Geothermics 72 (2018) 64–73

Contents lists available at ScienceDirect

Geothermics

journal homepage: www.elsevier.com/locate/geothermics

Feasibility study and economical evaluations of geothermal heat pumps in Iran

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ARTICLE INFO

Keywords:
Geothermal
Heat pump
Renewable energy
RETScreen

ABSTRACT

Negative effects of fossil fuels and the fact that their reserves will be exhausted in the near future have made nations all around the world look for novel replacing technologies. In recent years, the Ground Source Heat Pump (GSHP) has been considered as one of those beneficial solutions in industrial countries. It is obvious that for a replacing technology to be economically favourable is as important as being technically feasible. Iran is a country of several climates and needs to expand its energy basket for development. In this paper, the impact of temperature and humidity variations on the economics of a GSHP system is studied. In order to find the best region to install GSHPs, 9 different areas are selected with respect to ambient temperature and humidity diversity. Then, feasibility studies are carried out using RETScreen software to estimate the profitability of the project. The result indicates that the impact of a humidity variation is negligible in comparison with the temperature variation. Also, to determine the importance of the Iranian government's incentive on the feasibility of GSHP projects, the natural gas price trend is considered in two scenarios. Further, a predicting equation to calculate annual cost based on temperature and a relative cooling/heating load is conducted by a regression method. Finally, the reduction in CO_2 emissions due to the possible utilization of a GSHP system is determined in each region.

1. Introduction

The problem of diminishing fossil fuels and their negative effects on the environment has become a crucial issue around the world since energy consumption has increased in the past decades. Therefore, applying a new source of energy as an alternative is a beneficial solution to overcome this concern. Renewable energy comprises resources which are widely used to reduce fossil fuel damage (Carvalho et al., 2015; Noorollahi et al., 2017b).

There is an array of different renewables such as wind, solar, biomass, and hydropower. Unfortunately, geothermal resources have an inferior acceptance among developed and developing countries. The direct use of geothermal energy in Iran is not yet widespread but has led to the maximum capacity of 81 MWt by the end of 2014. Rashidi et al. (Rashidi et al., 2013) reviewed some projects related to GSHP in Iran. In this paper GSHP is compared with commercially available heating/cooling split units economically. Finally, Results show that although the return of investment may take a long period, the GSHP units are profitable. The geothermal heat pumps distribution in Iran is shown in Fig. 1 up to 2014, which have been caused 60 percent energy saving (Saffarzadeh et al., 2010).

The reason for this lack of attention may be difficulties in finding geothermal energy potential as much as its installation (Bleicher and Gross, 2016). On the other hand, direct use of geothermal energy has increased among several countries over the years, i.e. the immediate use of energy in both heating and cooling. Based on recent studies, about 55.2% of direct geothermal energy all over the world is related to ground source heat pumps (Lund and Boyd, 2016). In Fig. 2 the share of different geothermal energy applications around the world in 2015 is shown (worldwide capacity of heat pumps, MW). As it is illustrated, a large part of installed geothermal energy capacity is due to GSHPs. According to Fig. 3, installed GSHP capacity all around the world is expected to grow by approximately 150% between 2013 and 2020 (Konrad, 2014). Furthermore, the total installed capacity of geothermal heat pumps in Iran is demonstrated in Fig. 4 and shows a significant progress in this field (Saffarzadeh et al., 2010).

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http://dx.doi.org/10.1016/j.geothermics.2017.10.017
Received 10 August 2017; Received in revised form 4 October 2017; Accepted 25 October 2017

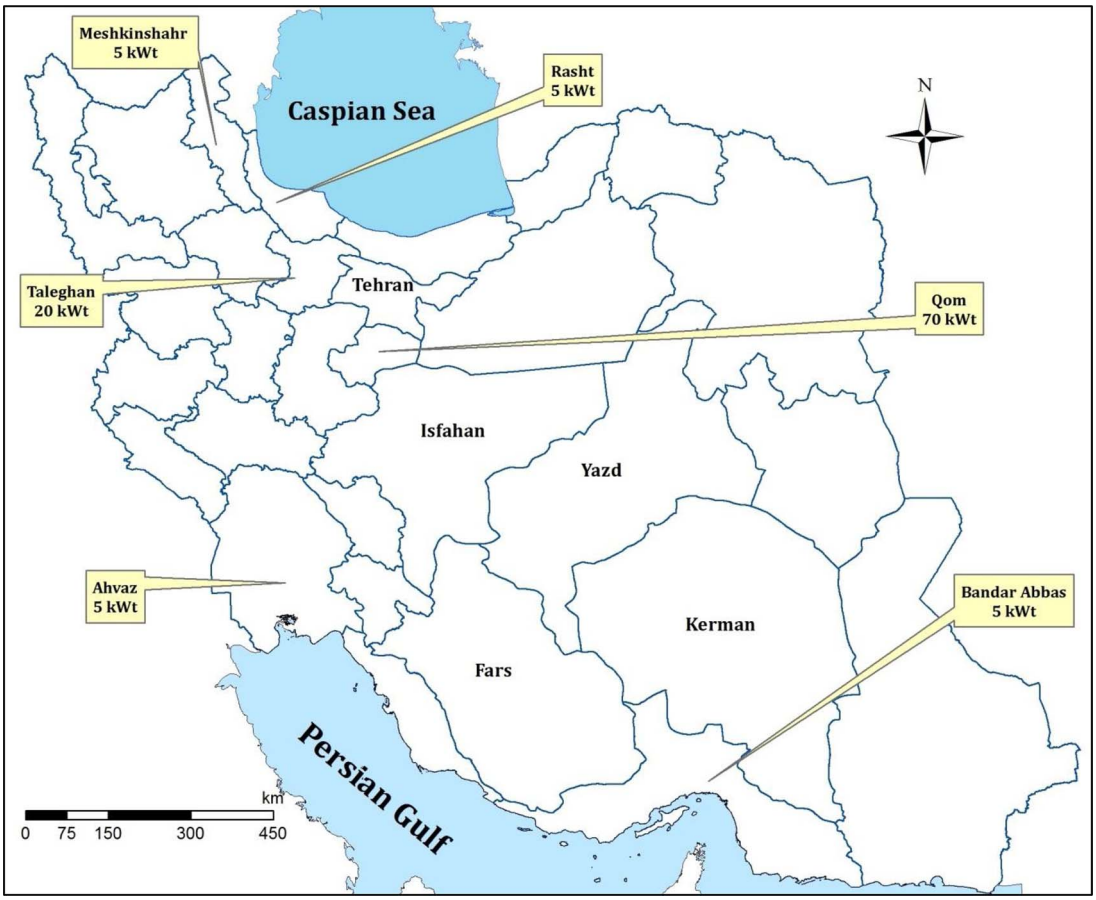

Fig. 1. Geothermal heat pumps distribution in Iran (Saffarzadeh et al., 2010).

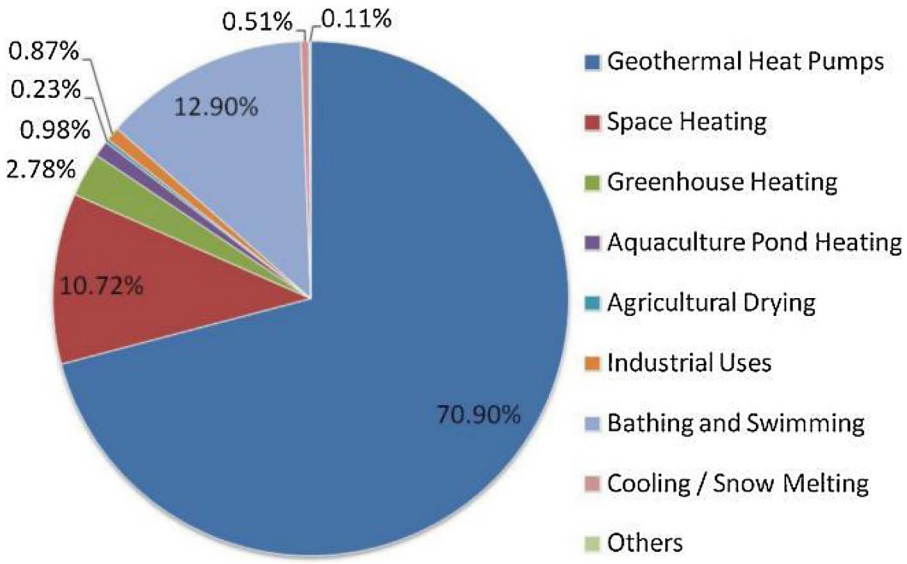

Fig. 2. Direct geothermal energy applications around the world by percentage of total installed capacity (MWt) in 2015 (Lund and Boyd, 2016).

Some feasibility studies have been carried out in order to recognize the scope for GSHP applications. For instance, a regional study utilizing GIS was implemented in South Italy (Galgaro et al., 2015). The results of a study in Australia proved a 100% success rate from direct-use geothermal energy (heat pumps) (Pujol et al., 2015). In another study a technology to use geothermal heat pumps in the arid zone of Australia has been presented. As a result, geothermal energy is widely used in Australia (Pujol et al., 2015; Russell and Gurgenci, 2014). The development of large scale geothermal heat pump plants has been analyzed in Germany. In this analysis economic circumstances were considered to find out which were the most appropriate regions in which to introduce GSHPs (Sanner et al., 2003). In Tabatabaei and Truer paper (Tabatabaei and Treur, 2016), the economic aspect for heating is analyzed for different regions of Iran and for different pricing strategies for electricity and gas based on numerical simulations over a year based on temperature data, for domestic heating based on a heat pump in comparison to gas-based heating.

In recent studies in Iran several uses are considered for heat pump