Japan-Renewed Emphasis

Country update of geothermal energy development in Japan and the activity of JOGMEC

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Matsukawa 23,500kW
Kakkonda 80,000kW
Uenotai 28,800kW
Mori 25,000kW
Ohnuma 9,500kW
Ohgiri 30,000kW
Takigami 25,000kW
Kuju 990kW
Hachijojima 3,300kW
Suginoi 3,000kW
Onikoube 12,500kW
Ohnuma 9,500kW
Ohgiri 30,000kW
Yanaizu Nishiyama 65,000kW
Sugawara 5,000kW
Yamakawa 30,000kW
Kakkonda 80,000kW
Kirishima 100kW

Total Installed Capacity: 525MW (33 units)
Annual Budgets for the development

- Establishment of NEDO
- Re-classification of new energy
- Political decision of no technology development
- No budget for technology development
- Excluding from RPS list
- Subsidy for renewable energy
- Subsidy for management
- Subsidy for development
- Promotion Survey
- Research and Development
- Oil shock (1st)
- Oil shock (2nd)
- Sunshine Project
- Budget (x 10,000 USD)

Year

What is JOGMEC?

**Japan Oil, Gas and Metals National Corporation**

- **Established**: 29 February, 2004
- **Capital**: JPYen 699.6 Billion (Approx. $5.8B as of 2015 March)
- **President**: Keisuke Kuroki
- **Employees**: 542 (as of 2015 March)
- **Domestic Network**: (24) Tokyo Head Office, Technology & Research Center (Chiba)
  - Mine Pollution Control Project Support Offices (5)
  - Site Management Offices (15) –Oil & Gas Stockpile
  - Metal Technology Center / Test Field Office

[Images of Head Office (Tokyo), Technology & Research Center (Chiba), Metals Technology Center (Akita)]
JOGMEC Overview
Mission and Activities

**Mission**
Secure constant and stable supplies of oil, natural gas and mineral resources to support industries and citizens in Japan through various activities relating these resources. In 2012 Geothermal function was added to the role of JOGMEC.

**Activities**

<table>
<thead>
<tr>
<th>Oil &amp; Gas Upstream Investment and Research &amp; Development</th>
<th>Metals Strategy &amp; Exploration, and Technology Development</th>
<th>Stockpiling</th>
<th>Mine Pollution Control</th>
<th>Coal Strategy &amp; Exploration, and Technological Support</th>
<th>Geothermal Resources Development</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.jpg" alt="Oil &amp; Gas" /></td>
<td><img src="image2.jpg" alt="Metals Strategy" /></td>
<td><img src="image3.jpg" alt="Stockpiling" /></td>
<td><img src="image4.jpg" alt="Mine Pollution" /></td>
<td><img src="image5.jpg" alt="Coal Strategy" /></td>
<td><img src="image6.jpg" alt="Geothermal Resources" /></td>
</tr>
</tbody>
</table>
Organisations

Government
- Ministry of Environment (MOE)
- Ministry of Agriculture, Forestry & Fisheries (MAFF)
- Ministry of Economy, Trade & Industry (METI)
- Agency for Natural Resources & Energy
- Japan Oil, Gas & Metals National Corporation (JOGMEC)
- New Energy & Industrial Technology Development Organization (NEDO)
- The Institute of Advanced Industrial Science & Technology (AIST)

Incorporated Administrative Agencies
- Japan Geothermal Association (JGA)
- The Geothermal Research Society of Japan (GRSJ)
- New Energy Foundation (NEF)
- Thermal & Nuclear Power Engineering Society (TENPES)
- Japan Mining Industry Association (JMIA)
- Japan Mining & Materials Processing Institute of Japan (MMIJ), etc.
Ministry of Economy, Trade and Industry, METI, announced “Long-term Energy Supply and Demand Outlook” pursuant to the policies of the Strategic Energy Plan, what mentioned Geothermal energy would be increased to 1.0-1.1% of Primary energy by FY 2030.
Japanese government initiated Japan’s Feed-In-Tariff (FIT) in 2012 to accelerate the introduction of renewable energy.

<table>
<thead>
<tr>
<th>Energy source</th>
<th>Solar PV</th>
<th>Wind power</th>
<th>Geothermal power</th>
<th>Small- and medium-scale hydraulic power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procurement category</td>
<td>10 kW or more</td>
<td>Less than 10 kW (purchase of excess electricity)</td>
<td>20 kW or more</td>
<td>Less than 20 kW</td>
</tr>
<tr>
<td>Cost</td>
<td>Installation cost</td>
<td>280,000 yen/kW</td>
<td>427,000 yen/kW</td>
<td>300,000 yen/kW</td>
</tr>
<tr>
<td>Operating and maintenance costs (per year)</td>
<td>9,000 yen/kW</td>
<td>4,300 yen/kW</td>
<td>6,000 yen/kW</td>
<td>—</td>
</tr>
<tr>
<td>Pre-tax IRR</td>
<td>6%</td>
<td>3.2%(*1)</td>
<td>8%</td>
<td>1.8%</td>
</tr>
<tr>
<td>Procurement price per kWh (Tax inclusive)</td>
<td>¥37.80 yen</td>
<td>¥38 yen(*1)</td>
<td>¥23.19 yen</td>
<td>¥57.75 yen</td>
</tr>
<tr>
<td>Procurement period</td>
<td>20 years</td>
<td>10 years</td>
<td>20 years</td>
<td>20 years</td>
</tr>
</tbody>
</table>

(*1) Costs in parenthesis are estimates, and may vary depending on specific conditions.

(*2) IRR calculation based on estimated cost and revenue over the period specified.
Recovery of budget

Establishment of NEDO

Oil shock(2nd)

Sunshine Project

Oil shock(1st)

Subsidy for management

Subsidy for development

Promotion Survey

Research and Development

Political decision of no technology development

No budget for technology development

Excluding from RPS list

Subsidy for renewable energy

Budget (x 10,000 USD)

Year

Financial supports for development

- Subsidized projects (47)
- Equity Capital projects (1)(2015)
- Liability Guarantee projects (3)

As of end of Dec, 2015
Wasabizawa Geothermal Power Plant
A large-scale power plant since 2000

- Wasabizawa geothermal power plant (in Yuzawa city, Akita Pref.) under construction and will be commenced to operate with a capacity of 42 MW in 2019.
- This is the first large-scale project in about twenty years for constructing such a plant with a capacity of 10,000 kW or more.
- JOGMEC provide a liability guarantee for 80% (about US$ 200 million) of the total loan.
- This project is expected to be the herald of booming geothermal development in the near future.
Research & Development

➢ **Artificial recharge by river water (EGS technology)**

The research and development to stabilize the geothermal production by improving evaluation accuracy of fluid flow, and optimizing artificial recharge technique.

This project is carried out under a collaborative research with EPRI (Electric Power Research Institute in USA).

➢ **Technology for Exploration of Geothermal Reservoirs**

Improvement of exploration accuracy will be expected by applying the seismic method to image the geothermal reservoir structure by solving these issues.

➢ **Drilling Technology**

Develop the PDC* bit cutter and body for geothermal well drilling and conduct verification test in order to reduce a drilling cost.

*PDC : Polycrystalline Diamond Compact
Some of geothermal power plants in Japan are facing difficulty in producing necessary amount of steam or hot water stably due to the deplete of the geothermal fluid.

To address this challenge, JOGMEC tries to research and development to stabilize the production of subsurface geothermal steam and hot by not only improving accuracy in evaluation of behavior of the fluid, but also recharging water to the geothermal reservoir.

※Geothermal water recharge
A hydrologic process where surface water like rainfall moves downward to geothermal reservoir.
## Test site for EGS technology

<table>
<thead>
<tr>
<th>Field</th>
<th>Yanaizu-Nishiyama Geothermal Power Plant</th>
<th>Location: Yanaizu Town, Fukushima Pref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant capacity</td>
<td>65,000kW (Single flash type)</td>
<td>The largest geothermal unit in Japan</td>
</tr>
<tr>
<td>Start of commercial operation</td>
<td>May 25, 1995</td>
<td>20 years of operation (as of Sep, 2015)</td>
</tr>
</tbody>
</table>

### Annual Power Generation (MWh)

![Annual Power Generation Graph](image-url)

- After Thermal and Nuclear Power Engineering Society (2014)
- Agency of Natural Resources and Energy website
Example of 2013FY Achievements

Since the recent processing techniques of seismic data have been much advanced in oil and gas field, we applied these techniques to the data at geothermal fields which was acquired more than a decade ago.

We recognized the improved image of the main geothermal productive reservoir (faults location indicated by red arrows), and are expecting the further efficacy by applying the seismic method to geothermal reservoir exploration.
JOGMEC conducts heli-borne geophysical survey that aims to acquire basic data for the evaluation of geothermal resources in order to promote geothermal development start-up.
Views of Survey

Gravity Gradiometry Survey

Time-Domain Electro-Magnetic Survey

(hhttp://www.cgg.com)
International activities

Member of international organisation

MOU

Iceland, New Zealand

Joint works

EPRI(US), GNS(New Zealand)
Conclusion

- Japanese Government has been trying to expand the developable area, reduce investment risk and promote understanding of local people.

- JOGMEC has a important role to achieve above mission.

- These measures is expected to bring new interest and new investment in geothermal development in the future.

- Technology developments are also conducted
Thank you for your attention!

For the better global environments

Any Question and comments?