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On the Japan's Geothermal Energy Development and the Role of JOGMEC

Hidefumi NAKASHIMA, Sukenori HOSOYA, Toshiyuki TOSHA, and Tadaaki SHIMADA

10-1, Toranomon 2-chome, Minato-ku, Tokyo, 105-0001 Japan

hidefumi-nakashima@jogmec.go.jp

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ABSTRACT

Geothermal energy development in Japan has been suspended since the last commercial geothermal power plant commenced to operate in 1999. After the terrible disaster happened on 11 March 2011, demand for the stable energy supply including geothermal energy has been increasing. The Japanese government decided to increase the electricity produced by renewable energy and introduced FIT (Feed In Tariff) for private company to make the development and the investment easily. As to the geothermal energy development, the government eliminated the regulation on the development in the national park and made revisions of the JOGMEC law, which integrate the development and the promotion of energies, resulting that JOGMEC has added a new function for the geothermal energy. The new function includes potential survey, technology developments, and financial supports.

The airborne survey by a helicopter was carried out to measure the spatial gravity gradient with gradiometer and the variation of the magnetic field corresponded to the underground resistivity, aiming to the new geothermal field and reservoir structure. On the technology development, seismic reflection method applied to the geothermal field and the reservoir management for the depleted geothermal resources are conducted. Financial supports of granting subsidy, equity capital and liability guarantee are also included in the new function in JOGMEC. The developer applies for the JOGMEC's grant which supports the survey on the surface and the drilling of the investigation wells. In 2013, twenty developers applied for the grant.

1. INTRODUCTION

Geothermal energy development in Japan was commenced in 1919, when a shallow well was drilled for the production of geothermal fluid, followed by the geothermal power production of 1.12kW in Beppu, Kyushu Island. During two oil shocks happened in 1970s the Japanese government decided to increase the electricity produced by geothermal energy. Under this policy, the nation-wide survey and technology development with subsidy were conducted by NEDO, which is a government enterprise and was established in 1980 to promote the governmental decision. In 2003 the budget for the geothermal technology development was suspended and other government budgets for the geothermal energy was rapidly declined.

After the terrible disaster happened on 11 March 2011, the demand for the stable energy supply, which is independent from the nuclear power, has been increasing. The geothermal energy, a stable energy of the renewable energies, has been expected for the replacement of the nuclear power as base-load energy. The government revised the legislation and made a new framework on developing geothermal energy.

JOGMEC was established in 29 February 2004 as a government enterprise and has many experiments to exploit subsurface resources such as oil and metals. A function of geothermal resource development was newly added in JOGMEC in September 2012. After the political decision to increase the geothermal energy was announced, new projects have started. In this paper, we will present a new framework of the geothermal energy development in Japan.

2. WHAT IS JOGMEC?

JOGMEC stands for Japan Oil, Gas and Metals National Corporation and is a government enterprise with the capital of 502 Billion Yen as of March 2013. JOGMEC aims to secure stable supply of natural resources, which are oil, natural gas, coal, metals and geothermal energy for Japanese industries and citizens. The action of JOGMEC is based on the Japan Oil, Gas and Metals National Corporation Act, by succession of the functions operated by Japan National Oil Corporation (JNOC), established in 1967, and Metal Mining Agency of Japan, established in 1964, which are both the agencies of Japanese government. Therefore JOMEC has much experience in survey and exploitation of underground resources and takes a roll of the technology development of the geothermal resource.

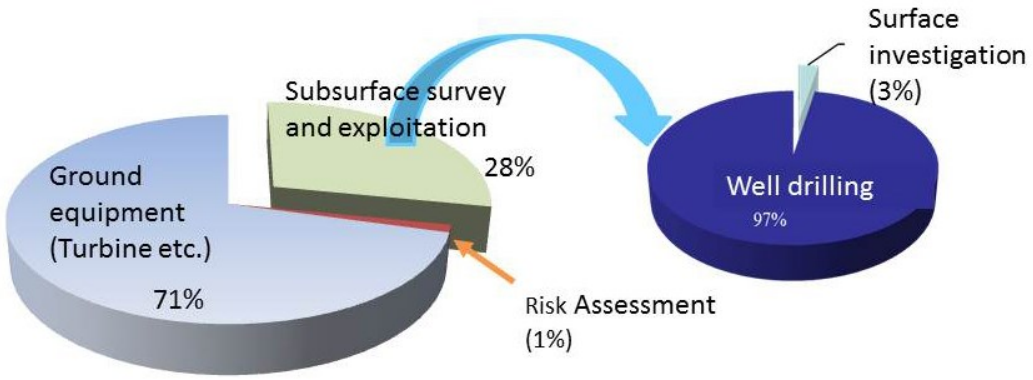
Figure 1: JOGMEC was established in February 2004 as one of government companies, succeeding functions of JNOC and MMAJ.

2.1 Geothermal function in JOGMEC

After the suspension of the electricity supply by the nuclear power plant, the revision of the JOGMEC Act was made, which defines the roll and the target of activity in JOGMEC in September 2012 and JOGMEC took on the additional function of supporting geothermal resource development in Japan as well as that of the coal development overseas of Japan. In accordance with the revision of the law and the launch of the new operation, JOGMEC swiftly set up a geothermal resource development support program to cover technological developments, subsidies, equity capital finance and liability guarantees.

2.2 Assistant of geothermal energy development

The typical procedure for the development of geothermal resources is contained surface survey and exploitation, drill of the investigation wells, precious survey using wells including to determine hydrological parameters, computer simulation to decide the electricity output, additional drill for the operation, and construction of the power plant. The total cost for construction of the geothermal power plant with a generator of 30,000kW is discussed and estimated by a committee, which was organised by the government to verify the cost of the renewable energies (Cost Verification Committee, 2011). As shown in Fig 2, the ground equipment such as buildings, turbine and generator is the major part of the cost and is estimated more than 70% of the total cost and the other 30% is necessary for the survey and investigation. However, no return is expected until the power plant is constructed and start operation. Even if a promising reserve of geothermal resources is found at the exploration stage, major risks remain, such as the long term burden of interest, additional drilling for production and reinjection, construction of a power station and so on. To cope with these risks JOGMEC offers geothermal potential survey for the wide area and several types of financial support, such as subsidy, equity capital and liability guarantee.



Subjects	Cost(Million USD)	
Subsurface Survey and exploitation	7,300	28%
Enviornmental assessment	300	1%
Ground equipment	18,300	71%
Total	25,900	100%

Figure 2: An example of the cost estimation for the construction of a 30MW geothermal power plant.

2.3 Survey program

For the survey project, quite uniform data are obtained by aircraft, helicopter, and satellite even if survey area includes national parks. JOGMEC are conducting a helicopter survey using a gradiometer and TEM data acquisition equipment. At the former survey spatial gradients of the gravity are measured and precise structure is mapped. At the later survey we measure temporary magnetic field to estimate the subsurface resistivity structure, implying that the lower resistivity is concordant with the cap rocks overlaying the geothermal reservoir. Shimada et al. (2015) discussed the results obtained by the gradiometer in the geothermal fields of Kyushu Island.

2.4 Financial supports

To cope with several risks associated with the geothermal energy development, JOGMEC presents several financial support plans for Japanese companies. One of the supports is the granting subsidy. The surface survey at the primary stage of the development has a high risk. A subsidy can be applied, which supports up to 75% of the cost for the survey. In the case of the application by the local company including the local government, application for 100% of the cost is permitted. Next to the surface survey, a survey will be continued, where more precise geological structure is examined using investigation wells. The survey using investigation wells can be supported for the cost up to 50% and 100% by the subsidy for the ordinary company and the local company, respectively.

After the initial survey is over, we can identify the geothermal reservoir and have to estimate the ability of the production. At this stage several wells are drilled and reservoir simulation is carried out to evaluate the reservoir and to decide how much electricity will be expected. JOGMEC can invest up to 50% of the equity capital of the company. At the construction stage of a power plant, a huge amount of money is required to drill sufficient numbers of wells. JOGMEC therefore supports the development by the liability guarantee, where up to 80% of the expenses are guaranteed. In Fig.3 financial supports in JOGMEC is shown.

In 2013 twenty projects were applied to the granting subsidy and a half of them were continued projects from 2012 (Fig.4). Seven of the 20 projects were applied by the local company or the local government. The average of the subsidy was about 30 million USD.

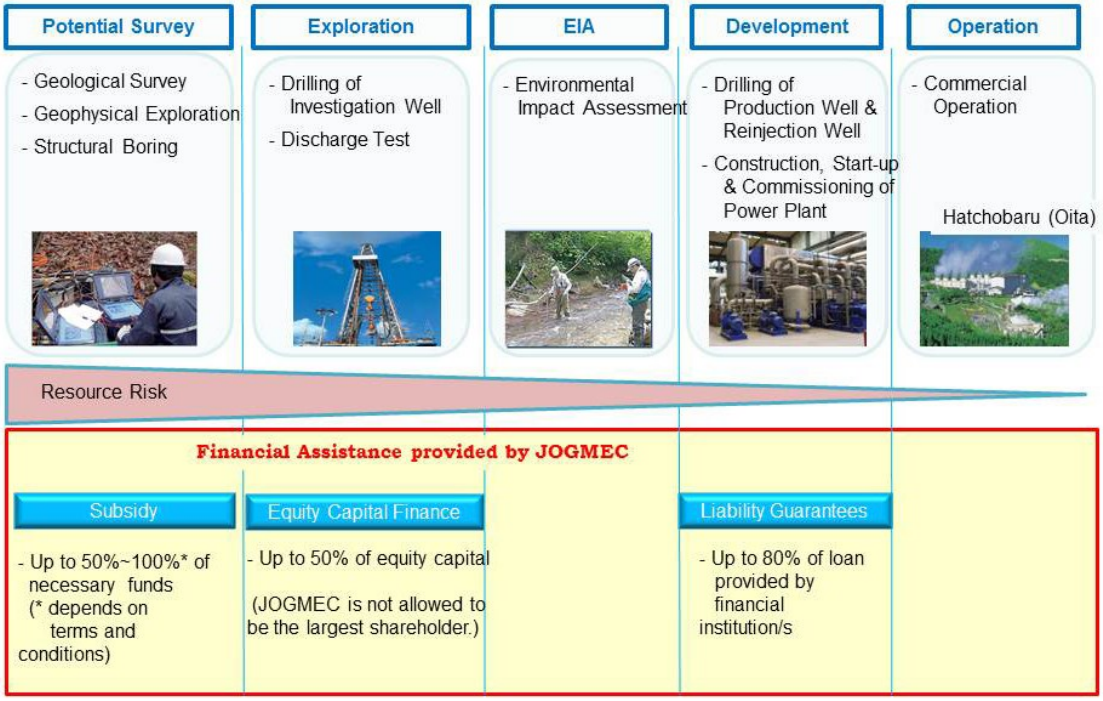


Figure 3: Outlines of financial supports by JOGMEC

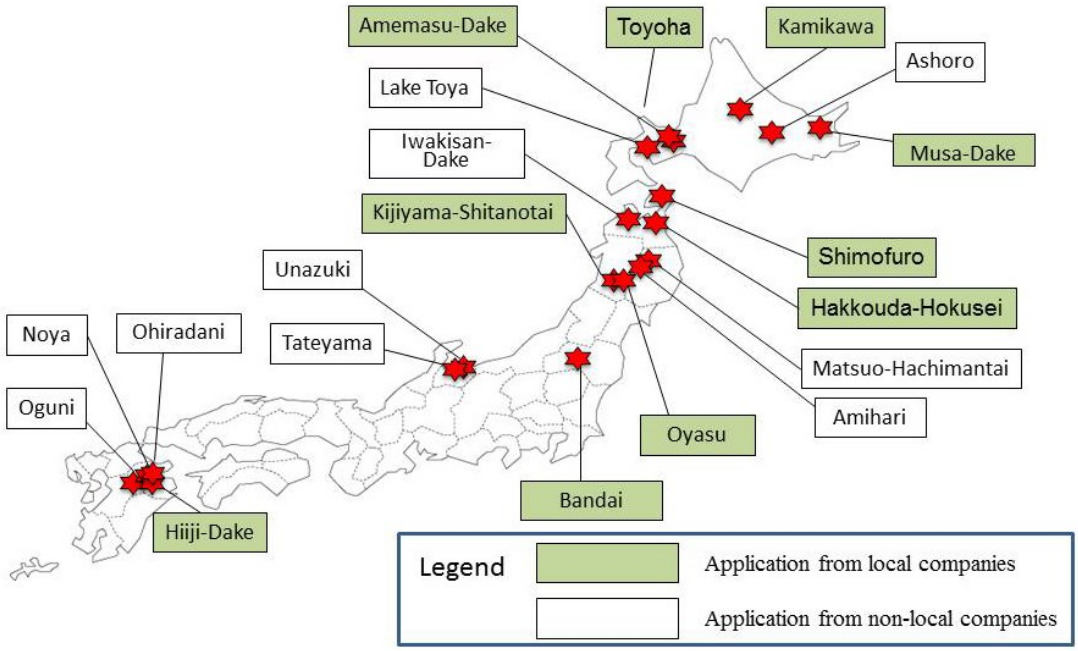


Figure 4: Subsidized 20 projects implemented during 2013

3. TECHNOLOGY DEVELOPMENTS

JOGMEC are also conducting the technology developments such as the reflection seismic profile (Tosha et al., 2015), TEM measurement with SQUID magnetometer (Fukuda et al., 2015), and reservoir management (Okabe et al., 2015).

Seismic reflection method is commonly used to find out anticline structure for oil and gas exploration because the method can image the geological structure precisely. The detection of the fault and fracture in the geothermal reservoir is expected by the seismic reflection method and the data had been collected at several geothermal fields to detect fractures associated with geothermal resources. However, faults were not always detected clearly by the reflection data. We applied recent analysis technique

to the data taken in the geothermal field and obtained the fault structure clearly in the seismic reflection image. There is a possible way to reveal the fault and fracture system precisely but the problem of the cost is remained.

JOGMEC has developed a TEM (transient or time-domain electromagnetic) survey system using High-Temperature SQUID (superconducting interference device) magnetometer. The system is named SQUITEM. We applied the AQUITEM system to a geothermal field where resistivity structure is well described in order to pick up the issue to operate the SQUITEM system and to solve it. The experiment with the SQUITEM system was conducted in Ogiri geothermal field, where the survey by a helicopter was applied.

Some geothermal fields are facing difficulty in producing steam needed to operate stably due to the depletion of the geothermal fluid. JOGMEC make a R&D project to stabilize the production of subsurface geothermal steam and hot water by not only improving accuracy in evaluation of behaviour of the geothermal fluid but also recharging water to the geothermal reservoir. A test field was selected and the artificial injection was conducted to prevent the depletion of the fluid.

4. CONCLUSION

NEDO had conducted all of the geothermal energy R&D and financial supports until 2003. From 2012 JOGMEC have carried out a new function of the technical and financial supports for the geothermal development. On the ground facilities are still being conducted by NEDO such as the improvement of the turbine and generator, the diffusion simulation of hydrogen sulfide (H_2S) and so on. Thus JOGMEC and NEDO will make further progress by respective roles on the development of the geothermal energy in Japan.

The last geothermal power plant in a large scale was constructed in 1999. Since then there is a binary power generator with the capacity of 2,000kW which was installed using excess geothermal fluid in the steam-turbine geothermal power plant at Hacchobaru, Kyushu Island in 2006. A new geothermal power plant with the installed capacity of 1,500kW was constructed at Ibusuki, southern Kyushu Island in 2014. This power plant is planned to supply electricity to a hospital where much electricity is needed for highly advanced medical treatments. In 2019 a new geothermal power plant for commercial use will be commenced to operate with a capacity of 42,000kW. The power plant, which is tentatively named Wasabizawa Power Plant, is subjected to the environmental impact assessment. JOGMEC makes a financial support to the power plant. There are a lot of possible places for the geothermal power plant and JOGMEC will support the geothermal energy development not only financially but technically as well.

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