

LAS PIZARRAS PROJECT

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PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

Las Pizarras project, in Peru, is a run-of-the-river hydropower technology that utilizes the water flow of the Chancay River to generate electricity. The water is directly diverted from this river, going through a low pressure tunnel consisting of two trams, one upstream with a length of 2.03 km, and the other downstream with a length of 0.96 km, and then sent into a 90 m penstock that then splits into two other trams of 30.03 m and 32.35 m respectively, which in turn feed the water to the downstream power house turbines to transform the potential energy of water into mechanical energy. The project is not considering any reservoir or regulation tank for its normal operation, only a water diversion and a forebay.

The design discharge will be 23.2 cubic meters per second (m^3/s). The project has an installed capacity of 19.992 MW and generates approximately 106.598 GWh per year. The project employ two new Francis turbines with horizontal shafts and of 10.023 MW each. The plant is connected to the national grid SEIN through 138 kV transmission line to the Espina Colorada sub-station, with a total length of approx. 14.43 km.

The project's construction was commenced on 14/04/2011¹, and the hydropower plant started its commercial operation on 30/04/2013². During the monitoring period presented of 30/04/2013 to 30/09/2015, the total GHG emissions reductions amounted to 107,925t CO₂e, as a result of displacement the electricity generated in fossil fuel fired power plants of the grid.

Please refer to registered CDM-PDD section A.2 for further details.

1.2 Sectoral Scope and Project Type

Sectoral scope 1. VCS sectoral scope: Energy Industry (renewable/non-renewable).

The proposed project activity is not a grouped project.

¹ The construction of the access road was initiated, as indicated in works acceptance report

² The project commenced its commercial operation on 30th April 2013, according with the document "Aprobación de puesta en operación comercial"

1.3 Project Proponent

Organization name	Empresa Eléctrica Río Doble S.A.
Contact person	Mr. Ignacio Giménez
Title	Operations Manager
Address	General Recavarren, 103, Of. 902, Lima 18, Peru
Telephone	(511) 9739 0265
Email	igimenez@riodoble.com

1.4 Other Entities Involved in the Project

Organization name	-
Role in the project	VCS Consultant
Contact person	Rosa Mª Pérez Puente Carlos Álvarez García
Title	Independent Consultant
Address	Sevilla – Spain
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1.5 Project Start Date

The project has its start date on April 30th 2013. This is the date of commencement for the commercial operation of the project.

1.6 Project Crediting Period

The crediting period of the project will be 10 years. It will run from April 30th, 2013 to April 29th, 2023. The crediting period lasts 10 years and is renewable at most twice. The first crediting period will start on April 30th 2013. The last VCS crediting period will end at the date when the last CDM crediting period of the project activity will expire as per paragraph 3.8.3 of the VCS Standard (version 3.5). This means, VCS crediting period will end on December 31th 2033.

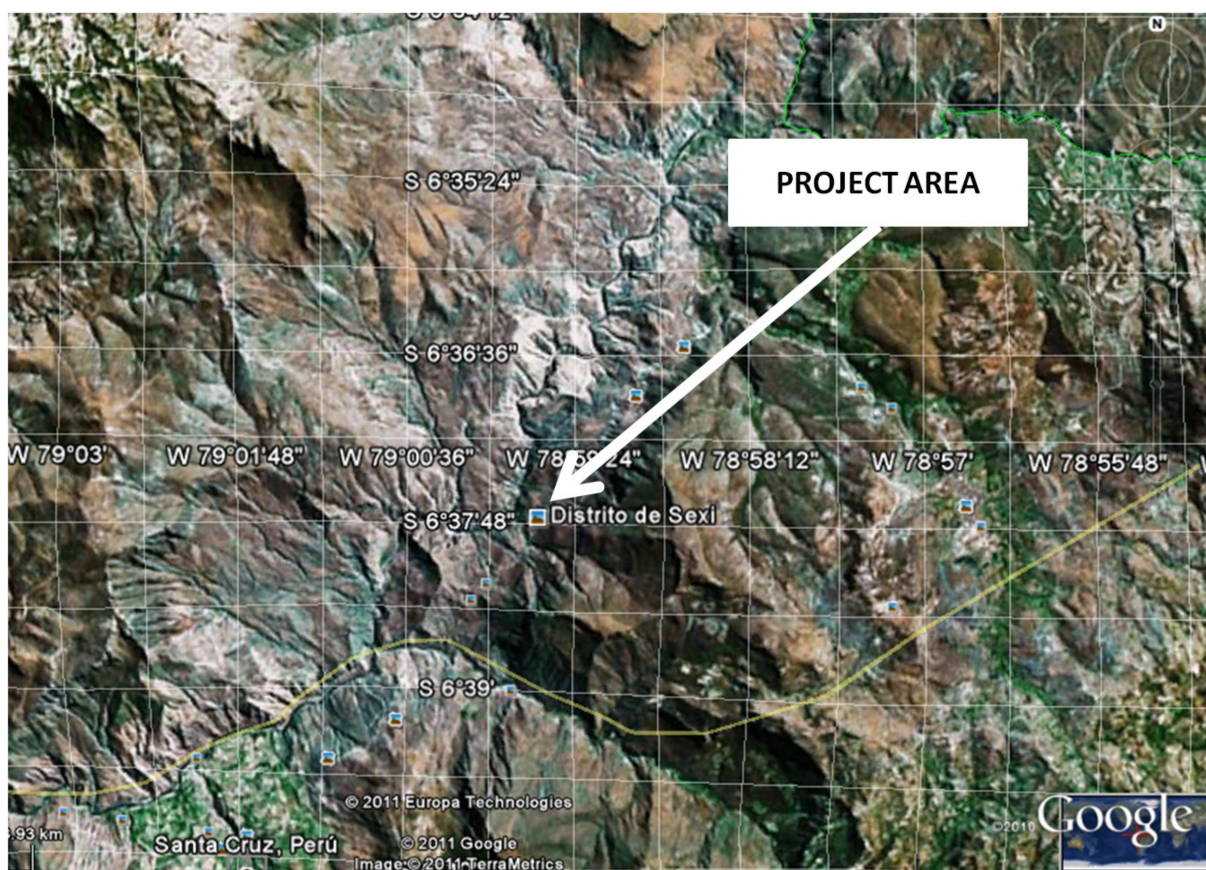
1.7 Project Location

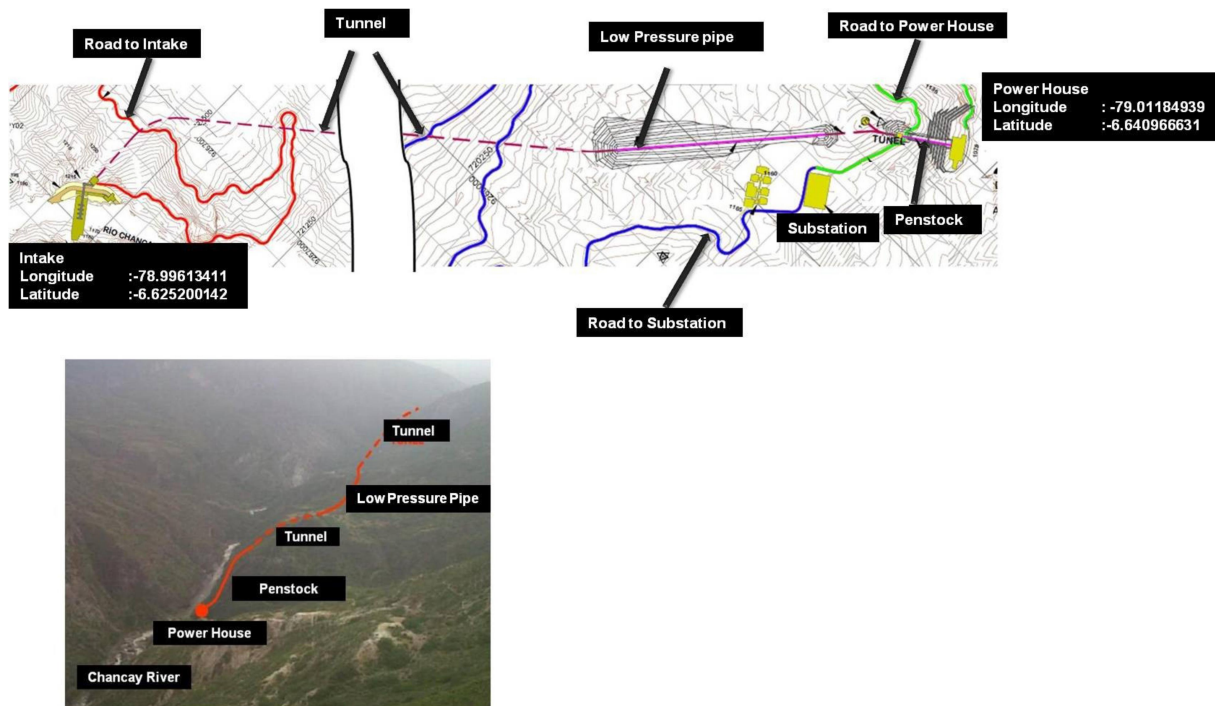
The project will be located in the northern part of Peru, within the District of Sexi, Province of Santa Cruz, and Department of Cajamarca. The power house will be located along the right margin of the Chancay River, at approximately 1,078 m.a.s.l.

According to the project's license to undertake studies for electricity generation, granted by the Institute of Natural Resources (INRENA) and then ratified by the water authority (Autoridad Nacional del Agua - ANA), the coordinates for the intake and discharge are the following:

Intake Coordinates			
UTM Coordinates	X (East): 721.737	Y (North): 9267.716	PSAD 56
Geographical Coordinates	Longitude: -78.99442485	Latitude: -6.620835649	
Discharge Coordinates			
UTM Coordinates	X (East) : 714.470	Y (North): 9263.575	PSAD 56
Geographical Coordinates	Longitude: -79.05998099	Latitude: -6.658534724	

The location of the project can be seen in the following figures:





1.8 Title and Reference of Methodology

The project will use the UNFCCC approved consolidated baseline and monitoring methodology ACM0002 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources --- Version 12.3.0".

The project will use the following UNFCCC tools, also referred in the methodology:

- "Tool to calculate the emission factor for an electricity system --- Version 02.2.0"
- "Tool for the demonstration and assessment of additionality --- Version 06.0.0"

1.9 Other Programs

- Emission Trading Programs and Other Binding Limits: The project does not reduce GHG emissions from activities that are included in an emission-trading program or any other mechanism that includes GHG allowance trading. There is no national program or cap, applicable to this project. The project will not use its GHG emission reductions and removals for compliance, under any such programs or mechanisms.

Peru is not an Annex I country of the Kyoto protocol so it is not participating in the Assigned Amount Unit (AAU) markets. Also the country has not implemented a national emission rights market.

- Other Forms of Environmental Credits: The project is a renewable energy generation project, which discharges no emission during operation period. Thus, the project does not

fall into categories that create GHG emissions primarily for the purpose of its subsequent removal or destruction.

The project has not created another form of environmental credit, now or in the future. This will be verified by the DOE.

- Participation under Other GHG Programs: The project is registered under the CDM scheme. CDM project is registered in UNFCCC on 19th October 2012 with reference 6967 "Las Pizarras Project". But no GHG credits have been claimed under other GHG programs.

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

Las Pizarras Project started its commercial operations on April 30th 2013. Hence, the carbon crediting period and therefore the monitoring starts on April 30th 2013, when the plant commenced electricity generation. At the time of starting the commercial operations, the project was fully operational.

During the first monitoring period (30/04/2013 to 30/09/2015), the project has operated continuously and satisfactorily, with the exception of the following event:

- From June 15th 2013³ to November 14th 2013, the power plant was stopped due to the collapse of the headrace tunnel which affected to 829.20ml⁴.

The rehabilitation works took five months from June 30th 2013⁵ to November 14th 2013⁶ and were carried out by the company IESA, a specialized firm in mining services and construction.

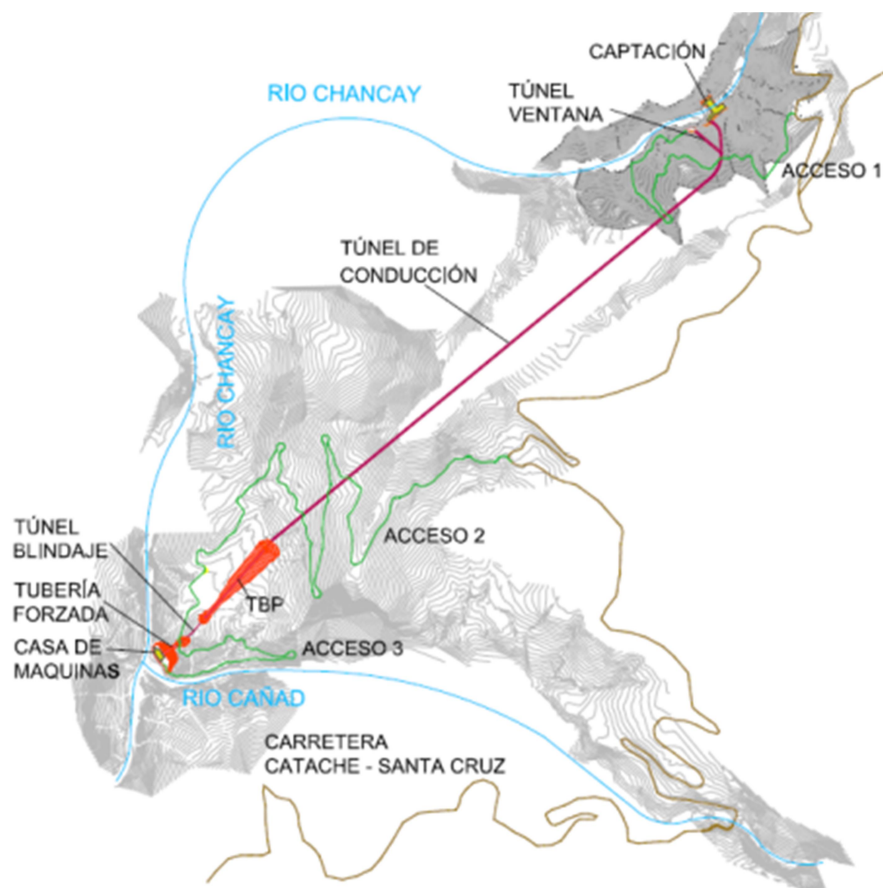
Once the rehabilitation works were finished, the project could start to operate again in November 14th 2013.

³ Final report from Empresa Eléctrica Río Doble S.A. to insurance company Rimac Seguros y Reaseguros, page 1.

⁴ Final report from Empresa Eléctrica Río Doble S.A. to insurance company Rimac Seguros y Reaseguros, page 13.

⁵ IESA S.A. invoice as an advance in rehabilitation works in tunnel. Document IESA -20130711-FT 001-006933

⁶ IESA S.A. final invoice related with rehabilitation works in tunnel. Document IESA -20131130-FT 001-7130



No other relevant event or situations have been reported during the monitoring period.

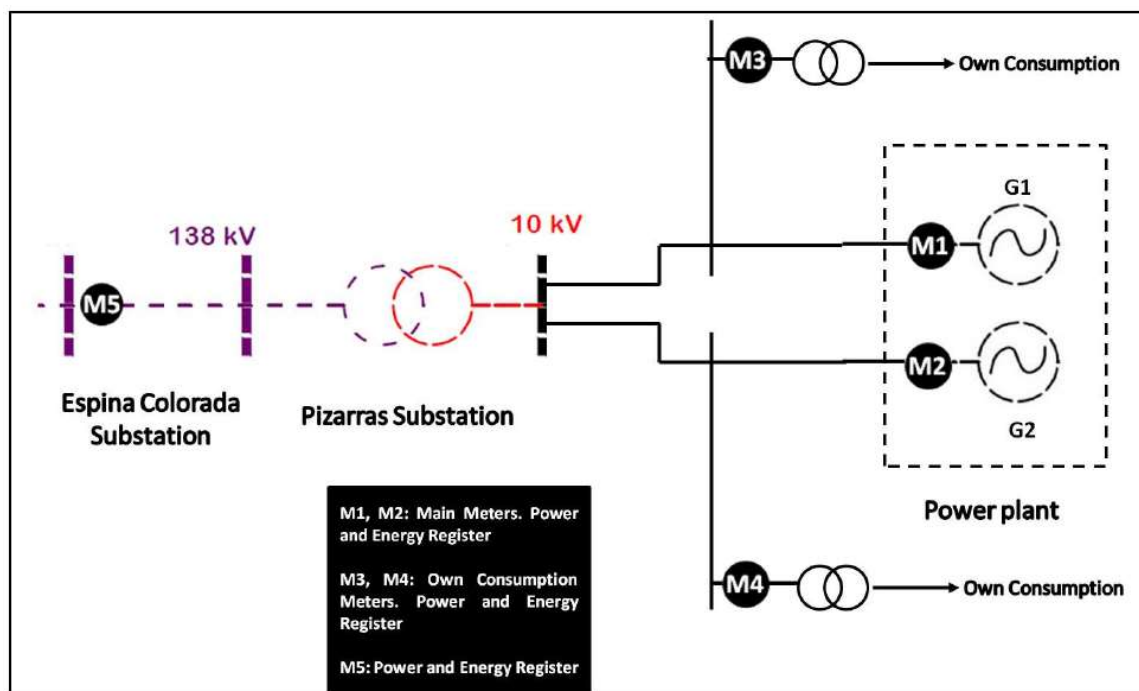
The amount of energy generated has been continuously measured by one main meter (M1) and two backup meters (M2 and M3) installed at Espina Colorada substation. These measurements equipment are certified and calibrated complying IEC standards.

2.2 Deviations

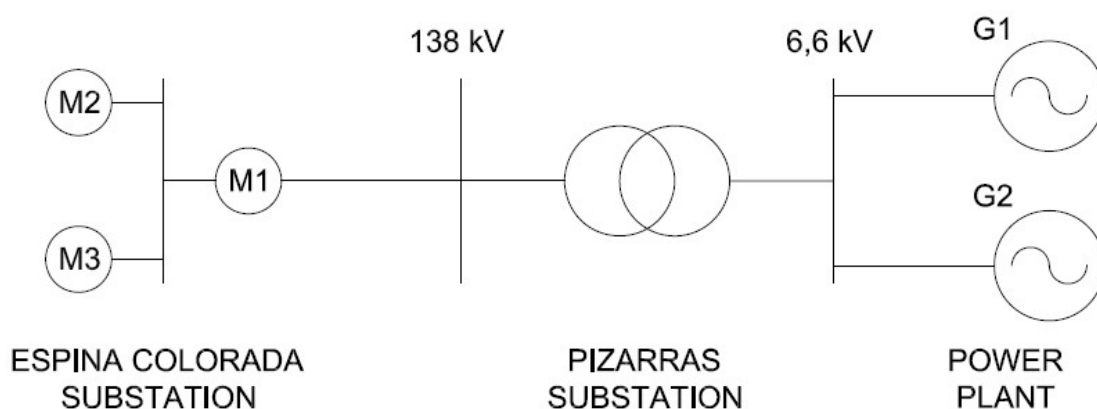
2.2.1 Methodology Deviations

The initial monitoring plan described in the Project Description Document of the CDM project has been revised in order to remove redundant meters and implement a more simply and realistic system.

It was stated in the PD a tentative meters location as per the following figure:



Meters M1 and M2 (main meters) are considered redundant, so these have been unified at M1. In the other hand, M4 and M3 are not considered useful since the current meters are bidirectional, and these measure the value of net electricity to the grid. M5 has been substitute by two backup meters (M2 and M3). In the following figure it is shows the new meter location:



M1: Main Meter
M2, M3: Backup Meter

The values obtained from the meters will be cross check with the invoices issue to the SEIN.

This new plan has been carried out from the beginning of the commercial operation of the plant, and it doesn't affect to the conservative calculation of the emission reduction, since there are not substantial changes, but only redundant meters have been removed.

This new monitoring plan has been develop in compliance with the applicable methodology and does not involve any impacts on the additionality or baseline of the project as the only change has been to remove redundant meters, only used for internal control of the project participant. Further details of the new monitoring plan are available in section 3.3.

In the other hand, in the registered PDD, the General Manager was in charge of:

- Compile and analyze all the monthly monitoring reports every year.
- Elaborate an estimate of emission reductions in an Emission Reduction Monitoring Report.
- Calculate the Combined Margin and recalculate the Grid Emission Factor every year.
- Compile and analyze all the calibration reports in a Maintenance Report Status every year.
- Manage and supervise all monitoring activities under the generation project. □ Ensure that all data is recorded accurately.
- Supervise the maintenance and operation departments.
- Ensure that the operators from the maintenance and operations departments are appropriately trained for monitoring/checking the different parameters/meters with training sessions and an instruction manual.
- Draft the Emission Reduction Monitoring Report with all its attachments, which will be verified by the DOE.

As explain in section 3.3. (Organizational structure), some tasks have been assigned to the Plant Manager, This change doesn't impact the conservativeness of the quantification of GHG emission reduction

2.2.2 Project Description Deviations

There has been a change on the turbines and total installed capacity of the Project. It was stated in the PD that the project would employ two new Francis turbines with horizontal shafts and of 9 MW each and the total capacity this would be of 18 MW, with an electricity generation potential of 103.32 GW·h per year.

In reality, two Francis Turbines with horizontal shafts and of 10.023 MW each have been employed, the total installed capacity is now 19.992 MW, and the total electricity generation potential is 106.598 GW·h.

Given that the PDD redaction was carried out during the project phase, this change occurred during the construction phase when it was detected and mistake in the river daily flow, could produce a reduction on the estimated energy production. In order to get the estimated energy production it was decided to change the turbines previously considered and increment the total installed capacity up to 19.992 MW.

The difference in production is mainly due to two factors with opposing effects: For once, calculation was revised when it was found out that the river daily flow would yield an income of about 3% lower than originally planned. Which led to a subsequent detailed study by the engineering department of the manufacturer, allowing the PP to work with the distributor of the turbine to change it, which meant a greater flow path and therefore greater peak power and higher output (but only in those moments where the plant is at full load). With which fortunately it was able to counteract the above factor.

The following table shows the differences between the estimated initial data, considered in the registered PD, and the real data of the final installed equipment:

	Turbinable flow rate	Rated net head	Turbine installed capacity	Generator installed capacity	Maximum theoretic production
Initial estimate data	22.1 m3 / sec	95.67 m	9.1125 MW (10.125 KVA)	9 MW	103,902 MWh / year
Final data	23.2 m3 / sec	105.35 m	10.023 MW	9.996 MW	106,598 MWh / year

2.3 Grouped Project

Project is not classified as a grouped project.

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

Data / Parameter	$EF_{CO_2,i,y}$ and $EF_{CO_2,m,i,y}$
Data unit	tCO ₂ /GJ
Description	CO ₂ emission factor of fuel type i used in power unit m in year y
Source of data	IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.
Value applied:	Diesel Oil = 72,600 Residual Fuel Oil = 75,500 Natural Gas = 54,300 Other Primary Solid Biomass = 84,700 Landfill Gas = 46,200 Coal = 87,300
Justification of choice of data or description of measurement methods and procedures applied	The CO ₂ emission factor is used to calculate the CO ₂ emission coefficients of the power plants in the grid.
Purpose of the data	Calculation of baseline emissions (specifically this data is used for the calculation of the $EF_{grid,BM}$).
Comments	None

Data / Parameter	$EF_{EL,m,y}$
Data unit	tCO ₂ /MWh
Description	CO ₂ emission factor of power unit m in year y
Source of data	COES Annual Statistics report and IPCC default values for CO ₂ emission factor of fossil fuel type
Value applied:	All Thermal Plants Emission Factors (see registered spreadsheets for BM and OM calculations)
Justification of choice of data or description of measurement methods and procedures applied	The CO ₂ emission factor of the power unit ($EF_{EL,n,y}$) is calculated as per the guidance for the simple OM, using the option A2: $EF_{EL,m,y} = EF_{CO_2,m,i,y} \times 3.6 / \eta_{m,y}$ The thermal plant emission factor has been used to calculate both

	BM emission factors as per guidance of tool to calculate the grid emission factor. This information has been collected from the source of data described by Inabensa-Zeroemissions for the calculation of the combined margin CM emission factor of the grid
Purpose of the data	Calculation of baseline emissions (specifically this data is used for the calculation of the $EF_{grid,BM}$).
Comments	None

3.2 Data and Parameters Monitored

Data / Parameter	$EG_{PJ,h}$ and $EG_{PJ,y}$
Data unit	MWh
Description	Electricity displaced by the project activity in hour h of year y
Source of data	Empresa Eléctrica Río Doble S.A., based on electricity meters explained below.
Description of measurement methods and procedures to be applied	COES. This data will be continuously measured and recorded every 15 minutes. The proportion of data to be monitored is 100% and the data will be archived electronically.
Frequency of monitoring/recording	Hourly or yearly, as applicable.
Value monitored:	$EG_{PJ,2013} = 18,392 \text{ MWh}$ $EG_{PJ,2014} = 100,659 \text{ MWh}$ $EG_{PJ,2015} = 81,728 \text{ MWh}$
Monitoring equipment	The electricity displaced by the project activity is monitored by the sales records to the SEIN. Electricity supplied by the project activity to the grid, double check with sales receipts. Additionally, the equipment used to monitor these parameters are the main meter M1 and backup meters M2 and M3. The three meters are class 0.2 (as currently required by COES) and monitor the energy supplied to SEIN. Additional information of the meters: • Type: bidirectional • Accuracy class: Max error 0.2 KWh • Calibration frequency: The PD stated that calibration would be done at appropriate intervals according to manufacturer specifications, but at least once in three years. Given that manufacturer doesn't specify any appropriated interval, the calibration is being carried out once each year, complying with

	the requirements of doing it at least once in three years, according with the approved monitoring methodology.
QA/QC procedures to be applied	Measurement equipment are certified to national or IEC standards and calibrated according to the national standards and reference points or IEC standards and recalibrated at appropriate intervals according to manufacturer specifications. Monthly the electricity measured by the meters has been cross checked with reports of active energy transfers provided by COES⁷ and invoices to ensure consistency. Conservative values have been used for calculation of emission reductions. This data has been archived electronically and will be kept at least for two years after the end of the last crediting period.
Purpose of the data	Calculation of baseline emissions
Calculation method	In case of failure or maintenance of the main meter M1, the Plant Manager will request the electricity supplied by the project to the Coordinator of the grid node Carhuaquero, who will develop an energy balance with the rest of electricity meters of the system.
Comments	The three meters could be configured to work either in a unidirectional or bi-directional way, but for the project purposes they have been configured to work in a bidirectional way. The electric energy displaced by the project activity is the net energy delivered to the grid. This net energy considers the self-consumption of the auxiliary systems.

Data / Parameter	$EF_{CO_2,i,y}$ and $EF_{CO_2,m,i,y}$
Data unit	tCO ₂ /GJ
Description	CO ₂ emission factor of fuel type i used in power unit m in year y
Source of data	IPCC default values of the IPCC Guidelines on National GHG Inventories at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.
Description of measurement methods and procedures to be applied	Every time a new IPCC Guidelines on National GHG Inventories is published, these values will be updated.
Frequency of monitoring/recording	Every time a new IPCC Guidelines on National GHG Inventories is published

⁷ <http://www.coes1.org.pe/caracteristicas-del-sein/WebPages/DespachoEjecutadoDiario.aspx>

Value monitored	Diesel Oil = 72,600 Residual Fuel Oil = 75,500 Natural Gas = 54,300 Other Primary Solid Biomass = 84,700 Landfill Gas = 46,200 Coal = 87,300
Monitoring equipment	None
QA/QC procedures to be applied	Any consideration or recalculation undertaken by the IPCC will be considered in the ex-post calculations.
Purpose of the data	Calculation of baseline emissions (specifically this data is used for the calculation of the $EF_{grid,OM}$).
Calculation method	None
Comments	None

Data / Parameter	$EF_{CO_2,grid,y} = EF_{grid,CM,y}$
Data unit	tCO ₂ /MWh per year
Description	CO ₂ emission factor of the grid electricity in year y that is equal to combined margin CO ₂ emission factor for grid connected power generation in year y.
Source of data	COES records and Río Doble.
Description of measurement methods and procedures to be applied	The Emission Factor has been calculated following the “Tool to calculate the emission factor for an electricity system”, version 02.2.0. Based on the tool, the Combined Margin Emission Factor ($EF_{grid,CM,y}$) has been calculated through a weighted-average formula, considering both the $EF_{grid,OM-DD,y}$ and the $EF_{grid,BM,y}$ and the weights w_{OM} and w_{BM} $EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$ For hydroelectric projects: $w_{OM} = 0.5$ and $w_{BM} = 0.5$ for the first crediting period, and $w_{OM} = 0.25$ and $w_{BM} = 0.75$ for the second and third crediting period.
Frequency of monitoring/recording	Every year. For the calculation of the dispatch data analysis ($EF_{grid,OM-DD,y}$), the project developer shall use the year in which the project activity displaces grid electricity and update the emission factor annually during monitoring.

	For the calculation of the $EF_{grid,BM,y}$ the option 1 was chosen in the CDM-PDD, therefore the $EF_{grid,BM,y}$ does not require monitoring during the first crediting period as per the Tool to calculate the emission factor for an electricity system: for the first crediting period, ex-ante based on the most recent information available on units already built (sample group m) at the time of PD submission to the VVB for validation.
Value monitored:	$EF_{grid,BM} = 0.56934 \text{ tCO}_2/\text{MWh}$ $EF_{grid,OM-D,2013} = 0.68724 \text{ tCO}_2/\text{MWh}$ $EF_{CO2,grid,2013} = 0.62828 \text{ tCO}_2/\text{MWh}$ $EF_{grid,BM} = 0.56934 \text{ tCO}_2/\text{MWh}$ $EF_{grid,OM-DD,2014} = 0.49583 \text{ tCO}_2/\text{MWh}$ $EF_{CO2,grid,2014} = 0.53258 \text{ tCO}_2/\text{MWh}$ $EF_{grid,BM} = 0.56934 \text{ tCO}_2/\text{MWh}$ $EF_{grid,OM-DD,2015} = 0.47710 \text{ tCO}_2/\text{MWh}$ $EF_{CO2,grid,2015} = 0.52321 \text{ tCO}_2/\text{MWh}$
Monitoring equipment	None
QA/QC procedures to be applied	Any consideration or recalculation undertaken by the IPCC will be considered in the ex-post calculations. The spreadsheet of calculation has been archived electronically and will be kept at least for two years after the end of the last crediting period.
Purpose of the data	Calculation of baseline emissions
Calculation method	As per the 02.2.0.version of the "Tool to calculate the emission factor for an electricity system".
Comments	None

Data / Parameter	$EG_{m,y}$ and $EG_{n,y}$
Data unit	MWh
Description	Net electricity generated and delivered to the grid by power plant / unit m or n in year y or hour h. m: Power units included in the build margin. n: Grid power units in the top of the dispatch.
Source of data	COES records

Description of measurement methods and procedures to be applied	Data is directly measured based on the information provided by COES.
Frequency of monitoring/recording	Continuous measurement and at least monthly recording. Dispatch data OM: Hourly. BM: Fixed for the first crediting period.
Value monitored:	COES records
Monitoring equipment	None
QA/QC procedures to be applied	None, the data would be provided by the COES.
Purpose of the data	Calculation of baseline emissions
Calculation method	None
Comments	None

Data / Parameter	$\eta_{m,y}$
Data unit	%
Description	Average net energy conversion efficiency of power unit m in year y
Source of data	COES Annual Statistics Report ⁸
Description of measurement methods and procedures to be applied	Every year this data will be checked with the latest available Annual Statistics report of the COES.
Frequency of monitoring/recording	Annually
Value monitored:	COES Annual Statistics Report
Monitoring equipment	None
QA/QC procedures to be applied	If the data used is significantly lower than the default value of the applicable technology, project proponents should assess the reliability of the values and provide appropriate justification if deemed reliable. Otherwise, the default values shall be used.

⁸ http://www.coes1.org.pe/post-operacion/Publicaciones/Estadistica%20Anual%20COES/2014/02_Anuario/01_PDF/ESTADISTICA%20OPERACION%202014.pdf - Web link last accessed on 06/10/2015.

Purpose of the data	Calculation of baseline emissions
Calculation method	None
Comments	None

3.3 Monitoring Plan

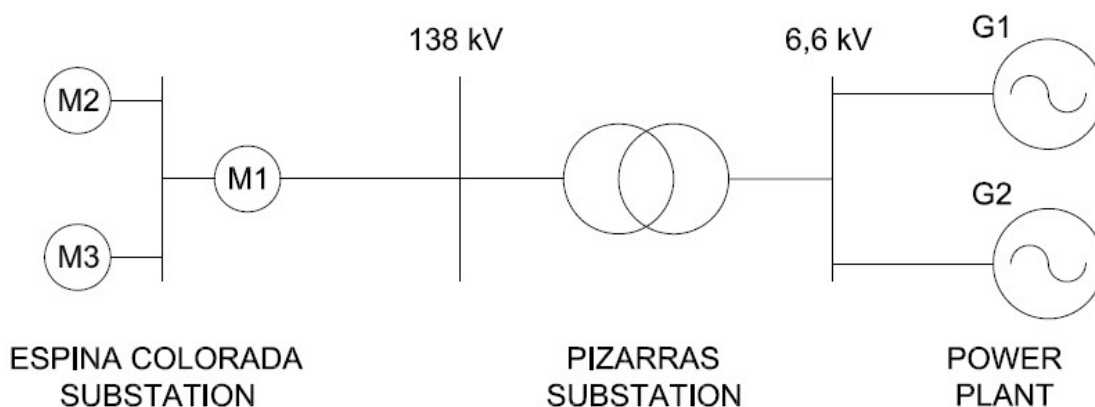
The Monitoring Plan is developed in accordance with the approved consolidated baselines and monitoring methodology for grid-connected electricity generation from renewable sources – ACM0002, version 12.3.0, and sets out the procedures for metering, monitoring and calculating the ERs generated through the net electricity supplied to the SEIN by the project activity.

Monitoring equipment

The 100% of electricity delivered to the grid by the project is continuously measured through the main meter M1 installed at Espina Colorada Substation. In order to ensure maximum availability of monitoring data and quality controls, after the main meter have been installed two backup meters, M2 and M3.

If problems which can affect the quality of data occur, the Plant Manager will initiate and supervise the implementation of corrective actions by the Maintenance Provider. In these situations, the Plant Manager will request the electricity supplied by the project to the Coordinator of the grid node Carhuaquero, who will develop an energy balance with the rest of electricity meters of the system.

The following grid connection diagram indicates the principles of positioning of metering instruments that have been used in the monitoring of the emission reductions:



M1: Main Meter
M2, M3: Backup Meter

Before the project initial commercial operation, calibration of the meters was carried out by Schneider Electric according to IEC standards to ensure the accuracy of the measurements. The main specifications of each one are the followings:

Meter	Type	Serial number	Accuracy	Calibration date	Carried out by
M1 Main meter	ION 8650	MW-1211A328-01	0.2	20/11/2012 14/09/2013 22/11/2014	Schneider Electric
M2 Backup meter	ION 8650	MW-1211A330-01	0.2	20/11/2012 22/08/2013 22/11/2013	Schneider Electric
M3 Backup meter	ION 8650	MW-1205A219-01	0.2	17/05/2012 14/09/2013 22/11/2014	Schneider Electric

The meters comply with the specifications set up in the PPA as the measurement equipment are electronic type class 0.2, available to connect through telephone and with capacity for 35 days of recorded information in order to invoice. Also, the three meters could be configured to work either in a unidirectional or bi-directional way, but for the project purposes they have been configured to work in a bidirectional way.

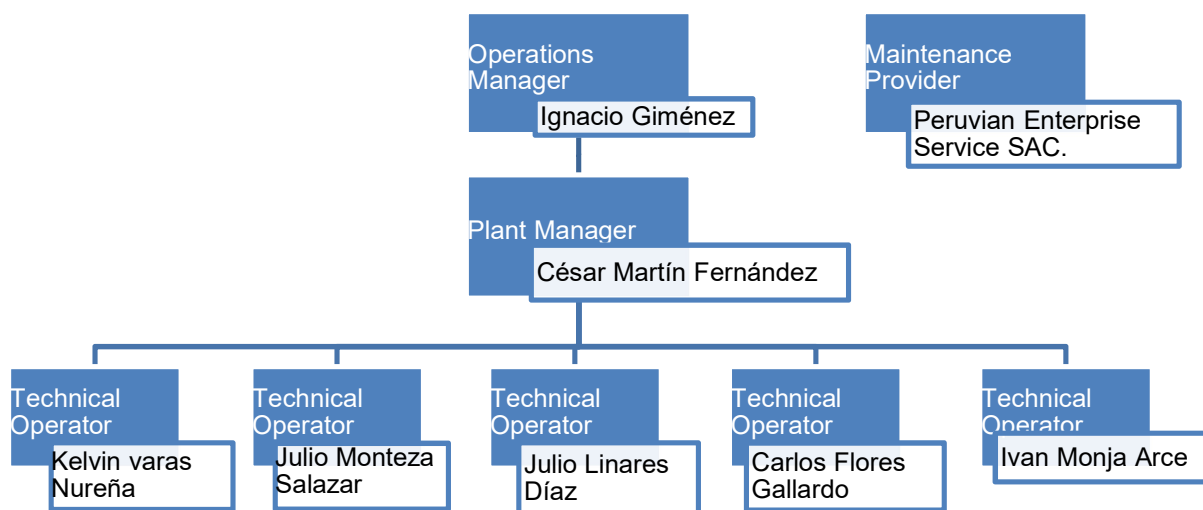
The electricity generated has been continuously measured and recorded every 15 minutes as well as recorded on monthly monitoring reports by Technical Operators. Due to the complexity of the invoice system of the Peruvian grid, the monthly recorded electricity has been cross checked with the monthly reports of active energy transfers provided by COES⁹, where state the income and outcome energy by the project. Conservative values are been used for calculation of emission reductions.

Procedures for maintenance and installation of equipment, as well as calibration, have been performed according to manufacturer specifications and will follow applicable requirements of the Electricity General Direction of the Peruvian Energy and Mines Ministry (these requirements are currently under development by the Ministry).

Organizational structure:

The following figure outlines the operational and management structure that the project proponent has implemented to monitor the emission reductions generated by the project activity. The responsible person for the monitoring of the entire data required is the Operations Manager that for the present monitoring period has been Ignacio Giménez.

⁹ <http://www.coes1.org.pe/caracteristicas-del-sein/WebPages/DespachoEjecutadoDiario.aspx>



Technical Operators

The monitoring performance of the project requires the fulfillment of operational data collection and processing obligations by the Technical Operators. The Technical Operators are obligated to ensure that sufficient and accurate information is available to calculate ERs in a transparent manner, and that adequate information is collected and maintained to facilitate successful verification of accounted ERs.

The Technical Operators are responsible for:

- Monitoring the following parameters:
 - Energy and power supplied by the project activity to the national grid.
 - The installed capacity of the hydro power plant.
- Record and store data from the main and back up meters.
- Control the accurate operation of any meters or equipment needed for monitoring, and preliminarily determine the needs for maintenance or repair work.
- Elaborate monthly monitoring report and send them to Plant Manager.

The Maintenance Provider

Maintenance and calibrations of the measuring equipments have been developed by the company Peruvian Enterprise Service SAC following the applicable requirements of the Electricity General Direction of the Peruvian MINEM (these requirements are currently under development by the Ministry), as well as manufacturer's specifications. Calibration certificates of the accredited calibration agency, and the relevant calibration document, have been collected by the Operations Manager and will be archived for at least 2 years after the last crediting period.

Plant Manager

The Plant Manager supervises the Technical Operators and is responsible for:

- Compile and analyze all the monthly monitoring reports.
- Compile all the calibration certifications.
- Ensure that the Technical Operators are appropriately trained for monitoring/checking the different parameters/meters with training sessions and an instruction manual.

Operations Manager

The Operations Manager has final responsibility for all aspects related to data measurements and the monitoring of data recordings. Mainly:

- Manage and supervise all monitoring activities under the generation project.
- Ensure that all data is recorded accurately.
- Supervise the Maintenance Provider and Plant Manager.
- Elaborate the draft Monitoring Report with all its attachments, which will be verified by the VVB.
- Elaborate an estimate of emission reductions in the Emission Reduction Monitoring Report.
- Calculate the Combined Margin and recalculate the Grid Emission Factor every year.

For the present monitoring period, the calculation of the Combined Margin to recalculate the annually Grid Emission Factor as well as the elaboration of the present Monitoring Report have been charged to the Consultants Rosa Pérez Puente, and Carlos Álvarez García, who have developed the present document.

The CO₂ Emission Factor for the electricity grid has been based on latest available data from the Official COES website and following the most recent version of the “Tool to calculate the emission factor for an electricity system”.

Data Collection and Integration

Below is summary the data gathering that has been carried out during the monitoring period:

- Net electricity dispatched to SEIN: The three meters measure one hundred per cent of the electricity in a continuous way. This measured energy has been recorded electronically each 15 minutes of every hour, day and month according with COES requirements.
- Calibration certificates of the accredited calibration agency, and the relevant calibration document.
- Monthly monitoring reports
- Spreadsheet of calculation the Combined Margin
- Spreadsheet of calculation the Emission Reductions
- Monitoring Report

All data gathering has been archived electronically and will be kept at least for 2 years after the end of the last crediting period.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

Baseline emissions include only CO₂ emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity. The baseline emission is calculated as the product of electrical energy baseline $EG_{PJ,y}$ expressed in MWh, produced by the renewable generating unit and multiplied by the grid emission factor:

$$BE_y = EG_{PJ,y} \times EF_{grid,CM,y}$$

Where:

BE_y : Baseline Emission in year y (tCO₂).

$EG_{PJ,y}$: 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).

$EF_{grid,CM,y}$: Combined margin CO₂ emission factor for grid connected power generation in year y calculated using the latest version of the Tool to calculate the emission factor for an electricity system (tCO₂/MWh).

Calculation of $EG_{PJ,y}$

The calculation of $EG_{PJ,y}$ is different for (a) Greenfield plants, (b) retrofits and replacements, and (c) capacity additions. These cases are described next:

Due to the fact that the project involves the installation of a new grid-connected renewable power plant/unit at a site where no renewable power plant was operated prior to the implementation of the project activity (Case (a) Greenfield plant), then:

$$EG_{PJ,y} = EG_{facility,y}$$

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/yr).

$EG_{facility,y}$: Quantity of net electricity generation supplied by the project plant/unit to the grid in year y (MWh/yr).

The net electricity generation as a result of the project activity to the grid is calculated based on monthly records from meter M1 measurements. The results are presented in the following table:

Year	Month	Net electricity generation (MWh)
2013	April	57.13
2013	May	3,598.24
2013	June	3,184.11
2013	July	0.00
2013	August	0.00
2013	September	0.00
2013	October	0.00
2013	November	1,588.84
2013	December	9,964.26
2014	January	9,355.66
2014	February	8,247.57
2014	March	12,743.36
2014	April	12,410.98
2014	May	14,044.26
2014	June	7,845.84
2014	July	3,931.30
2014	August	2,067.96
2014	September	3,933.31
2014	October	5,761.45
2014	November	8,170.27
2014	December	12,147.83
2015	January	14,060.97
2015	February	11,998.05
2015	March	13,844.55
2015	April	11,564.26
2015	May	13,848.99
2015	June	8,642.78
2015	July	4,002.09
2015	August	2,188.01
2015	September	1,579.14

The total electricity supplied by the project during the monitoring period is 200,781.21 MWh

$$EG_{PJ,2013} = EG_{facility,2013} = 18,392.58 \text{ MWh}$$

$$EG_{PJ,2014} = EG_{facility,2014} = 100,659.79 \text{ MWh}$$

$$EG_{PJ,2015} = EG_{facility,2015} = 81,728.84 \text{ MWh}$$

Calculation of the emission factor (EF) of the national electricity grid

The Tool to calculate the emission factor for an electricity system determines the CO₂ emission factor for the displacement of electricity generated by power plants in an electricity system by calculating the “operating margin”, “build margin” and “combined margin” through the following 6 steps:

Step 1: Identify the relevant electric power system.

Step 2: Choose whether to include off-grid power plants in the project electricity system.

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

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

Step 5: Calculate the build margin (BM) emission factor.

Step 6: Calculate the combined margin (CM) emission factor.

Step 1: Identify the relevant electric power system

The electricity generation will be supplied to the SEIN, therefore the project displace consumption of energy from Peru's SEIN.

Step 2: Choose whether to include off-grid power plants in the project electricity system.

There are 2 options in the Tool to choose from:

Option I: Only grid power plants are included in the calculation.

Option II: Both grid power plants and off-grid power plants are included in the calculation.

Because the data from grid connected power plants is available, Option I is chosen for the calculation of the grid emission factor.

Step 3: Select a method to determine the operating margin (OM)

Out of four options for the OM, the Dispatch Data Analysis OM (OM-DD) was selected. The Simple OM method cannot be used since low cost, must-run resources constitute more than 50% of total grid generation in Peru. Also, it was not necessary to use either the Simple Adjusted OM approach or the Average OM approach because detailed dispatch data is available.

Step 4: Calculate the operating margin emission factor according to the selected method

For this calculation the hourly generation in 2013, 2014 and 2015 was used, as it was the most recent data available. The formula for the OM-DD emission factor ($EF_{grid,OM-DD,y}$) used was provided by the Tool as follows:

$$EF_{grid,OM-DD,y} = (\sum_h EG_{PJ,h} \times EF_{EL,DD,h}) / EG_{PJ,y}$$

Where:

$EF_{grid,OM-y}$: Dispatch data analysis operating margin CO₂ emission factor in year y (tCO₂/MWh).

$EG_{PJ,h}$: Electricity displaced by the project activity in hour h of year y (MWh).

$EF_{EL,DD,h}$: CO₂ emission factor for grid power units in the top of the dispatch order in hour h in year y (tCO₂/MWh).

$EG_{PJ,y}$: Total electricity displaced by the project activity in year y (MWh).

h : Hours in year y in which the project activity is displacing grid electricity.

y : Year in which the project activity is displacing grid electricity.

The hourly emissions factor is calculated based on the energy efficiency of the grid power unit and the fuel type used, as follows:

$$EF_{EL,DD,h} = (\sum_n EG_{n,h} \times EF_{EL,n,y}) / \sum_n EG_{n,h}$$

Where:

$EF_{EL,DD,h}$: CO₂ emission factor for power units in the top of the dispatch order in hour h in year y (tCO₂/MWh).

$\sum_n EG_{n,h}$: Net quantity of electricity generated and delivered to the grid by power unit n , in hour h (MWh).

$EF_{EL,n,y}$: CO₂ emission factor of power unit n , in year y (tCO₂/MWh).

n : Power units at the top of the dispatch order.

h : Hours in year y in which the project activity is displacing grid electricity.

To determine the set of grid power units n that are at the top of the dispatch order at each hour h , the power units were stacked using the merit order. The group of power units n in the dispatch margin includes the units at the top $x\%$ of total electricity dispatched in the hour h , where $x\%$ is equal to the greater of either:

a) 10%, or

b) The quantity of electricity displaced by the project activity during hour h divided by the total electricity generations by grid power plants during that hour h .

The CO₂ emission factor of the power unit ($EF_{EL,n,y}$) is calculated as per the guidance for the simple OM, using the option A2.

$$EF_{EL,n,y} = EF_{CO2,n,i,y} \times 3.6 / \eta_{n,y}$$

Where:

$EF_{EL,n,y}$: CO₂ emission factor of power unit n in year y (tCO₂/MWh).

$EF_{CO2,n,i,y}$: Average CO₂ emission factor of fuel type i used in power unit n in year y (tCO₂/GJ).

$\eta_{n,y}$: Average net energy conversion efficiency of power unit n in year y (ratio).

n : All power units serving the grid in year y except low-cost/must-run power units.

y : Applicable year during monitoring (ex-post option).

THERMAL PLANTS	TECHNOLOGY	FUEL	$\eta_{m,y}$ (%) EFFICIENCY ⁽¹⁾	$EF_{CO_2,m,y}$ ⁽²⁾ KgCO ₂ /Tj	Emissions Factor $EF_{EL,m,y}$ (tCO ₂ /MWh) ⁽³⁾
AGUAYTIA TG1	GAS TURBINE	NATURAL GAS	0.299	54,300	0.6542
AGUAYTIA TG2	GAS TURBINE	NATURAL GAS	0.289	54,300	0.6762
BELLAVISTA ALCO	DIESEL	DIESEL 2	0.267	72600	0.9791
CHILCA1 CCOMB TG1	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.525	54,300	0.3723
CHILCA1 CCOMB TG1 & TG2	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.515	54,300	0.3795
CHILCA1 CCOMB TG1 & TG2 & TG3	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.518	54,300	0.3775
CHILCA1 CCOMB TG1 & TG3	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.522	54,300	0.3742
CHILCA1 CCOMB TG2	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.505	54,300	0.3872
CHILCA1 CCOMB TG2 & TG3	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.513	54,300	0.3810
CHILCA1 CCOMB TG3	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.520	54,300	0.3758
CHILCA1 TG1	GAS TURBINE	CAMISEA NATURAL GAS	0.348	54,300	0.5619
CHILCA1 TG2	GAS TURBINE	CAMISEA NATURAL GAS	0.339	54,300	0.5768
CHILCA1 TG3	GAS TURBINE	CAMISEA NATURAL GAS	0.332	54,300	0.5896
CHILINA SULZER 1 & 2	DIESEL	RESIDUAL 500	0.391	75,500	0.6947
CHILINA TV2	STEAM TURBINE	DIESEL 2	0.206	72,600	1.2682
CHILINA TV3	STEAM TURBINE	RESIDUAL 500	0.190	75,500	1.4287
CHILINA CICLO COMBINADO	COMBINED CYCLE GAS	RESIDUAL 500	0.294	75,500	0.9246
FENIX CCOMB GT11 - GAS	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.493	54,300	0.3966
FENIX CCOMB GT11>12 - GAS	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.502	54,300	0.3896
FENIX CCOMB GT12 - GAS	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.506	54,300	0.3864
FENIX GT11 - GAS	GAS TURBINE	CAMISEA NATURAL GAS	0.344	54,300	0.5682
FENIX GT12 - GAS	GAS TURBINE	CAMISEA NATURAL GAS	0.339	54,300	0.5774
HUAYCOLORO G1, G2 y G3	DIESEL	BIOGAS	0.323	46,200	0.5156
ILO1 CATKATO	DIESEL	DIESEL 2	0.412	72600	0.6350
ILO1 TG1	GAS TURBINE	DIESEL 2	0.330	72600	0.7928
ILO1 TG2	GAS TURBINE	DIESEL 2	0.333	72600	0.7854
ILO1 TV3	STEAM TURBINE	RESIDUAL 500	0.340	75,500	0.8000
ILO1 TV4	STEAM TURBINE	RESIDUAL 500	0.336	75500	0.8089
ILO2 TVC1	STEAM TURBINE	COAL	0.386	87,300	0.8138
INDEPENDENCIA	DIESEL	CAMISEA NATURAL GAS	0.385	54,300	0.5077
KALLPA CCOMB TG1	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.481	54,300	0.4061
KALLPA CCOMB TG1 & TG2	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.488	54,300	0.4010
KALLPA CCOMB TG1 & TG2 & TG3	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.502	54,300	0.3894
KALLPA CCOMB TG1 & TG3	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.489	54,300	0.3995
KALLPA CCOMB TG2	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.486	54,300	0.4024
KALLPA CCOMB TG2 & TG3	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.492	54,300	0.3977
KALLPA CCOMB TG3	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.489	54,300	0.3994
KALLPA TG1	GAS TURBINE	CAMISEA NATURAL GAS	0.342	54,300	0.5720
KALLPA TG2	GAS TURBINE	CAMISEA NATURAL GAS	0.339	54,300	0.5758
KALLPA TG3	GAS TURBINE	CAMISEA NATURAL GAS	0.340	54,300	0.5754
LAS FLORES TG1	GAS TURBINE	CAMISEA NATURAL GAS	0.348	54,300	0.5619
MALACAS TG4	GAS TURBINE	NATURAL GAS	0.300	54,300	0.6515
MALACAS TG4 GAS CON H2O	GAS TURBINE	NATURAL GAS	0.287	54,300	0.6809
MALACAS3 TG5	GAS TURBINE	DIESEL 2	0.371	72600	0.7044
MAPLE ETANOL	STEAM TURBINE	BAGASSE	0.205	84,700	1.4840
MOLLENDO MIRLESS 1 & 2 & 3	DIESEL	DIESEL 2	0.409	72,600	0.6395
OLLEROS TG1	GAS TURBINE	CAMISEA NATURAL GAS	0.353	54,300	0.5544
OQUENDO TG1 - D2	GAS TURBINE	CAMISEA NATURAL GAS	0.305	54,300	0.6401
OQUENDO TG1 - GAS	DIESEL	DIESEL 2	0.314	72,600	0.8322
PARAMONGA TV1	STEAM TURBINE	BAGASSE	0.088	84,700	3.4822
PISCO TG1	GAS TURBINE	CAMISEA NATURAL GAS	0.282	54,300	0.6923
PISCO TG2	GAS TURBINE	CAMISEA NATURAL GAS	0.281	54,300	0.6948
RF ILO TG1	GAS TURBINE	DIESEL 2	0.366	72,600	0.7138
RF ILO TG2	GAS TURBINE	DIESEL 2	0.360	72,600	0.7267
RF ILO TG3	GAS TURBINE	DIESEL 2	0.365	72,600	0.7164
SAN NICOLAS CUMMINS	GAS TURBINE	DIESEL 2	0.362	72,600	0.7227
SAN NICOLAS TV1	STEAM TURBINE	RESIDUAL 500	0.278	75,500	0.9763
SAN NICOLAS TV2	STEAM TURBINE	RESIDUAL 500	0.260	75,500	1.0471
SAN NICOLAS TV3	STEAM TURBINE	RESIDUAL 500	0.323	75,500	0.8410
SANTA ROSA UTI5	GAS TURBINE	CAMISEA NATURAL GAS	0.300	54,300	0.6526
SANTA ROSA UTI5	GAS TURBINE	DIESEL 2	0.272	72,600	0.9619

SANTA ROSA UTI6	GAS TURBINE	CAMISEA NATURAL GAS	0.295	54,300	0.6628
SANTA ROSA UTI6	GAS TURBINE	DIESEL 2	0.266	72,600	0.9827
STA ROSA WEST TG7 - D2 CON H2O	GAS TURBINE	DIESEL 2	0.325	72,600	0.8033
STA ROSA WEST TG7 - GAS	GAS TURBINE	CAMISEA NATURAL GAS	0.303	54,300	0.6447
STA ROSA WEST TG7 - GAS CON H2O	GAS TURBINE	CAMISEA NATURAL GAS	0.300	54,300	0.6526
SANTA ROSA TG8	GAS TURBINE	CAMISEA NATURAL GAS	0.337	54,300	0.5798
TABLAZO TG1	GAS TURBINE	NATURAL GAS	0.243	54,300	0.8044
TAPARACHI	DIESEL	DIESEL 2	0.352	72,600	0.7434
TUMBES	DIESEL	RESIDUAL 6	0.441	75,500	0.6169
VENTANILLA CCOMB TG3	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.506	54,300	0.3862
VENTANILLA CCOMB TG3 & TG4	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.491	54,300	0.3984
VENTANILLA CCOMB TG3 & TG4 F.DIRECTO	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.494	54,300	0.3957
VENTANILLA CCOMB TG3 F.DIRECTO	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.496	54,300	0.3944
VENTANILLA CCOMB TG4	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.499	54,300	0.3918
VENTANILLA CCOMB TG4 F.DIRECTO	COMBINED CYCLE GAS	CAMISEA NATURAL GAS	0.488	54,300	0.4002
VENTANILLA TG3	GAS TURBINE	CAMISEA NATURAL GAS	0.361	54,300	0.5416
VENTANILLA TG3	GAS TURBINE	DIESEL 2	0.356	72,600	0.7344
VENTANILLA TG3 D2 CON H2O	GAS TURBINE	DIESEL 2	0.341	72,600	0.7662
VENTANILLA TG4	GAS TURBINE	CAMISEA NATURAL GAS	0.358	54,300	0.5457
VENTANILLA TG4	GAS TURBINE	DIESEL 2	0.357	72,600	0.7318
VENTANILLA TG4 D2 CON H2O	GAS TURBINE	DIESEL 2	0.340	72,600	0.7687

The information on the hourly generation of all plants in the SEIN and their associated emission factors was entered using excel software and organized in columns where the position of the columns was determined by the monthly grid dispatch merit order. This organization helped identify the plants that fall within the x% of grid dispatch order each hour of the year.

The resulting DDA-OM emission factor was calculated as follows:

$$EF_{grid,OM-DD,y} = (\sum_h EG_{PJ,h} \times EF_{EL,DD,h}) / EG_{PJ,y}$$

$$EF_{grid,OM-DD,2013} = 0.68724 \text{ tCO}_2/\text{MWh}$$

$$EF_{grid,OM-DD,2014} = 0.49583 \text{ tCO}_2/\text{MWh}$$

$$EF_{grid,OM-DD,2015} = 0.47710 \text{ tCO}_2/\text{MWh}$$

Step 5: Calculate the build margin (BM) emission factor

The build margin emission 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:

$$EF_{grid,BM,y} = (\sum_m EG_{m,y} \times EF_{EL,m,y}) / \sum_m EG_{m,y}$$

Where:

EF_{grid,BM,y}: Build margin CO₂ emission factor in year *y* (tCO₂/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}: CO₂ emission factor of power unit *m* in year *y* (tCO₂/MWh).

m: Power units included in the build margin.

y: Most recent historical year for which power generation data is available.

According to the *Tool to calculate the emission factor for an electricity system*, the sample group of power units m used to calculate the build margin should be determined as per the following procedure, consistent with the vintage data 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);
- 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% of AEGtotal (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) (SET $\geq$ 20%) and determine their annual electricity generation (AEGSET- $\geq$ 20%, in MWh);
- c) From SET5-units and SET $\geq$ 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. Ignore steps (d), (e) and (f).
- d) Exclude from SETsample the power units which started to supply electricity to the grid more than 10 years ago. Include in that set the power units registered as CDM project activity, starting with power units that started to supply electricity to the grid most recently, until the electricity generation of the new set comprises 20% of the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) to the extent is possible. Determine for the resulting set (SETsample-CDM) the annual electricity generation (AEGSET-sample-CDM, in MWh); If the annual electricity generation of that set is comprises at least 20% of the annual electricity generation of the project electricity system (i.e. $AEGSET\text{-sample-CDM} \geq 0.2 \times AEGtotal$), then use the sample group SETsample-CDM to calculate the build margin. Ignore steps (e) and (f).

Otherwise:

- e) Include in the sample group SETsample-CDM the power units that started to supply electricity to the grid more than 10 years ago until the electricity generation of the new set comprises 20% of the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation);
- f) The sample group of power units m used to calculate the build margin is the resulting set (SETsample-CDM->10yrs).

Out of SET5-units and SET $\geq$ 20%, the latter group was selected as SETsample due to the fact that it includes the larger annual electricity generation.

In terms of vintage data, to calculate the build margin Option 1 shall be chosen for the proposed project.

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.

Due the present monitoring period is within the first crediting period, the $EF_{grid,BM,y}$ calculated in CDM-PDD has been adopted:

$$EF_{grid,BM,y} = 0.56934 \text{ tCO}_2/\text{MWh}$$

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

The calculation of the combined margin (CM) emission factor ($EF_{grid,CM,y}$) is based on one of the following methods:

- (a) Weighted average CM; or
- (b) Simplified CM.

The simplified CM method (option b) can only be used if:

- The project activity is located in a Least Developed Country (LDC) or in a country with less than 10 registered projects at the starting date of validation; and
- The data requirements for the application of step 5 above cannot be met.

The weighted average CM method (option a) shall be used as the preferred option:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$$

Where:

w_{OM} : Weighting of OM emission factor (%).

w_{BM} : Weighting of BM emission factor (%).

For the proposed project, the following default values are used: $w_{OM} = 0.5$ and $w_{BM} = 0.5$ ¹⁰

$$EF_{grid,CM,2013} = 0.68724 \times 0.5 + 0.56934 \times 0.5$$

$$EF_{grid,CM,2013} = 0.62828 \text{ tCO}_2/\text{MWh}$$

$$EF_{grid,CM,2014} = 0.49583 \times 0.5 + 0.56934 \times 0.5$$

$$EF_{grid,CM,2014} = 0.53258 \text{ tCO}_2/\text{MWh}$$

$$EF_{grid,CM,2015} = 0.47710 \times 0.5 + 0.56934 \times 0.5$$

¹⁰ According to the Tool to calculate the emission factor for an electricity system:

- Wind and solar power generation project activities: $w_{OM} = 0.75$ and $w_{BM} = 0.25$ (owing to their intermittent and non-dispatchable nature) for the first crediting period and for subsequent crediting periods;
- All other projects: $w_{OM} = 0.5$ and $w_{BM} = 0.5$ for the first crediting period, and $w_{OM} = 0.25$ and $w_{BM} = 0.75$ for the second and third crediting period, unless otherwise specified in the approved methodology which refers to this tool.

$$EF_{\text{grid,CM,2015}} = 0.52321 \text{ tCO}_2/\text{MWh}$$

Hence, the baseline emission is:

$$BE_y = EG_{\text{PJ,y}} \times EF_{\text{grid,CM,y}}$$

$$BE_{2013} = 18,392.58 \times 0.62828$$

$$BE_{2014} = 100,659.79 \times 0.53258$$

$$BE_{2015} = 81,728.84 \times 0.52321$$

4.2 Project Emissions

For most renewable energy project activities, the project emissions are neglected. Following the methodology, as the project is a run-of-the-river project, it does not lead to any GHG emissions and therefore project emissions are considered equal to zero.

$$PE_y = 0 \text{ tCO}_2\text{e / year}$$

4.3 Leakage

Following the applied methodology no leakage emissions are considered. The main emissions potentially giving rise to leakage in the context of electric sector projects are emissions arising due to activities such as power plant construction and upstream emissions from fossil fuel use (e.g. extraction, processing, and transportation). These emissions sources are neglected.

4.4 Net GHG Emission Reductions and Removals

The net GHG emission reduction is calculated following the guidance of the methodology ACM0002, as follows:

$$ER_y = BE_y - PE_y$$

Where:

ER_y : Emission reduction in year y (tCO₂)

BE_y : Baseline Emission in year y (tCO₂)

PE_y : Project emission in year y (tCO₂)

$$ER_y = BE_y - 0$$

$$ER_{2013} = 11,555 \text{ tCO}_2\text{e}$$

$$ER_{2014} = 53,609 \text{ tCO}_2\text{e}$$

$$ER_{2015} = 42,761 \text{ tCO}_2\text{e}$$

Year	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)
2013	11,555	0	0	11,555
2014	53,609	0	0	53,609
2015	42,761	0	0	42,761
Total	107,925	0	0	107,925