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Geothermal boom in Turkey: Growth in identified capacities and potentials

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ABSTRACT

Increasing activities of geothermal development especially in the last three years result in a geothermal boom in Turkey. Not only the addition of new sites, but also updating the data of existing ones increased the currently identified capacity significantly. With the discoveries of 13 new geothermal fields, power potentials increased by 1.6 times.

This study deals with hydrothermal and EGS potentials of Turkey. The geothermal resource base between 0 and 3 km depth in Turkey and the capacity of the currently identified 290 geothermal sites are determined to be 3.96×10^{23} J and 10,576 MW_t, respectively.

As of today, a total of 135 hydrothermal fields were individually studied, of which 38 medium to high temperature ($T \geq 100\,^{\circ}C$) fields were simulated to estimate the power generation. The remaining 97 fields were simulated to estimate the direct use potentials. The lower and upper limits of power generation potential corresponding to P10 and P90 values are 1673 and 3140 MW_e, respectively. Moreover, the lower and upper thermal potential limits of 135 hydrothermal fields corresponding to P10 and P90 values are 38.2 and 68.4 GW_t, respectively.

1. Introduction

As a developing country, energy and electricity demands in Turkey grow at rates of about 4.5% and 7% per year, respectively. Nearly 75% of energy demand is satisfied with the imported fuels. Therefore, energy dependency on imported resources has become an important issue and of concern. As of 2012, the present installed electricity generating capacity and energy consumption of Turkey have reached to 57 GW_e and 119 million TOE (tons oil equivalent), respectively. Official statistics (Ministry of Energy and Natural Resources) show that natural gas, coal-liquid fossil fuels, hydro, and other renewables provide 45%, 30%, 23% and 2% of the total electricity of the country, respectively. In order to reduce dependence on imported energy the country needs energy diversification. This diversification could be obtained by adding renewable resources to energy supply portfolio.

Although Turkey is rich in renewable energy resource potential such as wind, geothermal and solar, these resources are not yet harnessed sufficiently in terms of energy production. Geothermal energy remains as a small contributor to the power generation capacity of Turkey. Geothermal plants constitute only 0.3% of the installed power generation capacity and provide around 0.5% of total electricity. Although they provide a relatively modest contribution, Turkey needs to include geothermal resources in its energy supply portfolio. The assessment and determination of this contribution in a scientific manner are the aim of this study.

The first systematic study to assess the geothermal resources was presented by US Geological Survey (USGS) Circular 726 [1]. This assessment was updated in 1978 by USGS Circular 790 [2]. The same year Muffler and Cataldi [3] published their well known paper defining “methods for regional assessment of geothermal resources”. This paper presented a simple analytical method for determining resource potential. On the other hand, resource estimation reported in USGS Circular 790 by Brook et al. [4] was based on stochastic evaluation method. Later, another stochastic evaluation of reserve estimation for low temperature geothermal resources was published in USGS Circular 892 by Reed [5].

Muffler and Cataldi [3] mentioned a continuing need to revise geothermal resource assessments, owing to the rapidly changing state of geothermal knowledge, increasing data base, improving

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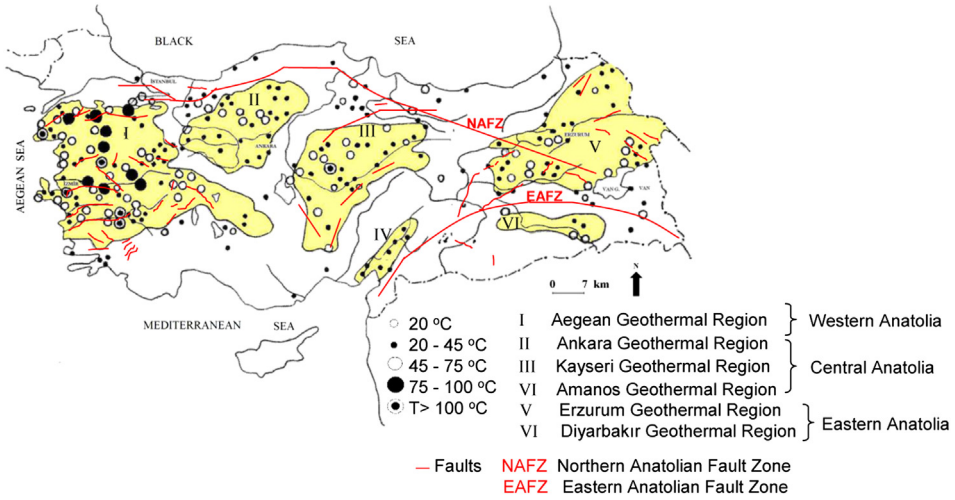

Fig. 1. Geothermal sites and regions in Turkey (modified from Erentoz and Ternek [24]).

technology and changing economics enabling periodic updating of geothermal resource appraisals. In this context, Reed and Williams [6–8] described a number of changes to be incorporated in new resource assessment. Based on these changes, USGS published a report on the review of methods for the assessment of identified geothermal resources [9].

The pioneering studies on geothermal resource assessment have been done in the USA. Today some other countries (although limited in number) such as Philippines [10], Mexico [11, 12], China [13], Brazil [14], Canada [15], Germany [16], Denmark [17], Switzerland [18, 19], Sweden [20], Korea [21] and Pakistan [22] have conducted resource assessment studies related to deep as well as shallow geothermal resources. For example for Germany the cited work [16] is only a local one.

Fig. 1 is the map of Turkey showing the low, moderate and high temperature of hot spring waters and possible geothermal regions. This map is modified by Korkmaz [23] from the study of Erentoz and Ternek [24]. There are already 290 sites discovered and more than 120 fields. However, there is a perception among geothermal developers and financiers that the resource in Turkey is substantially higher. The existing and imminent geothermal development, which yielded considerable growth in identified capacity and power plant installments in recent years, supports this perception.

Our study relies on the inventory data given by the state-owned directorate MTA (General Directorate of Mineral Research and Exploration) for 290 sites distributed throughout Turkey, and the data recently obtained from the geothermal activities in the country by private sector, and studies conducted on several geothermal resources by various universities.

According to MTA, there are more than 200 known geothermal fields and prospects in Turkey and there are plans for accelerated geothermal power development. In Fig. 2 boom in geothermal energy development is shown in terms of direct use and power capacities. Due to the privatization moves in the recent years, the growth of the installed direct use and installed power capacity has been impressive, 160% and over 800%, respectively. The installed power capacity is expected to reach to over 350 MW_e (based on the licenses issued by Energy Market Regulatory Authority) by 2014.

Korkmaz's 2010 study [23] was the first systematic effort to assess and estimate the geothermal resources of Turkey. This paper is the continuation of the study of Korkmaz [23] with new and updated values. All calculations are repeated and revised according to new and updated data obtained in last three years. In Korkmaz 2010's study a total of 122 geothermal fields were evaluated using volumetric method in order to estimate potentials. The identified capacities of 279 geothermal sites were also determined. In this

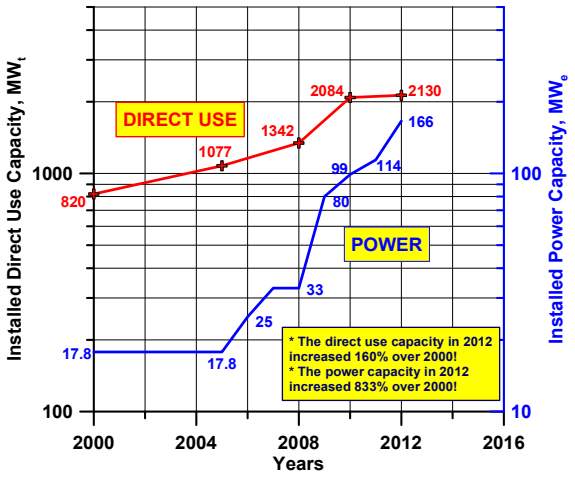

Fig. 2. Growth of installed direct use and power capacities in Turkey.

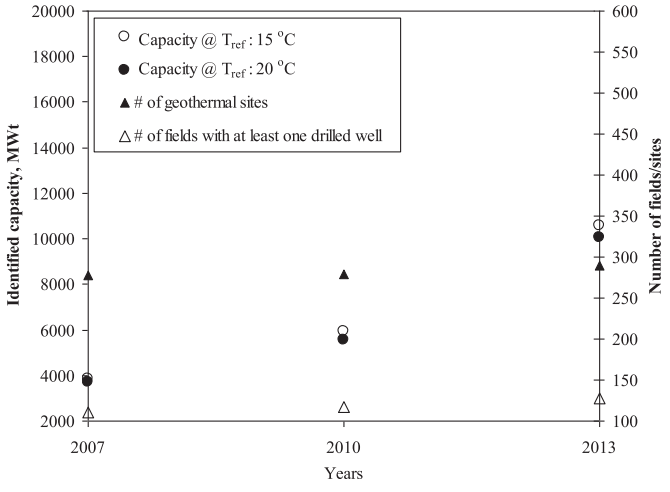

Fig. 3. The change of identified capacities and number of geothermal fields in terms of years.