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Turkey's Geothermal Potential on EGS - Enhanced Geothermal System

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ABSTRACT

The Hot Dry Rock Project has started firstly in Los Alamos – Fenton Hill (USA) in 1974. Mr. Mertoğlu was there as a trainer in 1978. We have been focused and still studying intensively on Hot Dry Rock, Enhanced/Engineered Geothermal System (EGS) technology during the last 3 years. In this framework, we have visited the EGS applications in Soults-France, Landau-Germany, Insheim-Germany in August 2012. In the meanwhile, we have tried to explain and introduce the importance of EGS to the experts of Renewable Energy and Energy Supply Commissions (as being the chairman of these commissions) of the Ministry of Development of Turkey.

We calculated the EGS- Enhanced Geothermal System Technical Electricity Production Potential of Turkey (3–5 km) as 400,000 MWe. The EGS- Enhanced Geothermal System Technical and Economical Electricity Production Potential of Turkey (3–5 km) is calculated as 250,000 MWe and the technical and economical EGS electricity production potential is expected to be 25,000 MWe during the next 25 years period and based on a feed-in-tariff of 20 US $ cent/kWh.

In some countries, the feed-in-tariff varies between ~20 and 30 € cent/kWh. In Japan it is in the range of 26–40 yen/kWh (25–39 US$ cent/kWh). A feed-in-tariff of 15 US$ cent/kWh would be reasonable and applicable to initiate the EGS Projects in Turkey. Seven years ago, Turkey's geothermal electricity installed capacity was 15 MWe and now it has reached to 311 MWe. Geothermal electricity production target for 2018 is estimated to be 750 MWe. One of the important high temperature geothermal fields is the Alasehir-Kavaklidere geothermal field in Manisa, where 287°C temperature was measured at 2,750 m depth in the well. The reservoir rock at this site is a Paleozoic granodiorite.

If our indigenous, renewable, national energy resource geothermal is supported by means of a feed-in-tariff minimum for 15 years (in many countries it is already being applied for 20 years), the dependence in energy to foreign countries will decrease and the current account deficit (about 60 billion USD/year for energy) will decrease, new employment areas will be created, and environment will be protected.

1. GLOBAL CALCULATION BASED ON EGS POTENTIAL

According to Turkey's geothermal potential; Menderes, Gediz and Edremit grabens; heat flow maps (Figure 1); down hole temperatures (> 500 available data); 60000 MWt potential while hydrothermal calculations up to 3 kilometers depth; 287°C temperature at 2750 m. depth from granite- granodiorite formations at Manisa Alaşehir (West Anatolia); taking into account that approximately 50000 km^2 of surface area of Turkey 778000 km^2 can be classified as granite and granodiorites and ignoring of 20% in that surface area because of the lakes, residential areas, rivers etc. have not suitable for drilling and building power plant, and at about 3000-5000 meters depth, the assumed average temperature of 200°C at that depth (calculations based on the rock volume of 1 km^3, cooled by 20°C, delivers about 10 MW of electric power and time of 20 years). Turkey's EGS technical potential could be calculated and estimated according to the conservative approach as minimum about 400000 MWe.

To achieve that potential, Turkish Government has to offer suitable feed in tariff. Our sector expectation about that tariff is 15–20 US $ cent/kWh. Now current feed in tariff for hydrothermal is 10,5 US $ cent/kWh. If such a feed in tariff could be applied, we would expect about 15000 MWe geothermal productions by EGS within the next 20 years. This is important since can significantly contribute to Turkey's economy, importing about 65% of its energy demand. Turkey's installed electricity power capacity is about 66000 MWe at the moment.

We have visited EGS sites in Europe such as France-Soultzs, Germany-Landau and Insheim. We have been informed about their technologies, developments, encountered problems, advantages and disadvantages. We utilize, develop most of the hydrothermal fields in Turkey and the Turkish Government and private sector will be deeply interested in EGS development, technology to produce electricity by means of EGS. We think that it could be started after 3 years mostly depending on the technological development and feed in tariff application.

In order to calculate this EGS potential, GEOELEC (an EU Project), publications, meetings, negotiations about this project, heat flow maps and temperature values at different depths published by EU, down hole temperature values gathered in Turkey since 1961, and collected data/evaluations by Turkish Geothermal Association were utilized.

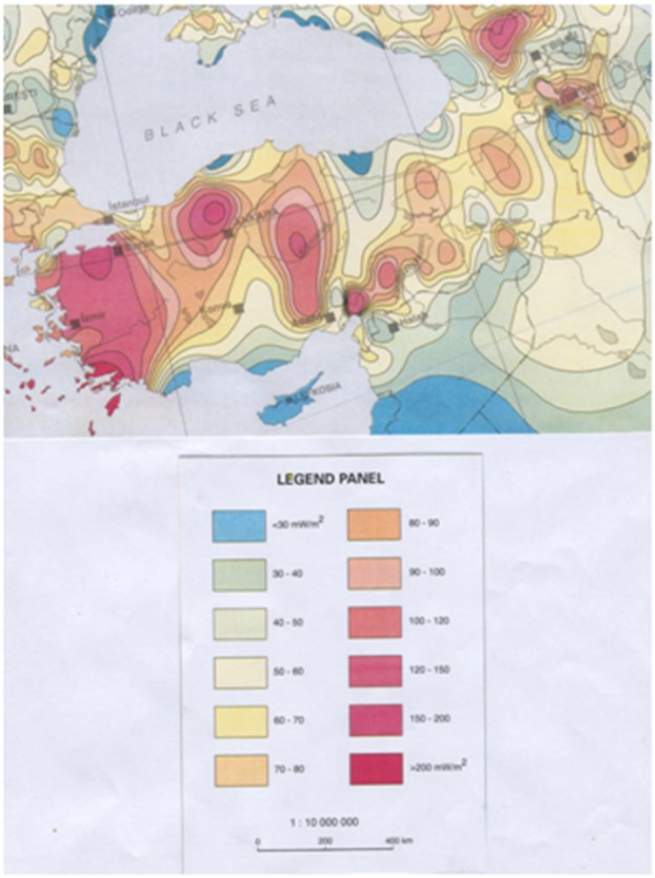

Figure 1: Heat Flow Map of Turkey

2. GEOTHERMAL POTENTIAL ON HYDROTHERMAL SYSTEMS

The total geothermal theoretical heat potential of Turkey (hydrothermal 0–3 km) has been calculated by Turkish Geothermal Association as 60000 MWt. The total geothermal theoretical electricity potential of Turkey (hydrothermal) (0–3 km) is 4500 MWe.

The total geothermal technical and economical electricity potential of Turkey (hydrothermal) (0-3 km) is 2000 MWe (16 billion kwh/year), with incentive (15 US $ cent/kwh feed in tariff, durations of the FIT effectiveness in 15 years).

The geothermal electricity production target of Turkey for 2018 has been estimated as 750 MWe (6 Billion kWh/Year) (10, 5 US $ cent/kWh existing feed in tariff, durations of the FIT effectiveness in 10 years).

3. EGS POTENTIAL AND PROJECTIONS

The total EGS-Enhanced Geothermal System technical and economical electricity production potential of Turkey (3-5 km) is 250.000 MWe (20 US $ cent/kWh).

The EGS-Enhanced Geothermal System target of Turkey (3-5 km) is 15.000 MWe. This production potential expected to be realized during the next 20 years period, with the feed in tariff of 15 US $ cent/kWh.

The economic potential for geothermal power in Europe in 2030 can be seen in Figure 2.

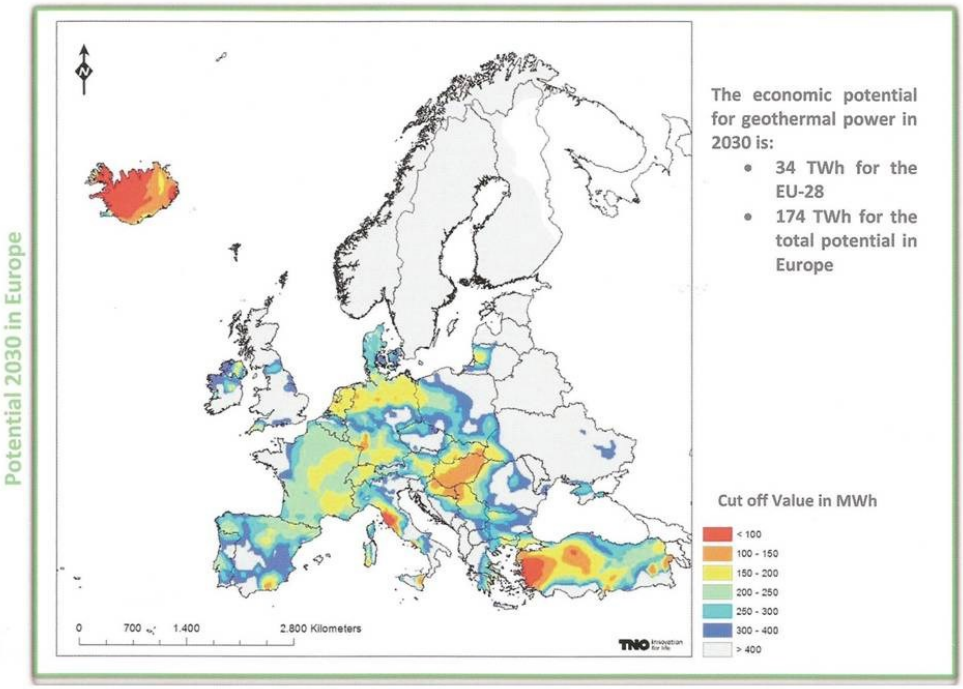

Figure 2: The economic potential for geothermal power in Europe in 2030 (from EGEC GEOELEC report, 2013)

4. GEOELEC PROJECT IN EUROPE

According to the GEOELEC report, economic potential per country normalized to the surface area (MW_e/km^2), which can be generated for less than 200 €/MWh (27 US $ cent/kWh). According to that report, the scenario for 2020 EGS doublet coheat; Iceland could have about 1, 2 MW_e/km^2 economic potential for LCOE (Levelize Cost of Energy) with less than 200 €/MWh. According to that, Hungary has about 0.65, Turkey has about 0.35, and Italy has about 0.18 MW_e/km^2. If we make a calculation regarding land areas of these countries:

Turkey; 778000 km^2 x 0, 35 MW_e/km^2 = 272000 MW_e

Iceland; 103000 km^2 x 1, 2 MW_e/km^2 = 123600 MW_e

Hungary; 93000 km^2 x 0, 65 MW_e/km^2 = 60450 MW_e

Italy; 301300 km^2 x 0, 18 MW_e/km^2 = 54234 MW_e

Therefore Turkey is the most suitable and economical choice among other countries for EGS utilization projects in Europe.

5. CONCLUSIONS

1. Based on the GEOELEC report Iceland (123600 MW_e), Turkey (272000 MW_e), Hungary (60450 MW_e), and Italy (54234 MW_e) have a huge potential for EGS, but Turkey has the biggest EGS power potential because of its larger land area.

2. EGS needs more technical development and support as an incentive, by the Turkish government (e.g., 15–20 US$ cent/kWh for 15 years of FIT effectiveness).

3. Turkey' annual cost for the imported oil and naturel gas is about 60 billion US $. It is a kind of deficit for the foreign trade. Therefore in order to partly compensate this deficit, EGS power generation could be a good alternative because of domestic and renewable resources.

4. The EGS-Enhanced Geothermal System target of Turkey (3–5 km) is 15.000 MWe. This production potential expected to be realized during next 20 years period and feed in tariff of 15 US $ cent/kWh (durations of the FIT effectiveness 15 years).

REFERENCES

Enhanced Geothermal Systems (EGS) - State of the Art and Perspectives, Prof.em. Ladislaus Rybach

Master Thesis + Extension Master Thesis of Jon Limberger, Supervised by Prof. Dr. J.D.A.M. Van Wees, Dr. M. Ter Voorde & Dr. F. Beekman

Atlas of Geothermal Resources in Europe, European Commission Research Directorate – General, ISBN: 92-828-0999-4, 2002

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