25</td>
<td>366,000</td>
<td>4,207</td>
<td>3,984</td>
<td>58.0</td>
<td>233,400</td>
</tr>
<tr>
<td>MPCP1H701DA</td>
<td>212,500</td>
<td>7,000</td>
<td>6,435</td>
<td>51.4</td>
<td>142,100</td>
</tr>
<tr>
<td>MPCP2H701DA</td>
<td>464,000</td>
<td>4,974</td>
<td>6,610</td>
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<td>284,200</td>
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<tr>
<td>MPCP3H701DA</td>
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<td>6,585</td>
<td>51.8</td>
<td>426,300</td>
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<tr>
<td>MPCP1H701F</td>
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<td>5,807</td>
<td>5,504</td>
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<td>397,300</td>
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<td>MPCP2H701F</td>
<td>1,126,000</td>
<td>5,788</td>
<td>5,486</td>
<td>62.2</td>
<td>758,600</td>
</tr>
<tr>
<td>MPCP1H701G</td>
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<td>6,071</td>
<td>5,755</td>
<td>59.3</td>
<td>325,700</td>
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<td>MPCP2H701G</td>
<td>999,400</td>
<td>6,051</td>
<td>5,735</td>
<td>59.5</td>
<td>615,400</td>
</tr>
<tr>
<td>MPCP1H701J</td>
<td>701,000</td>
<td>5,779</td>
<td>5,677</td>
<td>62.3</td>
<td>672,300</td>
</tr>
<tr>
<td>MPCP1H701JAC</td>
<td>650,000</td>
<td>+5,629</td>
<td>+5,332</td>
<td>+64.0</td>
<td>641,700</td>
</tr>
<tr>
<td>MPCP2H701JAC</td>
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<td>+5,629</td>
<td>+5,332</td>
<td>+64.0</td>
<td>800,700</td>
</tr>
</tbody>
</table>

**Notes:**
1. All ratings are defined at ISG standard reference conditions: 181.3°Fa, 10% and 46% Mr.
2. All ratings are at governor terminals and are based on the use of natural gas fuel.
3. Exhaust flow and exhaust losses.