



**CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006**

CONTENTS

- A. General description of project activity
- B. Application of a baseline and monitoring methodology.
- C. Duration of the project activity / crediting period
- D. Environmental impacts
- E. Stakeholders' comments

Annexes

- Annex 1: Contact information on participants in the project activity.
- Annex 2: Information regarding public funding
- Annex 3: Baseline information
- Annex 4: Monitoring plan

**SECTION A. General description of project activity****A.1. Title of the project activity:**

Las Pizarras Project
Document V.4
Date Completed: 16/07/2012

A.2. Description of the project activity:

The Las Pizarras Project in Peru (hereafter referred to as the “Project”) is a new run-of-river hydroelectric power project located at approx. 1,078 m.a.s.l, on the high basin of the Chancay river, in the district of Sexi, province of Santa Cruz, region of Cajamarca, in Peru (the “Host Country”).¹ The total installed capacity of the Project will be of 18 MW, with an electricity generation potential of 103.32 GWh per year.² The Project will be implemented by “Empresa Eléctrica Río Doble S.A.” (hereafter referred to as “Río Doble”).

The Project aims to generate renewable electricity by using water from the Chancay river and supply this energy to the National Interconnected Electric Grid (SEIN). The reduction of baseline emissions results from the displacement of electricity generated by power plants within the SEIN, which include fossil-fuel based power plants emitting CO₂. The spatial extent of the Project boundary is the SEIN. The definitive study developed for the Project includes the construction of a 138 kV transmission line from the Project to the Espina Colorada sub-station, with a total length of approx. 14.43 km.³ This transmission line is built at the cost of the Project developer and is a requirement for the Project to be able to connect to the SEIN and therefore be able to sell its electricity to it.

The Project is expected to start construction in 14/04/2011 and to start its commercial operations in 31/12/2012. The start date of the Project is 14/03/2011, when Energie Baden-Württemberg AG – EnBW (hereafter referred to as EnBW) and ALUZ C&O Perú S.A.C. (hereafter referred to as Aluz) sold their shares (the former owned 45% and the latter owned 55%) in Río Doble to Eólica Galenova Perú S.A.C. (hereafter referred to as Eólica Galenova),⁴ a company that is represented by Alarde Sociedad de la Energía S.A. (hereafter referred to as Alarde). Río Doble is therefore the sole owner of the Project; however EnBW is also considered a project participant due to its interest in the carbon revenues, secured through the signature of an Emissions Reduction Purchase Agreement (ERPA).

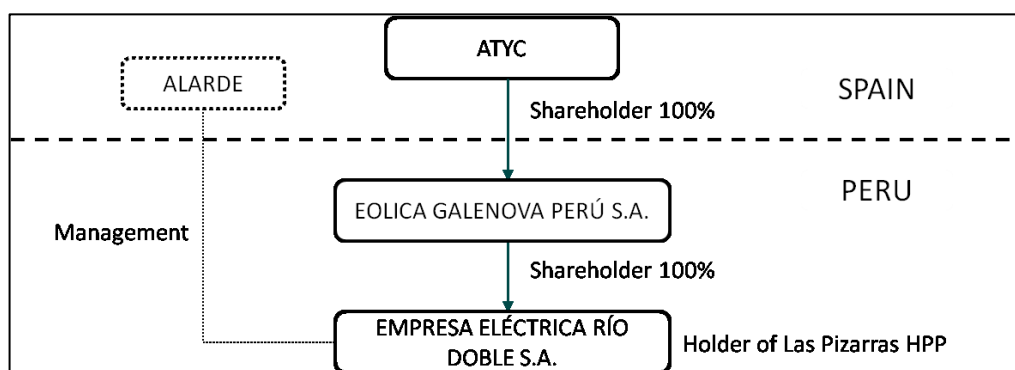
¹ Socoin (2011). *Proyecto Básico Las Pizarras* (Basic Project Las Pizarras), p. 4.

² Socoin (2011). *Proyecto Básico Las Pizarras* (Basic Project Las Pizarras), p. 15.

³ Socoin (2011). *Proyecto Básico Las Pizarras* (Basic Project Las Pizarras), p. 13.

⁴ The purchase contract between Eólica Galenova and Aluz was signed on 10/02/2011 but incorporated a clause whereas the purchase agreed was subjected to EnBW's agreement in a Board Meeting, which was undertaken on 14/03/2011. The purchase contract between Eólica Galenova and EnBW was signed on 14/03/2011.

Figure 1: Ownership and Operation Structure of the companies involved in the Project



Source: Project Developer.

The Project is expected to avoid the emission of 68,132 tons of carbon dioxide equivalent (tCO₂e) per year, which will amount to 476,926 tCO₂e for the first crediting period of 7 years, generating the equivalent amount of greenhouse gas (GHG) emissions reductions (ERs). The greenhouse gas (GHG) emissions of the proposed Project activity will be negligible, thus there will be no need to monitor them, and this will not be taken into account when calculating ERs.

The Project will have an expected minimum operating lifetime of 40 years.⁵ The proposed Project activity has all applicable permissions and authorizations required for its construction and operation, and it also complies with all the environmental requirements mandated by the Ministry of Energy and Mines (MINEM).

The Project contributes to sustainable development by:

- Creating a source of renewable energy in a sustainable way.
- Employing local labour in the construction phase and later in the operation of the plant.
- Contributing to Peru's fiscal accounts through the payment of taxes.
- Contributing to the economy of the region by using local materials, such as cement, metals, wood, and construction equipments, among others.
- Committing to a social agenda as described in detail in Section E of this PDD.
- Expanding the national electricity grid's capacity, which will in turn allow more towns to be able to connect to this grid.
- Improving the infrastructure in and around the Project area due the project activities.

A.3. Project participants:

⁵ Andritz Hydro (2011). Technical lifetime assessment letter.



Name of Party involved (*) ((host) indicates a host Party):	Private and/or public entity(ies) project participants(*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Peru (host)	Empresa Eléctrica Río Doble S.A.	No
Germany	EnBW Kraftwerke AG. ⁶	No
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its <u>approval</u> . At the time of requesting registration, the approval by the Party(ies) involved is required.		
Note: <i>When the PDD is filled in support of a proposed new methodology (forms CDM-NBM and CDM-NMM), at least the host Party (ies) and any known project participants (e.g. those proposing a new methodology) shall be identified.</i>		

A.4. Technical description of the project activity:**A.4.1. Location of the project activity:****A.4.1.1. Host Party(ies):**

Peru

A.4.1.2. Region/State/Province etc.:

Department of Cajamarca, Province of Santa Cruz.

A.4.1.3. City/Town/Community etc.:

District of Sexi, Hamlet of Sexi.

A.4.1.4. Details of physical location, including information allowing the unique identification of this project activity (maximum one page):

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),⁷ the coordinates for the intake and discharge are the following:

⁶ There was an internal transfer in the EnBW Group, whereas the International Climate Business Unit was transferred to EnBW Kraftwerke AG (hereafter referred to as EnBW).



Intake Coordinates:

UTM (PSAD 56): 9'267,716 metres North, 721,737 metres East

Converted to Geographical: Longitude -78.99442485, Latitude -6.620835649

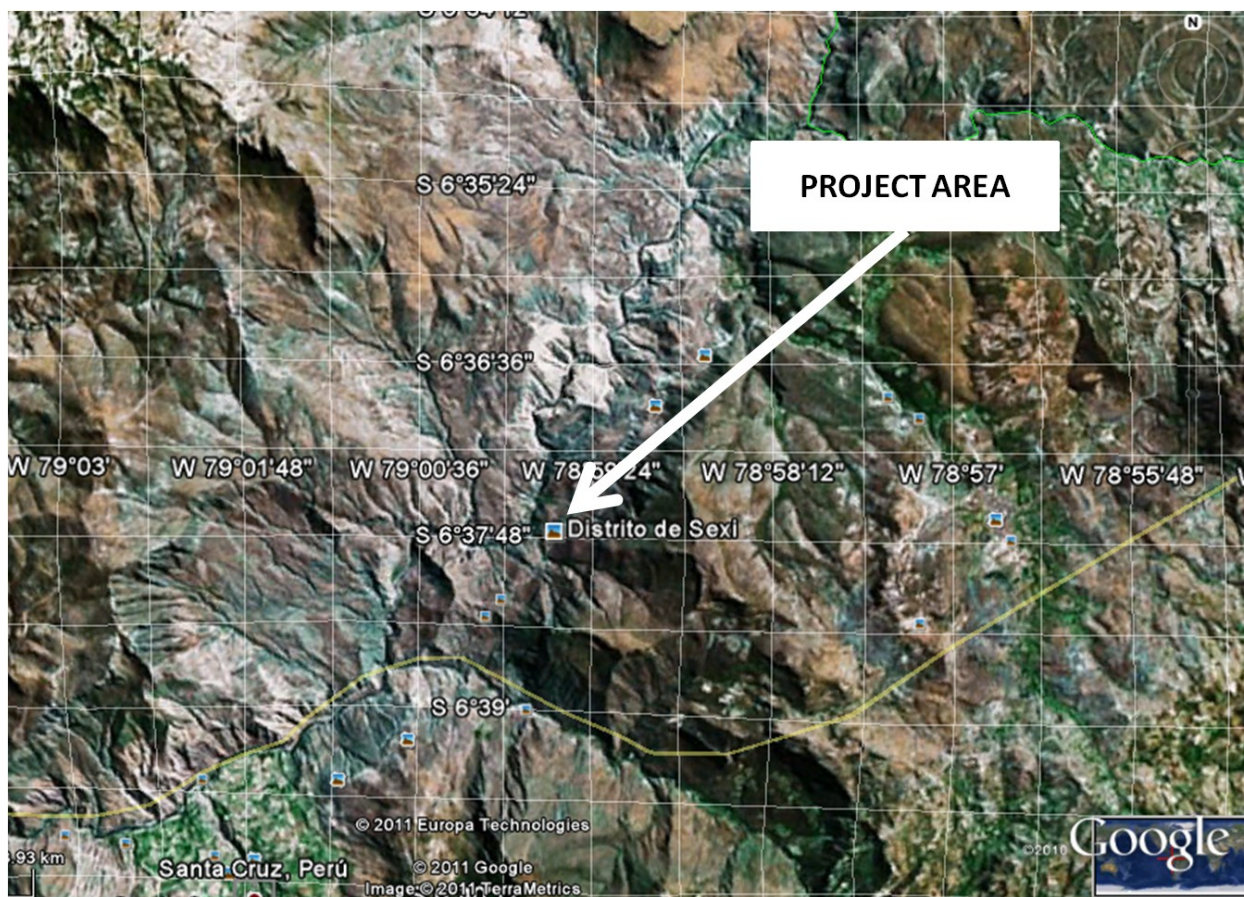
Discharge Coordinates:

UTM (PSAD 56): 9'263,575 metres North, 714,470 metres East

Converted to Geographical: Longitude -79.05998099, Latitude -6.658534724

The location of the Project can be seen in Figure 2 and Figure 3:

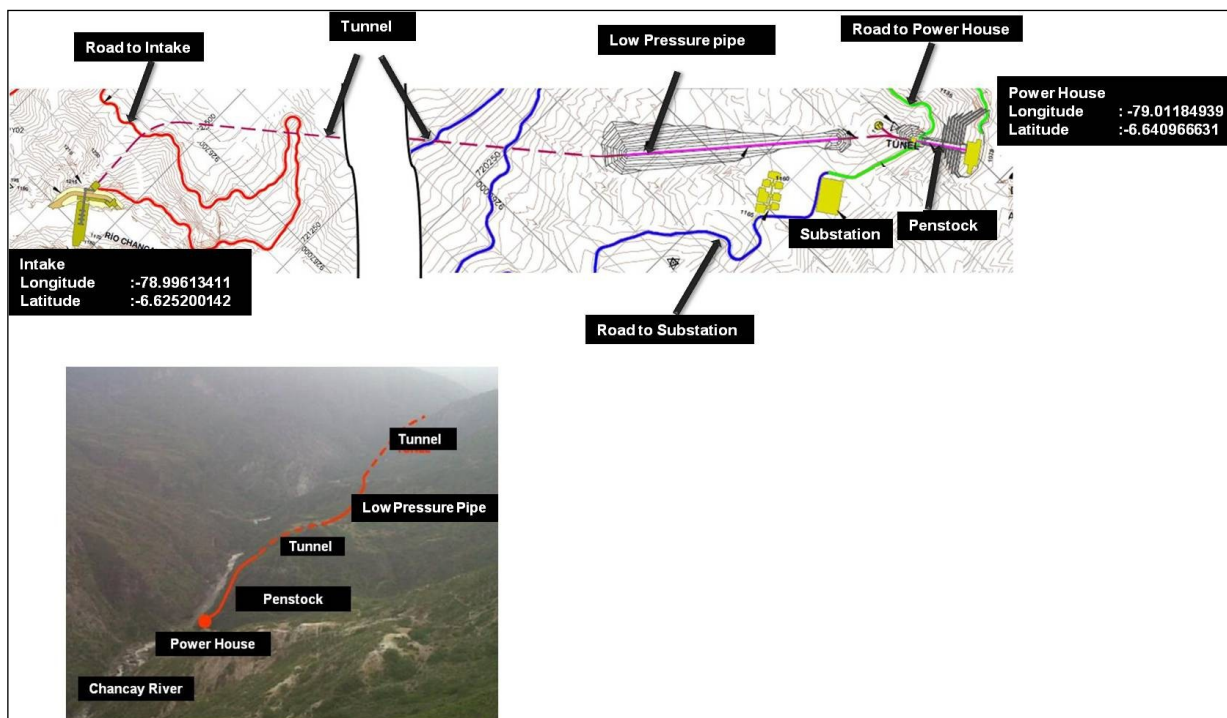
Figure 2: Project Location



Source: Project Developer.

Figure 3: Detailed Project Location

⁷ Resolution No. 001-2008-INRENA-IRH granted on 08/01/2008 and Resolution No. 0078-2009-ANA-DARH granted on 28/08/2009. The coordinates may be subject to minor changes as later permits are granted and construction is initiated.



Source: Project Developer.

A.4.2. Category(ies) of project activity:

Sectoral scope 1: Energy industries (renewable sources)

A.4.3. Technology to be employed by the project activity:⁸

The Project will be 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 0.96km,⁹ and then sent into a 90m penstock that then splits into two other trams of 30.03m and 32.35m respectively,¹⁰ 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 22.1 cubic meters per second (m³/s). The Project will have an installed capacity of 18 MW and will generate approximately 103.32 GWh per year.¹¹ The Project will employ

⁸ The technology characteristics and specifications have been obtained from the studies available to date, however this can be subject to minor changes as final studies are undertaken and construction is initiated.

⁹ Socoin (2011). *Proyecto Básico Las Pizarras* (Basic Project Las Pizarras), p. 8 and 9.

¹⁰ Socoin (2011). *Proyecto Básico Las Pizarras* (Basic Project Las Pizarras), p. 10.

¹¹ Socoin (2011). *Proyecto Básico Las Pizarras* (Basic Project Las Pizarras), p. 15.



two new Francis turbines with horizontal shafts and of 9 MW each,¹² designed for a water flow of 10.06 m³/s.¹³

Table 1: Technology Characteristics

Characteristic	Value	Unit
Turbine⁽¹⁾		
Type	Francis Horizontal Axis	2
Discharge	22.10	m ³ /s
Rated net head	95.67	m
Expected lifetime	40	Years
Expected energy generation	103.32	GWh
Alternator⁽²⁾		
Type	Synchronic three-phase	
Capacity	10.125	MVA
Voltage	6.6	kV
Expected lifetime	40	Years
Transformer⁽¹⁾		
Primary voltage	6.6	kV
Secondary voltage	138	kV
Capacity	20	MVA
Transmission Line⁽¹⁾		
Length	14.43	km
Connection voltage	138	kV
Arrival substation	Espina Colorada	

(1) Socoin (2011). *Proyecto Básico Las Pizarras* (Basic Project Las Pizarras).

(2) Socoin (2011). *Proyecto Básico Las Pizarras* (Basic Project Las Pizarras) – Annex IV.

A.4.4. Estimated amount of emission reductions over the chosen crediting period:

The first crediting period lasts 7 years and will span from 01/01/2013 to 31/12/2019, with the option of being renewed twice.

Following baseline methodology ACM0002: *Consolidated baseline methodology for grid-connected electricity generation from renewable sources* (version 12.3.0),¹⁴ the Project is estimated to reduce **476,926 tCO₂e** during the first 7 years of operation.

¹² Socoin (2011). *Proyecto Básico Las Pizarras* (Basic Project Las Pizarras), p. 17.

¹³ Socoin (2011). *Proyecto Básico Las Pizarras* (Basic Project Las Pizarras), p. 41.

¹⁴ <http://cdm.unfccc.int/methodologies/DB/C505BVV9P8VSNNV3LTK1BP3OR24Y5L/view.html> - Web link last accessed on 20/07/2011.

**Table 2: Ex-ante estimated amount of emission reductions over the first crediting period**

Year	Annual estimation of emissions reductions in tonnes of CO ₂ e
2013	68,132
2014	68,132
2015	68,132
2016	68,132
2017	68,132
2018	68,132
2019	68,132
Total estimated reductions (tonnes of CO₂e)	476,926
Total number of crediting years	7
Annual average over the crediting period of estimated reductions (tonnes of CO₂e)	68,132

A.4.5. Public funding of the project activity:

The Project has not received, and will not receive, any type of public funding or public financial support.

SECTION B. Application of a baseline and monitoring methodology**B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:**

Version 12.3.0 of ACM0002: *Consolidated baseline methodology for grid-connected electricity generation from renewable sources* (EB 58).

Version 02.2.0 of the *Tool to calculate the emission factor for an electricity system* (EB 61/Annex 12).¹⁵

Version 06.0.0 of the *Tool for demonstration and assessment of additionality* (EB 65/Annex10).¹⁶

B.2. Justification of the choice of the methodology and why it is applicable to the project activity:

¹⁵ <http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.2.0.pdf> - Web link last accessed on 20/07/2011.

¹⁶ <http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v6.0.0.pdf> - Web link last accessed on 19/06/2012.



This Project satisfies the applicable conditions of ACM0002 because it is a new power plant at a site where no renewable power plants were operated prior to the implementation of the Project activity (Greenfield plant). The applicability conditions are described in the table below:

Table 3: Applicability of the Proposed Project to ACM0002

ACM0002 applicability conditions	The Project
The project activity is the installation, capacity addition, retrofit or replacement of a power plant/unit of one of the following types: hydro power plant/unit (either with a run-of-river reservoir or an accumulation reservoir), wind power plant/unit, geothermal power plant/unit, solar power plant/unit, wave power plant/unit or tidal power plant/unit.	The proposed project activity is the installation of a new hydropower plant.
In the case of capacity additions, retrofits or replacements, the existing plant started commercial operation prior to the start of a minimum historical reference period of five years, used for the calculation of baseline emissions and defined in the baseline emission section, and no capacity expansion or retrofit of the plant has been undertaken between the start of this minimum historical reference period and the implementation of the project activity.	Not applicable. No capacity additions, retrofits or replacements are implemented in the proposed Project.
In the case of hydro power plants, one of the following conditions must apply: • The project activity is implemented in an existing reservoir, with no change in the volume of reservoir. • The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the Project Emissions section, is greater than 4 W/m². • The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the Project Emissions section, is greater than 4 W/m².	There is no reservoir or regulating tank in the Project, as it involves only the construction of an intake, tunnel, low-pressure tunnel, forebay, and powerhouse.
The methodology is not applicable to the following: • Project activities that involve switching from fossil fuels to renewable energy sources at the site of the project activity, since in this case the baseline may be the continued use of fossil fuels at the site. • Biomass fired power plants. • Hydro power plants that result in new reservoirs or in the increase in existing reservoirs where the power density of the power plant is less than 4 W/m².	• Not applicable. • Not applicable. • Not applicable

**B.3. Description of the sources and gases included in the project boundary:**

According to the definition of project boundary as per ACM0002, the spatial extent of the Project boundary includes the Project power plant and all power plants connected to the electricity system that the Project is connected to. The electricity system is defined according to the *Tool to calculate the emission factor for an electricity system*.

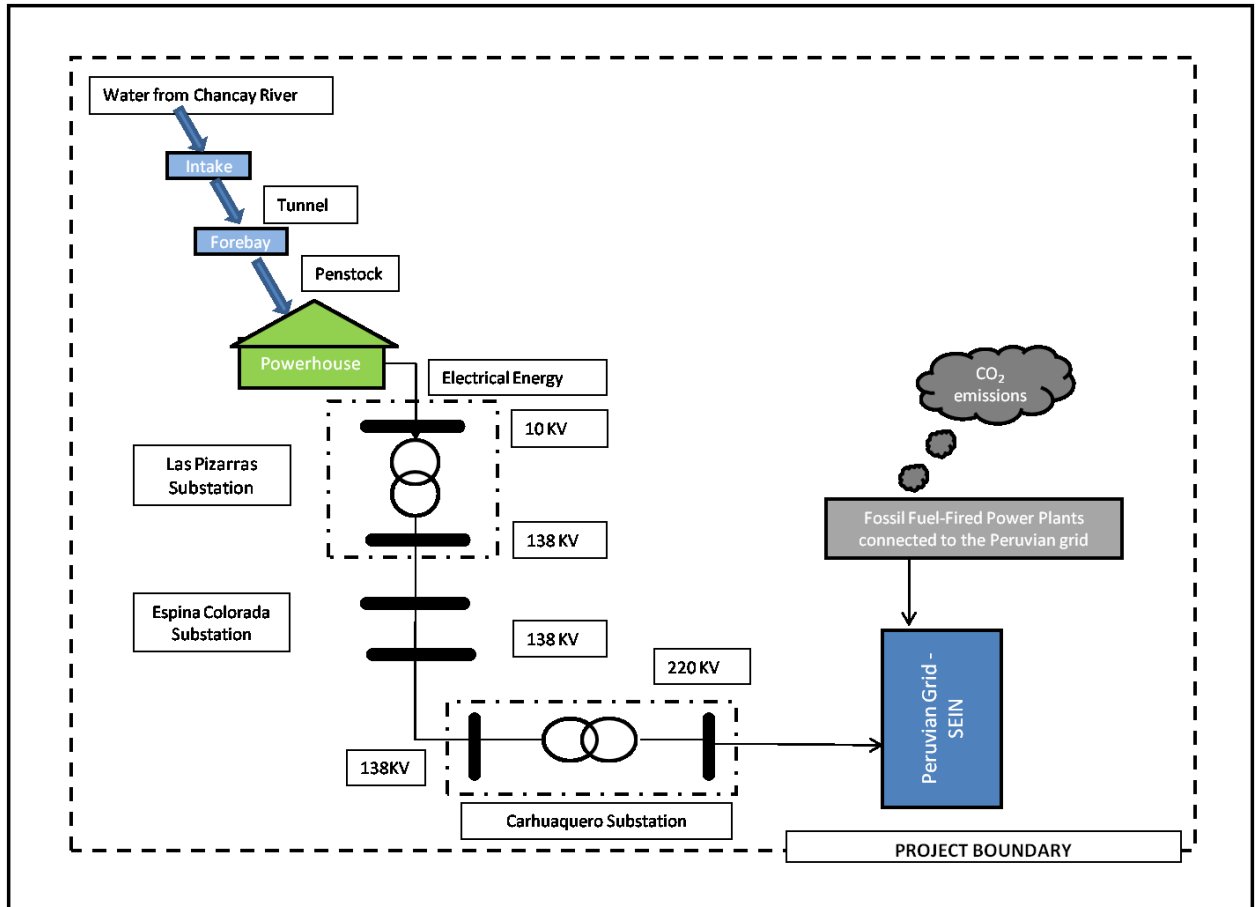
Hence, the Project boundary is the area of the concession of the Las Pizarras hydroelectric plant and transmission line. The Project will be connected to the SEIN through a transmission line that feeds into the Espina Colorada sub-station, which is located in the vertex 7 of the Carhuaquero 138 KV line. The transmission line will reach the SEIN by interconnecting to the Carhuaquero 220 KV sub-station; so the SEIN will also be included in the Project's boundary.

Table 4: Description of sources and GHG included in the Project Boundary

	Source	GHG	Included?	Justification / Explanation
Baseline	CO ₂ emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity.	CO ₂	Yes	Main emission source.
		CH ₄	No	Minor emission source. According to ACM0002, the emission can be ignored.
		N ₂ O	No	Minor emission source. According to ACM0002, the emission can be ignored.
		CO ₂	No	Minor emission source. According to ACM0002, the emission can be ignored.
Project	Activity Emissions of CH ₄ from the reservoir	CH ₄	No	The Project is not considering any reservoir or regulation tank for its normal operation, only a water diversion and a forebay.
		N ₂ O	No	Minor emission source. According to ACM0002, the emission can be ignored.

The project boundary is shown in the figure below.

Figure 4: Project Boundary



Source: Project Developer.

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

According to the methodology ACM0002, if the Project is the installation of a new grid-connected renewable power plant/unit, the baseline scenario is the following:

The electricity delivered to the grid by the Project would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin (CM) calculations described in *Tool to Calculate the Emission Factor for an Electricity System*.

The Project consists of the installation of a new grid-connected renewable power plant that connects with - and delivers electricity to - the SEIN. Therefore, according to the *Tool to Calculate the Emission Factor for an Electricity System*, the delineation of the Project electricity system is the SEIN.



As per the methodology ACM0002, the baseline scenario of the Project is the provision of an equivalent amount of annual energy to the SEIN by the existing grid-connected power plants and the addition of new grid-connected power plants. For a detailed analysis please refer to Section B.5.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

Demonstration of prior consideration of CDM:

According to the *Guidelines on the Demonstration and Assessment of Prior Consideration of the CDM* (version 03)¹⁷, new project activities starting after 02/08/2008 must notify the Designated National Authority (DNA) and the UNFCCC in writing about the commencement of the Project activity. The Project was announced to the UNFCCC secretariat on 26/04/2010 by Río Doble. After that moment, Río Doble entered into negotiations with EnBW to complete the project finance and negotiate the rights to the carbon credits that the Project may generate.

The real and continued actions taken to secure CDM status of the project can be demonstrated by the elements presented in Table 5. The milestones in Table 5 demonstrate that CDM income was the key factor that allowed the Project to be purchased by an investor that secured the Project's financial closure. The intention to apply to the CDM is made explicit in the analysis undertaken by Fichtner¹⁸ and is evidenced by the ERPA signed between Río Doble and EnBW on 14/03/2011.

Table 5: Actions towards CDM status of the Project

Date	Action	Description
01/11/2009	The consultant firm Exergia undertakes a basic design study of Pizarras HPP.	The document considers income from the sale of CERs in its financial analysis, thus demonstrating prior consideration of CDM.
09/04/2010	A pre due diligence of Las Pizarras is undertaken by the consultancy firm Fichtner. ¹⁹	The report considers the income from the sale of CERs in its financial analysis.
26/04/2010	Prior Consideration of Las Pizarras HPP.	The Prior Consideration of the Project was announced to the UNFCCC. ²⁰
16/06/2010	Shareholder agreement between Aluz and EnBW.	At this moment Aluz Clean Energy was the owner of Río Doble. The parties agree to develop Las Pizarras as a CDM project under a Special Purpose Vehicle (SPV) company that would be owned by both (55% Aluz and 45% EnBW).

¹⁷ http://cdm.unfccc.int/Reference/Guidclarif/reg/reg_guid04.pdf - Web link last accessed on 20/07/2011.

¹⁸ Fichtner (2010). Pre-Due-Diligence of Hydropower Projects in Peru – Las Pizarras HPP.

¹⁹ <http://www.fichtner.de/en/index.html> - Web link last accessed on 20/07/2011.

²⁰ http://cdm.unfccc.int/Projects/PriorCDM/notifications/index_html - Web link last accessed on 20/07/2011.



03/10/2010	Proposal from the consultancy company ÉcoRessources to develop CDM documentation.	ÉcoRessources sends a proposal to Aluz to develop the CDM documentation and process of the Las Pizarras HPP.
18/12/2010	The company Eólica Galenova demonstrates interest in the purchase of Río Doble.	Eólica Galenova proposes a purchase of Aluz's shares in Río Doble.
06/01/2011	The law firm Estudio Olaechea sends a proposal for the legal due diligence of the purchase of Río Doble.	The proposal establishes the conditions to undertake the legal due diligence of the purchase of Río Doble by Eólica Galenova (represented by Alarde).
21/01/2011	Agreement signed between ÉcoRessources Carbono S.A.C. and EnBW.	The agreement assigns ÉcoRessources Carbono as the consultants in charge of developing the CDM documentation of the Project and assisting during the validation and registration processes.
31/01/2011	The consultancy company Socoin presents the results of its technical due diligence of the Las Pizarras HPP.	Earlier that month Eólica Galenova (represented by Alarde) commissioned Socoin to undertake a technical due diligence of the Project as part of their final process towards the decision of purchasing Río Doble.
14/03/2011	Eólica Galenova purchases Río Doble. This is the <u>start date</u> of the Project.	The total shares of Río Doble were sold to the company Eólica Galenova. Eólica Galenova had considered carbon revenues in the financial analysis of the Project purchase, and an ERPA agreement was signed at that date.
14/03/2011	Emission Reductions Purchase Agreement (ERPA) signed between EnBW and Río Doble.	The signed ERPA grants EnBW the rights to the carbon credits that the Project may generate and secures Río Doble's income from the certificates.
14/04/2011	Construction initiated.	The construction of the access roads was initiated.
10/08/2011	National Approval Process initiated.	The project's file is submitted to the Peruvian Designated National Authority, the Ministry of the Environment (MINAM), to start the process that will end with the Letter of Approval.
22/09/2011	The Letter of Approval was issued by the Peruvian DNA.	The Ministry of the Environment (MINAM) issued the Project's Letter of Approval.

The proposed hydropower Project is additional to the baseline scenario as CDM income was the key factor that allowed the Project to be purchased by an investor that secured the Project's financial closure after cost overruns impeded the previous owner from continuing with it. The intention to apply to the CDM is made explicit in several documents as detailed in the table above.

The additionality of the Project is demonstrated on the basis of the *Tool for demonstration and assessment of additionality*.

**Step 1: Identification of alternatives to the project activity consistent with current laws and regulations*****Sub-step 1a: Define alternatives to the project activity:***

As per ACM0002, *Consolidated baseline methodology for grid-connected electricity generation from renewable sources*, since the Project activity is the installation of a new grid-connected renewable power plant, the baseline scenario is the electricity delivered to the grid by the project activity that would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin calculations described in the *Tool to calculate the emission factor for an electricity system*.

Therefore, two alternative scenarios are evaluated:

Scenario 1: Implementation of the Project as a hydroelectric power generation plant without CDM incentives.

Scenario 2: Continuation of the current practice, whereas the Project participants do not invest and that power is generated by the operation of grid-connected power plants and by the addition of new generation sources.

Sub-step 1b: Consistency with mandatory laws and regulations:

The scenarios identified above are in compliance with all applicable legal and regulatory requirements, including the Electric Concessions Law.²¹ Some relevant articles of this law are described below:

- a) Article 1: Electricity generating activities can be developed by people or legal entities, i.e. private companies, whether they are Peruvian nationals or foreigners, as long as the legal entities are incorporated under Peruvian laws.
- b) Article 3: A concession is required for the development of hydropower plants (or geothermal power plants) if their installed capacity is greater than 500 kW.
- c) Article 4: An authorization is required to develop fossil fuel-fired power plants with an installed capacity greater than 500 kW.
- d) Article 6: The concessions and authorizations can be granted by Peru's Ministry of Energy and Mines (MINEM).
- e) Article 7: Electricity generating activities that do not require a concession or authorization can be developed freely provided they comply with technical standards and adhere to conservation of environmental quality and cultural heritage. The developer of such activities should inform the MINEM of the project activity and its technical characteristics.

²¹ <http://www2.osinerg.gob.pe/MarcoLegal/pdf/LEYCE-DL25844.pdf> - Web link last accessed on 20/07/2011.



- f) Article 9: The Peruvian Government seeks to preserve the environmental quality and cultural heritage of the country, as well as the rational use of natural resources in the development of activities related to generation, transmission and distribution of electricity.

Therefore, under Step 1 both alternatives are plausible.

Step 2: Investment analysis

The objective in this section will be to evaluate the financial attractiveness of the Project without CDM income. For the purpose of this PDD the investment analysis constitutes the ultimate barrier analysis with regard to the additionally of the project activity.

Sub-step 2a: Determine appropriate analysis method

Since the alternative to the Project activity is the supply of electricity from a grid and this is not an investment, a benchmark analysis is appropriate.

Sub-step 2b: Option III. Apply benchmark analysis

The financial indicator that will be used is the Project's internal rate of return (IRR). The Project IRR is compared to a calculated benchmark, a discount rate of 12% that has been selected as a benchmark to evaluate the economic viability of an investment in the electricity sector in Peru. This 12% discount rate is established by the government in the Electric Concession Law as the reference rate to evaluate investments in the power sector. This rate has also emerged in several studies as well as in official governmental decisions related to project investment evaluation.²²

Sub-step 2c: Calculation and comparison of financial indicators

The main parameters of the IRR analysis are based on conservative assumptions available to the Project developer at the time of the investment decision, and are shown below:

²² Law 25844 – Electric Concessions Law. Article 79, Page 40. A specific discount rate for the electric sector has been determined by the Ministry of Energy and Mines within the Peruvian Electric Concession Law, and is used principally by the electric sector regulator assessing the opportunity cost of investment for the new additions to the system in order to forecast and determine the regulated tariff in Peru. This discount rate is 12% and represents an official rate of discount for the Peruvian electric sector, and has been widely used for investment evaluations by both the private and the public sectors. It is considered to be a conservative discount rate since public investment is driven by social interests and often has access to attractive loan terms. In this analysis, the discount rate is used as a benchmark for the minimum rate of return expected by investors and borrowers in Peru. A copy of the concession law will be provided to the DOE.
<http://www2.osinerg.gob.pe/MarcoLegal/pdf/LEYCE-DL25844.pdf> - Web link last accessed on 20/07/2011.

**Table 6: Main parameters for calculation of financial indicators**

Parameters	Unit	Value	Data Source
Electricity Price – Peak Hours	USD per kWh	0.037087	OSINERGMIN Resolution N° 079-2010-OS/CD. Fixed prices applicable for the period between 01/05/2010 and 30/04/2011. ²³
Electricity Price – Off-Peak Hours	USD per kWh	0.030155	OSINERGMIN Resolution N° 079-2010-OS/CD. Fixed prices applicable for the period between 01/05/2010 and 30/04/2011. ²⁴
PPA Price	USD per kWh	0.064	Power Purchase Agreement Contract signed between the Ministry of Energy and Mines and Río Doble, dated 30/11/2010.
PPA Volume	MWh per year	85,000	Power Purchase Agreement Contract signed between the Ministry of Energy and Mines and Río Doble, dated 30/11/2010.
Guaranteed Power Capacity Tariff	USD per kW per month	5.816327	OSINERGMIN Resolution N° 079-2010-OS/CD. Fixed prices applicable for the period between 01/05/2010 and 30/04/2011. ²⁵
Generation Capacity	MW	18.00	Socoin (2011). Revisión de Estudios y Diseño (Revision of Studies and Design). 31/01/2011.
Load Factor	%	66.0	Socoin (2011). Revisión de Estudios y Diseño (Revision of Studies and Design). 31/01/2011.
Initial Investment	USD Mio.	33.73	Socoin (2011). Revisión de Estudios y Diseño (Revision of Studies and Design). 31/01/2011.
Running Costs – Operation & Maintenance	USD Mio. per year	0.79	Project developer calculations undertaken in January 2011.
Contribution to OSINERG	% of income per year	1.00	Executive Order No. 136-2002-PCM, dated 24/12/2002. ²⁶
Water Tariff	% of income per year	1.00	Law 25844 – Rulebook for the Electric Concessions Law. Article 214, Page 92. ²⁷

²³ <http://www2.osinerg.gob.pe/Resoluciones/pdf/2010/OSINERGMIN%20No.079-2010-OS-CD.pdf> – Web link last accessed on 20/07/2011.

²⁴ <http://www2.osinerg.gob.pe/Resoluciones/pdf/2010/OSINERGMIN%20No.079-2010-OS-CD.pdf> – Web link last accessed on 20/07/2011.

²⁵ <http://www2.osinerg.gob.pe/Resoluciones/pdf/2010/OSINERGMIN%20No.079-2010-OS-CD.pdf> – Web link last accessed on 20/07/2011.

²⁶ <http://www.osinerg.gob.pe/newweb/uploads/JARU/CD/008fiscalizacion/ds136-2002-pcm.pdf> – Web link last accessed on 20/07/2011.

²⁷ <http://www2.osinerg.gob.pe/MarcoLegal/pdf/REGLACE.pdf> - Web link last accessed on 20/07/2011.



Depreciation – Civil Works	years	33	Rulebook for the Income Tax Law, Chapter VI, Article 22: Sets the standard depreciation rates per category. ²⁸
Depreciation – Machinery & Equipment	years	10	Rulebook for the Income Tax Law, Chapter VI, Article 22: Sets the standard depreciation rates per category. ²⁹
Income Tax	%	30	Income Tax Law, Chapter VII, Article 55. ³⁰
Distribution of Income to Workers	%	5	Law 892, Article 2. ³¹
Discount Rate	%	12	Law 25844 – Electric Concessions Law, Article 79, Page 40. ³²
Exchange Rate	S/. per USD	2.842	OSINERGMIN Resolution N° 079-2010-OS/CD. Fixed prices applicable for the period between 01/05/2010 and 30/04/2011. ³³
CER Price	EUR	11.88	Carbon Market Daily 16/12/2010
Emission Factor	tCO ₂ e / MWh	0.65943	Calculated in accordance to the CDM rules, with latest available data.
Technical Lifetime of Project	Years	40	Andritz Hydro (2011). Technical lifetime assessment letter.

A comparison of the IRR for the proposed Project activity and the financial benchmark IRR (12%), with and without CDM revenues, is shown in Table 7. Without CDM revenues, the IRR of the total Project investment is 9.82%, which is considerably below the benchmark level. The proposed Project can be considered as financially unattractive to investors.

With the CDM revenue the IRR of the total investment would increase 194 basis points to 11.76%. The attractiveness of the Project activity to the new investor is improved with CDM revenue, as the Project has been made attractive from the combination of the return it brings out of its income from its operation and from the sale of emission reduction credits. Hence, the economic evaluation demonstrates the

²⁸ <http://www.sunat.gob.pe/legislacion/renta/reglamento.html#> - Web link last accessed on 20/07/2011.

²⁹ <http://www.sunat.gob.pe/legislacion/renta/reglamento.html#> - Web link last accessed on 20/07/2011.

³⁰ <http://www.sunat.gob.pe/legislacion/renta/ley/capvii.htm> - Web link last accessed on 20/07/2011.

³¹ <http://www.mintra.gob.pe/contenidos/archivos/prodlab/D.%20Leg.%20892%2011-11-96.pdf> - Web link last accessed on 20/07/2011.

³² <http://www2.osinerg.gob.pe/MarcoLegal/pdf/LEYCE-DL25844.pdf> - Web link last accessed on 20/07/2011.

³³ <http://www2.osinerg.gob.pe/Resoluciones/pdf/2010/OSINERGMIN%20No.079-2010-OS-CD.pdf> - Web link last accessed on 20/07/2011.



importance of CDM benefits to achieve more profitable margins that help to overcome the barriers presented in this document.

Table 7: Comparison of financial indicator with and without CER revenue

Item	Unit	Without CER revenue	Benchmark	With CER revenue
IRR	%	9.82	12.00	11.76

Sub-step 2d: Sensitivity Analysis

For the proposed Project activity, the following financial parameters were taken as uncertainty factors for the sensitivity analysis as they constitute around or more than 20% of the Project revenues and expenses:

1. Energy Sales (from variations in the spot price of energy)
2. Energy Sales (from variations in the load factor)
3. Initial investment
4. Operation & Maintenance costs

Table 8 shows the variation magnitude that each one of the above parameters would need in order for the project IRR to reach the benchmark level.

Table 8: Sensitivity Analysis of Project IRR

Turning point condition to reach the benchmark of 12%			
Energy Sales (from variations in the price of energy)	Energy Sales (from variations in the load factor)	Initial Investment Costs	Operation & Maintenance Costs
22%	+38%	-18%	-154%

The probability of such large variations in any of these parameters is considered highly improbable in practical terms, as detailed below:

The revenues from energy sales are not projected to increase in levels superior to those analysed due to the following main reasons:



- (i) In the case of Las Pizarras HPP, most of the income during the first 20 years depends on a price fixed by the PPA. This price will only change if a factor based on the US PPI Index WPSSOP3500 (Finished Goods Less Food and Energy) increases or decreases more than 5% with respect to the previous year's factor, as established in the PPA Contract. However, an analysis of the behaviour of the index for the past 20 years shows that there was never a fluctuation of the calculated factor that surpassed the $\pm 5\%$.³⁴ Therefore, fluctuations over the established limits are considered highly improbable.
- (ii) The energy that is not sold through the PPA contract will be sold in the spot market. The energy price is set by the regulator OSINERGMIN, who calculates this price based on the cost of the fuel used in the total electricity generation, which is mainly natural gas and diesel. Natural gas has a very low price³⁵ due to the Camisea contract, which also guarantees that the price will be kept at a similar level, impeding the set price by OSINERGMIN to increase significantly, and even leading it to a decrease.³⁶ Therefore, a variation in the income from energy sales rooted in an increase in the price of energy is not likely to occur due to variations in the spot price.
- (iii) Energy sales are not expected to increase due to an increase in the generation capacity (load factor) due to the fact that an increase in the load factor of 38% would mean a load factor higher than 100%, which is technically impossible.

The initial investment is not likely to decrease in levels superior to 10% as the figures are already conservative, and as mentioned prices have tended to increase during the last decade. Evidence even discusses the concern regarding the escalation of the cost of civil works for the hydropower projects in Peru which seems to have increased significantly higher than the general rate of inflation.³⁷ Furthermore, the Project's last updated budget³⁸ presents a figure of USD Mio. 42.56, which is already 26% higher than the investment figure available at the start date of the Project (14/03/2011).

The operation and maintenance costs are not likely to decrease in levels superior to 10% due to the fact that the Project developer undertook an extensive analysis of all items involved in the cost structure, and furthermore prices have tended to increase during the last decade.³⁹

³⁴ http://data.bls.gov/timeseries/WPSSOP3500?include_graphs=false&output_type=column&years_option=all_years – Web link last accessed on 20/07/2011.

³⁵ “The current Peruvian price of gas for power generation is below the opportunity cost, as set by the international market for traded LNG”, in ESMAP (2011), *Peru Opportunities and Challenges for Small Hydropower Development*, p. 19.

³⁶ “The low price of natural gas and the resulting low tariff for power generation (which is even *declining* in real terms) have made it very difficult for most small hydro projects to compete in the marketplace”, in ESMAP (2011), *Peru Opportunities and Challenges for Small Hydropower Development*, p. 19. It must be noted that reference to small hydro projects is intended for those that have a capacity smaller than 20MW.

³⁷ ESMAP (2011), *Peru Opportunities and Challenges for Small Hydropower Development*, p. 21.

³⁸ Undertaken in 01/05/2011 by Alarde / Eólica Galenova.

³⁹ The wholesale general price index increased by 29% in the ten-year period from March 2001 to March 2011, while the construction materials price index increased by 51% for the same period, according to the economic data published by the National Institute of Statistics and Informatics (Instituto Nacional de Estadística e Informática – INEI): www.inei.gob.pe - Web link last accessed on 20/07/2011.



In conclusion, the sensitivity analysis conducted above confirms that the Project is not financially attractive for private investors and its successful implementation requires the assistance of the CDM revenues. As a result, the Project is considered additional under Step 2.

In the following Step 3: Barrier analysis provides additional difficulties the project activity is facing without discriminating the findings established in the investment analysis. Those information below are given for information purposes only and shall complement the investment analysis in its understanding.

Step 3: Barrier analysis

Sub-step 3a: Identify barriers that would prevent the implementation of the proposed CDM project activity:

- **Investment barriers**

Aluz, the previous owner of Río Doble, needed project finance to develop the Las Pizarras Project. A shareholder agreement was therefore signed between Aluz and EnBW on 16/06/2010, where EnBW invested in 45% of the shares of Río Doble for the development of the CDM Project. The shareholder agreement clearly states that the Project is to be developed as a CDM project, and it reflects the fact that EnBW's sole motivation for investing was the acquisition of the emission reduction certificates that could be generated by the Project, as the agreement includes an Emission Reduction Purchase Agreement clause whereas EnBW is granted the right to acquire the generated CERs, and the agreement also includes a put option for EnBW to sell its shares if the Project is not registered under the CDM. Furthermore, EnBW's investment in a hydro power project in Peru is solely for the purpose of securing carbon credits for its own commitments compliance, as according to the present strategy of the EnBW Group, Peru is not a target country for investments.⁴⁰

Hence, the previous owner had secured the project finance through EnBW's investment, which was conditioned on the CDM characteristic of the Project. This was key as the Project otherwise had limited possibilities for project finance without the CDM incentive. The Project's nature (small hydropower) faces a high risk premium in the eyes of traditional investors, who therefore pay little interest to hydro generation investment possibilities.⁴¹ Local banks consider this type of project as high risk because of the associated risks that they accrue to all hydropower projects (i.e. construction risks, water availability risk), and their financing conditions increase project development costs.⁴² Furthermore, banks in average

⁴⁰ EnBW Annual Report (2010): "EnBW is focusing on selected countries in central and eastern Europe as well as Turkey", p. 105. See also pages 25 and 124.

⁴¹ "Access to finance is limited by the high transaction costs in relation to profitability of such small projects, and also by the lack of familiarity of banks with the project characteristics and issues that need to be appraised. Although debt finance is available in principal, in actual fact developers would be unlikely to receive project financing for 12 to 15 years at competitive rates", in ESMAP (2011). *Peru Opportunities and Challenges for Small Hydropower Development*, p. 49. It must be noted that reference to small hydro projects is intended for those that have a capacity smaller than 20MW.

⁴² "Small hydro projects suffer from their association with large hydro projects, where the completion risk is clearly greater. Even though few small hydro projects involve tunneling risk, the banks and asset fund managers take the view that completion risks are sufficiently great to require the involvement of large EPCs. But this significantly increases construction costs, which are under great pressure from the low tariff", in ESMAP (2011). *Peru Opportunities and Challenges for Small Hydropower*

impose not only high interest rates for their credit, but also impose restrictive conditions (in terms of financial performance⁴³ and management), restrict their loans to short maturity terms which require high annually payments,⁴⁴ require high guarantees, and charge considerable transaction costs due to the fact that the corporate finance departments of the major banks have limited staff who are focused on larger transactions, leading them to have little interest in smaller projects located in remote areas that pose difficulties for the due diligence.⁴⁵ The Project's nature (hydropower) also faces a disadvantage when compared to the other common type of energy generation used in Peru, thermal generation. Under the existing regulatory framework in Peru, the payment that a generating unit receives for its electricity supply is in function of its contribution to the peak power demand (capacity). Firm capacity of thermal and hydroelectrically units are defined under the electric concessions law⁴⁶ as each unit's capacity to provide power to the grid with a high level of certainty. Under the calculation method proposed by the law, a hydroelectric unit faces a disadvantage if compared to a thermal plant, as the firm capacity of the former will always be lower than that of the latter and therefore hydroelectric units in general are less profitable considering projects of similar size and conditions.⁴⁷ Additionally, investment costs per KW for other technology options are considerably lower than those incurred by the Project, as shown below. All these issues place hydropower projects at a serious disadvantage when looking for traditional investment sources.

Table 9: Capital cost for power generation technologies (USD/kW)

Capital cost per technology		
Technology	Size-Range (MW)	Investment Cost (USD/kW)
Mini Hydro ¹	5.0	1,400 – 2,200
Gasoline/Diesel Power System ¹	5.0	600
Combustion Turbine ¹	150.0	490
Combined Cycle Turbine ¹	300.0	650
Las Pizarras HPP ²	18.00	1,873.73

¹ The World Bank. (2006). "Technical and Economic Assessment: Off Grid, Mini-Grid, and Grid Electrification Technologies Summary Report".

² Socoin (2011). *Revisión de Estudios y Diseño* (Studies and Design Revision).

Development, p. 50. It must be noted that reference to small hydro projects is intended for those that have a capacity smaller than 20MW.

⁴³ "Project financing is generally difficult to obtain and the debt-to-equity ratios required by Peruvian banks for such projects are high by international standards", in: ESMAP (2011). *Peru Opportunities and Challenges for Small Hydropower Development*, p. 35.

⁴⁴ "Although debt finance is available in principal, in actual fact developers would be unlikely to receive project financing for 12 to 15 years at competitive rates", in: ESMAP (2011). *Peru Opportunities and Challenges for Small Hydropower Development*, p. 49. It must be noted that reference to small hydro projects is intended for those that have a capacity smaller than 20MW.

⁴⁵ ESMAP (2011). *Peru Opportunities and Challenges for Small Hydropower Development*, p. 39. It must be noted that reference to small hydro projects is intended for those that have a capacity smaller than 20MW.

⁴⁶ <http://www2.osinerg.gob.pe/MarcoLegal/pdf/LEYCE-DL25844.pdf> - Web link last accessed on 20/07/2011.

⁴⁷ COES (2009). *Annual Statistics Report*. Chapter XIII, p. 99.

<http://www.coes.org.pe/Dataweb2/2009/STR/estadistica/anual/anual.htm> - Web link last accessed on 20/07/2011.



At the beginning of 2011 Aluz decided to sell the Project to Eólica Galenova, a company that had already manifested interest in the Project,⁴⁸ considering the stable income it had secured by winning a RER (Renewable Energy Resources) auction whereas it was granted a power purchase agreement for an annual generation of 85,000 MWh at a fixed price,⁴⁹ and especially the additional income the Project could achieve from CDM revenues that would allow it to reach a financial return comparable to the established government benchmark, making the Project an attractive investment (as demonstrated in step 2). Eólica Galenova's purchase of Río Doble was based on a financial structure that considered CDM income, which is why on the same date that the total sale is confirmed in the Board of Directors (14/03/2011) an ERPA is signed between Río Doble (now owned by Eólica Galenova) and EnBW to secure this income.

- **Technological barriers**

With respect to the technical and technological issues that surround hydropower investment and credit, while adequate technical capacity exists in Peru to build and operate small hydroelectric power plants, the technology nonetheless faces a range of technical challenges and performance risks related to the inherent limits on water resource availability. This is coupled with the particular hydrological regimen, geological conditions, and possible design failures that can only be fully known *ex-post*. In terms of technology, hydropower plants constitute a much more challenging investment than fossil fuel-fired plants.

Moreover, fossil fuel-fired plants can also be built as close as necessary to the end-user, reducing considerably the transmission line investment costs.⁵⁰ In the case of the Project activity, the Las Pizarras Hydroelectric Plant can only be constructed on the selected site, considering the water availability and other geographical conditions, and it will only be possible with the development of a new transmission line.

These technological barriers are indirectly mitigated by the Project's CDM income as they add to the hydropower project's higher costs when compared to other technologies such as thermal, and also add to the causes for which local banks do not favour project finance for hydropower projects, as explained previously.

Sub-step 3b: Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity)

The investment and technological barriers identified in sub-step 3a would not prevent scenario 2. Scenario 2 would probably lead to the growth in energy demand being met by another form of supply, most probably a fossil fuel-fired thermal plant, as these have been the business-as-usual scenario for energy generation in Peru since the Camisea gas project and the government's measures to promote the use of natural gas. The two-part system regulation for generation (capacity and energy) has favoured thermal units against hydro, and furthermore hydro projects have the disadvantage against thermal

⁴⁸ As stated in an email sent by Eólica Galenova / Alarde to the representative of Aluz on 18/12/2010.

⁴⁹ The power purchase agreement (PPA) contract was granted by the Peruvian government and dated 28/05/2010, and later signed on 30/11/2011.

⁵⁰ ESMAP (2011). *Peru Opportunities and Challenges for Small Hydropower Development*, p. 51.



projects because of their need for longer transmission networks.⁵¹ Fossil fuel-fired thermal plants have lower up-front investment costs and higher financial viability, as the limited financing options and investors lean towards natural gas investment due to the technology being more widely available and well-known, and to the fact that these projects are not regarded as risky as hydropower projects since they do not face water resource limitations and do not require unique and limited geographical conditions, being able to be located almost anywhere.

As a result, scenario 1 faces restrictions due to the identified investment and technological barriers. The only remaining scenario is the baseline (scenario 2), which implies no investment from the Project developer.

The barrier analysis conducted demonstrated that in addition to the restrictions identified the barriers are real, but not preventive.

Step 4: Common practice analysis

Step 1: Calculate applicable output range as +/-50% of the design output or capacity of the proposed project activity.

The project activity has been analyzed based on installed capacity, then the range will be between 9 MW and 27 MW.

Step 2: In the applicable geographical area, identify all plants that deliver the same output or capacity, within the applicable output range calculated in Step 1, as the proposed project activity and have started commercial operation before the start date of the project. Note their number N_{all} .

The applicable geographical is the one covered by the SEIN, and considers only the projects that have started commercial operation before the start date of the project and are connected to the grid. Information used in the present analysis has been given by COES annual statistical report, information send via CD and formal letter of submission or online documents.⁵²

Registered CDM project activities and projects activities undergoing validation are not included in the evaluation.

The following table details the operative power plants in the SEIN, their type, installed capacity and CDM condition. The project plants in bold are in the range determined in Step1.

Table 9: Operative power plants in the SEIN

⁵¹ ESMAP (2011). *Peru Opportunities and Challenges for Small Hydropower Development*, p. 51.

⁵² Website: <http://www.coes.org.pe/>. 2011 statistics:
http://www.coes.org.pe/wcoes/coes/salaprensa/estadistica_anual.aspx. Web link last accessed: 14/06/2012.



Power Plant	Technology	Energy source/fuel	Installed Capacity (MW)	CDM Status
<i>Paramonga</i>	<i>TV</i>	<i>Bagasse</i>	<i>23.0</i>	<i>-</i>
Pías	Francis	Hydro	6.3	Registered
Platanal	Pelton	Hydro	220.0	Registered
Chimay	Francis	Hydro	142.8	-
Yanango	Francis	Hydro	42.3	-
<i>Huanchor</i>	<i>Francis</i>	<i>Hydro</i>	<i>18.4</i>	<i>-</i>
Callahuanca	Pelton	Hydro	82.6	-
Huampani	Francis	Hydro	31.4	-
Huinco	Pelton	Hydro	258.4	-
Matucana	Pelton	Hydro	120.0	-
Moyopampa	Pelton	Hydro	75.4	-
Santa rosa	TG	Natural Gas	446.7	-
Ventanilla	Ccomb	Natural Gas	522.0	Registered
Malacas	TG	Natural Gas	135.7	-
Charcani I	Francis	Hydro	1.8	-
Charcani II	Francis	Hydro	0.6	-
Charcani III	Francis	Hydro	4.2	-
<i>Charcani IV</i>	<i>Francis</i>	<i>Hydro</i>	<i>15.5</i>	<i>-</i>
Charcani V	Pelton	Hydro	145.4	-
<i>Charcani VI</i>	<i>Francis</i>	<i>Hydro</i>	<i>9.0</i>	<i>-</i>
Chilina	CC	Diesel 2	48.5	-
Mollendo	Diesel	Residual 500	31.7	-
Pisco	TG	Natural Gas	74.8	-
Machupicchu	Pelton	Hydro	90.5	-
Caña Brava	Kaplan	Hydro	5.3	Registered
Cañon del pato	Pelton	Hydro	246.6	-
Carhuaquero	Pelton	Hydro	95.1	-
Carhuaquero IV	Pelton	Hydro	10.0	Registered
<i>Chiclayo Oeste</i>	<i>Diesel</i>	<i>Residual 6</i>	<i>26.7</i>	<i>-</i>
<i>Chimbote</i>	<i>Tg</i>	<i>Diesel 2</i>	<i>21.0</i>	<i>-</i>
Las Flores	Tg	Natural Gas	192.5	-
Piura	Diesel - Tg	Residual 6 - Diesel 2	34.7	-
<i>Aricota I</i>	<i>Pelton</i>	<i>Hydro</i>	<i>23.8</i>	<i>-</i>
<i>Aricota II</i>	<i>Pelton</i>	<i>Hydro</i>	<i>11.9</i>	<i>-</i>
<i>Independencia</i>	<i>TG</i>	<i>Natural Gas</i>	<i>22.9</i>	<i>-</i>
Mantaro	Pelton	Hydro	798.0	-
Restitucion	Pelton	Hydro	210.4	-
Emergencia Trujillo	Diesel	Diesel 2	64.0	-
<i>Tumbes</i>	<i>Diesel</i>	<i>Residual 6</i>	<i>18.7</i>	<i>-</i>
Yuncan	Pelton	Hydro	130.1	At validation
Chilca	TG	Natural Gas	559.8	-
<i>Ilo1</i>	<i>Diesel</i>	<i>Diesel 2</i>	<i>238.6</i>	<i>-</i>
<i>Ilo2</i>	<i>TV</i>	<i>Carbón</i>	<i>135.0</i>	<i>-</i>



La Joya	Francis	Hydro	10.0	Registered
Kallpa	TG	Natural Gas	629.0	-
Roncador	Francis	Hydro	3.8	-
Huaycoloro	Diesel	Biogás	4.8	-
San Gaban II	Pelton	Hydro	110.0	-
Bellavista	Diesel	Diesel 2	4.8	-
Taparachi	Diesel	Diesel 2	6.7	-
Santa Cruz	Francis	Hydro	7.0	Registered
Santa Cruz II	Francis	Hydro	7.0	Registered
Purmacana	Francis	Hydro	1.8	-
Oquendo	TG	Natural Gas	31.0	-
San Nicolás	TG - TV	Diesel 2	68.5	-
Poechos ii	Kaplan	Hydro	10.0	Registered
Cahua	Francis	Hydro	43.6	-
Gallito Ciego	Francis	Hydro	34.0	-
Malpaso	Francis	Hydro	54.4	-
<i>Oroya</i>	<i>Pelton</i>	<i>Hydro</i>	<i>9.0</i>	<i>-</i>
<i>Pachachaca</i>	<i>Pelton</i>	<i>Hydro</i>	<i>9.0</i>	<i>-</i>
Pariac	Francis	Hydro	4.9	-
Yaupi	Pelton	Hydro	108.0	-
Huayllacho	Pelton	Hydro	0.3	-
Misapuquio	Pelton	Hydro	3.9	-
San Antonio	Francis	Hydro	0.6	-
San Ignacio	Francis	Hydro	0.5	-
Aguaytia	TG	Natural Gas	191.9	-

Source: COES

As per the previous table, N_{all} is 12.

Step 3: Within plants identified in Step 2, identify those that apply technologies different that the technology applied in the proposed project activity. Note their number N_{diff} .

As can be seen in table 9:

- Power plants Paramonga (bagasse), Chiclayo Oeste, Chimbote and Tumbes (Residual fuel oil) and Independencia (natural Gas) are power plants with a different technology and energy/fuel source.
- Charcani IV is a hydro power plant implemented between 1959 and 1970. Therefore the power plant construction and investment decision was made in a different regulatory and economic framework. The energy sector was significantly modified with the Electric Concessions Law in 1992 (desegregation in distribution, transmission and generation activities and companies, creation of a wholesale market and regulated market, concession system, among others). In addition the project owner of Charcani IV is now Egasa⁵³, which is a public company created in

⁵³ EGASA <http://www.egasa.com.pe>. Charcani IV description on: http://www.egasa.com.pe/esp/institucional/instalaciones/instalaciones_detalle.php?id=4. Web link last accessed on 14/06/2012



1994 under private law and is part of the FONAFE Corporation⁵⁴. In Peru, FONAFE is responsible for regulating and directing the business activities of the government, and then all productive companies where the government is the major shareholder are part of the corporation. By doing this, projects have to comply with special requirements in order to be implemented, e.g. fulfilling SNIP procedures (project evaluation system for governmental projects)⁵⁵. As a conclusion, Charcani IV faced a different investment climate in the date of the investment decision and is owned by a company with a different management structure compared to the project developer which is entirely private.

- Charcani VI faces the same conditions as Charcani IV. The power plant is property of EGASA and started operations in 1976⁵⁶, therefore is not considered similar to the proposed project activity since faced a different investment climate in the date of the investment decision and is owned by a company with a different management structure compared to the project developer.
- Aricota I and Aricota II have the same conditions as Charcani IV since the projects were implemented in 1966 and 1967. Now are owned by the public company under private law named Egesur⁵⁷ that is also part of FONAFE⁵⁸. In addition both projects operate with Pelton turbines while the proposed project will use Francis turbines.
- Oroya and Pachachaca also faced a different investment climate in the date of the investment decision since the power plant started operations in 1914⁵⁹ and 1917⁶⁰ respectively. The power plants were built to satisfy the energy requirements of the company Cerro de Pasco Copper Corporation (or CENTROMIN, after the nationalization), then were part of the company Electroandes in 1996 and are now property of a private company named SN Power Perú Holding S.R.L.⁶¹ In addition the projects operate with Pelton turbines while the proposed project will use Francis turbines.

Considering the previous paragraphs, 11 projects identified in Step 2 apply a different technology as per the descriptions Additionality Tool (Paragraph 9), then N_{diff} is 11.

⁵⁴ Fonafe webpage: <http://www.fonafe.gob.pe/portal?accion=empresas&t=1&i=5&o=01&m=3>. Web link last accessed on 14/06/2012

⁵⁵ http://www.mef.gob.pe/index.php?option=com_content&view=article&id=306&Itemid=100883. - Web link last accessed on 15/06/2012 and <http://www.fonafe.gob.pe/portal?accion=c&t=13&i=103&n=1&o=103&m=2> Web link last accessed on 14/06/2012

⁵⁶ Charcani VI, <http://www.egasa.com.pe/esp/institucional/instalaciones/instalaciones.detalle.php?id=00000000006>, Web link last accessed on 15/06/2012

⁵⁷ EGESUR: <http://www.egesur.com.pe>. Web link last accessed on 15/06/2012. Aricota I in <http://www.egesur.com.pe/pages/instal/aricota1.aspx> and Aricota II in <http://www.egesur.com.pe/pages/instal/aricota2.aspx>.

⁵⁸ Fonafe webpage: <http://www.fonafe.gob.pe/portal?accion=empresas&t=1&i=2&o=01&m=3>. Web link last accessed on 14/06/2012

⁵⁹ Oroya power plant description in SN Power webpage: <http://www.snpower.com.pe/operaciones/centrales-de-produccion/oroya/>

⁶⁰ Pachachaca power plant description in SN Power webpage: <http://www.snpower.com.pe/operaciones/centrales-de-produccion/pachachaca/>

⁶¹ Equilibrium report (Risk classification). <http://www.equilibrium.com.pe/Electroandes.pdf>.

Step 4: Calculate factor $F = 1 - N_{diff} / N_{all}$ representing the share of plants using technology similar to the technology used in the proposed project activity in all plants that deliver the same output or capacity as the proposed project activity.

The result of the applicable two formulas is:

$$a) F = 1 - N_{diff} / N_{all} = 1 - 11/12 = 0.08$$

$$b) N_{all} - N_{diff} = 12 - 11 = 1$$

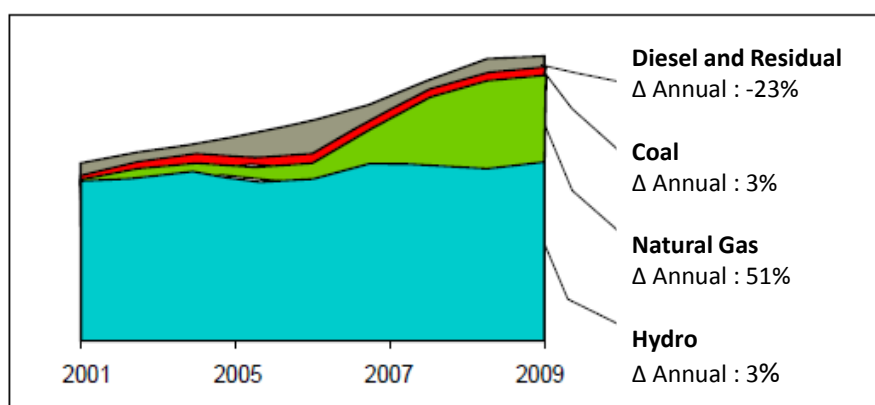
The result of a) is below 0.2 and the result of b) is below 3, then the project activity is not considered a common practice and is additional.

Additional comments on the Peruvian electric market

The investment environment for a hydropower project has not been enthusiastic. As a matter of fact, hydropower generation only increased by 5% from 2003 to 2007,⁶² as almost all the increase in electricity demand has been supplied by new thermal generation,⁶³ which is a more viable investment in terms of costs and access to finance.

According to MINEM's 2010 report on Peru's electricity sector,⁶⁴ the evolution of the sources used for electricity generation shows that energy generated by the hydropower sector has increased 3% annually in the last five years, while the average annual growth in the use of natural gas for generation has been of 51%.

Figure 5: Evolution of the sources used for electricity generation



Source: Peru electricity sector 2010.⁶⁵

⁶² ESMAP (2011). *Peru Opportunities and Challenges for Small Hydropower Development*, p. 1.

⁶³ ESMAP (2011). *Peru Opportunities and Challenges for Small Hydropower Development*, p. 1.

⁶⁴ <http://www.minem.gob.pe/publicacion.php?idSector=6&idPublicacion=52> - Web link last accessed on 20/07/2011.

⁶⁵ <http://www.minem.gob.pe/publicacion.php?idSector=6&idPublicacion=52> - Web link last accessed on 20/07/2011.



Under this scenario, the larger power plants that are interconnected to the SEIN use natural gas for energy production. The following table shows the thermoelectric power plants that have been added to SEIN since the year 2000.

Table 9: Thermoelectric power plants added to the SEIN since 2000

Power Plant	Date of Entry to the SEIN	Technology	Installed Capacity (MW)
Pisco TG1	September 2010	Natural gas turbine	37.40
Pisco TG2	September 2010	Natural gas turbine	37.40
Independencia	September 2010	Diesel/Natural gas turbine	22.93
Las flores	April 2010	Natural gas turbine	192.50
Kallpa TG3	February 2010	Natural gas turbine	233.00
Paramonga	January 2010	Gas Turbine/Biomass	23.00
Santa Rosa TG8	August 2009	Natural gas turbine	193.18
Chilca 1 TG3	July 2009	Natural gas turbine	199.80
Trujillo Norte	June 2009	Diesel 2 / Residual	64.00
Kallpa TG2	June 2009	Natural gas turbine	216.00
Oquendo TG1	January 2009	Natural gas turbine	31.00
Chilca 1 TG2	July 2007	Natural gas turbine	179.24
Kallpa TG1	July 2007	Natural gas turbine	180.00
Chilca 1 TG1	December 2006	Natural gas turbine	179.24
Ventanilla	October 2006	Combined cycle	457.00
Santa Rosa UTI5 – UTI6	August 2006	Natural gas turbine	119.20
Santa Rosa WTG7	June 2005	Natural gas turbine	127.50
Yarinacocha	March 2003	Diesel 2 / Residual	25.36
San Nicolas Cummings	July 2001	Diesel 2 / Residual	1.25
Tumbes	February 2001	Diesel 2 / Residual	18.68
Ilo2 TV1	August 2000	Steam Turbine / Coal	135.20

Source: COES Annual Statistic Reports.⁶⁶

The following table shows the hydropower plants that have been added to SEIN since the year 2005.

⁶⁶ <http://www.coes.org.pe/wcoes/coes/estadistica/estadanual.aspx> - Web link last accessed on 20/07/2011.

**Table 10: Hydropower plants added to the SEIN since 2005**

Power Plant	Date of Entry to the SEIN	Technology	Installed Capacity (MW)	CDM Status
Santa Cruz II ⁶⁷	May 2010	Hydro	3.50	Registered project
Poechos II ⁶⁸	April 2010	Hydro	10.00	Registered project
Roncador	April 2010	Hydro	3.80	-
El Platanal ⁶⁹	December 2009	Hydro	220.00	Registered project
La Joya ⁷⁰	July 2009	Hydro	10.00	Registered project
Santa Cruz I ⁷¹	February 2009	Hydro	6.20	Registered project
Caña Brava ⁷²	November 2008	Hydro	5.31	Registered project
Carhuaquero IV ⁷³	May 2008	Hydro	10.00	Registered project
Santa Rosa I ⁷⁴	January 2006	Hydro	1.02	Registered project
Yuncan ⁷⁵	August 2005	Hydro	130.14	Validation

Source: COES Annual Statistic Reports⁷⁶

This scenario is a result of the discovery of substantial gas fields in the country.⁷⁷ The government has been developing the domestic natural gas market to obtain energy self-sufficiency and attend the growing energy demand. Therefore, newly constructed hydropower plants are not common practice, but sporadically built as a result of special conditions.

⁶⁷ <http://cdm.unfccc.int/Projects/DB/AENOR1265015026.4/view> - Web link last accessed on 20/07/2011.

⁶⁸ <http://cdm.unfccc.int/Projects/DB/DNV-CUK1210240197.56/view> - Web link last accessed on 20/07/2011.

⁶⁹ <http://cdm.unfccc.int/Projects/DB/DNV-CUK1236231305.7/view> - Web link last accessed on 20/07/2011.

⁷⁰ <http://cdm.unfccc.int/Projects/DB/DNV-CUK1214563651.47/view> - Web link last accessed on 20/07/2011.

⁷¹ <http://cdm.unfccc.int/Projects/DB/DNV-CUK1234847056.6/view> - Web link last accessed on 20/07/2011.

⁷² <http://cdm.unfccc.int/Projects/DB/DNV-CUK1195731585.43/view> - Web link last accessed on 20/07/2011.

⁷³ <http://cdm.unfccc.int/Projects/DB/DNV-CUK1195027195.68/view> - Web link last accessed on 20/07/2011.

⁷⁴ <http://cdm.unfccc.int/Projects/DB/SGS-UKL1125047848.33/view> - Web link last accessed on 20/07/2011.

⁷⁵ http://www.dnv.com/focus/climate_change/upload/peru%20yuncan%20pdd%20-%20final%20version%2025%20september%202007.pdf - Web link last accessed on 20/07/2011.

⁷⁶ <http://www.coes.org.pe/wcoes/coes/estadistica/estadannual.aspx> - Web link last accessed on 20/07/2011.

⁷⁷ The San Martín and Cashiriari fields (known as Block-88 - Camisea) are home to one of the most important non-associated natural gas reserves in Latin America, and represent around ten times all of the other existing natural gas reserves in Peru. <http://www.camisea.pluspetrol.com.pe/project.asp> - Web link last accessed on 20/07/2011.



Natural Gas promotion in Peru began in 1999, when the law for the Promotion of Development of the Natural Gas Industry (Law No. 27133)⁷⁸ was promulgated. Thus, since the year 2000 the contracts were signed for the development of the Camisea Project. The studies to exploit the Camisea natural gas estimated that reserves were of 11 TCF (Trillion cubic feet) of natural gas and that the estimated recovery, considering the proven and probable, was of 8.24 TCF of gas and 482 million barrels of natural gas liquids. Natural Gas price and promotion policies of the government have made the use of this fuel in generating electricity more feasible, generating significant investments in the installation of new power plants since then.

All this is reflected in the evolution of natural gas consumption, as natural gas has become one of the most important components in the electric power generation of the SEIN. The 2010 annual report of the Committee for the System's Economic Operation (COES) shows that the use of the Camisea natural gas for electricity generation has been increasing over time, while hydropower production has increased very little compared to this.

In the case of the hydropower plants that have been interconnected to the SEIN since the year 2005, almost all of them have been registered as CDM projects or are under validation process. The only exception to this behaviour is the Roncador Hydropower Plant, which cannot be considered as similar to the proposed Project activity due to the fact that the Roncador project is a 3.8 MW project with an investment cost of 658 USD/kW,⁷⁹ which is considered very low when compared to the Las Pizarras Project (representing 7.4% of the investment cost of Las Pizarras). Based on these elements, it is clear that the construction of thermal power plants has been the common practice in the country, adding most of the power generation capacity over the last years. Furthermore, over the last 6 years all hydropower projects have been registered under the CDM or are currently under validation (except, as mentioned, Roncador). In the case of the thermal power plants, only the Ventanilla thermoelectric plant has applied to the CDM for the conversion of a single cycle system to a combined cycle system.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

The 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)

⁷⁸ http://www.minem.gob.pe/minem/archivos/file/Hidrocarburos/normas_legales/ley27133.pdf - Web link last accessed on 20/07/2011.

⁷⁹ Ministerio de Energía y Minas (2007). *Portafolio de Proyectos de Centrales de Generación (Portfolio of generation projects)*, p. 36.

**I. Project Emissions (PE_y)**

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.

II. 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.

III. Baseline Emissions (BE_y)

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:

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

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).

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 (optional).
- 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 Project supplies energy to the National Interconnected Electric Grid (SEIN), therefore it will displace electricity from the SEIN. Hence, the identified electricity power system is SEIN.

The Project will displace electricity from an electricity distribution system (in this case, the SEIN) that is or would have been supplied by at least one fossil fuel fired generating unit.

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

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**

The formula for the OM-DD emission factor ($EF_{grid,OM-DD,y}$) used was provided by the Tool as follows:

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

Where:

$EF_{grid,OM-DD,y}$	:	Dispatch data analysis operating margin CO ₂ emission factor in year y (tCO ₂ /MWh).
$EG_{PJ,h}$	:	Electricity displaced by the project activity in hour h of year y (MWh).
$EF_{EL,DD,h}$	:	CO ₂ emission factor for grid power units in the top of the dispatch order in hour h in year y (tCO ₂ /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.

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

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

Where:

$EF_{EL,DD,h}$	:	CO ₂ emission factor for power units in the top of the dispatch order in hour h in year y (tCO ₂ /MWh).
$EG_{n,h}$	:	Net quantity of electricity generated and delivered to the grid by power unit n , in hour h (MWh).
$EF_{EL,n,y}$	:	CO ₂ emission factor of power unit n , in year y (tCO ₂ /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:

- 10%, or
- 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 ($EF_{EL,m,y}$) is calculated as per the guidance for the simple OM, using the **option A2**.

$$EF_{EL,m,y} = (EF_{CO2,m,y,i} * 3.6) / n_{m,y}$$



Where,

$EF_{EL,m,y}$	:	CO ₂ emission factor of power unit m in year y (tCO ₂ /MWh).
$EF_{CO_2,m,y,i}$	:	Average CO ₂ emission factor of fuel type i used in power unit m in year y (tCO ₂ /GJ).
$n_{m,y}$	:	Average net energy conversion efficiency of power unit m in year y (ratio).
m	:	All power units serving the grid in year y except low-cost/must-run power units.
y	:	Applicable year during monitoring (ex-post option).

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:

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

Where:

$EF_{grid,BM,y}$	:	Build margin CO ₂ emission factor in year y (tCO ₂ /MWh).
$EG_{m,y}$	:	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh).
$EF_{EL,m,y}$	:	CO ₂ emission factor of power unit m in year y (tCO ₂ /MWh).
m	:	Power units included in the build margin.
y	:	Most recent historical year for which power generation data is available.

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:

- 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 ($SET_{5-units}$) and determine their annual electricity generation ($AEG_{SET-5-units}$, in MWh);
- Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEG_{total} , 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 AEG_{total} (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 ($AEG_{SET \geq 20\%}$, in MWh);
- From $SET_{5-units}$ and $SET_{\geq 20\%}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample}); Identify the date when the power units in SET_{sample} started to supply electricity to the grid. If none of the power units in SET_{sample} started to supply electricity to the grid more than 10 years ago, then use SET_{sample} to calculate the build margin. Ignore steps (d), (e) and (f).



- (d) Exclude from SET_{sample} 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 ($SET_{sample-CDM}$) the annual electricity generation ($AEG_{SET-sample-CDM}$, 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. $AEG_{SET-sample-CDM} \geq 0.2 \times AEG_{total}$), then use the sample group $SET_{sample-CDM}$ to calculate the build margin. Ignore steps (e) and (f).

Otherwise:

- (e) Include in the sample group $SET_{sample-CDM}$ 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 ($SET_{sample-CDM \rightarrow 10yrs}$).

Out of $SET_{5-units}$ and $SET_{\geq 20\%}$, the latter group was selected as SET_{sample} 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.

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:

$$EF_{grid,CM,y} = EF_{grid,OM,y} * W_{OM} + EF_{grid,BM,y} * W_{BM}$$

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 $W_{BM} = 0.5$.⁸⁰

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	$EF_{CO2,i,y}$ and $EF_{CO2,m,i,y}$
Data unit:	tCO ₂ /GJ
Description:	CO ₂ emission factor of fossil fuel type <i>i</i> in year <i>y</i> .
Source of data used:	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 <i>IPCC Guidelines on National GHG Inventories</i> .
Value applied:	Diesel Oil = 72,600 Residual Fuel Oil = 75,500 Natural Gas = 54,300 Coal = 87,300
Justification of the choice of data:	The CO ₂ emission factor is used to calculate the CO ₂ emission coefficients of the power plants in the grid. This is a step necessary to find the baseline CO ₂ emission of the grid.
Any comment:	None.

Parameter:	$EF_{EL,m,y}$
Unit:	tCO ₂ /MWh
Description:	CO ₂ emission factor of power unit <i>m</i> in year <i>y</i> .
Source of data:	COES Annual Statistics report and IPCC default values for CO ₂ emission factor of fossil fuel type.
Value of data:	All Thermal Plants Emission Factors (see spreadsheets for BM and OM calculations).
Justification of the choice of data:	CO ₂ emission factor of power unit

⁸⁰ 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.



	$EE_{EL,m,y} = (EF_{CO2,m,y,i} * 3.6) / n_{m,y}$ The $EF_{EL,m,y}$ will be calculated as per the guidance for the simple OM, using the option A2.
QA/QC procedures to be applied (if any):	The thermal plant emission factor will be used to calculate both OM and BM emission factors as per guidance of tool to calculate the grid emission factor.
Any comment:	None.

Data / Parameter:	$EF_{CO2,grid,y} = EF_{grid,CM,y}$
Data unit:	tCO ₂ e/MWh
Description:	CO ₂ emission factor of the grid electricity in year <i>y</i> .
Source of data:	COES records and Río Doble.
Value applied:	0.65943
Justification of the choice of data:	A combined margin (CM) will be used, consisting of the combination of operating margin (OM) and build margin (BM), according to the procedures prescribed in the “Tool to calculate the Emission Factor for an electricity system”. This is included for reference purposes as in the ex-post calculation this monitoring parameter should be monitored each year during the crediting period, as per the “Tool to calculate the Emission Factor for an electricity system”.
Any comment:	None.

B.6.3. Ex-ante calculation of emission reductions:

The baseline emission factor was calculated *ex-ante* in a transparent and conservative manner as a combined margin (CM) consisting of an average of the operating margin (OM) and the build margin (BM), according to the procedures prescribed in the *Tool to calculate the emission factor for an electricity system* and explained in section B.6.1.

Emission Reductions

The estimated annual Emission Reductions (ER) for the Project were calculated as follows:

$$ER_y = BE_y - PE_y$$

- ER_y : Emission reduction in year *y* (tCO₂)
 BE_y : Baseline emission in year *y* (tCO₂)
 PE_y : Project emission in year *y* (tCO₂)

I. Project Emissions (PE_y)

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



$$PE_y = 0$$

II. Leakage

As mentioned in section B.6.1., following the applied methodology no leakage emissions are considered.

III. Baseline Emissions

The baseline emission is calculated as the product of the electrical energy baseline $EG_{BL,y}$, expressed in MWh, produced by the renewable generating unit and multiplied by the grid emission factor:

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

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. The case of the project activity is 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).

Net electricity generation as a result of the project activity is calculated as an “approximation” of the total electricity that the Project would have generated in 2010. The net electricity generation is estimated to be 103,320 MWh per year.⁸¹

⁸¹ Socoin (2011). *Proyecto Básico Las Pizarras* (Basic Project Las Pizarras) – Annex IV.



$$EG_{facility,y} = 103,320 \text{ MWh per year}$$

$$EG_{PJ,y} = EG_{facility,y} = 103,320 \text{ MWh per year}$$

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

As explained in section B.6.1. and using the *Tool to calculate the emission factor for an electricity system*, the CO₂ emission factor for the displacement of electricity generated by power plants in an electricity system was obtained by calculating the “operating margin”, “build margin” and “combined margin”, which include the following 6 steps:

Step 1: Identify the relevant electric power system

The electricity generation will be supplied to the SEIN, therefore the Project displaces consumption of energy from Peru’s SEIN.

Step 2: choose whether to include off-grid power plants in the project electricity system (optional)

The Tool proposes 2 options:

- 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 of grid connected power plants is available, Option I will be chosen for calculating 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.⁸² Furthermore, 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 (OM) emission factor according to the selected method

For this calculation the hourly generation in 2010 was used, as it was the most recent data available. At the time that the Project’s baseline study was completed, the hourly generation data did not yet exist for

⁸² COES Annual Statistics Report (2010). Table N° 2.2A. According to this table, thermal generation in 2010 totalled 13,462.27 GWh, which represents 41.52% of total generation; while, hydro generation totalled 18,964.56 GWh, which represents 58.48% of total generation. Therefore, low cost must-run resources constitute more than 50% of total grid generation in Peru.
<http://www.coes.org.pe/wcoes/coes/estadistica/estadannual.aspx> - Web link last accessed on 20/07/2011.



one entire year. Therefore, it was assumed that the project activity will generate 103,320 MWh/year. Considering this assumption, the variables were defined as follows:

The formula used for the OM-DD emission factor ($EF_{grid,OM-DD,y}$) was provided by the Tool as follows:

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

Where:

$EF_{grid,OM-DD,y}$	:	Dispatch data analysis operating margin CO ₂ emission factor in year y (tCO ₂ /MWh).
$EG_{PJ,h}$	:	Electricity displaced by the project activity in hour h of year y (MWh).
$EF_{EL,DD,h}$	:	CO ₂ emission factor for grid power units in the top of the dispatch order in hour h in year y (tCO ₂ /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 determined based on the energy efficiency of the power unit and the fuel type used. The electricity displaced by the Project activity is estimated to be 103,320 MWh per year.

$EG_{PJ,y}$ is an “estimation” of the total electricity generated by the Project in 2010.

$$EG_{PJ,y} = 103,320 \text{ MWh}$$

$EG_{PJ,h}$ is an “approximation” of the total electricity generated by the Project in each hour of 2010. It was calculated by dividing the Project’s estimated generation by 8,760 hours in a year.

$$EG_{PJ,h} = 103,320 / 8,760$$

$$EG_{PJ,h} = 11.795 \text{ MWh}$$

The emission factor for power units at the top of the dispatch order in each hour is calculated as follows:

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

Where:

$EF_{EL,DD,h}$	:	CO ₂ emission factor for power units in the top of the dispatch order in hour h in year y (tCO ₂ /MWh).
$EG_{n,h}$	:	Net quantity of electricity generated and delivered to the grid by power unit n , in hour h (MWh).
$EF_{EL,n,y}$	:	CO ₂ emission factor of power unit n , in year y (tCO ₂ /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 ($EF_{EL,m,y}$) is calculated as per the guidance for the simple OM, using the **option A2**.

$$EF_{EL,m,y} = (EF_{CO2,m,y,i} * 3.6) / n_{m,y}$$

Where,

$EF_{EL,m,y}$	:	CO ₂ emission factor of power unit m in year y (tCO ₂ /MWh).
$EF_{CO2,m,y,i}$	:	Average CO ₂ emission factor of fuel type i used in power unit m in year y (tCO ₂ /GJ).
$n_{m,y}$	:	Average net energy conversion efficiency of power unit m in year y (ratio).
m	:	All power units serving the grid in year y except low-cost/must-run power units.
y	:	Applicable year during monitoring (ex-post option).



Table 11: Emission Factors for Thermal Units in the SEIN in 2010

THERMAL PLANTS	TECHNOLOGY	FUEL	$\eta_{m,y} (\%)^{(1)}$ EFFICIENCY	$E_{CO_2, m, i, y}^{(2)}$ KgCO ₂ /Tj	Emissions Factor $EF_{EL, m, y}^{(3)}$ (tCO ₂ /MWh)
AGUAYTÍA TG1	GAS TURBINE / NATURAL GAS	NATURAL GAS	30%	54,300	0.6516
AGUAYTÍA TG2	GAS TURBINE / NATURAL GAS	NATURAL GAS	30%	54,300	0.6516
BELLAVISTA ALCO	DIESEL 2 / RESIDUAL	DIESEL 2	31%	72,600	0.8431
BELLAVISTA MAN1	DIESEL 2 / RESIDUAL	DIESEL 2	38%	72,600	0.6878
CHICLAYO OESTE	DIESEL 2 / RESIDUAL	DIESEL 2	35%	72,600	0.7467
CHILCA1 TG1	GAS TURBINE / NATURAL GAS	NATURAL GAS	35%	54,300	0.5585
CHILCA1 TG2	GAS TURBINE / NATURAL GAS	NATURAL GAS	35%	54,300	0.5585
CHILCA1 TG3	GAS TURBINE / NATURAL GAS	NATURAL GAS	33%	54,300	0.5924
CHILINA SULZ12	DIESEL 2 / RESIDUAL	DIESEL 2	39%	72,600	0.6702
CHILINA TV2	STEAM TURBINE / RESIDUAL	RESIDUAL 500	21%	75,500	1.2943
CHILINA TV3	STEAM TURBINE / RESIDUAL	RESIDUAL 500	23%	75,500	1.1817
CHIMBOTE	GAS TURBINE / DIESEL	DIESEL 2	24%	72,600	1.0890
CICLO COMBINADO	COMBINED CYCLE GAS - STEAM TURBINE	DIESEL 2	29%	72,600	0.9012
DOLORESPATA ⁽⁴⁾	DIESEL 2 / RESIDUAL	DIESEL 2	30%	72,600	0.8712
MOLLEND	DIESEL 2 / RESIDUAL	RESIDUAL 500	43%	75,500	0.6321
ILO1 CATKATO	DIESEL 2 / RESIDUAL	DIESEL 2	42%	72,600	0.6223
ILO1 TG1	GAS TURBINE / DIESEL	DIESEL 2	30%	72,600	0.8626
ILO1 TG2	GAS TURBINE / DIESEL	DIESEL 2	33%	72,600	0.7920
ILO1 TV2	STEAM TURBINE / RESIDUAL	RESIDUAL 500	35%	75,500	0.7788
ILO1 TV3	STEAM TURBINE / RESIDUAL	RESIDUAL 500	34%	75,500	0.8089
ILO1 TV4	STEAM TURBINE / RESIDUAL	RESIDUAL 500	35%	75,500	0.7878
ILO2 TV1	STEAM TURBINE / COAL	COAL	40%	87,300	0.7857
INDEPENDENCIA	GAS TURBINE / DIESEL	DIESEL 2	39%	72,600	0.6702
KALLPA TG1	GAS TURBINE / NATURAL GAS	NATURAL GAS	33%	54,300	0.5924
KALLPA TG2	GAS TURBINE / NATURAL GAS	NATURAL GAS	34%	54,300	0.5749
KALLPA TG3	GAS TURBINE / NATURAL GAS	NATURAL GAS	34%	54,300	0.5749
LAS FLORES	GAS TURBINE / NATURAL GAS	NATURAL GAS	34%	54,300	0.5749
MALACAS TG1	GAS TURBINE / NATURAL GAS	NATURAL GAS	21%	54,300	0.9309
MALACAS TG2	GAS TURBINE / NATURAL GAS	NATURAL GAS	22%	54,300	0.8885
MALACAS2 TG4	GAS TURBINE / NATURAL GAS	NATURAL GAS	27%	54,300	0.7240
OQUENDO	COGENERATION / NATURAL GAS	NATURAL GAS	34%	54,300	0.5749
PAITA 1	DIESEL 2 / RESIDUAL	DIESEL 2	34%	72,600	0.7687
PAITA 2	DIESEL 2 / RESIDUAL	DIESEL 2	32%	72,600	0.8168
PISCO TG1	GAS TURBINE / NATURAL GAS	NATURAL GAS	27%	54,300	0.7240
PISCO TG2	GAS TURBINE / NATURAL GAS	NATURAL GAS	27%	54,300	0.7240
PIURA 1	DIESEL 2 / RESIDUAL	DIESEL 2	37%	72,600	0.7064
PIURA 2	DIESEL 2 / RESIDUAL	DIESEL 2	37%	72,600	0.7064
PIURA TG	GAS TURBINE / DIESEL	DIESEL 2	21%	72,600	1.2446
CUMMINS	DIESEL 2 / RESIDUAL	DIESEL 2	38%	72,600	0.6878
SAN NICOLÁS TV1	STEAM TURBINE / RESIDUAL	RESIDUAL 500	28%	75,500	0.9707
SAN NICOLÁS TV2	STEAM TURBINE / RESIDUAL	RESIDUAL 500	29%	75,500	0.9372
SAN NICOLÁS TV3	STEAM TURBINE / RESIDUAL	RESIDUAL 500	30%	75,500	0.9060
SANTA ROSA TG8	GAS TURBINE / NATURAL GAS	NATURAL GAS	35%	54,300	0.5585
SANTA ROSA UT15	GAS TURBINE / NATURAL GAS	NATURAL GAS	29%	54,300	0.6741
SANTA ROSA UT16	GAS TURBINE / NATURAL GAS	NATURAL GAS	27%	54,300	0.7240
SANTA ROSA WTG TG7	GAS TURBINE / NATURAL GAS	NATURAL GAS	33%	54,300	0.5924
SULLANA	DIESEL 2 / RESIDUAL	DIESEL 2	34%	72,600	0.7687
TAPARACHI	GAS TURBINE / DIESEL	DIESEL 2	35%	72,600	0.7467
TRUJILLO NORTE	DIESEL 2 / RESIDUAL	DIESEL 2	38%	72,600	0.6878
TUMBES	DIESEL 2 / RESIDUAL	DIESEL 2	43%	72,600	0.6078
VENTANILLA CICLO COMBINADO	COMBINED CYCLE GAS TURBINE	NATURAL GAS	50%	54,300	0.3910
YARINACocha	DIESEL 2 / RESIDUAL	DIESEL 2	39%	72,600	0.6702

(1) Source: COES 2010 Annual Statistics Report. Chart No 4.7. Thermal Efficiency %.

(2) Source: IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter I of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.

(3) The emission factor of each power is determined using Option A2 for simple OM.

(4) The default value from Annex 1 of the *Tool to calculate the emission factor for an electricity grid* is being used due to lack of information from this power plant.



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 top x% of grid dispatch order each hour of the year.

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

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

$$EF_{grid,OM-DD,y} = 77,440.87 / 103,320$$

$$EF_{grid,OM-DD,y} = 0.74952 \text{ tCO}_2/\text{MWh}$$

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

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

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

Where:

$EF_{grid,BM,y}$	:	Build margin CO ₂ emission factor in year <i>y</i> (tCO ₂ /MWh).
$EG_{m,y}$	:	Net quantity of electricity generated and delivered to the grid by power unit <i>m</i> in year <i>y</i> (MWh).
$EF_{EL,m,y}$	:	CO ₂ emission factor of power unit <i>m</i> in year <i>y</i> (tCO ₂ /MWh).
<i>m</i>	:	Power units included in the build margin.
<i>y</i>	:	Most recent historical year for which power generation data is available.

According to the *Tool to calculate the emission factor for an electricity system*, for BM calculations the sample group of power units *m* used should be determined as per the following procedure, consistent with the data vintage selected above:

- 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 (SET_{5-units}) and determine their annual electricity generation (AEG_{SET-5-units}, in MWh);
- Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEG_{total}, 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 AEG_{total} (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) (SET_{≥20%}) and determine their annual electricity generation (AEG_{SET-≥20%}, in MWh);



- (c) From $SET_{5-units}$ and $SET_{\geq 20\%}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample}); Identify the date when the power units in SET_{sample} started to supply electricity to the grid. If none of the power units in SET_{sample} started to supply electricity to the grid more than 10 years ago, then use SET_{sample} to calculate the build margin. Ignore steps (d), (e) and (f).

Out of $SET_{5-units}$ and $SET_{\geq 20\%}$, the latter group was selected as SET_{sample} due to the fact that it includes the larger annual electricity generation.

Moreover, none of these power plants started to supply energy to the grid more than ten years ago.

Table 12: Capacity Additions in the SEIN (2005-2010)

POWER PLANT	Technology	Date of Entry To SEIN ⁽¹⁾	Installed Capacity ⁽²⁾ (MW)	2010 Energy Generation ⁽³⁾ (GWh)
PISCO TG1	Gas Turbine/Natural Gas	Sep-10	37.40	3.60
PISCO TG2	Gas Turbine/Natural Gas	Sep-10	37.40	10.20
INDEPENDENCIA	Diesel/Natural Gas	Sep-10	22.93	5.27
SANTA CRUZ II	Hydro	May-10	3.50	18.51
POECHOS II	Hydro	Apr-10	10.00	28.29
RONCADOR	hydro	Apr-10	3.80	7.65
LAS FLORES	Gas Turbine/Natural Gas	Apr-10	192.50	13.08
KALLPA TG3	Gas Turbine/Natural Gas	Feb-10	233.00	1,078.30
PARAMONGA	Gas Turbine/Biomass	Jan-10	23.00	77.48
EL PLATANAL	Hydro	Dec-09	220.00	720.56
STA ROSA TG8	Natural Gas turbine	Aug-09	193.18	763.86
LA JOYA	Hydro	Jul-09	10.00	18.02
CHILCA1 TG3	Natural Gas turbine	Jul-09	199.80	930.46
TRUJILLO NORTE	Diesel 2 / Residual	Jun-09	64.00	120.97
KALLPA TG2	Natural Gas turbine	Jun-09	216.00	1,252.34
SANTA CRUZ I	Hydro	Feb-09	6.20	34.46
OQUENDO TG1	Natural Gas turbine	Jan-09	31.00	203.60
CAÑA BRAVA	Hydro	Nov-08	5.31	29.08
CARHUAQUERO IV	Hydro	May-08	10.00	67.03
CHILCA1 TG2	Natural Gas Turbine	Jul-07	179.24	406.19
KALLPA TG1	Natural Gas Turbine	Jul-07	180.00	880.43
CHILCA1 TG1	Natural Gas Turbine	Dec-06	179.24	1,092.95
VENTANILLA TG 3 & TG 4 & TV	Combined cycle	Oct-06	457.00	3,214.64
SANTA ROSA UTI 5 - UTI6	Natural Gas Turbine	Aug-06	119.20	56.56
SANTA ROSA I	Hydro	Jan-06	1.02	0.00
YUNCAN	Hydro	Aug-05	130.14	692.59
SANTA ROSA WTG7	Natural Gas Turbine	Jun-05	127.50	86.45

(1) Source: COES. Estadística de Operaciones 2010. Chart No 2.6A "2010 Energy production"

(2) Source: COES. Estadística de Operaciones 2010. Chart No 15.5 "Features of the Generating Companies"

(3) Source: COES. Estadística de Operaciones 2010. Chart No. 2.6A "2010 Energy production"

In Table 12 it can be seen that most of the additions to the SEIN are thermal generation units, and that even the larger power plants are thermal.

However, to identify the SET_{sample} power plants ($SET_{5-units}$, $SET_{\geq 20\%}$) and calculate de BM, the CDM-registered projects should be excluded (El Platanal, La Joya, Santa Cruz I, Santa Cruz II and Poechos II),



therefore the set of five power plants built most recently that are considered to calculate the BM are: Pisco TG1, Pisco TG2, Independencia, Roncador and Las Flores.

The SET_{5-units} power plants have an annual generation of 39.79 GWh, which represents 0.12% of the total annual generation (32,426.83 GWh). The annual generation of SET_{≥20%} power plants is 6,846.37 GWh, which represents 21.11%; therefore the second group was selected to calculate the BM.

In the following table it is shown how the SET_{sample} power plants have been chosen to calculate the BM.

Table 13: Selection of SET_{sample} power plants

Date of Entry To SEIN	Power Plant	Plant Type	Most recent year generation (GWh)	SET _{≥20%}	AEG _{SET≥20%} (GWh)	SET _{5-units}	AEG _{SET-5-units} (GWh)
Sep-2010	PISCO TG1	Natural Gas turbine	3.60	1	3.60	1	3.60
Sep-2010	PISCO TG2	Natural Gas turbine	10.20	1	10.20	1	10.20
Sep-2010	INDEPENDENCIA	Diesel 2	5.27	1	5.27	1	5.27
Apr-2010	RONCADOR	Hydro	7.65	1	7.65	1	7.65
Apr-2010	LAS FLORES	Natural Gas turbine	13.08	1	13.08	1	13.08
Feb-2010	KALLPA TG3	Natural Gas turbine	1,078.30	1	1,078.30	-	-
Jan-2010	PARAMONGA	Biomass	77.48	1	77.48	-	-
Sep-2009	STA ROSA TG8	Natural Gas turbine	763.86	1	763.86	-	-
Aug-2009	CHILCA1 TG3	Natural Gas turbine	930.46	1	930.46	-	-
Jun-2009	KALLPA TG2	Natural Gas turbine	1,252.34	1	1,252.34	-	-
Jun-2009	TRUJILLO NORTE	Diesel 2 / Residual	120.97	1	120.97	-	-
Mar-2009	OQUENDO	Natural Gas turbine	203.60	1	203.60	-	-
Jul-2007	CHILCA1 TG2	Natural Gas Turbine	406.19	1	406.19	-	-
Jul-2007	KALLPA TG1	Natural Gas Turbine	880.43	1	880.43	-	-
Dec-2006	CHILCA1 TG1	Natural Gas Turbine	1,092.95	1	1,092.95	-	-
Aug-2006	SANTA ROSA UTI 5 - UTI6	Natural Gas Turbine	56.56	-	-	-	-
TOTAL				15	6846.37	5	39.79

Due to the fact that the SET_{sample} is SET_{≥20%} power plants, the BM is calculated as follows.

To calculate the BM, the selected set of plants (SET_{≥20%}) was organized according to their annual generation output (the annual generation was provided by COES) and the corresponding emission factor (the emission factor of the power plants included in the BM was calculated using option A2 for the simple OM). Using the formula:

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

$$\sum_m EG_{m,y} = 6,846,369.87$$

$$\sum_m (EG_{m,y} * EF_{EL,m,y}) = 3,897,905.82$$

$$EF_{grid,BM,y} = 3,897,905.82 / 6,846,369.87$$

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

Table 14: BM Calculation



Power Plant	SET _{sample} (MWh)	EF _{EL,m,y} (tCO ₂ /MWh)
PISCO TG1	3,602.68	0.72400
PISCO TG2	10,195.67	0.72400
INDEPENDENCIA	5,267.44	0.67015
RONCADOR	7,646.19	0.00000
LAS FLORES	13,082.49	0.57494
KALLPA TG3	1,078,303.49	0.57494
PARAMONGA	77,475.38	0.00000
STA ROSA TG8	763,864.22	0.55851
CHILCA1 TG3	930,457.59	0.59236
KALLPA TG2	1,252,339.07	0.57494
OQUENDO	203,598.40	0.57494
CHILCA1 TG2	406,185.47	0.55851
KALLPA TG1	880,434.62	0.59236
TRUJILLO NORTE	120,970.23	0.68779
CHILCA1 TG1	1,092,946.93	0.55851

$\sum EG_{m,y} \times EF_{EL,m,y}$	3897905.82
$\sum EG_{m,y}$	6846369.87
$EF_{grid,BM,y}$	0.56934 (tCO ₂ /MWh)

Step 6: Calculate the Combined Margin (CM) Emissions Factor

The Baseline Emission Factor was calculated as a CM, which is the simple average⁸³ of the OM and the BM. All margins are expressed in tCO₂/MWh.

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

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times 0.5 + EF_{grid,BM,y} \times 0.5$$

$$EF_{grid,CM,y} = 0.74952 \times 0.5 + 0.56934 \times 0.5$$

$$EF_{grid,CM,y} = 0.65943 \text{ tCO}_2/\text{MWh}$$

The resulting Baseline Emission Factor ($EF_{grid,CM,y}$) for the year 2010 is 0.65943 tCO₂/MWh.

Calculation of the Project's Emission Reductions Prior to Validation

⁸³ The default weights of 50%-50% were kept.

**I. Project emissions (PE_y)**

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

II. Leakage

Following the applied methodology, leakage was not considered.

III. Baseline emissions (BE_y)

The baseline emission is calculated as the product of the electrical energy generation that is produced and fed into the grid as a result of the implementation, $EG_{PJ,y}$ (expressed in MWh), produced by the renewable generating unit and multiplied by the grid emission factor.

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

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. The case of the project activity is 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).

**CDM – Executive Board**

page 48

Net electricity generation as a result of the project activity is calculated as an “approximation” of the total electricity that the Project would have generated in 2010. The net electricity generation is estimated to be 103,320⁸⁴ MWh per year.

$$EG_{facility,y} = 103,320 \text{ MWh}$$

$$EG_{PJ,y} = EG_{facility,y} = 103,320 \text{ MWh}$$

$$EG_{PJ,y} = 103,320 \text{ MWh}$$

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

$$BE_y = 103,320 \text{ MWh} * 0.65943$$

$$BE_y = 68,132 \text{ tCO}_2/\text{year}$$

Emission Reductions (ER_y)

Finally, the emission reductions are:

$$ER_y = BE_y - PE_y$$

$$ER_y = 68,132 - 0$$

$$ER_y = 68,132 \text{ tCO}_2/\text{year}$$

B.6.4 Summary of the ex-ante estimation of emission reductions

Year	Estimation of project activity emissions (tons of CO ₂ e)	Estimation of baseline emissions (tons of CO ₂ e)	Estimation of leakage (tons of CO ₂ e)	Estimation of overall emission reductions (tons of CO ₂ e)
2013	0	68,132	0	68,132
2014	0	68,132	0	68,132
2015	0	68,132	0	68,132
2016	0	68,132	0	68,132
2017	0	68,132	0	68,132
2018	0	68,132	0	68,132
2019	0	68,132	0	68,132
Total	0	476,926	0	476,926

B.7. Application of the monitoring methodology and description of the monitoring plan**B.7.1 Data and parameters monitored:**

⁸⁴ Socoin (2011). *Proyecto Básico Las Pizarras* (Basic Project Las Pizarras) – Annex IV.



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 fossil fuel type <i>i</i> in year <i>y</i> .
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 <i>IPCC Guidelines on National GHG Inventories</i> .
Value of data applied for the purpose of calculating expected emission reductions in section B.5:	Diesel Oil = 72,600 Residual Fuel Oil = 75,500 Natural Gas = 54,300 Coal = 87,300
Measurement procedures (if any):	The CO ₂ emission factor is used to calculate the CO ₂ emission factors of the power plants <i>m</i> in the grid.
Monitoring frequency:	Any change or update on behalf of the IPCC will be taken into account for future calculations.
QA/QC procedures to be applied:	None.
Any comment:	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 <i>m</i> or <i>n</i> in year <i>y</i> or hour <i>h</i> . <i>m</i> : Power units included in the build margin. <i>n</i> : Grid power units in the top of the dispatch.
Source of data:	COES records.
Value of data applied for the purpose of calculating expected emission reductions in section B.5:	COES records.
Measurement procedures (if any):	The latest publicly available information is used for the ex-ante calculation, which is the COES Annual Statistics from 2010. Data is directly measured based on the information provided by COES. This data will be measured and recorded every 15 minutes. The proportion of data to be monitored is 100% and the data will be archived electronically.
Monitoring Frequency:	Continuous measurement and at least monthly recording. Dispatch data OM: Hourly. BM: For the first crediting period. For the second and third crediting period, only once ex-ante at the start of the second crediting period.
QA/QC procedures to be applied:	None, the data would be provided by the COES.
Any comment:	None.

Data / Parameter:	$EG_{PJ,h}$ and $EG_{PJ,y}$
Data unit:	MWh



CDM – Executive Board

page 50

Description:	Electricity displaced by the project activity in hour h of year y (MWh).
Source of data used:	Empresa Eléctrica Río Doble S.A. will provide the records.
Value of data applied for the purpose of calculating expected emission reductions in section B.5:	$EG_{PJ,y} = 103.32$ GWh per year (expected) $EG_{PJ,h} = 11.795$ MWh (expected)
Measurement procedures (if any):	COES. This data will be measured and recorded every 15 minutes. The proportion of data to be monitored is 100% and the data will be archived electronically.
Monitoring frequency:	Hourly or yearly, as applicable.
QA/QC procedures to be applied (if any):	Sales records to the SEIN or to the final client, as well as other records are used to ensure consistency. Electricity supplied by the project activity to the grid, double check with sales receipts. The equipments used to monitor these parameters should be class 0.2 (as currently required by COES ⁸⁵) and will monitor in real time through the SCADA system. Should standards and requirements change, the type of equipments and system could be modified to comply with these new requirements. Measurement equipment should be 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, but at least once in three years.
Any comment:	The records will be cross checked with electricity purchase/sale invoices by comparing the values of the power and auxiliary system consumption with the substation meter records. 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:	$\eta_{m,y}$
Data unit:	%
Description:	Average net energy conversion efficiency of power unit m in year y .
Source of data:	COES Annual Statistics Report. ⁸⁶
Value of data applied for the purpose of calculating expected emission reductions in section B.5:	COES Annual Statistics Report.
Measurement procedures (if any):	Every year this data will be checked with the latest available Annual Statistics report of the COES.
Monitoring frequency:	Annually.
QA/QC procedures to	If the data used is significantly lower than the default value of the applicable

⁸⁵ COES Procedure No. 20, Annex C. See:<http://www.coes.org.pe/coes/Procedimientos/procedimientos.asp> - Web link last accessed on 20/07/2011.⁸⁶ <http://www.coes.org.pe/wcoes/coes/estadistica/estadannual.aspx> - Web link last accessed on 20/07/2011.



be applied:	technology, project proponents should assess the reliability of the values and provide appropriate justification if deemed reliable. Otherwise, the default values shall be used.
Any comment:	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 <i>y</i> .
Source of data:	COES records and Río Doble.
Value of data applied for the purpose of calculating expected emission reductions in section B.5:	0.65943
Measurement procedures (if any):	A combined margin (CM) will be used, consisting of the combination of operating margin (OM) and build margin (BM), according to the procedures prescribed in the <i>Tool to calculate the emission factor for an electricity system</i> .
Monitoring frequency:	As per the <i>Tool to calculate the emission factor for an electricity system</i> . For the calculation of the dispatch data analysis (OM), the project developer shall use the year in which the project activity displaces grid electricity and update the emission factor annually during monitoring. However, if the data to calculate the combined emission factor in a certain period of time is not available during the monitoring, then the most recent data available should be used. For the calculation of the BM the option 1 was chosen, therefore the BM does not require monitoring during the crediting period, and it should be calculated as per the <i>Tool to calculate the emission factor for an electricity system</i> : for the first crediting period, ex-ante based on the most recent information available on units already built (sample group <i>m</i>) 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.
QA/QC procedures to be applied:	Nevertheless that a value is given due to ex-ante calculation, the parameter will be calculated in an ex-post basis. Any consideration or recalculation undertaken by the IPCC would be considered in the ex-post calculations.
Any comment:	None.

B.7.2. Description of the monitoring plan

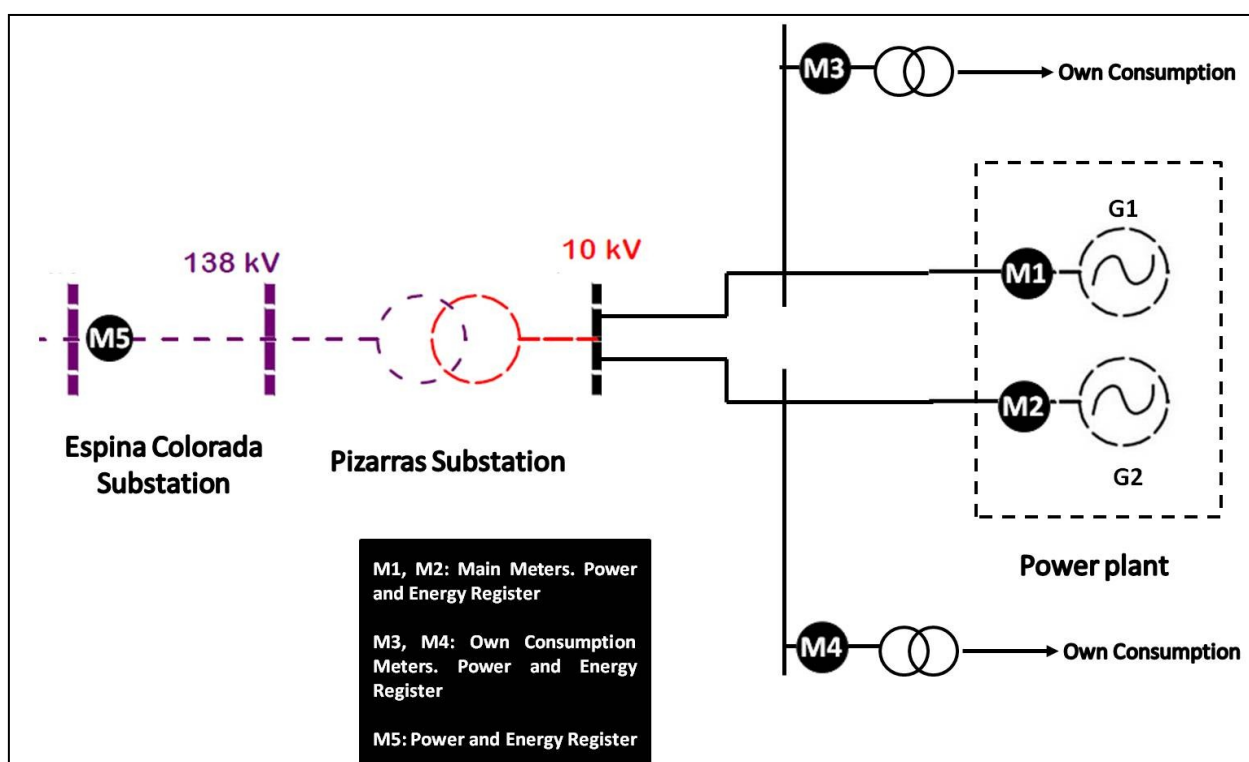
The monitoring methodology follows the ACM0002 definition, which states that “the monitoring shall consist of metering the electricity generated by the renewable energy technology.” However, for more

accuracy the emission factor will be calculated ex-post according to the *Tool to Calculate the Emission Factor for an Electricity System*.

The Project activity will need special monitoring equipment. ÉcoRessources will provide Río Doble with a Monitoring Plan and pre-programmed spreadsheets such that the Project participants will only need to collect the information as described and apply the formulas as instructed in the Monitoring Plan. COES, the dispatch centre, will provide the data for the annual ex-post calculation of the Project's ERs, and the energy generation of the Project will be provided by the Project developer. Further details of the MP are available in Annex 4.

The following figure shows the tentative meter locations for informative purposes. Specifications regarding the meters will comply with section B.7.1 and Annex 4.

Figure 6: Tentative Meter Locations



B.8. Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies):

The Baseline and monitoring methodology were completed on 20/07/2011 by the ÉcoRessources Carbone team.



Contact Person:

Luis Salgado
ÉcoRessources Carbone
Director for Latin America
luis.salgado@ecoressources.com

The entity/ies mentioned are not considered Project participants.

SECTION C. Duration of the project activity / crediting period**C.1. Duration of the project activity:****C.1.1. Starting date of the project activity:**

14/03/2011. This is the date that the company Río Doble (owner of the Project) was sold to a new investor. This is defined as the first real action of the Project activity.

C.1.2. Expected operational lifetime of the project activity:

40 years.

C.2. Choice of the crediting period and related information:**C.2.1. Renewable crediting period:****C.2.1.1. Starting date of the first crediting period:**

01/01/2013

C.2.1.2. Length of the first crediting period:

7 years, with two potential renewable periods.

C.2.2. Fixed crediting period:**C.2.2.1. Starting date:**

N.A.

C.2.2.2. Length:

N.A.

**SECTION D. Environmental impacts****D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:**

According to the Peruvian Electric Concessions Law (Law No. 25844),⁸⁷ for the development of hydroelectric power plants of less than 10 MW the only requirement is a Generation Authorization, and a completion of an Environmental Impact Assessment (EIA) or its approval is not required. With the introduction of the Law to Assure the Efficient Development of Electric Generation (Law No. 28832)⁸⁸ on 23/07/2006, the limit for a Generation Authorization was increased to 20 MW. As a result, the Project is not legally required to present an EIA.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

The area where the Project will be located is mainly unpopulated terrain, without any archaeological sites⁸⁹ or protected natural areas.

Environmental impacts identified by the project participants were not considered to be significant. Most of them were expected to occur during the construction phase, and are considered to be only temporary. Appropriate and standard mitigation measures are being taken by the project participants to manage these minimal impacts. On the other hand, during the operation phase, the majority of impacts are expected to be positive, mainly because the Project will lead to improved social and economic conditions for the local inhabitants.

SECTION E. Stakeholders' comments**E.1. Brief description how comments by local stakeholders have been invited and compiled:**

The National Environmental Fund (FONAM) was mandated to undertake a local consultation process with the objective of matching the interests of the Project sponsor with those of the local community. Hence, Río Doble and FONAM held meetings to explain the objectives, scope and commitments of the Project with respect to the local stakeholders' livelihoods and with the environment.

To establish the Project's zone of influence FONAM set a radius of 6 km. around the Project with the use of maps and geographical coordinates of strategic locations, such as the main square of the district of Santa Cruz and the hydropower plant of the Project. Once this zone of influence was established, the communities inside it were located through interviews and a site visit where the access routes around the

⁸⁷ <http://www2.osinerg.gob.pe/MarcoLegal/pdf/LEYCE-DL25844.pdf> - Web link last accessed on 20/07/2011.

⁸⁸ <http://www2.osinerg.gob.pe/MarcoLegal/pdf/LEY%2028832.pdf> – Web link last accessed on 20/07/2011.

⁸⁹ Socoin (2011). *Proyecto Básico Las Pizarras* (Basic Project Las Pizarras), p. 13.



Project were visited, as well as the nearby district of Catache. The main actors or representatives of the communities were also identified, and FONAM proceeded to interview the local authorities of the communities and the district, as well as survey the local population on their living conditions, their knowledge on environmental issues (local and global), and their knowledge on the Project.

To prepare for the information workshops, an informative brochure about the Project was developed by FONAM, as well as some flipcharts about global environmental issues and the Project activity.⁹⁰ The authorities and representatives of the communities were then sent written invitations⁹¹ to the workshop, and among the other diffusion measures undertaken to invite the population to the final workshop were flyers that were handed out at different hours, a radio announcement, and posters.

Two information workshops were held, one on 08/06/2011 and the other one on 10/06/2011, with a total participation of 41 members of the Santa Cruz and Catache districts, including local authorities and school teachers. During these meetings, FONAM shared information on climate change, the greenhouse gas effect, the Clean Development Mechanism, and the environmental and social benefits of the Project, as well as an explanation of the Project in detail. They then listened to the concerns of the local inhabitants. All the information gathered from both meetings was compiled and detailed in a written report, and there are lists with the names and signatures of the participants.

A final information workshop was held on 10/06/2011, with the participation of 59 members of the local community, and during this meeting representatives of Río Doble and the Executive Director of FONAM were present to address the main concerns of the local populations and present the main elements of the social investment plan of the Project.

This process was part of the Peruvian DNA's requirements for the Letter of Approval for the Project's CDM process. All the details of the process will be available to the DOE by request.

E.2. Summary of the comments received:

The Project has been received positively by the local stakeholders. Specifically, in FONAM's workshops the stakeholders' concerns and questions were discussed and answered thoroughly with the help of presentations, written material, maps and statistics. The main topics discussed were:

- Environmental impacts during the Project's construction and their mitigation.
- Water shortage and water quality within the river-bordering localities.
- Support to communities through educational infrastructure.
- Support to communities through health infrastructure.

As a result of this consultation process the local stakeholders who participated agreed to support the implementation of the CDM Project.

E.3. Report on how due account was taken of any comments received:

⁹⁰ Available in Annex 2 and 3 of FONAM's Local Stakeholder Consultation report.

⁹¹ Available in Annex 1 of FONAM's Local Stakeholder Consultation report.



The comments of the local stakeholders were taken into account and are considered on the elaboration of the Social Investment Plan. Río Doble committed itself to the following, as registered in FONAM's report of the process:

- The company will support the dissemination of environmental knowledge by contributing with two environmental education modules, one for each secondary school of the region. This is programmed for March 2013.
- The company will support the Santa Cruz high schools with modules 10 computers for each school (a total of 20 computers). This is programmed for March 2012.
- The company will coordinate with the city of Santa Cruz to develop a reforestation program. This is programmed for January 2014.
- The company will support the health center of Santa Cruz with a contribution of USD 7,000 to purchase a portable X-ray equipment and a lighting system for the surgery room. This is programmed for September 2012.

**Annex 1****CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY**

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URL:	
Represented by:	Mr. Ignacio Giménez
Title:	Operations Manager
Salutation:	Mr.
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CDM – Executive Board

page 58

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There is no public funding involved in the Project.

**Annex 3****BASELINE INFORMATION**

Table A3-1 below shows EF_{ELs} calculations with actual 2010 Net Energy Conversion Efficiency (NECs) from the Annual Statistics (Estadística Anual de Operaciones) published by COES. In the monitoring, EF_{ELs} should be updated using the latest Annual Statistics.

Table A3-1: EFELs calculations

THERMAL PLANTS	TECHNOLOGY	FUEL	$\eta_{m,y}(\%)^{(1)}$ EFFICIENCY	EFCO _{2,m,i,y} ⁽²⁾ KgCO ₂ /TJ	Emissions Factor EF _{EL,m,y} ⁽³⁾ (tCO ₂ /MWh)
AGUAYTÍA TG1	GAS TURBINE / NATURAL GAS	NATURAL GAS	30%	54,300	0.6516
AGUAYTÍA TG2	GAS TURBINE / NATURAL GAS	NATURAL GAS	30%	54,300	0.6516
BELLAVISTA ALCO	DIESEL 2 / RESIDUAL	DIESEL 2	31%	72,600	0.8431
BELLAVISTA MAN1	DIESEL 2 / RESIDUAL	DIESEL 2	38%	72,600	0.6878
CHICLAYO OESTE	DIESEL 2 / RESIDUAL	DIESEL 2	35%	72,600	0.7467
CHILCA1 TG1	GAS TURBINE / NATURAL GAS	NATURAL GAS	35%	54,300	0.5585
CHILCA1 TG2	GAS TURBINE / NATURAL GAS	NATURAL GAS	35%	54,300	0.5585
CHILCA1 TG3	GAS TURBINE / NATURAL GAS	NATURAL GAS	33%	54,300	0.5924
CHILINA SULZ12	DIESEL 2 / RESIDUAL	DIESEL 2	39%	72,600	0.6702
CHILINA TV2	STEAM TURBINE / RESIDUAL	RESIDUAL 500	21%	75,500	1.2943
CHILINA TV3	STEAM TURBINE / RESIDUAL	RESIDUAL 500	23%	75,500	1.1817
CHIMBOTE	GAS TURBINE / DIESEL	DIESEL 2	24%	72,600	1.0890
CICLO COMBINADO	COMBINED CYCLE GAS - STEAM TURBINE	DIESEL 2	29%	72,600	0.9012
DOLORESPATA ⁽⁴⁾	DIESEL 2 / RESIDUAL	DIESEL 2	30%	72,600	0.8712
MOLLENDON	DIESEL 2 / RESIDUAL	RESIDUAL 500	43%	75,500	0.6321
ILO1 CATKATO	DIESEL 2 / RESIDUAL	DIESEL 2	42%	72,600	0.6223
ILO1 TG1	GAS TURBINE / DIESEL	DIESEL 2	30%	72,600	0.8626
ILO1 TG2	GAS TURBINE / DIESEL	DIESEL 2	33%	72,600	0.7920
ILO1 TV2	STEAM TURBINE / RESIDUAL	RESIDUAL 500	35%	75,500	0.7788
ILO1 TV3	STEAM TURBINE / RESIDUAL	RESIDUAL 500	34%	75,500	0.8089
ILO1 TV4	STEAM TURBINE / RESIDUAL	RESIDUAL 500	35%	75,500	0.7878
ILO2 TV1	STEAM TURBINE / COAL	COAL	40%	87,300	0.7857
INDEPENDENCIA	GAS TURBINE / DIESEL	DIESEL 2	39%	72,600	0.6702
KALLPA TG1	GAS TURBINE / NATURAL GAS	NATURAL GAS	33%	54,300	0.5924
KALLPA TG2	GAS TURBINE / NATURAL GAS	NATURAL GAS	34%	54,300	0.5749
KALLPA TG3	GAS TURBINE / NATURAL GAS	NATURAL GAS	34%	54,300	0.5749
LAS FLORES	GAS TURBINE / NATURAL GAS	NATURAL GAS	34%	54,300	0.5749
MALACAS TG1	GAS TURBINE / NATURAL GAS	NATURAL GAS	21%	54,300	0.9309
MALACAS TG2	GAS TURBINE / NATURAL GAS	NATURAL GAS	22%	54,300	0.8885
MALACAS2 TG4	GAS TURBINE / NATURAL GAS	NATURAL GAS	27%	54,300	0.7240
OQUENDO	COGENERATION / NATURAL GAS	NATURAL GAS	34%	54,300	0.5749
PAITA 1	DIESEL 2 / RESIDUAL	DIESEL 2	34%	72,600	0.7687
PAITA 2	DIESEL 2 / RESIDUAL	DIESEL 2	32%	72,600	0.8168
PISCO TG1	GAS TURBINE / NATURAL GAS	NATURAL GAS	27%	54,300	0.7240
PISCO TG2	GAS TURBINE / NATURAL GAS	NATURAL GAS	27%	54,300	0.7240
PIURA 1	DIESEL 2 / RESIDUAL	DIESEL 2	37%	72,600	0.7064
PIURA 2	DIESEL 2 / RESIDUAL	DIESEL 2	37%	72,600	0.7064
PIURA TG	GAS TURBINE / DIESEL	DIESEL 2	21%	72,600	1.2446
CUMMINS	DIESEL 2 / RESIDUAL	DIESEL 2	38%	72,600	0.6878
SAN NICOLÁS TV1	STEAM TURBINE / RESIDUAL	RESIDUAL 500	28%	75,500	0.9707
SAN NICOLÁS TV2	STEAM TURBINE / RESIDUAL	RESIDUAL 500	29%	75,500	0.9372
SAN NICOLÁS TV3	STEAM TURBINE / RESIDUAL	RESIDUAL 500	30%	75,500	0.9060
SANTA ROSA TG8	GAS TURBINE / NATURAL GAS	NATURAL GAS	35%	54,300	0.5585
SANTA ROSA UTI5	GAS TURBINE / NATURAL GAS	NATURAL GAS	29%	54,300	0.6741
SANTA ROSA UTI6	GAS TURBINE / NATURAL GAS	NATURAL GAS	27%	54,300	0.7240
SANTA ROSA WTG TG7	GAS TURBINE / NATURAL GAS	NATURAL GAS	33%	54,300	0.5924
SULLANA	DIESEL 2 / RESIDUAL	DIESEL 2	34%	72,600	0.7687
TAPARACHI	GAS TURBINE / DIESEL	DIESEL 2	35%	72,600	0.7467
TRUJILLO NORTE	DIESEL 2 / RESIDUAL	DIESEL 2	38%	72,600	0.6878
TUMBES	DIESEL 2 / RESIDUAL	DIESEL 2	43%	72,600	0.6078
VENTANILLA CICLO COMBINADO	COMBINED CYCLE GAS TURBINE	NATURAL GAS	50%	54,300	0.3910
YARINACOA	DIESEL 2 / RESIDUAL	DIESEL 2	39%	72,600	0.6702

(1) Source: COES 2010 Annual statistics report. Chart No 4.7. Thermal Efficiency %



- (2) Source: IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
- (3) The emission factor) of each power is determined using Option A2 for simple OM
- (4) Due to lack of information for this power plant, the default value obtained from Annex 1 of the *Tool to calculate the emission factor of an electricity grid* has been used.

Table A3-1 above includes the emission factor formulas. Actual NECs, as well as data on technology and fuel, were obtained from COES. All this data is publicly available at the COES website in its annual statistics. The specific information source is the chart titled “*Costos Variables de las Centrales Termoeléctricas del SEIN*”, which appeared in the COES Annual Statistics for the year 2010 as chart number 4.7.

Justification of the usage of COES information system data for baseline calculation:

The baseline calculation disregarded the data that is not collected by COES and deemed COES data to be the best approximation of total SEIN data on both generation and installed capacity additions. It was also deemed to be the best data to allow a good monitoring practice because of two reasons:

1. There is no better quality data on generation in the SEIN than what is being presently collected by COES. Information on plants connected to the SEIN but not registered with COES regarding generation and installed capacity additions is provided by the plants’ management periodically to the MINEM. However, this data does not pass through a verification or validation process, nor is it required to comply with technical standards as rigorously as COES requires from the power plants that are its own members.
2. The limitations of MINEM’s final annual reports and data availability would not allow for a good monitoring practice.

Annex 4

MONITORING INFORMATION

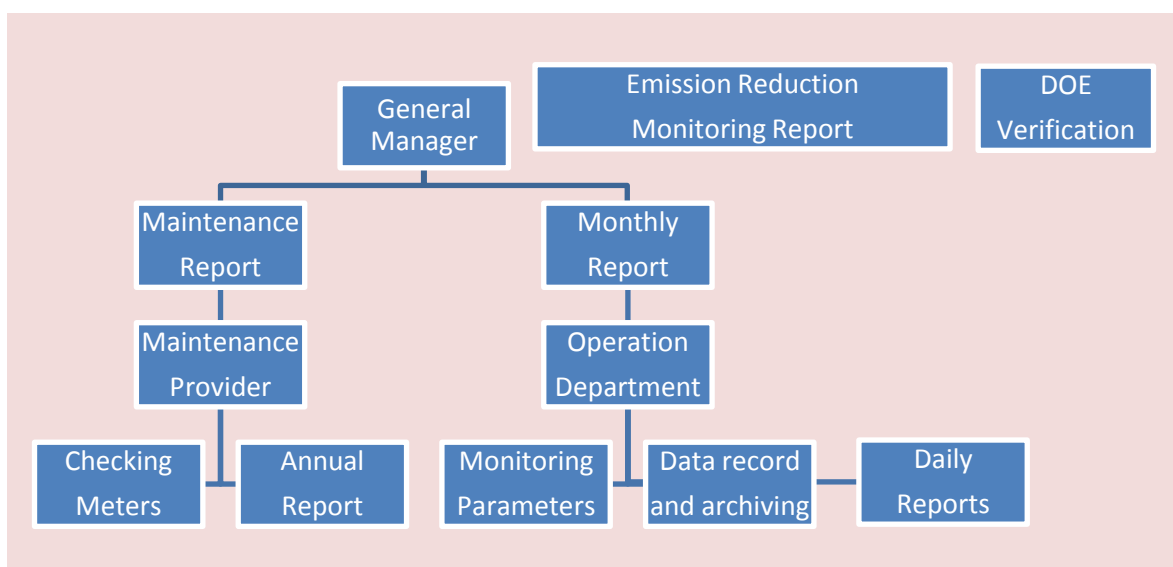
This report presents the Monitoring Plan (MP) for the Project activity. The MP defines a standard against which the performance in terms of the Project's ERs will be monitored, following the selected methodology ACM0002 and in compliance with all relevant requirements of the Kyoto Protocol's CDM. Both the Baseline and the MP are subject to monitoring procedures.

The MP identifies key performance indicators of the Project activity and sets out the procedures for metering, monitoring and calculating the ERs generated by the Project activity annually. Adherence to the instructions in the MP is necessary for the Project operator to successfully measure and track the impact of the Project activity, and to prepare all data required for the periodic audit and verification process that must be undertaken to confirm the attainment of the corresponding ERs.

Organizational:

Figure A4-1 outlines the operational and management structure that the Project proponent will implement to monitor the emission reductions generated by the Project activity. The Project Proponent will define a person responsible for the monitoring of the entire data required.

Figure A4-1 Organization Monitoring



a) The Operations department

The monitoring performance of the Project requires the fulfilment of operational data collection and processing obligations by the Project operator. The Project operator is 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 Operations department will be 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.
 - The quantity of electricity supplied to the SEIN (which will be based on latest available data from an official website).
- Record and store data using a Supervisory Control and Data Acquisition (SCADA) system.
- Control the accurate operation of any meters or equipment needed for monitoring, and preliminarily determine the needs for maintenance or repair work.
- Elaborate the daily monitoring reports of the Project.
- The daily reports will serve as back-up purpose and archived at Project site. All data will be kept at least for 2 years after the end of the last crediting period.
- Consolidate daily reports on a monthly monitoring report and send them to the General Manager.

The amount of energy and power generation of the hydropower plant will be measured and recorded by a SCADA system. The energy and power generation parameters will be checked and monitored in real time in both the power plant and the substation. Energy generation will be registered electronically at the power plant and the substation each 15 minutes of every hour, day and month, and will be kept for two years after the end of the crediting period.

The power plant will have a class 0.2 meter that will work as the main measuring and recording equipment and at least one secondary measuring equipment working as a backup in case of failure of the main equipment. In addition, the substation site will have one class 0.2 meter working as main measuring and recording equipment and at least a class meter working as a backup in case of failure of the main meter.

Both the power plant and the substation meters could be configured to work either in a unidirectional or bi-directional way, but for the Project purposes they will be configured to work in a bidirectional way. To ensure the quality of the parameters and the recording, all the equipments that are going to be used for monitoring and registering will comply with the IEC and ANSI international standards.

In case of failure of the main recording equipments the secondary measuring equipment in the power plant and in the substation will continue the monitoring of the Project parameters. If problems which can affect the quality of data occur, the Operations Department will initiate and supervise the implementation of corrective actions by the Maintenance Provider. First, the monitoring system will be checked on whether it runs properly and whether the monitored results are correct. Second, a spot check of daily/monthly data reported will be undertaken. An internal audit report will be submitted upon completion of the procedure.

The records of the main meters will be cross checked with electricity purchase/sales invoices by comparing the values of the power plant and the substation. The records of the main meters will be cross checked by electricity purchase/sales invoices by comparing the values of the power plant and the substation. The main measure and register meter will be located in the substation, and will quantify the net power and energy delivered to the SEIN. However, there will also be measuring and recording



equipment in the power house, as well as meters for the self consumption of the auxiliary equipment. The records will be cross checked with electricity purchase/sale invoices by comparing the values of the power and auxiliary system consumption with the substation meter records.

b) The Maintenance Provider

Maintenance and calibrations of the measuring equipments will be developed by a specialized firm annually and will follow 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, will be collected by the General Manager and archived for at least 2 years after the last crediting period.

c) General Manager

The General Manager will have final responsibility for all aspects related to data measurements and the monitoring of data recordings. Mainly:

- 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.

Data Collection and Integration:

Grid Emission Factor: It is required that the Project operator calculate the Project's ERs based on the most recent available information. The CO₂ emission factor for the electricity grid will be based on latest available data from the Official COES website.

All data required for calculating the Combined and Build Emission Margins will come from the COES information system.

Project performance parameter: Electricity production by the plant and any internal usage will be metered continuously to account for the net level of electricity dispatched to the SEIN. Procedures for maintenance and installation of equipment, as well as calibration, will be 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).

Data gathering and processing should be done monthly by the operator, as follows:

Table A 4-1 Monthly Data collection

	At the end of each month:
COES (Data Provider)	• Report hourly generation of plants in the SEIN (measurement: 15’). • Report dispatch merit orders, data will come from COES. • Use real NECs per power plant in the SEIN.
Operator (Data Processor)	• Direct measurement. The operator will make a monthly report for the energy and power provided to the grid. • Fill in monthly data in all required spreadsheets. • Issue a monthly report.