Significant Progress of Geothermal Development Activities in Turkey - a Success Story

Orhan Mertoglu, Nilgun H. Basarir

Turkish Geothermal Association, Hosdere cad. 190/12, 06550 Çankaya/Ankara, Turkey

tjd@jeotermaldernegi.org.tr

Keywords: geothermal, direct use, electricty production, projections

ABSTRACT

First geothermal district heating system have been started in İzmir- Balçova Dokuz Eylül University Campus at 1983 in Turkey, and was followed by Balıkesir-Gönen in 1987 and Kütahya-Simav, Kırşehir, Afyon, Kızılcahamam-Ankara, Salihli, İzmir-Balçova, İzmir-Narlıdere, Kırşehir-Kozaklı, Sarikaya-Yozgat, Yerköy-Yozgat, Sorgun-Yozgat, Edremit-Balikesir and now Bursa Heating Project which is under construction.

Among the above mentioned geothermal district heating systems, the biggest one is built in İzmir-Balçova which has now 35.000 residences equivalence heating capacity.

According to the renewable energy law of Turkey, If the local goverrnorships and municipalities own geothermal resources they have to built and operate geothermal district heating systems.

According to Turkey's experience with geothermal district heating more then 20 years the geothermal selling price is 60 % cheaper than the natural gas equivalance.

Since 2010, the installed geothermal electricity capacity has reached 162,2 MWe (Aydin-Germencik, Aydin-Salavatli, Denizli-Saraykoy, Aydin-Hidirbeyli, Canakkale-Tuzla, and Aydin Hidirbeyli), which shows that the geothermal power production capacity has doubled in last 4 years.

1. INTRODUCTION

At the beginning of the Izmir Balcova Geothermal District Heating System investment, the company of governorship have started to built the geothermal district heating system and then operated about 7 years, and then the company have been converted to incorporated company with the partnership of equally partnership with the İzmir grand metropolitan municipality.

Geothermal district heating systems in Turkey have been owned mostly by local governorship and municipalities. Geothermal district heating systems are of interest for the municipalities and local governorships. But it is essential to have the relation and connection to the municipality.

Renewable Energy Law (No: 5346) was released in May 2005. With this law incentives to the rewable energy sources was given by different electricity buying prices. As it was amended in 2010 the incentives have been increased.

Law on Geothermal Resources and Natural Mineral Waters (3.06.2007, No: 5686,) and its Implementation Regulation (2007, No: 26727) providing prospecting license and operating license to the investors. Moreover, this law and regulations are providing solutions to the problems of legislative matters and obligations of the exploration and production concession rights, technical responsibility, control and protection of the geothermal areas.

The release of the geothermal law lead to increase geothermal electricity production, geothermal exploration and well drilling in Turkey for last 3-4 years.

With the release of the geothermal law, General Directorate of Mineral Research and Exploration has transferred the rights of the geothermal fields suitable for geothermal electricity production to the private sector in the form of operation licenses by means of tenders. The high temperature geothermal fields have been transferred between 6,5 – 110 Million USD selling prices to the Turkish Private Sector. Geothermal electricity production investments have been mostly realized by Turkish private sector in Turkey.

After the tendering process, the companies gave speed to exploration, development and drilling works of the geothermal fields, which let to explore more deeper geothermal reservoirs, especially in the Buyuk Menderes Graben.

The reason that the geothermal district heating systems have not gained a similar increase as the geothermal power production, is that there is not enough incentives applied for geothermal district

heating systems if compared to geothermal power production investments in Turkey.

Since 2010, the geothermal direct use applications in Turkey have increased by 30 % and the geothermal power production capacity has been increased by 100%.

2. DIRECT USE APPLICATIONS

The geothermal direct use applications (Table 1) with a total of 2705 MWt (as of the end of 2012) is the equivalence of 260.000 residences geothermal heating in Turkey. In 16 cities, the residences are heated geothermally in Turkey (partly) (Table 2).

The first geothermal greenhouse heating application has been started with 2000 m^2 in 1973 in Denizli-Kizildere under the United Nations Development Programme (UNDP). Since then, geothermal greenhouse heating applications have gained a rapid increase in terms of investment especially in the recent years. Especially in the last 3-5 years, this development has been achieved. The major greenhouse applications heated geothermally are as follows:

Izmir-Dikili,Bergama : 1,000,000 m^2

Manisa-Salihli,Urganli : 305,000 m^2

Kutahya-Simav : 310,000 m^2

Denizli-Kizildere-Tosunlar : 200,000m^2

Sanliurfa-Karaali : 474,000 m^2

Izmir-Balcova : 100,000 m^2

Table 1: Geothermal direct use applications and their capacities

GEOTHERMAL DIRECT USE APPLICATIONS	CAPACITY
GEOTHERMAL DISTRICT HEATING (CITY, RESIDENCES)	89443 Residences Equivalence **(805 MWT)**
GREENHOUSE HEATING	2.832.000 m^2 (612 MWt)
THERMAL FACILITIES HEATING	42.000 Residences Equivalence (380 MWt)
BALNEOLOGICAL USE	350 Spa, thermal facility (870 MWt) (Annual 16 million visitors)
GEOTHERMAL HEAT PUMP	38 MWt
TOTAL GEOTHERMAL HEAT USE	**2705 MWt (260.000 Residences Equivalence)**

If compared with the 2010 figures, the geothermal direct use capacity has increased by 30%.

Table 2: Some of the Geothermal district heating systems of Turkey

LOCATION	Number of residences Heated by Geothermal	Operation Date	Temp. of Geoth. Water (°C)	Investor
Izmir-Balçova-Narlidere	35000	1983	140	Equal partnership of Governorship and Municipality Inc.
Gönen	3400	1987	80	Mainly Municipality Inc.
Simav	7500	1991	125	Municipality
Kırşehir	1900	1994	57	Local Governorship (Mainly) + Municipality Inc.
K.Hamam	2500	1995	70	Mainly Municipality Inc.
Afyon	8000	1996	95	Local Governorship (Mainly) Municipality Inc.
Kozaklı	3000	1996	90	Mainly Municipality Inc.
Sandıklı	6000	1998	75	Mainly Municipality Inc.
Diyadin	570	1999	70	Mainly Local Governorship Inc.
Salihli	7292	2002	94	Municipality
Sarayköy	2200	2002	95	Municipality to PrivateSect.
Edremit	4881	2003	60	Municipality + Private Sector Inc. (%75)
Bigadiç	1500	2005	96	Municipality
Bergama	450	2008	65	Municipality Ltd. company
Güre	650	2009	65	Municipality
Sorgun	1500	2008	80	Municipality
Others*	3100			
TOTAL	**89443 RE****			

* There are other district heating systems with 3100 RE install capacity whereas the heating systems are not operational due to different reasons and are not included into the list.

**RE = Residence equivalent, 1 RE = 100 m^2

3. GEOTHERMAL ELECTRICITY PRODUCTION

With the release of the renewable energy law and the geothermal law, the geothermal power production capacity has increased about 100 % since 2009.

Geothermal electricity production investments have been increased rapidly to 162,2 MWe since 2009 (Figure 1).

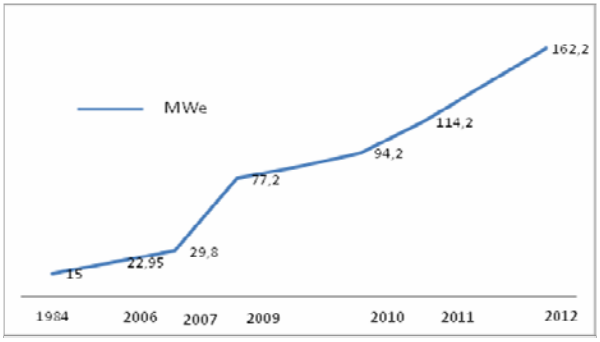

Figure 1: Increase of geothermal power install capacities in Turkey

Except Çanakkale Tuzla geothermal power plant, all other power plants are located at the Buyuk Menderes Graben (Table 3) near Aydin and Denizli cities.

Table 3: Installed capacity of the geothermal power plants

Geothermal Field	Owner	Operation Year	Installed Capacity (MW_e)
Kizildere, Denizli	ZORLU	1984	15
Salavatlı -Dora-I	MENDERES	2006	7,95
Kizildere, Denizli	BEREKET	2007	6,85
Germencik, Aydin	GÜRMAT	2009	47,4
Tuzla-Çanakkale	ENDA	2010	7,5
Salavatlı Dora-II	MENDERES	2010	9,5
Hıdırbeyli-1	MAREN	2011	20
Hıdırbeyli-2	MAREN	2012	24
Hıdırbeyli-3	MAREN	2012	24
TOTAL			**162,2**

About 150 MWe geothermal power production is expected to be in operation until the end of 2013.

According to the T.R. Ministry of Development 10th Development Plan (2014-2018) Geothermal Commission Reports; until the end of 2018 the geothermal electricity production installed capacity is expected to reach 750 MWe.

4. ECONOMICAL EVALUATION

One house holder (100 m^2 area) is paying as a subscription fee of 1500 – 3000 US$/100 m^2 residence for the geothermal district heating investment. Therefore, minimum % 50 of the geothermal district heating investment have been met by that subscription fee. It is a very good pre-finance system for the investor.

The existing situation and economical evaluations of the feasibility studies shows that the payback period of the geothermal district heating investments due to the pre-financing system the investment as a equity based, payback time is 2-3 years, and the payback time at the project based is 5-7 years.

In terms of equity capital of 30% and credit of 70%, the Internal Rate of Return (IRR) varies at 28 % – 35 % and the Pay back duration varies between 1-3 years. In terms of Total Project, Internal Rate of Return (IRR) varies between 19 % - 24 % and the pay back duration varies between 4,5 – 6 years

750 MWe power production, 4000 MWt heating, 2040 MWt greenhouse heating, 500 MWt drying, 1100 MWt balneological use (bathing, healing), 300 MWt cooling and 400 MWt aquaculture applications are aimed for the year 2018. The economical value added to the Turkey's economy by means of above mentioned utilizations until the the end of 2018 is 32 Billion USD/year. The created employment (Direct and Indirect) is 300.000 person.

5.CONCLUSION

Being one of the richest countries in geothermal potential, Turkey's geothermal activities have been developed significantly in electricity and moderate in direct use applications from 2009 to 2013.

Turkey has a deficit between import and export figures. Turkey is paying about 50 billion $/annualy for natural gas and oil. To use the geothermal energy resources for electricity generation, district heating, and other applications would lead to decrease this difference.

Today, if finance will be procured by banks by means of foreign investors, the geothermal district heating investments could be speed up and started up again. If the good examples will be with the foreign investors, the Turkish private sector could be effected positively from these examples. As they could see the good examples from the foreign private sector, the Turkish private sector could take a role and procure the finance and the geothermal district heating investments will be bombed like geothermal electricity investment.

The release of the Geothermal Law in 2007 has given way to increase of the geothermal applications.

The main important items for research and development for the next period of geothermal resources in Turkey are given below;

- New fields should be investigated.
- . Deep and high temperature reservoirs should be searched.
- Emphasize should be given to Enhanced Geothermal Systems (EGS) for the development of deep geothermal less permeable or non permeable reservoirs. Governmental support has high importance regarding the development of EGS in Turkey.
- Adequate incentives shall be applied to geothermal district heating investments.
- Exploration of new fields, and determination of characteristics and capacities of present fields, providing the required support to MTA, Iller Bankasi, Universities and Private Organizations for their research, development and application projects.
- . Scaling and corrosion problems which affect the management of geothermal energy, have been solved by the injection of the chemical inhibitor. Consequently, it is necessary to activate the fields and to accelerate the investments at this sector.
- More geothermal wells should be drilled and the well risk should supported by the state or funds.
- . Determination of utilization possibilities of geothermal fields and planning of these fields in the form of integrated utilization (electricity generation, district heating, thermal and balneological applications) and encouragement of the geothermal uses.
- Turkey is suitable for heating purposes, so geothermal district heating investments could be realized and operated with the cooperation of local governments, municipalities, people and private sector.
- Thermal tourism and balneological utilization with the sea/sun/cultural tourism brings important economical development to the region and country.
- . More financing aids/investors should be achieved and international cooperation should be developed for the geothermal development projects.
- . To supply the required support about know-how transfer, education, finance and equipment necessities via realization of projects in common with international organizations,
- Privatization of the existing geothermal district heating systems owned by the local governorships and municipalities would help to enhance and develop the existing geothermal district heating systems.
- Geothermal energy in Turkey must be used as the main energy source at the regions where it is found, as it is very cheap, clean, and sustainable for the benefit of the mankind.

6. REFERENCES

Mertoglu, O., Simsek, Ş., Dagistan, H., Bakir, N., Dogdu, N.: Geothermal Country Update Report of Turkey (2005-2010), *Proceedings of the World Geothermal Congress 2010*, Bali-Indonesia, (2010) paper #0119.

TGA, 2013, Geothermal Energy Development Report, Turkish Geothermal Association (TJD) Ankara**.**