The Geothermal Potential, Current and Opportunity in Taiwan

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ABSTRACT

Located in the west Pacific Rim of Fire, Taiwan possesses rich geothermal resources due to volcanic activities and rapid uplifting of plate collision. Based on available data prior to 1980, Taiwan may have about 1 GWe of potential shallow geothermal energy, which is less than 3% of the national gross power generation. A 3-Mw pilot power plant, therefore, was constructed in 1981 and terminated in 1993 in the Chingshui geothermal field of Ilan, northeastern Taiwan. Recently, one of the National Science & Technology Program (NSTP) projects has been conducting research and reevaluating the island-wide deep geothermal energy. Four hot potential sites have been recognized. They are: (1) Tatun Volcano Group of northern Taiwan; (2) I-Lan Plain of NE Taiwan; (3) Lu-Shan area of Central Taiwan; and (4) Hua-Tung area of eastern Taiwan. We found that the geothermal resource in Taiwan may be as high as 160 GWe, with 33.6 GWe of exploitable geothermal energy. There are no any commercial geothermal power plants until now in Taiwan, although the potential is great. However, geothermal energy has been listed as one of major tasks of National Energy Program, Phase II (NEP-II) in Taiwan. We will conduct more detailed geothermal energy surveys on some proposed hot sites and to construct an EGS pilot geothermal plant with 1 MWe capability in a few years.

Currently, there are three nuclear power plants, named No. 1, 2 & 3, in operations, which produce 16.5% gross generation of electricity and one (No. 4) is under construction, but is stopped and sealed now in Taiwan. Furthermore, the life-span of 40-year operation for those three power plants will be close-at hand and retire in 2018-2019, 2021-2023 and 2024-2025, respectively. Therefore, to find alternative energy sources, especially on the clean, renewable and sustainable ones for generating electricity are emergent and important for Taiwan's government in next few years. Among various energy sources, geothermal energy can be as base-load electricity and offers an opportunity for a country with naturally free-resource and less dependence on fossil fuel. However, development of geothermal energy has been stopped for more than 30 years, and currently no working geothermal power plant existed in Taiwan. To jump-start the geothermal exploitation rather than solely rely on knowledge, we also need to introduce the techniques from outside of this country. This conference provides you not only to know what the geothermal situation is, but also to find the collaborating and business opportunities in Taiwan.

Keywords: Geothermal potentials, EGS, Taiwan, Chingshui geothermal field

1. Introduction

Taiwan is located at the ring of fire and is famous for the young orogenic belt, which the Philippine Sea plate is colliding with Eurasian continental margin (Fig. 1). Presently, the Philippine Sea plate is moving towards WNW at about 70 mm/yr (Seno and Maruyama, 1984), and it is believed the mountain-building process is still in progress (Tsai et al., 1981; Yu and Chen, 1994). A dominant collision zone frequently inducing folding and fault thrusting in the area may exist in central Taiwan. At southern

Taiwan, the Philippine Sea plate is riding up over the continental shelf of the South China Sea. Farther south in Taiwan, an oceanic part of the Eurasian plate is subducting beneath the Philippine Sea plate along the Manila trench, which results in the bulldozing of shelf sediments both upward and westwardly. Such active movements over the last 5 million years have been creating the island of Taiwan (Ho, 1986; Teng, 1987, 1990). Therefore, rapid crustal movements and widely distributed active structures make up the geological characteristics of this young tectonic entity (Peng et al., 1977; Chen, 1984; Yu et al., 1997, 1999; Chang et al., 1998). In the north, the Philippine Sea plate subducts underneath the Eurasian plate, leading to the formation of Ryukyu arc (Fig.1). The Okinawa Trough is a back arc basin, which extends from southwest Kyushu Island (Japan) to the Ilan Plain. Several active volcanoes have been identified in inland and offshore of this island, and high uplift mountain range occurs in the eastern and central parts of Taiwan. Those tectonic settings provide a very good environments to be rich in geothermal energy.

Taipower, only commercialized power company in Taiwan has installed capacity being 40.79 GWe, which produce the gross electricity about 219.2 billion kWh (Taipower, 2014). They are produced by fossil fuels including oils, coals and natural gases, nuclear power, hydropower and renewable energy etc. Among them most are the fossil fuels (72.78%) and the second is nuclear power (18.61%), while the renewable energy only occupies 2.86%. There are four nuclear power plants in Taiwan, named No. 1, No. 2 and No. 3, which three are in operation and the fourth is under construction, but is sealed now due to considering non-safe after 2011 Fukushima nuclear disaster, Japan. However, those three operating ones are old, more than 30 years old, and will be decommissioned from 2018 to 2025. The electricity will be less than 18.61%, about 40.79 billion kWh and need to find alternatives for it at next 10 years in Taiwan. It, thus, provides an opportunity for developing geothermal energy.

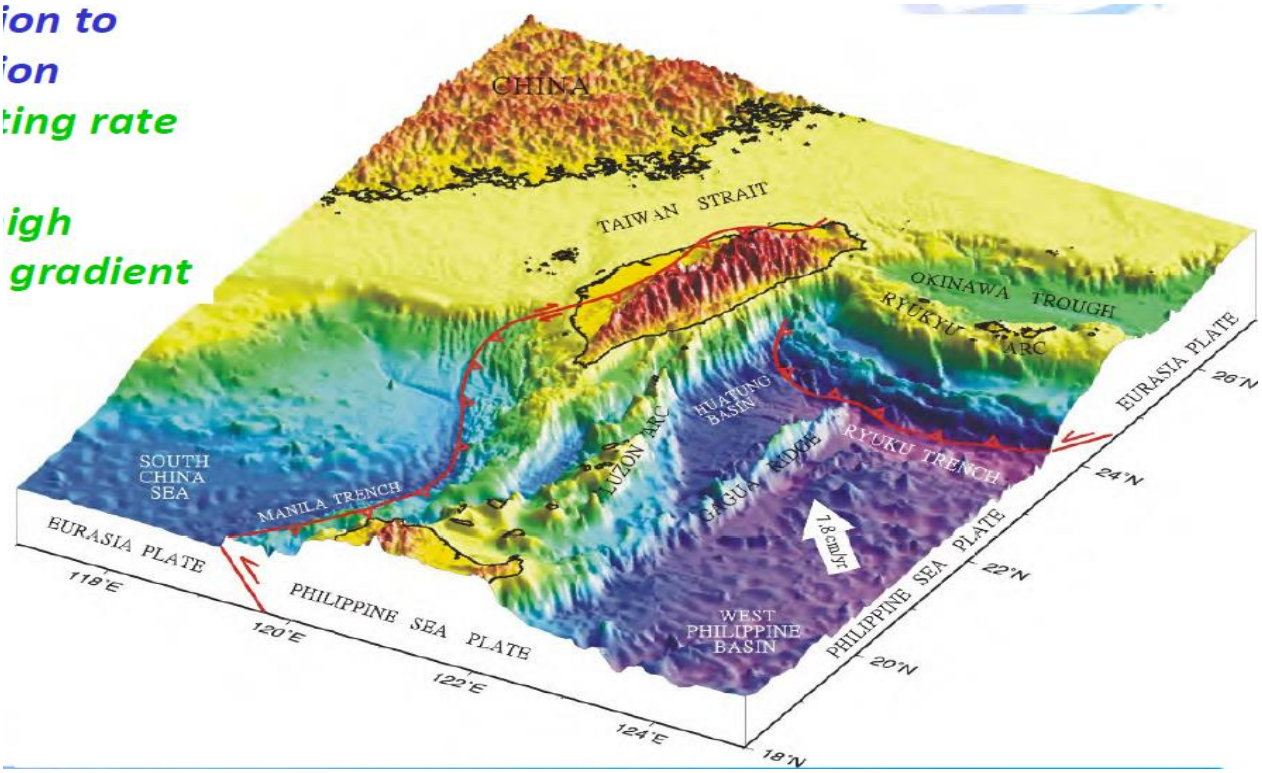

Fig.1: Tectonic framework of Taiwan, where is located at the collision zone of Philippine Sea plate and Eurasian plate.

2. Geothermal Potentials in Taiwan

Based on the results of different geophysical surveys and heat flows measurements from Silica geothermometry performed over the last decade, the distribution map of geothermal gradient was constructed and the temperature in the deep can be estimated in Taiwan (Liu et al., 2015). Meanwhile, a 3D visualized model also has been developed to calculate the volume of hot rock reservoirs (Chang et al., 2014). We used the method of USGE Circular 790 to evaluate the geothermal potentials of Taiwan. The result is shown in Figure 2. Considering the altitude below 1,000 m, the depth shallower than 4 km and the temperature higher than 175 ℃, a total geothermal resource can be gotten about 33,640 MW. They are predominately distributed at four different regions, Hua-Tung area, Lu-shan area, Ilan area and Tatun volcano group. It is very similar to the result from ITRI's calculation, which the data source is different from ours with the same method.

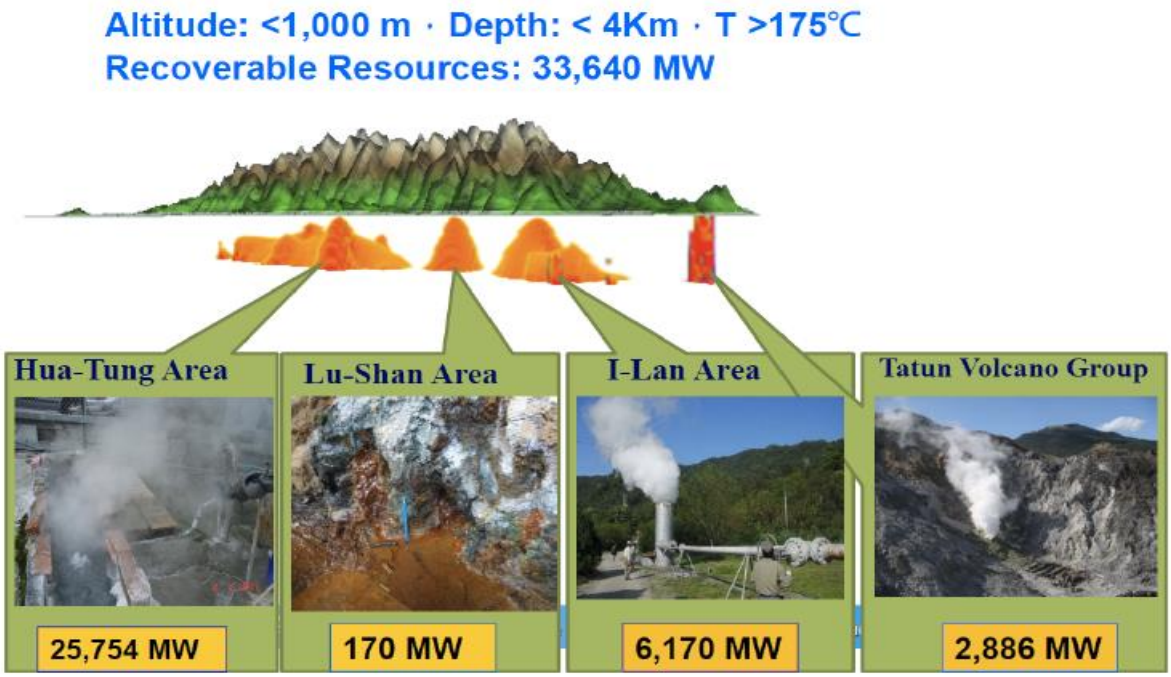

Fig.2: The distributions of geothermal resources in Taiwan.

3. Government's policy and Current geothermal projects

For developing the geothermal energy to generate electricity, several policies have been proposed by Bureau of Energy, Ministry of Economic Affairs (MOEA), R.O.C. The first, also the most important one was to pass the law, the Renewable Energy Development Act in 2009. It defines the geothermal heat as renewable energy and the electricity fee is adapted to the Feed-in-Tariff (FIT). Currently, the FIT price is NT$ 4.9428/kWh (equal to 16 cents USD) for 20 years to geothermal energy, which the electricity fee is 2.85/kWh in average for public. For encouraging exploration of geothermal energy, the MOEA also subsidies funds about NT$ 50 million (~1.6 million USD) for drilling the depth being over 1,000 m deep. Meanwhile, for developing geothermal energy, it also promotes as major projects of National Energy Projects II and invests large money for research and development funds.

Current Geothermal Projects in Taiwan (2014~2018) which are supported by the National Energy Major Program II (NEP-II) of Ministry of Sciences and Technology (MOST). There are 7 projects which have been approved and are listed as below:

1. High efficient geothermal energy technology research project (ITRI)
2. Exploration of deep geothermal resources and evaluation of sites for enhanced geothermal system (EGS) in the Ilan area
3. The study of heat extraction of supercritical CO2 on the reservoir of the enhanced geothermal system (EGS)
4. Technique developments and simulation of enhanced geothermal system (EGS) in the Ilan area

5. Integration of geothermal systems and development of 1 MW geothermal power systems
6. Study of deep geothermal power generation at Lize, Ilan
7. Deep geothermal drilling project of northern Taiwan (10,000 m)

4. CONCLUSIONS

- Geothermal potentials of install capacity are 33 Gwe in Taiwan.
- Hot springs for bathing and swimming are the largest geothermal industry.
- 50 KW pilot power plant is installed in the Chingshui geothermal field.
- The geothermal energy for electricity is just kick off.
- Currently, the explorations and developments of geothermal energy focus on the Ilan area, northeast Taiwan.
- Taiwan government will probably speed up for the geothermal developments in the near future.

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