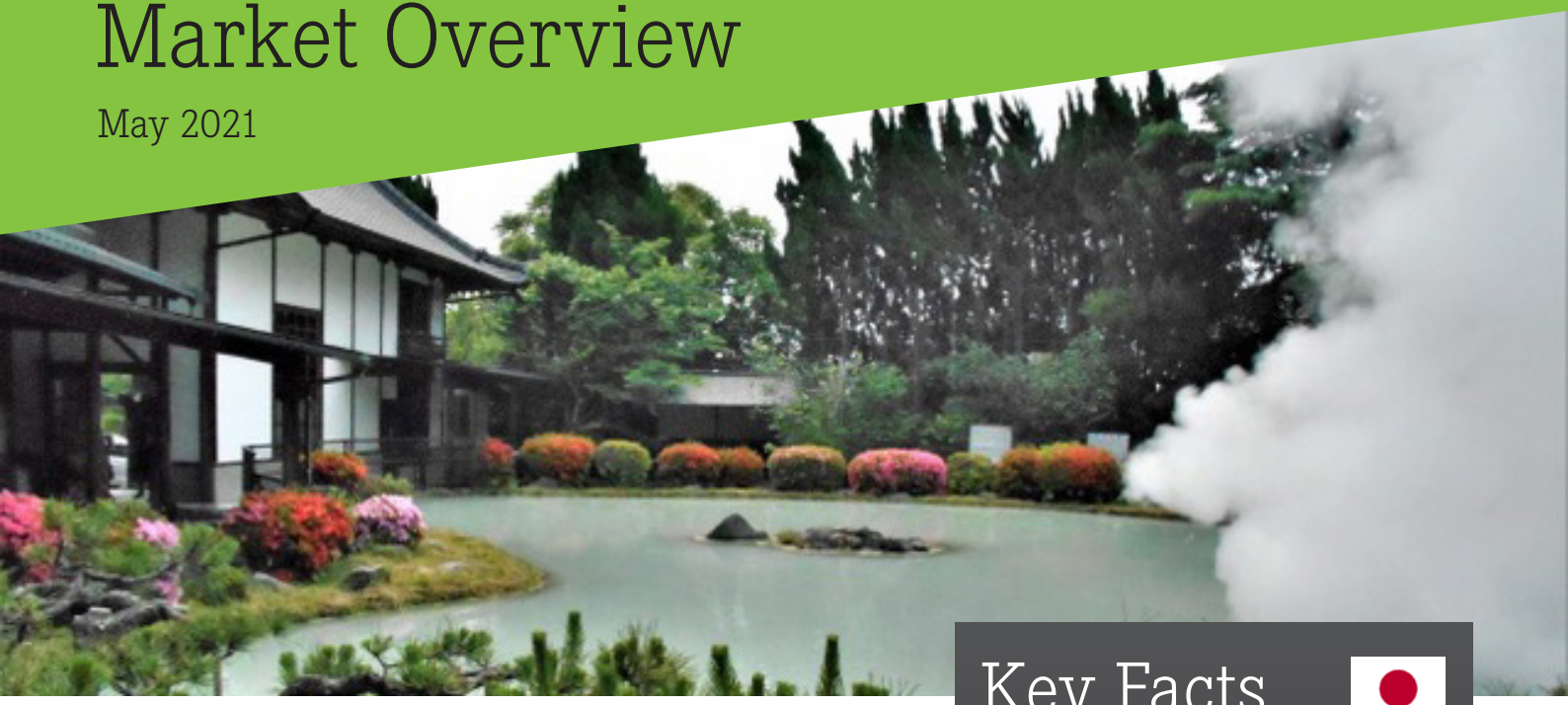
Japan
Geothermal Energy Market Overview

May 2021

THINK GEOENERGY



Abstract:

Located on the Pacific ring of fire, Japan has around 100 active volcanoes and geothermal is an elementary part of living with a bathing culture built upon local hot springs (onsens). The country also has been in the forefront of geothermal energy development beyond local hot spring use. The first experimental geothermal power plant already operated in 1925. For many years, Japan has been one of the leading nations in power generation utilising its geothermal resources. The country has an estimated resource potential of 23,000 MW and is with that one of the top three countries based on potential.

The country's industrial players, such as Fuji Electric, Mitsubishi and Toshiba have been dominating players in the supply of turbines for geothermal power plants to countries around the world. At the same time, Japanese development aid has helped nations around the world develop their resources.

At some point along the way though, development in Japan stagnated and came essentially to a halt. Only in recent years has the geothermal sector seen increasing attention and development. While mostly small in scale, these plants – often connected to local onsen operations – highlight the fact that there is an opportunity for geothermal development despite local concerns and opposition. With the Paris Climate Agreement, Japan also is pushing ahead with renewable energy ambitions and recently indicated a drive to further expand geothermal development. One can surely only hope that this will help see the development of further geothermal power plants in the country, both small and larger in size.

Key Facts

- Installed geothermal power generation capacity 603 MW
- Japan is ranked no. 10 globally based on installed power generation capacity
- Geothermal resource potential estimated at 20,000 MW at 3km depth
- Favourable feed-in-tariff scheme
- Historic use of geothermal in geothermal baths (onsen)
- Japanese companies dominating in turbine supply worldwide

Country Overview

With a population of 126 million, Japan is an island country comprising 6,800+ islands extending the Pacific coast of Asia stretching 3,000 km (1,900 miles) northeast from the Sea of Okhotsk to the south-east of the East China Sea. The main five islands, north to south, are Hokkaido, Honshu, Shikoku, Kyushu, and Okinawa. Large parts of the country are uninhabitable due to its mountainous terrain. Politically the country is a unitary parliamentary, constitutional monarchy. It consists of 8 main regions with 47 prefectures.

The Country‘s Energy Market

The electricity consumption of Japan was 1,018,000 GWh (1,012 TWh) in 2018 with a peak demand of around 165,200 MW. There are two wide area synchronous transmission grids running at different frequencies in the country. This provides for limited possibility for transmission between the North (50 Hz) and South/ Middle of Japan (60Hz). The interconnection capacities are limited, yet are expanding with a focus on stable supply and acceptance of more renewable energy. The electricity market is geographically divided into ten areas with each having a “long-standing vertically integrated utility“ operating. These utilities essentially have had a monopoly, incl. generation, transmission, distribution, and retailing.

A gradual market liberalisation has taken place since 2000 with full market liberalisation in 2016/ 2017. In 2012, Japan introduced a feed-in-tariff system for renewable energy technologies, prices have since been adapted for solar, but remained for geothermal. Japan‘s Ministry of Economy, Trade and Industry (METI) targets a four-fold amount of electricity generated by geothermal by 2030 compared to 2013 data.

Before the Fukushima nuclear disaster of 2011, about one-third of the electricity in the country was generated by nuclear power, now mostly replaced by coal and natural gas.

The liberalisation efforts past 2011 created around 250 supplier companies competitively selling electricity.

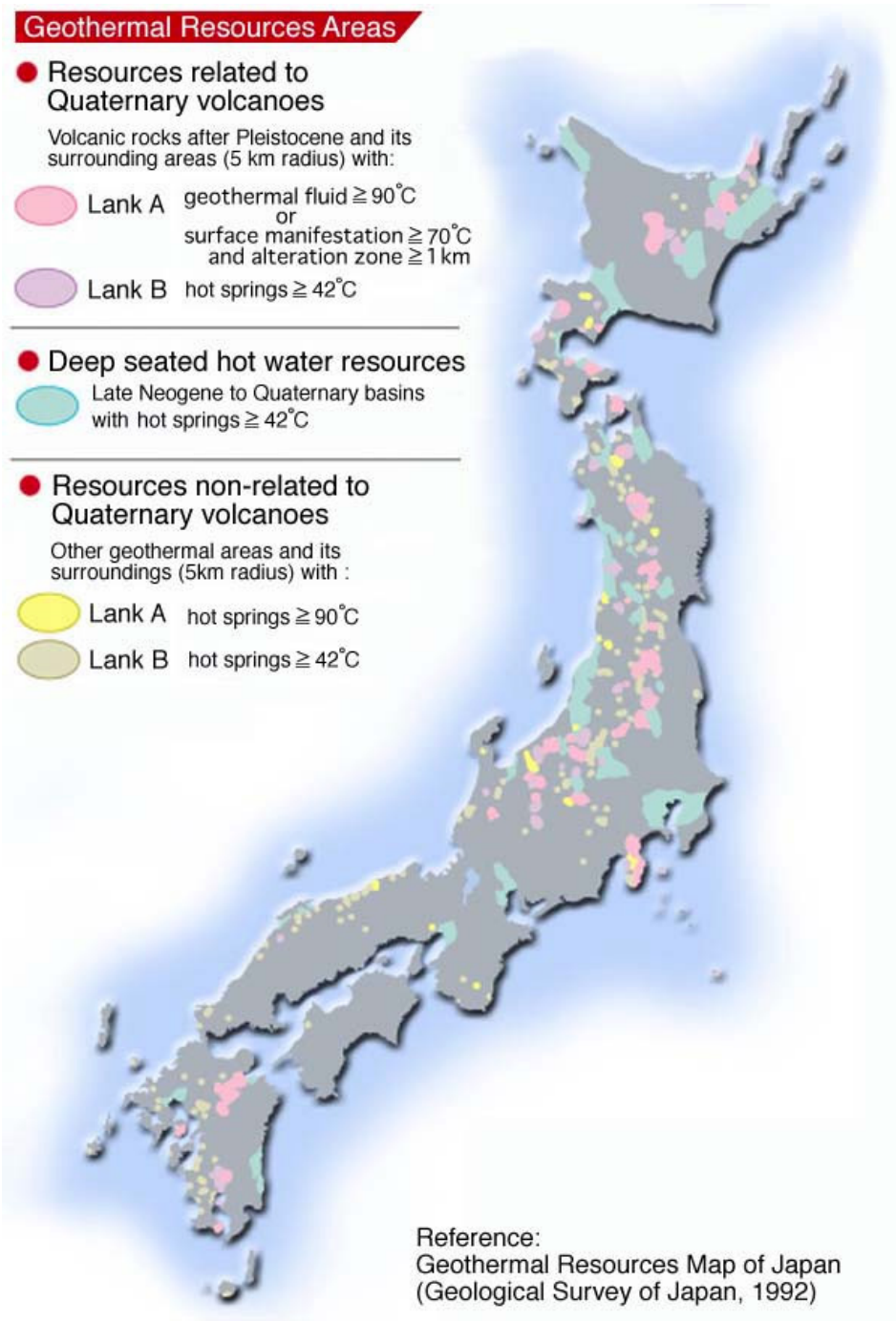
Ten major utility companies plus Electric Power Development (J-Power and Japan Atomic Power company) are the main players in the generation of electricity.

Municipal governments and some private companies have their own power plants for their own consumption selling surplus electricity on a wholesale basis to utilities and registered retailers. Some of the power generators focusing on renewable energy have a considerable amount of generation capacity.

Geothermal Resources and Potential

With geothermal resources estimated at around 23,000 MW at a depth of 3,000m, Japan is considered one of the top 5 countries based on geothermal resources. Only Indonesia (28,000 MW) and the United States (30,000 MW) have more estimated resource potential.

Despite the resource potential, utilisation of geothermal energy has been limited and currently only contributes around 0.2% of total installed power generation capacity. Only limited development has been recorded for the past two decades, with the only first larger-scale plant (48 MW) coming online in 2019. With the introduction of favorable feed-in-tariffs, there has been hope for more development, but so far only small-scale development of around and less than 1 MW has happened. Key reasons for limited development can be attributed to resources mostly to be found in national parks, development risk and cost, as well as the negative sentiments towards development by local hot spring owners.



Regulatory framework

The regulatory framework for geothermal energy is represented by Japan Oil, Gas and Metals National Corporation (JOGMEC). Established based on different predecessors in 2004, JOGMEC‘s main mission is to secure a stable supply of oil, gas and mineral resources for Japanese Industries and social activities.

Until 2012, JOGMEC‘s main functions were oil & gas upstream business, oil & gas upstream technology, stockpile, metals strategy & exploration, metals technology and financial support. From 2012, new functions were added that include geothermal resource development and coal development. Geothermal resource development is seen as an integrated effort based on JOGMEC’s oil & gas and metals work.

In 1974, the Environmental Agency (currently the Ministry of the Environment, MOE) decided to limit geothermal development within

the national parks to six sites. A commission revisited the impact of geothermal power to the natural environment in 2011-2012 and in 2017, MOE decided to deregulate geothermal development within the national parks on specific conditional, excluding core areas of national parks.

Geothermal development is not allowed within core areas of national parks. However, survey of the surface is admitted if it does not impede the conservation of the natural environment and is restorable.

In other areas, the following actions are admitted: drilling from outside the park, drilling and power plant construction in harmony of conservation of the natural environment and development of power projects, as well as construction of small-scale geothermal plants with no serious impact on scenic beauty, as well as small binary cycle plants using existing hot spring water.

To support geothermal development, JOGMEC provides financial assistance in the form of subsidies, equity capital finance and liability guarantees.

A geothermal feed-in-tariff has been set up and is termed for 15 years from the start of operation. The tariffs are differentiating between plants of less than 15 MW of installed generation capacity, as well as 15 MW and more. There is a further differentiation between new-built plants and refurbishment/replacement of various equipment. The prices range from JPY 12 to 40/ kWh (around USD 0.11-0.37/ kWh).

Geothermal Energy Utilisation today

Despite the resource potential, utilisation of geothermal energy has been limited and currently only contributes around 0.2% of total installed power generation capacity. Only limited development has been recorded for the past two decades, with the only first larger-scale plant (48 MW) coming online in 2019. With the introduction of favorable feed-in-tariffs, there is hope for more development, but so far only small-scale development of around and less than 1 MW has happened. Key reasons for limited development can be attributed to resources mostly to be found in national parks, development risk and cost, as well as the negative sentiments towards development by local hot spring owners.

There are a total of around 47 geothermal power plants operating in Japan today with a total installed power generation capacity of 603 MW and an average size of 12.8 MW. A total of 26 plants have an installed power generation capacity of 2 MW and less. This includes a large number of very small plants of around 200 kW and less. Only 11 plants have an installed capacity of 20 MW and more. The most installed geothermal power generation capacity can be found in Tohoku and Kyushu. Geothermal direct use has played a traditional visible role in Japan with a strong geothermal bathing history in the various onsen/hot springs across the country. So it is no surprise that the use of geothermal energy for bathing and swimming represents the vast majority of the annual energy use of geothermal energy in Japan.

Geothermal plant in Hachimantai City, Iwate Prefecture, Japan (source: Iwate Chinetsu)

Geothermal Market & Industry

Japan has been utilising its onsens (hot springs) for centuries, yet was also very early in early utilisation for power generation with the first experimental geothermal power generation unit set up 1925 in Beppu, in Oita Prefecture. Research and development efforts continued after the interruption of World War II. The first full-scale geothermal plant, the Matsukawa plant, commenced operation in 1966. Throughout the 1970s to the mid-1990s, the country added the majority of the capacity operating today. From the 1990s to 2010, there was no development in Japan, while Japanese turbine companies have been supplying geothermal plants around the world. The companies of Fuji Electric, Toshiba and Mitsubishi Heavy Industries have supplied turbines with a capacity of around 9,500 MW as of 2020. They have also expanded their capacity beyond steam turbines either through their own development of binary cycle technology or acquisition internationally. The various Japanese conglomerates are also engaged in geothermal development internationally, either directly through e.g. EPC/construction services and investment, or indirectly through equity stakes.

At the same time the Japanese International Cooperation Agency (JICA), has been supporting early exploration work and development in several regions worldwide.

Following the Fukushima nuclear disaster of 2011, the strong efforts of Japan to push renewable energy development also reawakened efforts on geothermal energy development mostly driven by favourable feed-in-tariffs. This has resulted in current geothermal power generation capacity being mostly represented by the large utility companies of Tohoku Electric Power and Kyushu Electric Power representing around two thirds of Japan's geothermal power generation capacity. They are followed by Electric Power Dev. Co./ J-Power and Hokkaido Electric Power. Then a large number of smaller companies represent around 38 MW in generation capacity. Then there are about 21 companies representing plants of a total of 1.7 MW.

Current Project Development

ThinkGeoEnergy has identified around 90 geothermal projects and prospects across Japan. The sizes of the projects vary and while some are of industrial size of more than 5 MW in capacity, the vast majority are projects of a size smaller than 1 MW, mostly in the context of local hot springs.

The majority of these projects and prospects identified have received funding from JOGMEC. The projects are located across Japan with most of the projects to be found in the Northern part of the country in Hokkaido and Tohoku and in the South of Kyushu.

Outlook

The installation of the first larger-scale geothermal power plant in Japan for a long time in 2019, clearly has created hope for more larger scale development. Yet, the vast majority of projects in planning or development phases are small scale geothermal plants driven by small development companies, including a number of international players and suppliers.

Sources

Country Update Report for Japan, World Geothermal Congress 2020,

This report builds on the research activities of ThinkGeoEnergy, to learn more about our research or explore wider opportunities for desktop research, visit ThinkGeoEnergy.com/research.

All rights reserved. © ThinkGeoEnergy ehf. 2021