Aydin Salavatli Dora-1 Geothermal Power Plant

Document Prepared by South Pole Carbon Asset Management Ltd.

Project Title	Aydin Salavatli Dora-1 Geothermal Power Plant (hereafter referred to as "the Project")
Version	2.0
Date of Issue	06-09-2018
Prepared By	Lixiang Hu South Pole Carbon Asset Management Ltd.
Contact	x.hu@southpole.com www.southpole.com

Table of Contents

1 PROJECT DETAILS

1.1 Summary Description of the Project

MENDERES Geothermal Elektrik Üretim A.Ş, (hereafter referred to as "the Project Owner") is the owner and the license holding company for the grid connected 7.951 MW Aydin Salavatli Dora-I Geothermal Power Plant. The company has been established in 1999 and is headquartered in Aydın. The company was established as a "generation company" in accordance with the terms and conditions stated in the Electricity Market Licensing Regulation published in the Official Gazette dated 04.08.2002, numbered 248336. The Project Owner continues to invest in the renewable energy sector.

The project activity aims to generate electricity from geothermal energy at a heat between 78°C and 170°C. The geothermal fluid is pumped up to the surface through production wells. The thermal fluid is passed through a heat exchanger and the heat from the fluid is transferred to a secondary fluid - hydrocarbon. The secondary fluid is vaporized to generate electricity via the turbine and the generator. After having passed the heat exchanger, the geothermal fluid drops to 78°C and is re-injected back to the reservoir via a re-injection well. The production cycle is closed due to complete re-injection of the geothermal brine; thus avoiding any adverse effects to the environment and the performance parameters of the geothermal reservoir. The inhibitor and the dosing pump installed at the well prevent the fluid from causing corrosion and silica sediment deposits.

This project is located in Salavatlı, Aydın, the Sultanhisar-Salavatlı geothermal field of Turkey.

The electricity generated by this project is connected to the national grid of Turkey to replace the equivalent electricity generated by fossil fuel power plants. Through avoiding the emission of fossil fuel, it could generate emission reductions.

Before the project activity, there was no geothermal for electricity production activities. The Turkey national grid is mainly consisted with fossil fuel power plants. The electricity generated by this project would have been generated by these fossil fuel power plants.

The Project is the first private geothermal power plant in Turkey, which was taken into operation and the first employing the specific "Organic Rankine Cycle & Binary technology" for increased efficiency. Thus, it can be considered as the pioneer private geothermal power plant in whole Turkey.

Construction was initiated in May 2005.The Project commissioned in May 10, 2006. The first crediting period of this project is from 01/07/2008 to 30/06/2018. Now this project is applying for renewal of crediting period, and the second crediting period is from 01/07/2018 to 30/06/2028. The emission reduction is estimated to be 30206tCO_2/yr.

1.2 Sectoral Scope and Project Type

According to UNFCCC sectoral scopes definition for CDM projects, the Project Activity is included in the Sectoral Scope 1, category "Energy industries (renewable - / non-renewable sources)".

The project is a single Greenfield investment and is not part of a project group or bundle.

1.3 Project Proponent

Organization name	MENDERES Geothermal Elektrik Uretim A.Ş.

Contact person	Mr. Murat Haluk Tufekcioğlu
Title	Manager
Address	Mugla Bulvari No: 7/1, 09100. Aydin. Turkey
Telephone	/
Email	egeenerji@mb.com.tr

Organization name	South Pole Carbon Asset Management Ltd.
Contact person	Mr. Yang Xuan
Title	Country Manager Turkey
Address	Technoparkstrasse 1.8005. Zurich. Switzerland.
Telephone	+ 41 44 633 78 79 + 49 179 975 9803
Email	x.yang@southpolecarbon.com

1.4 Other Entities Involved in the Project

N/A

1.5 Project Start Date

The project reached financial closure on 4 April 2003.This is the project start date.

1.6 Project Crediting Period

The crediting period is from 01/07/2008 to 30/06/2028.

1.7 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Small Project	√
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
01/07/2018 -31/12/2018 (184days)	15,227
2019	30,206
2020	30,206
2021	30,206
2022	30,206
2023	30,206
2024	30,206

2025	30,206
2026	30,206
2027	30,206
01/01/2028-30/06/2028 (181days)	14,979
Total estimated ERs	302,060
Total number of crediting years	10 years
Average annual ERs	30,206

1.8 Description of the Project Activity

As discussed above the project covers an area of 25'000 square meter including two sides. One of them hosts the production wells named AS-1 and ASR-2. They are connected to the electricity generation facility through a 900-meter-long isolated tubes in the case of well AS-1 and 100 meter for the ASR-2 well. The re-injection well, named AS-2, is located right at the generation facility.

The electricity is being fed to the national grid through a 3.5-kilometer long underground cable, which has been constructed by the Project Owner. The generation process works as follows: 3% Steam and 97% hot brine are pumped from four wells from a depth between 1300 meter (ASR-2) and 1510 (AS-1) meter. The thermal fluid is passed through a heat exchanger and the heat from the fluid is transferred to a secondary fluid, hydrocarbon. The secondary fluid is vaporized to generate electricity via the turbine and the generator. After leaving the heat exchanger water will then be re-injected back to the reservoir through the additional 962-meter deep re-injection well. Thus, a closed system is formed where any adverse effect to the environment can be avoided. Additionally, some of the waste heat -instead of reinjecting the fluid directly to the earth- is planned to be used in various greenhouses in the future.

The Project employs latest geothermal technology. As the first private geothermal power plant in Turkey the Project uses the specific "Organic Rankine Cycle & Binary technology" for increased efficiency. The employed turbine is produced by Ormat Industries Ltd. [1]. And the lifetime is about 25 years.

Installation works have been accompanied by expertise and consultancy from Istanbul and abroad. The Dora-I power plant operates for 8125 hours a year. The rest of the time is dedicated to maintenance works at the power plant for assuring proper condition of the production facilities.

In absent of the project, the electricity generated by this project would have been provided by the national grid connected power plants. And the geothermal would not be used.

1.9 Project Location

The Dora-I power plant has been constructed in the West of the village Salavatlı, which is located in the Northeast of the city of Aydın. The geographical location of the Project is 37°53'22.85'' N and 28°06'33.50'' E.

1 https://www.ormat.com

It was built in a free area in the marginal lands of the village and covers an area of 25’000 square meter including two sides. One of them hosts the production wells named AS-1 and ASR-2. They are connected to the electricity generation facility through 900-meter-long isolated tubes in the case of well AS-1 and 100 meter for the ASR-2 well. The re-injection well, named AS-2, is located right at the generation facility.

Figure 1. Project location

1.10 Conditions Prior to Project Initiation

The project is a Greenfield project. At project location, prior project initiation, there was no geothermal or electricity production activities. The Turkey national grid is mainly consisted with fossil fuel power plants. The electricity generated by this project would have been generated by these fossil fuel power plants.

The baseline scenario is the same with conditions prior to the project initiation. The detail for baseline justification can be seen in section 2.4.

1.11 Compliance with Laws, Statutes and Other Regulatory Frameworks

Relevant laws have been identified and summed up in Table 1.

Relevant Laws	Number/Enactment Date
Environmental Law	Nr. 2827 / 11.08.1983
Electricity Market Law	Nr. 4628 / 03.03.2001
Law on Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy	Nr. 5346 / 18.05.2005
Energy Efficiency Law	Nr. 5627 / 02.05.2007

The project received all authorizations and permits to operate, proving that the project is in line with all laws and regulations of Turkey.

1.12 Ownership and Other Programs

1.12.1 Project Ownership

An Emission Reductions Purchase Agreement will be provided for validation that grants all reductions/removals to the proponent.

1.12.2 Emissions Trading Programs and Other Binding Limits

This project reduces GHG emissions from activities are not included in an emissions trading program or any other mechanism that includes GHG allowance trading.

1.12.3 Other Forms of Environmental Credit

This project has not sought or received another form of GHG-related environmental credit or renewable energy certificates.

1.12.4 Participation under Other GHG Programs

This project has not been registered, or is seeking registration under any other GHG programs.

1.12.5 Projects Rejected by Other GHG Programs

This project has not been rejected by any other GHG programs.

1.13 Additional Information Relevant to the Project

Eligibility Criteria

N/A.

Leakage Management

N/A

Commercially Sensitive Information

All commercial and financial information are considered as confidential by the Project Owner and will only be disclosed to the validator.

Sustainable Development

Reduces greenhouse gas emissions in Turkey compared to the business-as-usual scenario.

Helps to stimulate the growth of the geothermal power industry in Turkey.

Creates local employment during the construction and the operation phase of the geothermal power plant.

Provide health check and work training for the workers, which could improve their health condition and working ability.

Reduces other pollutants resulting from power generation industry in Turkey, compared to a business-as-usual scenario.

Helps to reduce Turkey's increasing energy deficit.

Diversify the electricity generation mix and reduce import dependency.

Further Information

N/A

2 APPLICATION OF METHODOLOGY

2.1 Title and Reference of Methodology

AMS-I.D.: Grid connected renewable electricity generation (v18.0)[2].

Tool to calculate the emission factor for an electricity system(v7.0)[3].

Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion(v03)[4]

ACM0002 Grid-connected electricity generation from renewable sources (V19.0) [5]

Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period (version 03.0.1)[6]

2.2 Applicability of Methodology

The choice of the CDM methodology AMS-I.D （v18.0） can be justified through its applicability criteria as listed below:

Table 2. Methodology applicability

Applicability criteria	Compliance check
1. This methodology comprises renewable energy generation units, such as photovoltaic, hydro, tidal/wave, wind, geothermal and renewable biomass: （a） Supplying electricity to a national or a regional grid; or (b) Supplying electricity to an identified consumer facility via national/regional grid through a contractual arrangement such as wheeling.	The project is a renewable energy generation unit utilizing geothermal power and exports it to and in the process displaces electricity from the national electricity grid of Turkey.
2. This methodology is applicable to project activities that: (a) install a Greenfield plant; (b) involve a capacity addition in (an) existing plant(s); (c) involve a retrofit of (an) existing plant(s); (d) involve a replacement of (an) existing plant(s); or (e) Involve a replacement of (an) existing plant(s).	The project activity involves the installation of a Greenfield plant –a new power plant at a site where there was no renewable energy power plant operating prior to the implementation of the project activity, as per option (a).
3. Hydro power plants with reservoirs that satisfy at least one of the following conditions are eligible to apply this methodology: (a)The project activity is implemented in an existing reservoir with no change in the volume of reservoir;	The project is not a hydropower plant.

[2] http://cdm.unfccc.int/methodologies/DB/W3TINZ7KKWCK7L8WTXFQQOFQQH4SBK

[3] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v7.0.pdf

[4] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v3.pdf
[5] http://cdm.unfccc.int/methodologies/DB/VJI9AX539D9MLOPXN2AY9UR1N4IYGD
[6] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-11-v3.0.1.pdf

Applicability criteria	Compliance check
(b) The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the Project Emissions section, is greater than 4 W/m^2; •(c)The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the Project Emissions section, is greater than 4 W/m^2.	
4. If the new unit has both renewable and non-renewable components (e.g., a wind/diesel unit), the eligibility limit of 15 MW for a small-scale CDM project activity applies only to the renewable component. If the new unit co-fires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15 MW.	The project has only renewable component with an installed capacity less than 15 MW.
5. Combined heat and power (co-generation) systems are not eligible under this category.	The project is not a combined heat and power system.
6. In the case of project activities that involve the capacity addition of renewable energy generation units at an existing renewable power generation facility, the added capacity of the units added by the project should be lower than 15 MW and should be physically distinct1 from the existing units.	This project does not include capacity addition.
7. In the case of retrofit, rehabilitation or replacement, to qualify as a small-scale project, the total output of the retrofitted or replacement unit shall not exceed the limit of 15 MW	The project is not an additional to an existing renewable power generation facility as explained above.
8. In the case of landfill gas, waste gas, wastewater treatment and agro-industries projects, recovered methane emissions are eligible under a relevant Type III category. If the recovered methane is used for electricity generation for supply to a grid then the baseline for the electricity component shall be in accordance with procedure prescribed under this methodology. If the recovered methane is used for heat generation or cogeneration other applicable Type-I methodologies such as “AMS-I.C.: Thermal energy production with or without electricity” shall be explored.	This project is not landfill gas, waste gas, wastewater treatment and agro-industries project.
9. In case biomass is sourced from dedicated plantations, the applicability criteria in the tool “Project emissions from cultivation of biomass” shall apply.	This project does not include biomass consumption.

2.3 Project Boundary

Table 3. Project boundary

Source		Gas	Included?	Justification/Explanation
Baseline	CO_2 emissions that are displaced due to the Project Activity from electricity generation in fossil fuel fired power plants connected to national grid	CO_2	Yes	Main emission source. The dominant emissions from power plants are in the form of CO_2, therefore CO_2 emissions from fossil fuel fired power plants connected to the grid will be accounted for in baseline calculations.

Source		Gas	Included?	Justification/Explanation
		CH_4	No	Minor emission sources
		N_2O	No	Minor emission sources
		Other	No	Minor emission sources
Project	For binary geothermal power plants, fugitive emissions of CH_4 and CO_2 from non-condensable Gases contained in geothermal steam	CO_2	No	Fugitive emissions of carbon dioxide and methane due to release of non-condensable gases from produced geothermal steam aren't accounted as Project Emissions, because the non-condensable gases resulting from the produced steam are isolated and delivered to Linde Gaz A.Ş. that belongs to Linde Group being internationally recognized supplier of industrial gases.
		CH_4	No	Neglected
		N_2O	No	Neglected
		Other	No	Neglected
	For binary geothermal power plants, fugitive emissions of hydrocarbons such as n-butane and isopentane (working fluid) contained in the heat exchangers	Low GWP hydrocarbon /refrigerant	No	The working fluid in this project is pentane, so the emission is neglected
	CO_2 emissions from consumption of fossil fuels for electricity generation in geothermal power project	CO_2	Yes	The project emissions due to the diesel consumption will be monitored regularly and if these emissions contribute for more than 1% of baseline emissions than they will be deducted from the baseline emissions to calculate emission reductions of the project activity.
		CH_4	No	Minor emission sources
		N_2O	No	Minor emission sources
		Other	No	Minor emission sources

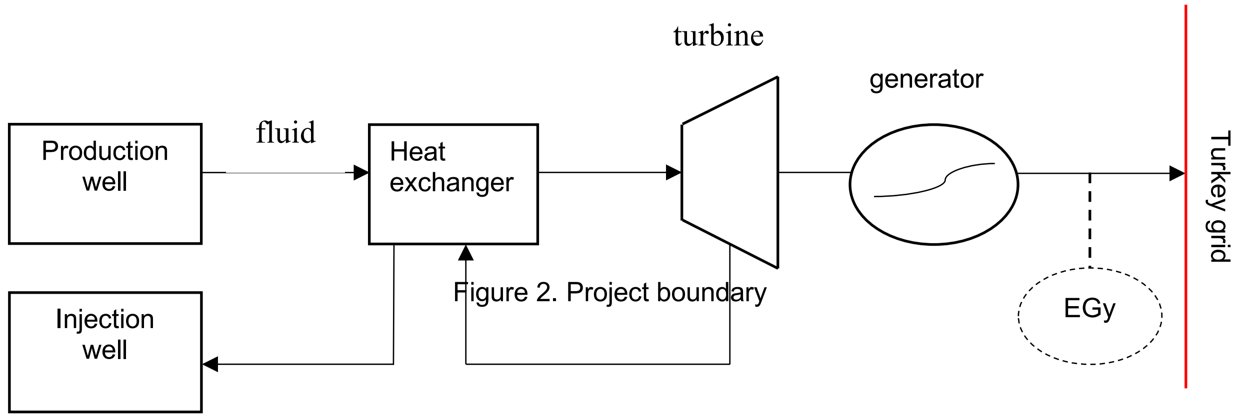


Figure 2. Project boundary

2.4 Baseline Scenario

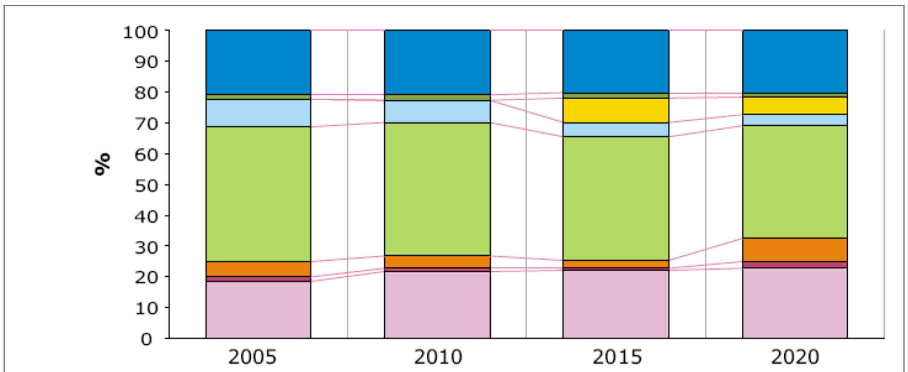
The baseline scenario is that the electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources into the grid. This scenario would be the continuation of the business as usual which is displayed in Figure 2.

The share of fossil fuel-fired capacity of the grid is 66.8% (Natural Gas+ Lignite+ Hard Coal+ Imported Coal+ Liquid Fuels) of the total capacity in 2016. Renewable resources constitute 33.2% of total capacity where only 1.76% is geothermal resources[7].

Figure 3. below shows the expected share of resources in generating capacity between 2005-2020. The share of lignite and imported coal is expected to rise while the percentage of hydro power is also expected to slightly decrease during the period. Thermal resources are expected to still comprise 72.5% of total capacity in 2020[8].

[7] Annual development of renewable electricity generation share in Turkey total generation share 2000-2016 (https://www.teias.gov.tr/tr/iii-elektrik-enerjisi-uretimi-tuketimi-kayiplar

[8] Chapter.5.Projections and Mitigations Scenarios, First National Communication of Turkey on Climate Change, January 2007, (pg. 121-157) (http://www.undp.org.tr/Gozlem2.aspx?WebSayfaNo=531)



	2005	2010	2015	2020
Hydro	21.2	21.0	20.5	20.2
Wind	1.3	1.8	1.6	1.5
Nuclear	0.0	0.0	7.8	5.8
F.Oil+Diesel	8.7	7.1	4.8	3.6
Natural Gas	43.8	43.4	39.8	36.5
Imported Coal	4.9	3.9	2.7	7.4
Dom. Hard Coal	1.4	1.1	0.8	2.0
Lignite	18.6	21.7	22.0	23.0

Figure 3. Electricity Generation Forecast (2008-2017)

Based on the Methodological Tool *"Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period. (Version 03.0.1)"*, the following steps are used for assess the validity of the current baseline for the next crediting period:

Step 1: Assess the validity of the current baseline for the next crediting period

The validity of the current baseline is assessed using the following Sub-steps:

Step 1.1: Assess compliance of the current baseline with relevant mandatory national and/or sectoral policies

'If the current baseline complies with all relevant mandatory national and/or sectoral policies which have come into effect after the submission of the project activity for validation or the submission of the previous request for renewal of the crediting period and are applicable at the time of requesting renewal of the crediting period, go to Step 1.2. '

The current baseline also is the equivalent electricity is supplied by Turkey power grid, complies with all relevant mandatory national and/or sectoral policies which have come into effect after the submission of the previous request for renewal of the crediting period and are applicable at the time of requesting renewal of the crediting period, so go to Step 1.2.

Step 1.2: Assess the impact of circumstances

'Assess the impact of circumstances existing at the time of requesting renewal of the crediting period on the current baseline emissions, without reassessing the baseline scenario. '

There is no impact of circumstances existing.

'In the situation where the baseline scenario identified at the validation of the project activity was the continuation of the current practice without any investment, an assessment of the changes in market characteristics is required for the renewal of the crediting period. '

The baseline scenario for the project is to import equivalent electricity from Turkey power grid, which is dominated by thermal power plants in the previous crediting period. In the renewal crediting period, the power grid is still dominated by thermal power plants. There is no big change in the national power grid. Moreover, the small changes of the power grid market have little relationship with the baseline scenario.

'Evaluate whether the conditions used to determine the baseline emissions in the previous crediting period are still valid. Assess the availability of new fuels or raw materials and the impact of electricity or fuel prices in the identification of the current practice for the baseline emissions;'

Turkey power grid is dominated by thermal power plants, so new fuels, raw materials and electricity will not have significant impact on the baseline scenario. However, the electricity proportion of delivered to power grid from other power plants and renewable source plants may impact the emission factor a little. The emission factor has been updated according to 'tool to calculate the emission factor for an electricity system (Version 07.0). The baseline emission will be updated based on the methodology AMS-I.D (version 18.0)

'If the new circumstances make a continued validity of the current baseline not plausible, then the current baseline needs to be updated for the subsequent crediting period. '

Through the analysis above, the current baseline is continued. So, the baseline would not be updated in the subsequent crediting period.

Step 1.3: Assess whether the continuation of use of current baseline equipment(s) or an investment is the most likely scenario for the crediting period for which renewal is requested.

'This sub-step should only be applied if the baseline scenario identified at the validation of the project activity was the continuation of use of the current equipment(s) without any investment and, the projects proponents or third party (or parties) would undertake an investment later due, for example, to the end of the technical lifetime of the equipment(s) before the end of the crediting period or the availability of a new technology. '

The baseline scenario of this project is that the equivalent electricity generated by the project activity would be imported from the Turkey power grid, which was not an investment activity. So this is not applicable.

'Assess whether the remaining technical lifetime of the equipment that would have continued to be used in the absence of the project activity, as determined in the CDM-PDD or CDM-PDD-REN, exceeds the crediting period for which renewal is requested. '

This is not applicable.

Take into consideration the market penetration of different technologies. Evaluate the penetration rate of different technologies that are available in the market and evaluate how they could affect the baseline.

This is not applicable.

'If the baseline scenario of the project activity is the continuation of use of the current equipment(s) without any investment and the projects proponents or third party(ies) will undertake an investment later, but before the end of a crediting period, then the current baseline needs to be updated for that crediting period or the crediting of emission reductions should be limited to the period before the baseline equipment would cease its operation.'

This is not applicable.

Step 1.4: Assessment of the validity of the data and parameters

'Assess whether data and parameters that were only determined at the start of the crediting period and not monitored during the crediting period are still valid or whether they should be updated. Updates should be undertaken in the following cases: '

• *'Where IPCC default values are used, the values should be updated if any new default values have been adopted and published by the IPCC, for example, in guidelines for national GHG inventories, IPCC assessment report or special reports by the IPCC; '*

For renewal of the crediting period, the updated IPCC 2006 was adopted.

• *'Where emission factors, values or emission benchmarks are used and determined only once for the crediting period, they should be updated, except if the emission factors, values or emission benchmarks are based on the historical situation at the site of the project activity prior to the implementation of the project and cannot be updated because the historical situation does not exist anymore as a result of the CDM project activity. '*

The emission factors are updated.

'If any of the data and parameters that were only determined at the start of the crediting period and not monitored during the crediting period are not valid anymore, the current baseline needs to be updated for the subsequent crediting period. '

The data and parameters that were only determined at the start of the crediting period and not monitored during the crediting period, which are not valid anymore, so the data and parameters need to be updated for the subsequent crediting period.

'If the application of Steps 1.1, 1.2, 1.3 and 1.4 confirmed that the current baseline as well as data and parameters are still valid for the subsequent crediting period, then this baseline, data and parameters can be used for the renewed crediting period. Otherwise, proceed to Step 2. '

The current baseline still valid, but the data and parameters need to update, so it proceeds to step 2.

Step 2: Update the current baseline and the data and parameters

This step is only applicable if any of the Steps 1.1, 1.2, 1.3 and/or 1.4 showed that the current baseline needs to be updated.

Step 2.1: Update the current baseline

Update the current baseline emissions for the subsequent crediting period, without reassessing the baseline scenario, based on the latest approved version of the methodology *applicable to the project activity. The procedure should be applied in the context of the sectoral policies and circumstances that are applicable at the time of request for renewal of the crediting period.*

This is not applicable, as the baseline is not changed.

Step 2.2: Update the data and parameters

'If the application of Step 1.4 showed that the data and/or parameter(s) that were only determined at the start of the crediting period and not monitored during the crediting period are not valid anymore, project participants should update all applicable data and parameters, following the guidance in Step 1.4. '

In this project, all the parameters related to the emission factors of the power grid are determined at the start of the crediting period and not monitored during the crediting period, so they are updated in the second crediting period. The detail can be seen in annex 2.

As analysed above with "*Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period. (Version 03.0.1)*", the baseline is the same as the first crediting period, i.e. the electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources into the grid.

2.5 Additionality

For the demonstration of additionality the "project test" as prescribed in the VCS 2007 guidelines has been chosen.

Step 1: Regulatory Surplus

The Project has not been mandated by any enforced law, statute or other regulatory framework. Please, see section 1.11 for details.

Step 2: Implementation Barriers

According to the VCS guidelines the project shall face one (or more) distinct barrier(s) compared with barriers faced by alternative projects. Thus, technological and institutional barriers have been identified and will be elaborated in detail:

Institutional barriers:

Access to finance: The Project Owner has experienced grave difficulties in securing the finance for the Project because of the following reasons;

- <u>Project Financing:</u>

Non-availability of a bank loan: The Project Owner was not able to finance the project by "Project Financing" because it was the first of its kind and banks deemed the project to be too risky. The low Annual Debt Service Cover Ratio (ADSCR) of the project further increased the non-availability of Project Financing by the banks.

Necessity of Exim credits by the Equipment supplier: As a result of the reluctance of the banks to take part of the first mover risks the Project Owner is exposed to, it had to resort to an Exim credit of the equipment supplier. Thus, only the Project Owner and the equipment supplier as an attempt to sustain its business were willing to take the risks of employing this new technology in Turkey, being exposed to non-availability of experience, high risks of tectonic activity and high country risks rates.

Equipment and land mortgage: Only a small fraction of the investment could be covered by the Project Owner's equity and the Exim credit. Thus, additional capital had to be acquired and could be secured in form of a loan by the Turkish development bank Türkiye Kalkınma Bankası A.Ş. after all the difficulties only under the non-favourable condition of a mortgage on the land and the equipment. Given that due to the debt the investment became possible, it did not change the situation with regard to the risk distribution for the Project.

● Country Risk: Turkey faces a relatively high volatility of its economy. The associated country credit ratings of Turkey lead to higher interest rates for debt financing, since commercial risks affect expected return. This perception results in elevated investment costs and a more selective approach by banks for their financing decision, and led to non-availability of financing in the case of the Project.

● Regulatory framework and policy: The Energy Efficiency Law, mentioned in Table 1, on the one hand defines a minimum price of 5 Eurocent per kWh for the first 10 years for plants put in operation before 2012 whereas on the other hand a price gap of 5.5 cent per kWh limits the income to the producer. Due to increasing electricity demand in Turkey the current electricity price is higher, which let the incentive scheme of this regulation fade away.

● Long Payback Period: As a result of higher debt interest rates and initial investment requirements, geothermal plant investments generally have long payback periods and a low ADSCR. This created difficulties in accessing finance for the Project where its financial performance directly depends on very volatile electricity prices, inter alia due to political reasons, competition with fully depreciated old state owned power plants, which do not reflect the real costs of electricity generation onto prices. Additionally, the privatization of the distribution company will lead to additional price risks as explained below.

●Transmission line: An 3.5 km long underground cable has been laid in order to feed the produced electricity to the 31,5 kV Aydın - Nazilli transmission line. The financing of this transmission cable would in theory be the legal obligation of the grid operator. In the underlying case, the Project Owner privately financed it for avoiding inefficiencies due to probable and disagreeable delays.

●Wells drilling: A main risk is wells drilling. The cost and number of wells is known only after drilling and testing the wells and this contains the risk of significant additional and unexpected investment requirements. This risk has never been taken by a private investor in the geothermal sector before and therefore posed a great investment barrier.

●Privatization of the national distribution system: Privatization of grid operation and distribution is enforced and ongoing in Turkey. While these activities do not bring any chances for geothermal power producers, they rather contain the risk of rising distribution fees and lower electricity prices. With the mentioned privatization the new distribution companies are being obliged to buy a certain fraction of energy from renewable sources thereby looking for the lowest possible price. This will expose the Project Owner to lower prices due to the lack of bargaining power of a small geothermal project in comparison to very large electricity suppliers.

All these uncertainties had to be considered within the financial planning of the project and complicated the access to equity and loans for the geothermal power investment.

Technological Barriers:

Technology transfer: Turkey is a developing country and technology / know how transfers are significant factors for its sustainable development. The successful implementation of geothermal power plants in Turkey will enable a faster exploration of the geothermal potential and a more diversified local renewable energy market. However, since geothermal plants are not a proven technology in Turkey, the procurement of specific services and equipment in Turkey is almost impossible, at least at a desired level of quality. A significant portion of the required technology –practically all the electricity generating equipment and know how- had therefore to be imported.

Equipment Selection: The Project is the first private investment employing the specific "Organic Rankine Cycle & Binary technology"[9]. The ORC - turbines, have higher prices than comparable turbines. This choice is justified by their high quality, reliability, extensive technical support, grid friendliness, low maintenance requirements and acceptable noise level. However, it amplifies the investment volume, thus posing another barrier.

Lack of Skilled Labour: Skilled and properly trained technical staff in the construction and operation of geothermal plants is unavailable in Turkey, which causes difficult maintenance and operation conditions and a considerable risk of underperformance. Experienced staff is crucial for geothermal power plants as any malfunctioning, disrepair or poor maintenance of the equipment and the turbines may result in long and costly interruptions in electricity generation.

Step 3: Common Practice

Common Practice Analysis checks whether the proposed project type has already diffused in the relevant sector and region.

Sub-step 3a. Analyze other activities similar to the project activity

At the time of VCS-PD compilation only two more operating geothermal power plants exist, which are used for electricity generation and which export electricity to the national electricity grid:

Table 4. Geothermal power plants in operation

Project name	Company	Operational start	Installed capacity (MW)	Business Model
Kizildere	EÜAġ	1984	15	State owned

[9] www.ormat.com

Denizli-Sarayköy	Bereket Jeotermal Enerji Üretim Anonim ģirket	2008	6.85	Usage of waste heat from the already running geothermal power plant Kizildere

It is more difficult to get an impression of the ongoing developments regarding geothermal power plants that are under construction or shall soon be built. From what is known at the date of PDD compilation there are five more geothermal projects in the planning stage. In the Çanakkale region in the west of Turkey, the Tuzla power plant is at project phase and wells have been drilled for reaching a final capacity of 22 MWe. Further there are the 10 MW Simav and the 10/20 MW Seferihisar projects – both not yet under operation. Another plant – the Aydın Germencik Geothermal Power Plant will start operation by the end of 2008 at 45 MWe installed capacity and 9 wells have been drilled by the Mineral Research and Exploration Institute.

Sub-step 3b. Discuss any similar options that are occurring

The 15 MW geothermal power plant in Kizildere in the region of Denizli was operated by EÜAŞ since 1984, a state owned utility. It was an investment by the state under completely different economical and political conditions in a period, where private investment could not be undertaken in the energy market since it had been a state monopoly. It is not comparable with a risky private investment under present conditions. Besides there is one additional geothermal power plant currently operating, where the conditions for its realization have been completely different from those for the Dora-I project[10]. The recently commissioned Denizli-Sarayköy 6.85 MW Geothermal Power Plant uses the waste heat of the Kizildere Geothermal power plant, which did not impose the same risk of non-performance to the project since wells have been drilled and work proven[11]. Geothermal energy so far has been used mainly for district - and green house heating, producing electricity from a geothermal source is still marginal (<100 MW out of 41’692 MW, the total capacity installed in Turkey). The proposed geothermal project is also the first one in the region and the first where private investment started with drilling of production wells, thus taking all risks from the beginning. Thus the project activity cannot be considered common practice.

Conclusion:

As opposed to common practice fossil fuel based power plants, the project activity faces several barriers. VCU revenues help the project activity to overcome these barriers by reducing the overall risk profile of the project through an improved financial feasibility. The emissions reductions from the proposed Project are therefore additional to what would have occurred in absence of the project activity.

2.6 Methodology Deviations

N/A

[10] The 15 MW Kizildere Geothermal Power Plant started operation in 1984 and was 100 percent state owned and financed. See: http://www.osti.gov/energycitations/product.biblio.jsp?osti_id=6210201, (28/04/2008

[11] See: http://www.bereketenerji.com.tr/eng/tesisler_kizildere.asp, (28/04/2008).

3 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

3.1 Baseline Emissions

The Project aims to generate electricity and CO_2 reduction through the substitution of grid electricity generation by fossil fuel fired power. According to the baseline methodology AMS-I.D., the emission reduction ERy by the project activity during a given year y is defined as:

$ER_y = BE_y - (PE_y + LE_y)$ Equation 1

Where BE_y is calculated as:

$BE_y = EG_{PJ,y} * EF_{grid,y}$

$= EG_{PJ,facility,y} * EF_{grid,y}$ Equation 2

= 51284 MWh *0.589tCO_2e/MWh

= **30,206 tCO_2e**

Parameter	SI Unit	Description
ER_y	tCO_2e	Emission reductions achieved by the project activity in year y
BE_y	tCO_2e	Baseline Emission in year y
PE_y	tCO_2e	Project Emission in year y
LEy	tCO_2e	Leakage Emissions in year y
$EF_{grid,y}$	tCO_2e/MWh	Combined margin CO_2 emission factor for grid connected power generation in year y
$EG_{PJ,facility,y}$	MWh/year	Quantity of net electricity generation supplied by the project plant/unit to the grid in year y

Calculation of $EF_{grid,y}$

In AMS-I.D(V18), the symbol of emission factor of national grid is $EF_{grid,y}$. $EF_{grid,y}$ equals with $EF_{grid,CM,y}$ in Tool to calculate the emission factor for an electricity system(v7.0)

A combined margin (CM) emission factor, consisting of the combination of operating margin (OM) and build margin (BM) emission factors are calculated according to procedures prescribe in the approved methodological “tool to calculate the emission factor for an electricity system(v7.0)”

The geothermal power plant is connected to the interconnected national grid, for which the OM and BM emission factors are calculated according to the “*Tool to calculate the emission factor for an electricity system”, version 07.0.*

The baseline emissions are calculated in a conservative manner by calculation of the emission factor of the grid mix consisting of several sources although new coal reserves are expected to be primarily utilized for power generation in the forthcoming years. As to the OM and BM, ex ante option is chosen, so, the grid emission factor will remain same during the crediting period. Furthermore, the most conservative data have been used for calculations where no data is available. The lower emission factors for fossil fuels are applied and the power plants are assumed to use best available technology.

The operation margin refers to a cohort of power plants that reflect the existing power plants whose electricity generation would be affected by the proposed project activity. The build margin refers to a cohort of power plants that reflect the type of power units whose construction would be affected by the project activity.

The combined emission factor $EF_{grid,CM,y}$ for the project activity is calculated as a weighted average of Operating Margin emission factor and Build Margin emission factor as described in the "*Tool to calculate the emission factor for an electricity system" version 07;*

$$EF_{grid,CM,y} = w_{OM} * EF_{grid,OM,y} + w_{BM} * EF_{grid,BM,y} \qquad \text{Equation 3}$$

Where:

Parameter	SI Unit	Description
$EF_{grid,CM,y}$	tCO_2e/MWh	Combined margin CO_2 emission factor for grid connected power generation in year y
$EF_{grid,BM,y}$	tCO_2e/MWh	tCO_2/MWh Build margin CO_2 emission factor for grid connected power generation in year y
$EF_{grid,OM,y}$	tCO_2e/MWh	tCO_2/MWh Operating margin CO_2 emission factor for grid connected power generation in year y
w_{OM}	%	Weighting of operation margin emissions factor; Default value 25% for the second and third crediting period, unless otherwise specified in the approved methodology which refers to this tool.
w_{BM}	%	Weighting of built margin emissions factor; Default value 75% for the second and third crediting period, unless otherwise specified in the approved methodology which refers to this tool.

The detailed calculation can be seen in Annex.2.

3.2 Project Emissions

According to the methodology AMS-I.D (v18.0), emissions related to the operation of geothermal power plants (e.g. non condensable gases, electricity/fuel consumption) have to be considered following the procedure described in the most recent version of ACM0002.

The most recent ACM0002(v19.0) defines the emissions from fossil fuel combustion, and emissions from the operation of geothermal power plants as follows:

$$PE_y = PE_{FF,y} + PE_{GP,y} \qquad \text{Equation 4}$$

Where,
$PE_{FF,y}$ =Project emissions from fossil fuel consumption in year y (tCO_2e/yr)
$PE_{GP,y}$ = Project emissions from the operation of dry, flash steam or binary geothermal power plants in year y (tCO_2e/yr).

Project emissions from fossil fuel consumption are calculated as per 'Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion (version 03.0)' as follows:

$$PE_{FF,y} = \sum_i FC_{FF,I,y} * COEF_{FF,i,y} \qquad \text{Equation 5}$$

Where

$PE_{FF,y}$	Are the CO_2 emissions from fossil fuel combustion during the year y (tCO_2/yr)
$FC_{FF,i,y}$	Is the quantity of fuel type i combusted during the year y. In this project, the fuel is diesel (t/yr)
$COEF_{FF,i,y}$	Is the CO_2 emission coefficient of fuel type i in year y (tCO_2/t)
i	Are the fuel types combusted during the year y

The CO_2 emission coefficient $COEF_{i,y}$ can be calculated using Option B of the tool as follows

$COEF_{FF,i,y}=NCV_{i,y}*EF_{CO2,I,y}$ Equation 6

Where,

$COEF_{FF,i,y}$ Is the CO_2 emission coefficient of fuel type i in year y (tCO_2/mass or volume unit)

$NCV_{i,y}$ Is the weighted average net calorific value of the fuel type i in year y (GJ/mass or volume unit)

$EF_{CO2,i,y}$ Is the weighted average CO_2 emission factor of fuel type i in year y (tCO_2/GJ)

The above calculation shall be used for calculating the GHG emissions due to diesel generator in the plant premises. Hence there shall be only one fuel of type i, i.e., diesel.

In the previous monitoring period of the first crediting period, the emission of fossil fuel ($PE_{FF,y}$) is less than 1% of the baseline emission, and thus neglected. In the second crediting period, the diesel amount will also be monitored and deducted from baseline emission if $PE_{FF,y}$ is less than 1% of baseline emission.

For geothermal and solar thermal projects, which also use fossil fuels for electricity generation, CO_2 emissions from the combustion of fossil fuels shall be accounted for as project emissions ($PE_{FF,y}$). $PE_{FF,y}$ shall be calculated as per the latest version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion(v03.0)'

$PE_{GP,y}$ is calculated as follows:

$PE_{GP,y}= PE_{dry\ or\ flash\ steam,y}+PE_{binary,y}$ Equation 7

Where:

$PE_{GP,y}$ = Project emissions from the operation of geothermal power plants due to the release of non-condensable gases in year y (tCO_2e/yr)

$PE_{dry\ or\ flash\ steam,y}$ =Project emissions from the operation of dry, flash steam geothermal power plants due to release of non-condensable gases in year y. This project is not gry, flash steam, so this parameter can be neglected.

$PE_{binary,y}$=Project emissions from the operation of binary geothermal power plants due to physical leakage of non-condensable gases and working fluid in year y

This project is binary system, so

$PE_{GP,y}=PE_{binary,y}=PE_{steam,y}+PE_{working\ fluid,y}$ Equation 8

Where:

$PE_{steam,y}$ =Project emissions from the operation of binary geothermal power plants due to physical leakage of non-condensable gases in year y. In case the difference between steam inflow and outflow to the power plant is less than 1%, then the project participants are not required to account these project emissions. In this project, the non-condensable gases resulting from the produced steam are isolated and delivered to Linde Gaz A.Ş. that belongs to Linde Group being internationally recognized supplier of industrial gases. This means that, the non-condensable gas (including CH_4 and CO_2) in the steam is not flowing into heat exchanger, and it is recycled for industrial use. Thus, the physical leakage due to the flow in and out of the exchanger is not existed in this project. So, $PE_{steam,y}$ can be considered as 0.

$PE_{working\ fluid,y}$=Project emissions from the operation of binary geothermal power plants due to physical leakage of working fluid contained in heat exchangers in year y

In this project, the working fluid is pentane. After checking the AR4 report of IPCC[12], GWP of pentane is not found. So, the project emission of working fluid is not considered. Therefore,

$PE_{GP,y}=0$ Equation 9

In conclusion, $PE_y=0$

3.3 Leakage

According to AMS-I.D. Leakage Emission only have to be considered if the energy generating equipment is transferred from another activity or if the existing equipment is transferred to another activity.

Since this is not the case in the underlying Project, leakage can be considered as:

$LE_y=0$

3.4 Net GHG Emission Reductions and Removals

The following formula has been used for the calculation of the emission reductions generated by the Project.

$ER_y=BE_y-PE_y-LE_y$

As described in detail in Annex 2, the combined baseline emission factor of the project is 0.589tCO_2/MWh.

The measured annual electricity export to the grid has been 51,284 MWh in 2007. This amount of electricity will be used for the ex-ante estimation of BE in the second crediting period. The monitored data will be used for ex-post calculation.

The BE_y is ex-ante calculated as follows:

$ER_y=BE_y-PE_y-LE_y$ =51,284*0.589-0=30,206tCO_2

As previously mentioned, there are no GHG project and leakage emissions. Thus, the amount of generated emission reductions by the project activity equals to the baseline emissions.

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
01/07/2018-	15,227	0	0	15,227

[12] https://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-3-2.html

31/12/2018 (184days)				
2019	30,206	0	0	30,206
2020	30,206	0	0	30,206
2021	30,206	0	0	30,206
2022	30,206	0	0	30,206
2023	30,206	0	0	30,206
2024	30,206	0	0	30,206
2025	30,206	0	0	30,206
2026	30,206	0	0	30,206
2027	30,206	0	0	30,206
01/01/2028-30/06/2028 （181days）	14,979	0	0	14,979
Total	302,060	0	0	302,060

4 MONITORING

4.1 Data and Parameters Available at Validation

Data / Parameter	$NCV_{i,y,}$
Data unit	GJ/t
Description	weighted average net calorific value of the fuel type i in year y. In this project, type i is diesel.
Source of data	2006 IPCC Guidelines for National Greenhouse gas inventories.
Value applied	43.3
Justification of choice of data or description of measurement methods and procedures applied	IPCC default values at the upper limit of the uncertainty at a 95% confidence interval. This data shall be fixed ex-ante for the duration of the crediting period of the project activity and shall be updated at the renewal of crediting period.
Purpose of Data	Calculation of project emissions
Comments	Provide any additional comments

Data / Parameter	$EF_{CO2,i,y}$
Data unit	tCO_2/ GJ
Description	Weighted average CO_2 emission factor of fuel type i in year y

Source of data	2006 IPCC Guidelines
Value applied	0.0748
Justification of choice of data or description of measurement methods and procedures applied	2006 IPCC default values at the upper limit of the uncertainty at a 95% confidence interval. This data shall be fixed ex-ante for the duration of the crediting period of the project activity and hall be updated at the renewal of crediting period.
Purpose of Data	Calculation of project emissions
Comments	/

Data / Parameter	$FC_{i,y}$
Data unit	$t/10^3m^3$
Description	Amount of fuel type i consumed by power plant in year y
Source of data	Public data by TEIAS.
Value applied	Detail could be seen in EF calculation sheet
Justification of choice of data or description of measurement methods and procedures applied	This data is published by TEIAS, which is an authorized third party. https://www.teias.gov.tr
Purpose of Data	Calculation of $EF_{grid,y}$
Comments	/

Data / Parameter	$NCV_{i,y}$
Data unit	GJ/t or 10^3m^3
Description	Net calorific value (energy content) of fuel type i in year y
Source of data	Public data by TEIAS.
Value applied	Detail could be seen in EF calculation sheet
Justification of choice of data or description of measurement methods and procedures applied	This data is published by TEIAS, which is an authorized third party. https://www.teias.gov.tr
Purpose of Data	Calculation of $EF_{grid,y}$
Comments	/

Data / Parameter	$EF_{CO2,i,y}$
Data unit	tCO_2/GJ
Description	CO2 emission factor of fuel type i used in year y
Source of data	Public data by 2006 IPCC
Value applied	Detail could be seen in EF calculation sheet
Justification of choice of data or description of measurement methods and procedures applied	2006 IPCC
Purpose of Data	Calculation of $EF_{grid,y}$
Comments	/

Data / Parameter	$EG_{m,y}$
Data unit	MWh
Description	Net electricity generated by power plant m in year y
Source of data	There is no public data for electricity generated by fuel I of power plant m in Turkey. The $EG_{m,y}$ could be calculated by the installed capacity, commissioning date, and average generation hours from the public data from TEIAS.
Value applied	Detail could be seen in EF calculation sheet
Justification of choice of data or description of measurement methods and procedures applied	All the data are from TEIAS website.
Purpose of Data	Calculation of EF
Comments	/

Data / Parameter	Other parameters related to EF calculation
Data unit	
Description	
Source of data	Public data from TEIAS.
Value applied	Detail could be seen in EF calculation sheet
Justification of choice of	All the data are from TEIAS website.

data or description of measurement methods and procedures applied	
Purpose of Data	Calculation of EF
Comments	/

4.2 Data and Parameters Monitored

Data / Parameter	$EG_{PJ,facility, y}$
Data unit	MWh
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y*
Source of data	Measured by electricity meter and verified against electricity sale receipts.
Description of measurement methods and procedures to be applied	Measured continuously by a power meter and recorded monthly by monitoring employees. Only the net electricity export to the grid shall be taken into account. This means that the monitoring measurement method shall exclude electricity imported from the grid by the project activity and possible transmission losses.
Frequency of monitoring/recording	Continuous monitoring, hourly measurement and monthly recording
Value applied	The annual net electricity supply to the grid has been measured and was 51,284 MWh/2007. This amount is used for ex-ante calculation of baseline emission.
Monitoring equipment	The $EG_{PJ,facility,y}$ is monitored by qualified electricity meter.
QA/QC procedures to be applied	Exported electricity to the grid is measured by a kilowatt meter which is controlled by both the power plant operator and by the power grid company • Trained and qualified staff is responsible for recording electricity export data from the kilowatt meter • Meters will be calibrated periodically according to national standards • Data measured by meters and will be crosschecked by electricity sales receipts. In sales receipts, incomes not deriving from electricity production but declared as electricity supplied to grid because of limitations of accounting system shall be identified and subtracted. If differences still occur, the more conservative amount shall be used.
Purpose of data	Calculation of baseline emissions
Calculation method	NA
Comments	/

Data / Parameter	$FC_{FF,i,y}$
Data unit	tons
Description	Fuel consumed Diesel consumed from running the diesel generator
Source of data	Plant records
Description of measurement methods and procedures to be applied	Diesel Consumption will be calculated by the operating hours of the diesel generator engine and consumption rate of technical specification.
Frequency of monitoring/recording	Measured continuously, recorded monthly
Value applied	Value of data would be used to calculate project emissions if emissions contribute to more than 1% of baseline emission.
Monitoring equipment	/
QA/QC procedures to be applied	/
Purpose of data	Calculation of project emissions
Calculation method	NA
Comments	/

4.3 Monitoring Plan

The objective of the monitoring plan is to ensure the complete, consistent, clear, and accurate monitoring and calculation of the emissions reductions during the whole crediting period. The Project Owner is mainly responsible for the implementation of the monitoring plan. The grid company (TEDAŞ) uses its own measurements and payment of electricity delivery to the grid takes place against receipt. The measurements are in accordance with the relevant Measurement Regulation of Turkey (Turkish Standards, International Electro-technical Commission Standards), and are not accessible by the project participants or any other party except TEDAŞ. This prevents any intervention and assures the accuracy and quality of the measurements.

1. Monitoring Objective

The only parameter to be monitored is the amount of electricity supplied to the grid since the baseline emission factor is fixed by ex-ante calculations.

2. Monitoring Organization

The Project Owner supervises and verifies metering and recording, collects data (meter's data reading, sales/ billing receipts), calculates emission reductions and will use a monitoring report.

Additionally the switchgear station, where the measurement instruments are read periodically by TEDAŞ. On the last day of each month, the TEDAŞ staff performs the reading, upon which the invoicing will be based. The data collected before PDD compilation has been in accordance with the Measurement Regulations of Turkey and receipts have been obtained against delivery. These receipts will be provided for validation and verification.

3. Monitoring Equipment and program

The electricity generation is monitored by electricity meter (or kilowatt meter). The grid company (TEDAŞ) has installed a kilowatt meter and measures the amount of electric power supplied to the power grid.

The electricity generation is measured by the electricity meter continuously, and recorded each hour and each day through the online recording system. This monitoring system is guaranteed by TEDAS.

The electricity recorded by the electric energy meter will suffice for the purpose of billing and emission reduction verification.

The Project Owner reads and checks the electric energy meter and records the data periodically as the first hand record of the supplied electricity to the grid;

The Project Owner compiles the recorded data of the supplied electricity to the grid monthly and provides the monthly balance sheet of electricity sales to TEDAŞ;

TEDAŞ confirms the amount of electricity exported by the Project Owner after the verification, confirmation and acceptance of the electricity data offered by the Project Owner;

The Project Owner provides an electricity sales invoice to TEDAŞ according to actual amount of electricity delivery reflected by the grid company's confirmation.

The Project Owner properly keeps the balance sheet of electricity sales to the grid company. The periodical records of the electricity meter's data readings are archived electronically and on paper.

4. Data Management

The Project Owner properly keeps the electronic spreadsheets and printout of the monthly records of the amount of supplied electricity to the grid as well as the first hand record of the electricity supplied to the grid. Besides that, the Project Owner collects sales receipts for the power delivered to the grid as a crosscheck. At the end of each crediting year, the Project Owner compiles a monitoring report. Physical documentation of relevance for the monitoring process, such as paper-based maps and diagrams, are collected in a central place, together with the monitoring plan. The Project Owner stores all paper-based information. All data records will be kept for a period of at least 5 years following the end of the crediting period.

5. Data quality assurance and data replacement procedures

If during a periodic meter calibration it is found that the meter has a higher error than defined in the meter's manual, the metering data will be adjusted accordingly for the last three months or beginning at the last calibration, whichever happened later. If the TEDAŞ meter fails, then data from the Dora-I meter are used. If both meters fail, conservative data substitution procedures are used from the calculation of energy production (for the purpose of VER calculation)

5 SAFEGUARDS

5.1 No Net Harm

The project's specific contribution on sustainable development and environmentally friendly energy production can be summarized as following:

it does not emit residuals that can have a negative impact on soil and water quality

As a renewable energy source, geothermal energy can be used without putting the supply of primary energy sources into danger for future generations.

it reduces the dependence on fossil fuel of Turkey

it results in extra employment in the region during both construction phase (100 additional employees) and operation (25 permanent jobs).

In conclusion, this project does not have negative environmental and socio-economic impacts.

5.2 Environmental Impact

As a renewable energy project, it does not have negative impact on the environment. According to Turkey's regulation and laws, it does not need to conduct environment assessment impact report.

5.3 Local Stakeholder Consultation

The project has no negative social or environmental impacts. Furthermore, the project is located in the marginal lands of the village and inhabitants are not impacted by the project. Therefore, no public consultation has been organised.

So, the stakeholders are workers of the plant. In the project manager 's office, there is a grievance book for working staffs. Workers who have comments or grievance can put them on the book.

5.4 Public Comments

No public comments were received. No changes of the project design occur in the second crediting period.

APPENDIX 1: <BASELINE INFORMATION>

In accordance with the selected methodology (AMSI.D), baseline emission is the electricity produced by the renewable generating unit multiplied by an emission factor as defined in section B.2. by the equation:

$BE_y=EG_{PJ,y}*EF_{grid,CM,y}$ **Equation 2**

Parameter	SI Unit	Description
BE_y	tCO_2e	Baseline Emission in year y
$EF_{grid,CM,y}$	tCO_2e/MWh	Combined margin CO_2 emission factor for grid connected power generation in year y
$EG_{PJ,y}$	MWh/year	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of CDM project activity in year y

The emission factor is calculated using option (a).
(a): A combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the '*Tool to calculate the emission factor for an electricity system* 7.0'(hereafter referred to as the Tool).

STEP 1. Identify the relevant electricity systems.

Turkish interconnected electricity grid comprises all the power plants connected together serving the whole country. Turkey national grid is dominated by fossil fuel fired power plants. The percentage of renewal electricity generation is less than 35% of the total electricity generation[13]. There are little imported and exported electricity. However, there is no detailed information about which country these electricity is from and to. The power plants could be dispatched without significant transmission losses. The transmission loss is less than 3% every year[14]. Therefore, the spatial boundary is selected as national electricity grid for the project.

In order to determine the CO_2 emission factor for net electricity imports from a connected electricity system within the same host country, the following options are available:
a) $0tCO_2/MWh$, or
b) The simple operating margin emission rate of the exporting grid, determined as described in Step 4, if the conditions for this method, as described in step 3 below, apply to the exporting grid; or
c) The simple adjusted operating margin emission rate or of the exporting grid, determined as described in Step 4 below; or
d) The weighted average operating margin (OM) emission rate of the exporting grid, determined as described in Step 4 below.

Option b) has been chosen for the calculations.

STEP 2. Choose whether to include off-grid power plants in the project electricity system(*optional*).

"Option I: Only grid power plants are included in the calculation". has been chosen.

STEP 3. Select a method to determine the operating margin (OM).

13 https://www.teias.gov.tr/tr/iii-elektrik-enerjisi-uretimi-tuketimi-kayiplar
Annual development of renewable electricity generation share in Turkey total electricity generation 2000-2016.
14 https://www.teias.gov.tr/tr/iii-elektrik-enerjisi-uretimi-tuketimi-kayiplar
Annual development of electricity generation-consumption and losses in Turkey 1993-2016.

In order to calculate the emission factor, '*Tool to calculate the emission factor for an electricity system version 07.0*' has been used. Four different methods for the calculation of the operating margin are proposed by the tool:

(a) Simple OM; or
(b) Simple adjusted OM; or
(c) Dispatch Data Analysis OM; or
(d) Average OM.

The simple OM method only can be used when low-cost/must run resources constitute less than 50% of total amount of grid generating output 1) in the recent five years, or 2) by taking into account long-term normal for hydroelectricity generation.

Table 11 shows the share of primary sources in electricity generation for the five most recent years. There are no nuclear power plants in Turkey and there is no indication that coal is obviously used as a must run. Therefore; hydro and other renewable energy sources, as well as the electricity imports are accepted as low cost/must run sources and their share is below 50%. In accordance with the Tool, (a) Simple OM method will be used in the calculations. Simple adjusted OM and Average OM methods are not applicable due to data constraints. Dispatched Data analysis Method is also not applicable as there is no hourly dispatch data is publicly available for Turkish grid.

Table 11 – Share of primary sources in electricity generation, 2011– 2015

	2011	2012	2013	2014	2015
Hydro	52,338.6	57,865.0	59,420.5	40,644.7	67,145.8
Wind	4,723.9	5,860.8	7,557.5	8,520.1	11,652.5
Geothermal	694.4	899.3	1,363.5	2,364.0	3,424.5
Solar	0.0	0.0	0.0	17.4	194.1
Renewable Wastes+waste heat	469.2	720.7	1,171.2	1,432.6	1,758.2
Renewable total	58,226.1	65,345.8	69,512.7	52,978.8	84,175.1
Imported electricity	4555.8	5826.7	7429.4	7953.3	7135.5
Total electricity	229,395.1	239,496.8	240,154.0	251,962.8	261,783.3
Share of primary sources	27.4%	29.7%	32%	24.2%	34.9%

Data source:
Annual development of renewable electricity generation share in Tuekey total electricity generation 2000-2016
; Annual development of electricity generation-consumption and losses in Turkey 1993-2016
(https://www.teias.gov.tr/tr/iii-elektrik-enerjisi-uretimi-tuketimi-kayiplar)

For the data vintage, the ex-ante option is selected and 3 year-generation-weighted average based on the most recent data available is used as data vintage.

STEP 4. Calculate the operating margin emission factor according to the selected method.

The simple OM emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation (tCO_2/MWh) of all generating power plants serving the system, not including low cost must run power plants. Two options are offered based on the data available:

- Option A: Based on the net electricity generation and a CO_2 emission factor of each power plant / unit , or
- Option B: Based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system.

Option B can only be used if:

- (a) The necessary data for Option A is not available; and
- (b) Only nuclear and renewable power generation are considered as low-cost/must-run power sources and the quantity of electricity supplied to the grid by these sources is known; and
- (c) Off-grid power plants are not included in the calculation (i.e., if Option I has been chosen in Step 2).

Since there is no power plant specific data available for every power plant Options A is not applicable for the calculation. There is no nuclear power plant in Turkey and renewable power generation is considered to be low cost/must-run power sources and the quantity of electricity supplied to the grid by those sources is known. Off-grid power plants are not included in the calculations as well. Therefore; Option B has been selected.

$$EF_{grid,OMsimple,y} = \frac{\sum_i FC_{i,y} * NCV_{i,y} * EF_{CO2,i,y}}{EG_y}$$ Equation 11

Parameter	Definition
$EF_{grid,OMsimple,y}$	Simple operating margin CO_2 emission factor in year y (tCO_2/MWh)
$FC_{i,y}$	Amount of fossil fuel type *i* consumed in the project electricity system in year y (ton or 1000m^3)
$NCV_{i,y}$	Net calorific value (energy content) of fossil fuel type *i* in year y (GJ/ton or TJ/mil m^3)
$EF_{CO2,i,y}$	CO_2 emission factor of fossil fuel type *i* in year y (tCO_2/GJ)
EG_y	Net electricity generated and delivered to the grid by all power sources serving the system, not including lc-mr power plants, in year y (MWh)
i	All fossil fuel types combusted in power sources in the project electricity system in year y
y	Relevant year as per the data vintage chosen in Step 3

Net Calorific Values could be calculated by annual heating values for each fuel type divided by the fuel consumption for each year. NCV values for each year have been calculated. This approach gives more country specific values for OM calculations. (Table.12).

Table 12: Net Calorific Values for each fuel type for Turkey

Fuel Type	**NCV (TJ/kt, TJ/10^6m^3)**		
	2013	**2014**	**2015**
Hard Coal+ Imported Coal	23.79	23.93	24.08
Lignite	7.26	7.11	7.16
Fuel Oil	42.61	41.32	44.22
Diesel Oil	44.11	43.44	43.78
Natural Gas	37.14	37.49	37.84

Data source:
FUELS CONSUMED IN THERMAL POWER PLANTS IN TURKEY BY THE ELECTRIC UTILITIES 2006-2016(https://www.teias.gov.tr/tr/iv-turkiye-termik-santrallarinda-kullanilan-yakit-miktarlari-isil-degerleri-ve-kojenerasyon)
HEATING VALUES OF FUELS CONSUMED IN THERMAL POWER PLANTS IN TURKEY BY THE ELECTRIC UTILITIES2006-2016(https://www.teias.gov.tr/tr/iv-turkiye-termik-santrallarinda-kullanilan-yakit-miktarlari-isil-degerleri-ve-kojenerasyon)

There are no country specific coefficients available for the power plants in order to estimate CO_2 emission factor (tCO_2/TJ). Therefore; the lower values for CO_2 emission coefficient from IPCC 2006 guidelines for GHG inventories[15] have been used. The total CO_2 emissions generated by electricity generation have been approximately 347.2 million tonnes CO_2 during years 2013-2015.

Table 13- Calculation of emission by electricity generation (2013-2015)

Fuel	Lower COEF[16] ($kgCO_2/TJ$)	Total Fuel Consumption (t or m³)			Total Emission (2013 - 2015) (tCO_2)
		2013	**2014**	**2015**	
Hard Coal+ Imported Coal	94,600	12,105,930	14,501,934	16,629,492	97,941,646.11
Lignite	90,900	47,120,306	57,696,139	49,940,131	100,857,343.3
Fuel Oil	75,500	573,534	754,283	66,569,623	5,923,843.48
Diesel Oil	72,600	129,359	119,988	516,912	1,550,435.17
LPG	61,600	0	0	238,388	0
Naphtha	69,300	0	0	0	0
Natural Gas	54,300	22,909,746	50,426,014	0	140,930,850.93
Total Emissions					347,204,119.00

In order to estimate net electricity generation by thermal power plants, the ratio between total gross and total net generation (including low-cost/must run plants) has been calculated for each year. The same ratio is assumed to be valid for the thermal power plants. Summing up total net generation with the imported electricity, total supply excluding low cost / must run sources for each year is determined and given in Table 14.

Table. 14: Net Electricity Generation from fossil fuel power plants (units in GWh)

Year	Gross generation（GWh）	Net generation（GWh）	Net/ Gross	Gross fossil fuel electricity generation (GWh)	Renewable electricity generation	Net fossil fuel electricity generation [17]	Import	Total Supply to the grid(GWh)
2013	240154.0	228977.0	0.953	170641.300	69512.7	162699.5	7429.4	170129
2014	251962.8	239448.8	0.950	198984.000	52978.8	189101.2	7953.3	197,055
2015	261783.3	249899.5	0.955	177608.200	84175.1	169545.6	7135.5	176,681
			Total Net Generation			521346.3	22518	543865.0

Data source of gross generation, net generation, import: Annual development of electricity generation-consumption and losses in turkey1993-2016 (https://www.teias.gov.tr/tr/iii-elektrik-enerjisi-uretimi-tuketimi-kayiplar)

[15] Table 2.2. Default Emission Factors for Stationary Combustion in the Energy Industries, Vol.2. Energy, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf)
[16] 2006IPCC Guidelines for National Greenhouse Gas Inventories (https://www.ipcc-nggip.iges.or.jp/public/2006gl/)
[17] https://www.teias.gov.tr/tr/iii-elektrik-enerjisi-uretimi-tuketimi-kayiplar

Data source of Renewable electricity generation: Annual development of renewable electricity generation share in Turkey total electricity generation 2000-2016
https://www.teias.gov.tr/tr/iii-elektrik-enerjisi-uretimi-tuketimi-kayiplar
There is no information about the source of imported electricity. For conservative, the emission factor of the imported electricity is considered as '0' when calculate the $EF_{grid,OM}$

The OM electricity factor for the Turkish national grid as described above has been found to be:

$EF_{grid,OM}$=347204119tCO_2 / 543865 GWh= 0.638 tCO_2/MWh.

STEP 5. Calculate the build margin (BM) emission factor.

In terms of vintage of data, there are two options defined:

Option 1: For the first crediting period, calculate the build margin emission factor *ex ante* based on the most recent information available on units already built for sample group *m* at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

Option 2: For the first crediting period, the build margin emission factor shall be updated annually, *ex post*, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emissions factor shall be calculated *ex ante*, as described in Option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.

Option 1 is selected for the data vintage.

The sample group of power units m used to calculate the build margin are determined as per the following procedure, consistent with the data vintage selected above:

(a) Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently (SET5-units) and determine their annual electricity generation (AEGSET-5-units, in MWh);

The most recently 5 power plants can be seen from the Energy Ministries website[18]. However, the electricity generation of each plant is no longer provided by the website. Therefore, electricity generation of each power plant and each fuel is calculated with the installed capacity and operation time estimated by the database from TEIAS website.

Table 15. The latest plants capacity in 2015[19]

Name of plant	Type of fuel	Commissioning date	Generation capacity (MW)
İÇDAŞ BİGA RES	wind	31/12/2015	12.8
UMURLU JES	geothermal	30/12/2015	9.72
ITC-KA ELAZIĞ ÜRETİM TESİSİ	biomass	30/12/2015	2.83

[18] http://www.enerji.gov.tr/tr-TR/EIGM-Raporlari

[19] http://www.enerji.gov.tr/tr-TR/EIGM-Raporlari

HANAK HES	Hydropower	29/12/2015	5.139
ALPERTEKS SANTRALİ	Diesel	25/12/2015	4.290
Total			34.779

(b)Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEGtotal, in MWh). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20 per cent of AEGtotal (if 20 per cent falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) (SET≥20 per cent) and determine their annual electricity generation (AEGSET-≥20 per cent, in MWh);

For determination of plants that comprise 20% of the system's generation, gross generation in year 2015 which is 261,783GWh has been taken as reference and its 20% has been determined as about 52,357GWh. Summing up the capacity additions through 2015 to 21/06/2013, an amount of 50242GWh is reached. Since 20% of the most recent year's generation falls partly on capacity of a plant, this plant was fully included in the calculations as requested by the methodological tool applied. Thus, total capacity included in BM calculation has increased to 55824 GWh.

(b) From SET5-units and SET≥20% select the set of power units that comprises the larger annual electricity generation (SETsample); Identify the date when the power units in SETsample started to supply electricity to the grid. If none of the power units in SETsample started to supply electricity to the grid more than 10 years ago, then use SETsample to calculate the build margin. In this case ignore steps (d), (e) and (f).

SET≥20% is selected as (SETsample) because the set of power units that comprises the larger annual electricity generation. (Even if each power plant operates 8760h per year, the total electricity generation of the SET5-units is 306GWh, less than 52357GWh) . There is no power units in SETsample started to supply electricity to the grid more than 10 years ago. Therefore the steps (d), (e) and (f) are ignored.

STEP 6. Calculate the build margin emission factor.

The build margin emissions factor is the generation-weighted average emission factor (tCO2/MWh) of all power units *m* during the most recent year y for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} * EF_{EL,m,y}}{\sum_m EG_{m,y}} \qquad \text{Equation 12}$$

Where:

$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year *y* (tCO_2/MWh).
$EG_{m,y}$= Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh).
$EF_{EL,m,y}$ = CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
m = Power units included in the build margin.
y = Most recent historical year for which power generation data is available.

Table 16. Calculation of emission factor from most recent power plants

Fuel type	Emission factor[20] (tCO_2/GJ)	Efficiency[21]	Emission factor (CO_2/MWh)
Coal	0.0946	40%	0.8514
Lignite	0.0909	39%	0.8391

[20] The lower value of 95% confidence interval from 2006IPCC Guidelines for National Greenhouse Gas Inventories (https://www.ipcc-nggip.iges.or.jp/public/2006gl/)
[21] Default value from Determining the baseline efficiency of thermal or electric energy generation systems(v02.0)

Fuel Oil	0.0755	42%	0.6471
Diesel Oil	0.0726	42%	0.6223
LPG	0.0616	39%	0.5686
Naphta	0.0693	39%	0.6397
Natural Gas	0.0543	62%	0.3153

The electricity generation of each power plant is not founded in public website of Turkey. However, installed capacity, commissioning date, fuel type can be searched from Energy Ministries website.
The total electricity generation of each fuel in Turkey can be found from TEIAS website. Therefore, the average operation hours can be calculated. With the average operation hour and installed capacity, the electricity generation of each power plant is calculated.

The build margin emission factor has been determined for the most recent capacity additions as shown in table below.

Table 17. Most recent capacity additions corresponding to 20% by fuel source

Fuel type	Most recent power plant electricity generation in 2015 (MWh)			Total (MWh)	Emission factor (CO_2/MWh)	Emission (tCO_2)
	power plants commissioned in 2013	power plants commissioned in 2014	power plants commissioned in 2015			
Coal	0	15,050,000	125,465	15,175,465	0.8514	12,920,391
Lignite	0	473,480	70,500	543,980	0.8391	456,454
Fuel Oil	0	49,280	0	49,280	0.6471	31,889
Diesel Oil	17,425,485	11,809,490	638,556	29,873,531	0.6223	18,590,299
LPG	0	0	0	0	0.5686	0
Naphta	0	0	0	0	0.6397	0
Natural Gas	0	0	0	0	0.3153	0
Renewable	3,825,383	4,132,338	2,223,909	10,181,630	0.000	0
Total	21,250,868	31,514,588	3,058,430	55,823,886		31,999,033

Finally, by summing up the weighted EF values, overall build margin emission factor has been calculated as:

$EF_{grid, BM, y}$ =31,999,033/55,823,886=0.573tCO_2/MWh

Step 6. Calculate the combined margin (CM) emissions factor.

$EF_{grid, CM, y} = w_{OM} * EF_{grid, OM, y} + w_{BM} * EF_{grid, BM, y}$ Equation 13

Where
$EF_{grid,BM,y}$=Build margin CO_2 emission factor in year y (t CO_2/MWh)
$EF_{grid,OM,y}$= Operating margin CO_2 emission factor in year y (t CO_2/MWh)
w_{OM}= Weighting of operating margin emissions factor (per cent) . 0.25 for the second and third crediting period
w_{BM}= Weighting of build margin emissions factor (per cent) . 0.75 for the second and third crediting period

$EF_{grid,CM,y}$ = 0.638 tCO_2/MWh * 0.25 + 0.573 tCO_2/MWh * 0.75 = **0,589 tCO_2/MWh**