

## Provide Legal Solutions for the Development of Geothermal Heat Pumps Using Existing Energy Laws in Iran

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### ABSTRACT

The need to increase the share of renewable energy and reducing greenhouse gas (GHG) emission, along with raising environmental consciousness to protect the environment from pollution and unsustainable practices such as consuming fossil fuel resources, will promote geothermal heat pump development for heating and cooling in Iran. Although the price of energy is considerably low in Iran, there is a vast amount of energy in place to use from geothermal energy resources in the country in such a way that they are more reliable and more convenient to use. This capacity could enhance the reduction of environmental pollution and increase the efficiency of heating, ventilation, and air conditioning (HVAC) systems such as heating and cooling mechanism.

Majority of urban and pre-urban areas throughout the country are equipped with a network of natural gas pipeline energy distribution system which provides the heating system. In some areas, generally mountainous villages, the gas network has not been built and people in these areas are facing difficulties for providing heating to their buildings.

The same difficulties forced to communities living in arid and semi-arid areas of the country, especially during the sweltering hot summers, which start almost in early April. The electricity demand exceeds in a drastically high level to the amount that the power consumption need cannot be met by infrastructures that the ministry of energy installed and dedicated to the region. The cooling system with such a high demand for power supply encounters an overall grid now and then power cut due to the high demand for cooling. It is worth mentioning that the standard cooling systems were used by these communities generally have very low efficiency. Therefore, a more reliable source of energy is a huge demand.

Considering these two extremes in the spectrum of the climate, it was proposed to install a heat pump to maintain indoor cooling and heating systems in this paper. Moreover, it summarized the available laws and regulations which could support the strategy of renewable energy and especially heat pumps. Although the derivation and force full use of these regulations needs affirmative mandates supported by government and key opinion leaders to follow through for any possible success, these laws are the primary source to objectify. They have been summarized and categorized into two main sections the efficient use of energy and renewable energy incentives.

### 1. INTRODUCTION

Iran is a country with multiple and different climate conditions due to the existence of mountainous, desert, and humid plain areas. Different regions of Iran experiences changing weather conditions, which are unlike the other surrounding locations within the same day. Fluctuations of temperature and humidity in various regions caused the need for heating and cooling systems to make their places pleasant with air conditioners.

Adopting a network of gas pipelines in the vast area of the country, availed a constant source for inhabitants to take advantage of gas energy and gas heaters to provide heating for indoors. This heating system has low efficiency due to the high amount of gas consumed by different equipment. Using a ground source heat pump (GHSP) with high efficiency can reduce gas consumption and at the same time can reduce the environmental pollutants emitted from burning natural gas. The risk associated with natural gas heating system and the possibility of explosion and fire is other disadvantages of this heating method. The neighboring country in northwest Iran, Turkey has long purchased natural gas at a reasonable price; if export and revenue from exports considered, instead of burning fossil fuel it is enormous merit for the country.

In some of the mountainous regions with low number of households, the construction of gas pipelines is not economically viable. To accumulate the amount of capital investment the dedicated share for each family is considerable too. Also, steep pathways make it technically impossible for pipelines to be constructed easily in these regions. A possible highly recommended potential for construction of ground source heat pump systems is those villages far from gas networks, mainly having mountainous roads, difficult to pass, and costly to move through.

During high temperature and warm months of the year in aired and semi-arid areas, people use evaporative coolers to maintain the indoor cooling. The system with high water consumption and low efficiency seems less desirable to provide cooling despite the general practice of household users.

Along with the southern parts of the Caspian Sea and north region of the Persian Gulf and Oman Sea, local inhabitants use air conditioners due to hot weather and high humidity; during warm months of the year in these areas, even the chillers cannot maintain the needed temperature. These coolers are capable of reducing humidity and simultaneously providing pleasant temperatures. These air conditioners with high level of power consumption, unfortunately, lack the needed efficiency in terms of energy standards.

One of the most promising target areas to install heat pumps is in these regions. By planning to replace air conditioners with heat pumps, it is possible to reduce the power consumption from the network and at the same time, hit the amount of gas emission and related pollution production in the power plants. Note that the radioman in power generation from thermal power plants is less than 30 %.

## 2. GROUND SOURCE HEAT PUMP IN IRAN

To show the performance of ground source heat pump, several small pilot projects have been installed in various parts of the country. The monitoring information of the systems has been observed and recorded over a long time to compare the performance of the above systems with the current conventional heating and cooling systems. The total installed capacity of ground source heat pumps is around 300kw-thermal. The biggest one has a capacity of 150kw-thermal and has been installed near Tehran in an administrative building. The performance of installed systems compared to current air conditioning systems shows a reduction of approximately 50 to 60% of energy consumption when ground heat pump administrated.

It is worth noticing that construction costs of the GHSP device and its coils could rise about 3 to 4 times higher than conventional systems therefore number of incentives and scaling up schemes for site installation should be adopted for feasible projects. Subsequently, the absence of government support and failure to implement financial incentive schemes can affect the overall prospective of any possible development of a geothermal heat pump system in Iran.

## 3. LAWS AND REGULATIONS TO BOOST RENEWABLE ENERGIES

To develop and construct renewable energy power generation schemes, renewable energy and energy efficiency organization of Iran (SATBA), under the supervision of the ministry of energy concluded a power purchase agreement guideline in the form of a contract to purchase the electricity generated by wind, solar, biomass, geothermal and hydroelectric plants for a period of twenty years, the contract has a Sovran grantee of payment by the government. It should be noted that during previous years, the price of electricity was around 11 cents per kWh, but due to encountered economic turmoil, the electricity price was reduced to approximately 3 cents per kWh. No financial support mechanism has been defined for measures of power consumption reduction or installation of renewable energy methods, none the less for geothermal heat pumps. Another problem is the multiple organization and ministries with the tasks interrelated and, in some cases, overlapped and parallel in energy sector. Ministry of Power and Ministry of Petroleum have duties and responsibilities which not well defined toward renewable energies. These made the matter more complicated for privet sector to follow through for productive investments.

The most related law and regulations listed as below;

### Energy Reform Act on Consumption No. 1770

This law, in implementation of Article 123 of the Constitutional law of the Islamic Republic of Iran, was adopted on December 12, 2010, and approved. The law contains **75** articles and **20** note-amendment. Renewable Energy and Energy Efficiency Organization are obligated to implement all of its content nationwide especially in fuel sector, by implementing general policies to reform the consumption pattern. Important legal materials related to energy optimization management in the industrial sector are as follows:

- **Article 6:** The Ministries of Power, petroleum, Agriculture and Industries, and Mines are required to identify and adopt all the technologies needed in the specialized field for the supply and consumption of energy over the next 20 years and to design and improve them for use by manufacturers and producers.

- **Article 10:** The Ministries of Petroleum and Energy within the framework of the Country's Annual Budget and the Subsidy Targeting Act are obliged to cooperate with the relevant Ministries, the Iranian Institute of Standards and Industrial Research Institute of Iran to adopt and introduce a proper technology and energy-efficient consumption methods for different sectors of industries (including oil and power industries), mines, mining, agriculture and water pumping by considering the climatic conditions, consumer culture and habits. Also, determine the monthly consumption pattern of energy carriers for the domestic, commercial and public sectors.

**Article 14:** To encourage consumers to use equipment, assemblies and processes with less energy consumption and better standards regarding environmental pollution. Financial resources should be mobilized, like annual budget bills, incentives. The executive by-law of this Article shall be prepared by the Ministries of petroleum and Power at the latest in next six months after the adoption of this Act and shall be approved by the Cabinet. e.g., So far, no executive order or guild line has been adopted

**Note-amendment:** The responsibility to form a working group to maintain the work related to this article in the field of fuel and combustion is with the Ministry of Petroleum and in the field of Electricity is with the Ministry of Energy. e.g., Parallel works and interrelation caused many problems

**Article 16:** budget allocation for any reconstruction and development of industries shall be subject to compliance with environmental standards and specifications dictated and, after obtaining the necessary authorization from the Iranian Institute of Standards and Industrial Research Institute. E.g., standards and procedures have not been applicable so far.

**Article 24:** All energy consumers with an annual consumption of more than five million cubic meters of gas or equivalent petroleum or more than one megawatt of electricity shall establish an energy management unit to promote and do affirmative actions toward energy savings without expanding any government unit or interference. These shall conduct energy audits and optimize energy consumption and implement necessary measures to optimize energy consumption to meet the criteria outlined in this Law. e.g., So far, no executive order or guild line has been adopted

**Article 25:** The Ministries of Petroleum and Energy shall, upon receiving a report from the Iranian Institute of Standards and Industrial Research Institute, penalize industrial units subject to mandatory standard regulations that do not meet the criteria outlined in the Standard in accordance with Article 26. e.g., So far, no executive order or guild line has been adopted.

**Article 26:** Industrial entities will be penalized as a percentage of the sales price of energy carriers if they do not comply with the specifications, specifications and standards of energy consumption as recognized by the Ministries of petroleum, and Industries and Mines. Funds raised will be deposited into the treasury of the country as a general revenue account and will be spent on implementing industry optimization strategies under this Act. e.g., So far, no executive order or guideline has been effectively adopted.

**Article 45:** The Ministries of petroleum and energy are required to support industrial, constructions, and agricultural and public entities who are generating electricity, heat, and refrigeration at the site of consumption by all available means. e.g., So far, no executive order or guideline has been effectively adopted.

#### . 4-ECONOMIC ANALYSIS

To calculate the needed capital investment in geothermal heat pump projects, three different scenario projects defined as follows.

In the first project, the cooling and heating capacity of a 100 square meter home with approximate 5 tonnes, the second project is for twenty houses with the same conditions and the last scenario, the third one, is for two hundred houses with the same conditions considered. The cost of these scenarios projects calculated for open-loop, horizontal-loop and vertical-loop ground coils has been calculated. Based on the calculations, the investment cost of the mentioned projects is shown in a table below.

| Capital cost of investment (\$) | Ground level coil system | Project Capacity   |
|---------------------------------|--------------------------|--------------------|
| 7,000                           | Open                     | 50 Tonn Capacity   |
| 7,833                           | Closed Horizontal        |                    |
| 15,000                          | Closed Vertical          |                    |
| 115,000                         | Open                     | 100 Tonn Capacity  |
| 131,667                         | Closed Horizontal        |                    |
| 255,000                         | Closed Vertical          |                    |
| 1,033,333                       | Open                     | 1000 Tonn Capacity |
| 1,233,333                       | Closed Horizontal        |                    |
| 2,225,000                       | Closed Vertical          |                    |

It was considered to use three modes of climate to calculate the rate of energy consumption reduction. In some parts of Iran, such as the south (north of the Oman Sea and the Persian Gulf), about 6 to 7 months of the year, the cooling system needs to be turned on.

In these areas, almost no heating system is needed. For these areas, the cooling hours are estimated to be 2700 hours per year, and for the 5, 100, and 1000 ton projects 2.5, 250, and 2500 kWh respectively are considered as the power consumption reduction per hour.

In mountainous regions, the heating system is needed around 5 and 6 months of the year due to the high altitude and generally cold weather of these areas. Due to low temperature, one can assume there is no need for cooling system. For these areas, the heating rate of 2700 hours per year is considered, while for the 5, 100 and 1000 ton projects 2.4, 240 and 2400 cubic meters respectively, the reduction of natural gas consumption per hour is intended.

Elsewhere around the country, air conditioning systems need to be turned on for about 3 to 4 months to provide a pleasant environment and heating systems also for 4 to 5 months. For these areas, the heating needed hours are 2160 hours per year and for the cooling systems 1674 hours per year.

According to reports prepared by the Ministry of Energy, \$ 0.0601 is paid to produce one kWh. It is also reported that per each cubic meter, \$0.33 will be paid for exporting natural gas to Turkey. On this basis, the values shown in the table below can be calculated for the amount of revenue (in dollars) resulting from the reduction in energy consumption in the states listed above.

| Heating & cooling | Just heating | Just cooling | Project capacity  |
|-------------------|--------------|--------------|-------------------|
| 1,962             | 2,138        | 406          | 50 tonn capacity  |
| 1,962             | 2,138        | 406          |                   |
| 1,962             | 2,138        | 406          |                   |
| 196,217           | 213,840      | 40,556       | 100 tonn capacity |
| 196,217           | 213,840      | 40,556       |                   |

|           |           |         |                    |
|-----------|-----------|---------|--------------------|
| 196,217   | 213,840   | 40,556  | 1000 tonn capacity |
| 1,962,169 | 2,138,400 | 405,563 |                    |
| 1,962,169 | 2,138,400 | 405,563 |                    |
| 1,962,169 | 2,138,400 | 405,563 |                    |

Accordingly, a simple economic analysis to calculate the payback period of capital investment, one can conclude that in different projects the return period of capital will be as follows.

| Heating & Cooling | Heating | Cooling | Ground Level Coil System | Project Capacity   |
|-------------------|---------|---------|--------------------------|--------------------|
| 3.567             | 3.273   | 17.260  | Open                     | 50 Tonn Capacity   |
| 3.992             | 3.663   | 19.315  | Closed Horizontal        |                    |
| 7.645             | 7.015   | 36.986  | Closed Vertical          |                    |
| 0.586             | 0.538   | 2.836   | Open                     | 100 Tonn Capacity  |
| 0.671             | 0.616   | 3.247   | Closed Horizontal        |                    |
| 1.300             | 1.192   | 6.288   | Closed Vertical          |                    |
| 0.527             | 0.483   | 2.548   | Open                     | 1000 Tonn Capacity |
| 0.629             | 0.577   | 3.041   | Closed Horizontal        |                    |
| 1.134             | 1.040   | 5.486   | Closed Vertical          |                    |

## 5-CONCLUSION

According to the studies conducted for this report, one of the most critical factors for successful ecumenical viable projects is the scaling of the geothermal heat pump projects, e.g. the total capacity and number of geothermal heat pump devices as one package and installation. So, if a project with a capacity of about 200 tones is defined for about 20 households, this system can be economically feasible.

One more factor is the type of geothermal heat pump installation; ground coil installation has advantages over other types. The availability of water from nearby sources is also a significant factor. In places where the water level is near the surface or installations near rivers and seaside are more likely to be feasible in terms of payback of investments in short term designation, providing adequate technical considerations in such projects.

Considering the export opportunity, a proven alternative scenario all the calculations compared against export of natural gas to neighboring countries. The study can be detailed with more data on cost of construction of the gas pipeline, etc.

Reviewing the calculation, it is illustrated that it is best to develop a heat pump for heating systems only and administrating open circle of ground coils.

For master planning, execution of heat pumps for remote areas without access to natural gas pipeline network and heating will be recommended.

It is also envisaged that if, like other renewable energy alternatives such as solar, biomass and wind power which their electricity purchased via power purchase agreement of twenty years, the Ministry of Energy calculates and refunds the reduced power consumption by using the geothermal pump system and be guaranteed for a long time purchase at a reasonable price it deemed that heat pump system in combination use will be developed by the private sector at an acceptable speed in Iran. It will achieve the goals of environmental pollutants reduction and reeducation of energy consumption in each sector.