BARRIERS OF GEOTHERMAL POWER GENERATION IN KOREA AND POSSIBLE SOLUTIONS

Tae Jong LEE[1] and Yoonho SONG[1]
[1]Korea Institute of Geoscience and Mineral Resources (KIGAM),
124 Gwahang-no, Yuseong-gu, Daejeon 305-350, Korea
e-mail: megi@kigam.re.kr

ABSTRACT

Most of the barriers for geothermal power generation (GPP) seem to stem from acknowledge of the fact that Korea does not have any high enthalpy geothermal resources. Due to lack of high quality geothermal resources near the surface, we have to go deeper into the earth, which inevitably draws concerns about higher costs and risks, and needs higher level of technology and infra-structures. These can be one of the main reasons to make the government and private sector including power companies to hesitate investment to geothermal. Continuous efforts for geothermal explorations from Pohang area, Jeju island, Seokmo island, and Ulleung island lead some project to get the budget for drilling exploration wells. But this time, we face technical barriers including lack of infra-structures and experiences in drilling tools and technology, logging tools, engineering experiences at depth, and so on. The drilling was delayed and again the investors hesitate to put more budget into the project. But we have just started the learning curve and need to show people a successful story; say, steam first in Pohang project, which can activate investments from governments and industries who are very eager to find economic alternative renewables to solar or wind.

Keywords: geothermal power generation, barriers, Pohang, Ulleung island, Seokmo island

1. INTRODUCTION

It was 2003 that Korea Institute of Geoscience and Mineral Resources (KIGAM) had launched a project to develop the deep-seated geothermal water for large-scale space heating in Pohang city, located south-eastern part of Korean Peninsula, with government funding. Valuable geological information had been gathered from intensive geological and geophysical surveys such as airborne gravity and magnetic surveys, radioactive, geochemistry and magnetotelluric surveys for more than 6 years of project period (Song et al., 2006a; Lee and Song, 2008). Since then, there had been several efforts to develop the geothermal water and to utilize it either for district heating or for GPP. Despite those efforts Korea is still struggling to make a successful story of GPP.

In this article, we discuss about the barriers on the GPP in Korea either in technical aspect and/or in legal or governmental support. For those, we first summarize the geothermal characteristics and then discuss about three different case studies in geothermal developments in Korea. And finally, discussion on the governmental support will be followed.

2. EGS POTENTIAL IN KOREA

Korea does not have high enthalpy geothermal resources related to the volcanic or tectonic activities. Thus we have to go deeper to get high temperature, but the deeper we drill into, on the other hand, the less possible to get enough flow rate. Song et al. (2011) has estimated the EGS potential of Korea based on the geothermal database

(D/B), which contains various geothermal properties of rock in Korea, including 2,163 thermal conductivity, geothermal gradient from 715 well data, 492 heat flow data, and 180 heat production data. They followed the protocol for calculation of EGS potential, which was proposed by Beardsmore et al. (2010) and endorsed by international organizations. Estimated theoretical potential from 3 km to 10 km beneath the South Korea reached 6,975 GWe which is 73 times of total power generation capacity of Korea in 2015. Technical potential down to 6.5 km is 19.6 GWe, which considers the current technological limits, land accessibility, thermal recovery ratio of 0.14, and temperature drawdown factor of 10 °C.

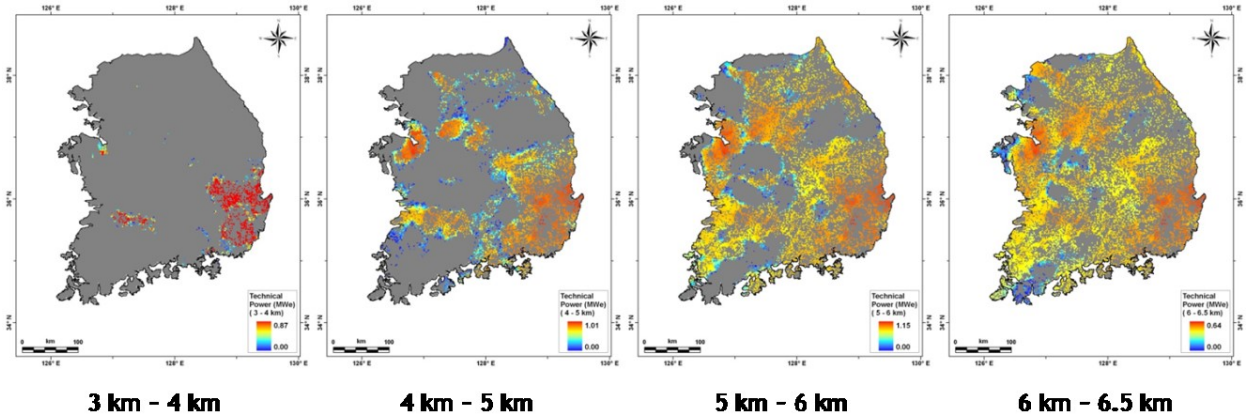

Fig. 1. Technical EGS potentials for each 1 km depth interval from 3 – 6.5 km, considering the current technological limits, land accessibility and so forth (Song et al., 2011).

3. EFFORTS FOR GEOTEHRMAL POWER GENERATION IN KOREA

Apart from economic feasibility, Korea does have huge amount of geothermal EGS potential as discussed in previous section. To develop and utilize the geothermal resources, researchers and experts devoted their efforts to explore the geothermal resources and to develop the technologies for exploration and development of geothermal resources. Thanks to their efforts some projects for GPP have succeeded in getting the budget from the government.

1) Seokmo Island project (2009-2011)

Seokmo Island project for GPP was funded by Korea Institute of Geoscience and Mineral Resources (KIGAM) and lasted for 3 years (Lee et al., 2011), which was the first trial for GPP in Korea. Various geophysical surveys including magnetotelluric (MT), seismic, and geophysical loggings for more than 20 boreholes and wells has been performed to delineate geothermal system of the area. An exploration well was scheduled to be drilled down to 3,000 m to get the temperature higher than 100 ℃ and information about possible fractures containing hot geothermal water. Unfortunately, however, the well couldn't reach down to 3 km due to lack of experience, technology, and also infra-structures for deep drilling with big diameter.

2) Pohang EGS pilot project (2010 – current)

Geothermal exploration in Pohang area has been carried out for more than 6 years by KIGAM and four deep boreholes have been drilled. The deepest well, BH-4, has reached down to 2,384 m and geothermal gradient

is about 38 °C/km from the measured temperature at 2 km depth of 91 °C (Song et al., 2006a; Lee and Song, 2008). In this background, the first proof of concept project for GPP by EGS in Pohang has been started in Dec. 2010. The project aims to construct a MW scale GPP in 5 years within 5 km depth of the site. Nexgeo Inc.,a small business, as principal contractor leads the project with two research orgnizations (KIGAM and Korea Institute of Construction Technology (KICT)), one university (Seoul National University (SNU)), and two industries (POSCO and Innogeo Tech. Inc.) participations. The due of the project was December 2015, but again it was delayed mostly due to lack of experience in drilling. Korean government allows one more years until December 2016, and stimulations for both wells are scheduled on early November this year.

3) Exploration in Ulleung Island (2014-2016)

Ulleung Island is a volcanic island located in the middle of East Sea, and the last volcanic activities have been occurred in about 5,600 years ago. It was in 2011 that the first two boreholes had been drilled to measure the underground temperature of the island, and surprisingly, the bottom hole temperatures showed of 73.8 ℃ at 600 m and 66.1 ℃ at 497 m deep, which corresponds to the geothermal gradients of 94.3 ℃/km and 99.2 ℃/km, respectively. Compared to the average geothermal gradient of main land of Korea being about 25 ℃/km, it is very promising result for geothermal energy developments. A geothermal exploration project has been launched in 2014 with two years term. Two more boreholes with 1,000 m deep have been drilled to measure the temperature and to get various physical properties from the cores. A 3D MT interpretation showed possible permeable structures with E-W trends in the island (Yun et al., 2016). With those promising results, a special purpose company has been founded to develop the geothermal resources and to build geothermal power plants in the island.

4. GOVERNMENTAL SUPPORT

1) Geothermal load map

In the year 2011, a technological roadmap for GPP has been setup (KETEP, 2011). The scenario was as follows. Ongoing project in Pohang will build 1.5 MWe GPP by 2015 and then well network technology will be developed to expand the install capacity up to 20 MWe at the same area by 2020. And by 2030, the 20 MWe system will be applied to 8 to 10 sites according to the geothermal potential, so that a total of 200 MWe GPP installation is to be achieved.

2) Renewable Portfolio Standard (RPS) system

In the year of 2012, Korean government activated the Renewable Portfolio Standard (RPS) system, which pushes 13 electricity companies of installation capacity larger than 500 MW to cover a certain ratio of electricity that should be generated by renewables. The ratio started from 2.0 in 2012 and becomes bigger as years, eventually reached to 10.0% in 2022. Though Korea does not have any geothermal power plant, geothermal is already included in the RPS system from March 2015.

3) Legal frame

A separate law has not been set up yet for geothermal development in Korea. Geothermal development so far is related to various laws such as hot spring law, construction law, groundwater law, and so on. Researchers and industry continuously ask the government to make a separate law for geothermal development to support

the developer's right as well as to consider the resources, environments and sustainability.

5. DISCUSSION

Longer than 10 years, geothermal development in Korea has been suffering from numerous difficulties and barriers. Those difficulties are mainly from lack of experiences and technologies, insufficient infrastructures, poor related industry, and so on. Poor related industry makes it difficult to procure domestic parts and services for drilling and engineering. Those barriers resulted in the delay of progress, which in turn makes the decision makes to hesitate to invest their money to geothermal.

But we have just started the learning curve and need to show people a successful story; say, steam first in Pohang project, as early as possible, which can activate investments from governments and industries who are very eager to find good and new alternative renewables to solar or wind.

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