graph

MITSUBISHI
HEAVY INDUSTRIES 2014

No.175

[Special Feature]

Transforming Blessings of the Earth and Sky into ENERGY

Geothermal × Hydropower

Leading Player – Interview with an Innovator

MHI's Energy-Efficient Technology Crossing the Seas

Meet MHI – Life with MHI

Natural gas into fertilizer!
MHI electric buses score big in Brazil! ... and more

Domain Information

Introduction of Four Business Domains

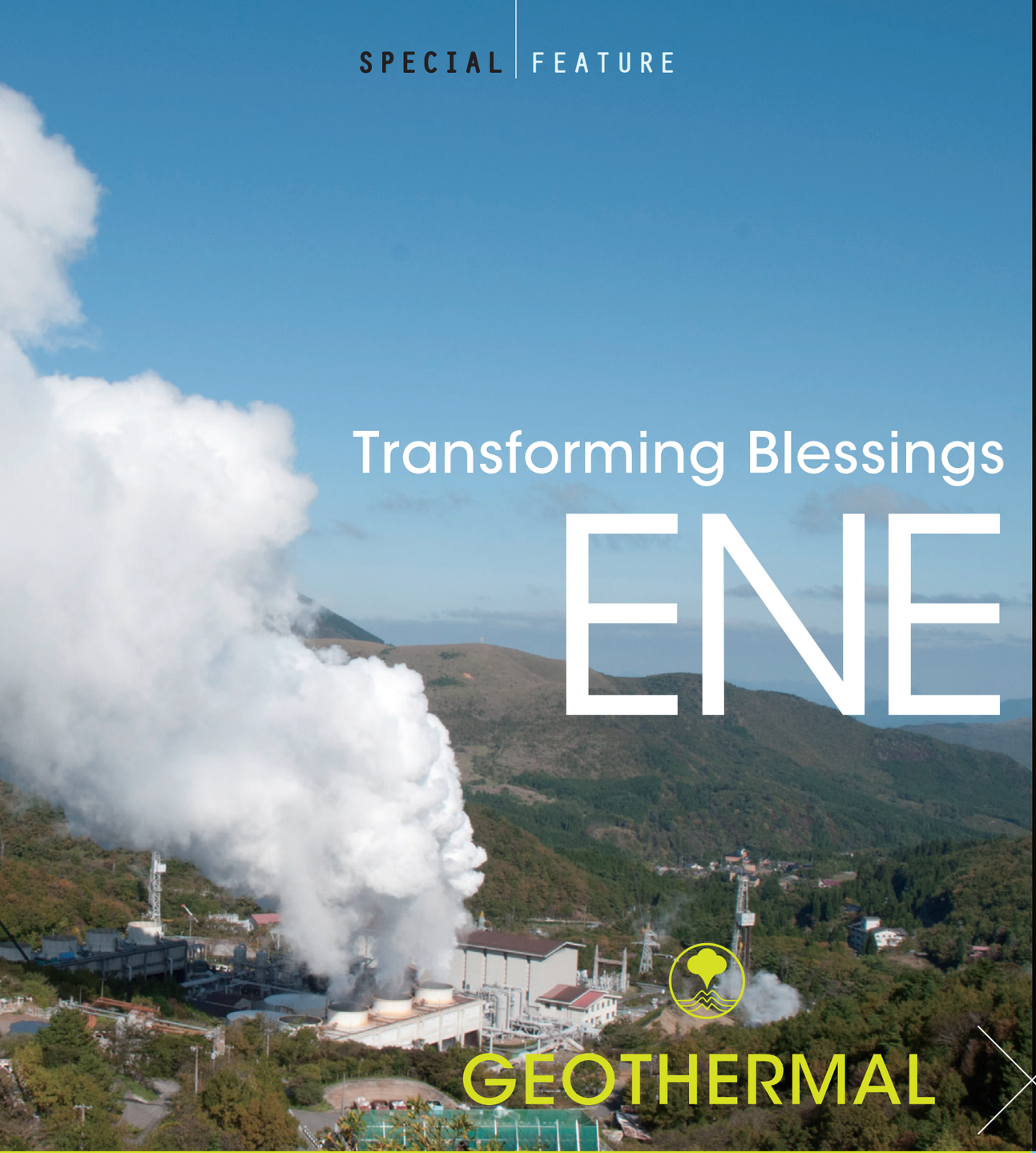
Engineers, Be Ambitious!

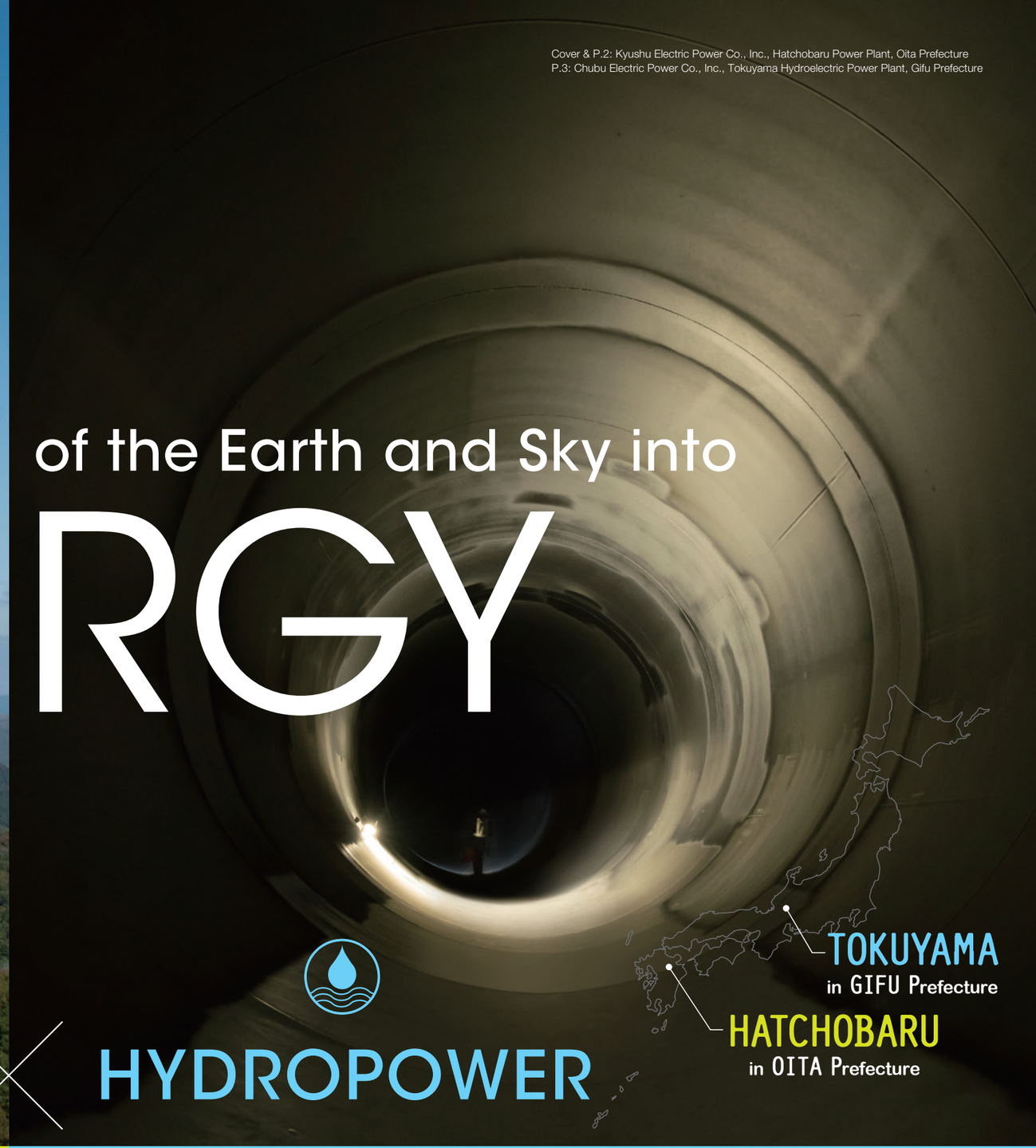
A Woman Committed to the Development of Marine Machinery

Cover & P.2: Kyushu Electric Power Co., Inc., Hatchobaru Power Plant, Oita Prefecture
P.3: Chubu Electric Power Co., Inc., Tokuyama Hydroelectric Power Plant, Gifu Prefecture

Transforming Blessings of the Earth and Sky into ENERGY

GEOTHERMAL × HYDROPOWER





High-temperature water from deep underground furnishes a vast and constantly replenishable energy resource.

High-pressure flow of water through pipes generates hydroelectric power.

Awash with nature's bounty, Japan has various sources of renewable energy directly tied to the land. They can be put into service to benefit power consumers without importing fossil fuels. Among these, geothermal energy and hydropower hold promise for providing a stable supply of electricity. MHI has been engaged in constructing hydroelectric power plants for almost a century and geothermal power plants for half that long. We invite you to explore the options for generating electricity using sustainable energy.

1967 ▸ PAST

First water-dominated geothermal power plant in Japan

The Otake Power Plant began generating electricity in 1967 in Oita Prefecture. Because of the lessons learned from the Otake project, the Hatchobaru Power Plant incorporated the double-flash cycle method.

2014 NOW

The double-flash steam cycle can generate about 20% more power than the conventional method. Converting hot water into steam with the flasher generates power more efficiently.

20XX ▸ NOW ▸ FUTURE

More efficient production of Earth's energy

The binary cycle method allows water at lower temperatures to be used. This extends the life cycle of the heat sources and expands the possibilities for energy sources not previously utilized in geothermal power generation.

GEOTHERMAL

'Hatchobaru Type,' the global standard

Geothermal power plants create electricity by harnessing the energy present in steam from underground water that has been heated by magma. When Unit No. 1 of the Hatchobaru Power Plant came online in 1977, the innovative system sparked worldwide interest. This system, developed by MHI* and known as the "Hatchobaru Type," has been adopted around the globe.

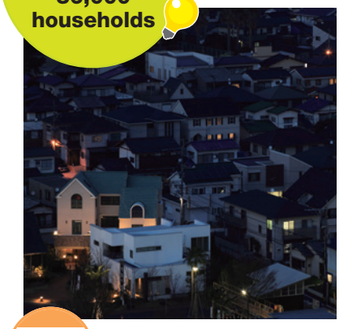
* The geothermal power business was transferred to Mitsubishi Hitachi Power Systems, Ltd. (joint venture of MHI and Hitachi, Ltd.) in 2014. The project is ongoing, and, thus, the name MHI is used here.

Resources from the Earth's bounty → *Steam drives turbine generators to produce electricity.* → **Energy to power approximately 36,000 households**

Steam and hot water captured from the ground are sent to the power plant through a two-phase flow transmission pipe. A single-pipe design reduces the construction cost.

The turbine rotates at 3,600 rpm to run the generator, producing 55,000 kW of electricity per hour.

After the steam does its work in the turbine, it is drawn into the condenser, where it becomes moderately hot water. The cooling tower lowers the warm water's temperature and sends it back for cooling purposes to the condenser.



View video clips on MHI's website

Power generation systems for geothermal installations built by MHI are generating electricity in 13 countries.

Geothermal power generation is attracting favorable attention because it can deliver a practically inexhaustible reserve of energy night and day, regardless of the weather. How has this remarkable power generation system been developed?

MHI teamed up with Kyushu Electric Power Co., Inc. in 1964 to develop a geothermal power generation system. MHI delivered Japan's first water-dominated geothermal power plant — the Otake Power Plant — which was commissioned in 1967. In 1977, MHI established itself as a pioneer in the geothermal arena with an innovative "double-flash cycle method" at the Hatchobaru Power Plant.

MHI has delivered more than 100 geothermal power plants to customers in 13 countries, including the U.S. and Iceland. The total electric capacity of these plants accounts for approximately 30% of the world's installed geothermal electric capacity.

New developments in geothermal power generation continue apace. Conversion to the "binary cycle system," which efficiently extracts energy from a low-temperature geothermal heat source, is under way for many of the currently operating facilities. MHI's goal is to lead the technology vanguard to develop energy sources more friendly to the environment.

Refer to P.8 for more info on the double-flash steam cycle and geothermal energy.

Visit the "MHI Graph" page on MHI's website (http://www.mhi-global.com/discover/graph/index.html) to view video clips.

HYDROPOWER

Penstocks to convey water to the turbine

In order to permit a huge amount of water to flow through a steep slope of as much as 50 degrees, high-tensile-strength steel that can withstand higher water pressure is used for the penstocks. MHI is among only a few companies in Japan that possess the specialized skills necessary to accomplish the demanding welding tasks.

The maximum penstock pipe incline is approximately 50 degrees. This drop in height produces immense water power.

NOW

1995 — 2014 — 2014.05～

PAST

FUTURE

Okumino Power Plant, once Japan's largest hydropower station

The 1,500,000 kW Okumino Power Plant went into operation in 1995. At the time, it was Japan's largest hydroelectric plant. Technological developments resulting from work on this penstock were instrumental in future plant projects.

Courtesy of Chubu Electric Power Co., Inc.

Tokuyama Hydroelectric Power Plant, a new source of energy

The Tokuyama Hydroelectric Power Plant is a new source of electricity for an area served by Chubu Electric Power Co., Inc. It achieves a maximum output of 153,400 kW — the power equivalent for about 80,000 households (based on the estimated annual power generation of about 300,000,000 kWh).

Hydroelectric power generation taps the energy of water flowing down from a higher level to a lower level. MHI* has a long history of manufacturing penstocks for hydroelectric power plants dating back to 1921. MHI's know-how and advanced welding technology proved invaluable to the completion of the Tokuyama Hydroelectric Power Plant.

* Part of the hydroelectric power business was transferred to Mitsubishi Heavy Industries Mechatronics Systems, Ltd. (wholly owned by MHI) in 2009. The project is ongoing, and, thus, the name MHI is used here.

Technology and experience connecting penstock pipes

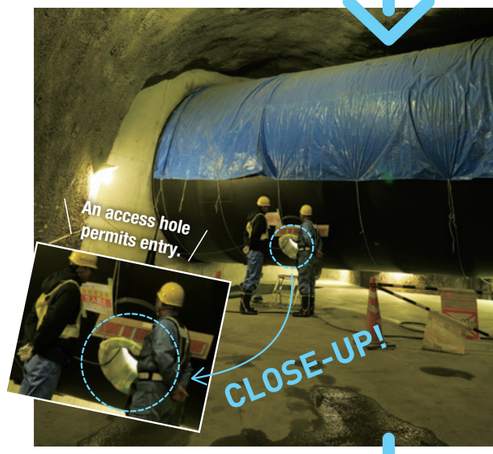
Hydroelectric power generation has played a vital role in people's lives for many years. MHI has manufactured and installed more than 60,000 kilometers of penstocks for hydroelectric power plants, both in Japan and abroad, as well as turbines, pumps, and other key components. MHI was a major contractor in the construction of the Okumino Power Plant in Gifu, Kannagawa Power Plant in Gunma, and Omarugawa Power Plant in Miyazaki. The company installed the penstocks that transfer water to the turbines directly connected to the generator from the dam reservoir for Tokuyama Hydroelectric Power Plant. The Tokuyama plant boasts a maximum capacity of 153,400 kW and started generating power in May 2014.

During the construction process, a workshop with an automatic welder was built on the site. Each piece of steel piping for the penstocks was precisely welded to meet the steep gradient of up to about 50 degrees. The combined length of the steel pipes reached approximately 900 meters. "MHI demonstrated advanced technical skills in welding, which was especially important given the strict time constraints of the construction process," commented Kenji Kuwabara, Vice-Director of the Tokuyama Hydroelectric Power construction site for Chubu Electric Power Co., Inc. MHI's expertise also supports numerous hydroelectric power plants all over the world.

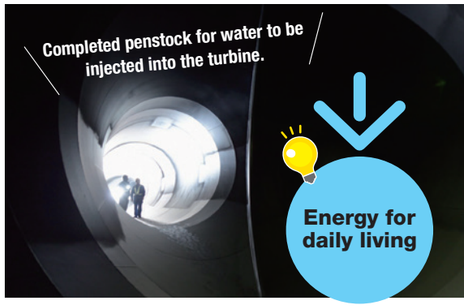
MHI is strengthening its competitiveness internationally, as demand for energy production relying on water resources continues to grow in Asia, Latin America and other regions.

Refer to P.9 for more info on penstock and hydropower.

Read interviews with MHI staff and customers involved in the installation of penstocks on "MHI Graph" page of MHI's website (http://www.mhi-global.com/discover/graph/index.html).



After placing the penstock in the tunnel, workers enter the access hole to weld and inspect the roughly 5-meter-diameter cylindrical structure.



Hydropower plants exploit the movement of falling water to generate electricity. A large difference in height and an enormous volume of water result in incredible force on the turbine. Strong penstocks capable of withstanding such force are required.

View video clips on MHI's website

Optimizing limited resources for the future

MHI is committed to developing natural energy sources that are constantly and sustainably replenished. To derive electricity in harmony with nature, MHI has achieved numerous technological innovations that permit greater access to renewable energy sources and enable more efficient harnessing of power.

Courtesy of Gifu City

Visit the "MHI Graph" page on MHI's website (http://www.mhi-global.com/discover/graph/index.html) to view video clips.

Geothermal energy and hydropower = electric power

How can you obtain renewable energy from natural sources and at the same time improve the efficiency of power generation? We'll see how geothermal energy and the power of water can be captured and turned into electricity.

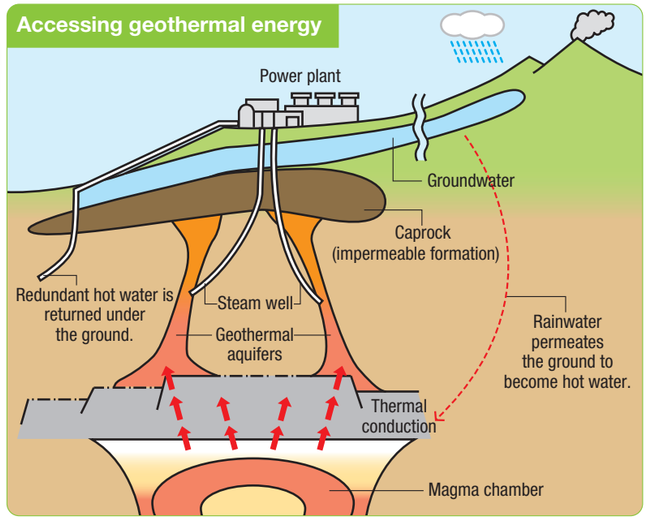
Geothermal Power Generation

What is a "geothermal aquifer" ?

The energy source of geothermal activity is the magma chambers created by frictional heat from plate movement and other factors. The temperature several kilometers below the ground in areas of high geothermal energy density, where volcanoes, natural fumaroles, and hot springs exist, is around 1,000℃. If a clayey caprock, or other impermeable formation through which water does not pass, sits above the geothermal zone, the hot water and steam rising from the deeper core become trapped beneath the layer of impermeable rock. This natural process forms a geothermal aquifer.

Drilling a steam well into the geothermal aquifer facilitates access to this powerful source of energy. The illustration depicts a geothermal electricity power plant as it would be constructed in an area containing reachable geothermal resources.

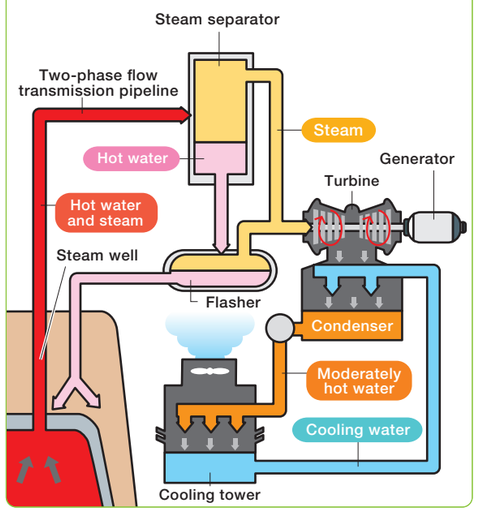
Accessing geothermal energy



Revised from "Walking with the earth: Geothermal energy" Serial No. 87 (July 1999) on MHI' s website

Efficient means for harnessing geothermal energy

Double-flash steam cycle



Revised from "Guide of Geothermal Power Plant" by Kyushu Electric Power Co., Inc.

The ideal system to generate low-cost electricity

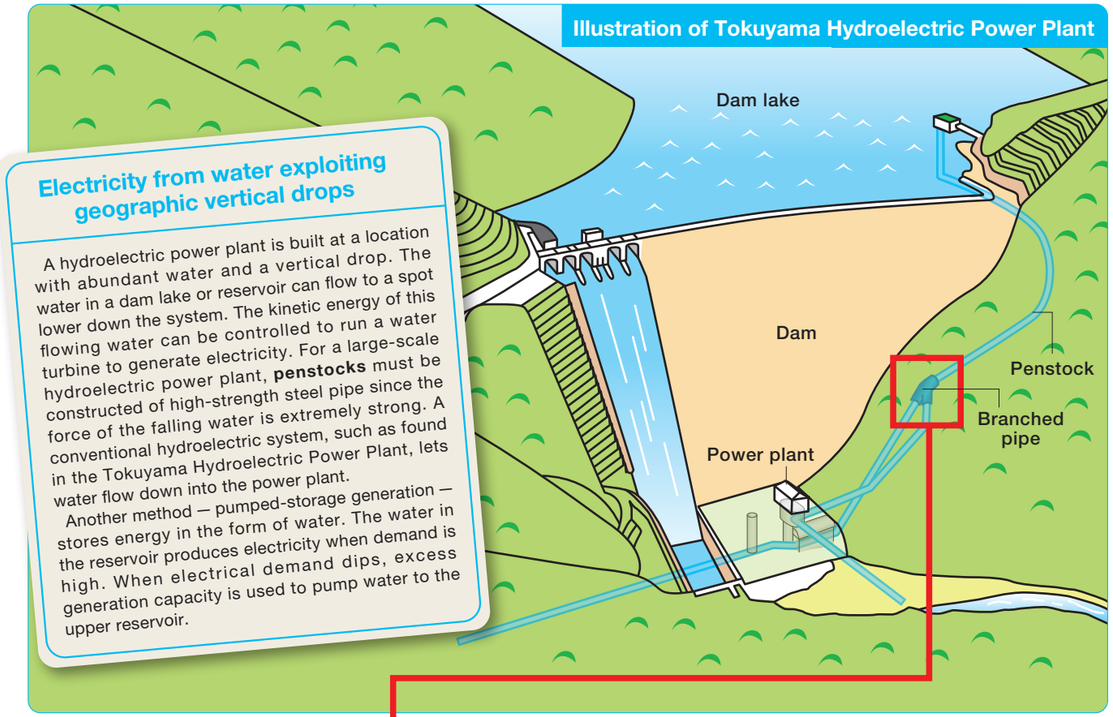
How does geothermal energy produce electricity? In a single-flash steam cycle, a mixture of hot water and steam extracted from the steam well is transferred to the steam separator via a **two-phase flow transmission pipeline**. The steam separated here drives a **turbine**, which spins a generator to create electricity. After producing electricity, the exhaust steam is cooled in the condenser and conveyed to the cooling tower as moderately hot water. The warm water is further cooled in the atmosphere and routed back to the condenser for reuse as cooling water.

In a **double-flash steam cycle**, the hot water separated in the separator is then turned into vapor in the **flasher** through a reduction in pressure. This flashed steam is also used to produce electricity. Output increases by almost 20% compared with the single-flash steam cycle.

The **binary cycle method** employs a secondary, or binary, fluid whose boiling point is lower than water. Geothermal energy converts the binary fluid into steam. The steam in turn rotates the turbine of an electrical generator. Since the binary cycle can operate with geothermal fluid at lower temperatures from a heat source close to the Earth' s surface, this technique is taking on greater interest thanks to the smaller initial investment for exploration and survey.

Hydroelectric Power Generation

Illustration of Tokuyama Hydroelectric Power Plant



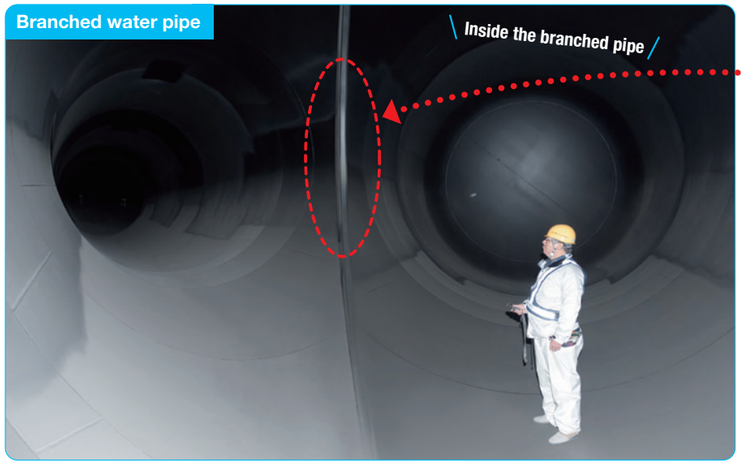
Electricity from water exploiting geographic vertical drops

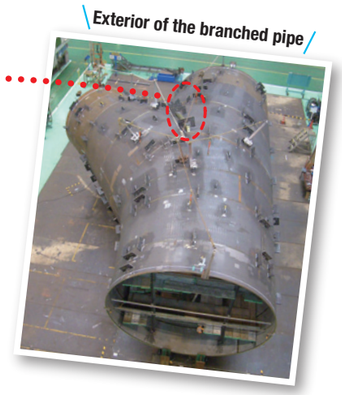
A hydroelectric power plant is built at a location with abundant water and a vertical drop. The water in a dam lake or reservoir can flow to a spot lower down the system. The kinetic energy of this flowing water can be controlled to run a water turbine to generate electricity. For a large-scale hydroelectric power plant, **penstocks** must be constructed of high-strength steel pipe since the force of the falling water is extremely strong. A conventional hydroelectric system, such as found in the Tokuyama Hydroelectric Power Plant, lets water flow down into the power plant.

Another method — pumped-storage generation — stores energy in the form of water. The water in the reservoir produces electricity when demand is high. When electrical demand dips, excess generation capacity is used to pump water to the upper reservoir.

Revised from "Electricity Tomorrow" in Chubu Electric Power Co., Inc. website

Branched water pipe





Welding a branched pipe connecting two penstocks is done carefully to accommodate the extremely strong force of water that occurs at this spot.

High-tensile steel for high strength and excellent durability

A penstock is a pipe that transports water from the dam lake to drive the turbine in the power station. Penstocks are made from **high-tensile steel**. It has a long service life and can stand up to the force of water without the need for even heavier material.

The steel pipeline in the Tokuyama Hydroelectric Power Plant spans about 900 meters and features a maximum diameter of 5 meters. The maximum strength of the steel pipes for the plant is 570 MPa (steel for general construction is about 400 MPa). The Okumino Hydraulic Power Plant and Kannagawa Hydraulic Power Plant also benefit from steel penstocks with superior tensile strength grades.

However, working with high-tensile steel demands great skill and specialized welding technology, including accurate temperature controls. MHI is the only Japanese company with an excellent track record of handling high-tensile 100k steel materials.

* For the topics in bold, refer to the pictures on P.4-7.

Leading Player

Interview with an Innovator

MHI's Energy-Efficient Technology Crossing the Seas

Turbochargers are indispensable marine machinery for diesel-powered ships, and with over a century of production to its credit, MHI*1 ranks as one of the world's three largest turbocharger manufacturers. Keiichi Shiraishi has devoted his entire career to the development and design of turbochargers at MHI Nagasaki Shipyard & Machinery Works. In a highly competitive business, this engineer, a seasoned player on the world stage, talks about the sources of his inspiration and the secrets of business success.

What is a turbocharger?

An essential device for any diesel-powered ship; it delivers a large volume of oxygen in the form of compressed air to the engine to ensure significantly improved fuel combustion and engine performance.

Challenging numerous projects

Q Why are MHI turbochargers so popular?

A Marine engine turbochargers are essential to speed up ships and have a long and brilliant history at MHI. Today we are maintaining our tradition for superb engineering, and our turbochargers are renowned in the shipping industry for outstanding reliability, simplified structures to facilitate maintenance even by the crew, and high performance that keeps engines in good condition. When I joined MHI in the 80s, the basic design was well established and for many years I have helped to improve and advance it.

Pick Up Innovator ▸▸▸

Profile

Keiichi Shiraishi
Senior Manager
Mitsubishi Heavy Industries
Marine Machinery & Engine Co., Ltd.

Since joining MHI in 1986, Shiraishi has worked exclusively on turbochargers, developing a stream of hybrid, VTI, and electric assist turbochargers. Today he is involved in planning and sales.

Q And your most memorable project…

A We wanted to retain the basic design and yet come up with something really novel, so we successfully developed a hybrid turbocharger*2 by adding a power generation capability. An engineer working for an overseas marine engine manufacturer, a client of ours, gave us a hint, and when we heard our competitors had given up on the idea, I kept saying within MHI that this was something we needed to pursue. Finally our team managed a power test of an existing turbocharger equipped with a small-sized power generator. Really the key point and challenge was working with a world-class overseas power generator manufacturer with a lot of technical know-how. At the time many people thought that communication would obviously be easier with domestic manufacturers, but by overcoming the language barrier, the project engineers came up with really innovative solutions leading to a truly wonderful product.

Ideas: The developer's lifeblood

Q Inspiration, where and when?

A Normally I'm not very good at idling away my time. I am always thinking about work or hobbies. It was during my so-called free-time, when I was looking at a cross-section of an existing product, that inspiration struck. The exhaust gas inlet area of our conventional turbochargers is divided into two parts, and I wondered what would happen if we installed valves on one side, and then maybe by simply closing the valves, the force of exhaust gas would increase, thus restraining fuel consumption. I controlled my excitement and quickly sketched this idea. It turned out to be rather practical and became the VTI turbocharger.*3

Q What's it like when an idea takes shape?

A The moment I had this VTI turbocharger idea, I became really confident, and my whole body was filled with a feeling of positive exhilaration, as if I was a genius. MHI thoroughly grasps the challenges of engineers, and once a drawing is sent to production, they produce a prototype. Honestly, it's a dream place for engineers.

Q What's important when dealing with world markets?

A Meeting our customers' demands is a minimum obligation. We always need to add a bit of extra value in some way. Responding quickly and with information that catches the customer's interest is also essential. Particularly for those customers who respond quickly to our proposals, I reply immediately. Being honest, even if the news is not good for MHI, and informing the customer right away helps in winning their trust and respect. They know we are not here to waste their time.

Benefits of turbochargers to our life

Q How do turbochargers contribute to society?

A Marine transport will continue as the mainstay of global economic transport activities and logistics. Turbochargers are widely used in large container carriers, pure cargo containers for coal, iron ore, and grain and even in fishing boats. If turbochargers reduce the fuel consumption of diesel engines, this will significantly benefit transport costs and favorably impact the global prices of exports and imports. Also, improved fuel efficiency will reduce CO_2 and exhaust gas emissions and minimize the use of fuel oil, resulting in decreased consumption of limited fossil resources. Moreover, hybrid turbochargers are capable of providing all onboard electricity requirements.

Q And for the future…

A My present role is to more broadly promote MHI turbochargers. Listening closely to our customers and providing feedback to our design teams will help in delivering excellent products all over the world.

*1 **Mitsubishi Heavy Industries**
Mitsubishi Heavy Industries Marine Machinery & Engine Co., Ltd. is a wholly owned subsidiary of MHI launched on October 1, 2013. Business activities in this article occurred before the new company was set up, and, thus, the MHI name is used.

*2 **Hybrid turbocharger**
A highly efficient generator coupled with a turbocharger. Engine exhaust gas is used for driving the turbocharger compressor and for generating power for the ship's electrical systems.

*3 **Variable turbine inlet turbocharger**
A turbocharger with a variable turbine nozzle in the exhaust gas inlet area that allows two-step variation of the turbine capacity. Even at low-speeds, the device rotates the turbine at high speed, delivering improved fuel consumption.

You can also view this on the "MHI Graph" page of MHI's website (http://www.mhi-global.com/discover/graph/index.html).

MHI graph Search

Meet MHI

MHI's innovative technologies and outstanding products surround us, expanding across land, sea, air, and even out into space. The company is quietly supporting every aspect of our daily lives — technologies from Japan across the world and far beyond.

Life with MHI

Meet 01

Cherepovets, Republic of Tatarstan, Russian Federation

Natural gas into fertilizer! A valuable contribution to global food production

The world's population has been rapidly expanding since the mid-20th century, giving rise to an increasing demand for fertilizers that contribute to a stable food supply. The production of nitrogen fertilizers* generated from natural gas or the like has grown nine-fold in the 50 years since 1961.

After delivering its first fertilizer plant in 1958, MHI has gone on to build many more fertilizer plants around the world. Capitalizing on the abundant natural gas fields of Russia, the company is currently constructing two fertilizer plants: one in Cherepovets, some 400 km to the north of Moscow, and the other in the Republic of Tatarstan, some 1,000 km to the east of Moscow. The fertilizers are for use in Russia and abroad.

Today, that green and tasty salad on your plate may very well have been grown with natural gas fertilizer courtesy of MHI.

* Fertilizer with nitrogen as the main ingredient, e.g. ammonium sulfate, ammonium nitrate, urea

Fertilizers from natural gas contribute to a stable food supply

Fertilizer plant under construction in the Republic of Tatarstan (as of 2014)

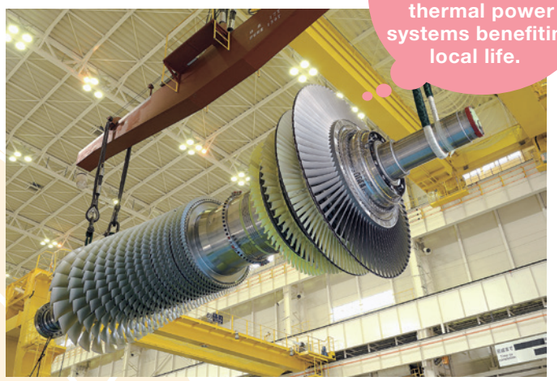
Meet 02

Yokohama City, Kanagawa Prefecture, and others

MHPS further expands thermal power generation in Japan and abroad

In February 2014, MHI and Hitachi, Ltd. merged their respective thermal power generation systems businesses to form Mitsubishi Hitachi Power Systems, Ltd. (MHPS). With increasing economic growth and demand for electricity from newly emerging nations, the improved efficiency of thermal power generation has become an essential factor in the important task of protecting the global environment. Under such circumstances, MHPS products and unique technologies will make a real contribution to reducing environmental impact and stabilizing supplies of electricity, as convincingly shown by the Gas Turbine Combined Cycle (GTCC) power plant with a conversion rate of over 60% fuel to power, and the Integrated coal Gasification Combined Cycle (IGCC) power plant, generating power with about 20% less CO_2 emissions than conventional coal-fired thermal power plants. This powerfully enriched and integrated product lineup, including highly efficient gas turbines and boilers, and environmental systems that remove harmful substances from exhaust gas, will be the mainstay of energy generation for utility companies through to factories with in-house power generation. The synergy created with the birth of MHPS will be beneficial for improving energy efficiency and solving the environmental issues of our expanding global society.

The stage is the world market: highly efficient thermal power systems benefiting local life.



A key product — the gas turbine: The J-series gas turbine incorporates unique MHPS technology and ranks among the world's top class in power generation efficiency with a fuel-to-power conversion rate of more than 60%.

MITSUBISHI HITACHI POWER SYSTEMS

Mitsubishi Hitachi Power Systems, Ltd. (MHPS). Head office in Yokohama, and Works in Hitachi, Yokohama, Takasago, Nagasaki and other cities.

Energy & Environment

Meet 03

Kokonoe Town, Kusu County, Oita Prefecture

Kyushu tourism and hot springs fired up by geothermal power generation!

Clean energy development is very popular, and geothermal power generation is one of today's hottest topics with a technology that holds a promising future for volcanic Japan. Several kilometers underground molten magma flows at around 1,000°C, ideal for harnessing power to operate turbines. In 1967 MHI delivered Japan's first water-dominated geothermal power plant to the Otake Power Plant in Oita Prefecture. Today, MHI has delivered to five other sites in Oita and Kagoshima Prefectures. The plants not only supply power to local communities, but also hot water to hot spring resorts. After power generation, steam is effectively used as a hot water resource for neighboring hotels. For the Japanese people who love their hot spas, it's just a case of clean energy serving two essential needs with one hot idea.

After power generation, steam becomes a valuable resource for neighboring hotels.

Hot spring water from the Oita Prefecture Hatchobaru Power Plant heats up neighboring hot spring resorts.

Meet 04

São Paulo State, Brazil

MHI electric buses score big in Brazil!

Brazil may be half a world away from Japan, but both are humming with new MHI environment-conscious electric buses. With the latest batteries and citywide charging, the system has been successfully demonstrated in the four Japanese cities of Kyoto, Aomori, Fukuoka and Nagasaki (within the shipyard).

Our partner is the METRA Group, a local bus company in São Paulo, and in November 2013, after technological development of the storage and charging systems was completed, a six-month road test began with regular passengers. Brazil has many Japanese descendants and many are engineers, so our project team has been outstanding effectively. This summer, Brazil hosted the 2014 FIFA World Cup, and MHI electric buses played a winning role in transporting the thousands of football fans to their goal.

Articulated electric bus in Brazil powered by MHI battery systems

With an overall length of 18m and a passenger capacity of 150, the double-car "E-bus" is put through the paces. (as of April 2014)

You can also view this on the "MHI Graph" page of MHI's website (http://www.mhi-global.com/discover/graph/index.html).

MHI graph Search

MITSUBISHI HEAVY INDUSTRIES, LTD.

Domain Information

An introduction to the four domain's extensive range of innovative technologies compiled over more than a century.

Energy & Environment

Energy & Environment offers optimal solutions in the energy-related fields of thermal power, nuclear energy and renewable energy, in such environmental areas as water and flue gas treatment, and for chemical and industrial plants. MHI's integration of large-scale infrastructure projects supports society and generates new power for the future.
By leveraging the benefits of its wide range of products this domain focuses on responding to the needs of its customers and society. MHI is developing new businesses to combine the design, procurement, and construction operations of each of the domain's businesses to become a leading company in the energy and environment-related industries.

- **Thermal Power Generation Systems**
  Mitsubishi Hitachi Power Systems, Ltd.
  Thermal Power Generation Systems/
  Environmental Plants for Coal-Fired Facilities
- **Nuclear Energy Systems Division**
  Pressurized Water Reactor (PWR) Plants/
  Advanced Reactor Plants/
  Nuclear Fuel Cycle Plants and Facilities/
  Nuclear Fuel
- **Chemical Plant & Infrastructure Division**
  Chemical Plants/Water Solutions
- **Renewable Energy Business Division**
  Wind Power Systems/
  Pump Applications
- **Marine Machinery & Engines**
  Mitsubishi Heavy Industries
  Marine Machinery & Engine Co., Ltd.
  Marine Machinery and Engines

Commercial Aviation & Transportation Systems

Commercial Aviation & Transportation Systems delivers advanced land, sea and air transportation systems, including civilian aircraft, commercial ships and transit networks. MHI moves society, supporting its transportation and logistics infrastructures with superior safety, guaranteed quality and first-rate reliability backed by state-of-the-art technology. The domain complies with strict safety regulations and requirements by standardizing production systems and coordinating technological development in each field of land, sea and air throughout its operations and has created an integrated business model for its products to further expand into new markets.

- **Shipbuilding & Ocean Development Division**
  Passenger Ships/Commercial Ships/
  Special-Purpose Vessels/
  Marine Structures/Submersibles/
  Ship Repair & Conversion/
  Technical Services & Automated Systems/
  Engineering Business/
  Overseas Shipbuilding Business
- **Land Transportation Systems Division**
  Land Transportation Systems/
  Air Brake Equipment
- **Commercial Airplanes Division**
  Boeing Sustaining/Bombardier/
  Established Commercial Airplanes
- **787 Division**
  Boeing Sustaining
- **Commercial Aero Engines Dept.**
  Commercial Aero Engines
- **MRJ**
  Mitsubishi Aircraft Corporation
  Independently Developed Aircraft

Integrated Defense & Space Systems

Integrated Defense & Space Systems provides unified land, sea, air and space defense systems, including naval ships, defense aircraft, missiles, launch vehicles and special vehicles, as well as space-related services. MHI technology and expertise developed in its defense and space business contribute to security across the planet.
As Japan's leading defense and space systems integrator, the Integrated Defense & Space Systems Domain combines the technology and expertise of each of its businesses to reinforce MHI's international competitiveness in the space industry and create innovative systems to coordinate land, sea and air defense initiatives.

- **Aircraft Division**
  Defense Aircraft
- **Guidance & Propulsion Division**
  Missile Systems/Aero Engines/
  Applied Products
- **Space Systems Division**
  Space Systems
- **Special Vehicle Division**
  Special Vehicles/Naval Ship Engines
- **Naval Ship Division**
  Naval Ships
- **Maritime & Space Systems Dept.**
  Undersea & Shipboard Systems

Machinery, Equipment & Infrastructure

Machinery, Equipment & Infrastructure's wide range of products, including machine tools, material handling, construction machinery, air-conditioning and refrigeration systems, lay at the foundation of industrial development. MHI applies its broad business experience, high reliability and technical expertise to support social and industrial infrastructure by connecting people to people, businesses to businesses, and the present to the future.

- **Engine Division**
  Engines (Diesel/Gas Engines/
  Air-Cooled Gasoline Engines)
- **Automotive Parts Division**
  Turbochargers/
  Automotive Thermal Systems
- **Air-Conditioning & Refrigeration Division**
  Commercial Use Air-Conditioners/
  Residential Use Air-Conditioners/
  Heat Pump Water Heaters/Heat Pump
  Module Chillers/Centrifugal Chillers/
  Transport Refrigeration Units/
  Applied Refrigeration Use Machinery
- **Machine Tool Division**
  Large Machines/Gear Cutting Machines,
  Cylindrical Grinding Machines/
  Special-Purpose Machines/High-Precision
  Machining Centers/Wafer Bonding Machines/
  Precision Cutting Tools/Engine Valves/
  Power Transmissions/Precision Position
  Feedback Sensors
- **Hydraulics & Machinery Division**
  Hydraulic Devices/Testing Systems
- **Business Development Dept.**
  Advanced Mechanical Systems
- **Group Companies**
  Machinery/
  Environmental Protection Systems/
  Mechatronics System Machinery/Printing
  and Paper Converting Machinery/Steel
  Structures/Agricultural Machinery and
  Facilities/Automotive Thermal Systems/
  Material Handling Equipment

Pick Up! Domain

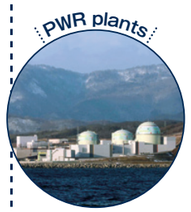
Energy & Environment

MHI, by promoting its energy and social infrastructure business, helps enrich society while minimizing environmental impact. MHI generates sustainable energy today to sustain society tomorrow.

Thermal Power Generation Systems

By combining the extensive thermal power generation systems know-how of its two parents, MHI and Hitachi, Ltd., Mitsubishi Hitachi Power Systems, Ltd., aims to take full advantage of its inherited comprehensive and in-depth strength to become a number-one global player in the thermal power generation system and environmental project markets. Drawing on the world's most advanced thermal power generation and environmental technologies, the new company is committed to developing a wide global lineup of outstanding high-performance products, including gas turbines, steam turbines, and boilers.

Nuclear Energy Systems Division



MHI provides a full range of services from plant development to manufacture, operation and maintenance. Based on advanced monozukuri (manufacturing) skills developed through more than 50 years of experience with pressurized water reactor (PWR) plants and major plant equipment, the company, both in Japan and abroad is developing the most advanced technology available in the world and simultaneously working proactively on spent fuel reprocessing and in other nuclear fuel cycle related fields.

Chemical Plant & Infrastructure Division

MHI has provided a wide spectrum of production plants around the world, particularly for fertilizer and methanol as well as various types of petrochemical plants. Other facilities include oil and gas plants, water treatment and desalination plants, flue gas CO_2 recovery plants and LNG tanks and receiving terminals. Responding to a broad range of industrial infrastructure needs, the MHI Group provides highly reliable and safe plants by applying its extensive experience in project management and advanced technological skills and capabilities.

Renewable Energy Business Division

The MHI Group provides comprehensive low-environmental-load energy-related technologies, including large-scale wind power systems and a broad selection of pumps. Worldwide, the Group has supplied over 17,500 pumps for use in countless applications, such as power stations, plants, and ships. In preparation for mass production of turbines in Europe, MHI in a joint-venture with the Danish firm Vestas Wind Systems A/S is entering the offshore wind power systems market and anticipating rapid growth.

Marine Machinery & Engines

Currently about half of the world's large merchant fleets are fitted with MHI-brand marine products. The MHI Group produces its own independently developed UE engines as well as MET turbochargers, propellers and other equipment. Offering optimal solutions geared toward the environment and saving energy through its Project MEET, MHI is helping make marine transport more economical while reducing the environmental load.

Domain News

MHPS Target: World's No. 1 manufacturer of thermal power generation systems

On February 1, 2014, with the merger of their thermal power generation businesses, MHI and Hitachi, Ltd. launched a new company, Mitsubishi Hitachi Power Systems, Ltd. (MHPS). By bringing together such advanced technologies and a broad range of exceptional products, the integration gives the maximum synergy needed to become the world's No. 1 manufacturer of thermal power generation systems.

MHI CO_2 capture system receives METI Minister's Award at 39th Outstanding Environmental Systems Awards

In July 2013, an MHI plant system that captures CO_2 from flue gas emissions received the Minister of Economy, Trade and Industry Award at the 39th Outstanding Environmental Systems Awards. With its world-class track record in commercial applications, the system was highly evaluated for its reliability and economy and its effectiveness in helping prevent global warming. The CO_2 captured by the system can be used to manufacture fertilizers and methanol, and an application for enhanced oil recovery (EOR) is also expected.

Pressurized hybrid power generation system clocks up 4,000 plus hours of continuous operation

Since 2008, MHI and now Mitsubishi Hitachi Power Systems, Ltd. (MHPS) has been developing a 200 kW class pressurized hybrid power generation system at MHI Nagasaki Shipyard & Machinery Works, incorporating solid oxide fuel cells (SOFC) and a micro gas turbine (MGT). The system is a world first with over 4,000 hours of uninterrupted operation and has demonstrated energy-saving and highly efficient power generation. MHPS now plans to conduct safety verification tests and explore the market for the system's business and industrial applications.

You can also view this on the "MHI Graph" page of MHI's website (http://www.mhi-global.com/discover/graph/index.html).

MHI graph Search

Engineers, Be Ambitious!

Application & Planning Team, Turbocharger Section,
Engineering Department, Marine Machinery Division,
Mitsubishi Heavy Industries
Marine Machinery & Engine Co., Ltd.

Haruna Ono

Since becoming an engineer two years ago, Ono has been actively involved with turbochargers* from development planning through to the delivery. Enthusiastic, keen to learn, and a good listener, every day she assesses customer and coworker opinions and incorporates them into the designs; every bit of information gleaned in this manner leads to the next design development. * See P.10

Partner Tool • Scientific electronic calculator		My powerful electronic friend and I take on figures face-to-face every day, turning our customer's dreams into our designs.

MHI listens to input today to output better products tomorrow

Visit the "MHI Graph" page on MHI's website
(http://www.mhi-global.com/discover/graph/index.html)
to view video clips.

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Onward and Upward 130TH Anniversary

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Please use the following link to send your questions or feedback:
URL: http://www.mhi-global.com/inquiry/index.html

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