

## **Edremit (Balikesir) 7,500 Residences Equivalence Geothermal District Heating and Thermal Water Supply System**

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### **ABSTRACT**

Edremit is a town of Balikesir province situated 87 km from the Balikesir city center. Its urban population is 39,202.

Edremit Geothermal District Heating System (GDHS) is fed from Edremit geothermal field, which is 3 km away to the Edremit city center located at the Aegean Sea Coast.

Edremit Geothermal District Heating System has begun to operate on December 2003 with 500 residences. Now 1500 residences are connected to the system by October 2004 (ORME, 2004). Total capacity of the project is 7,500 residences. As the first stage 2500 residences are planned to be heated. Additional to the two production wells and one re-injection well, seven production and two re-injection wells are planned to be drilled in order to realize the whole project with 7500 residences heating capacity. Each residence pays 22.20 US\$/month heating fee. With the utilization of the geothermal water in this project, decrease in Carbon Dioxide emission value will be 15,483 tons/year.

The system supplies heating in winter, hot tap water during the whole year. The geothermally heated clean water is transported with the pre-insulated pipes to the residences. The returning water is planned to be used for thermal tourism facilities.

### **1. INTRODUCTION**

The history of geothermal district heating systems is going back to the year 1983 in Turkey.

The first geothermal district heating system was realized by means of downhole heat exchangers in Balçova (Izmir) city. After this, as the scaling and corrosion problem was absolutely solved economically by means of chemical injection, the technological developments in the downhole pumps, utilization of automatic control and measurement equipments, technological development of the pre-insulated pipes, PC supported control systems, utilization of plate type heat exchangers and similar developments resulted in a wider usage of geothermal district heating systems in Turkey.

Edremit is a town of Balikesir province, which is located in the south of Marmara region. The average weather temperature in Edremit region is 16.5 °C. The minimum temperature has been measured as - 9 °C during December which occurs very rare, since Edremit city is protected by the Kaz Mountains against the North winds.

Agriculture and especially olive groves are very typical for Edremit city.

According to the made public survey, it has been determined that 49% of the public is using coal for heating purposes during winter. The rest of the people are using mostly wood and in minority electricity, fuel oil, diesel-oil, and LPG (ORME, 2003).

With the utilization of geothermal water for heating purposes in Edremit City the air pollution will decreased on a large scale and the living standard of the people will be increased.

### **2. PROPERTIES OF THE EDREMIT GEOTHERMAL FIELD**

The geothermal field surface area has been estimated as 1,6 km<sup>2</sup> according to the geological, hydrogeological, geochemical and geophysical properties of the geothermal field. A good cap rock and fault system is developed, which makes the geothermal fluid more suitable for utilization.

The cap rock is formed from Neogene sediments, which are including clayey levels. Volcanites, granodiorites, limestones, olistolite limestones and marble form the reservoir rock. The heat source is interpreted by the previous authors as volcanites with dome structure.

According to the SiO<sub>2</sub> geothermometers the reservoir temperature has been estimated as 83 °C.

The total flowrate of two geothermal wells is 109 l/sec with a temperature of 60°C.

Additional to the existing two production and one re-injection wells, one production and one re-injection well is going to be drilled in order to realize the 1<sup>st</sup> stage 2500 residences heating. The depths of these wells shall be 300 ± 100 m.

One additional geothermal production well is going to be drilled during October 2004, which is financed with the donation of Bank of Provinces of Turkey.

### **3. TECHNICAL EVALUATION OF THE PROJECT**

Edremit Geothermal District Heating System contains the below sections;

- Energy source (geothermal fluid),
- Geothermal Water Production,
- Transportation,
- Re-injection,
- Heat Center,
- Energy Transportation Line,

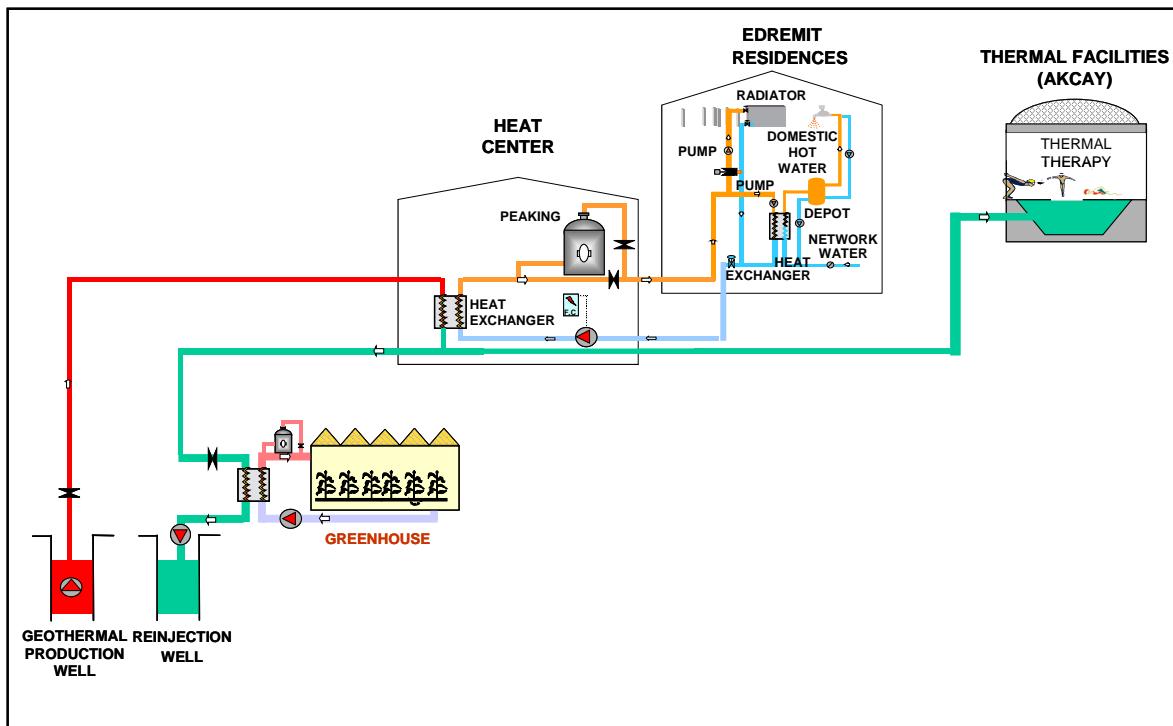


Figure 1: Flowchart of Edremit Geothermal District Heating System

- City Distribution Network,
- Consumers (Residences, Thermal Facilities).

Figure 1 shows the flow chart of the Edremit geothermal district heating system.

The energy source of the system in the first stage will be the 60°C geothermal water, which is produced from production wells in the Edremit geothermal field.

In the Heat Center; geothermal water re-injection pumps, plate type heat exchangers, inhibitor dosage and clean water rehabilitation systems, clean hot water circulation pumps, electric transformer station, frequency converters, closed expansion system and peaking system are found.

Closed cycle clean water, which is heated, by geothermal water will be transported to the city with insulated package pipes.

The clean hot water is transported to the residences and transfers its energy to cold water via heat exchangers at the buildings, which are heated geothermally.

The clean water which releases its energy in the residences (heating+hot water in winter, hot water in summer) will turn back to the heat center.

The temperature of the geothermal fluid cycle or clean hot water cycle will stay constant as the flowrate will change according to the heat demand of consumers in both cycles. As a result of this, Edremit Geothermal District Heating System is working with constant temperature and variable flowrate system.

The total heat demand of 2500 residences is 44 GWh/year (Residences heating + hot tap water supply). The annual

average geothermal water flowrate needed by the system is 70,54 L/sec.

It is necessary for the buildings that the radiator installation inside the residences has been done before being connected to the geothermal network.

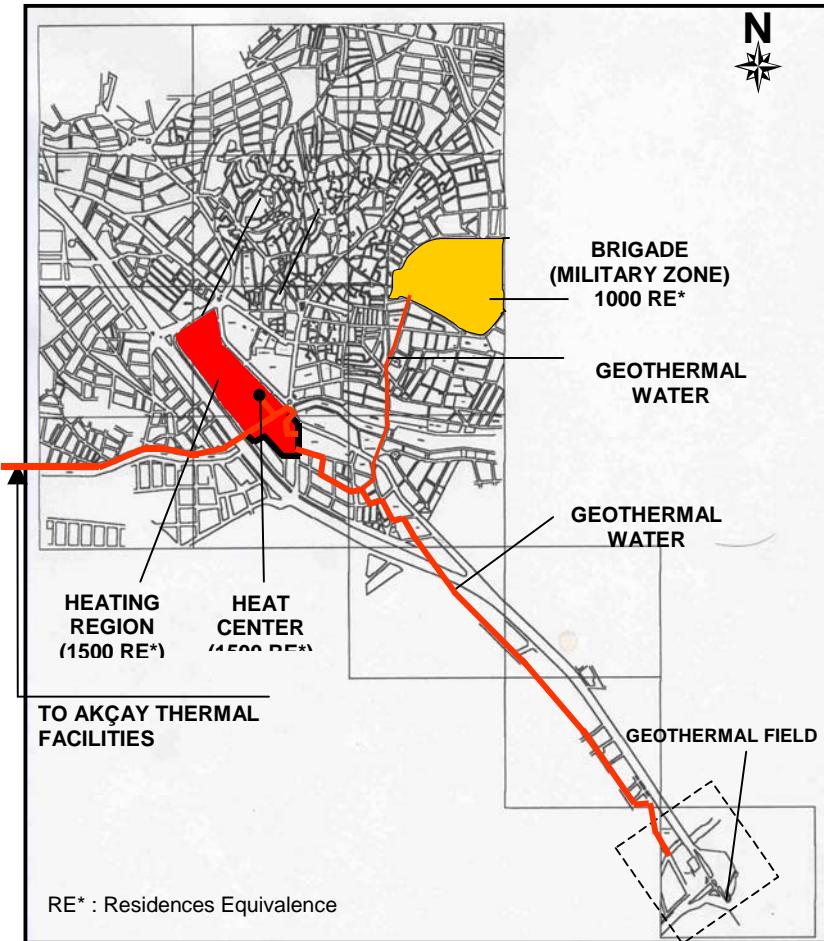
### 3.1 Construction and Development of the System

Geothermal water transportation and re-injection pipe line between the geothermal field and the heat center (city) will be constructed by planning the whole system capacity of the project which is 7,500 Residences Equivalence. The other parts and the equipments are planned with modular growth, as the consumers will integrate to the system with the time. In this way the system will start to operate with a minimum cost while it will reach its target capacity of 7,500 Residences Equivalence in the future. This contributes to the economical realization of the investment.

The installed capacities of the system are shown in Table 1.

Table 1: The installed capacities of Edremit Geothermal District Heating system

	Installed Capacity for 2500 residences equivalence (1 <sup>st</sup> stage)
<b>RESIDENCES</b>	17,150 kW
<b>City Heating Center secondary cycle</b>	17,340 kW
<b>City Heating Center Peaking System</b>	6,035 kW
<b>City Heating Center geothermal energy system</b>	11,305 kW



**Figure 2: Planned geothermal district heating areas in Edremit City.**

This investment also includes thermal water supply for balneological utilization to the facilities in Akcay City located at the Aegean Sea coast. There are 21 Hotels, which will use thermal water in Akcay region for balneological purposes. So the actual tourism season will be longer and the number of the customers (tourists) will increase.

Figure 2 shows the planned geothermal heating areas in Edremit geothermal district heating system.

The outside design temperature of the system is 0°C. The total heat load during the winter season is met from the geothermal energy. Principally, the geothermal water is transported to the city center.

The total number of the days of geothermal district heating is 222 days per year.

#### 4. ECONOMICAL AND FINANCIAL EVALUATION

Geothermal district heating systems are very economic comparing with the other conventional fuel heating systems in Turkey. Also the demand for geothermal district heating systems increases continuously by the individual residences, apartment buildings, official and commercial building (hotel, business center, etc) owners because it is environmentally benign and reliable (No fire, explosion and poisoning risk) during natural disasters and brings comfort.

The cost of heat energy in the 2500 residences equivalency Edremit geothermal district heating system which could be

increased to 7500 residences is 1.6 \$Cent/kWh. The cost of the same service with fuel oil is 4 \$Cent/kWh and with natural gas is 3.5 \$Cent/kWh.

The monetary equivalence of the substituted fuel by heating of 2500 residences geothermally in Edremit City is shown in Table 2.

**Table 2: Financial contribution gained from heating of 2500 residences equivalency geothermal district heating system (Oct. 2003)**

Type of Fuel	Fuel Substitution Per Year	Monetary Equivalence of the Substituted Fuel (USD/Year)
Fuel Oil	4,806 ton/year	2,643,300
Imported Coal	7,262 ton/year	1,113,507
Domestic Coal	11,443 ton/year	1,449,447
Electricity	44,444,444 kWh/year	4,632,415
Fuel-oil (No 6)	5,011 ton/year	1,291,017
Natural Gas	5,029,000 m <sup>3</sup> /year	1,254,733

The citizens are paying 1595 US\$ per residence (100 m<sup>2</sup>) according to a suitable installment plan to pre-finance the investment.

The total investment amount of the 1<sup>st</sup> stage (2500 residences geothermal heating) is 4,7 Million US\$. The payback period of the investment is 5,4 years.

Residences heating with geothermal energy are 50-75 % cheaper than heating with natural gas (TGA, 2004)

## 5. ENVIRONMENTAL EFFECT

According to the calculations, the decrease in the CO<sub>2</sub> emission value will be 15,483 ton/year comparing with petroleum equivalence energy substitute. In other words it is equal to cancel 8,794 vehicles from the traffic (as peak emission amount in December-January) in Edremit.

Geothermal water will be re-injected to the reservoir by means of re-injection wells and will not be discharged to the environment and reservoir parameters will be prevented.

## 6. SOCIAL EFFECTS

Geothermal district heating system will supply continuously heat to the consumers during the winter season and domestic hot water during the whole year.

These two cases will bring comfort and increase the living standard of Edremit citizens.

Especially in winter, there is a rise in stove ash and this pollutes the environment. With running of Edremit geothermal district heating system the environmental pollutants will be prevented.

According to our experience so far today, the popularity of geothermally heated buildings is increasing. This is recognized by observing the increment of the flat sale/rent prices.

Furthermore, educated staff and firms will do central heating and domestic water installation. So, this will constitute a new business sector and serious employment opportunity in this area. This will continue for a long period if we take central heating installation maintenance works into account.

## 7. RESULTS

For the last recent time, coal or other fossil types are used for heating during winter season. This case, which becomes a critical level for human health had caused air pollution. Using imported coal and natural gas reduced this level. But, harmful chemicals such as CO<sub>2</sub>, NO<sub>x</sub>, SO<sub>x</sub> have been still polluted air and have been causing global green house effect.

The geological, hydrogeological, geochemical and geophysical properties of Edremit geothermal field shows adequate geothermal potential for 7500 residences equivalence geothermal district heating and balneological utilization (2000 bed capacity).

Serious employment will be provided to Edremit citizens during the construction phase of the system and also during radiator and domestic hot water preparation installations inside the buildings.

Consumer's income will rise because of paying less for heating if compared to other fossil fuel types. This will contribute to consumers budget directly.

It is very important that drilling of the additional production and reinjection wells is continuing for further development of the Edremit Geothermal District Heating System.

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