JOGMEC promotes HSE in accordance with the following policies:

1. Compliance with laws and regulations
2. Reduction of burden through self-regulation and collaboration with affiliate companies
3. Dissemination of policies and education/training
4. Disclosure of information

July 2019

Japan Oil, Gas and Metals National Corporation
http://www.jogmec.go.jp
Message from the Chairman & CEO

Seeking a stable supply of natural resources and energy for Japan and the World

We at JOGMEC, an organization that covers natural resources in general, perform the activities with the purpose of, among others, contributing to stable and inexpensive supplies of oil, natural gas, metals, coal, and geothermal energy. With respect to oil and gas, JOGMEC provides financial and technical support for exploration and development projects carried out by Japanese private companies. JOGMEC is also engaged in R&D, such as for the development of methane hydrate, and enhanced oil recovery technologies (CO2EOR). Also, with the amendment of the Act on JOGMEC in 2016, JOGMEC has strengthened support functions to Japanese private companies and is able to assist the acquisition of capital tie-ups with overseas resource companies, and make additional investment for petroleum projects that have moved from the exploration phase to the development phase. Regarding metals, JOGMEC provides financial and technical support for the exploration and development of base and rare metals, in addition to conducting surveys on deep-sea minerals, including polymetallic massive sulfide deposits. Furthermore, JOGMEC is working to prevent pollution from domestic abandoned mines. In the area of coal, in addition to providing financial and technical support for exploration and development, JOGMEC performs the activities related to the government’s policy of transitional measures taken for the closed domestic coal mines. For the exploration of oil, gas, metals, and coal, JOGMEC directly conducts initial explorations that are risky for private companies, aiming to hand over its exploration interests to Japanese companies at a later stage.

When it comes to geothermal energy, which is attracting attention as one of the renewable energy sources, JOGMEC provides financial and technical support for promoting the utilization of geothermal energy in Japan. JOGMEC is also engaged in resource stockpiling-related areas in preparation for possible supply disruption, setting up a structure that manages the national stockpiles of petroleum, petroleum gas (LPG), and rare metals, and it releases the stockpiles in an agile manner during the event of an emergency.

Looking out over the world, the situation surrounding resources and energy is undergoing major upheaval such as the arrival of the EV age and dramatic advances in IT technology. Meanwhile, the global economy faces uncertainty in terms of geopolitical instability, an increasingly complex international situation and so on. Under such circumstances, for Japan, which relies on imports to provide most of its resources and energy, it is essential to secure stable and economical supplies.

The new five-year medium-term target period (the 4th term) has started from the year 2018. While playing a part of government’s resource diplomacy through strengthening relations with resource-rich countries, more than ever, JOGMEC is committed to offering risk money to support Japanese private companies acquiring resource interests, enriching functions as a center of expertise and information on resources and energy, and enhancing technical and human resource development functions.

JOGMEC’s mission of securing stable supply of Japan’s resources and energy is becoming more and more important. To efficiently advance a broad range of activities, we will not only reinforce our unity as the organization, but also actively seek cooperation with the Government of Japan, the governments of resource-rich countries, government agencies, and domestic and international corporations. Then we will build a flexible structure for conducting the needed activities. We at JOGMEC continue to make greater efforts. I deeply appreciate your continuous understanding and support for our activities.

Tetsuhiro Hosono
Chairman & CEO
Importance of securing resources in Japan

It is essential to secure stable supplies of resources since they are the driving force of modern life and economic activities for every nation. Japan may face serious threats to securing resources as competition for resources intensifies, because it largely depends on imports. Therefore, Japan needs to steadily secure resources for people’s lives and economic development.

JOGMEC’s 4 areas of responsibility

To contribute to dynamic development of natural resources and energy, JOGMEC’s main areas of responsibility are defined as:

- Oil and natural gas
- Metals
- Coal
- Geothermal

JOGMEC joins hands with Japanese private companies in each of these areas at various phases of projects through geological surveys, technological development, financial support, stockpiling, environmental protection, and gathering and provision of information, to name just a few. International cooperation and collaboration is also at the forefront of JOGMEC’s activities, which are designed to contribute to the stable supply of natural resources and energy, indispensable for the national livelihoods.

Flow of natural resource development

Survey → Exploration → Development → Production → Stockpiling → Supply → Environmental protection

Dependence of natural resources on imports

- Oil: 99.7%
- Natural gas: 97.6%
- Copper ore: 100%
- Coal: 99.4%

Eight multi-faced activities

1. Geological survey
2. Survey for marine resource development
3. Financial support for Japanese companies
4. Technological development
5. National stockpiling
6. Environmental protection
7. International cooperation and resource diplomacy
8. Collection and provision of information

JOGMEC’s partners

Japanese public

JOGMEC contributes to the stable supply of natural resources and energy, indispensable for the national livelihoods.

Japanese companies

JOGMEC joins hands with Japanese private companies in technological and financial areas.

Foreign governments and companies

Mutually cooperative and beneficial relationship is established.

About us

JOGMEC is a governmental organization that collaborates with governmental agencies and companies both at home and abroad with a view to secure stable supplies of natural resources and energy for Japan, while contributing to the development of resources and energy business worldwide as the duty of a large energy-consuming nation.
**Oil and natural gas**

To ensure stable supplies of oil and natural gas, JOGMEC is contributing in a wide variety of areas including survey, research, development and production.

**Geological and geophysical surveys**

JOGMEC is conducting geological and geophysical surveys, evaluation studies of oil/gas fields, feasibility studies, etc. in countries where new exploration and development projects of oil and natural gas are expected. Through these surveys and studies, JOGMEC builds cooperative relationships with resource-rich countries, and also encourages Japanese companies to participate in exploration and development projects by providing the survey results and priority negotiation rights acquired through the survey process. JOGMEC also conducts geological and geophysical surveys in Japan, since domestic resources could become the most secure supply sources.

**Overseas geological and geophysical surveys**

Overseas geological and geophysical surveys are conducted to evaluate the potential of prospective area, on the request from foreign governments and national oil companies or on the advice of JOGMEC. Through these surveys, we build cooperative relationships with the host country. JOGMEC encourages the participation of Japanese companies through the surveys. Since 1979, 64 overseas geological surveys have been conducted in 28 countries.

**Recent achievements**

- **Transfer of a geological and geophysical survey project in Eastern Siberia to Japanese companies**
  - JOGMEC transferred a joint exploration project in Eastern Siberia to 2 Japanese companies. The project had been conducted by JOGMEC under the scheme of overseas geological and geophysical survey. After the takeover, JOGMEC provides equity capital to the project for further exploration activity.

- **Acquired exploration sites in Greenland**
  - JOGMEC and its predecessor JNOC have conducted a geological and geophysical survey project in Greenland since 1989. Greenland Petroleum Exploration Co., was established to implement the priority negotiation rights acquired through the survey project, and in 2013 it was awarded two exploration areas in the northeastern offshore Greenland.

- **Geological and geophysical survey project in Kenya**
  - Eastern Africa has a potential to evolve into a new oil producing region. JOGMEC has been carrying out an overseas geological and geophysical survey project in onshore Kenya with National Oil Corporation of Kenya (NOCK) since 2012.

**Domestic oil and gas survey program**

Oil and natural gas resources surveys in Japan are a part of Japan’s national policy to ensure energy security. JOGMEC conducts seismic surveys and exploratory drilling to gather fundamental data and facilitate further exploration activities. In line with the global shift of offshore exploration toward the depth of 2,000 meters or above, JOGMEC is commissioned to operate a government owned survey vessel “Shigen” and conduct three-dimensional seismic surveys. This vessel enables JOGMEC to identify three-dimensional underground structures at a wider area with more accuracy.
Technological development

It is essential to improve various technologies for exploration, development and production of oil and gas, not only to conduct exploration and development projects more efficiently but also to secure more resources. As a core organization for oil and gas development technology in Japan, JOGMEC is continuously accumulating technology, technically supporting operations, conducting joint research with oil and gas-producing countries, supporting new projects, conducting expert training programs for geologist and geophysicist and so forth.

Exploration and development technology

Development of exploration technologies plays an essential role in securing future oil and gas production. JOGMEC promotes research and development of exploration technology for oil, gas and non-conventional resources such as shale gas/oil and methane hydrate. Also, JOGMEC carries out technological assessment of exploration and development projects by Japanese companies worldwide, joint studies with NOCs, technological trend surveys and human-resource development related activities.

Examples

**JAPAN-GTL technology**

GTL (Gas to Liquids) is a technology that converts natural gas to liquid fuel such as clean kerosene and gas oil. Since the produced GTL fuel does not contain sulfur and aromatics, it attracts attention as a clean fuel. JOGMEC has co-developed the JAPAN-GTL technology with six Japanese companies. It enables to use CO₂ as a raw material for GTL, and it does not require expensive oxygen production equipment. Three years of verification tests were successfully completed in 2011, and JOGMEC is currently discussing the introduction of JAPAN-GTL with the national oil companies of Turkmenistan and Mozambique.

![JAPAN-GTL technology](image)

**Technology for developing methane hydrate resources**

Methane hydrate, also known as “fired ice”, is an ice-like substance composed of methane gas and water. It is abundant in low-temperature, high-pressure environments such as polar and deep sea. In line with Japan’s Methane Hydrate R&D Program of METI in 2001, JOGMEC is conducting research on resource assessment, field tests, etc., as a member of the Research Consortium for Methane Hydrate Resources in Japan. Based on a detailed survey conducted in eastern Nankai Trough, a zone where concentrated methane hydrate was found, a reservoir consisting of alternating layers of sand and mud, and the methane gas resource was estimated for the offshore area. After conducting onshore production tests in Canada by the depressurization method, JOGMEC conducted the world’s first offshore production test in March 2013, successfully producing roughly 120,000m³ of methane gas in six days.

![Technology for developing methane hydrate resources](image)

**Optimization of shale gas development**

For the commercial development of shale gas, it is essential to utilize horizontal well drilling and hydraulic fracturing technologies as the gas is stored in nano-scale pore spaces in shale rocks. To understand the gas storage and flow in the shale rocks and efficiency of the hydraulic fracturing, fundamental R&D is still required. JOGMEC has started a joint research project with Mitsubishi Corporation and Encana Corporation to contribute to their shale gas operation in Canada. In the joint research, JOGMEC has been conducting, for the purpose of the optimization of shale gas development, laboratory experiments and seismic data interpretation that is developed through a fractured reservoir characteristic.

![Optimization of shale gas development](image)

**Environmental protection technology**

Minimizing the environmental load is an unavoidable challenge in oil and gas development. For example, CO₂ reduction technology and technologies related to the treatment and reuse of water trapped in underground formations that is brought to the surface along with oil or gas production (produced water) are attracting attention.

**CO₂-EOR technology**

JOGMEC is conducting research and development on CO₂-EOR (enhanced oil recovery by injecting carbon dioxide) as one of the technologies of EOR, and improves the oil recovery. By combining CO₂-EOR with a CCS (Carbon Dioxide Capture & Storage) technology to separate, recover and store in the ground the CO₂ emitted from power plants, factories and other industrial plants, JOGMEC aims to establish environmental protection technologies that also increase revenue. JOGMEC is carrying out joint R&D with national oil companies of Abu Dhabi and Vietnam.

![CO₂-EOR technology](image)

**FMS technology**

JOGMEC has been developing RAS technology since 2009, at the request of the Mexican national oil company, PEMEX. In RAS technology, oil and solids contained in produced water are flocculated using magnetic powder and flocculating agent, and the aggregate is then separated from water by using a strong magnet to attract it. RAS equipment is compact yet the process is rapid, and the quality of processed water is high. As a new oil production technology of Japan, RAS attracts global attention.

![FMS technology](image)
In light of increasing technical difficulties of oil and gas developments, Exploration and Production projects need a wide range of new technologies. JOGMEC is ready to answer this growing demand. Technical solutions project provides advanced and cutting-edge technologies (seeds) of Japanese companies to solve technical problems (needs) of oil and gas-producing countries. JOGMEC's prime task is to promptly grasp technical needs of the oil and gas-producing countries to propose the right technical solutions for their needs. As a foundation of this project, JOGMEC actively continues technological development with a wide range of Japanese industries. JOGMEC customizes the Japanese high-end technologies, in addition to conventional technologies, to make a suitable technical solutions package for oil and gas-producing country.

JOGMEC Techno Forum connects the needs of oil-and gas-producing countries with Japanese technology

JOGMEC hosts “JOGMEC Techno Forum” which provides unique opportunities to discuss technical challenges in oil and gas industry and discover Japanese innovative technologies applicable to needs of oil and gas-producing countries. The first forum was launched in May 2013, attracting many participants from a wide range of Japanese industries and several NOCs/IOCs. We will host this forum annually to support interactions between Japanese companies and oil and gas-producing countries.

Technology Development & Demonstration

JOGMEC will continue to propose technological development packages that utilize the high-end technologies of Japanese companies, in addition to conventional technologies.
Financial assistance to Japanese companies

Oil and natural gas exploration and production projects (E&P projects) require huge amounts of investment. JOGMEC provides equity capital to Japanese companies for oil and natural gas E&P projects to mitigate the risks for them. After the commercial discovery of oil or gas reserves, JOGMEC also provides liability guarantees for oil and natural gas E&P projects conducted Japanese companies to support their finance.

Equity capital
To launch oil and natural gas exploration and development projects by a Japanese company, it usually establishes a project company to operate each project. The project company raises funds for exploration by issuing new stock, and, JOGMEC provides equity capital by purchasing such stock. After a decision for commercial development is made, JOGMEC’s policy is to divest its capital holdings.

Liability guarantees
JOGMEC provides liability guarantees to Japanese companies for their finance for oil and natural gas development projects or asset purchases (purchase of oil/gas fields). JOGMEC also provides completion guarantees for projects.

Resource stockpiling

Japan depends on imports for virtually all of its energy resources, despite being the fifth largest consumer of energy in the world.* Thus, people’s lives and the economy would be disrupted in the event of unforeseeable circumstances. To prepare for disruption in the supply of energy resources, JOGMEC is promoting the stockpiling of petroleum and petroleum gas (LP gas) at the request of the Japanese government.

*Source: BP Statistical Review of World Energy (June 2016)

Stockpiling system

Stockpiling of petroleum in Japan is performed in three programs. First, there is national stockpiling, which is run directly by the Japanese government. Second, there is private stockpiling, which by law must be performed by private oil companies. Third, there are stockpiles held jointly in collaboration with oil-producing nations. The three programs have a combined stockpile of approximately 80 million kiloliters of petroleum (equivalent to approximately 207 days of domestic consumption, as of the end of March 2016). Stockpiling of petroleum gas (LP gas) in Japan is being promoted through two programs: the national stockpiling program which is directly controlled by the government, and the private-sector stockpiling program which is implemented by private companies under obligation by law. Two programs have a combined stockpile of approximately 2.8 million tons of LP gas (equivalent to approximately 103 days of import volume, as of the end of March 2016).

Stockpiling quantity in Japan (as of the end of March 2016)

<table>
<thead>
<tr>
<th></th>
<th>National stockpile</th>
<th>Private-sector stockpile</th>
<th>stockpiles held jointly with oil-producing nations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petroleum</td>
<td>47.8 million KL</td>
<td>31.3 million KL</td>
<td>1.3 million KL</td>
</tr>
<tr>
<td>LP gas</td>
<td>1.150 thousand tons</td>
<td>1.738 thousand tons</td>
<td></td>
</tr>
</tbody>
</table>

Huge gas fields have been discovered in offshore Mozambique, where a JOGMEC-associated Japanese company is participating in an exploration project. This area is expected to contribute to a stable energy supply for Japan as a major LNG supply base.

Recent examples of our support

Increasing support to LNG projects in Oceania

Oceania is expected to be the largest LNG supply area for the East Asian market. JOGMEC is providing equity capital and liability guarantees to multiple LNG development projects in Australia and Papua New Guinea in which Japanese companies are participating.

Progress of LNG projects in Mozambique

Huge gas fields have been discovered in offshore Mozambique, where a JOGMEC-associated Japanese company is participating in an exploration project. This area is expected to contribute to a stable energy supply for Japan as a major LNG supply base.

Image courtesy of INPEX CORPORATION

Stockpiling capacity by base

<table>
<thead>
<tr>
<th>Petroleum</th>
<th>LP gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 640 Tomakomai</td>
<td>1 200 Kamisu</td>
</tr>
<tr>
<td>2 570 Mutsuogawara</td>
<td>2 250 Nanao</td>
</tr>
<tr>
<td>3 450 Akita</td>
<td>3 400 Kurashiki</td>
</tr>
<tr>
<td>4 175 Kuji</td>
<td>4 450 Namikata</td>
</tr>
<tr>
<td>5 340 Fukushima</td>
<td>5 200 Fukushima</td>
</tr>
<tr>
<td>6 150 Kirkuk</td>
<td>6 560 Shishahima</td>
</tr>
<tr>
<td>7 540 Shishahima</td>
<td>7 440 Kamijotou</td>
</tr>
<tr>
<td>8 500 Shibushi</td>
<td>8 500 Shibushi</td>
</tr>
<tr>
<td>9 175 Kushikino</td>
<td>9 500 Shibushi</td>
</tr>
</tbody>
</table>

(Unit: thousand tons)
Stockpiling methods

For the national petroleum stockpiling bases, different stockpiling methods are employed depending on the characteristics of each site. National LP gas stockpiling bases are required by law to be constructed adjacent to private LP gas importing bases, to reduce costs by effectively using existing facilities and commissioning operations and so on. Suitable stockpiling methods are selected for each site, as with national petroleum stockpiling bases.

Petroleum stockpiling methods

Aboveground tank system

This is the most commonly used stockpiling method at national petroleum stockpiling bases. It is a common type of petroleum storage tank and has a proven track record including safety performance and advantages such as relatively low construction cost.

In-ground tank system

In this stockpiling method, most of the tank body is buried in the ground. The risk of petroleum leakage or penetration into the ground is low, and the structure has excellent earthquake resistance. This type of tank has approximately three times the capacity of an aboveground tank for the same land area, because the tank diameter and depth of the tank can be made larger.

Water-sealed type underground rock cavern tank system

In this stockpiling method, an underground rock cavern is excavated and used to store petroleum. This type of tank has advantages of low risk petroleum leakage and is resistant to natural disasters such as earthquake, lightning, etc. In addition, there is minimal effect on the surrounding scenery because the storage facility requires only limited space for incidental facilities.

Floating tank system

In this stockpiling method, storage facilities are installed offshore to utilize the available ocean space. Each “storage vessel,” which has a double hull structure, is set afloat on the sea and surrounded by double petroleum fences to provide maximum protection against petroleum leakage or diffusion.

LP gas stockpiling methods

On-ground low-temperature tank system

In this stockpiling method, LP gas, which is liquefied by cooling, is stored at low temperature in a cylindrical double-shell tank with a flat bottom. The double-shell tank consists of an inner tank and an outer tank made of low temperature resistant steel, and the space between the tanks is filled with insulator (cold insulation). The principle is the same as that of a thermos flask. This is the most common storage method used at LP gas importing bases.

Water-sealed type underground rock cavern tank system

In this stockpiling method, LP gas at normal temperature is sealed in a rock cavern by groundwater pressure. The storage tank is installed underground at a depth where the groundwater pressure is slightly higher than the pressure of the LP gas, preventing leakage of the gas to the outside. Water is supplied to the bedrock from water-sealing tunnels and water-sealing boring in order to stabilize the groundwater pressure.

Safety management of stockpile bases

At stockpile bases, we strictly monitor compliance with relevant laws including the Fire Service Act, Act on the Prevention of Disaster in Petroleum Industrial Complexes and Other Petroleum Facilities, and the High Pressure Gas Safety Law, to ensure safety and prevent disasters. We also strictly monitor operational management.

Technological development

In order to improve the safety and reliability of national stockpile bases and reduce the cost of the national stockpiling programs, JOGMEC is carrying out various surveys and research on stockpiling technology, including preservation of petroleum quality, maintenance of tanks, etc., and studies on safety and disaster prevention.

Releasing petroleum in emergency situations

In cooperation and collaboration with the IEA, JOGMEC will respond to emergency situations by appropriately combining measures such as releasing petroleum from the stockpile and suppressing demand and taking into account such factors as the degree and expected duration of supply shortage and the domestic demand and supply trends.

Collection and provision of information

As an organization that gathers, analyzes and provides information, JOGMEC is constantly carrying out research on worldwide resources and energy trends, tax systems in oil and natural gas producing countries, published information on new mining areas, the trends of resource development companies, and so on. We provide information in a timely manner through our websites and briefing sessions.

Wide variety of events

International seminars
Overseas exhibitions
Monthly briefings on oil and gas business trends
Metals

JOGMEC seeks to ensure a stable supply of metal resources which are indispensable for Japanese industry, and contributes to a wide range of fields including surveying, exploration, development, production and stockpiling to recycling and environmental protection.

While implementing and assisting geological surveys in prospective areas for metal resources, JOGMEC also supports exploration and development by Japanese companies by providing equity capital and liability guarantees. JOGMEC also actively carries out technological development and provides technical support in each stage of metal resource development, and operates national stockpiling programs as a safeguard against disruptions to the supply of rare metals, which are unevenly distributed by region. In addition, JOGMEC is working on environmental protection including projects for mine pollution prevention and associated project development, as well as proactively providing related technology and knowledge to resource-rich countries.

SQUITEM: Exploration method for deep underground
"SQUITEM" is the transient electromagnetics (TEM) system using the high temperature superconductive quantum interface device (HT SQUID) magnetometers. JOGMEC has developed "SQUITEM", which increases the depth and accuracy of exploration.

Geological survey

Recent rise of emerging economies coupled with hikes in metal prices has made access to natural resources extremely competitive, especially at the development phase. Consequently, JOGMEC from time to time participates in risky primary exploration projects with NOCs and private companies aiming to hand over its exploration interests to Japanese companies at a later stage.

Joint venture survey

JOGMEC actively carries out joint mineral exploration with overseas national corporations and non-ferrous metal companies. For projects with promising results, JOGMEC’s share of interests may be transferred to Japanese companies with reduced initial exploration risk. Principle exploration targets are base metals and rare metals. Target areas are selected based upon geological potential, mining investment environment, including safety and Japanese companies’ interest.

Major recent achievements

Discovery of platinum group metals deposits by JV survey in South Africa

JOGMEC participated in an exploration project in the Frontera district, which was in the initial exploration stage, and identified the possibility of existence of mineable copper and gold deposits. JOGMEC has transferred its interests in the project to a Japanese private company, accelerating the shift from survey to development.

Transfer of a world-class mining to Japanese private company

JOGMEC received the Mining Journal Outstanding Achievement Awards 2012 for this discovery.
Technological development

As mineral exploration field move into deeper and more remote areas of the world, more efficient exploration is needed. JOGMEC is challenging R&D of mineral exploration technology and metal resource recycling technology and improving metal extraction technology. JOGMEC is also carrying out R&D for promoting ocean metal resources development.

Development of exploration and production technology

Exploration of metallic mineral ore deposits using remote sensing technology

JOGMEC has developed mineral exploration technologies to identify hydrothermal alteration zone by using optical sensors data, and also realized geology discrimination technologies to promote the efficient mineral exploration in vegetated areas by using Synthetic Aperture Radar data. JOGMEC is developing more accurate technologies for identification of mineralization by using data from hyper-spectral image sensors that can measure 185 or more spectral bands.

Verification of lithium extraction technology in Bolivia

JOGMEC is currently performing experiment and evaluation to establish a technology for extracting lithium from the Uyuni Salt Lake in Bolivia. JOGMEC has invited Bolivian experts to Japan to participate in the experiment, JOGMEC is helping to create the lithium industry envisioned by the Bolivian government as well as building trusty relationship between Japan and Bolivia.

Bioleaching is a technology to enhance the leaching of metal ions by using the action of microorganisms, and is used in the leaching process in a hydrometallurgical system. JOGMEC is performing search and evaluation of microorganisms and column leaching tests and, based on the test data, carrying out validation tests at a pilot plant in Chile, using locally-produced copper ore.

Development of metal recycling and refining technology

Small electronic and electric appliances contain base metals such as copper and zinc, precious metals including gold, as well as rare metals such as tantalum and cobalt. JOGMEC has been carrying out tests for recovering these metals from waste small electronic and electrical appliances and fact-finding surveys, as well as basic tests for establishing the flow for recovering rare metals. Since 2012, JOGMEC has also been developing recycling technology for recovering tantalum and cobalt.

Exploration of marine mineral resources and technological development

Manganese nodules, cobalt-rich ferromanganese crusts and sea-floor hydrothermal deposits lie on the deep sea floor, and those are greatest unexploited mineral resources on the earth. JOGMEC is actively surveying deepsea-floor to secure stable supply of mineral resources to Japan.

Survey of sea-floor poly-metallic sulphides

From 1985 to 2003, JOGMEC carried out surveys for poly-metallic sulphides in the East Pacific Rise, the Okinawa Trough and the by-pass back-arc basin. JOGMEC has been conducting resource assessment surveys since 2008. In 2012, JOGMEC conducted a deep drilling survey of sea-floor poly-metallic sulphides in the Okinawa Trough using the marine resource research vessel "Hakuho" and discovered a new, deeper ore body which could turn out to be a large-scale deposit. In addition, JOGMEC successfully carried out the world's first caveling and mining test using a small test mining machine and has started to develop actual machines.

Cobalt-rich ferromanganese crusts

Cobalt-rich ferromanganese crusts are similar to manganese nodules and consist of iron and manganese oxides. They occur the bedrock in the slopes and tops of seamounts, with thicknesses ranging from several millimeters to several tens of centimeters. The cobalt content of cobalt-rich crusts is roughly three times that of manganese nodules, and cobalt-rich ferromanganese crusts also contain small amounts of platinum.

Manganese nodules

Manganese nodules are lumps of iron and manganese oxides of roughly 2 to 15 centimeters in diameter, which are half-buried on flat ocean floors at depths between 4,000 and 6,000 meters. They contain useful metals such as nickel, copper and cobalt.

JOGMEC has been performing search and evaluation of rare metals in the Area in the central to north-west Pacific. Based on the survey results and after screening by the International Seabed Authority, JOGMEC acquired exclusive exploration rights to an area (3000 km²) in international waters 600 km southeast of Minami Torishima (Marcus Island). We plan to commence a full-scale exploration including R&D of production technology that will take 15 years.

Marine resource research vessel "Hakuho"
Environmental protection

Mines greatly benefit the countries and local societies in various ways, but can also cause environmental problems such as mine pollution that affects seriously to the lives of local residents. JOGMEC’s environmental protection activities mainly consist of sharing information and providing technical and financial supports to local governments, entities seeking to prevent mine pollution, and governments of metal resource-producing countries.

JOGMEC’s activities in Japan: at the abandoned Matsuo Mine

Japan used to be a leading mining country but now has nearly 5,000 abandoned mines, and mine pollution such as water pollution has occurred at about 450 sites of them. Therefore, JOGMEC has been working mine pollution control since 1973. JOGMEC was commissioned by the Iwate prefectural government to operate and manage a water treatment facility at the abandoned Matsuo Mine, which used to be the largest sulfur mine in Asia. The facility has the largest water treatment capacity of acid mine drainage from abandoned mines in Japan, and commenced full-scale operation in 1982. Since then, we have been continued neutralization of highly-acidic mine drainage, which contains toxic heavy metals such as iron and arsenic, at a rate of 18 tons per minute. Sludge are separated and deposited as waste dam and the clear supernatant liquid is discharged. In addition, we have been redring and maintaining the scenery of the region through measures such as maintaining the sedimentation dam and providing soil cover and vegetation over the closed open-pit, thereby protecting the clean water of Kitakami River for over 30 years.

Technological development: Survey and research related to passive treatment technology

Passive treatment is an almost maintenance-free water treatment technology. This technology can greatly reduce the cost of treatment of mine drainage. The advantage of passive treatment technology is that it fully uses the natural cleaning function of microorganisms to precipitate the heavy metals, which are then easily removed or absorbed by vegetation. JOGMEC is carrying out various tests aiming to introduce passive treatment on site in the near future.

Technical support to the governments of metal resource-producing countries

Utilizing its experience and technical know-how on mine pollution control developed over the years, JOGMEC has been providing information and technical support to resource-producing countries in recent years through overseas seminars on mine pollution control, dispatching of advisors, etc., thereby contributing to environment-friendly and sustainable development of mine and strengthening relationships with resource-producing countries.

Strengthening relationships with resource-producing countries

JOGMEC signed a memorandum of understanding (MOU) with Peru in December 2008 concerning the dispatching of an expert on preventive policy for mine pollution. In 2013, JOGMEC newly signed MOUs in the field of mine pollution control with countries such as Cambodia and Laos. Thus, JOGMEC’s activities to support mine pollution control are steadily spreading around the world.

Holding seminars and other programs

To strengthen the cooperative relationships with resource-producing countries in the field of mine pollution control, JOGMEC is providing various technical support such as holding seminars on mine pollution control and hosting observation teams and trainees in Japan.

Seminars held on mine pollution control

<table>
<thead>
<tr>
<th>Country</th>
<th>Date</th>
<th>No. of Participants</th>
<th>Principal participating agencies</th>
</tr>
</thead>
<tbody>
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<td>Peru</td>
<td>2016.2</td>
<td>110</td>
<td>Ministry of Energy and Mines</td>
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<tr>
<td>Bolivia</td>
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<td>192</td>
<td>Ministry of Mining and Metallurgy and local governments</td>
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<td>SERNAGEOMIN</td>
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<td>Vietnam</td>
<td>2012.8</td>
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<td>Ministry of Natural Resources and Environment</td>
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<td>China</td>
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<td>Cambodia</td>
<td>2012.2</td>
<td>96</td>
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<td>Government officials from South Africa, Angola, Bolivia, Congo, Gabon, Lesotho, Madagascar, Malawi, Mozambique, Namibia, Niger, Tanzania, Zambia, Zimbabwe</td>
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<td>124</td>
<td>Ministère du Développement de l'Industrie et Mines</td>
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<tr>
<td>Zimbabwe</td>
<td>2016.3</td>
<td>125</td>
<td>Ministry of Mines &amp; Mining Development</td>
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</table>

Dispatching advisors on mine pollution policies to Peru

At the request of the Peruvian government, which highly evaluates JOGMEC’s efforts in mine pollution control projects, JOGMEC signed an MOU on the dispatch of advisors on mine environment policies in 2008 and has been dispatching experts on mine environment to Peru since 2009. In addition, JOGMEC has been providing technical support to the engineers of the Ministry of Energy and Mines since 2012, by conducting water systems surveys in the field as the OJT (technical transfer).

Seminars held on mine pollution control

<table>
<thead>
<tr>
<th>Country</th>
<th>Date</th>
<th>No. of Participants</th>
<th>Principal participating agencies</th>
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<tr>
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<td>Ministry of Mining and Metallurgy and local governments</td>
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<td>SERNAGEOMIN</td>
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</tbody>
</table>
Financial support for Japanese companies

JOGMEC provides funds required for metal resource exploration projects in the form of equity support or loan, to assist Japanese companies in expanding and expediting exploration, leading to the faster transition to mine development stages. JOGMEC also provides liability guarantees for development funds loaned by private financial institutions, in order to ensure the smooth procurement of enormous investment funds. The funds support by JOGMEC can be provided to the projects through participation of Japanese companies.

**Equity capital loan and investment system for acquisition of assets**

To enhance and expedite high-risk mineral exploration, JOGMEC provides the necessary funds in the form of equity support or loan. Since 2010, a scheme of equity participation was also started to assist Japanese companies for the acquisition of mining interests in the development and production stages.

**Liability guarantee**

Projects in the development stage require massive amount of investment, ranging from several tens of millions to more than one billion dollars. JOGMEC provides liability guarantees for development funds loaned by private financial institutions to Japanese companies, in order to ensure the smooth procurement of development funds and to reduce the business risks and country risks associated with each project.

Recent examples of our support

**Liability guarantee for large-scale copper mine development projects in Chile**

In Chile, the largest copper-producing country in the world, JOGMEC provided liability guarantees for the funds loaned by private financial institutions to Japanese companies participating in the Esperanza, Caserones and Sierra Gorda mining projects. These projects are expected to greatly help ensure a stable supply of copper, with most of the copper concentrate produced at these mines being supplied to copper smelters in Japan.

**Supporting Japan’s first lithium development project**

In 2012, JOGMEC provided a liability guarantee for part of the development funds for the lithium development project in Salar de Olaroz (Olaroz Salt Lake), Argentina, in which a Japanese trade company participated.

**Investing in the world’s largest niobium production company**

JOGMEC invested in the world’s largest Brazilian niobium producer with Japanese steel makers and a trade company. Niobium is an essential metal for manufacturing high-grade steel, thereby securing an established source for stable supply of niobium.

**Collection and provision of information**

The world situation concerning metal resource development is changing rapidly, due to the expanding demand for metals, increasing competition to acquire mining areas, and the impact of tighter environmental regulations on mining management. Accordingly, the value of information is also increasing. JOGMEC collects, studies and analyzes information on international trends in mining, and distributes such information through various media, lecture meetings and websites, thereby assisting Japanese companies.

**Metal resources investment seminar**

JOGMEC organizes investment seminars for metal resource exploration and development, inviting high level government officers from resource-rich countries and industry experts as speakers, to promote overseas mining investment by Japanese companies. JOGMEC also attends various mining-related events to exchange information with resource concerned parties.

**Rare metals stockpiling**

Rare metals, which are widely used in applications ranging from automobiles, electronics and aviation to IT and environmental protection, are an important and vital resource for Japanese industry. JOGMEC has been promoting a national rare metal stockpiling project as a safeguard against short-term supply interruptions of rare metals and to stabilize the Japanese economy.

**National rare metals stockpiling project**

The rare metals stockpiling system was established in 1983 as a cooperative system between the government and private sector, to ensure natural resource security and economic security. Since then JOGMEC has been engaged in the national rare metal stockpiling project. Stockpiled rare metals will be released in response to interruption of supply from overseas or shortage in domestic supply.

**National stockpile warehouse**

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Coal

Coal is a vital resource for the Japanese economy and industry, and demand for it has been rising worldwide. JOGMEC contributes to the coal industry in various ways including conducting geological surveys, developing technologies, and providing financial support and information, in order to secure stable coal supply in Japan.

Geological survey

It is important for Japan to expand the supply capacity of coal-producing countries and acquire new coal resources because Japan deeply depends on coal from foreign countries. JOGMEC conducts surveys on coal development and related projects in addition to organizing exploration projects jointly with the governments of coal-producing countries, foreign companies, and national corporations to help Japanese companies develop coal resources smoothly and efficiently.

Joint survey with foreign companies (Joint venture survey)

JOGMEC organizes joint venture surveys by designating foreign companies as joint venture partners, and conducts geological surveys, geophysical and drilling surveys with the partners and summarizes the results. If the result is promising and Japanese companies show strong interest in them, JOGMEC invites them for bids and transfers JOGMEC’s rights under the joint venture agreement to the successful bidder. It contributes to reducing the risk involved in developing coal resources for Japanese companies.

Major recent achievements

Coal JV survey with Australian company

JOGMEC concluded a joint exploration agreement with Stanmore Coal Limited of Australia for a project in Clifford area, its first JV survey project in coal exploration. There are high hopes for this area with its highly combustible and high-quality steam coal resources.

Joint survey with government agencies of coal-producing countries

JOGMEC conducts joint surveys with the government agencies of coal-producing countries, and analyzes coal resources and geological structures of the coal layers to assess the potential for resource exploration, confirming the presence and extent of coal resources in high-risk areas where private companies cannot easily explore by themselves. JOGMEC contributes to securing a stable coal supply for Japan by acquiring benefits for the entry of Japanese companies from the government agencies of coal-producing countries as well as facilitating future development of such coal resources. JOGMEC conducts surveys in highly expected countries by Japanese companies in addition to in key areas such as in Southeast Asia and Africa.
Financial support for Japanese companies

JOGMEC has established an integrated financing system that covers from the initial exploration through development and production. Coal exploration projects involve extremely high-risk, so JOGMEC facilitates exploration by providing equity capital. Moreover, JOGMEC provides liability guarantees for the funds that Japanese companies borrow from private financial institutions because a lot of investment is needed for the development stage.

Equity participation in overseas exploration

JOGMEC provides equity capital up to 50% of the project cost to facilitate high-risk exploration projects of coal resources when a Japanese company explores for coal in a foreign country. Financing is provided by stock acquisition, and JOGMEC has a policy to sell its interests when the purposes of the exploration are achieved.

Liability guarantee for overseas development fund

JOGMEC provides liability guarantees for up to 80% of the debt borrowed from private financial institutions as funds necessary for investment for coal mining, subsequent cleaning and other related operations in a foreign country.

Technological development and technical transfer

Based on agreements with government of coal-producing countries, JOGMEC helps to ease the tight supply and demand caused by increased demand in coal-producing countries, by demonstrating and diffusing coal-related technologies such as for effectively using low-grade coal. JOGMEC is also strengthening relations with coal-producing countries mainly in Asia such as by transferring coal extraction and security technologies to them.

Technology for efficient utilization of low-grade coal

About half of the world’s recoverable coal reserves are low-grade coal called subbituminous coal and brown coal; their uses are limited because they have high moisture, low calorific value, and a high risk of spontaneous combustion. At the request of Indonesia, one of Japan’s major coal suppliers, for technological cooperation, JOGMEC conducts experiments to verify technology for producing liquefied fuel called coal slurry using low-grade coal.

Transfer of coal exploration technology project

Many Asian coal-producing countries have been increasing their domestic consumption of coal, and they need to both expand production and ensure security at coal mines. In technical transfer projects, production and security technologies are transferred to coal mine workers in these countries using the knowledge and networks of Japan. JOGMEC also dispatches Japanese engineers to coal-producing countries and gives technical guidance according to local requirements.

Collection and provision of information

Coal demand has been growing rapidly especially in Asia, and is likely to continue increasing. It is important to acquire information on the continuously changing situation of coal resources worldwide, promptly and precisely. JOGMEC supports Japanese companies who make the investment decisions by analyzing and providing comprehensive coal-related information, including the trends of coal-producing countries and resource development companies, and coal mining technology.

Organizing seminars

JOGMEC holds seminars to introduce attractiveness of investment destinations as needed. In December 2013, JOGMEC held a coal seminar focusing on the State of Queensland, Australia, an important partner as a coal supplier whose coal accounts for 25% of Japan’s coal imports, jointly with the state.
Geothermal

As with the many types of renewable energy resources, geothermal energy is a clean source that has a much lower environmental impact than conventional energies, and is considered constantly replenished and sustainable. Geothermal Power Generation, harnessing geothermal energy for electricity production, attracted more attention as one of base load energy sources after the accident in Fukushima in 2011, and the circumstances around geothermal power generation have been changed to advance toward expansion.

To drive geothermal development and geothermal power generation in Japan, JOGMEC provides various support ranging from development to power plant construction, conducts R&D, and provides the related data and information.

Geological survey

As the development of geothermal resources requires quite a long time with specific risks in the development up to operating a power plant, JOGMEC provides Japanese companies with financial support for their geological surveys and conducts its own R&D for geothermal technology.

Geothermal Potential Survey

JOGMEC conducts advanced airborne geophysical surveys by a helicopter for the first time in Japan for geothermal development, aiming to acquire basic data for evaluation of geothermal resources.

Airborne Gravity Gradiometer (AGG) and Helicopter Time-Domain Electromagnetic survey (HeliTEM) are used. AGG acquires the highest resolution airborne gravity data available. HeliTEM explores deeper than conventional survey to narrow down prospective areas efficiently.

Subsidized Projects

JOGMEC provides Japanese companies and local governments with subsidies for their surveys. The subsidies are provided to expenses for high-risk initial surveys including surface survey, geophysical exploration and well drilling survey. Costs of environmental assessments and monitoring surveys are also subsidized to protect the natural environment and to maintain harmony with hot spring areas.

A total of 26 survey projects were subsidized in the fiscal year 2016.

Financial Support

In addition to the support of subsidy above-mentioned, JOGMEC provides other 2 support measures to be applied to the following stages of geothermal development.

Investments and Liability Guarantees

At the stage of estimate of the production ability after the initial surveys, JOGMEC can invest up to 50% of the equity capital of the special project company. The first investment was made for Matsuohachimantai exploration project in 2015.

At the construction stage of a power plant, JOGMEC provides companies with a liability guarantee for up to 80% of the loan if they need to be financed from private financial institutions as development funds. Such liabilities were invested for 2 geothermal binary plants, Tsuchiyu of 0.4MW and Sugawara of 5MW in 2013, and Wasabizawa geothermal power plant of 42MW in 2014.
**R&D for Geothermal Technology**

**Exploration Technology**
In the initial stages of geothermal exploration, it is quite important to visualize subsurface structures in detail. Then, JOGMEC has been applying seismic survey which has recently showed remarkable achievement in the oil exploration fields.

**PDC Bit**
JOGMEC’s efforts are underway to develop versatile PDC bits for geothermal development which are further suitable at high temperature and to igneous rocks than conventional bits, as such bits have not been developed and available.

**Enhanced Geothermal System**
There are some geothermal power plants of which power generation often fluctuate due to the uncertainty of required volumes of steam or hot water. In order to work out such issues, JOGMEC will develop technology to extract optimal and stable volumes of steam or hot water by properly controlled injection to geothermal reservoirs.

**Data Collection & Information**
JOGMEC is tasked with promotional activities to increase public awareness of geothermal energy. The activities include symposiums, exhibitions and other events related to geothermal energy. In addition, JOGMEC provides results of surveys, achievements of R&D and guidance documents to assist Japanese companies, and conducts technical seminars to foster geothermal engineers.

**Cooperation with foreign agencies**
- **Joint research with EPRI**
  In 2014, joint research was realized with Electric Power Research Institute (EPRI) in U.S. on Enhanced Geothermal System (EGS).
- **IEA-GIA**
  JOGMEC is proactively working to share data, technologies, and expertise for further geothermal development through its participation in IEA-GIA.

**Geothermal development in Japan**

**Current situation of geothermal power generation**
As of 2014, there are 38 geothermal power plants in operation with the capacity of 524MW in Japan. Matsukawa Geothermal Power Plant, commenced in 1966, is the first plant of 23.5MW in Japan. Hachihara Geothermal Power Plant, the largest geothermal power plant in Japan, has a total capacity of 112MW. Until very recently, after Hachijojima Geothermal Power Plant was constructed to start operation in 1999, no major geothermal power plants have been constructed except for several small-scale plants, newly constructed to start operation in 2015 are Sugiwara Binary Plant of 5MW and Tsuchiyu Binary Plant of 0.4MW. While in terms of geothermal potential Japan has approximately 23,000MW, estimated to be the third largest in the world, its geothermal installed capacity is ranked tenth in the world in 2016.

- **Geothermal power plants in Japan**
- **Geothermal Resource Potential and Installed Capacity**

**Agencies related Geothermal Development**

- **Government**
  - Ministry of Environment (MOE)
- **Incorporated Administrative Agencies**
  - Japan Oil, Gas & Metals National Corporation (JOGMEC)
  - New Energy & Industrial Technology Development Organization (NEDO)
- **Related Associations**
  - Japan Geothermal Association (JGA)
  - The Geothermal Research Society of Japan (GRSJ)
  - New Energy Foundation (NEF)
  - Thermal & Nuclear Power Engineering Society (TNEPS)
  - Japan Mining Industry Association (JMA)
  - Japan Mining & Materials Processing Institute of Japan (JMMPI), etc.
JOGMEC has been and will continue strengthening mutually cooperative relationship with NOCs and host governments in line with the Japanese government’s energy policy.

**Contents of resource diplomacy**

1. Mutually cooperative relationship fostered through meetings with key figures from host governments and NOCs to pave the way for further collaboration on projects, R&D, and human resources development, resulting in strategic partnerships.

2. JOGMEC participates actively in international conferences and exhibitions to raise the presence of the Japanese resource industry and JOGMEC.

3. JOGMEC’s contribution to host countries in human resources development through various courses in Advanced Technical Training.

### Business matching between Japanese companies and resource-rich African countries

JOGMEC held the Japan Sustainable Mining, Investment & Technology business forum (commonly known as J-SUMIT) in Tokyo jointly with the Ministry of Economy, Trade and Industry in 2013. This event was designed to help Japanese companies invest in resource development in Africa and promote business matching between Japanese state-of-the-art technologies and the resource development field, and it attracted more than 2,000 visitors from home and abroad. Lectures on Japanese technologies and exhibition booths featuring the technologies of Japanese companies attracted attention from visitors. Moreover, information was actively exchanged and business negotiations were held, making this a lively event that brought together industry, academia, and government.

### Human resource development and technology transfer seminar in the Botswana Geologic Remote Sensing Centre

JOGMEC has been holding technical training for the mineral resource exploration project and professionals in geology for the Southern African Development Community (SADC) in the Geologic Remote Sensing Centre in the Republic of Botswana. JOGMEC signed a memorandum of understanding with 11 countries in the SADC community. It also conducted joint analyses and local surveys using satellite image analysis technology with a total of about 300 geology professionals for the five years between 2008 and 2013, and transferred technologies to these professionals of the SADC countries, while also selecting and organizing projects in promising areas. As a result, some SADC countries have developed sufficiently skilled human resources to teach experts studying geology in their home countries.
On February 29, 2004, JOGMEC was established for the purpose of securing supplies of oil and natural gas and those of the Metal Mining Agency of Japan (MMAJ) through the merger of the functions of the Japan Oil, Gas and Metals National Corporation (JOGMEC) established through the integration of Japan Petroleum Development Corporation (JPCD), National Oil Corporation (JNOC) and the Metal Mining Corporation (JPDC). JOGMEC’s functions strengthened due to the addition of the Metal Mining Agency of Japan (MMAJ) in September 15, 2012.

In addition, the business of assisting coal and geothermal energy support activities related to coal and geothermal energy.

**Organization**

<table>
<thead>
<tr>
<th>Division/Unit</th>
<th>Office Location</th>
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<tr>
<td>Management Division</td>
<td>Head Office: Toranomon Twin Building, 2-10-1, Toranomon, Minato-ku, Tokyo 105-0001 JAPAN</td>
</tr>
<tr>
<td>Internal Audit Office</td>
<td>Tel: +81-3-6758-8000, Fax: +81-3-6758-8008</td>
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<tr>
<td>General Coordination Department</td>
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<td>Human Resources Department</td>
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<td>Financial Management &amp; Accounting Department</td>
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<td>Evaluation Department</td>
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<tr>
<td>Oil &amp; Gas Upstream Business Unit</td>
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<td>Geothermal Exploration and Technology Department</td>
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</tr>
</tbody>
</table>

**History**

- **1967** Japan Petroleum Development Corporation (JPCD) established
- **1968** Renamed “Japan National Oil Corporation” (JNOC)
- **1973** Renamed “Metal Mining Agency of Japan” (MMAJ)
- **1978** Japan Oil, Gas and Metals National Corporation (JOGMEC) established through the integration of Japan National Oil Corporation (JNOC) and the Metal Mining Agency of Japan (MMAJ)
- **2004** JOGMEC’s functions strengthened due to the addition of support activities related to coal and geothermal energy.
- **2012**