



# MITSUBISHI POWER PROFILE



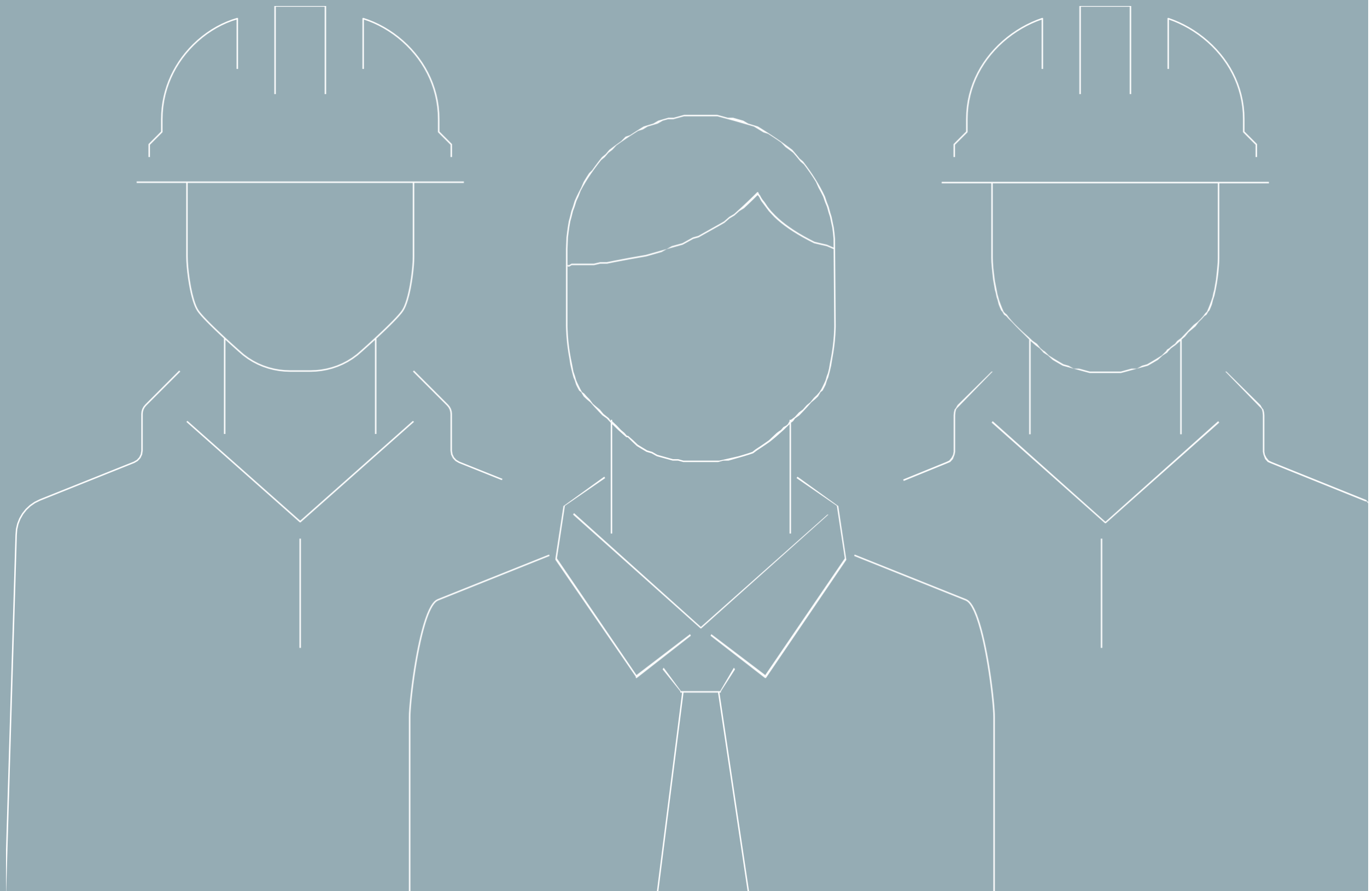
MOVE THE WORLD FORWARD MITSUBISHI  
HEAVY  
INDUSTRIES  
GROUP

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# — ABOUT US

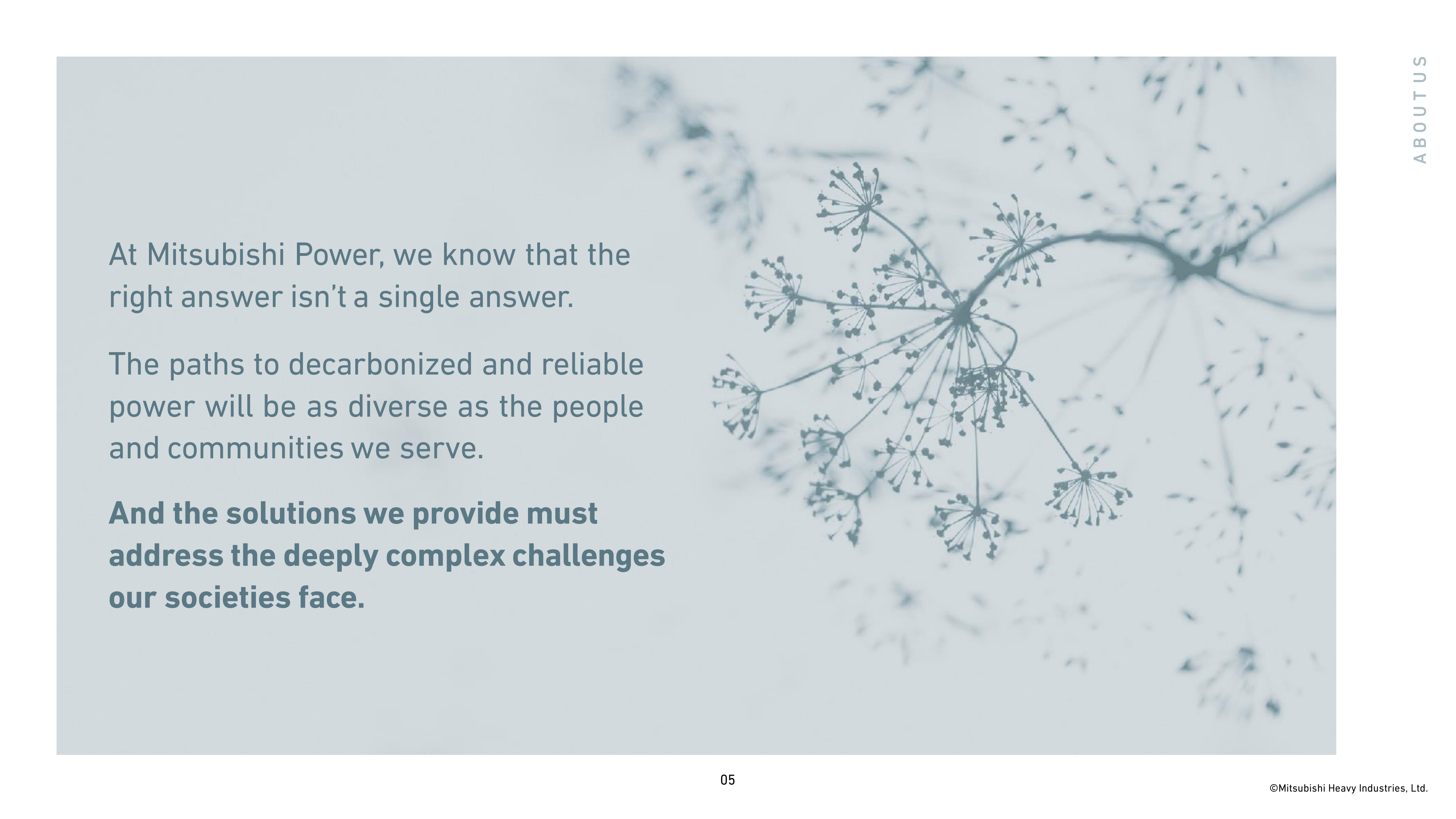




The energy story is the story of progress.

Our ability to generate power has enriched lives in communities and flourished nations throughout history.

But the energy sector's impact on our climate has presented us with what may seem to be an urgent and binary choice: either continue to use energy to advance the world or restrict energy usage to protect the environment.



At Mitsubishi Power, we know that the right answer isn't a single answer.

The paths to decarbonized and reliable power will be as diverse as the people and communities we serve.

**And the solutions we provide must address the deeply complex challenges our societies face.**



# OUR MISSION

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.

# OUR INTERNATIONAL NETWORK

We are present in more than 30 countries, ensuring that we bring our expertise and accumulated years of experience to customers and communities around the world.



# — OUR PRODUCTS AND SERVICES





# POWER PLANT SOLUTIONS

## ➤ GAS TURBINE COMBINED CYCLE (GTCC) Highly Decarbonized and Efficient Power Generation

GTCC power plants provide optimal efficiency: in addition to electricity produced by a gas turbine, they also capture and redirect waste heat for steam power generation.

Plants employing our state-of-the-art J-Series gas turbines run at record levels of efficiency, with our latest J-Series Air-Cooled (JAC) gas turbine operating at 64%. Our GTCC power plants also have a wide output range: between 30 and 1,280 MW. They can reduce CO<sub>2</sub> emissions 65% better than conventional coal-fired power plants.



## ➤ STEAM POWER Fuel Source Flexibility in Power Generation

Steam power plants utilize a variety of fuel sources including biomass, by-product gas, oil pitch and other fossil fuels to generate electricity.

We have an extensive record of developing high-efficiency ultra-supercritical press boilers and steam turbines with outputs of over 1,000 MW. We also offer advanced air quality control systems (AQCS) to reduce emissions from the power plants regardless of which fuel is used.



# POWER PLANT SOLUTIONS

## ➤ INTEGRATED COAL GASIFICATION COMBINED CYCLE (IGCC) Decarbonized Power Generation with Coal Gasification

Large IGCC plants, which comprise a coal gasifier and a GTCC system, can raise power generation efficiency by 10% to 15%. They have enhanced environmental performance: apart from lowering emissions of  $\text{SO}_x$ ,  $\text{NO}_x$  and dust, IGCC power plants also consume less water than traditional power systems.

We offer two types of world-leading coal gasification technologies – air-blown and oxygen-blown – catering to various customer needs for efficient and cleaner power generation. Additionally, we can equip IGCC plants with carbon capture and storage (CCS) capabilities to help reduce emissions produced during power generation. This technology converts solid fuel into hydrogen and other gaseous components; the hydrogen created can be used as a clean fuel, further contributing to the decarbonization of the power generation process.

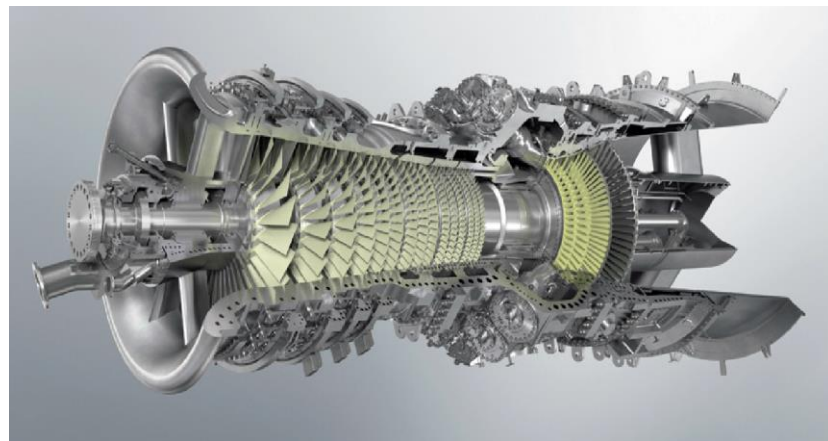


## ➤ GEOTHERMAL Cutting-Edge Technologies to Harness Natural Energy

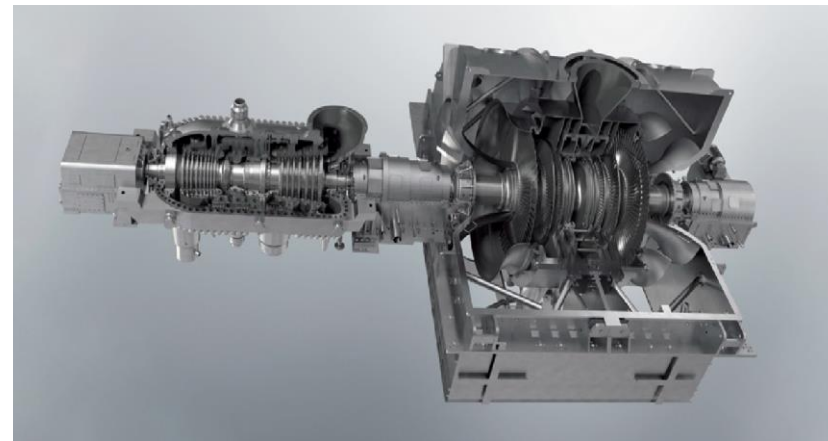
We have a proven track record in reliability and delivery of geothermal power systems, ranging in output from 100 kW to 160 MW. To date, we have supplied over 100 units of geothermal steam turbines, generating more than 3,000 MW of electricity across 13 countries. We are also the first in the world to apply a combined system comprising a two-phase flow transportation system and a double-flash cycle – an innovation that has become the standard in the category.



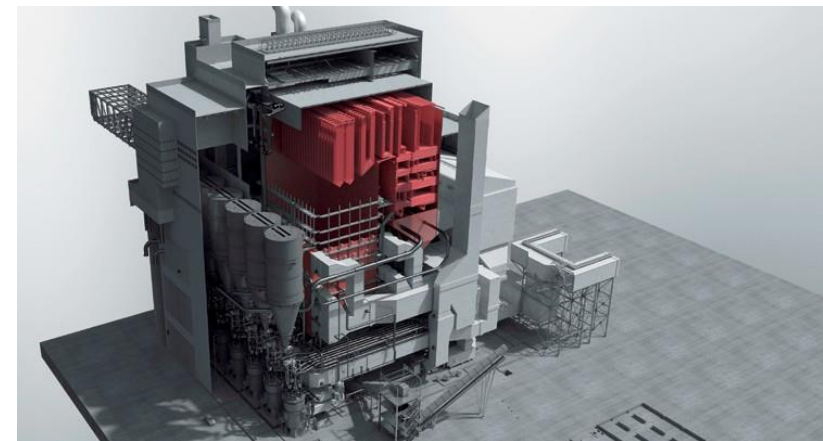
# PRODUCTS AND EQUIPMENT



> GAS TURBINES



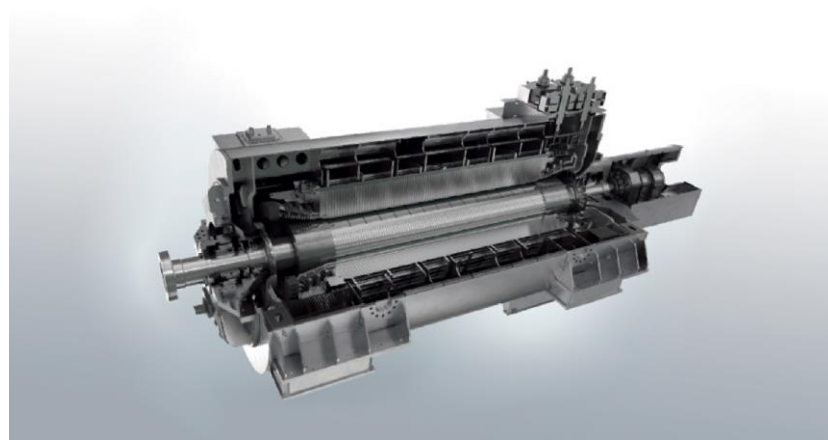
> STEAM TURBINES



> BOILERS



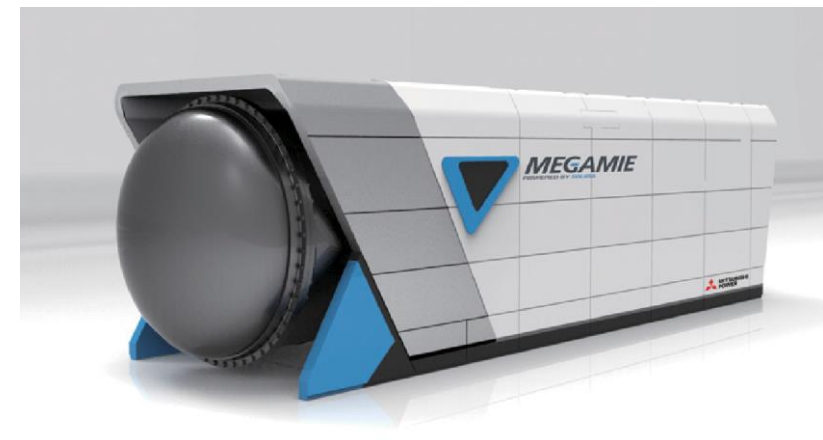
> AIR QUALITY CONTROL SYSTEMS



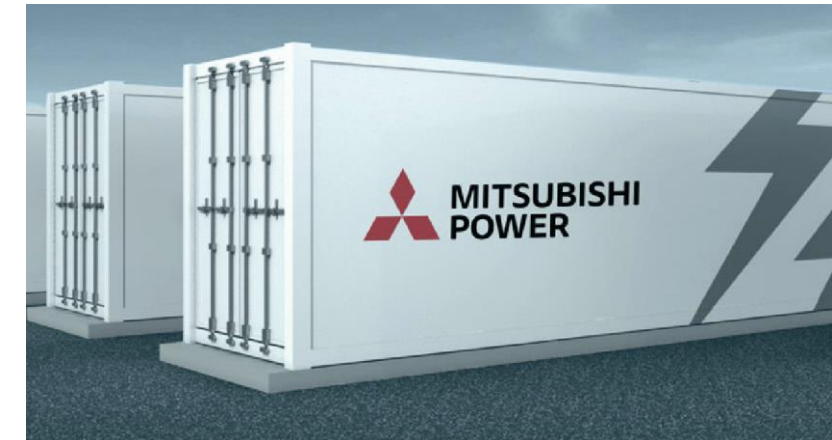
> GENERATORS



> CONTROL SYSTEMS & UPGRADES

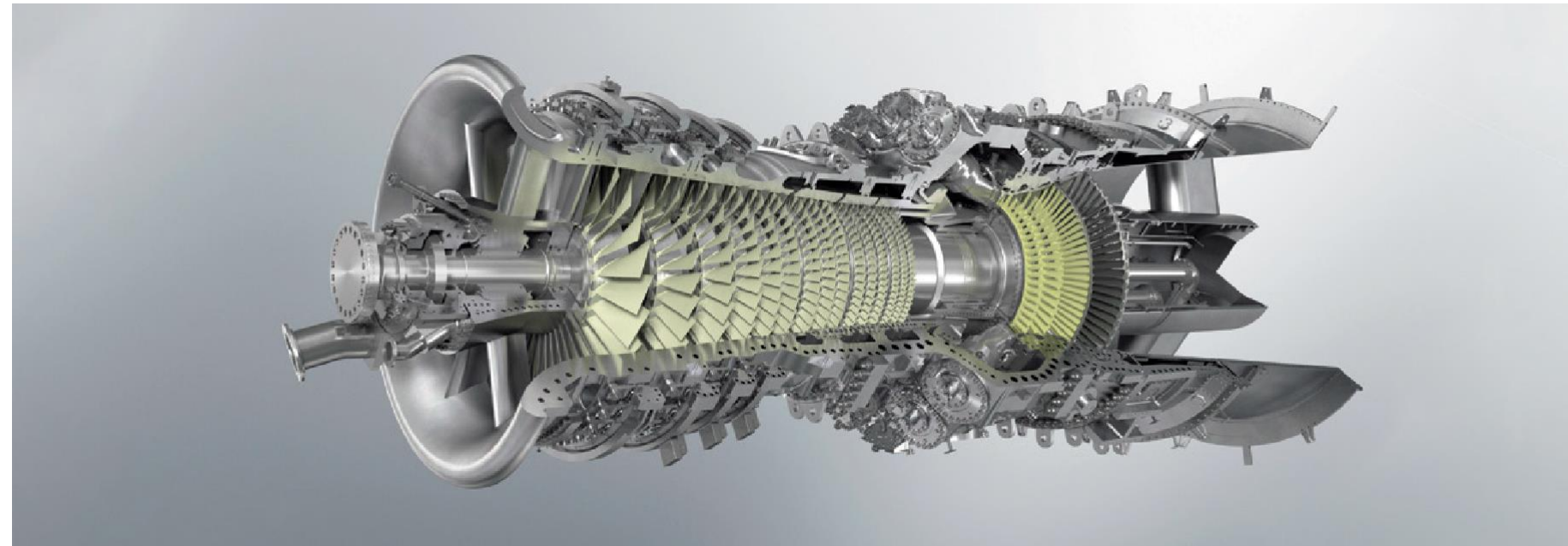


> FUEL CELLS



> ENERGY STORAGE SYSTEMS

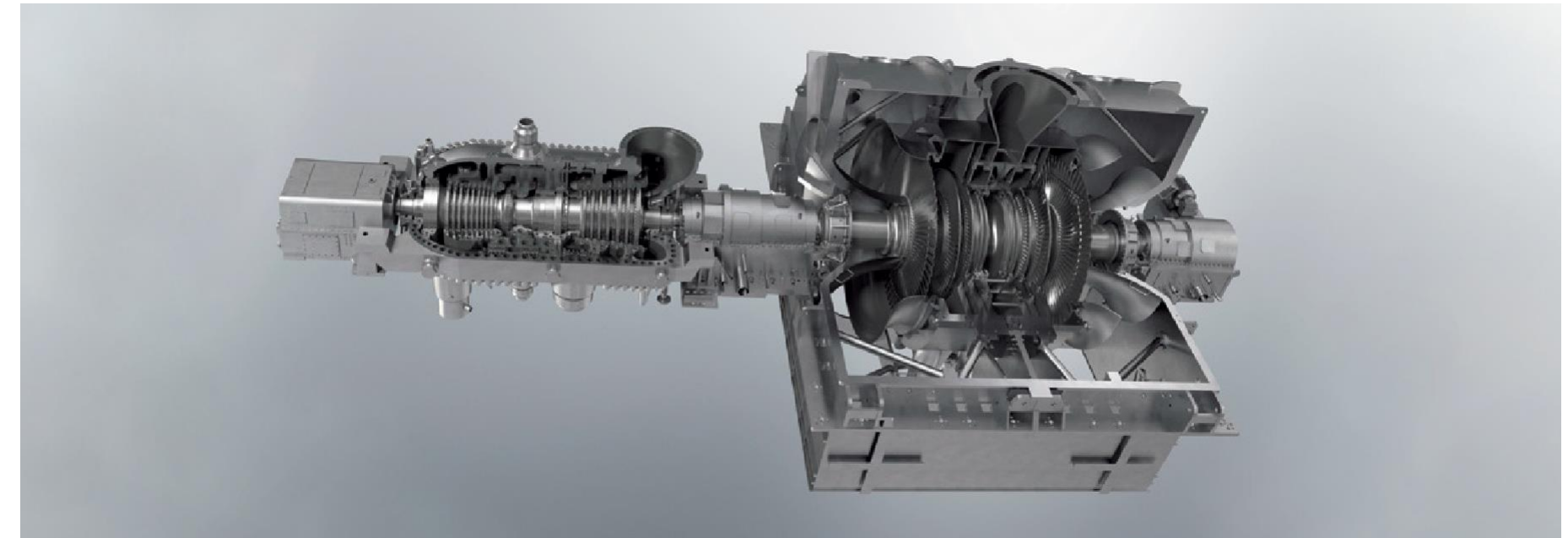
# PRODUCTS AND EQUIPMENT



## > GAS TURBINES

We have installed more than 1,600 gas turbines in national grids and industrial systems across more than 50 countries. These include 560 MW large capacity units as well as 30 MW aero-derivative models which are an important auxiliary power source for renewable energy systems. Apart from exclusive gas firing, we have also developed equipment to facilitate co-firing with hydrogen, ammonia and other fuels, as well as combined cycle systems.

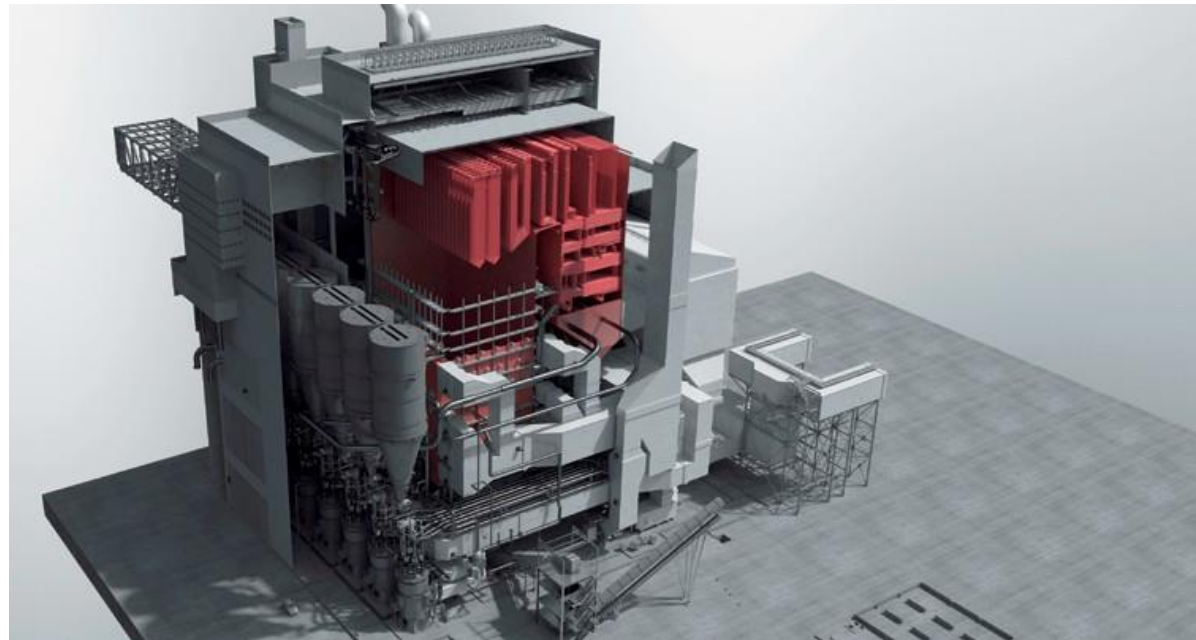
Our T-Point 2 facility at Takasago Machinery Works is the hub of our gas turbine development. With its unique long-term prototype validation process, T-Point 2 ensures that we provide our customers the most reliable and efficient power generation equipment. Currently being tested is our enhanced J-Series Air-Cooled (JAC) model which incorporates the latest technologies in aerodynamics, cooling design, and materials.



## > STEAM TURBINES

We manufacture a comprehensive lineup of steam turbines for a wide range of applications – from small turbines for industrial use to large ones for nuclear power generation. Each steam turbine is manufactured according to customer specifications and undergo strict in-house testing and quality management. Our heavy-duty steam turbines can handle various combinations of fuel sources and frequencies, with the capability to produce up to 1,000 MW of power. We are constantly seeking ways to develop and apply the latest cutting-edge technologies to improve the efficiency of our steam turbines and reduce their environmental impact.

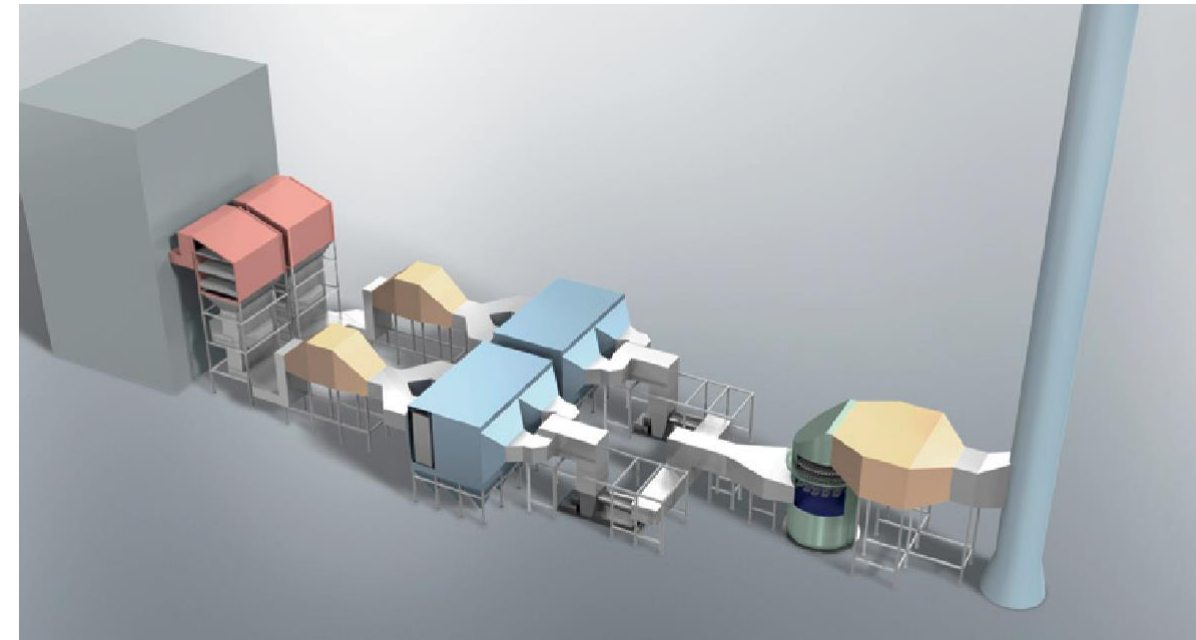
# PRODUCTS AND EQUIPMENT



## > BOILERS

We have developed unique combustion technologies to handle different types of fuel, including coal, heavy oil, biomass and natural gas. Our boilers can operate under high steam temperatures of over 600°C and are very efficient and reliable.

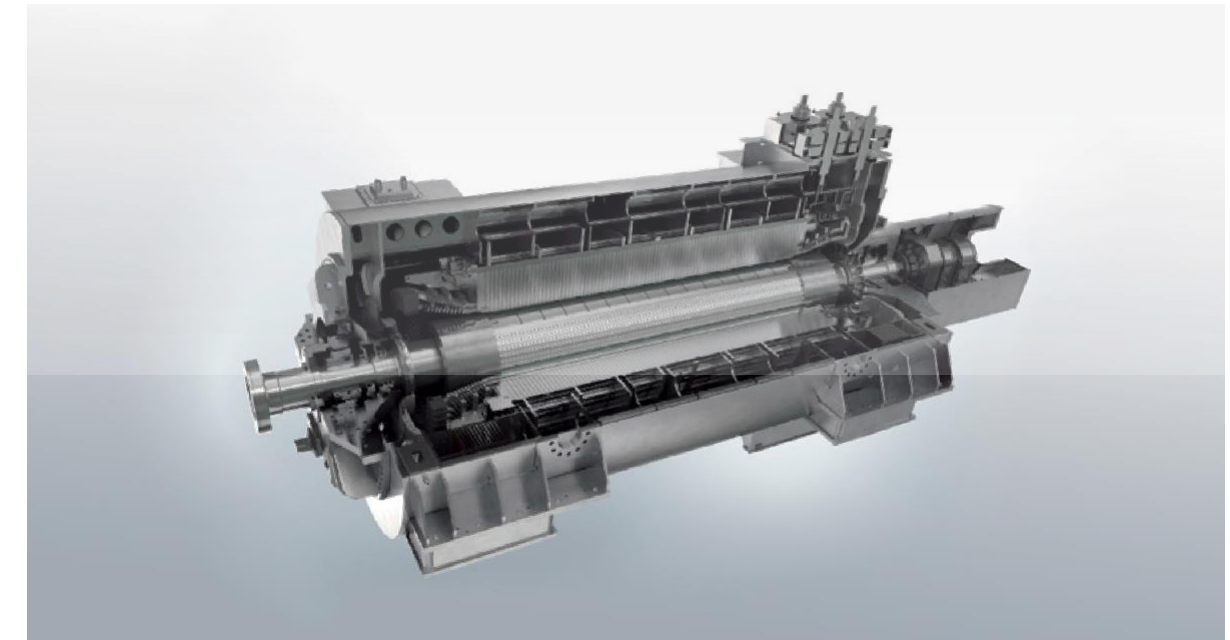
With an operational track record in using biofuels in coal-fired boilers, we have the capacity to enable different levels of biomass co-firing. Our combustion technologies can be applied to newly developed plants as well as existing coal-fired boilers, allowing our customers to use biomass as either a primary, complementary, or blended source of fuel.



## > AIR QUALITY CONTROL SYSTEMS

Our world-leading Air Quality Control Systems (AQCS) reduce environmental impact of power generation through pollutant control technologies including selective catalyst reduction (SCR) systems for NO<sub>x</sub>, electrostatic precipitators for soot and dust, and flue gas desulfurization (FGD) systems for SO<sub>x</sub>.

To date, Mitsubishi Power has implemented over 1,400 SCR systems, 400 FGD systems including a Marine Exhaust Gas Cleaning System, and over 3,300 electrostatic precipitators to capture and contain pollutants, helping our customers attain their environmental targets.



## > GENERATORS

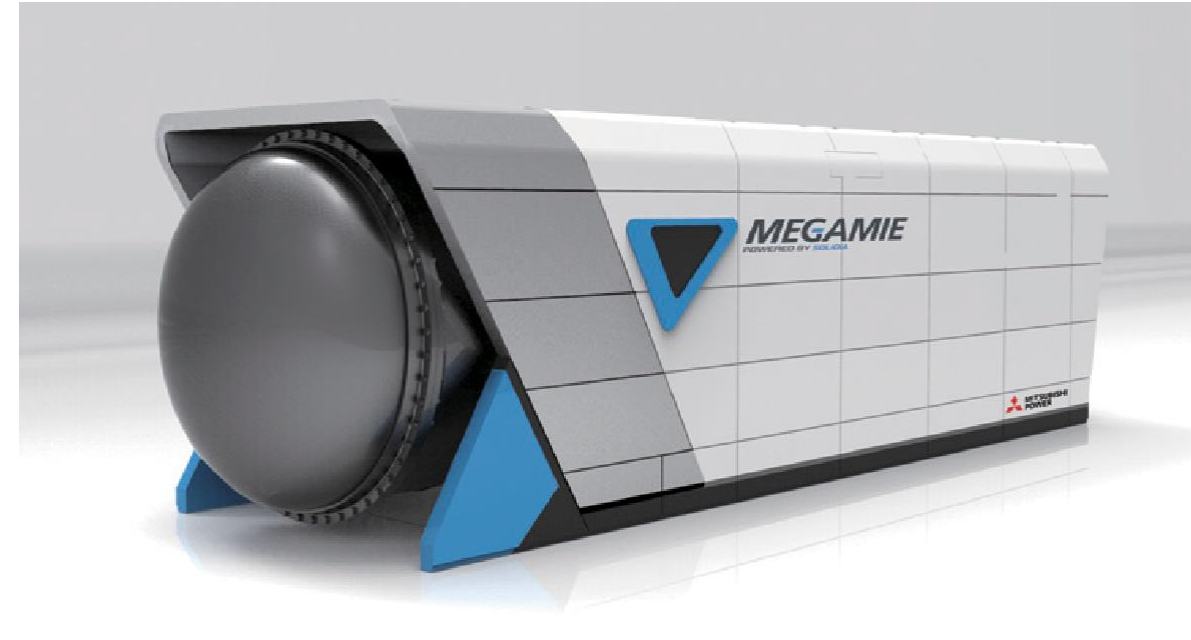
We design and manufacture special generators to meet an array of customer needs, including synchronous condensers to achieve power-system stabilization as well as short-circuit generators for laboratories and institutes. Our highly efficient turbine generators employ a range of cooling systems, such as air cooling, hydrogen cooling, and water/hydrogen cooling.

# PRODUCTS AND EQUIPMENT



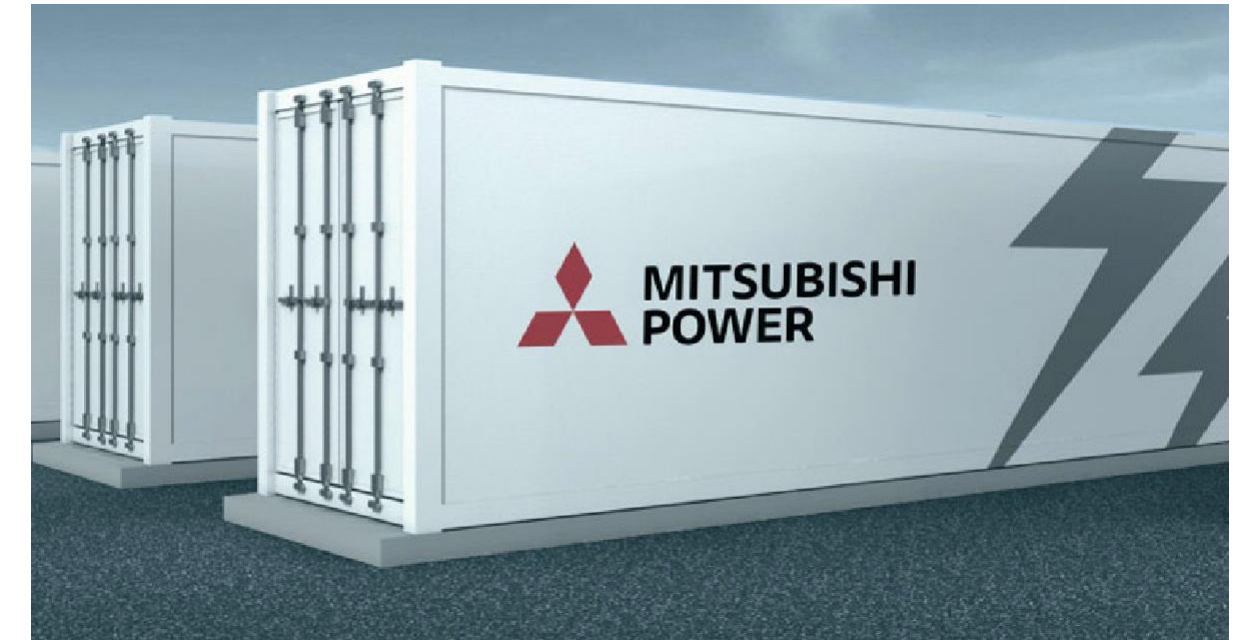
## > CONTROL SYSTEMS & UPGRADES

We develop and deliver control systems which offer high reliability and utilization rates and bring out the full potential of the equipment. We also provide responsive service solutions including long-term maintenance support, system migration to the cloud, and technologies to ensure functional safety and cybersecurity.



## > FUEL CELLS

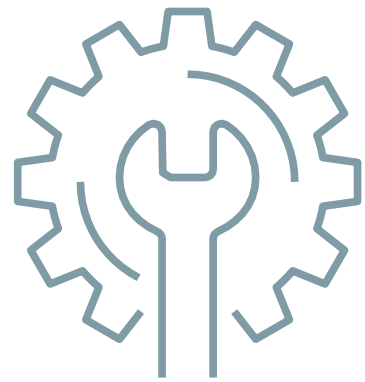
Solid oxide fuel cells (SOFCs) operate under high temperatures and can form high-efficiency power generating systems with integrated micro gas turbines. Our system boasts a total efficiency of over 70% and reduces CO<sub>2</sub> emissions by half when compared to conventional cogeneration systems. The flexibility and broad applicability of fuel cells makes them the future of decentralized power generation.



## > ENERGY STORAGE SYSTEMS

Drawing from our experience designing lithium-ion batteries, we can supply the full design and turnkey Engineering, Procurement and Construction of energy storage systems and energy management systems. Our energy storage systems lower grid loads by levelling output from large renewable energy power plants and other sites by reducing consumption peaks. These comprehensive energy storage systems are built within portable containers, which are ideal for offices and condominium complexes as power backup for renewables-integrated setups and during outages.

# SERVICES AND MAINTENANCE



## > TAILORED SERVICES TO IMPROVE PLANT LIFE CYCLE

Our engineers, each having a minimum of 10 years knowledge and experience in plants maintenance and skill-sets critical to plant operation. This includes preventative maintenance, plant operator training, performance improvement and environmental load reduction, fuel conversion modifications and recommendations to optimize the plant life cycle.



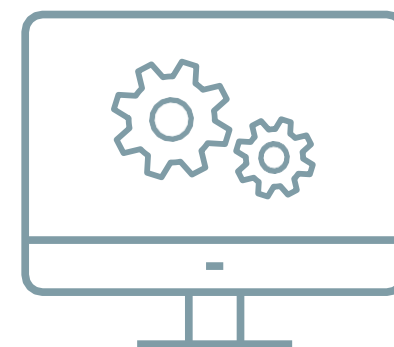
## > LONG TERM SERVICE AGREEMENTS (LTSA) FOR POWER PLANTS

Our LTSA-based solutions help minimize customer risk by prioritizing plant optimization and overall reliability. We offer short- and long-term maintenance, supply quality replacement parts, and provide technical support, remote monitoring as well as operation of data diagnosis systems.



## > SERVICE OFFICE NETWORKS AROUND THE WORLD

Our power business has approximately 80 sales and service offices worldwide, which have been combined to have developed a unique service network called "Diamond Service Network" to realize timely and speedy service for customers around the world.



## > INTELLIGENT SOLUTIONS TOMONI™

We are driving the realization of smarter power plants by utilizing the intelligent solution "TOMONI" developed based on the operation & maintenance and knowledges of power plants for many years. Our solutions use advanced analytics and are driven by customer collaboration to deliver powerful financial and environmental advantages.

# TOTAL SOLUTIONS



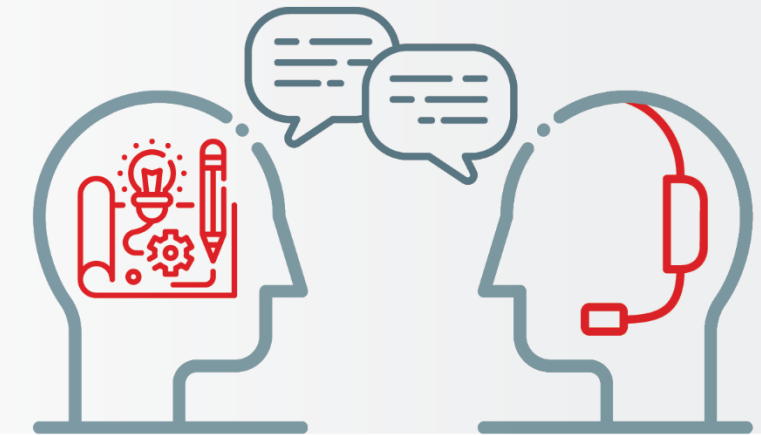


# FROM DESIGN TO MAINTENANCE

We can support customers throughout the power value chain – from equipment design, manufacturing, construction and commissioning to service and long-term maintenance.

## > DEVELOPING END-TO-END SOLUTIONS

With a tried-and-tested system to manage complex, large-scale projects, we are one of few EPCs globally with sophisticated project management capabilities, backed by an extensive track record in the successful completion of EPC projects. We can also provide our customers access to the wide-ranging products and expertise.



## > OFFERING SUPPORT THROUGHOUT THE PLANT LIFE CYCLE

We provide operational support and a full range of maintenance and repair services, bolstered by cutting-edge technology, preventive equipment maintenance, human resource development, rapid recovery support, and long-term service agreements to meet the diverse needs of our global customer base.

## > APPLYING THE LATEST DEEP TECHNOLOGIES

TOMONI™ is our customizable suite of user-driven, intelligent power plant solutions fueled by cutting-edge analytics and decades of experience. With TOMONI, we can turn large volumes of big data into valuable, actionable insights to increase efficiency and profitability of power plants.



# — OUR INNOVATIONS



# ADVANCING POWER GENERATION

From having power plants embedded with the latest in artificial intelligence technology to gas turbines that undergo the most rigorous validation process in the industry, Mitsubishi Power is constantly innovating to help customers meet their business targets and deliver reliable and decarbonized power to all.



## > ACCELERATING DECARBONIZATION

Achieving the global mission of net-zero carbon emissions from power generation requires a fundamental shift in the use of fuels. Hydrogen is the solution to a cleaner energy future.



## > DRIVING DIGITALIZATION

Navigating the ever-shifting patterns in power demand and supply requires technologies for smarter power plant operations. Digitization and adoption of deep technologies such as artificial intelligence and machine learning can usher in the future of power generation.



## > ASSURING RELIABILITY

Purpose-built for long-term prototype validation, our T-Point 2 combined cycle power plant validation facility provides customers with greater certainty in the reliability of the solutions they purchase.

# ACCELERATING DECARBONIZATION

Decarbonization is one of the greatest challenges faced by modern society, and the power sector has a significant role to play in solving it. Hydrogen will be critical to achieving our vision of carbon neutrality by 2050.

Hydrogen as a fuel source is flexible and can be used in both traditional and renewable power systems. It can be obtained in various ways: from carbon-based fuels to renewables such as biomass, geothermal, solar or wind and through electrolysis of water.

## > HYDROGEN IN ACTION



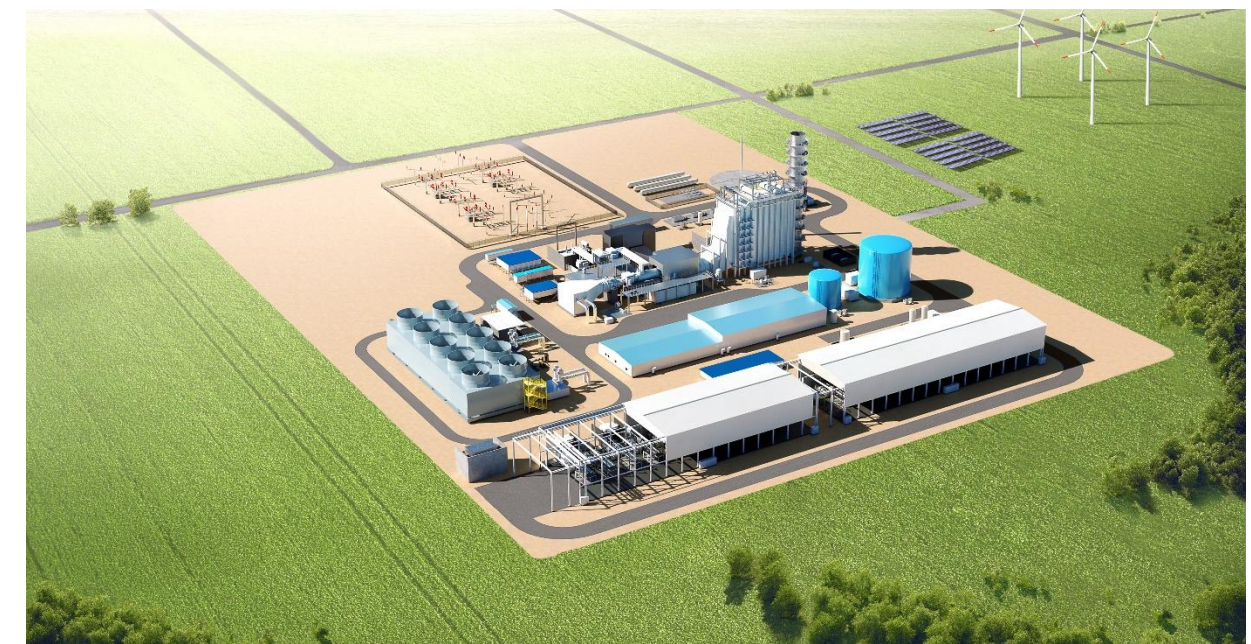
### Hydrogen gas turbines development

We have successfully tested a large-scale gas turbine with 30% hydrogen co-firing which resulted in a 10% reduction in carbon emissions. A new combustion system for 100% H<sub>2</sub> firing is currently under development and will be completed in the near future. In the UK, we are involved in the Zero Carbon Humber Project which aims to decarbonize the Humber industrial region, where a feasibility study for the conversion of our GTCC to H<sub>2</sub> firing at Triton Power Plant is currently underway.



### Producing and storing hydrogen

At our Advanced Clean Energy Storage Project in the United States, green hydrogen is created using excess power from renewables and stored in large underground salt caverns, which can hold upwards of 150 gigawatt hours of energy. We also launched the world's first standard packages for green hydrogen integration, paving the way for power plants to be more hydrogen ready.



### Utility-scale power generation with hydrogen

The Intermountain Power Plant in Utah is set to deliver utility-scale carbon-free power generation using our JAC gas turbines, designed to systematically obtain 100% hydrogen firing between 2025 and 2045. Together with the Advanced Clean Energy Storage Project, this facility will form a renewable hydrogen energy hub in the Western United States.

# DRIVING DIGITALIZATION

Mitsubishi Power is leading the development of the smart power plant of the future with TOMONI™, a suite of intelligent solutions enabled by decades of O&M and plant knowledge. Our solutions use advanced analytics and are driven by customer collaboration to deliver powerful financial and environmental advantages.

Our TOMONI suite of intelligent digital solutions provides powerful building blocks for autonomous power plant operations. It helps power plant operators make smarter, more data-driven decisions to enhance productivity and reliability.



## Data Foundation & Enablers

TOMONI intelligent solutions provide a customized range of platforms and upgrades to provide exactly the right data management and control system capabilities needed to achieve your digitalization objectives.

From cybersecurity and digitalization assistance to control system upgrades, enabling platforms and remote monitoring and diagnostics, TOMONI provides the foundation and enablers needed to make your plant smarter.



## O&M Optimization

TOMONI intelligent solutions leverage decades of O&M experience to provide asset-management solutions that directly improve your power plants operation and maintenance, increasing plant effectiveness and productivity.

Remote Monitoring Centers around the world provide expert recommendations, which can help you make smarter, more informed decisions. The result is more effective maintenance planning and improved total plant reliability and uptime.



## Performance Improvement

TOMONI intelligent solutions organizes complex data for practical use to improve the performance of power plants.

As the energy industry transitions to increasingly competitive wholesale power markets, improved dispatchability is pivotal to plant performance. These total plant solutions help increase your plant's output and efficiency, which benefits your business and boosts your profits.



## Flexible Operation

TOMONI intelligent solutions use AI simulation technology that respond quickly to changes in the environment, ensuring the reliability of baseload operation of power generation facilities while enabling flexible operation.

Our Flexible Operation solutions equip you to nimbly meet the changing demands of the market – such as new support requirements, less predictable fuel characteristics and renewable energy penetration – and lead to new revenue streams in ancillary service markets.

# ASSURING RELIABILITY

Our solutions have among the highest rates of reliability in the market, giving our customers peace of mind that their power systems will function optimally for decades to come.

T-Point 2 at Takasago Machinery Works in Japan is a one-of-a-kind facility — functioning as both a power plant and a demonstration plant. It is at the core of Mitsubishi Power's unique approach to push the limits of technology while minimizing risk to customers.

## ➤ AN ICONIC VALIDATION AND POWER GENERATION FACILITY



### Validating advanced class gas turbines

Our J-Series Air Cooled (JAC) gas turbine, already the most efficient heavy-duty gas turbine in the market, has been enhanced and is currently undergoing long-term verification at T-Point 2. Once it completes 8,000 hours of testing under real-life operating conditions, the new JAC model will further revolutionize the industry with its record-setting reliability and efficiency.



### Paving the way for autonomous power plants

TOMONI™ technologies to enhance plant flexibility, reliability and performance are currently being validated at T-Point 2. These advanced intelligent solutions can usher in a future where power plants can operate more efficiently, smartly and even autonomously.

# — OUR DELIVERY RECORD



# OUR DELIVERY RECORD

We delivered some of the world's largest power plants, helping to provide electricity to countless people everywhere – from megacities to rural areas.

## ➤ GAS TURBINE COMBINED CYCLE (GTCC) / GAS TURBINE POWER PLANTS



**Client** PT. PLN  
**Plant (country)** Tanjung Priok (Indonesia)  
**Generating Power** 880 MW  
**Start Up** 2019



**Client** GRDA (Grand River Dam Authority)  
**Plant (country)** Grand River Energy Center (Americas)  
**Generating Power** 505 MW  
**Start Up** 2017



**Client** JERA Co., Inc.  
**Plant (country)** Kawasaki Thermal Power Station Group 1, 2 (Japan)  
**Generating Power** 3,420 MW  
**Start Up** 2009 / 2016



**Client** Gulf JP NS Company, Limited  
**Plant (country)** Nong Saeng Power Plant (Thailand)  
**Generating Power** 1,600 MW  
**Start Up** 2014



**Client** Tohoku Electric Power Co., Inc.  
**Plant (country)** Niigata Thermal Power Station Group 5 (Japan)  
**Generating Power** 109 MW  
**Start Up** 2011



**Client** Sonelgaz  
**Plant (country)** Algeria  
**Generating Power** 1,350 MW (FT8MP x 54)  
**Start Up** 2011 / 2014 / 2015 / 2017



# OUR DELIVERY RECORD

## ➤ STEAM POWER PLANTS



**Client** ENEA Wytworzenie S.A.  
**Plant (country)** Kozienice Thermal Power Plant Unit 11 (Poland)  
**Generating Power** 1,075 MW  
**Fuel** Bituminous coal / Subbituminous coal  
**Start Up** 2017



**Client** JERA Co., Inc.  
**Plant (country)** Hitachinaka Thermal Power Station Units 1, 2 (Japan)  
**Generating Power** 2,000 MW  
**Fuel** Bituminous coal / Subbituminous coal  
**Start Up** 2003 / 2013



**Client** PT Paiton Energy  
**Plant (country)** Paiton III Thermal Power Plant (Indonesia)  
**Generating Power** 866 MW  
**Fuel** Subbituminous coal  
**Start Up** 2012



**Client** Vattenfall  
**Plant (country)** Boxberg Power Plant (Germany)  
**Generating Power** 670 MW  
**Fuel** Lignite  
**Start Up** 2012



**Client** Capital Power Corporation / TransAlta Corporation  
**Plant (country)** Genesee Power Generating Station Phase 3 (Canada)  
**Generating Power** 495 MW  
**Fuel** Bituminous coal  
**Start Up** 2005



**Client** NIPPON STEEL CORPORATION  
**Plant (country)** Oita Works (Japan)  
**Generating Power** 330 MW  
**Fuel** Coal, by-product gas  
**Start Up** 2002

# OUR DELIVERY RECORD

## ➤ ENVIRONMENTAL PLANTS Selective Catalyst Reduction (SCR)



**Client** Hidroeléctrica del Cantabrico S.A.  
**Plant (country)** Aboño PS Unit 2 (Spain)  
**Generating Power** 556 MW  
**Start Up** 2017



**Client** JERA Co., Inc.  
**Plant (country)** Joetsu Thermal Power Station Units 1-1 / 1-2 (Japan)  
**Generating Power** 1,190 MW  
**Start Up** 2012 / 2013



**Client** Xcel Energy  
**Plant (country)** Allen S. King Generating Station (U.S.A.)  
**Generating Power** 598 MW  
**Start Up** 2007

## Flue Gas Desulfurization (FGD)



**Client** JERA Co., Inc.  
**Plant (country)** Hitachinaka Power Station Unit 2 (Japan)  
**Generating Power** 1,000 MW  
**Start Up** 2013



**Client** Electric Power Development Co., Ltd.  
**Plant (country)** Tachibanawan Power Station Unit 1 (Japan)  
**Generating Power** 1,050 MW  
**Start Up** 2000



**Client** Electrownia Kozenice S.A.  
**Plant (country)** Kozenice Power Station Units 3-6 (Poland)  
**Generating Power** 800 MW (200 MW x 4)  
**Start Up** 2006

# OUR DELIVERY RECORD

## ➤ GEOTHERMAL POWER PLANTS



**Client** Reykjavik Energy  
**Plant (country)** Hellisheidi Geothermal Power Plant (Iceland)  
**Generating Power** 250 MW  
**Start Up** 2006 — 2011



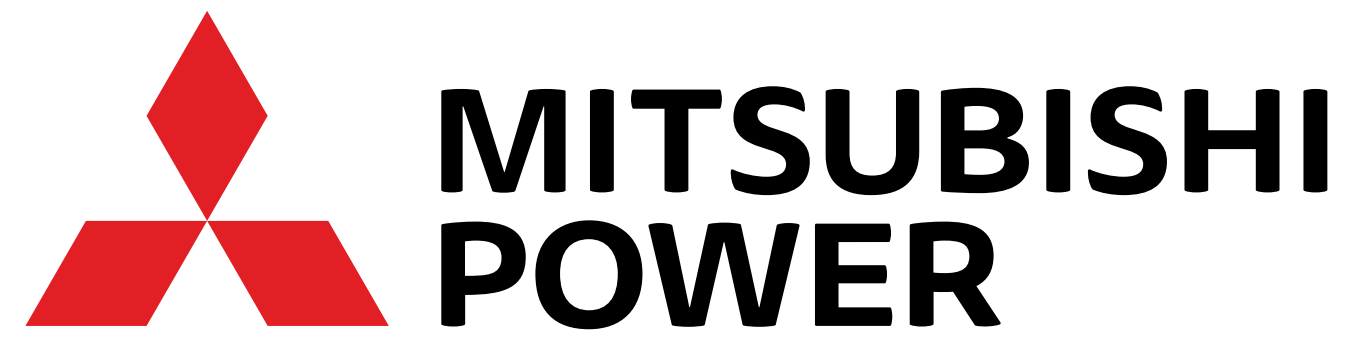
**Client** Instituto Costarricense de Electricidad  
**Plant (country)** Miravalles III Power Station (Costa Rica)  
**Generating Power** 27 MW  
**Start Up** 2000



**Client** Kenya Electricity Generating Company Limited  
**Plant (country)** Olkaria II Power Station (Kenya)  
**Generating Power** 105 MW  
**Start Up** 2003 / 2010



**Client** Kyushu Electric Power Co., Inc.  
**Plant (country)** Hatchobaru Power Plant Units 1, 2 (Japan)  
**Generating Power** 110 MW  
**Start Up** 1977 / 1990



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