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Privatization of Kizildere Geothermal Power Plant and New Approaches for Field and Plant

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ABSTRACT

Kizildere Geothermal Field is located between Denizli and Aydın Provinces in the northeastern extreme of the Büyük Menderes Graben of Western Turkey. Kizildere field is the first explored geothermal field in Turkey having adequate capacity to generate energy.

Kizildere Geothermal Power Plant is operated by Electricity Generation Co. Inc (EÜAS) on be half of the government for 24 years. With the acquisition of operational rights of the power plant and its surrounding (70 km^2) by Zorlu Energy Group, Kizildere Geothermal Field License including current power plant operation is transferred to Zorlu Energy on September 1, 2008 for 30 years .

Zorlu Energy Group started to work in the field both to increase capacity of current power plant and to establish a new power plant with 60 MWe capacity as the first stage of power expansion in the license area.

As a first step in the project, the power generation of the current power plant has been increased from 6 MW to 15 MW by cleaning of wells. After that extensive geological, geochemical and geophysical and reservoir studies have performed at the license area for the new power plant during the feasibility study period.

1. INTRODUCTION

Kizildere Geothermal Field was privatized on September 1, 2008. Thirty companies participated in the tender for the privatization through the "sales" method and Zorlu Energy acquired the operational rights of the geothermal plant in Denizli for a period of 30 years. Receiving all legal rights for the exploitation of this resource, Zorlu Energy commenced working on this new project with the ultimate aim of constructing a new, sustainable power plant with 60 MWe capacity as the first stage of power expansion

The acquisition of the plant has been completed after the approval of the tender by the Competition Authority and the Privatization Administration. Zorlu Energy carried out a comprehensive study to create a complete data base of the field for further studies.

Kizildere geothermal field has been studied by many companies and academicians. As a result there are many publications (field reports, feasibility studies, papers, thesis etc.) but not a complete – up to date report covering all these studies and reporting all the aspects of the field. Zorlu Energy Team has prepared comprehensive data gathering and evaluation of Kizildere geothermal field report beginning of the engineering studies.

2. HISTORICAL SUMMARY OF KIZILDERE GEOTHERMAL FIELD

Kizildere Geothermal Field, located in south east of Aegean Region of Western Anatolia, in the province of Denizli, Turkey, (Figure 1) was discovered by General Directorate of Mineral Research and Exploration (MTA) in 1965. Following this discovery, various scientific studies have been conducted at the site with the ultimate aim of converting this geothermal resource into electricity by MTA.

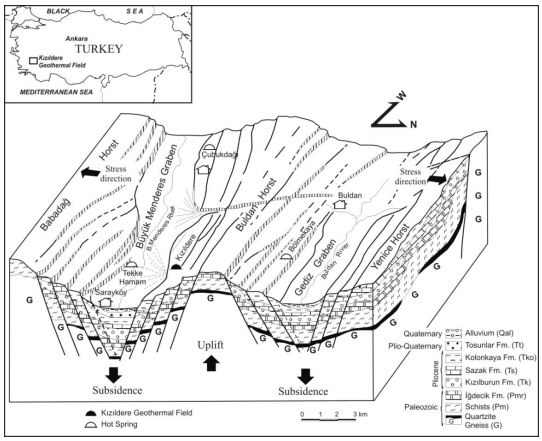

Figure 1: Block diagram of Kizildere Geothermal Field and surrounding area (Şimşek, 2005)

The first well KD1, had been drilled in the field after the completion of the joint project run by MTA-UNDP, (Figure 2). The well reached a depth of 540 meters and a temperature of 198 °C was observed. Until 1973, 16 wells have been drilled whose depths are varying from 370 to 1241 meters (MTA, 1975). In 1974 a 0.5 MWe pilot turbine is constructed by MTA and this turbine is mounted to KD-13. With this pilot turbine, three nearby villages' electricity need is supplied free of charge between 1974 and 1980. After the pilot test study made by MTA, in 1984, the first geothermal plant which has a generator output of 15 MWe and a total capacity of 17.4 MWe is constructed.

Between 1985-1986 3 new wells (KD-20, KD-21, KD-22) were drilled and the number of wells that supply steam to plant was increased to 9. Meanwhile, three re-injection well drillings also took place in the field for the effective utilization of the reservoir. R-1 was initially planned as a reinjection well and was drilled at a depth of 2261 m. in 1998. Later on a new well, R-2 was drilled to be used as a reinjection well in 2002 at a depth of 1428 m. At the moment, this well is the sole reinjection well at the Kizildere Geothermal Field (Table 1). The last re-injection welll drilled at the site, R-3, was observed to have the same temperature as R-1, proving once more the availability of high temperature (> 240 °C) in the reservoir.

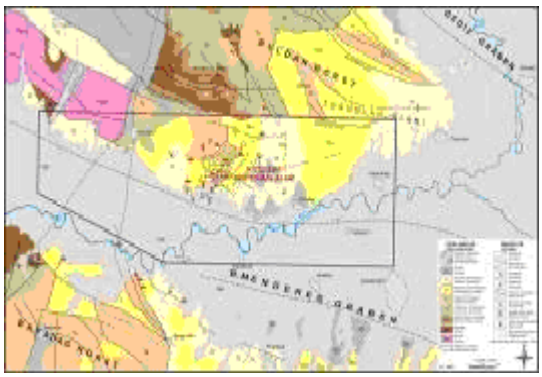

Figure 2: Geological map and well locations of Kizildere Geothermal Field (Zorlu Energy, 2009)

Other than the MTA surveys, the area was also studied by various domestic and foreign institutions such as ENEL (1990), WestJec (2002), EİE (2006) at different times.

Table 1: Geothermal Exploration and Production Wells in the Kizildere Area (Zorlu Report, 2009)

Well No	Beginning-Finishing date	Depth	T_{max} (°C)	Beginning of Production zone	Reservoir Thickness * First Reservoir **Second Reservoir *** Third Reservoir	Reservoir Lithology
KD-1	20. 04.1968 12. 05.1968	540	198.3 °C @ 535 m	436*	104*	KİREÇTAŞI-MARN *LIMESTONE-MARL*
KD-2	16.09.1968 08.11.1968	706.5	173.8 °C @ 650 m	650*	56.5*	KİREÇTAŞI-MARN *LIMESTONE-MARL*
TH.1	27.11.1968 19.17.1968	615.5	116 °C @ 580 m	-	-	KİREÇTAŞI-MARN *LIMESTONE-MARL*
KD-1A	17.01.1969 15.02.1969	571.1	193 °C @ 403 m	428*	141.1*	KİREÇTAŞI *LIMESTONE*
KD-3	26.03.1969 25.04.1969	370	158 °C @ 320 m	290*	90*	KİREÇTAŞI-MARN *LIMESTONE-MARL*
KD-4	07.05.1969 26.10.1969	486	172.5 °C @ 486 m	314*	172*	KİREÇTAŞI-MARN *LIMESTONE-MARL*
KD-111	01.07.1969 25.10.1969	504.85	164 °C @ 443 m	299**	203.85**	MERMER, MİKAŞİST, KUVARSİT *MARBLE, MİCA* SCHIST, QUARTİZE
KD-6	20.11.1969 25.01.1970	851	200.4 °C @ 700 m	653**	198**	KUVARSİT, MERMER, MİKAŞİST QUARTİZE, *MARBLE, MİCA* SCHIST
KD-9	01.02.1970 20.04.1970	1241	171.5 °C @ 403 m	1105**	136**	MERMER, MİKAŞİST *MARBLE, MİCA* SCHIST
KD-12	26.04.1970 18.06.1970	404.7	161.5 °C @ 390 m	301*	103.7*	KİREÇTAŞI-MARN *LIMESTONE-MARL*
KD-8	05.05.1970 10.06.1970	576.5	185 °C @ 540 m	508*	71.5*	KİREÇTAŞI-MARN *LIMESTONE-MARL*
KD-7	16.07.1971 17.07.1971	667	201.7 °C @ 647 m	531**	136**	MERMER, MİKAŞİST, KUVARSİT, *MARBLE, MİCA* SCHIST, QUARTİZE
KD-13	23.03.1971 24.04.1971	763	201 °C @ 590 m	590**	173**	MERMER, MİKAŞİST, KUVARSİT, *MARBLE, MİCA* SCHIST, QUARTİZE
KD-14	02.11.1970 29.12.1970	603.5	208 °C @ 451 m	450**	153.5**	MERMER, MİKAŞİST, KUVARSİT, *MARBLE, MİCA* SCHIST, QUARTİZE
KD-15	09.05.1971 31.05.1971	506.2	206 °C @ 445 m	444**	62.2**	MERMER, MİKAŞİST, KUVARSİT, *MARBLE, MİCA* SCHIST, QUARTİZE
KD-16	28.04.1973 09.06.1973	666.5	209 °C @ 450 m	450**	216.5**	MERMER, MİKAŞİST, KUVARSİT, *MARBLE, MİCA* SCHIST, QUARTİZE
KD-17	20.07.1975 07.08.1975	365.2	157 °C @ 272 m	340*	25.2*	KİREÇTAŞI-MARN *LIMESTONE-MARL*
KD-20	06.12.1985 27.01.1986	810	204 °C @ 491 m	491**	319**	MERMER, MİKAŞİST, KUVARSİT, *MARBLE, MİCA* SCHIST, QUARTİZE
KD-21	14.10.1985 29.11.1985	897	205 °C @ 526 m	526**	371**	MERMER, MİKAŞİST, KUVARSİT, *MARBLE, MİCA* SCHIST, QUARTİZE
KD-22	25.06.1985 27.07.1985	887.5	201 °C @ 555 m	555**	332.5**	MERMER, MİKAŞİST, KUVARSİT, *MARBLE, MİCA* SCHIST, QUARTİZE
TH-2	29.07.1996 18.10.1996	2001	168 °C @ 1980 m	1200**	801**	MERMER, MİKAŞİST, KUVARSİT, *MARBLE, MİCA* SCHIST, QUARTİZE
R-1	26.07.1997 21.01.1998	2261	242 °C @ 1600 m	1600***	661***	ŞİST, KUVARSİT, GNAYS SCHIST, QUARTİZE, GNEISSES

Kizildere Geothermal Power Plant was operated by the utility EUAS until September 2008. Zorlu took over the operation right in September 2008 for a period of 30 years and started to work for the development of Kizildere first stage 60MWe Geothermal Power Plant In this regard, as first step in these studies, Reservoir Assessment and Feasibility was prepared by Zorlu Energy Team.

Within the scope of the above mentioned work, Zorlu Energy is working with reputable foreign engineering and consultancy companies, namely, Power Engineers (PEI), Geologica, APEX, Veizades and Associates, SAIC, Cumming and Geoscience for the successful achievement of the project.

3. HISTORICAL SUMMARY OF KIZILDERE GEOTHERMAL FIELD

After the privatization of the 70 km^2 field, Zorlu Energy team ambitiously started to work for both the rehabilitation of current power plant and the construction of the new 60 MWe Power Plant. In this regard, the team has set forth important targets for the successful realization of the project and is determined to achieve these goals in every phase of the project, starting from the privatization of the field to the electricity production from 60 MWe new power plant. These goals can be investigated in three periods.

3.1 Short Term Goals

Increasing the operating efficiency of the current power plant has been set as the major short term goal and this target is met by increasing the capacity from 5.5 MWe to 15.5 MWe in 4 months.(Figure 3) In this context, some of the work carried out in the Field include; cleaning of production wells in the field, inhibitor selection to prevent the calcite scaling of the wells, establishing inhibitor injection systems and improving reinjection wells in the field (Figure 4a, 4b).

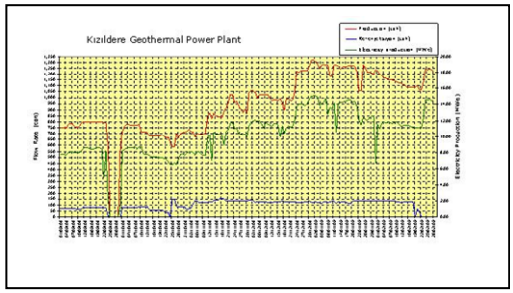

Figure 3: Electricity production in current power plant in Kızıldere

Figure 4a: Calcite scaling in KD14 well in Kızıldere Geothermal Field; 4b: Inhibitor system in KD14 well in Kızıldere Geothermal Field

$CaCO_3$ scaling formed in the production wells and surface facilities is cleaned by mechanical reaming and (HCI) acidizing operations. To prevent $CaCO_3$ scaling in production wells; 10 different inhibitors of 8 different companies from Italy, Germany, USA and Turkey are tested. Tests were started at 24 November 2008; and completed in a month successfully. For the inhibitor test existing wellhead equipment, downhole equipments and injection system was overviewed and prepared for the test. As a result of these studies, it is observed that 5 of the inhibitors are succeeded in preventing scaling.

3.2 Mid Term Goals (2009-2010)

When the feasibility and reservoir assessment studies for Kizildere Geothermal Fields are completed, the locations of the new wells, as well as the location of the new power plant and type of power plant will be determined exactly. Once the permit applications for the new plant are finalized and relevant permits are obtained, detailed engineering design of the first stage 60 MWe power plant will be done and, construction phase of the new power plant will commence. Total duration of the construction period is anticipated as 40 months.

3.3 Long Term Goals (2010-2013)

Long term goals include construction and commissioning of new power plant, starting to operate of power plant and electricity production. In the long term, also reservoir capacity of whole 70 km^2 license area will be determined, additional energy investment decisions will be made and alternative investment opportunities (such as integrated systems; district heating, greenhouses, thermal tourism and CO_2 marketing) will be investigated

4. PROJECT ACTIVITIES IN KIZILDERE GEOTHERMAL FIELD

4.1 First Steps After the Privatization of Kizildere Geothermal Field

After the privatization, initial field situation assessments were done by Zorlu. These studies include the preparation of a new organizational chart for the project by project management.

Data gathering and evaluation of Kizildere Geothermal Field report was prepared by consultants of Zorlu Energy. Also an action plan for the successful development of the field was prepared. The major activities performed within the scope of the plan are as follows;

1- Wells conditions and productivity of wells were revised.
2- Steam lines and their capacities were observed.
3- Power plant performance and deficiencies of plants were determined.
4- Steps to increasing yield of current power plant were determined.
5- Priority works for reservoir improvement were determined for the region.

4.2 Project Activities in the Licence Area before I The New Power Plant Installation

Kizildere first stage 60MWe Geothermal Power Plant Reservoir Assessment and Feasibility Studies has continued until the end of June 2009. Preliminary assessments regarding the project indicated that the project the power plant will utilize double flash system. Zorlu Energy worked with foreign engineering and consultancy companies, namely, Power Engineers (PEI), Geologica, APEX, Veizades and Associates, SAIC, Cumming and Geoscience for the project development.

The planned and ongoing activities in order to feed the first stage 60 MWe plant can be summarized as follows:

.4.2.1 Geological investigation at the Site

Geologica studies at the site started with gathering and filtering of all the available information up to date to assess current situation of the site. This study was sufficient for the rehabilitation of existing production and re-injection wells, as well as identification of further exploration activities. Within the scope of this roadmap:

Geochemical exploration studies have started in March 2009 and still continue. Water, condensate samplings were done by Zorlu Energy Geothermal Team and gas sampling were done by Zorlu Energy Geothermal Team and CNR (Italy). As well as water chemistry and stable isotope analysis, daily water monitoring has been realized for some parameters in the field. These studies are aimed at determining the geochemical properties of the reservoir fluid and to determine of the effects of pipe systems in the region.

Geophysical exploration including gravity- magnetic surveys and resistivity studies has started on March 2009. Gravity and magnetic surveys, conducted by MTA, are completed with the analysis of a total number of 888 point surveys. The results of this survey are being evaluated by the experts and the evaluation studies will be completed in May 2009. Resistivity studies, again being performed by MTA, have started in April 2009, were completed by mid-June 2009.

All exploration activities conducted in the first half of 2009 were towards identifying successful new well locations which may allow for the most beneficial exploitation of the third reservoir with a temperature of 242°C, and prove the existence of a fourth, deeper and hotter reservoir (>250°C).

Drillings for these new wells were scheduled to start by the last quarter of 2009. For this purpose, a detailed drilling budget is prepared; main procurement items and contractual services are being identified; and a work plan is being prepared.

4.2.2. Reservoir Capacity Estimation and Feasibility Study

Reservoir modeling studies have been started on February 2009, and completed by June 2009.

4.2.3 Permit Applications

Various legal permits are required for operating the power plant. These permits include; Exploitation License for Geothermal Field, Electricity Generation License from EMRA, Environmental Impact Assessment (depending on the legal status of the site). Exploitation license of the 70 km^2 field has been acquired on 2008 for a period of 30 years. Other permit applications are still ongoing as the project progresses.

4.2.4 Detailed Engineering:

After the completion of the feasibility studies, detailed engineering design of the first stage 60 MWe Power Plant will be done.

4.2.5 Power plant construction

After obtaining relevant permits, construction phase of the new power plant will commence. Total duration of the construction period is anticipated as 40 months.

CONCLUSION

After Zorlu Energy Group acquired the operational rights of the Kizildere Geothermal Power Plant and the geothermal field on September 2008, the Group immediately started to work on rehabilitate of current power plant. The Group aims to finalize the construction of 1st stage 60 MWe power plant

which will be the biggest geothermal power plant in Turkey, .in a few years

In this regard, firstly, the existing production wells were cleaned mechanically and acidified so as to increase the capacity of power plant from 6 MWe to 15 MWe.

Next, the feasibility and reservoir studies have been started for the new geothermal power plant. In this regard, geological, geophysical and geochemical studies have been conducted in order to obtain the most accurate geothermal reservoir model.

The existing data and reports, and preliminary results of the Feasibility Study conducted by PEI so far state that the resource capacity has a 90% probability of producing 65 MW electricity, 50% probability of 122 MW and 10% probability of 203 MW over 30 year life.

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