Gürmat 2 Geothermal Power Plant

EIA Addendum

Guris Holding

12 September 2014

Plan Design Enable

Notice

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1. Background

1.1. Introduction

Gürmat Elektrik Üretim A.Ş have applied to the European Bank for Reconstruction and Development ("EBRD"), and the International Finance Corporation ("IFC") (jointly referred to as "the Banks" or "the Lenders") for a loan to support the development of the Gürmat 2 Geothermal Power Plant (G2 GPP). The Gürmat 2 Geothermal Power Plant is to be located near the city of Aydin, Turkey (110 km south west of Izmir).

The Gürmat 2 GPP is initially rated at 123.3 MWe, consisting of four units (one large, dual flash unit plant at 47.4 MWe and three ORC flash binary units (each of 25.3 MWe), as well as the associated boreholes, pipelines and transmission lines. A second dual flash unit (47.4 MWe) may also be constructed if the GPP is considered to be commercially successful. The GÜRMAT 2 GPP may not be connected to the existing Gürmat 1 GPP. Both G1 and G2 are within a single concession area of 28km^2. Gürmat have been licensed to use the geothermal energy within the concession area for 49 years and the power plant has therefore been designed with an operational life of 49 years.

The Gürmat 2 GPP is classified as a Category 'A' project as defined by the Equator Principles, the EBRD's Performance Requirements, and IFC Performance Standards.

An Environmental and Social Due Diligence audit (ESDDA) was completed during 2014 by specialist consultants WS Atkins International Ltd. The audit assessed the environmental and social performance of the existing Gürmat 1 Geothermal Power Plant and considered compliance of the Gürmat 2 GPP with the requirements of Turkish law, the EBRD's Performance Requirements, IFC Performance Standards and European best practice. The ESDDA included a number of recommendations/ improvements to ensure compliance with these standards. These recommendations are listed with the Environmental and Social Action Plan, or ESAP. The ESAP forms part of the financial agreement between the Banks and the borrower and progress against the ESAP is monitored by the Banks on an annual basis.

One of the sources of information regarding the G2 GPP project was the Environmental Impact Assessment prepared by local consultants in 2012.

1.2. EBRD and IFC Requirements for EIA and Public Disclosure

When asked to finance investment projects, credit officers at the Banks will verify that the borrower has met any local or national requirements for environmental and social impact assessment, public information, consultation and disclosure that may apply to the project proposed for financing.

Environmental Impact Assessments or Environmental and Social Impact Assessments (EIA or ESIAs) are generally required for investments involving a new, "greenfield" development or a significant expansion or modification of an existing facility before the proposed development may be authorised. National EIA laws may cover a few social aspects (in particular cultural and archaeological heritage) but typically do not require a full consideration of social or cumulative impacts.

Turkish regulations on the EIA process require consultation with the public that may be affected by the project and prescribe the procedure for notification, public disclosure of the EIA, and public review and comment.

The EBRD believes that meaningful public consultation is a way of improving the quality of projects. Through the timely disclosure of project information, the EBRD helps to ensure accountability, transparency, improved decision making and openness. Borrowers seeking finance from the EBRD's for a project that would be classified "Category A" according to EBRD's Environmental Policy are required to make the EIA report publicly available at or near the location of the project.

All “Category A” projects to be financed by the EBRD or the IFC must, at a minimum, meet national requirements for public consultation and disclosure of EIAs or other environmental information on the project proposed for financing.

The borrower is responsible for releasing the EIA report publicly in a location at or near the project site which is accessible to locally affected communities. Disclosure should be in the local language and culturally appropriate. For some people, written communication may not be an effective means of transmitting the information. The EIA report should include a non-technical summary covering, at a minimum: physical characteristics of the proposed activity, significant effects on the environment and local communities and measures envisaged to prevent/reduce such effects.

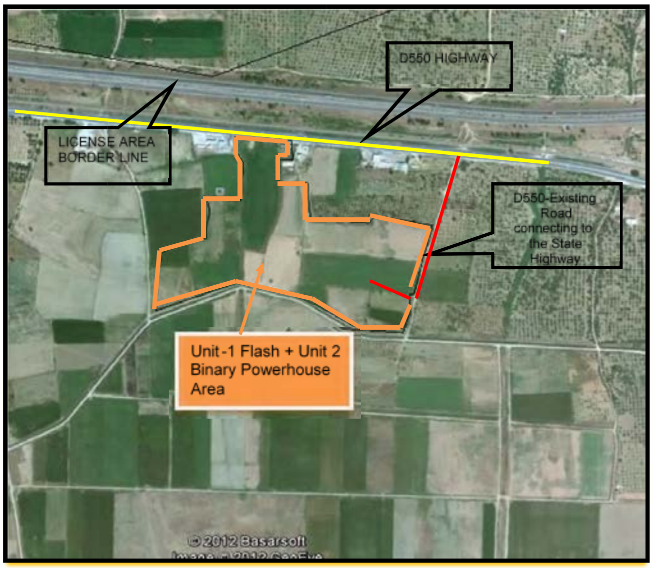
1.3. Local EIA

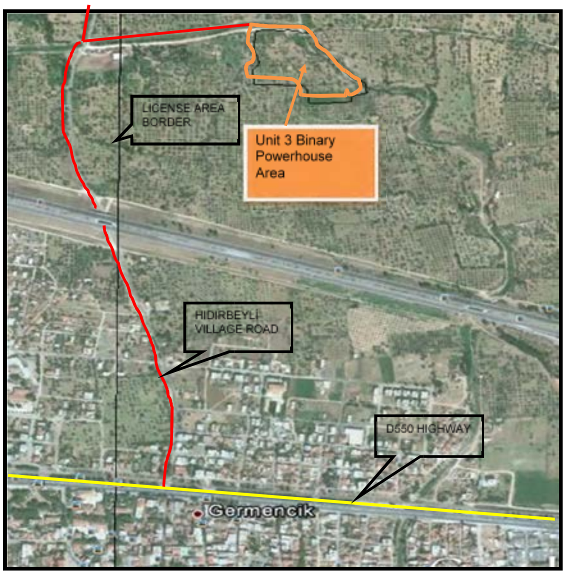
The local EIA was undertaken by Çinar Mühendislik Müşavirlik A.Ş. (Certificate of Competency No : 02, dated: 26.02.2010) and submitted in August 2012. The EIA was completed in line with APP-I List Item 47 – *Producing the geothermal source and plants that use geothermal energy (heat capacity 25 MWe and over)*.

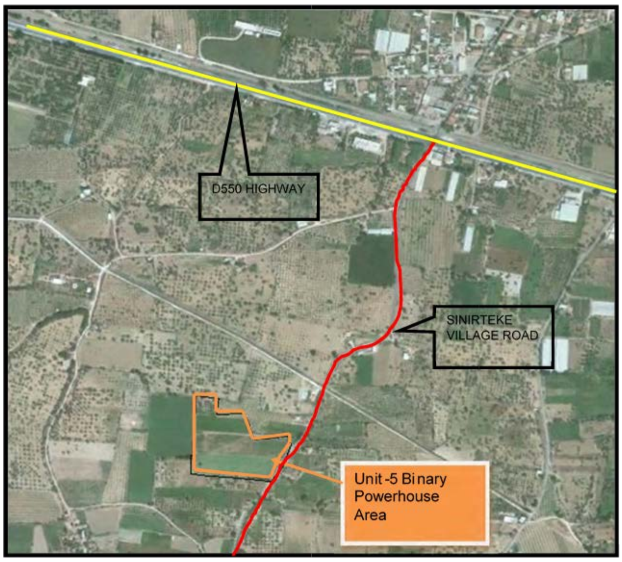
The EIA was undertaken on behalf of Burç Jeotermal Yatırım Elektrik Üretim A.Ş. The company plans to establish and operate the Gürmat 2 Geothermal Power Plant Project (G2 GPP) within the boundaries of Aydın Province, Germencik District and İncirliova District. The G2 GPP was described within the EIA as:

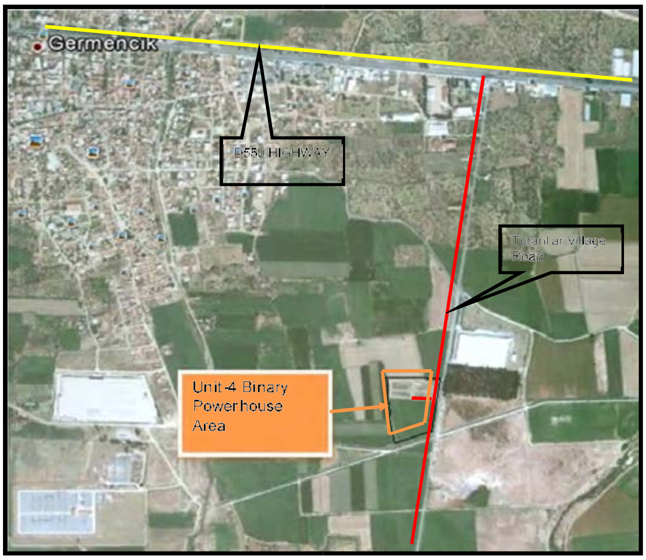
- Having 162.5 MWe installed power (1 x 72.5 MWe triple flash vapour powerhouse plus 4 x 22.5 MWe binary cycle powerhouses).
- The generated energy will be transferred to main power site that is located in the Unit1 + Unit2 Binary Power Plant area via 31.5 kV power line. From there the electrical energy will be transferred to Germencik main transformer station via a single 154 kV power line.

The GPP locations adopted for the EIA are shown in the following images.









1.4. Findings of the Local EIA

The EIA is a large document that contains a large amount of information regarding the characterisation of the local environment. The potential impacts of the development are discussed and mitigations suggested.

The key findings of the EIA ca be summarised as:

- The electricity generated by the GPP will be used to meet the increasing energy demand within Turkey. "*The electrical energy that will be generated at the powerhouse will partially supply the emerged supply deficit and will serve an important function in compensating the increasing electricity demand of Turkey. The continuous, reliable and high quality electricity will welcome the foreign investments to Turkey and contribute to the industrial development of the country".*
- *The energy consumption increases in parallel with the population increase, industrialization and technological progresses and increasing welfare level and the necessity of this and similar projects has been increasing day by day. The energy to be generated in this project, will make a contribution in compensating the energy needs of the provinces in the region and decrease our dependency on foreign energy sources. Geothermal energy is a renewable, sustainable, boundless, cheap, reliable, environmentally friendly, domestic and green type of energy.*
- *The emissions that will probably occur during the operation of the G2 Geothermal Energy Plant are* CO_2, N_2, CH_4, NH_3, H_2S *and* H_2 *gases and* CO_2*, which is 99% by volume in the geothermal reserve, has a big importance compared to the other gases. Feasibility studies show that total of 110 kg/h emission is expected from the cooling tower. During the operation of G2 Geothermal Energy Plant, the only emission expected to occur is from the cooling tower.*
- *The renting or purchasing of land will be carried out or expropriation will be conducted in compliance with Item 15 clauses c and d of Electricity Market Law No. 4628 (amended with the law No. 5496). Any work (land preparation and construction) will not be commenced on these areas before leasing and expropriation work are finalised.*
- *The separation of the groundwater aquifers and the geothermal fluid are totally separate and belong to different systems, they should definitely not mix with each other and the hot water steam delivered to the powerhouse and used in the powerhouse will arrive to the powerhouse in a totally closed circuit and will be reinjected after being used. For this reason there won't be any negative impact caused by this process or any interfere to the groundwater will not occur.*
- *At every stage of G2 Geothermal Power Plant Project, any activity that may destroy the action of irrigation and drainage channels, riverbeds etc. and spoil water quality will not be engaged.*

- *During the land preparation and construction works of the project, the drainage channels that were opened by SHW, will not be interfered whatsoever and the expropriation borders of the drainage channels will be complied.*
- *Mursallı Pumping Irrigation Main Channel will not be approached any closer than 10 metres and there will be a protection distance reserved.*
- *The possible environmental impacts during the land preparation, construction and operation stages and all of the precautions that are planned to be taken against these impacts.*
- *Whereas wastes will be collected as scrap and stored in a suitable location in the project land (in the work place). The products that can be recycled will be reused and/or sent to the licensed recycling companies. The iron, steel etc. metal pieces generated during the land preparation works, will be stored in a permeable and sheltered area. And the wastes that cannot be recycled will be disposed of via the waste collecting system of the municipality.*
- *It is estimated that 350 people will be employed during the construction stage and the number of employees will be 100 during the operation of the plant. In the project during the construction stage, the unqualified personnel will be primarily employed from the local community and during the operation stage by employing the permanent personnel from the local residents some contribution to the local economy will be maintained. The personnel who will work during the construction stage of the project will be accommodated at the site. The technical and social needs of the workers who will work in the scope of the project (accommodation, resting, dining hall etc.) will be supplied from the social facilities, which will be built in the area of the plant. Additionally, if needed, the technical and social needs will be provided from closest settlement areas, in case of failing to fulfil the needs from these places, they could be supplied from Germencik and İncirliova districts and Aydın City Centrum.*
- *After the "EIA Positive" certificate to the EIA Report for G2 Geothermal Power Plant Project will be given, the project owner will assign one of the companies/organisations with EIA proficiency to perform the site visits and in situ observations and will check whether the commitments given in EIA report for the investment and construction stages will be fulfilled. Within this frame, in accordance with the monitoring period set by Ministry of Environment and Forestry, "Final EIA Report Monitoring Reports Form" existing in the App-4 of "Notification of Qualification" enacted by the Official Gazette No. 27436 published on 18.12.2009, will be filled and delivered to the Ministry of Environment and Forestry within the intervals defined by the commission.*

1.5. The EIA Disclosure Pack

The local EIA completed by the Turkish consultants is considered to be of a good standard and in compliance with Turkish regulations. However, to ensure compliance with EBRD and IFC standards an Addendum to the local EIA (this document) has been produced to answer a number of questions in relation to Green House Gas releases, land acquisition and legal compliance. These issues are discussed in the sections below.

The EIA Disclosure Pack published by the EBRD comprises:

- This EIA Addendum
- A Non-Technical Summary ("NTS")
- An Environmental and Social Action Plan ("ESAP") based upon the findings of the ESDDA.
- A Stakeholder Engagement Plan ("SEP), and
- A Social Impact Assessment ("SIA").

2. Design of the G2 GPP

2.1. Design Overview

Gürmat has obtained a geothermal power concession of 28 km^2 (Concession no. J-553 /A,B), near the city of Aydin, about 110km from Izmir. The existing Gürmat 1 GPP is within this concession area. Gürmat hold a Generation License that allows for the construction of another GPP (i.e. Gürmat 2) with a maximum installed capacity of 162.3MW within the concession area. The area has a proven geothermal reserve, with highest temp of resource at 239°C.

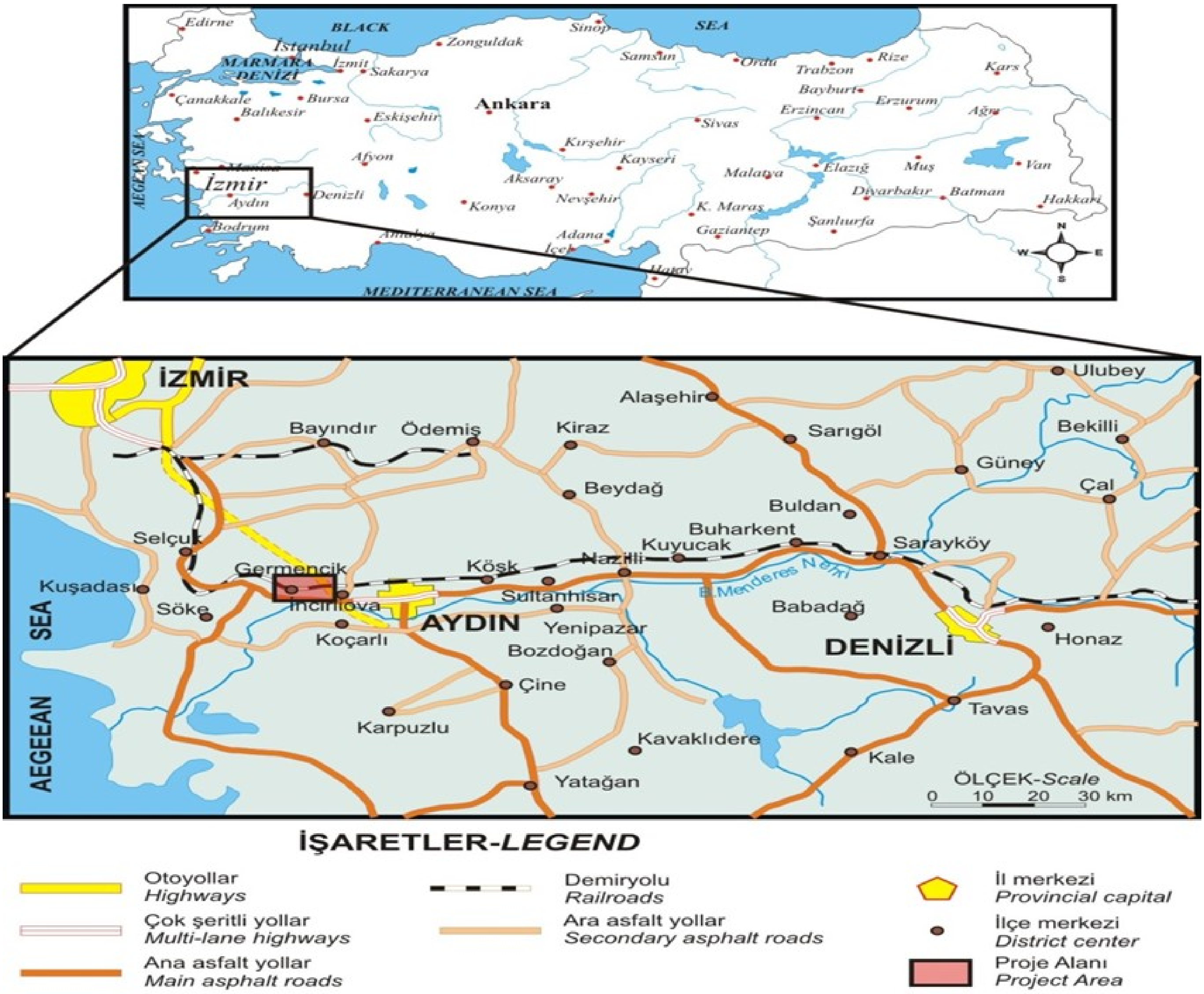


Figure 2-1 General location of the G2 GPP

The Gürmat 2 GPP will consist initially of four power generating units as well as the associated boreholes, pipelines and transmission lines as follows:

- Main power plant (EFE 1) of 47.4 MWe (dual flash) and three x Organic Rankine Cycle binary plant with extraction and release of NCG (referred to as "ORC flash binary" plants in this report for ease) (EFE 2, 3, and 4), each with a capacity of 25.3 MWe (123.3 MWe in total).
- Fifty four production and reinjection wells.
- Network of interconnecting pipework pumping the geothermal fluid from the wells to the power houses and back to the reinjection wells.
- Transformer station (within the boundary of the main power plant),
- 154 kV power line to connect the GPP substation to the Germencik main transformer station (2.75 km).
- Access roads that connect the boreholes and power plants with public roads,
- Administrative offices and control rooms at the main power plant and the binary plant installations.

The new G2 GPP will not form part of the existing G1 GPP but will utilise the same geothermal reservoir. The G2 GPP will initially have an installed capacity of 123.3 MWe; a fifth unit, (a maximum of 47.4 MWe dual flash) may be added if the first phase is commercially successful (2016 at the earliest).

Figures 2.2, 2.3 and 2.4 show the locations of the proposed units.

Figure 2-2 Satellite image showing the general locations of the power plants

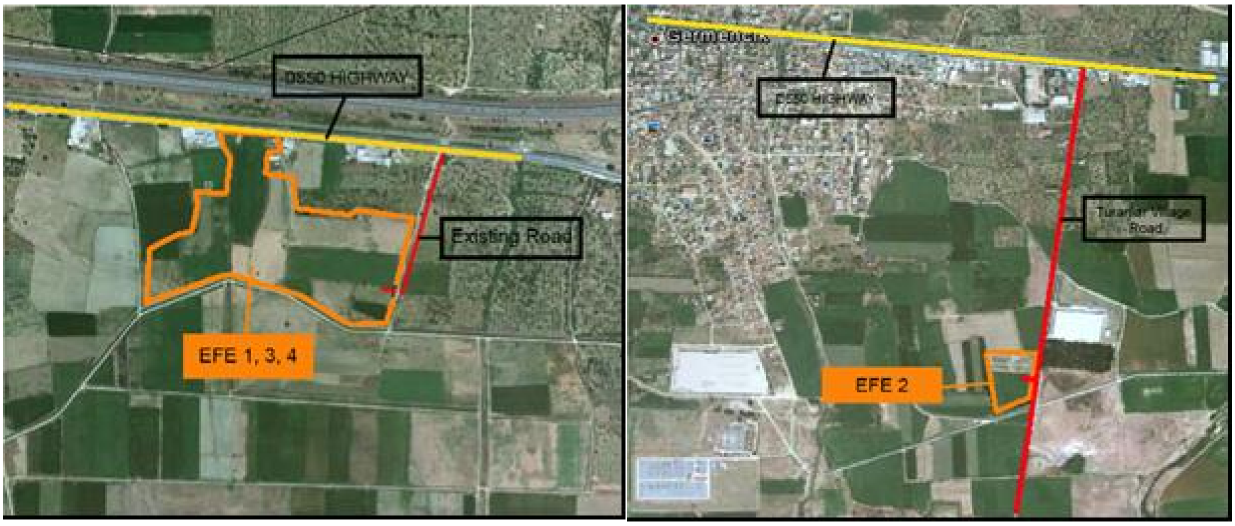


Figure 2-3 Satellite image showing the access to the power plants

Figure 2-4 Satellite image showing the G1 and G2 licences and the concession area

The Company has undertaken preliminary studies and completed an Environmental Impact Assessment (EIA) in 2012 for the project in accordance with Turkish regulations.

The construction of the G2 GPP will be completed within approximately 68 months. Pre-construction phase of the project is planning to be accomplished within 22 months and construction work will last approximately in 46 months.

2.2. Suitability of the Geothermal Resource

Situated at the Alpine-Himalayan orogneic belt, Turkey lies in a tectonically highly active region. Of the numerous geothermal prospects that are present, the majority are for low temperature applications, generally utilised for heating purposes.

The one area with temperatures (enthalpy) suitable for electricity generation is associated with the Büyük Menderes graben forming part of the Menderes Massif in western Anatolia. The Menderes Massif is a large dome like structure, consisting of metamorphic rocks of Palaeozoic age. The geologic setting of the Menderes Massif includes metamorphism, magmatism and deformation of the main rock formations and is characterized by cross faulting. During the Pliocene and Early Quaternary age, widespread normal faulting caused North-South extensions of the Massif, which resulted in the formation of the graben system.

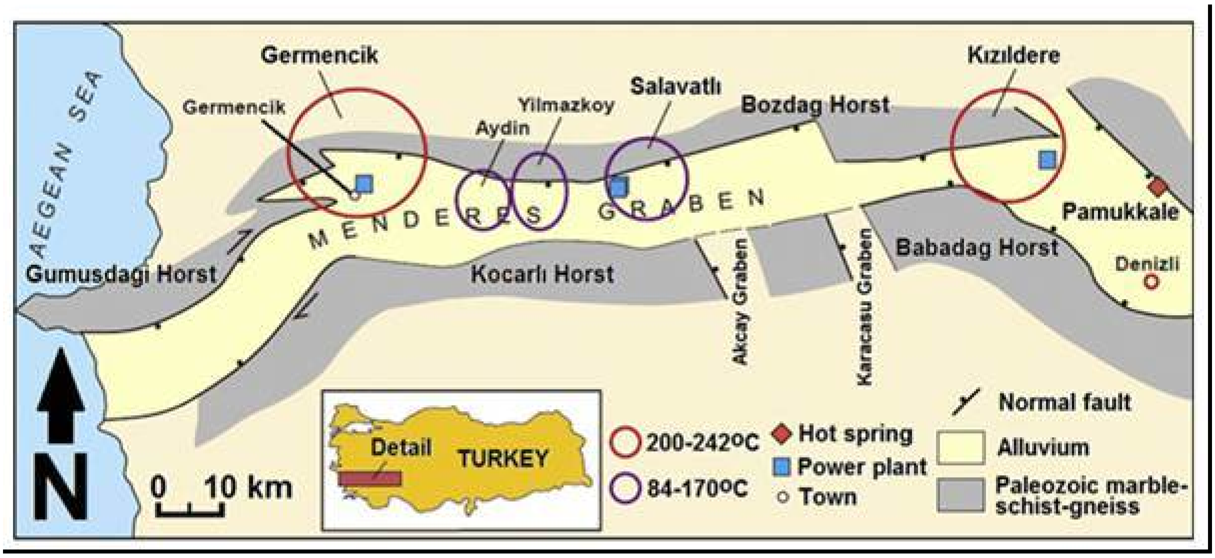


Figure 2-5 Menderes Graben and Location of Turkey's geothermal power plants

According to Öngür, high enthalpy systems in this area range between 120°C and 240°C in temperature. Among other geothermal fields of the Büyük Menderes graben, the Germencik Omerbeyli geothermal field is considered to be one of the most important. The Menderes metamorphic rocks form the basement rock of the graben system representing the main reservoir for geothermal applications.

Most geothermal CO_2 in regions of active volcanism has a volcano-magmatic origin. Western Anatolia is a region of extensional tectonics, with a relatively thin crust, shallow mantle and elevated thermal gradient with very little volcanism (see Figures 2-6 and 2-7). The CO_2 is associated with a combination of metamorphic processes (chemical reactions involving deeply-buried limestone) and some mantle contribution. The four principal sources of CO_2 (and processes) are:

- atmospheric (dissolved in the meteoric water that charges the geothermal system);
- metamorphic (released at mostly elevated temperatures and pressures by the chemical and physical breakdown and re-organization of bio-organic and inorganic materials);
- volcano-magmatic (released from magma as it rises to form volcanoes); and
- mantle discharge (released from the upper mantle or deepest crust without accompanying magma).

The Turkish geothermal field is a compressed water systems that tend to have notably high CO_2 even in the deep liquid-dominated portions of the reservoirs, which is likely to result from:

- continuous input from sources below the reservoir (metamorphic, the mantle and deep crust);
- limited masses of vapour phase (because temperatures are not sufficiently high relative to pressures);
- limited chemical buffering capacity (rock mineral assemblages that cannot consume much more CO_2 than they already bear).

If a geothermal reservoir is the compressed water type (i.e. where no gas-enriched vapour phase exists in the pre-exploitation state or develops after production begins), the CO_2 content of the reservoir water is typically relatively homogeneous, is not altered by production, and should remain relatively constant over time, except where diluted by injection (see below).

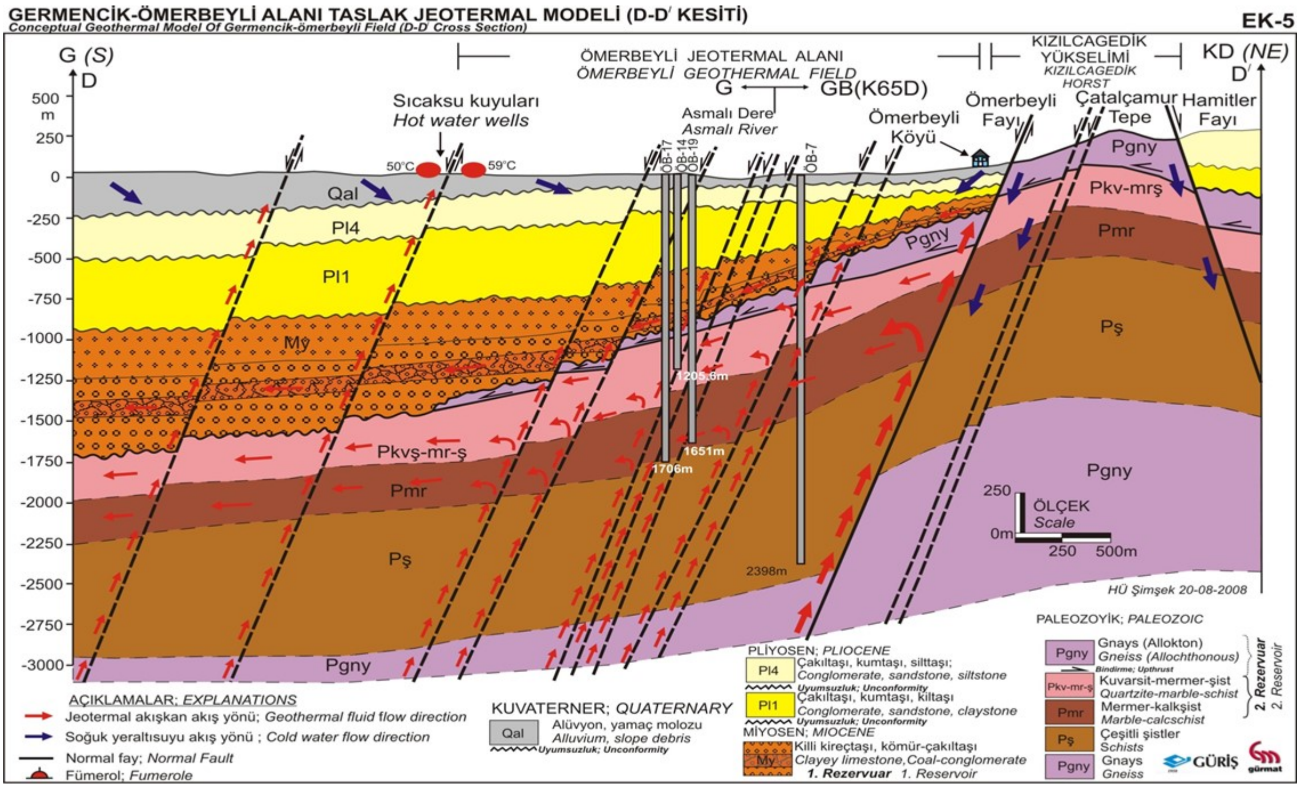


Figure 2-6 Fault lines within the local geology

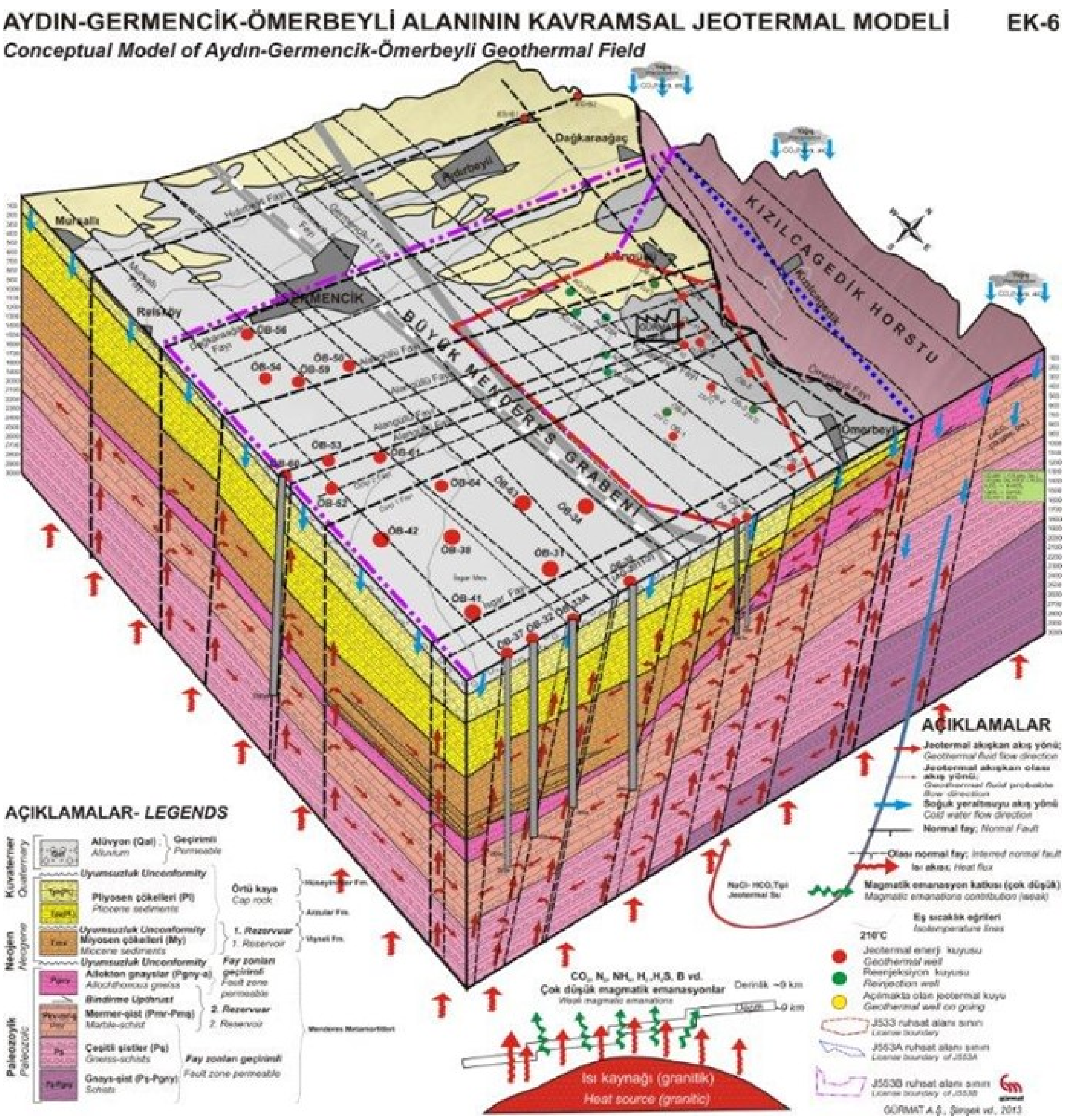


Figure 2-7 Conceptual Model of the Geothermal Field

The majority of geothermal resources in Turkey are operated from over-pressured reservoirs, i.e. the wells are self-flowing wells and do not need down-hole pumps. A significant source of the high pressure of the self-flowing wells comes from the gas present in the reservoir. The gas break-out depths vary from reservoir locations, well bore design and specific flowing characteristics of the wells. Gas break-out depth is the depth at which Non Condensable Gas (NCG) comes out of solution as a result of pressure drop and hydrostatic pressure. As the fluid travel up the well bore, the hydrostatic pressure decreases and gas "break-outs" of fluid to become a free gas. Unless wells are pumped and the pumped fluid is kept below the gas break-out pressure, NCG will come out of solution.

Ranges of geothermal resources temperature in Turkey are between 160°C and 245°C with NCG concentrations (by weight) in the reservoir between 1.5 to 2.3%. The Germencik reservoir has NCG concentration of 1.61% to1.81% weight. Turkish geothermal resources are characterized by high levels of NCG in the reservoir. Indeed, Turkish reservoirs have some of the highest produced NCG volumes in the world, with levels typically 10 to 15 times higher than those found in the USA. In New Zealand the NCG up to 4% and in Costa Rica the NCG is up to 2%.

The Germencik liquid-dominated field has been studied since 1967, and drilling in the 1980s indicated downhole temperatures of 200-232 °C (Filiz et al 2000). Flow tests confirmed these temperature values, but have also indicated high proportions of non-condensable gases. A feasibility study funded by the U.S. Trade and Development Agency (Shaw 2005) had estimated that the resource was sufficient to support over 70MW of generation.

2.3. GPP Technology

The simplest design of geothermal power plants passes the high-temperature brine released from the ground under pressure into “flash tanks” at the surface where the sudden decrease in pressure causes the liquid water in the geothermal fluid to “flash” or vaporize into steam. The steam is then used to power the turbine-generator set.

Geothermal power plants can be divided into two main groups, steam cycles and binary cycles. Typically the steam cycles are used at higher well enthalpies, and binary cycles for lower enthalpies. The steam cycles allow the brine from the reservoir to boil, and then the steam is expanded as it drives a turbine. Usually the brine is reinjected to the reservoir, or it is flashed again at a lower pressure. A binary cycle uses a secondary working fluid in a closed power generation cycle. A heat exchanger is used to transfer heat from the geothermal fluid to the working fluid, and the cooled brine is then rejected to the environment or re-injected.

2.3.1. Double flash steam cycle

The double flash cycle includes two steam separators, high pressure and low pressure (see Figure 2.8). The brine from the high pressure separator (point 2 on the figure) is reduced to a lower pressure level before being supplied to the low pressure separator (8). Steam is supplied to the turbine from both the high pressure and low pressure separators. The turbine is designed in such a way, that the pressure difference over the first stages is the same as the pressure difference between the high and low pressure separators. The mass flow in the lower pressure stages of the turbine is then higher than in the high pressure stages (5 and 9). The steam from the separators is then expanded through the turbine, driving the turbine, and then to the condenser (6). The brine from the low pressure separator (10), and is then re-injected into the reservoir (4). The condenser shown here is air cooled, with the cooling air entering the condenser at point c1 and leaving at point c2. Water cooling is often used for double flash plants.

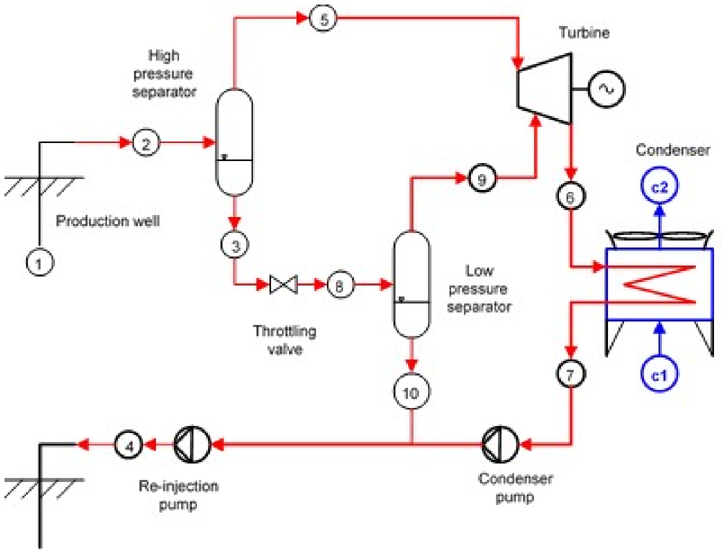


Figure 2-8 Schematic Layout of a Double Flash Plant

2.3.2. Organic Rankine Binary Cycle (ORC)

A schematic layout for an ORC binary cycle plant is shown in Figure 2.9. Pre-heated (in the regenerator) ORC fluid enters the vaporizer at point 2. The geothermal fluid is heated to saturation in the vaporizer, or with superheat in some cases. The vapour leaves the vaporizer (3), and enters the turbine. If the pressure is kept sufficiently high, no non-condensable gases will be separated from the liquid, and a gas extraction system is not necessary. The fluid is then cooled down in the vaporizer, and sent to re-injection at point *s2*.

The exit vapour from the turbine enters the regenerator (4), where the superheat in the steam can be used to pre-heat the condensed fluid prior to vaporizer entry. The now cooled vapour enters the condenser at point 5, where it is condensed down to saturated liquid at point 6. A circulation pump raises the pressure from the condenser pressure up to the high pressure level in point 1. There the fluid enters the regenerator for pre-heat before vaporizer entry. The condenser shown here is air cooled, with the cooling air entering the condenser at point c1 and leaving at point c2.

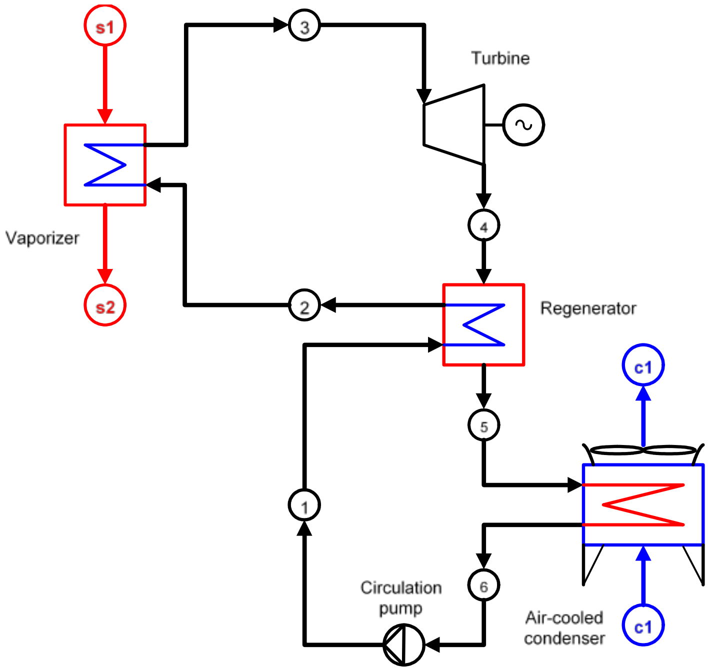


Figure 2-9 Schematic Layout of an ORC Binary Plant

3. Regulatory Compliance

3.1. Design modifications since the 2012 EIA

Gürmat have modified the design of the G2 GPP on two occasions since the EIA was published in 2012. During the initial site visit the configuration of the G2 GPP was a single 72.5 MWe triple flash unit and four flash binary plants, each with a capacity of 22.5 MWe (total installed capacity of 162.5MW). These plants were in four different locations, see Figure 3.1.

Figure 3-1 Satellite image showing the original GPP locations

The current configuration has been set to reflect the experience of operating the Gürmat 1 GPP, the general economics of the electricity market In Turkey but primarily to improve the lifespan of the reservoir. Triple flash units routinely operate at the highest pressures and tend to deplete the reservoir quickly. The replacement of the triple flash units with a double flash unit is expected to extend the life of the GPP from 25 to over 40 years (in line with the expected operational life of the GPP equipment).

The Gürmat management team confirm that the design changes will:

- Improve the sustainability of the geothermal reservoir.
- Reduced number and length of power lines. Reduced cost and land-take.
- Reduced length of brine pipework due to the central location.
- Reduced number of control rooms, from four to two.

3.2. Management of the Licences

A formal EIA for the project was undertaken in 2012 (as required by Turkish regulations) by an independent Turkish consultant. A single EIA was undertaken for the all of the GPP powerhouses, the pipe network, the high voltage power line connections and the associated infrastructure. The EIA was in line with local requirements and is considered by the auditors to be in line with Turkish best practice. However, the EIA was completed before the recent design changes and an addendum to this EIA is proposed as part of the EBRD Disclosure Package.

Gürmat have obtained the necessary operating permits for the G2 GPP. The key permits are:

- Operation licence of the Geothermal Field was granted on 28th November 2011.
- Generation License application to Energy Market Regulatory Authority (EMRA or EPDK) was submitted on 20th January 2012 for 162.5 MWe.
- EIA report submission in summer 2012.
- EIA Positive Certificate was granted on 29th November 2012.
- EPDK has approved the application of EFE Geothermal Power Plant as 162.3 MW as of 13th December 2012.

The primary regulatory mechanism for the Project is the Generation Licence, issued by EMRA. The Generation Licence covers the whole concession area of 28km^2 and Gürmat has some flexibility of operation within this Licence. However, the Generation Licence cannot be enacted until the Environmental License has been issued.

The first stage in obtaining the Environmental Licence is to submit an application to the Ministry of Environment and Infrastructure (MoEI) providing an outline description of the new project; essentially requesting a Screening Decision. The MoEI visit the site and, if appropriate they then request a formal EIA. Once completed, the MoEI consider the EIA submitted to them as part of the application for an Environmental Licence. If the MoEI are content with the findings of the EIA, they issue a Positive Certificate for the EIA; the Environmental Permit.

Both the Environmental Licence and the Generation Licence were issued for a maximum installed capacity of 162.3MW for the G2 GPP.

Guris have requested an amendment to the Environmental Licence granted in November 2012 on two occasions. The first, on 5th August 2013, amended the GPP configuration from one x triple flash plus four x ORC flash binary and the second, on 9th June 2014 to the current configuration of two x double flash and 3 x ORC flash binary (total capacity 162.2MW). The applications for these amendments are short (typically 4 or 5 pages) and focused on the locations of the EFE's, their configuration and their capacity.

Guris have requested an amendment to the Environmental Licence granted in November 2012 on two occasions. The first, on 5th August 2013, amended the GPP configuration from one x triple flash plus four x ORC flash binary to two x double flash (each 47.4MW) and three ORC flash binary (two of them 6,85MW and the third one 27MW). The second amendment was approved on 9th June 2014 for the current configuration of two x double flash (each 47.4MW)   and 3 x ORC flash binary (each 22.5MW) for a total capacity of 162.2MW. The applications for these amendments are short (typically 4 or 5 pages) and focused on the locations of the EFE's, their configuration and their capacity.

The Guris management team have confirmed that both occasions the MoEI have given their written approval as the installed power capacity is within the original limit set in the Generation Licence (i.e. 162.5 MW) and the location of the EFEs have not changed. Whilst the footprint of the main power plant has increased (it now accommodates EFE 1, 3, 4 and 5 rather than just EFEs 1 and 2) it is smaller than the footprint of the three locations it replaces. In addition, the land required to expand the footprint of the main EFE station is low grade agricultural land and is not protected under law.

It is noted that whilst the majority of the land within the concession area is agricultural, mainly cereals and vegetables, there are a number of fields that contain olive or fig trees as well as land used for grazing. Gürmat confirm that their Project plans avoid these fields and that they have no intention of trying to purchase any of these blocks (largely due to the cost implications of purchase).

The MoEI has approved the requested amendments to the Environmental Licence on the grounds of no substantial change (9th June 2014). This means that the original Environmental Licence remains valid and that a revision to the EIA is not required.

There is no regulatory control over carbon dioxide emissions in Turkey.

4. Green House Gas Management

4.1. GPP Technology Selection

The majority of the GPP projects operating in Turkey use a flashed binary system where the geothermal fluid is produced from over pressured wells into a two-phase gathering system comprised of brine and vapour. The vapour stage contains the majority of the NCG. The fluid is transferred via surface piping to separation stations.

All flash-cycle power plants (including flash cycles that extract heat from separated brine and steam using binary technology, and steam-turbine installations that use binary "bottoming cycles" to extract extra heat from the brine) must condense the steam phase to extract energy from it[1]. In a flash plant, steam is separated from the produced fluids and passed through the turbine, then condensed to reduce the turbine discharge pressure and to enhance efficiency. The NCGs present in the steam do not condense (hence the term "non-condensable"), and are typically drawn off from the condensers with steam-jet ejectors or vacuum pumps, (maintaining the low discharge pressure of the turbine). The NCGs must be either vented to the atmosphere, removed/ abated from the vent stream or injected back into the reservoir with the condensate. Various technologies are available to separate the NCG from the condensate but these do not eliminate the need to dispose of the NCGs in some way.

4.2. G2 GPP Technology

The plant technology originally considered by Gürmat for the G2 GPP included triple flash, double flash and ORC binary technology (and this is described within the original, Turkish EIA). However, having considered the desired performance characteristics of the GPP, Gürmat has based the final G2 GPP design on one x dual flash unit and three x binary ORC units.

The technology to be used for the G2 GPP is being supplied by a two US companies: Power Engineers are supplying the EFE 1 dual flash plant (with Mitsubishi generators); Ormat Technologies Inc. (Ormat) are supplying the EFE 2, 3 and 4 ORC binary plant.

The operational control of the GPP will be through a fully automated system, managed from a control centre. Maintenance will be undertaken, in line with manufacturer's recommendations and requirements identified by the company's technical staff.

The first stage of the main powerhouse system will be the flash separation of the geothermal fluid to high pressure vapour and liquid phases. After the high pressure steam has been flashed from the brine, the residual brine will be taken to a low pressure flash tank to remove additional energy in the form of low pressure steam for the turbine. Vapour from the separator will power the steam turbine; the generator will be connected directly to the turbine. The liquid from the low pressure separator will be pumped back to the reservoir via the reinjection wells.

The exhaust vapour from the turbine will pass through the vapour condenser cooled by water from the cooling tower. Non-condensable gas will be removed from the turbine by means of jet vapour absorbers and the remaining vapour will be condensed in the first stage intercondenser. The non-condensed gases remaining in the last condenser will pass to the cooling tower and released to atmosphere.

In the binary cycle, brine will flash to high pressure vapour and liquid phases. Both steam and brine will pass through a vaporizer which is a heat exchanger. Heat energy from the separated "brine" and "steam" is transferred to a secondary fluid (the "motive" or "binary" fluid) which vaporises. This vapour drives the blades of the steam turbine which is connected to a rotating generator which converts the energy to electricity.

The ORMAT® Energy Converters (OEC) units are based on the Rankine Power Cycle and use an organic working fluid. ORMAT consider that this has the advantage of being more efficient than steam when

[1] a single exception is primitive "back-pressure" turbines that release steam directly to the atmosphere.

operating on low-to-moderate temperature heat sources (as for the Germencik reservoir). The working fluid is selected to optimise the power output from the particular heat source, temperature and flow. The vapour expands as it passes through the organic vapour turbine, which is coupled to the generator. The exhaust vapour is subsequently condensed in an air-cooled condenser and is recycled to the vaporizer by the motive fluid cycle pump, see Figure 4.1.

The secondary used in the thermal cycle is N-Pentane, selected for optimal utilization of available heat source. N-Pentane has a closed loop and has no direct contact with the atmosphere.

The liquid from the low pressure separator will be pumped back to the reservoir via the reinjection wells. Geothermal fluid is abstracted from the eastern wells and re-injected into the western part of the geothermal field in Gürmat 1 GPP.

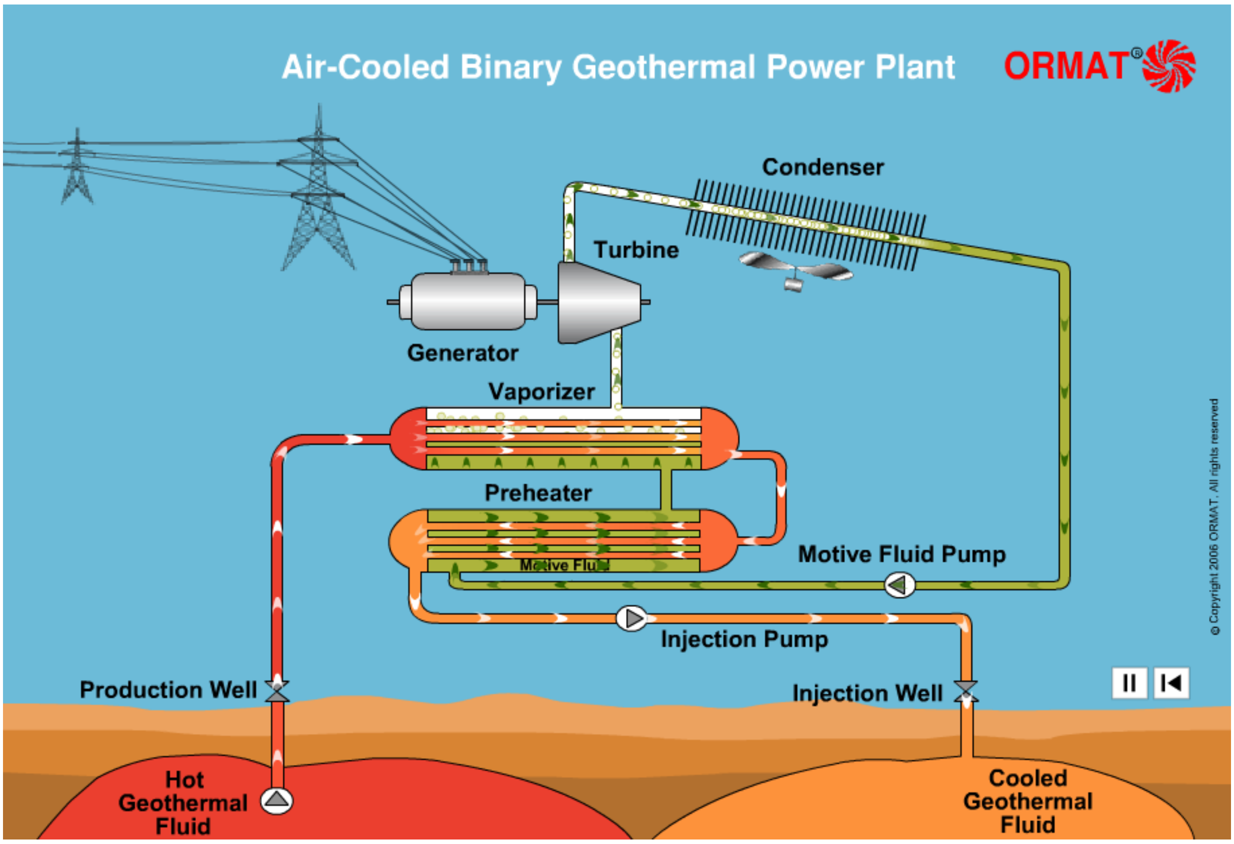


Figure 4-1 Schematic of an Ormat OEC Plant

It is noted that the ORC binary plants to be used by Gürmat will collect NCG which will be subsequently vented through a vessel on top of the vaporizer. For the reason, these units have been referred to in this document as “ORC flash binary”. The ORC flash binary plant has air cooled condensers rather than the open evaporative cooling towers used on the double flash units. The ORC flash binary plant exhausts the NCG and a small volume of steam as the steam/ gas mixture passes through the vaporizer.

4.3. Carbon Dioxide Releases

The release of CO_2 from the G2 GPP has been calculated jointly by Verkis (the technical due diligence consultants employed by the Lenders) and Atkins. The calculation method is based upon the flow of brine through each of the EFEs, the percentage of NCG within the brine, and the CO_2 content of the NCG.

The ORMAT designs were originally based upon a NCG content in brine of 2.3%. Operational data from G1 GPP shows that the actual figure will be much lower at between 1.6% and 1.75%. The data from G1 GPP indicates that there has been a reduction in %NCG from 1.81% in January 2010 to 1.61% in April 2015. It is possible that this percentage will reduce further as the reservoir is exploited but this cannot be confirmed yet.

The Project as defined by the Banks investment is only for EFE 1 to 4. The CO_2 releases from the Project will be around 869,639 tpa and the CO_2 intensity is 0.81 tCO_2/MWh (based upon Gross MW capacity), see Table 4.1.

Table 4-1 Estimated CO_2 Releases from the EBRD Funded Project

	Gross Capacity (MWe)	Flow Rate (tph)	NCG Content (%)	CO2 in NCG (%)	Operating Hours	CO2 emission (tph)	CO2 emission (tpa)
EFE-I	47.4	2,560	1.64%	0.9878	8,672	41.47	359,660
EFE-II	25.3	1,230	1.64%	0.9878	8,672	19.93	172,805
EFE-III	25.3	1,200	1.64%	0.9878	8,672	19.44	168,591
EFE-IV	25.3	1,200	1.64%	0.9878	8,672	19.44	168,583
Total	**123.3**						**869,639**
Estimated Yearly Electricity Generation (MWh)							1,069,307
tCO2/MWh							**0.81**

4.4. GHG Releases

Geothermal liquids contain non-condensable gases and solid particles whose amounts rise with the temperature. Non-condensable gases generally consists of carbon dioxide (CO_2) and varying amounts of hydrogen sulphide (H_2S), and ammonia (NH_3), nitrogen (N_2), hydrogen (H_2), mercury (Hg), boron vapour (B), radon (Rn), and hydrocarbons such as methane (CH_4). In this case, the Anatolian field is a high temperature, pressurised, liquid dominated field with a high percentage of CO_2 in the NCG.

It is expected that the G2 GPP will generate the same ratio of GHGs as the existing G1 GPP. The G2 GPP equipment suppliers have based their design on the NCG characteristics shown in Table 4.2.

Parameter	%, (by weight)
Carbon dioxide, CO_2	98.4 – 98.6
Hydrogen Sulphide, H_2S	0.179 - 0.231
Hydrogen, H_2	0.0301 – 0.0558
Oxygen, O_2	0.001
Nitrogen, N_2	0.41 – 0.48
Methane, CH_4	0.653 – 0.766

Ammonia, NH_3	0.07 – 0.167

Table 4-2 NCG Design Characteristics for the Gürmat 2 GPP

The NCG from the Germencik reservoir is composed of the following gas types in volume % (mol%):

CO_2 98.780 mol, %

N_2 0.767 mol, %

CH_4 0.237 mol, %

Ar/O_2 0.222 mol, %

H_2S <0.1 ppm

On a weight basis, the two green-house gasses within the NCG are: CO_2 99.26% and CH_4 0.09%. As the global warming potential (GWP) of CH_4 is assumed to be 25 times the effect of CO_2, the overall CO_2 Equivalence can be calculated as 101.51% of the total NCG or 1.0151 x 1.62 = 1.64% of the geothermal fluid taken from the resource.

On the basis of this figure, the G2 GPP to be funded by the Banks will release **893,673 tCO_2 equivalent pa** and the GHG intensity of the release will be 0.84 tCO_2 equivalent per MWh (Gross), see Table 4.3.

Table 4-3 Estimated GHG Releases from the EBRD Funded Project (as CO_2 e)

	Gross Capacity (MWe)	Flow Rate (tph)	NCG Content (%)	CO_2e in NCG (%)	Operating Hours	CO_2e emission (tph)	CO_2e emission (tpa)
EFE-I	47.4	2,560	1.64%	101.5%	8,672	42.62	369,600
EFE-II	25.3	1,230	1.64%	101.5%	8,672	20.48	177,581
EFE-III	25.3	1,200	1.64%	101.5%	8,672	19.98	173,250
EFE-IV	25.3	1,200	1.64%	101.5%	8,672	19.98	173,242
Total	**123.3**						**893,673**
Estimated Yearly Electricity Generation (MWh)							1,069,307
tCO2/MW							**0.84**

4.5. Possible Reduction of GHG Releases

NCG is currently planned to be vented from the cooling water towers on the double flash units and above the vaporizers on the flash binary plant.

Gas abatement is the only available mitigation option if NCGs must be released to the atmosphere. There is well-developed geothermal technology that removes H_2S (hydrogen sulphide) from vented NCGs. However, CO_2 capture systems coupled to points of release on flash-cycle plants are not yet practically implemented. Similarly, the use of a capture systems similar to those being tested at some large coal-burning power plants (for the demonstration of industrial-scale Carbon Capture Utilization and Storage) would represent a significant capital investment and higher effective operational costs, and would result in lower system efficiencies and parasitic power requirements. This option is not considered to be feasible.

The second option is to reinject the NCG into the reservoir. This option has been assessed and has been rejected as it is technical very complex and would require more energy that generated by the GPP as a whole.

5. Land Acquisition

5.1. Social Context

Farming is a main source of income for households living in villages around the Project concession area. It is noted that due to the age profile of the local residents, the next important source of income is a pension. Many people sell their products to agricultural cooperatives, whilst keeping some for household consumption. The average household owns between 1.5 and 2 ha of land. Households mainly work on the land by themselves and use machines. Help is only sometimes hired for harvesting crops / fruits.

According to the household survey carried out as part of the local EIA, the average size of a household in surveyed villages was 3.43, with about half of those interviewed having completed primary level education (47%). The average number of persons who work in the household is 0.92. The average income is USD 1,165 per month.

5.2. Public Consultation

As part of the Project EIA, a public meeting was held in March 2010 in a local village hall. The meeting was attended by representatives of the Ministry of Environment and Urban Planning, Aydın Provincial Directorate of Environment and Urban Planning, the Regional and District Directorates of State Hydraulic Works (SHW), village headmen (muhtars) and members of the local community. Participants asked that landowners are kept informed in advance of any drilling activities near their land; they asked for mitigation measures for any adverse impacts on fig and olive trees; they also asked if there are opportunities to design a heating system for settlements in the project area.

A household survey was also carried out as part of the local EIA. This survey indicated that the majority of local stakeholders obtained information on the Project from their village headmen (c. 47%) or from friends and neighbours (c. 31%). Only about 19% received information directly from Gürmat with about 3% from newspapers. An open dialogue with the headmen is clearly central to the consultation process.

Stakeholders were interviewed by the SIA consultants in June 2014. Meetings were held with the village headman of Omerbeyli, the Mayor of Germencik and four landowners; one of whom sold his land through an amicable process and three (out of eleven) whose land is currently under expropriation. The issues raised by the interviewed stakeholders included:

- A request for more interaction and cooperation between Gürmat and the local communities;
- Early information about expropriation and compensation to prevent the spreading of rumours;
- A suggestion that dust and steam from the existing Gürmat 1 plant is damaging crops and that the company should be compensating them for reduced production;
- Safety concerns regarding the above-ground pipework and the possible effects on agriculture;
- The impacts of the Gürmat plants will be being monitored and mitigated;
- Many local people are expecting the Project to provide them with a job, particularly the younger people and women
- There was a request for further community investments by Gürmat and that the communities should be consulted on what priority investments they need.

5.3. Land Acquisition

The Gürmat 2 GPP concession covers a land area of 28.3km^2, the majority of which is being used for agricultural purposes. A total of 61 plots of land (c. 69.4 ha) are needed for the power houses and wells (for EFE 1, 2, 3 and 4). Gürmat started the acquisition process in February 2013 and by the end of May 2014, fifty plots (57 ha) had been acquired through amicable agreements. For the remaining 11 plots (c.12.35 ha) Gürmat were not able to reach negotiated settlements and judicial proceedings in order to obtain the immediate expropriation decision from the local court were initiated on 11.09.2013. These plots are owned by 13 individuals and territorially within the village Ömerbeyli. They are all needed for the construction of EFE 1 plant. One plot of approx. 2.25 ha is owned by 4 landowners and one plot of approx. 0.48 ha is owned by 2 landowners. The price offered by Gürmat varied from 13 to 14 TL per m^2.

Turkish law permits the expropriation of land by a public agency in the “public interest”. In this case, the Energy Market Regulatory Authority (EMRA) is the public agency working with Gürmat. EMRA is acting on behalf of the Treasury. Following expropriation, the Treasury become the legal owners of the land with Gürmat leasing the land for a period of 49 years.

In accordance with Article 27 of the Expropriation Code, land acquisition is done through an immediate expropriation procedure. The steps in the expropriation process are as follows:

- The Company applies to EMRA, providing a list of needed land plots.
- EMRA takes a decision for immediate expropriation under Article 27 of the Expropriation Code No. 2942, after the decision of the Council of Ministers.
- EMRA then turns to the local court with requests to determine the price of affected land plots and to give the Company (Gürmat 2) the right to use the land plots.
- The court assigns at least 5 technical certified experts for assessing the land and includes in the group any additional local persons who know the prices of land in the area, if needed. The village headmen (muhtars) are also required to attend the appraisal.
- The experts prepare reports and send them to the court.
- The court takes a decision on the immediate expropriation of the land plots and on the basis of expert reports, determines the price for each land plot.
- The Company opens up accounts in the name of the landowners and deposits the court specified amounts in their bank accounts.
- The court takes a decision for immediate expropriation after the Company makes the payment.
- The Company then has the right to begin construction on the acquired land plots.
- EMRA sends an invitation letter to the landowners to attend negotiation meetings. The letter is accompanied by the court decision, the expert appraisal report and proof of payment of the expropriation price.
- At the negotiation meetings the Company can choose to provide higher amounts of compensation, so that an agreement can be reached.
- If an agreement is not reached, EMRA turns to the local court again, with requests to determine the price of needed land and to transfer title to the Treasury (with the right of use for the Company).
- New valuations are organized with a new group of court appointed experts.
- The owner and the Company can agree on a price up until the end of this second trial
- If the owner is not satisfied with the final price determined by the court he/she can appeal to the Supreme Court against the decision of the local court

Valuations of properties are done through field assessments. Valuation criteria include the type and quality of the property, the surface area, the location, all property components (including vegetation, structures, water sources, etc.), tax statements, the net revenue to be obtained from a property or a water source on land, the estimated amount made by official authorities during previous valuations, the price of similar land sold before the date of expropriation and any other objective measurements that can be used to determine the compensation amount. The value of agricultural land is based on the net income approach and includes all on-land physical assets and the value of crops based on the annual yield (three year average). If the involved parties still do not agree on the value at the next hearing, the judge will set a fair expropriation value based on reports by valuation experts.

Final determination of the expropriation price is made by the Court and Gürmat do not have a separate Grievance Mechanism to address third party complaints, as is required under relevant IFI policies (the Project SIA recommended one and the SEP now contains one). Involuntary resettlement may negatively affect people’s livelihoods, particularly if they are not able to replace the land plots they lost with the compensation they receive. Available data suggests that compensation was paid at market value, i.e. the quality of land was valuated, as well as all assets on the land, such as crops and assets were compensated at market prices. Transaction costs associated with transferring ownership to the Company were also borne by the Company. However, there was no provision for transaction costs or registration fees in the compensation for people who planned to buy new, replacement land. This suggests that replacement cost, as required under the respective IFI policies was not achieved. In addition, for those who did not manage to buy replacement land with the compensation they received at the end of 2014, at least one season of crops has been lost. A Livelihood Restoration Plan was not produced for the Project, as required by IFIs and therefore a census and survey were not carried out. As a result of that, there is no detailed information about affected people. For example, it is unknown if all affected people were identified, including any formal or informal users of land, which should have been compensated for the crops they lost. There is also no data on whether among the affected people there were some that as a result of vulnerability or other factors (i.e. not owning any other land and being severely impacted), were not or will not be able to restore their livelihoods with the compensation they received.

An important consideration for land acquisition and continued access to agricultural land is the proposed routing of the GPP pipework. As at July 2014, the pipework routing had not been finalised. The parts of land plots needed for the construction of the pipe network are acquired permanently by Gürmat. The company acquires six metres of land in width within which the pipeline is installed. The pipe itself only occupies a 2m strip, while the rest of the land can continue to be used by the landowner. However, Gürmat acquires a 6m strip of land so that can access the land for repairs and maintenance (i.e. the protection zone around the pipe), without having to compensate the landowner for any loss to crops or trees. As a matter of policy, Gürmat tries to follow roads and plot borders when aligning the pipework. This minimises the land required for acquisition. Gürmat recognises that owners must have access to their land and raises the pipeline at plot entrances to provide access by people, animals, and farm equipment.

For the EFE 2 pipework, the company used land it already acquired for wells and needed only a part of one additional plot (approx. 250 m^2). A total of 0.65 ha of land were acquired for the EFE2 pipework. The rest of the pipework was constructed along the channels and roads, which belong to the General Directorate of Hydraulic Works (GDHW). A protocol regarding the use of this land was signed between Gürmat and the GDHW.

Land plots needed for the construction of the overhead electricity transmission lines (ETLs) are being acquired in a specific procedure. For the construction of pylons (and their foundations), parts of land plots are permanently acquired (15 plots). In a preliminary procedure, Gürmat is contacting the landowners and offering them a fee for the right to construct the pylons on parts of their land, which will become inaccessible to them when construction is finalised. When such an agreement (i.e. act of settlement) with the landowner is reached and money paid, Gürmat begins construction. This is being done by Gürmat to speed up the construction process, as expropriation lasts a longer period of time, regardless of the fact that Gürmat will have to pay twice to the landowners. At the time of developing this document, Gürmat had already signed acts of settlements with all owners of land on which pylons have been or are being constructed.

After land has been acquired by Gürmat through acts of settlement, an expropriation procedure is initiated by the relevant agency. For the main line between EFE 1 and the National Grid, expropriation will be carried out by TEIAS (Turkish Energy Transmission Company). For the internal line between EFE 2 and EFE 1, expropriation will be carried out by EMRA. TEIAS will become the owner of the land beneath the ETLs and will grant Gürmat the permit to formally use the ETLs.

The issue of how land acquisition for a Project is handled and whether or not affected people are able to restore their livelihoods with the compensation they receive is important for IFI involvement in Projects, as it could pose a reputational risk for the banks. In light of all this, due diligence of previous land acquisition must be carried out, including all affected landowners whose land is being expropriated, to determine if there are corrective measures that need to be undertaken to bridge any gaps in relation to fulfilling IFI requirements. A livelihood restoration plan also needs to be prepared for all additional land acquisition for the project.

6. Summary of Impacts

6.1. Environmental Impacts

Whilst there will be some loss of land due to the construction of the G2 GPP, this is land is agricultural and of no intrinsic ecological value. There are no sensitive, protected, or conservation areas or national parks near to the power plant.

There will be no significant consumption of water or the discharge of wastewater to surface water streams.

The GPP will not use significant quantities of fuels, chemicals or other hazardous materials. Those materials that will be held on site are primarily for maintenance purposes and will be held in appropriately designed facilities.

There is a potential risk that noise from the new GPP may impact on local residents. The design of the power plants (and in particular the process cooling) must be reviewed to ensure that effective noise screening is provided. Noise monitoring will be undertaken by Gürmat when the plant is in operation.

There is a potential risk that hydrogen sulphide releases from the new GPP may impact on local residents. Hydrogen sulphide releases from the existing Gürmat GPP are monitored and do not appear to be a cause of concern to neighbours.

Particular note is made regarding the extent of the network of pipes that will transport the geothermal fluid. The concession area is large (28km^2) and, although centred on each of the powerhouses, the network is likely to be large. The current pipework system is clad with a highly reflective metal which means that the pipes are very visible within the landscape. Similarly, the steam plume from the open evaporative cooling towers will be visible from a distance.

There is no regulatory control over carbon dioxide emissions in Turkey. As a consequence, the project designers did not need to take CO_2 releases into account when selecting the main equipment. For the Project as defined by the Banks investment (i.e. EFE 1 to 4 only), the GHG releases will be around 893,673 tCO_2 equivalent pa and the GHG intensity of the release will be 0.84 tCO_2 equivalent per MWh, (based upon Gross MW capacity).

Gürmat have been considering the installation of a CO_2 capture and liquefaction unit at their existing GPP. The captured CO_2 could be used for production of dry ice and the commercial freezing of food. The scheduled date for installing the CO_2 liquefaction unit is 2016. It may be preferable to install the unit at G2 GPP, and this the subject of further consideration. The unit will however not be able to recover all of the CO_2 from G2 GPP due to the size of the market in Turkey for liquid CO_2. International export of liquid CO_2 may need to be considered to make this approach economically viable.

The potential for the reinjection of the NCG into the reservoir has been considered. However, ORMAT's initial investigations suggest that reinjection will be technically very complicated, will consume more energy that the GPP will produce and will be very costly. It therefore seems very unlikely that this option will be pursued.

6.2. Social Impacts

Gürmat has given careful consideration to the positioning of the GPPs, wells, ETLs and pipelines to minimise disruption to local landowners. Although this has been done to avoid programme delays, it does mean that the levels of (technical) involuntary resettlement are very low. In the majority of cases, Gürmat has managed to agree an acceptable price for the land being acquired. The 11 plots that are the subject of formal expropriation are being acquired in compliance with Turkish regulations. However, as there was no baseline survey carried out, the circumstances of the affected landowners are presently unknown as well as whether the loss of land will have a significant impact on their livelihoods, i.e. will cause economic displacement.

6.3. Cumulative Impact

There are two other GPPs within a 20km radius of the proposed G2 GPP. The power plant owned and operated to the north of the proposed G2 GPP will be part of the same license area but the second is not. The geothermal reservoir is sufficiently large that there is not expected to be significant loss of capacity within the reservoir.

The construction of a new GPP will increase the quantities of carbon dioxide being released into the air. The progressive removal of carbon dioxide from the reservoir will mean that concentration in the NCG will reduce over time. This means that the annual mass release of carbon dioxide will decrease over time.

All geothermal fields emit gases originating from the geothermal resource. This is potentially acute from high pressure liquid dominated fields like Germencik. It is likely that the exploitation of the Germencik reservoir by Gürmat will mean that the natural losses will decline (as the hydraulic pressure and %NCG in the brine reduces). In essence, this means that the release of GHGs from the GPP will cause a reduction in the natural loss of CO_2. It is extremely difficult to quantify the reduction, but the natural loss of CO_2 could be between a third and two thirds of the release from the G2 GPP.

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