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Determination of Heating Potential with Geothermal Energy in Greenhouses in Kırklareli Province

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Abstract

The most important variable in ensuring production independent of climate conditions in greenhouses is the provision of heating facilities. Especially in conditions where the air temperature is low, the desired temperature must be provided in the greenhouse for optimum plant development. In addition, the high cost of heating facilities has caused greenhouse farming to remain limited in some of our regions. In this respect, the provision of heating facilities provided by natural resources has become important in terms of the regional spread of greenhouse farming. Sustainable and low-cost heating facilities can be used without harming the environment by using natural resources in greenhouses. In this study, the development of heating facilities with geothermal resources in Kırklareli province, where greenhouse farming is not very developed, was investigated. In this context, potential geothermal resources in Kırklareli province were investigated within the scope of the literature and the heating potentials of the obtained geothermal resources were revealed. In the study, the potential for use of the newly found geothermal energy source in the Kırklareli - Asılbeyli region was revealed. Within the scope of this potential, the current status of greenhouse activities in Kırklareli province was determined in terms of heating with geothermal resources. With the research conducted, it can be concluded that greenhouse farming has a development potential with the increase in studies on finding existing geothermal resources in Kırklareli province. In addition, further research on heating greenhouse activities with natural resources in the region will have a positive impact on greenhouse-based production. The results obtained have shown that production in greenhouses using geothermal resources in Kırklareli province will contribute to the development of greenhouse farming in the province.

Key Words: *Greenhouse, Geothermal energy, Greenhouse Air Conditioning, Heating, Kırklareli.*

Introduction

Greenhouses are facilities where suitable environments for plant cultivation are created by controlling the environmental conditions depending on the climate. Creating optimum conditions in the greenhouse is only possible by equipping the greenhouses with systems such as heating, cooling, lighting, ventilation and humidification. Today, cultivation is carried out in automatic and fully controlled greenhouses in countries with cool climate zones such as England and the Netherlands. In countries with temperate climate zones, including our country, greenhouse cultivation has developed depending on ecological conditions (Tüzel et al., 2010).

The most important variable in ensuring production in greenhouses independent of climate conditions is the provision of heating facilities. Especially in conditions with low air temperatures, the desired temperature inside the greenhouse must be provided for optimum plant development. In this respect, temperature is one of the most important elements of the climate to be created inside the greenhouse. It is a known fact that every 10 °C increase in the temperature inside the greenhouse increases plant development approximately two-fold, provided that the other elements that make up the greenhouse climate are also at appropriate values and that the highest temperature allowed for the plant being grown is not exceeded (Yağcıoğlu, 2005).

The desired level of cultivation in greenhouses can be achieved by providing the desired conditions for the plants in the greenhouse. The purpose of heating, which has an important place in greenhouse air conditioning, is to increase yield and quality by successfully using heating systems to create the temperature desired by the plants in the greenhouse during cold times. One of the most important inputs of production in greenhouses is heating. Heating costs constitute 60% of all costs in the greenhouse. (Harzadın, 1994).

In greenhouse heating, some factors should be taken into consideration in terms of plant cultivation. The critical factor in the effectiveness of the heating system is not the air temperature inside the greenhouse, but the leaf and root temperature of the plant. The photosynthetic activity of the plant depends not only on the leaf temperature but

also on the speed and direction of air flow. The heat balance of the plant canopy also depends on the root temperature. It is possible to affect the air temperature by changing the root temperature (Gül et al., 1994).
One of the most important inputs in greenhouse production is heating. Heating costs constitute 60% of all greenhouse costs. Heating is done in very few greenhouses in our country. In most greenhouses, heating is done for a very limited time as a frost protection measure. Not heating greenhouses reduces yield, but it is possible to get products at certain times when the price is not high, hormone use for fertilization is difficult and therefore unhealthy products are produced (Harzadın, 1994).

Heating systems that can be used in greenhouses can be classified under different names. These heating systems are named as stove heating, central heating, hot air heating, heat pump heating, solar energy heating and geothermal energy heating. (Yağcıoğlu, 2005;Günay, 1999).

Among the renewable energy sources, geothermal, which is one of the most important, offers many benefits, like other renewable energy sources, to the energy sector and therefore to the countries. According to one definition, geothermal energy is a type of energy that is formed when the heat formed under the earth's crust heats the underground waters and then this water rises to the surface (Çukurçayır and Sağır, 2008). Geothermal energy is a type of energy that is difficult to consume, provided that it is used correctly. On the other hand, it is easy to detect and produce. It is also low-cost and the investment returns in a short time. It is also less harmful to the environment compared to other sources. Due to all these features, it is preferred not only in electricity production but also in different areas of the industry, in the health sector, in agriculture and tourism sectors, which are different but support each other (Külekçi, 2009).

Our country ranks 1st in Europe and 7th in the world in terms of geothermal energy potential with 31,500 MWt. As of 2004, we have only been able to benefit from 3-3.5% of this potential. Turkey ranks 5th in the world with 992 MWt in terms of direct use applications such as regional heating, greenhouse heating and thermal spring utilization (Dağdaş, 2004).

In the first studies on the use of geothermal resources in greenhouse heating, the use of fluids with a temperature of at least 60 °C was recommended. Later, it was determined that this lower limit was sufficient to be 20 - 25 °C. For example, it is known that projects using geothermal waters with a temperature of 40 °C in Italy, 34 °C in Greece, and 52 °C in Czechoslovakia have yielded quite successful results. In Israel, geothermal waters with a temperature of 30 - 60 °C are used for greenhouse heating in the winter, while some of these resources are also used for irrigation in the summer. In Sivas, it has been shown that greenhouse heating by circulating hot water with a temperature of 46 °C in plastic pipes located above and below the ground is sufficient for plant production (Kasap et al., 1990).

In this study, the development of heating opportunities with geothermal resources in Kırklareli province, where greenhouse farming has not shown much development, has been investigated. In this context, potential geothermal resources in Kırklareli province have been investigated. The heating potentials of the obtained geothermal resources have been revealed. In the study, the potential use of the newly found geothermal energy source in the Kırklareli Asılbeyli region has been revealed. Within the scope of this potential, the potential that can be heated with geothermal resources has been determined within the scope of the literature within the scope of the current situation of greenhouse farming in Kırklareli province. With the research, it can be concluded that greenhouse farming has a development potential with the increase in the studies on finding the existing geothermal resources in Kırklareli province. In addition, conducting more and detailed studies on heating greenhouse farming studies with natural resources in the region will have positive effects on greenhouse-based production. According to the results obtained within the scope of the literature, it has been seen that production in greenhouses by utilizing geothermal resources in Kırklareli province will contribute to the development of greenhouse farming in the province.

Materials and Methods

The research investigated the possibilities of developing heating opportunities with geothermal resources in Kırklareli province, where greenhouse farming has not shown much development. In this context, potential geothermal resources in Kırklareli province were investigated. The geographical location of the research area Kırklareli province is given in Figure 1.

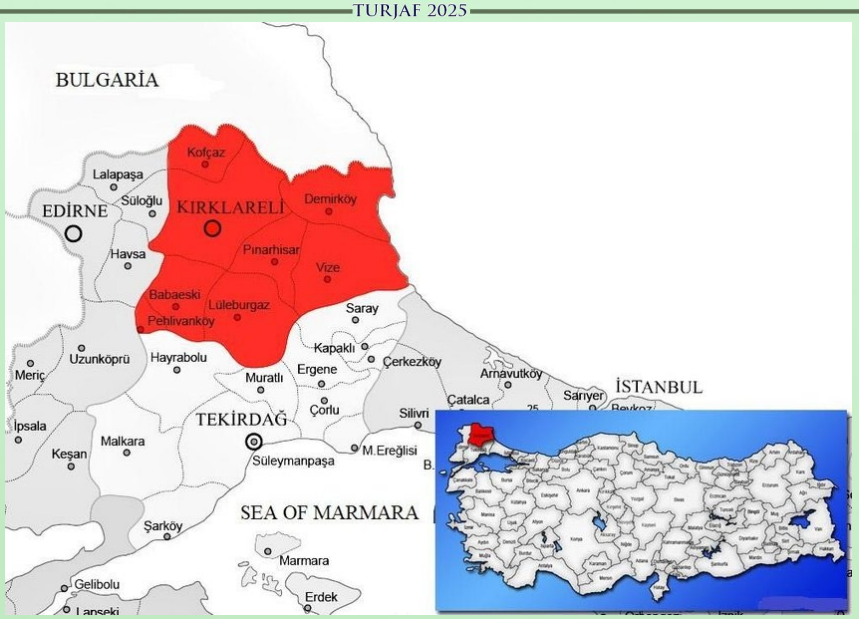

Figure 1. Research area

Kırklareli is located in the Thrace Region of Turkey and the annual average temperature is determined as 13.4 °C. The average sunshine duration is 4.6 hours and the average number of rainy days is determined as 98.6 days. When the maximum temperature values are examined, it is seen that the lowest temperature is -15.6 °C and the highest temperature is 42.5 °C. (MGM, 2025) The climatic values of the region are given in Table 1.

Table 1. Climatic values of Kırklareli province (MGM, 2025)

Kırklarelı/Months	1	2	3	4	5	6	7	8	9	10	11	12	Annual
Average Temperature (°C)	3,0	4,2	6,9	12,1	17,1	21,5	23,9	23,7	19,4	14,1	9,3	5,2	13.4
Average Highest Temperature (°C)	6,9	8,7	12,2	18,0	23,0	28,1	30,7	30,7	26,2	20,0	13,9	8,8	19,0
Average Minimum Temperature (°C)	0,1	1,0	3,0	7,2	11,6	15,6	17,9	17,8	14,1	9,9	5,9	2,4	8.9
Average Sunbathing Time (hours)	2,0	2,6	3,6	4,8	6,4	7,0	7,6	7,6	5,6	4,0	2,7	1,8	4,6
Average Number of Rainy Days	11,05	9,05	9,26	10,33	10,00	8,58	4,71	3,59	4,85	6,91	8,55	11,29	98.2
Highest Temperature (°C)	18,9	23,1	25,7	31,5	36,0	40,4	42,5	40,4	38,8	37,4	28,9	21,6	42.5
Lowest Temperature (°C)	-15,8	-15,0	-11,8	-3,0	1,4	5,8	8,8	8,7	3,0	-3,4	-7,2	-11,1	-15.8

Results and Discussion

When the greenhouse presence of Kırklareli province is examined, it is seen that greenhouses with plastic covers come to the forefront according to the covering material. Although there are no glass greenhouses, when the data of the last 20 years are examined, it is seen that the amount of greenhouses with plastic covering material has increased approximately 20 times. (TÜİK, 2025) The greenhouse amounts of Kırklareli province in the last 20 years are given in Figure 2.

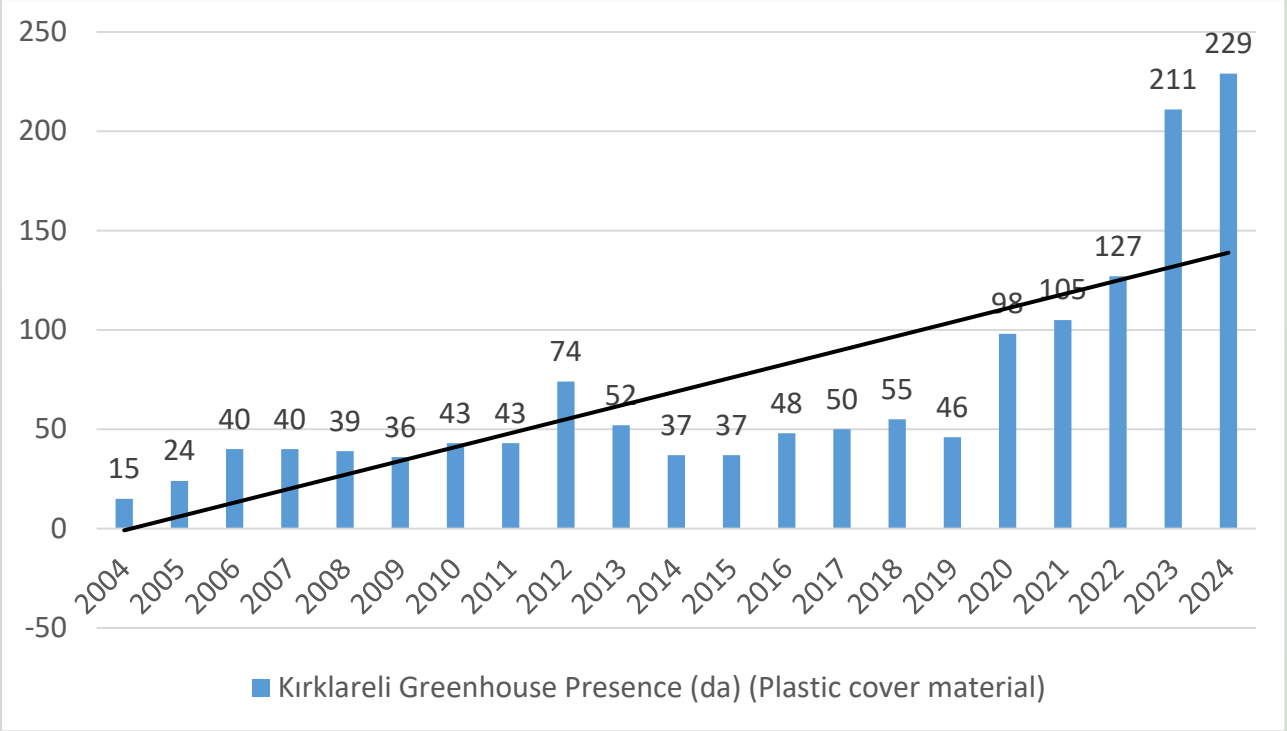

Figure 2. Greenhouse presence in Kırklareli province

Within the scope of the research, in order to determine the geothermal energy capacity in the region, research was conducted from many sources such as the Ministry of Energy and Natural Resources, Mineral Research and Exploration (MTA), Energy institutes and organizations. An existing geothermal energy potential was found in Asilbeyli Village, which is affiliated to the central district of Kırklareli province. (MTA, 2017-a). The people of Asilbeyli, which is 6 km away from the city center, generally work in agricultural areas. The area with potential geothermal energy is given in Figure 3.

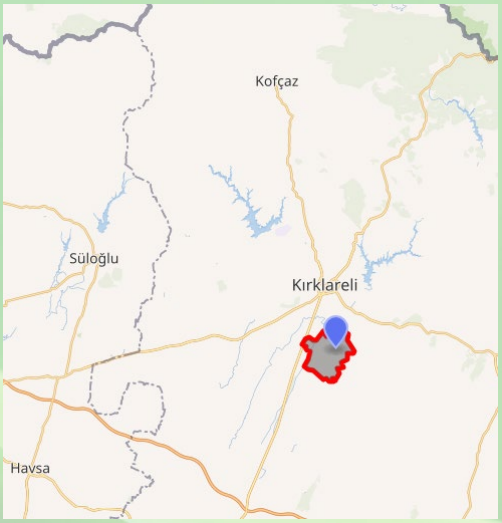

Figure 3. Potential geothermal energy field of Kırklareli province

The depth of the geothermal reservoir in the region is 1500 m. According to well test data, the maximum well static temperature is 74.38 °C at 1476 meters. According to the water loss test, the reservoir level is approximately 1100-1200 meters, which shows that the temperature is between 55 °C and 64 °C. The energy potential of the well is suitable for direct use applications such as home heating, greenhouse farming and thermal tourism. (MTA, 2017-a).

According to the data obtained as a result of the studies carried out in the first stage, the well has an energy potential of 2.38 MWt (MW thermal). Since Kırklareli has an important agricultural production, using this resource in

agricultural production in a reliable and environmentally friendly manner will be one of the best evaluation methods. (MTA, 2017-b).

In terms of using geothermal energy in greenhouse heating, it is aimed to find an optimum value in terms of flow rate with water inlet-outlet and pipe-environment equation combinations. As a result of the studies carried out in this context, greenhouses can be heated in an area of approximately 15 decares according to the thermal energy potential of the well in the region (MTA, 2017-b). This rate is approximately 20% of the plastic greenhouse assets of Kırklareli province. (TÜİK, 2025). This amount may vary with the type of greenhouse, the cover material used in greenhouses, the climatic requirements of the agricultural products to be grown and the detailed determination of the greenhouse heating needs.

Conclusion

Within the scope of the research, it has been seen that it is possible to use geothermal energy in greenhouse heating in Kırklareli province in the light of the literature. According to the current data and initial studies, the geothermal resource in the region can be used in a greenhouse of approximately 15 decares. This amount may vary depending on the product to be grown, the type of greenhouse and the new resources that may be found in the future. This situation may accelerate the development of greenhouse farming in Kırklareli province. The availability of geothermal energy in the region will also increase the use of different renewable energy resources. The use of geothermal energy will positively contribute to the design of greenhouse heating systems that integrate wind and solar energy. It will positively contribute to the development of the region and employment conditions. The decrease in cost with the use of geothermal resources, which is a renewable energy, in greenhouses will be positively reflected in food prices.

As a result, it can be said that the discovery of a new geothermal source in the province of Kırklareli will have a positive effect on the development of greenhouse farming in the region. In this context, considering the potential of finding new geothermal sources in the future, it is recommended to increase the development of geothermal heating systems in greenhouses. Optimum use of geothermal energy according to the plant requirements to be grown in greenhouses, calculation of system capacities and creation of the most appropriate architectural design for the region will accelerate the development of greenhouse farming.

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