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PRESENT STATUS AND FUTURE PROSPECTS OF GEOTHERMAL ENERGY USE FOR GREENHOUSE HEATING IN TURKEY

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Abstract

In order to obtain the highest yield of the expected product are grown in greenhouses, it is necessary to heat the greenhouse during periods of low temperatures. Conditions of our country, heating costs are one of the most important factors affecting the profitability of the greenhouse. Greenhouse heating costs vary depending on the product type, growing season and the region, accounted for 40% and 80% of the total cost. Due to the high costs of fossil fuels used for heating greenhouses heating applications cannot be done on a regular in many greenhouse of our country, heating is done only to protect plants from frost. Greenhouse heating applications, utilization of alternative energy sources instead of fossil energy sources is a priority need in order to today's energy assets and to protect the environment. In this study; current situation and problems of geothermal greenhouses in Turkey were assessed and the necessary suggestions were made to improve the utilization of geothermal resources in the greenhouse heating.

Key words*: geothermal energy, greenhouse heating, strategy development.*

INTRODUCTION

In the world of today's industry, the usage of energy and energy resources have crucial value. While the amount of natural resources (especially, fossil fuel resources) has been decreasing, the damage to the natural environment as many type of environmental pollutions has been increasing. Additionally, the technical improvements for the energy conversion can not be carried out as effective as needed. In order to determine the level of future energy production and consumption in developed and developing countries, there are many factors to be considered, such as population growth, economic productivity, consumer habits and technological advances. The style of energy sectors management will play an important role for the future of energy production, consumption and distribution. Careless use of energy resources and their scarcity, resulting unwanted side effects, so energy consumption must be planned and evaluated carefully and accurately.

Geothermal energy is of vital importance in terms of preventing environmental problems like greenhouse effects and acid rains arising from using and consuming fossil fuels. This is primarily because of natural superiority of geothermal energy as of environment when compared with other energy types. On the other hand, important developments have been achieved in terms of solving possible environmental problems that could occur as a result of geothermal energy use. This, in turn increased the importance of geothermal energy with regards to environment. Geothermal energy being one of our domestic resources must be evaluated in preference to other resources in order to decrease the dependency to petroleum in meeting our country's gap in energy and to prevent foreign currency loss. Geothermal energy is an inexhaustible energy resource as others like hydraulic, solar and wind energy resources. For that reason, when compared with fossil energy resources that are certainly exhaustible, geothermal energy resources are long-lasting and inexhaustible energy resources.

Bertani (2016) has analyzed the major activities carried out for geothermal electricity generation An increase of about 1.8 GW in the five year term 2010-2015 has been achieved (about 17%), following the rough standard linear trend of approximately 350 MW/year. Lund and Boyd (2015) reviewed the worldwide applications of geothermal energy for direct utilization. The report is based on country

update papers received from 70 countries and regions of which 65 reported some direct utilization of geothermal energy. The thermal energy used is 592.638 TJ/year (164.635 GWh/year), about a 39.8% increase over 2010, growing at a compound rate of 6.9% annually. The distribution of thermal energy used by category is approximately 55.2% for ground-source heat pumps, 20.2% for bathing and swimming (including balneology), 15% for space heating (of which 89% is for district heating), 4.9% for greenhouses and open ground heating, 2.0% for aquaculture pond and raceway heating, 1.8% for industrial process heating, 0.4% for snow melting and cooling, 0.3% for agricultural drying, and 0.2% for other uses. Energy savings amounted to 352 million barrels (52.8 million tons) of equivalent oil annually, preventing 46.1 million tons of carbon and 149.1 million tons of CO_2 being released to the atmosphere, this includes savings for geothermal heat pumps in the cooling mode (compared to using fuel oil to generate electricity). Considerable work has been conducted on geothermal fields in Turkey and the application of geothermal energy for district heating with respect to efficient and economic use of energy for sustainable development (Mertoglu et al., 2003). Comprehensive studies have been performed on geothermal energy use in agricultural production systems. Greenhouse heating with geothermal energy has been investigated by several authors (Rafferty 1986; Popovski 1988; Bakos et al., 1999; Popovski and Vasilevska, 2003). Optimization of geothermal energy use in agriculture is reflected in two ways, i.e. an increase in productivity at the existing level of energy inputs or conserving the energy without affecting the productivity. In many studies the influence of the direct energy input on energy efficiency was analyzed. Few publications have dealt with the problems related to geothermal energy use in greenhouses. Therefore, in the present study the present status and future prospect were analyzed to develop the geothermal energy use in greenhouse cultivation.

In greenhouse heating applications, using alternative energy resources rather than fossil energy resources is a primary necessity for conserving our energy wealth and preventing the environmental pollution. Some of the alternative energy resources that are used in greenhouse heating are; solar energy, geothermal energy and low temperature heat energy from the wastes of industrial facilities. In this study, the existing situation and problems of geothermal greenhouses in Turkey were evaluated and necessary proposals were given to increase the use of geothermal energy resources in greenhouses.

GEOTHERMAL ENERGY AND GREENHOUSE SECTOR IN TURKEY

Geothermal Energy Potential of Turkey

Turkey is located in the Alpine-Himalayan organic belt is an important region in terms of geothermal resources. In terms of geothermal resources, it is among the first seven countries in the world. Due to its location on Alpine Tectonic Zone, Turkey has a significant potential for geothermal energy. Our country is on the very effective zone in the point of tectonic with graben in the west, basin regime in the middle, compressive tectonic in east and North Anatolian Fault in the north. As a result of fracture and weakness zones and magma actions that reach from these zones to the shallow depths within the shell and/or the surface of earth, magmatic and volcanic events occur. Geothermal systems are developing with the help of geological and meteorological phenomena as a geothermal fluid. Theoretical and determined geothermal energy potential in our country are summarized in Table 1.

Table 1. Potential of Turkey's Geothermal Energy (Ozturk, 2015)

Energy	Theoretical potential	Determined potential
Electricity	4 500	200
Thermal energy	31 100	2 250

The areas containing high-temperature geothermal fluids are located in the west part of Turkey due to the grabens resulting the young tectonic activities. With the effect of volcanism and faulting low and medium temperature fields are located Central Anatolia, Eastern Anatolia and north side of Turkey with the North Anatolian Fault.

Geothermal Energy Use

Although it varies depending on the fluid temperature and regions conditions, geothermal energy use can be examined under two general categories:

1) Electricity generation
2) Direct use of geothermal energy

Heat exchanger systems, as wellhead and borehole heat exchangers, can vary in design depending on the area of the feature. The efficiency, continuity or success of the heating system is based on used accordance with technology. Geothermal water that contains chemical materials at a level causing them not to be directly used and whose heat exchangers and heat energies are transferred into supply network water clean enough to utilize, should be removed from the surroundings in order to avoid environmental pollution.

The benefits provided by the direct use of geothermal energy are:

- ✓ Conversion efficiency is high.
- ✓ Can be utilized in low temperature geothermal resources.
- ✓ Can be utilized from wells for research purposes
- ✓ Project implementation period is short.
- ✓ Drilling costs are cheaper in shallow depths.
- ✓ Geothermal fluid can be transported to long distances.

Depending on the geothermal fluid's chemical properties, heating systems show significant differences. If geothermal fluid does not cause problems as chemical content property, it can be used directly circulated through radiators and proper pipes system in radiator surface. However, if the fluid contains too much minerals and is likely to cause chemical problems (scaling, corrosion and so on), heat of the fluid is transferred to water with low chemical content (water used in city supply networks) via heat exchanger. Thus, the heating provided by the heated water does not cause problems in the system.

The direct use of geothermal energy can be divided into four groups:

1) Housing and workplaces
2) Industrial applications
3) Agriculture and related fields
4) Thermal and health tourism

Greenhouse Sector in Turkey

Greenhouse sector requires high investment and industrial activity. According to TurkStat data (TUİK, 2016), in Turkey in 2015, it has a total of 66,400 hectares of greenhouse area. Total greenhouse area of 30,900 hectares of plastic greenhouses, constitutes 8097 hectares of glass greenhouses. Greenhouse areas are more concentrated in southern provinces. The biggest reason is that southern provinces are warmer than in other cities in the winter. According to the Greenhouse Registration System (OKS), in Turkey, 48% of the greenhouse enterprises have the areas between 2-3 acres in 2013. The ratio of the greenhouse enterprises that have area more than 10 acres is only 1.8%. There are 9000 acres of greenhouses with modern conditions. In modern greenhouses, the average size is 27 acres (Ozturk et al., 2015).

A significant portion of the crops grown in greenhouses are the vegetables (95%) and the least portion is constituted by the fruits (5%). Between the vegetable species that grown in greenhouses, tomato production takes first place with the amount of 50%; cucumber, watermelon, green pepper and eggplant follow it. Production share of other vegetables such as melon, bean, zucchini and lettuce is gradually increasing. The most important type of vegetable, cultivation in low plastic tunnels is watermelon. In our countries greenhouse agriculture, widely produced fruits are banana, strawberry, grapes and nectarines. Cut flower production is increasing rapidly in Turkey and it is made in the regions of Marmara, Aegean and Mediterranean. In Turkey, with the 6.5 million tons of greenhouse production, 10 million TL GDP was provided in 2014 (Ozturk and et al., 2015).

GEOTHERMAL ENERGY USE FOR GREENHOUSE HEATING IN TURKEY

The Importance of Geothermal Energy in Heating Greenhouses

To provide optimal environmental conditions in terms of quality, quantity and development time of the products grown in greenhouses, mainly used for the out-of-season produce, it is required heating in the winter's cold period and ventilation in summer's hot period. Keeping

under control the ambient temperature, that has an effect mainly on the yield and quality of plant growth and development, is an important factor in greenhouse technology. To obtain maximum yield expected from the products cultivated in greenhouses, it is necessary to heat the greenhouse during periods of low temperatures. Even though it is required excess quantity of energy to heat the greenhouses in winter and summer seasons in Northern European countries, only the needed heating applications are not made enough during cold winter nights due to the suitable ecological conditions at most of the Mediterranean countries. In this case, negations are encountered, regarding the quality, quantity and harvest time of the product.

By controlling the climate conditions, it made greenhouse to spread wider in a year when the agricultural production process is the most important issue in the production of heating. In our countries conditions, heating costs are one of the most important factors affecting the profitability of the greenhouse. In greenhouse enterprises, heating costs depend on growing season, region and product type and they constitute 40% to 80% of the total cost (Ozturk, 2015). Due to the high costs of fossil fuels used for heating greenhouses, a regular heating can't be done in many greenhouses in the our country and the protecting plants from frost heating is only done. Not to be done regularly heating bring some concerns together such as low yield, limitations on the types of production, necessity of using drugs and hormones for agricultural struggle. However, a sufficient heating yield to provide the temperature at which the plant needs can increase by 50-60%. For this reason, in heated greenhouses using geothermal energy, required temperature is provided more economically for plant growth and fertilization and the relative humidity of greenhouse indoor air is controlled with the necessary ventilation, diseases can't occur and yield can increase.

According to the Ninth Development Plan (2007-2013) Mining Special Commission Energy Raw Materials Subcommittee of the Geothermal Working Group Report, including existing state and 2013 projections about Turkey's geothermal electricity generation and geothermal heating, it is stated that a qualification of geothermal energy to be emphasized in particular. In the same report, it is indicated that the use of geothermal energy for electricity generation is limited yet and there has been a steady increase in consumption for heating purposes in recent years, so 635 acres of geothermal heated greenhouse presence, has been targeted as 5000 acres in 2013. But according to the Ministry of Food, Agriculture and Livestock Protected Registration System (OCS), as of September 2013, Turkey's geothermal greenhouse uses of assets has reached to a total of 3202 hectares in 10 provinces. Although increased significantly in recent years, but reached the 64% of the target.

In Tenth Development Plan (2014-2018) Mining Special Commission Geothermal Working Group Report, greenhouse warming target is determined as 600 hectares for 2018 and 1500 hectares for 2023. The use of geothermal resources for heating in greenhouses has to be addressed as an innovation that provides economic and environmental benefits for the agricultural sector. The process of adoption of innovation is a multivariate and complicated process related on the one hand with innovation and on the other hand the systems and individuals that used the innovation. Before studies will be launched to increase the geothermal greenhouse area, first individual characteristics and resources of the target audience, its communication channels, time and social environment to be examined when considering. Besides, increases in national and international food prices increased transfers of the capital from non-agricultural sector to agriculture sector by reversing the situation. In addition, growing interest to the alternative energy resources made geothermal greenhouse investments attractive, especially using modern production technology (hydroponics etc.). Environment, making an agricultural production that does not harm human and animal health, preservation of natural resources, traceability and sustainability and manpower using knowledge in greenhouse activities for ensure reliable product supply has become the most important factor. However, investments initiated by parties who aren't making feasibility studies before starting

agricultural activities couldn't be reached to desired goals and leads to the formation of excess capacity for the country. To this end, education-extension and publicity studies and planning of human resources, that ensure required capacity at all parties from production to marketing, are required.

Greenhouse Areas Heated with Geothermal Energy in Turkey

Greenhouse heating applications made with geothermal energy in Europe began in Hungary and Yugoslavia in the 1960s. In our country, while heating greenhouses have gained great importance in the utilization of geothermal energy more effectively, applying technical and economic aspects are faced with some problems. Geothermal heating is one of the places where the most widely used of geothermal resources; geothermal greenhouse heating is becoming increasingly important in Turkey. Greenhouse heating system with geothermal energy was applied for the first time in Turkey in the 0.45 hectares areas of the Denizli-Kızıldere. To more accurately and efficiently take advantage of geothermal resources, low enthalpy will need to make use of advanced technology.

According to the 2013 OKS records in Turkey, greenhouses heated by geothermal energy fields are given in Table 2. In 10 provinces in 3202 decares area, is carried out under cover production using geothermal energy. Almost half of these areas are located in Izmir (24.48%) and Manisa (23.42%). While maximum business is located in Kutahya with 46 business, it is followed by Sanlıurfa and Denizli provinces with 26 business. As shown in Table 2, a very small part of the overall greenhouse is heated with geothermal energy in Turkey. While the value of apparent heat capacity that geothermal drilling issued is 3000 MW in 2002, it is reached to 7000 MW with an increase of 230% in 2012. A 10-year period between 2002-2012 years, our greenhouse space heated by geothermal energy has increased by 406% (Hasdemir et al., 2014).

Distance between geothermal resources and businesses vary too much between businesses. The most important factor in the transport of hot water is the temperature of resources. High temperature water can be used in heating by moving to longer distances. Hot water used for heating is used by bringing from the wells average 541 m away (Hasdemir et al., 2014). Greenhouse businesses use hot water from geothermal wells in heating by exchanger system or directly circulating in greenhouses. 67.21 % of greenhouse businesses use hot water directly and 32.79% of them use heat exchanger system (Hasdemir et al., 2014). Hot water taken into greenhouse largely use as a space heating on soil. Only one company was seen heating with underground pipes (Table 3).

Table 2. Greenhouse Areas Heated Through Geothermal Energy (Hasdemir et al., 2014)

Provinces	Number of business	Greenhouse area (da)	The ratio in total geothermal greenhouse area (%)
Afyon	6	358	11.18
Aydın	17	173	5.40
Denizli	26	456	14.24
İzmir	15	784	24.48
Kırşehir	1	97	3.03
Kütahya	46	125	3.90
Manisa	7	750	23.42
Nevsehir	1	61	1.91
Şanlıurfa	26	373	11.65
Yozgat	2	25	0.78

Table 3. Heating Systems in Greenhouses Heated with Geothermal Energy

Properties	Number of business	Ratio (%)
Direct heating	18	67.21
Heat exchanger use	40	32.79
Above ground heating system	121	99.18
Below ground heating system	1	0.82
Reinjection	21	17.21
Refiner	41	33.61
Dumping to the land	60	49.18

67.21 % of available geothermal resources have additional greenhouse warming potential. Despite the availability of geothermal fluid brought to surface, the reasons why the businesses cannot do additional greenhouses are stated by themselves as follows: 32.93 % for insufficiency of land, 29.27% for not being able to acquire official permit, 19.51% insufficiency of capital, 4.88% for high costs, 2.44 % for marketing problems, 1.22% insufficiency of workforce and technical reasons, 8.54% for other reasons.

RESULTS AND DISCUSSIONS

Legislation on Geothermal Resources Prioritizes Electricity Production

Due to problems that Turkey face in energy sector, the tendency is towards using local resources and for this reason certain subsidies and incentives were provided particularly in recent years to investors in these areas. In this context Article 6, Paragraph one of "*Law on the Use of Renewable Energy Resources for Electricity Production"* states that "For those who has the production license subject to Renewable Energy Resources Support Mechanism which are or will be in business from the enforcement of this law on 18/5/2005 to 31/12/2015, the prices annexed to this law in annex 1 as a chart will be applied for 10 years". This means that purchase of the energy produced by using renewable resources is guaranteed for 10 years. It is pledged in the document that the electricity produced through renewable resources is going to be purchased at the rates of 10.5 $cent/kWh, and for 13.2 $/kWh in cases where local manufacturing is utilized (Ozturk, 2015).

Additionally, due to the fact that licenses are provided for a limited period of 3+1 years and the high fluid temperatures figured after drilling creates a tendency in investors to launch Geothermal Energy Plants (GEP). Although there is no limitation for other areas, the uncertainties in these areas causes investors to steer their investments in electricity production. The investments are directed to electricity production because, when they want to use geothermal energy in greenhouse sector there is uncertainty in the number of people and the area that will utilize greenhouse sector; when they want to use it in household heating, there is the uncertainty of potential problems with local administrations and the people who will use it. Because that the GEP's in operation before end of 2015 will receive guaranteed purchases from the states, the owners of geothermal resources want to complete their energy investments before 2015. They plan their investments in other areas after completion of energy investments. When the temperatures of geothermal resources are not sufficient for energy production, they can be utilized in greenhouses. The owners of geothermal plants may use the remaining heating potential in greenhouses after energy production, if they wish to do so.

The Licensed Geothermal Areas

The biggest obstacle for geothermal resources to be used in greenhouses is that after a process of sale of geothermal areas through procurements, the owners and the people who would like to use these areas in greenhouses are different. The owners do not encounter problems when they would like to use the resources in greenhouses, however when others would like to use it the same way, they are either reluctant to give these for greenhousing or they sell it for too high prices. Because that geothermal investments are in abundance and the number of people who will perform greenhouse sector or that the areas where greenhouses are established are separated increasing costs of deploying geothermal energy makes it further difficult to use in greenhouse sector. In cases where the greenhouses would be established collectively closer to the geothermal resources, the transfer of geothermal energy to these areas will be less costly and thus the owners approach may change. In this regard, the purchasers of geothermal plants need to know the proximity of those greenhouses of whose owners are willing to use geothermal heating in their greenhouses. This way it will be easier for owners of geothermal energy to calculate the annual operation costs and determine the price of energy for greenhouse sector. For this reason, the greenhouses should be collectively established near the geothermal resources.

When preparing the law for the use of geothermal resources in other areas, it is necessary to consider giving initiative to the local administrations close to geothermal resources to define priorities based on needs of the region and to give them the opportunity to utilize the geothermal resources. Even if there is a change in law now, this will be beneficial for the areas up for future procurement. In case there is no change in current law, introducing a provision in the contract of procurement for the use of geothermal energy in other areas would provide ground for more efficient utilization of the geothermal resources. There is currently no sanction or enforcement for the owners of the

plants to use geothermal energy other than electricity production. Another difficulty is the determination of the price per hectares of geothermal energy provided by the owners. If the pricing is not reasonable, this is a problem for geothermal greenhouse sector. Measures are necessary in order to determine the price of geothermal energy and to avoid future conflicts.

Due to the fact that the geothermal areas are licensed, the initiative to decide on where to use the energy is held by owners. It is necessary to allow the social use by local administrations of blocked areas which surround the geothermal resources for their protection. It is absolutely necessary to make changes for local communities to use the geothermal resources. It does not appear to be a fair process to preserve the use of these areas which were held by the state until today only to the use of renters.

Finding Land and Geothermal Resources for Greenhouses

As a result of the use of geothermal resources after the introduction of the legislation, the number of entrepreneurs willing to invest in this area is increasing. Entrepreneurs mostly face difficulties to find areas for and to use geothermal energy for greenhouses. Sometimes they find the area for greenhouse sector but cannot find the energy, and sometimes otherwise. Consequently, it is important to keep entrepreneurs in business by promoting geothermal energy owners in investing in other areas and in greenhouse sector through incentives, subsidies or low-interest credit opportunities.

The owners of geothermal resources may face problems in finding greenhouse areas when they want to invest themselves. This is because there is not enough land owned by state or available land is private properties. When they want to buy land for investing in greenhouse sector, the prices may raise up to 10 fold. This affects geothermal greenhouse sector negatively.

The Cost of Searching and Developing Geothermal Resources

The high costs of geothermal investments make it more difficult for it to be utilized in geothermal greenhouse sector. Due to the fact that the drill operations for geothermal resource searching is costly and that the cost of re-injection wells and re-injection is high, investors tend to lean towards geothermal power plants which have lower costs and quick returns. The heavy metals, particularly the phototoxic boron in plants, have negative consequences for the environment which increases the costs due to compulsory reinjection and this effects greenhouse sector negatively.

Greenhouse Costs

Costs of modern technological hydroponic culture greenhouses change depending on the technology used and the cover material. The costs of PC sided and PE roofed steel construction and computer controlled greenhouses starts from 50-60 €/m², and of steel construction glass greenhouses starts from 75-100 €/m² (Ozturk, 2015).

Because that the current modern hydroponic culture greenhouses in Turkey are imported or patented outside of the country and that almost all of automation systems are imported as well, the costs are high. Thus it is important to develop local technologies in greenhouse automation systems. The high costs of greenhouses effects greenhouse sector and hence geothermal greenhouse sector negatively.

Problems Arising from Agriculture based Specialization Organized Industry Zones

The best means of greenhouse sector is through the establishment of Agriculture Based Specialization Organized Industry Zones in terms of more efficient use of geothermal source, healthier production, monitoring potential of production and healthier organization of marketing. There are problems both in legal and local terms in establishment of these Zones. These problems also negatively influence geothermal greenhouse sector

Published in 10.10.2009 at the Official Gazette numbered 27402 “The Application Regulation on Establishment of Agriculture Based Specialization Organized Industry Zones” was executed by Ministry of Science Industry and Technology and Ministry of Agriculture and Rural Affairs later in 12/03/2012 by Ministry of Food Agriculture and Livestock. In order for

greenhouse sector to be performed in larger areas, the elimination of the rule regarding the requirement of 75% treasury land in which Zones to be established for greenhouse sector will pave the way for greenhouse sector effectively. However, the future of rural population whose lands are already expropriated is concerning.

Many producers in this situation will opt for migrating to cities in which they will encounter adaptation and economic problems. In this case, the high income groups will invest in greenhouse sector in these Zones. This is why the geothermal resources have to be planned in a way to positively influence the lives of local communities rather than negatively. In the regulation, people whose lands were expropriated should be given priority places in Zones. Because that these are small-scale family businesses, it is difficult for them to invest in greenhouses with their own assets, thus they should be provided with 7-10 years credit opportunities without repayment in the first 2-3 years or grants.

As a result of the developments in greenhouse sector in recent years, it is largely modern technology hydroponic culture greenhouse sector. When these modern greenhouses grow, the costs decrease. This is why, if there is a plan to establish such a greenhouse for economic investment the lower limit should be at least an area of 2-2.5 hectares. It is stated that for a Zone to be established there should be at least 50 hectares of land and 30 persons should be involved in the project.

For a modern greenhouse sector in Zones to be economically meaningful it is necessary either to increase the area of Zones required or to decrease the number of people required to be involved. It is necessary to determine the sizes of lands depending on the technology applied in greenhouses.

However, if there is hydroponic culture greenhouses in Zones than the greenhouses should be planned at the minimum 2-2.5 hectares. It is important to take into account the clear water and the geothermal resource to be utilized in greenhouses in the process of establishment.

Administration Shares of Facilities Utilizing Geothermal Energy

In the relevant law and regulations, it is stated that 1% equivalent of the gross production of those facilities directly or indirectly utilizing geothermal fluids or gasses stated in the Law will be collected as administrative cost. In this situation, 1% equivalent of the gross production of greenhouses utilizing geothermal energy will be paid as Special Administration cost. 1% equivalent is a considerably high payment for geothermal greenhouses. 1% equivalent payment should be for those businesses which utilize the geothermal resources directly and whose sole input is geothermal energy such as electricity production, CO_2 producer facilities. For those facilities utilizing geothermal energy as a secondary or tertiary source, 1% should either not be paid or decreased.

Turkish Development Law and the Law on Construction Inspection

Greenhouses are regulated under 'Turkish Development Law No. 3194' and subjected to license. While greenhouses without geothermal heating are subjected licensing process of Ministry of Food Agriculture and Livestock and State Hydraulic Works, the ones with greenhouse heating go through licensing process of below institutions:

1. Provincial Directorate of Culture and Tourism,
2. Provincial Directorate of Science, Industry and Technology,
3. Provincial Directorate of Food, Agriculture and Livestock,
4. State Hydraulic Works,
5. Provincial Directorate of Environment and Urbanization,
6. Special Provincial Directorate of Administration,
7. Electricity Distribution Company,
8. Provincial Gendarmerie Command
9. Directorate of Highways

Legal Status of Greenhouse Sector

New legal arrangements are needed to regulate the legal status of greenhouse sector also addressing all the aspects of it; from planning to construction and production.

This can be resolved through new regulations to be introduced by The Ministry of Food

Agriculture and Livestock. Other relevant Laws and Regulations applicable to this subject also should be revised.

Greenhouses should be in accordance with 1:100.000 scaled Provincial Environment Oder Plans and excluded from the scope of the *Development Law*. Greenhouses should be also exempted from the Law on Construction Inspection. These greenhouses should be classified as agricultural structures under the new regulations to be implemented and all pre-construction and post-construction works or inspections, including planning and authorization should be centralized under the mandate of a single authority. The best implementation approach for this matter would be centralizing all these processes under the mandate of the Ministry of Food Agriculture and Livestock.

Government Incentives Available for Geothermal Greenhouse Production

Modern greenhouse production systems are expected to face a rapid growth with increased use of technology which improves yield and profitability. In order to achieve the targets of agricultural sector in the future, appealing incentives are offered by the government for greenhouse investments in our country. Greenhouse production is the third biggest sector of our country in terms of food and agriculture investments prominent after livestock and dairy sector. In 2012, greenhouse production was listed as the most invested sector following livestock and other relevant sectors.

Despite the diverse geothermal capacity that our country possess, as a result of the insufficient levels of use, geothermal sector have been endorsed for incentives. In this regard applicable legal arrangements are as follows:

- The Communiqué on "Support for Agriculture Investments (No#2011/9)" published in the Official Gazette No#27871 dated 11.03.2011 within the scope of Support Programs for Rural Development Investments.
- "The Regulation Amending the Regulation on Pasture Land" promulgated in the Official Gazette No#27857 dated 28.02.2011.
- The Communiqué on "The Procedure and Principles to be Pursued Regarding Public Domain Allotments for Technology, Geothermal Greenhouses and Organic Farming Investments" published in the Official Gazette No#26511 dated 03.05.2007.
- The regulation for "Implementation of Agro-Industries and Organized Greenhouse Sites" published in the Official Gazette No#27402 dated 10.11.2009.
- "The General Communiqué on National Estate" published in the Official Gazette No#27211 dated 26.04.2009 (I/N: 324)
- "The General Communiqué on National Estate" published in the Official Gazette No#27901 dated 10.04.2011 (I/N: 335)
- "The Decree on Concerning State Aids in Investments" published in the Official Gazette No#27290 dated 16.07.2009.

Within the framework of "Support Program for Rural Development Investments", renewable energy integrated greenhouse investments projects with a budget up to 3 million at max are remunerated by 50% through Financial State Aids. Furthermore, within the scope of the National Real Estate General Communiqué (number:352) published in the Official Gazette No# 27211 dated 26/04/2009, state land are allocated for entrepreneurs that shall invest on geothermal greenhouse systems. Accordingly, with respect to the changes made on the Law on Pastures, pasture lands are also available for geothermal greenhouse investment allocations.

Technology Transfer in Geothermal Greenhouses in Turkey and Sources of Agricultural Extension Information

Technology transfer, extension and adoption of innovations in geothermal greenhouses in Turkey are realized through different extension methods such as agricultural extension programs, demonstrations, field days, farmer meetings, farmer courses, farmer examination trips, incentive competitions, conferences, panels, other similar activities and mass extension media produced to be used in these activities. The information sources that are effective in decision making processes of enterprises using and not using geothermal energy resources are classified in three groups. These information sources were determined as; informal sources like the producer himself, his neighbors or relative and formal sources like Provincial/District Agricultural Directorates, agricultural consultants and technical staff of

the enterprises and pesticide and fertilizer distributors that provide input to agriculture and the media organizations. While the enterprises that are using geothermal resources are using formal information sources, the enterprises not using geothermal resources are using informal information sources.

CONCLUSIONS

In accordance with the Protected Cropping Registry System of Ministry of Food Agriculture and Livestock, as of September 2013, total land allocated for protected cropping with geothermal heating in Turkey reached 3202 da in 10 different provinces. Although a significant increase can be noted in recent years, only 64% of the set targets could be achieved. As indicated in the report of Geothermal Working Group of Specialization Commission for Mining, under Tenth Development Plan (2014-2018); the target for geothermal greenhouse heating was determined as 600 ha for year 2018 and it was indicated as 1500 ha for year 2023. It is fundamental to consider geothermal greenhouse heating systems as an innovation that endeavor economic and environmental benefits for agriculture sector. The adoption process of innovation is while eminently related to the innovation itself it is also a sophisticated process encompassing the system that the innovation will be implemented and the users. Before implementing the work connected with the efforts to increase greenhouse areas with geothermal heating, it is essential to consider individual features of the target group and resources including communication channels, time and social environment.

Organized Greenhouse Sites offering cost-efficient, secure, traceable, competitive, modern and planned protected cropping with strong brand equity, clustered in regions which are rich in terms of geothermal resources (such as Afyonkarahisar, Aydın, Denizli, Diyarbakır, İzmir, Kırşehir, Konya, Kütahya, Manisa, Şanlıurfa and Yozgat) are aimed to be established. Having a geothermal capacity of 31,500 MW, Turkey possess enough resources in terms of reaching the targeted 600 ha of land for year 2018 and 1500 ha of geothermal heated greenhouse area for year 2023. However, said resources should be efficiently managed and strategies should be in place to ensure the establishment of sustainable geothermal greenhouses.

Making use of alternate energy resources instead of fossil fuels for greenhouse heating systems is a priority concern in terms of conserving the energy resources of today's World and preventing environmental pollution. In Turkey, although effective use of geothermal energy for greenhouse heating has become more important, there are still some tackles resulting from the implementation in terms of economic and technical aspects. As geothermal heating known as a common way of adopting geothermal resources, geothermal greenhouse heating has become significantly important in Turkey. Recycled liquid injected back into Geothermal Power Plants for reinjection can also be used for greenhouse heating and legal arrangements should be made in this regard. It is fundamental to consider geothermal energy resources as an innovation that endeavor economic and environmental benefits for agriculture sector.

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