



**Monitoring report form for CDM project activity
(Version 06.0)**

Complete this form in accordance with the instructions attached at the end of this form.

MONITORING REPORT

Title of the project activity	LaGeo, S.A. de C.V., Berlin Geothermal Project, Phase Two	
UNFCCC reference number of the project activity	0297	
Version number of the PDD applicable to this monitoring report	21	
Version number of this monitoring report	1	
Completion date of this monitoring report	19/11/2018	
Monitoring period number	Second of the second crediting period.	
Duration of this monitoring period	One year Duration from 01/01/2015 to 31/12/2015	
Monitoring report number for this monitoring report	Not applicable	
Project participants	LaGeo, S.A. de C.V.	
Host Party	El Salvador	
Sectoral scopes	1. Energy industries (renewable - / non-renewable sources)	
Applied methodologies and standardized baselines	Methodology: ACM0002, version 14 Consolidated methodology for grid-connected electricity generation from renewable sources	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0 tCO ₂ e	139.768 tCO ₂ e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	139.768 tCO ₂ e	

SECTION A. Description of project activity

A.1. General description of project activity

LaGeo, S.A. de C.V., Berlin Geothermal Project, Phase Two is a capacity addition at the existing Berlin Geothermal Power Plant through the drilling of additional geothermal wells and the installation of a new 44 MW condensation power unit that started commercial operations in February 2, 2007. The electricity produced is supplied to the national interconnected grid. This power unit is named Unit 3.

Further information about this project can be found in the PDD and documents associated, which are available on UNFCCC website: <http://cdm.unfccc.int/Projects/DB/DNV-CUK1141464500.33/view>



Figure 1. Facilities of the project activity

Relevant dates for the project activity

- Registration as a large scale CDM project: May 25, 2006.
- Starting of the first crediting period: January 1st, 2007.
- Starting of generation tests and initial of electricity injections to the grid: January 4, 2007¹.
- Starting of commercial operations on February 2, 2007².
- End of the commissioning period and acceptance by LaGeo: April 17, 2007³.

LaGeo, S.A. de C.V. is the owner of Berlin Geothermal Plant that has operated the facilities of the project activity in accordance to the Environment Law ⁴ and Electricity General Law ⁵ of the El Salvador since activity project registration.

LaGeo, S.A. de CV is committed to contribute to sustainable development and to pursue the harmonious relations between the company and surrounding communities to Berlín geothermal field, with the purpose to create development opportunities for increase the quality of life of its neighbours. During the monitoring period, the Project Participant supported different community projects through its Corporate Responsibility Program, covering the environmental, social and economic dimensions of sustainable development and 24 communities of Alegría, Berlín and Mercedes Umaña municipalities resulted benefited.

The emission reductions due to the activity project during the monitoring period were 139,768 tCO₂e.

¹According to data registered by the electricity meter and downloaded by Transactions Unit (UT).

²Letter issued by Transactions Unit (UT, *Unidad de Transacciones*).

³Acceptance by LaGeo.

⁴Ministerio de Ambiente y Recursos Naturales, Ley del Ambiente, 1998, http://www.marn.gob.sv/index.php?option=com_phocadownload&view=category&download=56:I&id=6&Itemid=255.

⁵SIGET, Ley General de Electricidad, 1997, http://www.siget.gob.sv/images/documentos/electricidad/legislacion/ley_general_de_electricidad_junio2009_0.pdf

A.2. Location of project activity

- Host Party: El Salvador
- Department: Usulután
- Municipality: Alegría
- Coordinates: latitude 13.525064 and longitude -88.508661



Project
activity
site

Figure 2. Geographical location of the facilities of the project activity

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
El Salvador	LaGeo, S.A. de C.V.	No

A.4. Reference to applied methodologies and standardized baselines

For the second crediting period, the Project Activity uses the approved methodology: Consolidated baseline methodology for grid-connected electricity generation from renewable sources (ACM0002, version 14.0.0).

As well as the following methodological tools and methodologies:

- Type I: Renewable energy project
- Sectoral Scope: Energy industries (renewable - / non-renewable sources)
- Category Renewable electricity generation for a grid (energy generation, supply, transmission and distribution): Consolidated baseline methodology for grid-connected electricity generation from renewable sources (ACM0002, version 14.0.0)..¹
- Tool reference : Tool to calculate the emission factor for an electricity system (version 04.0)².
- 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

https://cdm.unfccc.int/filestorage/A/0/4/A04BWNRLUEP6O1QX75YVTH28JDICZ/EB%2075_repan13_ACM0002_ver%2014.0.pdf?t=Qmd8cGg1amlzfDBUDNQe6bbaB84gjm8ruE9C

² <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v4.0.pdf>

A.5. Crediting period type and duration

Renewable crediting period, seven (7) years, with the option of renewing the contract for two other 7-year crediting periods (total 21 years).

This monitoring report refers to the first monitoring period of the second crediting period. The duration of the crediting period corresponding to this monitoring period has the start and end dates in 01/01/2014 to 31/12/2020.

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

The project activity uses condensing units and includes the following facilities: TR-18, TR-17 and TR-19 platform wells, the steam and water conveyor systems, the power generation equipment, the electricity measurement system and auxiliary services. The following simplified diagram illustrates the main components of the power unit located within the physical boundaries of the activity project during the monitoring period⁶.

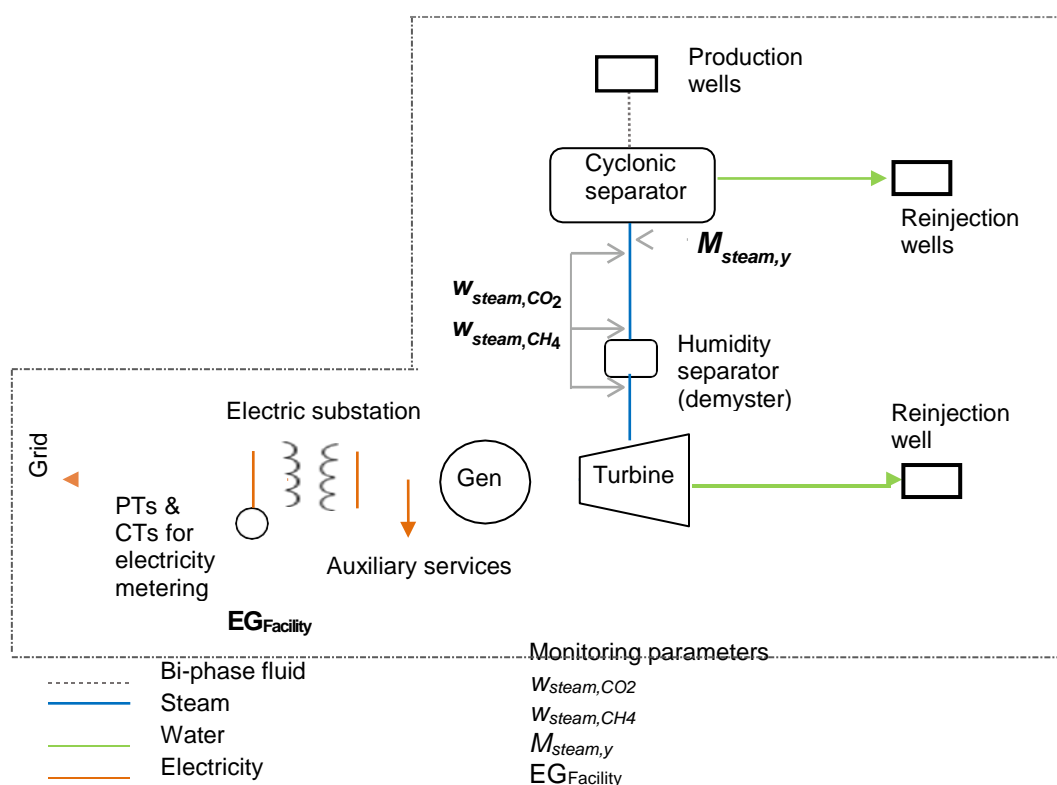


Figure 3. Boundaries of the project activity at the moment of the monitoring period

The platforms TR-18 and TR-17 comprises three production wells each one, from which geothermal fluid is extracted. Platform TR-19 comprises four injection wells. The description of the constructed wells is as follow:

Table 1. Characteristics of the constructed production wells for unit 3

	Type	Final diameter (inches)	Measured Depth (m)	Characteristics		
				WHP Bar g	Steam kg/s	Production (MWe)
TR-17	Vertical	8.5"	2,600	10.14	12.5	6.2
TR-17A	Directional	8.5"	2,690	10.10	12.5	6.1
TR-17B	Directional	12.25"	1,845	11.35	18.5	8.0
TR-18	Vertical	8.5"	2,660	13.70	14.2	6.2
TR-18A	Directional	12.25"	1,085	11.90	57.8	25.1
TR-18B	Directional	9.625"	1,191.5	9.26	13.18	5.7

⁶ The PDD establishes the boundaries of the project activity as: "It encompasses the physical, geographical site of the geothermal wells (extraction and re-injection) and power generation. The produced electricity will be fed into the grid and therefore the boundary includes the Salvadorian national grid".

Table 2. Characteristics of the constructed reinjection wells for unit 3

		Final diameter (inches)	Measured Depth (m)	Average reinjection rate (Tonnes/hour)
TR-19	Vertical	12.25"	1,176.5	180
TR-19A	Directional	8.5"	2,369	50
TR-19B	Directional	8.5"	3,125	325
TR-19C	Directional	8.5"	3,455	100

The geothermal fluid from the wells flows to the separators, where is separated in steam and liquid phases. Then, the surface pipelines deliver the steam to the powerhouse and high temperature liquid flow is delivered to the geothermal reservoir through the reinjection wells at TR-19 platform.

The powerhouse is equipped with a turbine and a synchronous generator as is illustrated in figure 4. The steam drives the turbine to produce electricity that is delivered to the grid through a line transmission. In order to avoid geothermal resource depletion, the steam used in the powerhouse passes to a condenser to return it to liquid phase before is injected back into earth through a reinjection well.

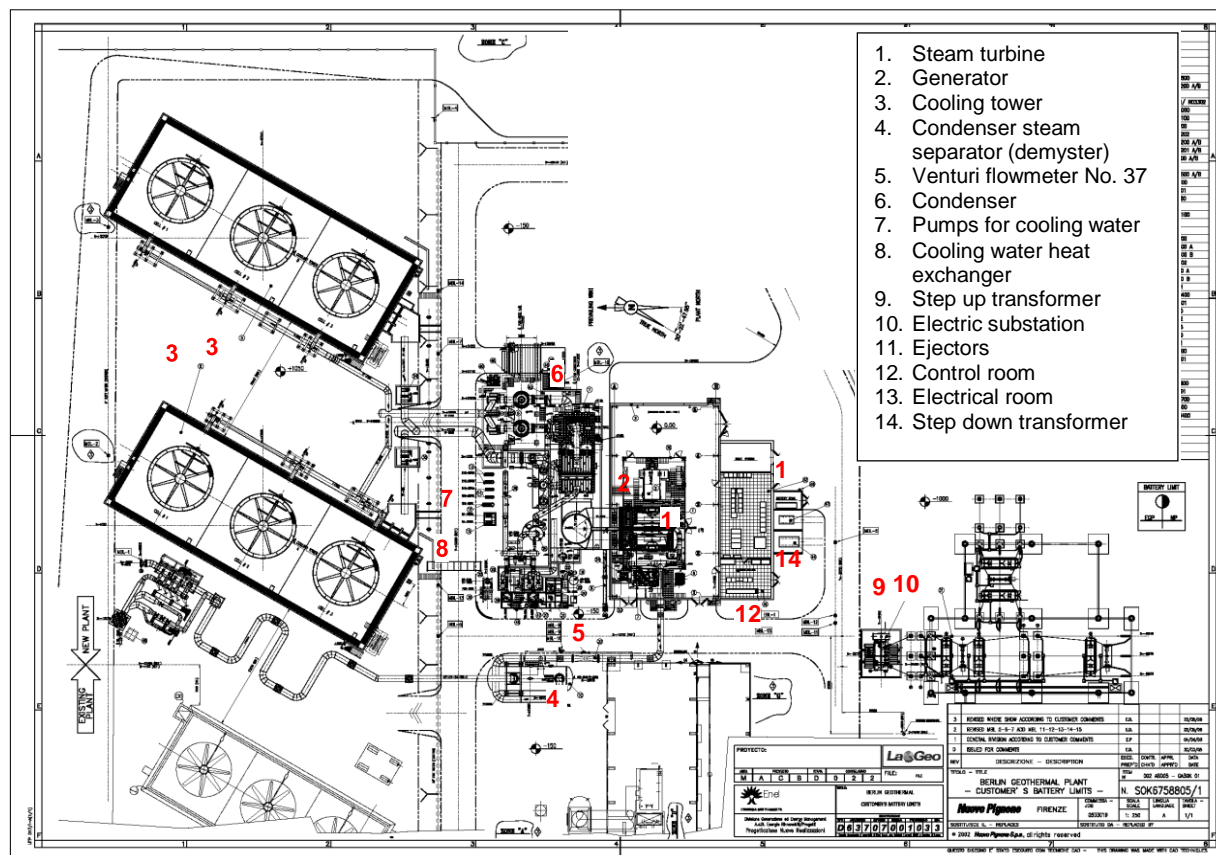


Figure 4. Components of the generating unit

The project activity began operation tests on January 4, 2007 and commercial operations on February 2, 2007.

B.2. Post-registration changes**B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies or standardized baselines**

Not applicable.

B.2.2. Corrections

Not applicable.

B.2.3. Changes to the start date of the crediting period

The starting date on the registered PDD changed for the crediting period was from June 1st, 2006 to January 1st, 2007.

The second crediting period started on January 1st, 2014 and finishes on December 31, 2020.

B.2.4. Inclusion of monitoring plan

Not applicable.

B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other applied standards or tools

The monitoring plan was revised twice during the first crediting period. The first revision was to consider the parameter $M_{t,y}$ (quantity of steam generated during well testing) as negligible. The revision was approved on June 10, 2009. The second revision of the monitoring plan was done in 2011 in order to be more realistic and according to the ACM0002, which was approved on May 3, 2011.

The monitoring plan was updated at the renewal of the crediting period according to the version 14 of the ACM0002. The parameter $EG_{facility,y}$ was introduced, taking in consideration that the project activity is a capacity addition.

B.2.6. Changes to project design

During this monitoring period, there have not been permanent changes in relation to the project design of the registered project activity.

SECTION C. Description of monitoring system

The implemented monitoring system consists of eight main processes illustrated in the following chart and each process comprises several procedures that are indicated in the tables of parameters described in section D.

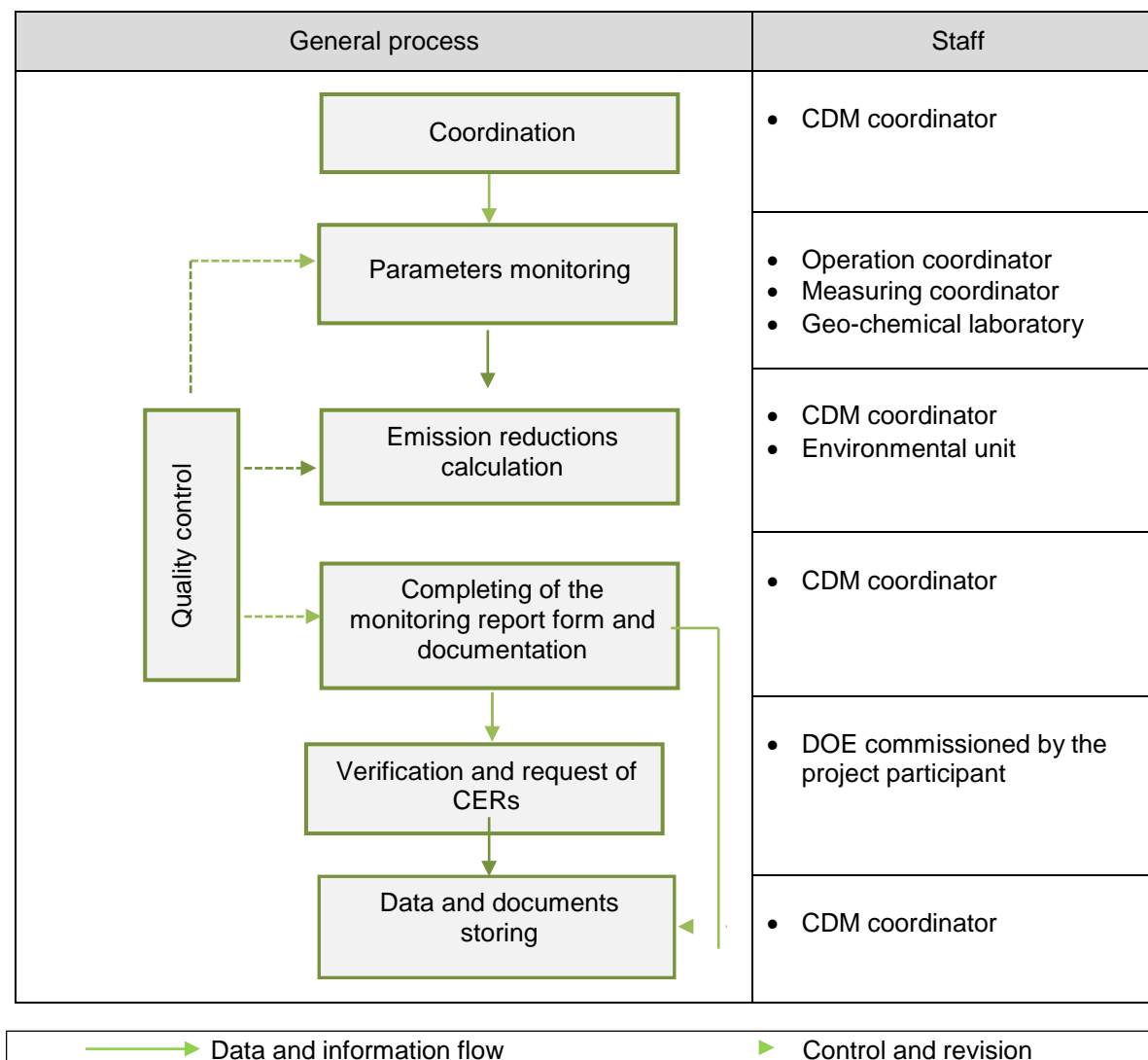


Figure 5. Process of the monitoring system

Quality control and quality assurance involves different procedures and good practices:

- Use of electric energy meters with accuracy and technical specifications according to Unit Transactions's standards.
- There is a back-up electricity metering equipment and duplicated sampling points to avoid loss of information.
- Development of clear and defined procedures for data downloading and recording.
- Development of clear and defined procedures for emissions reductions calculations.
- There are emergency procedures for each monitoring parameter.

Following figure shows the location of site where is measured the quantity geothermal steam produced ($M_{\text{steam},y}$) and the steam sampling sites to determinate the average mass fraction of CO_2 and CH_4 in the produced steam in year y . The figure also shows the configuration of wells connections.

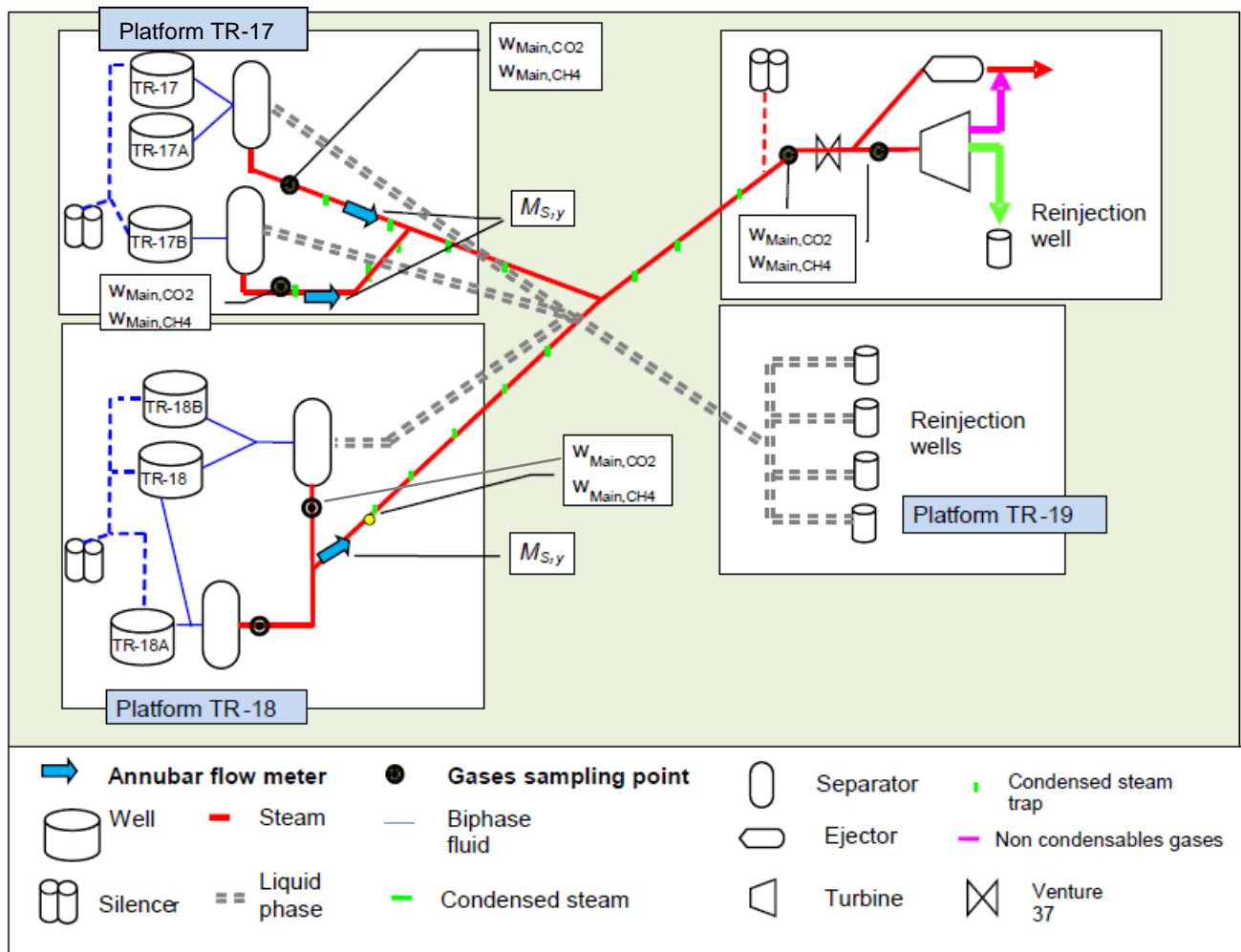


Figure 6. Location of flowmeters and the steam sampling points

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

As per the updated PDD at the renewal of the crediting period, and considering that the project activity is capacity addition, the parameters and data fixed ex ante are:

- EF (emission factor of the grid)
- GWP_{CH_4} (global warming potential of methane valid for the second commitment period)
- $EG_{historical}$ (annual average historical net electricity generation delivered to the grid by the existing renewable energy plant that was operated at the project site prior to the implementation of the project activity)
- $\sigma_{historical}$ (standard deviation of the annual average historical net electricity generation delivered to the grid by the existing renewable energy plant that was operated at the project site prior to the implementation of the Project Activity)
- $DATE_{BaselineRetrofit}$ (point in time when the existing equipment would need to be replaced in the absence of the project activity)

Their description is as follow:

Table 3. Emission factor of the grid

Data/Parameter	EF
Unit	tCO ₂ /MWh
Description	Emission factor of the grid
Source of data	Project design document updated at the renewal of the crediting period
Value(s) applied	0.569
Choice of data or measurement methods and procedures	Calculated as per the “Tool to calculate the emission factor for an electricity system”, version 4.0.
Purpose of data/parameter	This factor is used for baseline emissions calculation.
Additional comments	

Table 4. Global warming potential of methane valid for the second commitment period

Data / Parameter	GWP_{CH_4}
Unit	tCO _{2e} /tCH ₄
Description	Global warming potential of methane valid for the second commitment period.
Source of data	Table 2.14 of the errata to the contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change as per Decision 4/CMP.7.
Value(s) applied	25 tCO _{2e} /tCH ₄
Choice of data or Measurement methods and procedures	N/A
Purpose of data	Project emissions calculation
Additional comments	-

Table 5. Annual average historical net electricity generation delivered to the grid by the existing renewable energy

Data / Parameter	$EG_{\text{historical}}$
Unit	MWh
Description	Annual average historical net electricity generation delivered to the grid by the existing renewable energy plant that was operated at the project site prior to the implementation of the project activity.
Source of data	Electricity meters at project activity site prior the implementation of the project activity. Data provided by the Transactions Unit (UT).
Value(s) applied	440,843
Choice of data or Measurement methods and procedures	The project participant chooses the five last calendar years prior to the implementation of the project activity as the time span of historical data to determine $EG_{\text{historical}}$.
Purpose of data	Baseline emissions calculation
Additional comments	-

Table 6. Standard deviation of the annual average historical net electricity generation delivered to the grid by the existing renewable energy plant

Data / Parameter	$\sigma_{\text{historical}}$
Unit	MWh
Description	Standard deviation of the annual average historical net electricity generation delivered to the grid by the existing renewable energy plant that was operated at the project site prior to the implementation of the Project Activity
Source of data	Calculated from data used to establish $EG_{\text{historical}}$. Information provided by the Transactions Unit (UT).
Value(s) applied	12,904
Choice of data or Measurement methods and procedures	Parameter calculated as the standard deviation of the annual generation data used to calculate $EG_{\text{historical}}$.
Purpose of data	Baseline emissions calculation
Additional comments	-

Table 7. Point in time when the existing equipment would need to be replaced in the absence of the project activity

Data / Parameter	$DATE_{\text{BaselineRetrofit}}$
Unit	Date
Description	Point in time when the existing equipment would need to be replaced in the absence of the project activity.
Source of data	Project activity site
Value(s) applied	2029
Choice of data or Measurement methods and procedures	As per provisions in the methodology above
Purpose of data	Calculation of baseline emissions
Additional comments	- Calculation of $EG_{P,j,y}$ (quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year y).

D.2. Data and parameters monitored


As per the updated PDD at the renewal of the crediting period and considering that the project activity is capacity addition, the parameters monitored are:

- $W_{\text{steam},\text{CO}_2}$ (average mass fraction of CO_2 in the produced steam in year y)
- $W_{\text{steam},\text{CH}_4}$ (average mass fraction of CH_4 in the produced steam in year y)
- $M_{\text{steam},y}$ (Quantity of steam produced in year y)
- $EG_{\text{facility},y}$ (Quantity of net electricity generation supplied by the project plant to the grid in year y)

Its description is a follow:

Table 8. Average mass fraction of dioxide of carbon in the produced steam

Data / Parameter	$W_{\text{steam},\text{CO}_2}$		
Unit	tCO ₂ /t steam		
Description	Average mass fraction of CO ₂ in the produced steam in year y		
Measured/calculated/default	Measured		
Source of data	Laboratory report of analysis results		
Value(s) of monitored parameter	Year		$W_{\text{Main},\text{CO}_2}$
	Average CO ₂ fraction		Average mass fraction of carbon dioxide in the produced steam
	(mmol / 100 mol H ₂ O)		(t CO ₂ / t steam)
	January 2015	551,4578	1,3480E-02
	February 2015	551,4578	1,3480E-02
	March 2015	551,4578	1,3480E-02
	April 2015	461,4343	1,1280E-02
	may-2015	461,4343	1,1280E-02
	June 2015	461,4343	1,1280E-02
	July 2015	471,8367	1,1534E-02
	August 2015	471,8367	1,1534E-02
	September 2015	471,8367	1,1534E-02
	October 2015	579,1334	1,4157E-02
	November 2015	579,1334	1,4157E-02
	December 2015	579,1334	1,4157E-02
	CO ₂ molecular weight (g/mol)		44
	H ₂ O molecular weight (g/mol)		18
	Average mass fraction of CO ₂ in the produced steam in 2015 = 1.2613E-02 (t CO ₂ / t steam)		
Monitoring equipment	A titrimeter is used in the Geo-chemical Laboratory of LaGeo to determinate the CO ₂ fraction.		
	Type	Automatic titrimeter	
	Manufacturer	Mettler Toledo	
	Serial number	5126290638	
	Calibration frequency	Biannual	

Monitoring equipment (description)	<table border="1"> <tr> <td data-bbox="537 212 874 280">Date of calibrations performed, which are valid for the monitoring period</td> <td data-bbox="874 212 1426 280">09/12/2014 13/01/2015</td> </tr> <tr> <td data-bbox="537 338 874 427">Accuracy class</td> <td data-bbox="874 338 1426 427">± 0.1 mV (resolution of the voltage signal from the electrode immersed in the solution, see calculation method below)</td> </tr> <tr> <td data-bbox="537 427 874 555">Maintenance</td> <td data-bbox="874 427 1426 555">It includes an external and internal cleaning, physical revision of equipment components and auto-test performing as per manufacturer specifications.</td> </tr> </table>	Date of calibrations performed, which are valid for the monitoring period	09/12/2014 13/01/2015	Accuracy class	± 0.1 mV (resolution of the voltage signal from the electrode immersed in the solution, see calculation method below)	Maintenance	It includes an external and internal cleaning, physical revision of equipment components and auto-test performing as per manufacturer specifications.
	Date of calibrations performed, which are valid for the monitoring period	09/12/2014 13/01/2015					
	Accuracy class	± 0.1 mV (resolution of the voltage signal from the electrode immersed in the solution, see calculation method below)					
	Maintenance	It includes an external and internal cleaning, physical revision of equipment components and auto-test performing as per manufacturer specifications.					
<p>Following figure shows the titrimer used in the laboratory.</p>  <p>Figure 7. DL22 Analyzer</p>							
Measuring/reading/recording frequency	At least every three months.						
Calculation method (if applicable)	<p>The average mass fraction of carbon dioxide in the produced steam is calculated through a laboratory analysis of steam samples in the Geochemical Laboratory of LaGeo.</p> <p>CO₂ is determined with a DL22 analyzer from Metter Toledo by a titration method using a standard acid-base (NaOH) at PH 8.3. The solution brand is Titrisol and the used concentration is 0.1 mol in 1 liter; formula certified by Merck. The titration method consists in the measurement of the potential of the electrode immersed in the solution.</p>						
QA/QC procedures	<p>Quality is assured following good practices, activity procedures, an internal audit and international standards:</p> <ul style="list-style-type: none"> • Sampling is performed according to the internal procedures PT-MUE-01. The procedure is based on ASTM Standard Practice E1675 for Sampling 2-Phase Geothermal Fluid and the ASTM Standard Practice E947 for Sampling Single-Phase Geothermal Liquid or Steam for Purposes of Chemical Analysis. • The quality of the results are analyzed in accordance with the procedure PG-MET-008 and the uncertainty of the method has been estimated according to the procedure PG-MET-003. 						


⁷ The calibration performed on October 16, 2014 is valid up to the first calibration performed in the monitoring period (May 29, 2014).

QA/QC procedures (continuation)	<ul style="list-style-type: none"> The Geo-chemical Laboratory of LaGeo is accredited by ISO/IEC 17025⁸. An internal audit is carried out once a year under the Program of Internal Audit F-ASE-001 of the Geochemistry laboratory. Its objectives cover the evaluation and assessment of all management system in accordance with the requirements of the norm NSR ISO IEC 17025 and it comprises the review of all aspects of the management system implemented in different areas: water, gas and sampling of the laboratory, as per the Quality Control Manual.
Purpose of data/parameter	Calculation of activity project emissions.
Additional comments	<p><u>Data storage</u> Data is archived in electronic and paper</p> <p><u>Geothermal steam sampling procedure:</u></p> <ul style="list-style-type: none"> Geothermal steam sampling is conducted on-site, at production wells as well as steam field-power plant interface (turbine inlet of Unit 3). There are six sample points: one for each steam line coming from the wells (three lines, four sample points), other located upstream of the separator (demyster) and a sixth point at the turbine inlet, after the separator (demyster). See figure 6 in section C. Two samples are taken per sampling point and date. Steam samples are collected with glass flasks like the bottle; filled with 50 ml of sodium hydroxide solution. Under vacuum conditions, the solution absorbs the dioxide of carbon forming a calcium carbonate, while the methane remains in its gaseous phase. For the foregoing reason, the technical personnel verify the vacuum existence in the glass flasks to avoid air pollution during sampling. <p><u>Emergency procedures for the monitoring system</u> There is redundancy in the quantity of sampling points to avoid loss of data in case of a sample fails or a sample point is not available due to maintenance works at well platforms.</p> <p><u>Procedures for sampling and analysis</u></p> <p>PT-MUE-001: Procedure for geothermal steam sampling PT-MUE-003: Procedure to prepare glass flasks PT-MUE-004: Procedure for sampling at well pad (two phase line) PT-GAS-POT-001: Procedure for CO₂ determination F-GAS-001: Form to report operation tests of DL22 analyzer F-GAS-002: Form to report CO₂ calculations F-GAS-003: Form to report CO₂ results in mmol F-GAS-006: Form for calculation of geothermal gases F-GAS-004: Form for registration of results IT-GAS-EQ-OPE 002: Manual operation for titrimeter DL22 analyzer</p>

⁸ Consejo Nacional de Ciencia y Tecnología (CONACYT) accredits the laboratory from July 30, 2014 up to July 30, 2018. The Organismo Salvadoreño de Acreditación accredits the laboratory as of May 2014.

Table 9. Average mass fraction of methane in the produced steam

Data / Parameter:	W_{steam, CH_4}																																																	
Unit:	tCH ₄ /t steam																																																	
Description:	Average mass fraction of CH ₄ in the produced steam in year y																																																	
Measured/ Calculated / Default:	Measured																																																	
Source of data:	Laboratory report of analysis results																																																	
Value(s) of monitored parameter:	<table border="1"> <thead> <tr> <th rowspan="3">Year</th><th></th><th>W_{Main, CH_4}</th></tr> <tr> <th>Average CH₄ fraction</th><th>Average mass fraction of methane in the produced steam</th></tr> <tr> <th>(mmol / 100 mol H₂O)</th><th>(t CH₄/ t steam)</th></tr> </thead> <tbody> <tr><td>January 2015</td><td>0,1465</td><td>1,30E-06</td></tr> <tr><td>February 2015</td><td>0,1465</td><td>1,30E-06</td></tr> <tr><td>March 2015</td><td>0,1465</td><td>1,30E-06</td></tr> <tr><td>April 2015</td><td>0,0386</td><td>3,43E-07</td></tr> <tr><td>may-2015</td><td>0,0386</td><td>3,43E-07</td></tr> <tr><td>June 2015</td><td>0,0386</td><td>3,43E-07</td></tr> <tr><td>July 2015</td><td>0,0343</td><td>3,05E-07</td></tr> <tr><td>August 2015</td><td>0,0343</td><td>3,05E-07</td></tr> <tr><td>September 2015</td><td>0,0343</td><td>3,05E-07</td></tr> <tr><td>October 2015</td><td>0,1390</td><td>1,24E-06</td></tr> <tr><td>November 2015</td><td>0,1390</td><td>1,24E-06</td></tr> <tr><td>December 2015</td><td>0,1390</td><td>1,24E-06</td></tr> <tr><td colspan="2">CH₄ molecular weight (g/mol)</td><td>16</td></tr> <tr><td colspan="2">H₂O molecular weight (g/mol)</td><td>18</td></tr> </tbody> </table> <p>Average mass fraction of methane in the produced steam in 2014 = 7.97E-07 t CH₄/ t steam</p>	Year		W_{Main, CH_4}	Average CH ₄ fraction	Average mass fraction of methane in the produced steam	(mmol / 100 mol H ₂ O)	(t CH ₄ / t steam)	January 2015	0,1465	1,30E-06	February 2015	0,1465	1,30E-06	March 2015	0,1465	1,30E-06	April 2015	0,0386	3,43E-07	may-2015	0,0386	3,43E-07	June 2015	0,0386	3,43E-07	July 2015	0,0343	3,05E-07	August 2015	0,0343	3,05E-07	September 2015	0,0343	3,05E-07	October 2015	0,1390	1,24E-06	November 2015	0,1390	1,24E-06	December 2015	0,1390	1,24E-06	CH ₄ molecular weight (g/mol)		16	H ₂ O molecular weight (g/mol)		18
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CH ₄ molecular weight (g/mol)		16																																																
H ₂ O molecular weight (g/mol)		18																																																
Monitoring equipment:	<p>The Geo-chemical Laboratory uses a chromatograph with a mass selective detector HP 5973, serial number US81221621.</p> <table border="1"> <tr><td>Type</td><td>Chromatographer</td></tr> <tr><td>Manufacturer</td><td>Hewlett Packard 6890</td></tr> <tr><td>Serial number</td><td>US00022485</td></tr> <tr><td>Calibration frequency</td><td>Biannual</td></tr> <tr><td rowspan="3">Date of calibration/verification</td><td>24/10/2014</td></tr> <tr><td>28/04/2015</td></tr> <tr><td>13/10/2015</td></tr> </table>	Type	Chromatographer	Manufacturer	Hewlett Packard 6890	Serial number	US00022485	Calibration frequency	Biannual	Date of calibration/verification	24/10/2014	28/04/2015	13/10/2015																																					
Type	Chromatographer																																																	
Manufacturer	Hewlett Packard 6890																																																	
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	28/04/2015																																																	
	13/10/2015																																																	

Monitoring equipment (continuation):	<table border="1"> <tr> <td data-bbox="568 226 871 640">Accuracy class</td><td data-bbox="871 226 1385 640"> <p>Not applicable.</p> <p>The EPC gas control modules contain flow and/or pressure sensors that are calibrated at the factory. Sensitivity (slope of the curve) is quite stable, but zero offset requires periodic updating to flow calibration.</p> <p>The equipment is provided with an automatic calibration function that is executed following several steps in order to zeroing flow and pressure sensors.</p> </td></tr> <tr> <td data-bbox="568 640 871 790">Maintenance</td><td data-bbox="871 640 1385 790"> <p>The verification of the chromatograph is conducted to clean the mass selective detector and carry out tests of critical points according manufacturer protocol.</p> </td></tr> </table> <p>A photograph of the HP 6890 gas chromatograph is shown in the following figure:</p>  <p>Figure 8. HP 6890 gas chromatograph</p>	Accuracy class	<p>Not applicable.</p> <p>The EPC gas control modules contain flow and/or pressure sensors that are calibrated at the factory. Sensitivity (slope of the curve) is quite stable, but zero offset requires periodic updating to flow calibration.</p> <p>The equipment is provided with an automatic calibration function that is executed following several steps in order to zeroing flow and pressure sensors.</p>	Maintenance	<p>The verification of the chromatograph is conducted to clean the mass selective detector and carry out tests of critical points according manufacturer protocol.</p>
Accuracy class	<p>Not applicable.</p> <p>The EPC gas control modules contain flow and/or pressure sensors that are calibrated at the factory. Sensitivity (slope of the curve) is quite stable, but zero offset requires periodic updating to flow calibration.</p> <p>The equipment is provided with an automatic calibration function that is executed following several steps in order to zeroing flow and pressure sensors.</p>				
Maintenance	<p>The verification of the chromatograph is conducted to clean the mass selective detector and carry out tests of critical points according manufacturer protocol.</p>				
Measuring/ Reading/ Recording frequency:	At least every three months.				
Calculation method (if applicable):	<p>The geothermal steam samples are analyzed in the Geo-chemical Laboratory of LaGeo to determinate methane in gases of geothermal origin. The average mass fraction of CH₄ in the produced steam is determined using a gas chromatographic technique, the gas sample is vaporized and injected onto chromatographic columns and then separated into the gas components.</p> <p>Methane, CH₄, is analyzed following the internal procedure PT-GAS-CG-001.</p> <p>A moving gas (the mobile phase) carries the sample across a stationary phase (the solid support found within a GC column). The inert gas is from American Gas & Cilinder.</p>				

QA/QC procedures:	<p>Quality is assured following good practices, activity procedures, an internal audit and international standards:</p> <ul style="list-style-type: none"> • Sampling is performed according to the internal procedure PT-MUE-01. The procedure is based on ASTM Standard Practice E1675 for Sampling 2-Phase Geothermal Fluid for Purpose of Chemical Analysis. • The quality of the results is analyzed in accordance with the procedure PG-MET-008 and the uncertainty of the method has been estimated according to the procedure PG-MET-003. • The Geo-chemical Laboratory of LaGeo is accredited by ISO/IEC 17025¹⁰. • An internal audit is carried out once a year under the Program of Internal Audit F-ASE-001 of the Geochemistry laboratory. Its objectives cover the evaluation and assessment of all management system in accordance with the requirements of the norm NSR ISO IEC 17025 and it comprises the review of all aspects of the management system implemented in different areas: water, gas and sampling of the laboratory, as per the Quality Control Manual.
Purpose of data:	Calculation of activity project emissions
Additional comments:	<p><u>Data storing:</u> Data is archived in electronic and paper.</p> <p><u>Geothermal steam sampling procedure:</u></p> <ul style="list-style-type: none"> • Geothermal steam sampling is conducted on-site, at the platforms of the production wells as well as steam field-power plant interface (turbine inlet of Unit 3). There are six sample points: one for each steam line coming from the wells (three lines), other located upstream of the separator (demyster) and a sixth point at the turbine inlet, after the separator (demyster). See figure 6 in section C. • Two samples are taken per sampling point and date. Steam samples are collected with glass flasks; filled with 50 ml of sodium hydroxide solution. Under vacuum conditions, the solution absorbs the dioxide of carbon forming a calcium carbonate, while the methane remains in its gaseous phase. For the foregoing reason, the technical personnel verify the vacuum existence in the glass flasks to avoid air pollution during sampling. <p><u>The procedures followed by laboratory personnel for sampling and analysis are:</u></p> <p>PT-MUE-001: Procedure for geothermal steam sampling PT-MUE-003: Procedure to prepare glass flasks PT-MUE-004: Procedure for sampling at well pad (two phase line) F-GAS-006: Form for calculation of geothermal gases F-GAS-004: Form for register the results F-EQ-001: Template to report the results of the tests PT-GAS-CG-001: Procedure for CH₄ determination IT-GAS-EQ-OPE_001: Manual for Chromatograph operation.</p> <p><u>Emergency procedures for the monitoring system</u> There is redundancy in the quantity of sampling points to avoid loss of data in case of a sample fails or a sample point is not available due to maintenance works at well platforms.</p>

¹⁰ Consejo Nacional de Ciencia y Tecnología (CONACYT) accredits the laboratory from July 30, 2010 up to July 29, 2014. The Organismo Salvadoreño de Acreditación accredits the laboratory as of May 2014.

Table 10. Quantity of steam production

Data / Parameter:	$M_{steam,y}$																																							
Unit:	t steam/yr																																							
Description:	Quantity of steam produced during year y																																							
Measured/ Calculated / Default:	Measured																																							
Source of data:	Monthly production report																																							
Value(s) of monitored parameter:	Following table shows the quantity of steam production totalized by group of wells (wells in the same platform) and the total quantity of steam produced in 2015.																																							
Value(s) of monitored parameter (continuation):	<table border="1"> <tr> <td></td><td>Train TR-17A</td><td>Train TR-17B</td><td>Train TR-18</td></tr> <tr> <td>$M_{steam,y,t}$ t steam/2015</td><td>t steam/2015</td><td>t steam/2015</td><td>t steam/2015</td></tr> <tr> <td>3.566.248</td><td>622.781</td><td>684.296</td><td>2.259.171</td></tr> </table>					Train TR-17A	Train TR-17B	Train TR-18	$M_{steam,y,t}$ t steam/2015	t steam/2015	t steam/2015	t steam/2015	3.566.248	622.781	684.296	2.259.171																								
	Train TR-17A	Train TR-17B	Train TR-18																																					
$M_{steam,y,t}$ t steam/2015	t steam/2015	t steam/2015	t steam/2015																																					
3.566.248	622.781	684.296	2.259.171																																					
Monitoring equipment:	<p>Quantity of steam production is measured by annubar flowmeters. They basically are a Pitot tubes with an electronic pressure transmitter that measure simultaneously differential pressure, static pressure, and process temperature to dynamically calculate fully compensated mass flow.</p> <p>There are three flowmeters installed at the platforms of the wells. The pipes from the wells are connected in three configurations and there is a flowmeter for each one. Next table indicates the wells of each configuration during the monitoring period:</p> <table border="1"> <tr> <td>wells</td><td>Train TR-17A vertical well) TR-17 A (directional well)</td><td>TR-17 B (directional well)</td><td>• TR-18 (vertical well) TR-18A (directional well) TR-18B (directional well)</td></tr> </table> <p>Description of the flowmeters:</p> <table border="1"> <tr> <td></td><td>Train TR-17A</td><td>Train TR-17 B</td><td>Train TR-18</td></tr> <tr> <td>Type</td><td>Annubar flowmeter</td><td>Annubar flowmeter</td><td>Annubar flowmeter</td></tr> <tr> <td>Brand</td><td>Rosemount</td><td>Rosemount</td><td>Rosemount</td></tr> <tr> <td>Model</td><td>3095MFA</td><td>3095MFA</td><td>3095MFA</td></tr> <tr> <td>Serial No.</td><td>0020194</td><td>0034201</td><td>0041393</td></tr> <tr> <td>Installation date</td><td>Since plant construction</td><td>09/10/2009</td><td>20/02/2011</td></tr> <tr> <td>Date of calibrations</td><td>12/10/2013 06/04/2014 03/10/2014</td><td>11/10/2013 05/04/2014 03/10/2014</td><td>10/10/2013 06/04/2014 02/10/2014</td></tr> <tr> <td>Accuracy class</td><td colspan="3">The performance of the flowmeter is $\pm 0.90\%$ of mass flow rate accuracy.</td></tr> </table>				wells	Train TR-17A vertical well) TR-17 A (directional well)	TR-17 B (directional well)	• TR-18 (vertical well) TR-18A (directional well) TR-18B (directional well)		Train TR-17A	Train TR-17 B	Train TR-18	Type	Annubar flowmeter	Annubar flowmeter	Annubar flowmeter	Brand	Rosemount	Rosemount	Rosemount	Model	3095MFA	3095MFA	3095MFA	Serial No.	0020194	0034201	0041393	Installation date	Since plant construction	09/10/2009	20/02/2011	Date of calibrations	12/10/2013 06/04/2014 03/10/2014	11/10/2013 05/04/2014 03/10/2014	10/10/2013 06/04/2014 02/10/2014	Accuracy class	The performance of the flowmeter is $\pm 0.90\%$ of mass flow rate accuracy.		
wells	Train TR-17A vertical well) TR-17 A (directional well)	TR-17 B (directional well)	• TR-18 (vertical well) TR-18A (directional well) TR-18B (directional well)																																					
	Train TR-17A	Train TR-17 B	Train TR-18																																					
Type	Annubar flowmeter	Annubar flowmeter	Annubar flowmeter																																					
Brand	Rosemount	Rosemount	Rosemount																																					
Model	3095MFA	3095MFA	3095MFA																																					
Serial No.	0020194	0034201	0041393																																					
Installation date	Since plant construction	09/10/2009	20/02/2011																																					
Date of calibrations	12/10/2013 06/04/2014 03/10/2014	11/10/2013 05/04/2014 03/10/2014	10/10/2013 06/04/2014 02/10/2014																																					
Accuracy class	The performance of the flowmeter is $\pm 0.90\%$ of mass flow rate accuracy.																																							

Monitoring equipment (continuation):	Calibration frequency	<p>The calibration frequency is biannual</p> <p>The transmitters of the annubar flowmeters are initially calibrated in-factory by the manufacturer. According to the manufacturer, the electronics of the pressure transmitters of the annubar flowmeters is very stable in operation, allowing up to 10 year calibration cycles</p> <p>Personnel of the Instrumentation Laboratory perform a maintenance management system in order to systematize maintenance activities. This system is based on an internal quality control method, which requires that annubars flowmeters be tested on site when they are installed by first time, and routine activities are carried out biannually to verify meters accuracy and calibrations.</p>		
	Description of the data loggers (CM0214S595 has been substituted during 2015):			
		Train TR-17A	Train TR-17 B	Train TR-18
	Manufacturer	Pace Scientific	Pace Scientific	Pace Scientific
Model	XR440	XR440	XR440	
Serial number	CM0214S593	CM0214S594	CM0214S595	
Installation date ¹³	17/07/2014	17/07/2014	17/07/2014	
Calibration date in-factory	23/06/2014	23/06/2014	23/06/2014	
Accuracy class	±0.25% at 13 bits	±0.25% at 13 bits	±0.25% at 13 bits	
Calibration frequency	Each three years	Each three years	Each three years	
New data loggers:				
	Train TR-17A	Train TR-17 B	Train TR-18	
Manufacturer	Pace Scientific	Pace Scientific	Pace Scientific	
Model	XR440	XR440	XR440	
Serial number	CM0214S593	CM0214S594	CM0414s640	
Installation date ¹³	17/07/2014	17/07/2014	17/07/2015	
Calibration date in-factory	23/06/2014	23/06/2014	18/10/2014	
Accuracy class	±0.25% at 13 bits	±0.25% at 13 bits	±0.25% at 13 bits	
Calibration frequency	Each three years	Each three years	Each three years	
Measuring/ Reading/ Recording frequency:	<p>$M_{steam,y}$ is measured continuously and data is registered via a data logger each 15 minutes and the Measurement Technician downs load data daily.</p> <p>$M_{steam,y}$ data is registered daily.</p>			

¹² The instruments used to calibrate the transmitters of the flowmeters are the Fluke 754 and Fluke 744 process calibrators, and Fluke 700PD7 pressure modules and a Hart 375 communication protocol.

¹³ The data loggers were changed during the previous monitoring period because it is cheaper to buy new ones than to calibrate them.

Calculation method (if applicable):	Not applicable.
QA/QC procedures:	Quality is assured following good practices and activity procedures.
Purpose of data:	Project emissions calculations.
Additional comments:	<p><u>Data storing:</u> The Exploration coordinator is in charge of data storing.</p> <p>The personnel of the Reservoir Engineering Unit analyze the measurement and the resulting information are summarized in the "Daily production report" and in the "Monthly production report", which are available to engineering personnel through LaGeo Intranet. It is reported the total amount of steam production for each well in ktonnes.</p> <p><u>Measurement procedures (Internal codes):</u> PRA-655-01 Procedure for flow meter reading and data register PROC-627-001: Procedure for Calibration and Revision of Metering equipment.</p>
Additional comments (continuation):	<p><u>Emergency procedures for the monitoring system:</u> Additionally to annubar flowmeters at platform wells, a venturi flowmeter is installed at the turbine inlet to measure the quantity of geothermal steam flow used for electricity production.</p> <p>This venturi flow meter could be used as backup in case of annubar flowmeters failure and it could be used to verify the data registered by the annubars. The values registered by the annubar flow meters are compared against the data registered by the venturi according to procedure PRG-425-16, and difference must be around 2% due to the condensation of steam along pipes, being higher the value metered by annubar flowmeters. Since measurement from annubar flowmeters gives a higher value, it is considered more conservative for emissions reductions calculation.</p> <p>On the other hand, the temperature and pressure conditions are registered at production wells to define the steam properties and compare field data against the production models.</p>

Table 11. Quantity of net electricity generation supplied by the project plant to the grid

Data / Parameter	$EG_{facility,y}$
Unit	MWh
Description	Quantity of net electricity generation supplied by the project plant to the grid in year y
Measured/ Calculated / Default:	Measured
Source of data	Electricity meters at project site
	<p>There are separate electricity meters for each power unit at the facility, see figure 9, below.</p> <p>Hence, the net electricity supplied to the grid by the project plant is equal to the summation of the net electricity delivered by each power unit existing prior the project activity plus the net electricity provided by the project activity.</p>

Value(s) of monitored parameter		Unit 1	Unit 2	Unit 3	EGfacility,2015																				
	Month	MWh	MWh	MWh	MWh																				
	Jan-15	18.252,00	18.221,00	30.718,00	67.191,00																				
	Feb-15	16.108,26	17.048,00	27.992,04	61.148,30																				
	Mar-15	19.652,36	18.220,00	28.662,96	66.535,32																				
	Apr-15	18.966,60	17.845,00	29.165,31	65.976,91																				
	May-15	19.612,78	19.316,00	29.587,94	68.516,72																				
	Jun-15	18.835,32	18.638,00	27.885,19	65.358,51																				
	Jul-15	20.336,70	19.794,00	29.275,17	69.405,87																				
	Aug-15	20.892,61	20.331,00	27.271,28	68.494,89																				
	Sep-15	20.250,31	17.068,00	26.703,41	64.021,72																				
	Oct-15	19.702,91	7.883,00	26.747,57	54.333,47																				
	Nov-15	19.619,97	19.113,00	22.856,78	61.589,75																				
	Dec-15	19.451,02	19.446,00	27.092,93	65.989,95																				
	Total	231.680	212.923	333.958	778.561,00																				
Monitoring equipment:	Measurements are undertaken using two bidirectional electricity meters per power unit. One meter is used as the main and the other as the secondary or back-up.																								
	Meters measure the electricity delivery to the grid at the delivery point, receiving the voltage and current signal from the instrument transformers located in the step-up substation. The net electricity supplied to a grid is the difference between the measured quantities of the grid electricity export and the import.																								
	Next tables content the general information of all the power units:																								
	<table><tr><th colspan="3">Unit 1</th></tr><tr><td></td><td>Main meter</td><td>Back-up meter</td></tr><tr><td>Type¹⁴</td><td>Electricity meter</td><td>Electricity meter</td></tr><tr><td>Accuracy class</td><td>Meter 0.2 PT 0.3 CT 0.3</td><td>Meter 0.2 PT 0.3 CT 0.3</td></tr><tr><td>Serial number</td><td>128-0119306222</td><td>128-0119306323</td></tr><tr><td>Verification of meter accuracy frequency</td><td>Each two years</td><td>Each two years</td></tr><tr><td>Calibration date</td><td>14/06/2013 (It is valid up to 13/06/2015)</td><td>14/06/2013 (It is valid up to 13/06/2015)</td></tr></table>					Unit 1				Main meter	Back-up meter	Type ¹⁴	Electricity meter	Electricity meter	Accuracy class	Meter 0.2 PT 0.3 CT 0.3	Meter 0.2 PT 0.3 CT 0.3	Serial number	128-0119306222	128-0119306323	Verification of meter accuracy frequency	Each two years	Each two years	Calibration date	14/06/2013 (It is valid up to 13/06/2015)
Unit 1																									
	Main meter	Back-up meter																							
Type ¹⁴	Electricity meter	Electricity meter																							
Accuracy class	Meter 0.2 PT 0.3 CT 0.3	Meter 0.2 PT 0.3 CT 0.3																							
Serial number	128-0119306222	128-0119306323																							
Verification of meter accuracy frequency	Each two years	Each two years																							
Calibration date	14/06/2013 (It is valid up to 13/06/2015)	14/06/2013 (It is valid up to 13/06/2015)																							

Unit 2		
	Main meter	Back-up meter
Type ¹⁵	Electricity meter	Electricity meter
Accuracy class	Meter 0.2 PT 0.3 CT 0.3	Meter 0.2 PT 0.3 CT 0.3
Serial number	19524224	21372871
Verification of meter accuracy frequency	Each two years	Each two years
Calibration date	14/06/2013	14/06/2013
Substitution of meters by change of model		
Type ¹⁶	Electricity meter	Electricity meter
Accuracy class	Meter 0.2 PT 0.3 CT 0.3	Meter 0.2 PT 0.3 CT 0.3
Serial number	1258333	1258334
Verification of meter accuracy frequency	Each two years	Each two years
Calibration date	17/06/2013	20/06/2013

Unit 3 (capacity addition due to the project activity)		
	Main meter	Back-up meter
Type ¹⁷	Electricity meter	Electricity meter
Accuracy class	Meter 0.2 PT 0.3 CT 0.3	Meter 0.2 PT 0.3 CT 0.3
Serial number	49869279	49869280
Verification of meter accuracy frequency	Each two years	Each two years
Calibration date	14/06/2013	14/06/2013
Substitution of meters by change of model		
Type ¹⁸	Electricity meter	Electricity meter
Accuracy class	Meter 0.2 PT 0.3 CT 0.3	Meter 0.2 PT 0.3 CT 0.3
Serial number	46292125	46292226
Verification of meter accuracy frequency	Each two years	Each two years
Calibration date	30/06/2014	07/07/2014

¹⁴ The electricity meters are multifunctional, three-phase, bidirectional and equipped with a modem, they record energy in programmable intervals and store the data accumulatively, at least for two months.

¹⁵ The electricity meters are multifunctional, three-phase, bidirectional and equipped with a modem, they record energy in programmable intervals and store the data accumulatively, at least for two months.

¹⁶ The electricity meters are multifunctional, three-phase, bidirectional and equipped with a modem, they record energy in programmable intervals and store the data accumulatively, at least for two months.

¹⁷ The electricity meters are multifunctional, three-phase, bidirectional and equipped with a modem, they record energy in programmable intervals and store the data accumulatively, at least for two months.

¹⁸ The electricity meters are multifunctional, three-phase, bidirectional and equipped with a modem, they record energy in programmable intervals and store the data accumulatively, at least for two months.



Figure 9. Electricity meters at the control center of the facility. For each unit there is a back up and a main meter, from left to right, in this array.

<i>Measuring/ Reading/ Recording frequency</i>	<p>The net electricity generation supplied to the grid is monitored by the Project Participant as well as by the Transactions Unit (Unidad de Transacciones, UT). Because UT is the grid operator, the data monitored by UT constitutes the official data used for commercial purposes and emissions reductions calculation.</p> <ol style="list-style-type: none"> 1. Measurement: Measurements are undertaken using two bidirectional electricity meters per power unit with an accuracy class of at least 0.2. One meter is used as the main and the other as the secondary. Both meters measure the electricity delivery to the grid at the delivery point. The net electricity supplied to a grid is the difference between the measured quantities of the grid electricity export and the import. 2. Data Reading: Data reading will be carried out periodically by the project participant an UT, downloading data directly from the electricity meters or remotely. 3. Data Registration: Data downloaded from the electricity meters is saved monthly by the project participant in an electronic format.
Measurement methods and procedures	<ol style="list-style-type: none"> 4. Data Storage: All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period.
Calculation method (if applicable)	Continuous measurement and at least monthly recording.

QA/QC procedures	<ol style="list-style-type: none"> 1. Verification of the meters accuracy: The equipment used to measure the electricity delivered to the grid is audited at least each two years by private companies accredited by the national dispatch center (UT). Audits are performed in the presence of members from the power producer and the audit-company commissioned by UT. Meter accuracy of the electricity meters have to meet the UT's Annex of the Operation Norms of the Transmission System and Wholesale Market. In case of the meter accuracy is out of range or one of the meters is damaged, the meter is calibrated or substituted. 2. Cross checking: The project participant checks that the electricity generation data read by personnel of the power plant coincides with data stated in the monthly invoices. 3. Emergency procedures for the monitoring system: The electricity registered by the main meter constitutes the official metering. If this meter fails, the data of the back-up meter is used. The main and the back-up meter have been authorized by the Transactions Unit (Unidad de Transacciones, UT) of the electricity market. According to Wholesales Electricity Market and Transmission System Operation Regulation, if UT cannot to access the meters remotely, then downloads the metering data on site. When both meters fail, UT use the data registered by its SCADA system or the historical data or the data registered by LaGeo, in the mentioned order.
Purpose of data/parameter	These data will be used to calculate the baseline emissions.
Additional comment	Because electricity metering is by power unit at Berlin Power Plant, $EG_{facility,y}$ is calculated as the sum of the electricity measured by the electricity meters of units 1, 2 and 3 of Berlin Geothermal power plant.

D.3. Implementation of sampling plan

Not applicable.

SECTION E. Calculation of emission reductions or net anthropogenic removals

E.1. Calculation of baseline emissions or baseline net removals

According to the updated PDD, baseline emissions are calculated as follows:

$$BE_y = EG_{PJ,y} * EF_{grid,CM,y} \quad \text{Eq. 1}$$

Where:

BE_y	=	Baseline emissions in year y (tCO ₂ /yr)	=	See table 11 below
$EG_{PJ,y}$	=	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM Project Activity in year y (MWh/yr)	=	See explanation below
$EF_{grid,CM,y}$	=	Emission factor, fixed ex-ante according to the PDD	=	0.569 t CO ₂ /MWh
y	=	year	=	2015

Because the Project Activity consists of a new geothermal power unit installed next to an existing geothermal energy based power plant (units 1 and 2 of Berlin Geothermal Plant), $EG_{PJ,y}$ is calculated using the option 1 of the ACM0002 methodology as follows:

$$EG_{PJ,y} = EG_{facility,y} - (EG_{historical} + \sigma_{historical}) ; \text{until } DATE_{BaselineRetrofit} \quad \text{Eq. 2}$$

and

$$EG_{PJ,y} = 0; \text{ on/after } DATE_{BaselineRetrofit}$$

Where:

$EG_{PJ,y}$	=	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM Project Activity in year y (MWh)	=	324,814.04 See table 12 below
$EG_{facility,y}$	=	Quantity of net electricity generation supplied by the project plant to the grid in year y . In the updated PDD, this parameter is interpreted as the total electricity generation of the existing plant and the added unit (Because there are meters separately for each power units this parameter is the sum of the data read for units 1, 2, and 3). (MWh)	=	778,561
$EG_{historical}$	=	Fixed ex ante as the annual average historical net electricity generation delivered to the grid by the existing renewable energy plant that was operated at the project site prior to the implementation of the Project Activity (MWh)	=	440,843
$\sigma_{historical}$	=	Fixed ex ante as the standard deviation of the annual average historical net electricity generation delivered to the grid by the existing renewable energy plant that was operated at the project site prior to the implementation of the Project Activity (MWh)	=	12,904
$DATE_{BaselineRetrofit}$	=	Fixed ex ante as the point in time (date) when the existing equipment would need to be replaced in the absence of the Project Activity	=	2029

Then, the baseline emissions defined in equations 1 and 2 are computed using the spreadsheet called "Emission Reductions Calculation UIII_2015_V2.1.xls" according to the internal procedure **PRG-425-15** as follow:

Step 1. Calculation of the net electricity delivered by capacity addition (unit 3)

In the sheet "U3's electricity", entry the data from the electricity meter of the unit 3, in hourly form, in order to calculate the monthly values.

Step 2. Calculation of $EG_{\text{facility},y}$

In the sheet “ $EG_{\text{facility},y}$ ”, entry the amount of electricity generated by Units 1 and 2, which are the power units of the existing plant previous to the implementation of the project activity. Also, entry the amount of the electricity generated by the power unit 3 that is provided by the project activity. Data is in a monthly form.

Step 3. Calculation of $EG_{PJ,y}$

The quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM Project Activity is computed automatically by the spreadsheet.

Step 4. Baseline emissions calculation

The baseline emissions of the project are calculated automatically for each month of the monitoring period in the sheet called “ BE_y ”, whose results are shown in the following table.

Following a deductive approach, the results are:

Parameter as per the updated PDD	BE_{2015}	=	$EG_{PJ,2015}$	*	$EF_{\text{grid},CM,2015}$
Description	Baseline emissions		Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity		Emission factor
Unit	t CO ₂		MWh		t CO ₂ /MWh
	184,819		324,814		0.569

Table 12. Baseline emissions

Table 13. Calculation of Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity

Parameter as per the updated PDD	$EG_{PJ,2015}$		$EG_{\text{facility},2015}$		$EG_{\text{historical}}$		$\sigma_{\text{historical}}$
Brief description	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity		Quantity of net electricity generation supplied by the project plant to the grid		Annual average historical net electricity generation delivered to the grid by the existing energy plant (U1 & U2)		Standard deviation of $EG_{\text{historical}}$
Unit	MWh		MWh		MWh		MWh
Results	324,814	=	778.561,00	-	440,843	-	12,904

Table 14. Calculation of Quantity of net electricity generation supplied by the project plant to the grid

Parameter	$EG_{\text{facility},2015}$		Unit 1		Unit 2		Unit 3 (capacity addition)
Unit	Quantity of net electricity generation supplied by the project plant to the grid						
Results	778.561,00	=	231,680	+	212,923	+	333,958

E.2. Calculation of project emissions or actual net removals

Project emissions, PE_y , are calculated according to the internal procedure **PRG-425-15**. This procedure describes the steps to calculate the PE_y using the spreadsheet called "Emission Reductions Calculation UIII_2015_V2.1.xls". The spreadsheet was designed according to the version 14 of the ACM0002 methodology

As per methodology ACM0002, version 14, the project emissions consist of the fugitive carbon dioxide and methane emission due to the release of non-condensable gases from the produced steam, which are greenhouse gases plus project emissions from combustion of fossil fuel.

$$PE_y = PES_y + PEFF_y \quad \text{Eq. 3}$$

Where:

- PE_y = Project emissions (t CO₂ e)
- PES_y = Project emissions due release of CO₂ and CH₄ from geothermal steam (t CO₂ e)
- $PEFF_y$ = Project emissions due combustion of fossil fuels (t CO₂ e)
- y = 2015

Because project emissions due combustion of fossil fuels are negligible, $PEFF_y$ is zero and PE_y results equal to PES_y .

Therefore:

The project emissions, CO₂ emissions and CH₄ emissions are calculated from the fractional content of CO₂ emissions and CH₄ in the geothermal steam as follows:

$$PES_y(\text{t CO}_2 \text{ e}) = (W_{\text{Main,CO}_2} + W_{\text{Main,CH}_4} * GWP_{\text{CH}_4}) * M_{s,y} \quad \text{Eq. 4}$$

Where:

- PES_y = Project emissions due release of CO₂ and CH₄ from geothermal steam (t CO₂ e)
- $W_{\text{Main,CO}_2}$ = Average mass fraction of carbon dioxide in the produced steam
- $W_{\text{Main,CH}_4}$ = Average mass fraction of methane in the produced steam
- GWP_{CH_4} = Global warming potential of methane (default value 25 tCO₂/tCH₄)
- $M_{s,y}$ = Quantity of steam produced during the year (t)
- y = 2014

Then, PE_y are computed using the spreadsheet called "Emission Reductions Calculation UIII_2015_V2.1.xls" through the following steps:

Step 1. Entry variables $w_{\text{Main,CO}_2}$, $w_{\text{Main,CH}_4}$, GWP_{CH_4} and $M_{\text{steam},y}$ in sheet PE_y of "Emission Reductions Calculation UIII_2015_V2.1.xls"

Step 2. Project emissions are calculated automatically for each month of the monitoring period in the sheet called "BE_y", whose results are shown in the following table.

Table 15. Calculation of project emissions during the monitored period

Description	Project Emissions due to release of CO ₂ and CH ₄ from the produced steam	Project emissions from combustion of fossil fuels	Project emissions
Unit	t CO ₂ e	t CO ₂ e	t CO ₂ e
Total	45.051	0	45.051

E.3. Calculation of leakage emissions

The project activity does not imply emissions outside its boundaries, therefore leakages are zero and therefore:

L_y = Leakages occurred during the monitored period = zero

E.4. Calculation of emission reductions or net anthropogenic removals

Emission reductions, ERs, are calculated according to the internal procedure PRG-425-15. This procedure describes the steps to calculate the ERs using the spreadsheet called "Emission Reductions Calculation UIII_2015_V2.1.xls", which was designed according PDD and the methodology ACM0002 (version 14).

According to PDD, the leakages are negligible and there are not emissions due fuel consumption in the power plant ¹⁹; therefore, the emission reductions are calculated as the difference between the baseline emissions minus the project activity emissions, as equation 5 indicates.

$$ER_y(t\ CO_2\ e) = BE_y(t\ CO_2\ e) - PE_y(t\ CO_2\ e) \quad \text{Eq. 5}$$

Where:

- ER_y = Emission reductions given in tonnes of carbon dioxide equivalent in the monitored period.
- BE_y = Baseline missions given in tonnes of carbon dioxide equivalent in the monitored period.
- PE_y = Project emissions equal to sum of the fugitive carbon dioxide and methane emission due to the release of non-condensable gases from the produced steam.
- y = 2015

Equation 5 is calculated automatically for each month in the sheet called "ERy" of the spreadsheet "Emission Reductions Calculation UIII_2015_V2.1.xls" and the results for the monitoring period are presented in the next table.

	Baseline GHG emissions or baseline net GHG removals (t CO ₂ e)	Project GHG emissions or actual net GHG removals (t CO ₂ e)	Leakage GHG emissions (t CO ₂ e)	GHG emission reductions or net anthropogenic GHG removals (t CO ₂ e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	184.819	45.051	0	0	139.768	139.768

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO ₂ e)	Amount estimated ex ante (t CO ₂ e)
150,171	139.768

¹⁹ The energy for ancillary services and the activities related to the operation of the power unit is self-supplied through the step-down transformer when the power unit is online, otherwise ancillary services demand is supplied by the grid. Additionally, there is a battery to feed critical loads.

E.6. Remarks on increase in achieved emission reductions

The emission reductions achieved during this monitoring period represents the 93% of the value estimated in the ex-ante calculation of the registered PDD.

The decrement on emissions reduction is due to programed and non-programed outlines in the power units.

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Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
06.0	7 June 2017	Revision to: <ul style="list-style-type: none"> • Ensure consistency with version 01.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Make editorial improvements.
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: <ul style="list-style-type: none"> • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: <ul style="list-style-type: none"> • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from <i>F-CDM-MR</i> to <i>CDM-MR-FORM</i>; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
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