PROJECT DESIGN DOCUMENT FORM
FOR CDM PROJECT ACTIVITIES (F-CDM-PDD)
Version 04.0

PROJECT DESIGN DOCUMENT (PDD)

Title of the project activity	Potrero Hydropower Plant, Peru
Version number of the PDD	01
Completion date of the PDD	04/05/2012
Project participant(s)	Empresa Eléctrica Agua Azul
Host Party(ies)	Peru
Sectoral scope and selected methodology(ies)	Sectoral Scope 1: Energy Industry Methodology: ACM0002: Consolidated baseline methodology for grid-connected electricity generation from renewable sources, version 12.3.0
Estimated amount of annual average GHG emission reductions	88,266

SECTION A. Description of project activity
A.1. Purpose and general description of project activity

The Project "Potrero Hydropower Plant, Peru" (hereafter referred to as the "Project") is a run of river hydroelectric power plant located in the Province of San Marcos, Region of Cajamarca, in Peru (Host Country), and it is to be implemented by the company named "Empresa Electrica Agua Azul". The total installed capacity of the Project will be of 19.9 MW, with an expected net electricity generation of 138,778 MWh per year.

The Project aims to generate renewable electricity by using water from the Crisnejas River, who receives its water from two main river basins, Cajamarca River basin (111.9 km of length) and Condebamba River basin (92.7 of length). This energy will be supplied to the National Interconnected Electricity Grid (SEIN). The reduction of baseline emissions results from the displacement of electricity generated by power plants within the SEIN, which include fossil/fuel power plants emitting CO_2. The spatial extent of the Project boundary is the SEIN.

The project considers the construction of a substation located in the left margin of Crisnejas River, called Potrero substation (less than 200 meters away from Power House). The project will implement 2 horizontal Francis turbines for a nominal water flow of 8.74 m^3/s. A transmission line of 60 kV and 5 kms length will be installed between the Potrero substation and the Aguas Calientes substation[1].

The Project is expected to start construction in 02/01/2013 and commercial operations in 31/12/2015[2]. The Project is expected to avoid the emission of 88,226 tons of carbon dioxide equivalent (tCO_2e) per year, which will amount to 617,859 tCO_2e for the first crediting period of 7 years, generating the equivalent amount of greenhouse gas (GHG) emission reductions (ERs). The 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 CERs.

The Project will have an expected minimum operating lifetime of 50 years. 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:

a) Creating a source of renewable energy in a sustainable way.
b) Employing local labour in the construction phase and later in the operation of the plant.
c) Expanding the national electricity grid's capability.
d) Increasing the commercial activity of the community due to the fact that the construction and operation activities in the area will require services such as food, transportation, among others.
e) Helping Peru improve its hydrocarbon trade balance by reducing the consumption of oil derivates for electricity generation.
f) Helping the SEIN keep thermal power plants shut down and/or on stand-by for power generation, thus displacing expensive generation fired by heavy fuel, diesel, coal and natural gas, while reducing GHG emissions.
g) Contributing to local and national fiscal accounts through the payment of taxes.
h) Committing to a social agenda as described in detail in section G of this document.
i) Improving the infrastructure in and around the Project area due the Project activities.

[1] Kiev Asociados SAC (2012) Pre-Operative Studio Volume I (Page 8)
[2] Kiev Asociados SAC (2012) Pre-Operative Studio Volume II (Page 7)

A.2. Location of project activity
A.2.1. Host Party(ies)

Peru

A.2.2. Region/State/Province etc.

Region of Cajamarca / Province of San Marcos

A.2.3. City/Town/Community etc.

District of Eduardo Villanueva

A.2.4. Physical/Geographical location

The Project will be located in the north of Peru, in the district of Eduardo Villanueva, Province of San Marcos, Region of Cajamarca. The hydroelectric power plant's intake will be located in the town Aguas Calientes, at approximately 1,950 m.a.s.l., while the discharge will be located in the place called Potrero, at approximately 1,625 m.a.s.l.[3]

The intake structure will be developed in the Crisnejas River. The Project is located at the following geographical coordinates:

Table 1: Project coordinates[4]

Item	Expected Location	Expected Location (equivalent geographical coordinates)	Altitude
Water intake(1)	UTM WGS84 9 174 661 North 822 399 East	Longitude : - 66.0793 Latitude : -7.4570	1,950 m.a.s.l.
Water discharge(1)	UTM WGS84 9 174 299 North 825 835 East	Longitude:- -66.0482 Latitude : -7.4600	1,625 m.a.s.l.
Power house(2)	UTM PSAD 56 9 174 283 North 824 238 East	Longitude: -66.0632 Latitude : -7.4598	1,810 m.a.s.l.
Substation (2)Potrero	UTM PSAD 56 9 174 342 North 824 183 East	Longitude: -66.0627 Latitude : -7.4603	1,825 m.a.s.l.
Substation (2)Aguas Calientes	UTM PSAD 56 9 175 235 North 819 689 East	Longitude: -66.1039 Latitude : -7.4520	2,000 m.a.s.l.

(1) Hydrological study approval (Resolution No. 0302-2011-ANA-AAA-VI MARAÑON

(2) (Kiev Asociados SAC, 2012) Pre-Operative Studio Volume I (page 4)

[3] Hydrological study approval (Resolution No. 0302-2011-ANA-AAA-VI MARAÑON dated 29/12/2011 and pre-operative study (2012).

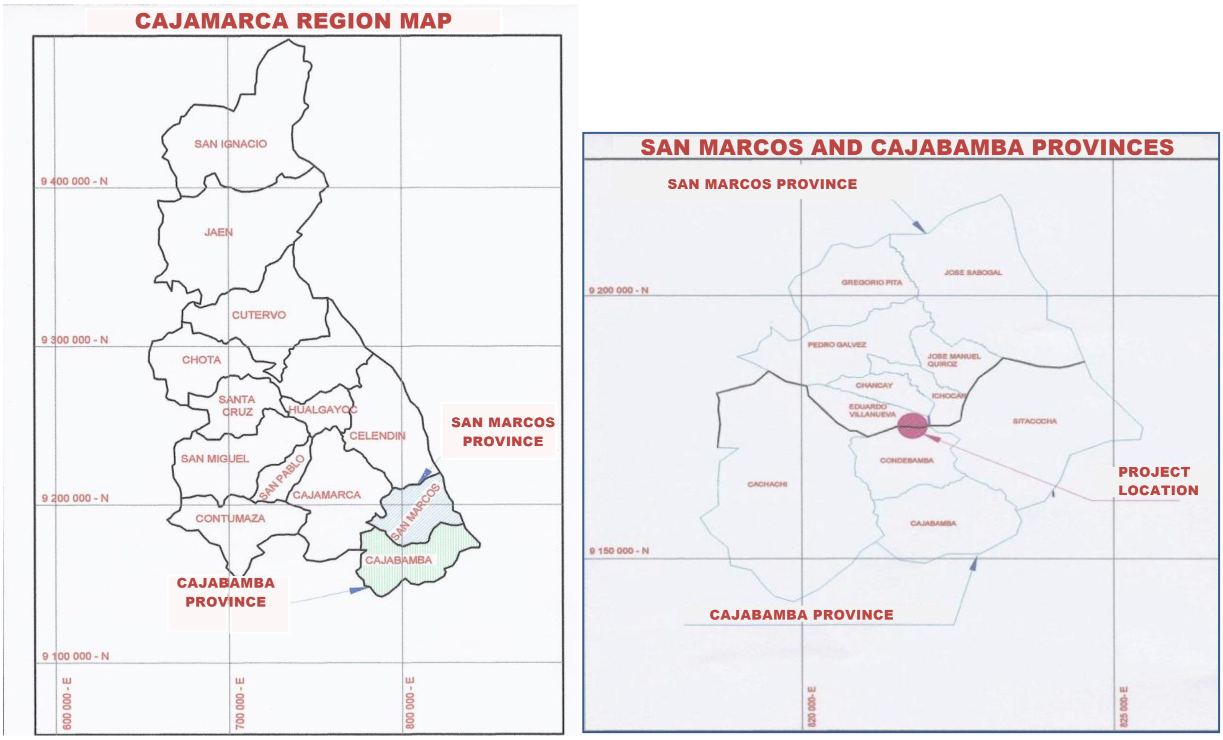
[4] The coordinates are approximations before construction and could be subject to move due to the uncertainty associated with the geological foundations variations will be non-significant). The pre-operative study of the project contains the coordinates of the power house and substations (Kiev Asociados, 2012), and the hydrological study approval has the coordinates of the water intake and devolution (Resolution No. 0302-2011-ANA-AAA-VI MARAÑON dated 29/12/2011).

The location of the Project can be seen in the following figures.

Figure 1: Project macro- location in Peru

Source: Project Developer

Figure 2: Project regional and micro location in Cajamarca



Source: Project developer.

A.3. Technologies and/or measures

The Project will be a run-of-the-river hydropower technology that utilizes the water flow of the Crisnejas River to generate electricity. The water is directly diverted from this river, going through a head-race channel (900 meters length) to a tunnel (800 meters length), and then, directing water into the Load Chamber to guarantee hydraulic charge, avoiding air from causing cavitation and efficiency loss. Finally, water will be fed through the penstock into 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[5].

The Project will have a design flow of 18 m^3/s diverted from Crisnejas river, and a net head of 130 m. There will be 2 turbines with a nominal capacity of 9.95 MW each[6], that totalizes a 19.99 MW capacity of Potrero Hydropower plant. The net electricity production will be of 138,778 MWh/year and will be injected into the Interconnected National Electric Grid (SEIN) through a 5 km transmission line of 60 KV (Potrero – Aguas Calientes). Aguas Calientes substation connects the Project to the SEIN: Cajamarca – San Marcos – Cajabamba[7].

The head race channel, the tunnel, load chamber and all civil works and electromechanical equipment, will be located at the left margin of the river. The Project will employ two new horizontal Francis turbines, with a nominal speed of 514 rpm[8].

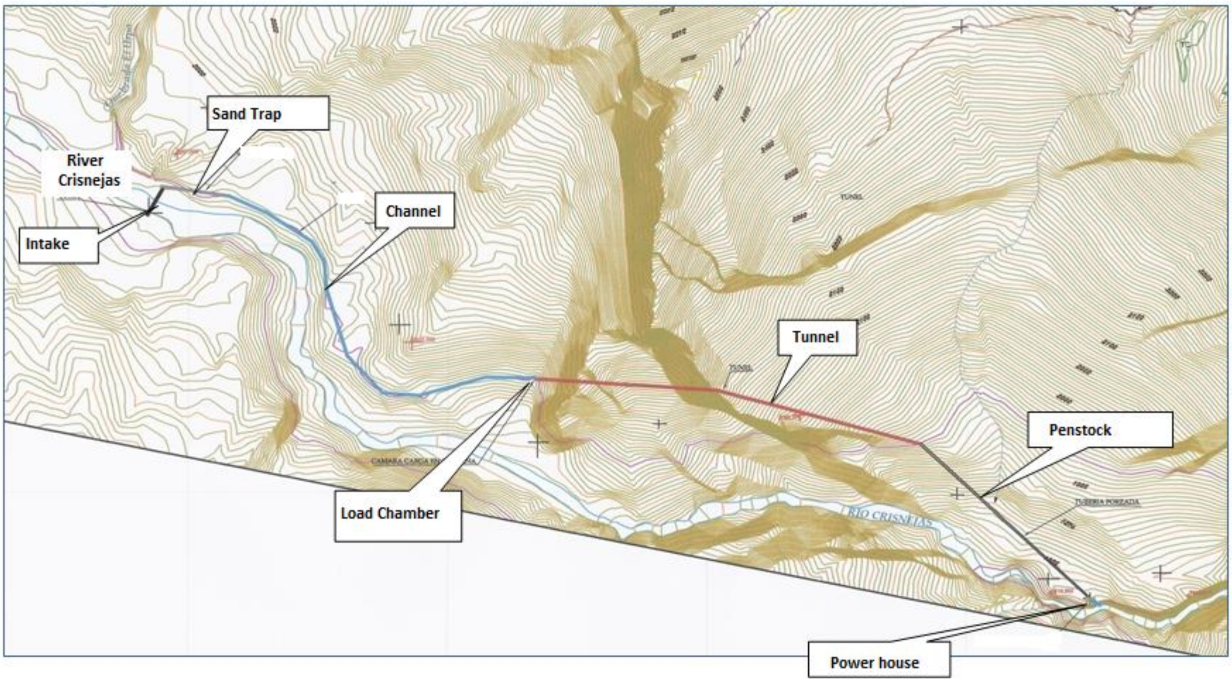
[5] Kiev Asociados SAC (2012) Pre-Operative Studio Volume II (page 11)
[6] Kiev Asociados SAC (2012) Pre-Operative Studio Volume II (page 12)
[7] Kiev Asociados (2012). Volume II. Project Pre-operative report, (page 6).
[8] Kiev Asociados (2012). Volume II. Project Pre-operative report, (page 11).

Table 2: Technology characteristics

Characteristic	Value	Unit
Installed Capacity(1)	19.9	MW
Head-race Channel(2)	900	m
Water Tunnel(2)	800	m
Penstock(2)	470	m
Turbine Type(1)	Francis horizontal axis	1
Turbine Rated Net Head(3)	130	m
Expected Net Energy Generation(X)	138,778	MWh

(1): (Empresa Eléctrica Agua Azul, 2011) Project Profile: Potrero Hydropower Plant.
(2) (Kiev Asociados SAC, 2012) Pre-Operative Studio
(3): (Kiev Asociados SAC, 2012) Pre-Operative Studio Volume II

Figure 3. Detailed project map



Source: Project developer.

A.4. Parties and project participants

Party involved (host) indicates a host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of Peru (host)	Empresa Eléctrica Agua Azul	No

A.5. Public funding of project activity

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

SECTION B. Application of selected approved baseline and monitoring methodology
B.1. Reference of methodology

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

Version 02.2.1 of the *Tool to calculate the emission factor for an electricity system* (EB 63/Annex 19).[9]

Version 06.0.0 of the *Tool for demonstration and assessment of additionality* (EB 65/Annex 21).[10]

B.2. Applicability of methodology

The Project satisfies the applicable conditions of ACM0002 (version 12.3.0) 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

Applicability conditions	Fulfillment of conditions
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 run of river hydropower plant.
In the case of capacity additions, retrofits or replacements (except for capacity addition projects for which the electricity generation of the existing power plant(s) or unit(s) is not affected): 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 addition 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 case of hydro power plants: • At least one of the following conditions must apply: o The project activity is implemented in an existing single or multiple reservoirs, with no change in the volume of any of the reservoirs; or o The project activity is implemented in an existing single or multiple reservoirs, where the volume of any of reservoirs is increased and the power density of each reservoir, as per the definitions given in the Project Emissions section, is greater than 4 W/m^2 after the	There is no reservoir or regulating tank in the Project, nor is constructed in an existing reservoir.

9 http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.2.1.pdf/history_view- Web link last accessed on 12/03/2012.

10 http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v6.0.0.pdf/history_view- Web link last accessed on 12/03/2012.

implementation of the project activity; or o The project activity results in new single or multiple reservoirs and the power density of each reservoir, as per the definitions given in the Project Emissions section, is greater than 4 W/m^2 after the implementation of the project activity. In case of hydro power plants using multiple reservoirs where the power density of any of the reservoirs is lower than 4 W/m^2 after the implementation of the project activity all of the following conditions must apply: • The power density calculated for the entire project activity using equation 5 is greater than 4 W/m^2; • All reservoirs and hydro power plants are located at the same river and were designed together to function as an integrated project[11] that collectively constitutes the generation capacity of the combined power plant; • The water flow between the multiple reservoirs is not used by any other hydropower unit which is not a part of the project activity; • The total installed capacity of the power units, which are driven using water from the reservoirs with a power density lower than 4 W/m^2, is lower than 15 MW; The total installed capacity of the power units, which are driven using water from reservoirs with a power density lower than 4 W/m^2, is less than 10% of the total installed capacity of the project activity from multiple reservoirs.	
The methodology is not applicable to the following: o 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; o Biomass fired power plants; o 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/m^2.	o Not applicable. o Not applicable. o Not applicable.
In the case of retrofits, replacements, or capacity additions, this methodology is only applicable if the most plausible baseline scenario, as a result of the identification of baseline scenario, is "the continuation of the current situation, i.e. to use the power generation equipment that	o Not applicable.

[11] This requirement can be demonstrated, for example, (i) by the fact that water flow from upstream power units spilling directly to the downstream reservoir, or (ii) through the analysis of the water balance. Water balance is the mass balance of water fed to power units, with all possible combinations of multiple reservoirs and without the construction of reservoirs. The purpose of such water balance is to demonstrate the requirement of specific combination of multiple reservoirs constructed under CDM project activity for the optimization of power output. This demonstration has to be carried out in the specific scenario of water availability in different seasons to optimize the water flow at the inlet of power units. Therefore this water balance will take into account seasonal flows from river, tributaries (if any), and rainfall for minimum three years prior to implementation of CDM project activity.

was already in use prior to the implementation of the project activity and undertaking business as usual maintenance".	

B.3. Project boundary

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	The Power Grid electricity production from the host country	CO_2	Included	According ACM0002, only CO_2 emissions from electricity generation should be accounted.
		CH_4	Excluded	Minor emission source according to ACM0002.
		N_2O	Included	According ACM0002, only CO_2 emissions from electricity generation should be accounted.
Project scenario	Project Activity	CO_2	Excluded	Minor emission source according to ACM0002.
		CH_4	Excluded	Minor emission source according to ACM0002.
		N_2O	Excluded	Minor emission source according to ACM0002.

According to methodology, the project boundary encompasses the Project power plant and all power plants connected physically 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 hydroelectric power plant. Since the Project is connected to the national grid, this will be included in the project boundary.

Figure 4: Project boundary

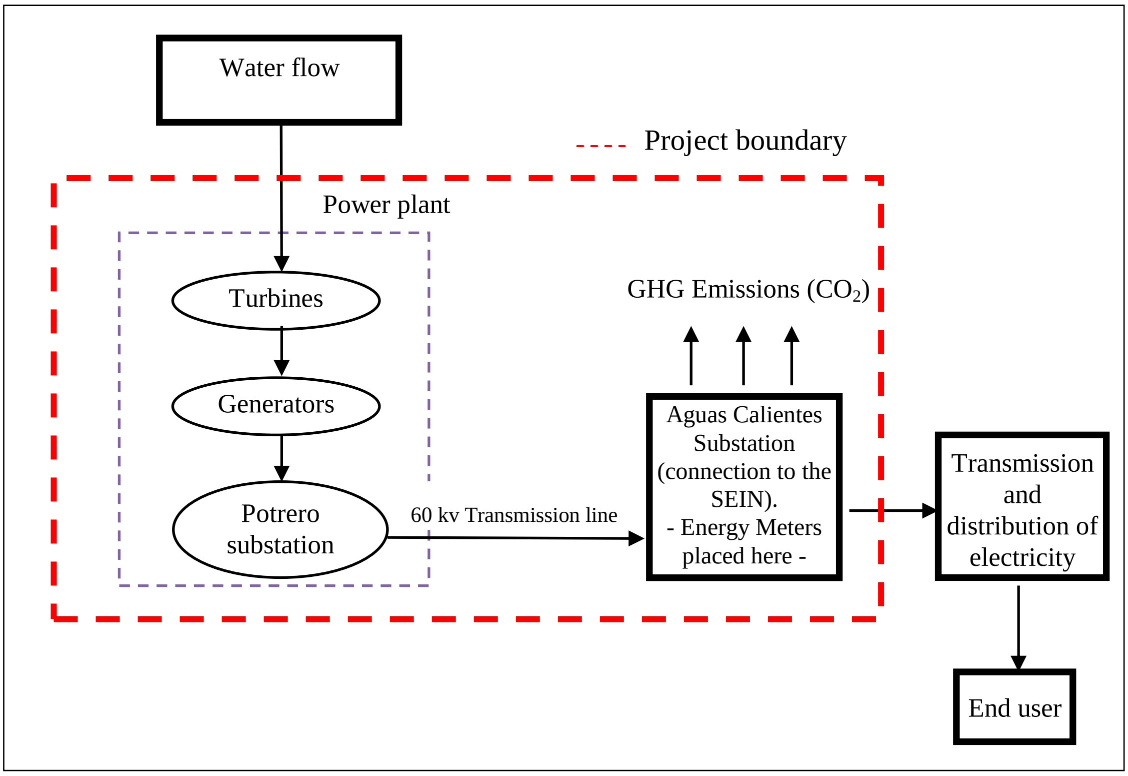
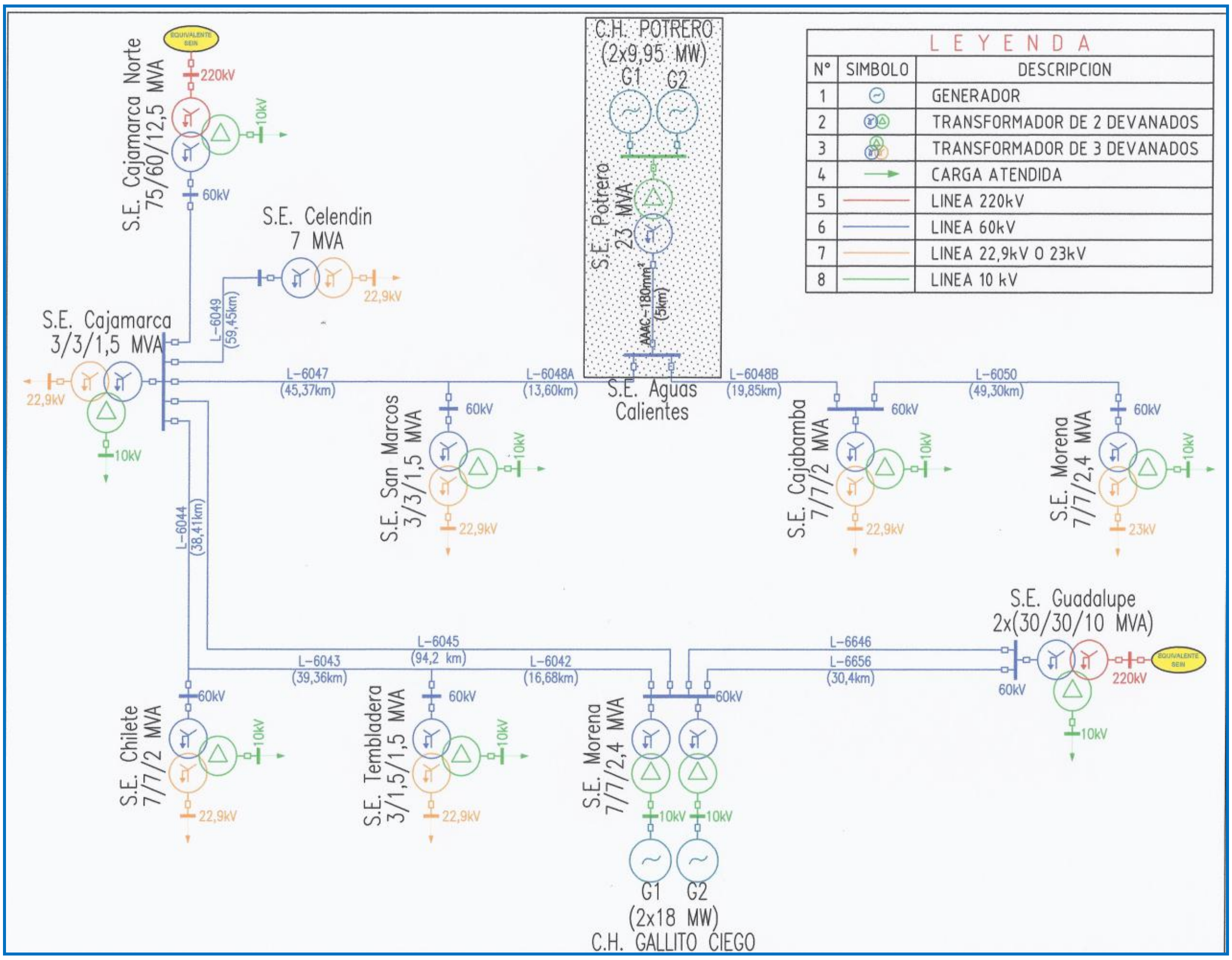


Figure 5: Project flowchart



Source: Preoperative report. Kiev Asociados (2012)

The greenhouse gases and emission sources included in or excluded from the project boundary are shown in the table below.

B.4. Establishment and description of 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 the 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. Demonstration of additionality

Demonstration of prior consideration of the CDM:

According to the Guidelines on the Demonstration and Assessment of Prior Consideration of the CDM (version 03), now part of the Clean Development Mechanism Project Cycle Procedure (Version 01.0)[12] 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 03/02/2012 and received on 18/02/2012[13].

The real and continued actions taken to secure CDM status of the Project can be demonstrated by the elements presented in the following table. The milestones demonstrate that CDM income was the key factor that allowed the Project to obtain its needed investment, as the investor's (Empresa Eléctrica Agua Azul) interest is the acquisition of the emission reduction certificates (CERs) that the Project should generate.

Table 4: Actions towards CDM status of the Project

Date	Key Event	Comment
29/12/2011	Hydrological study approval	Approved by the National Water Authority (ANA). This document is needed in order to have the definitive concession.
03/02/2012	Prior Consideration of the CDM.	Empresa Eléctrica Agua Azul sent the filled form of the Potrero Hydropower Plant to the UNFCCC and Peruvian DNA (MINAM).
18/02/2012	Prior Consideration of the CDM.	The UNFCCC published the Project's Prior Consideration of the CDM on the UNFCCC website.
14/03/2012	Local Stakeholder Consultation.	The local stakeholder consultation meetings, undertaken by the Project Developer and the National Environmental Fund (FONAM) were initiated and held on 14/03/2012, in Province of San Marcos.
14/02/2012	Contract with ÉcoRessources	A contract was signed between Empresa Eléctrica Agua Azul and ÉcoRessources for the development of the CDM documentation.

12 http://cdm.unfccc.int/filestorage/5/0/V/50V3N2XFTR48PDJKZECMLYQOU1I7SA/eb65_repan32.pdf?t=d1R8bTBzbGNufDCAdjecY7t0UxFXD_v5lnKp- Web link last accessed on 12/03/2012.

13 According to UNFCCC Prior Consideration Search http://cdm.unfccc.int/Projects/PriorCDM/notifications/index_html

31/05/2012	Request for Definitive Concession Submitted to Minister of Energy and Mines	The request for the Project's definitive concession is expected to be submitted to the Ministry of Energy and Mines.
05/06/2012	Documents submitted for the National Approval Process at the Peruvian DNA.	This kick-starts the process for the Peruvian Letter of Approval.
Fourth Trimester of 2012 or First Trimester of 2013	Construction contracts	The project aims to start construction on April 2013 and then the project starting date will be the one of the construction or equipment acquisition contracts.
First Trimester of 2013	Signature of PPA with the Peruvian government.	A power purchase agreement (PPA) is expected to be signed with the government in December 2012 or the first months of 2013, as it depends on the date of a Public Tender. **Date might change** PPA aims to ensure the sale of 138,778 MWh per year for a period of 20 years, at a fixed price. As the signature of this agreement will demand a money guarantee and a capitalization of the company, this will constitutes the starting date of the project activity if is before the construction or equipment acquisition contracts.
02/01/2013	Start of Construction	- This dates are defined in the Pre-Operative Studio of the project
31/12/2016	Start of power plant operation	

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 income.

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.[14] 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 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 the conservation of environmental quality and cultural heritage. The developer of such activities should inform the MINEM of the project activity and its technical characteristics.

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 alternative scenarios are plausible.

<u>Step 2: Investment analysis</u>

The objective of this section is to evaluate the financial attractiveness of the Project without CDM income.

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 by the Project developer, a benchmark analysis is appropriate.

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

The financial indicator that will be used is the Project's post-tax internal rate of return (IRR). The Project IRR is compared to an established benchmark, which is a post-tax discount rate of 12% that has been selected as a benchmark to evaluate the economic viability of an investment in the electricity sector in

[14] - Web link last accessed on 12/03/2012.

Peru. This 12% discount rate is established by the government in the Electric Concessions 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.[15]

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:

Table 5: Main parameters for the calculation of financial indicators

Parameters	Unit	Value	Data Source
Electricity Price – Peak Hours	USD per kWh	0.037469	OSINERGMIN Resolution Nº 067-2011-OS/CD. Fixed prices applicable for the period between 01/05/2011 and 30/04/2012.[16]
Electricity Price – Off-Peak Hours	USD per kWh	0.035865	OSINERGMIN Resolution Nº 067-2011-OS/CD. Fixed prices applicable for the period between 01/05/2011 and 30/04/2012.
Guaranteed Power Capacity Tariff	USD per kW per month	6.028520	OSINERGMIN Resolution Nº 067-2011-OS/CD. Fixed prices applicable for the period between 01/05/2011 and 30/04/2012.
Generation Capacity	MW	19.90	(Empresa Eléctrica Agua Azul, 2011) Project Profile: Potrero Hydropower Plant.
Load Factor	%	81.4535	(Empresa Eléctrica Agua Azul, 2011) Project Profile: Potrero Hydropower Plant.
Transmission Losses	%	2.264%	Project developer internal calculations.
Initial Investment: Civil Works	USD Mio.	27.75	Empresa Eléctrica Agua Azul, Potrero Hidropower Plant Budget
Initial Investment: Machinery & Equipment	USD Mio.	11.04	Empresa Eléctrica Agua Azul, Potrero Hidropower Plant Budget
Pre-Investment Costs	USD Mio.	0.8878	Empresa Eléctrica Agua Azul, Pre-Investment Costs Table
Investment related Taxes (IGV)	% of investment (Civil works + Machinery)	18%	Empresa Eléctrica Agua Azul, Potrero Hidropower Plant Budget

[15] 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 12/03/2012.

[16] http://www2.osinerg.gob.pe/Resoluciones/pdf/2011/OSINERGMIN%20No.067-2011-OS-CD.pdf – Web link last accessed on 12/03/2012.

Operation & Maintenance Costs	USD Mio. per year	0.28	Operative Experience of ALUZ with Hydropower projects: CH Langui and Empresa Eléctrica Valle Hermoso
Insurance Costs	% of investment	1 %	Based on Developer Experience with Pizarras Hydropower Plant.
Administrative Expenses	USD Mio. per year	0.528	Operative Experience of ALUZ with Hydropower projects: CH Langui and Empresa Eléctrica Valle Hermoso
Overhauling Costs	USD Mio. per year every 5 years	0.107	Project developer internal calculations based on other hydropower projects in Peru.
Contribution to OSINERG	% of income per year	1.00	Executive Order No. 136-2002-PCM, dated 24/12/2002.[17]
Water Tariff	% of electricity tariff per year	1.00	Law 25844 – Rulebook for the Electric Concessions Law. Article 214, Page 92.[18]
Contribution to COES	% of income per year	0.75	COES (Committee of Economic Operation of the System) Administrative Procedure 8A.[19]
Depreciation – Civil Works	% per year	3	Rulebook for the Income Tax Law, Chapter VI, Article 22: Sets the standard depreciation rates per category.[20]
Depreciation – Machinery & Equipment	% per year	10	Rulebook for the Income Tax Law, Chapter VI, Article 22: Sets the standard depreciation rates per category.[21]
Income Tax	% per year	30	Income Tax Law, Chapter VII, Article 55.[22]
Distribution of Income to Workers	% per year	5	Law 892, Article 2.[23]
Discount Rate	%	12	Law 25844 – Electric Concessions Law, Article 79, Page 40.[24]
Exchange Rate	S/. per USD	2.805	OSINERGMIN Resolution Nº 067-2011-OS/CD. Fixed prices applicable for the period between 01/05/2011 and 30/04/2012.
CER Price	EUR	8.49	Price based on midpoint of Highest Price and Lowest Price of last 52 weeks' range [25]
Emission Factor	tCO_2e /MWh	0.63602	Calculated in accordance to the CDM rules, with latest available data.

[17] http://www.osinerg.gob.pe/newweb/uploads/JARU/CD/008fiscalizacion/ds136-2002-pcm.pdf – Web link last accessed on 12/03/2012.
[18] http://www2.osinerg.gob.pe/MarcoLegal/pdf/REGLACE.pdf - Web link last accessed on 12/03/2012.
[19] http://www.coes.org.pe/dataweb2/2008/DO/PROCEDIMIENTOS/Proced_admin_8a.pdf - Web link last accessed on 12/03/2012.
[20] http://www.sunat.gob.pe/legislacion/renta/reglamento.html# - Web link last accessed on 12/03/2012.
[21] http://www.sunat.gob.pe/legislacion/renta/reglamento.html# - Web link last accessed on 12/03/2012.
[22] http://www.sunat.gob.pe/legislacion/renta/ley/capvii.htm - Web link last accessed on 12/03/2012.
[23] http://www.mintra.gob.pe/contenidos/archivos/prodlab/D.%20Leg.%20892%2011-11-96.pdf - Web link last accessed on 12/03/2012.
[24] http://www2.osinerg.gob.pe/MarcoLegal/pdf/LEYCE-DL25844.pdf - Web link last accessed on 12/03/2012.
[25] According to information found in: http://www.bloomberg.com/quote/BNSCER:IND/chart

Technical Lifetime of Project	Years	50	(Empresa Eléctrica Agua Azul, 2011) Project Profile: Potrero Hydropower Plant.

A comparison of the IRR for the proposed Project activity and the financial benchmark IRR (12%), with and without CDM revenues, is shown below. Without CDM revenues, the IRR of the total Project investment is 7.53%, which is 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 to 9.96%. 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 importance of CDM benefits to achieve more profitable margins that help to overcome the barriers presented in this document.

Table 6: Comparison of financial indicator with and without CER revenue

Item	Unit	Without CER revenue	Benchmark	With CER revenue
IRR	%	7.53	12.00	9.96

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. Running costs
5.

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 7: 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	Running Costs
+54.8%	+64.2%	-32.6%	-225%

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

- Energy sales are not expected to increase due to variations in the price of energy, as they are dependent on the spot price and if applicable, an special Peruvian renewable energy PPA price in the future[26]. The spot price is established by the regulator OSINERGMIN, who calculates it 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 price[27] 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.[28]
  If a PPA is signed, it is important to mention that PPA prices for renewable energy projects are mainly fixed, and then are not expected to undergo major variation during the 20 years of the contract due to the fact that this price will only change if a factor based on the US PPI Index WPSSOP3500 (Finished Goods Less Food and Energy) increases or decreases in more than 5% with respect to the previous year's factor, as established in the PPA Contract. However, an analysis of the behavior of the index for the past 20 years shows that there was never a fluctuation of the calculated factor that surpassed the ±5%.[29]

- Energy sales are not expected to increase due to an increase in the generation capacity (load factor) due to the fact that this is already established at 81.5%, therefore only being able to increase is a very limited amount. Furthermore, the transmission losses were calculated conservatively at 2,3%.

- The initial investment is not expected to decrease as the figures are conservative, and furthermore prices have tended to increase during the last decade, not decrease.[30] Up to the moment when the final contracts will be signed, increases in the final values are a probable scenario. 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.[31]

  Additionally, during their initial construction period, hydroelectric projects are subject to archaeological inspections by the National Institute of Culture (INC) in order to obtain the Certificate of Inexistence of Archaeological Remains (CIRA). Costs are also increased by the time delays, as the INC has no fixed period in which it must undertake its decision, therefore any remains found imply a high possibility of delays either because it is necessary to remove those remains or because the construction works need to be relocated.[32]

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[26] Renewable energy tenders in Peru are organized by OSINERG and do not have dates set for the future (are developed according the market evolution). Since the maximum tariff is not known by the project developer, there is high uncertainty of not winning it. At the moment of the PDD submission there have been 2 renewable energy tenders in Peru and the third one has not been officially approved.

[27] "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*, page 19.

[28] "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*, page 49. It must be noted that reference to small hydro projects is intended for those that have a capacity smaller than 20MW.

[29] http://data.bls.gov/timeseries/WPSSOP3500?include_graphs=false&output_type=column&years_option=all_years – Web link last accessed on 12/03/2012.

[30] The wholesale general price index, which shows the variation in the prices of intermediate demand goods, final consumer goods and capital goods, increased by 35% in the ten-year period from September 2001 to September 2011, 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 10/10/2011.

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

[32] Osinergmin (2008). *Analysis of entrance barriers for investments in hydropower plants*, p.80.

- The running costs cannot decrease in levels superior to 100% due to the fact that the Project developer has already experience in operative projects, and as mentioned prices have tended to increase during the last decade, not decrease.

Therefore, it can be concluded that the Project alone (scenario 1 – the proposed Project activity undertaken without CDM revenues) is not sufficiently attractive for private investors, therefore this scenario is not considered the most probable baseline scenario.

Step 3: Barrier analysis

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

- **Investment barriers**

The project owner, Empresa Eléctrica Agua Azul, must secure the necessary investment in order to undertake the Project. However, due to the Project's nature (small hydropower, which in Peru is set as projects with a generation capacity lower than 20 MW) and its financial unattractiveness, the Project has limited access to the national financial market. Access to long-term financing for small hydropower projects is considered highly difficult for companies without strong balance sheets, as there is a limited interest of commercial banks in financing small-scale projects due to extremely strict risk assessments and high transaction costs.[33]

The Project's nature (small hydropower) faces a high risk premium in the eyes of traditional investors, who are barely interested in hydro generation investment possibilities.[34] Local banks consider this type of project as High Risk because of the associated conditions that they accrue to all hydropower projects (i.e. construction risks, water availability risk), and also because their financing conditions increase project development costs.[35]

Furthermore, banks in average impose both high interest rates for their credit and restrictive conditions in terms of financial performance[36] and management. For example, they limit their loans to short maturity terms that imply high annually payments,[37] require high guarantees and charge considerable transaction costs as corporate finance departments have limited staff focused on larger transactions, not in smaller

[33] ESMAP (2011), *Peru Opportunities and Challenges for Small Hydropower Development,* p. xv.

[34] "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.

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

[36] "Project financing is generally difficult to obtain and the debt-to-equity rations 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.

[37] "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.

projects in remote areas with difficulties for the due diligence.[38]

The Project's nature (hydropower) also faces a disadvantage when compared to the 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 depends on its contribution to the peak power demand (capacity). Firm capacity of both thermal and hydroelectric units is defined under the Electric Concessions Law[39] as the 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 when compared to a thermal plant, as the firm capacity of the hydropower unit will always be lower than thermal units. Therefore, hydroelectric units tend to be less profitable considering projects of similar size and conditions.[40] 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.

In this scenario, CDM incentives plays a key role to close Project Financing, as it increases the financial indicators of the project and guarantees an additional revenue during project operations.

Table 8: Capital cost for power generation technologies (USD/kW)

Capital cost per technology		
Technology	**Size-Range (MW)**	**Investment Cost (USD/kW)**
Gasoline/Diesel Power System[(1)]	5.0	600
Combustion Turbine[(1)]	150.0	490
Combined Cycle Turbine[(1)]	300.0	650
Potrero Hydropower Plant[(2)]	**19.99**	**2,075.9**

(1) The World Bank. (2006). "Technical and Economic Assessment: Off Grid, Mini-Grid, and Grid Electrification Technologies Summary Report".
(2) Empresa Eléctrica Agua Azul, Potrero Hidropower Plant Budget

The existence of investment barriers can be demonstrated by the fact that the original project developer could only undertake the Project with the inclusion of CDM incentives.

- **Technological barriers**

With respect to the technical and technological issues that surround hydropower investment and credit, even though there is adequate technical capacity in Peru to build and operate small hydroelectric power plants, the technology faces some technical challenges and performance risks related to water resource availability. This important factor is related to hydrological regimen, geological conditions, and possible design failures that can only be fully known *ex-post*. In terms of technology, hydropower plants are much more challenging investments than fossil fuel-fired plants.

[38] 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.
[39] http://www2.osinerg.gob.pe/MarcoLegal/pdf/LEYCE-DL25844.pdf - Web link last accessed on 10/10/2011.
[40] 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 10/10/2011.

Moreover, fossil fuel-fired plants can also be built as close as necessary to the end-user, reducing considerably the transmission line investments.[41] In the case of the project activity, Potrero Hydropower Plant, it can only be constructed on the selected site, considering the water availability and other geographical conditions. Therefore, the project will only be possible with the development of a new transmission line.

These technological barriers and involved additional costs, are indirectly mitigated by the Project's CDM income.

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 based on other technology, most probably fossil fuel-fired thermal plant, as these have been the business-as-usual scenario for energy generation in Peru since the promotion of natural gas energy plants.

The two-part regulation system for generation (capacity and energy) and the requirements of hydroelectric plants to build longer transmission networks has influenced the development of thermal units instead of hydro plants.[42] Fossil fuel-fired thermal plants have lower up-front investment costs and higher financial viability. As there are limited financing options, investors prefer a well-known technology based on natural gas, avoiding excessive risks in hydropower projects.

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

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 9.95 MW and 29.85 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.[43]

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.

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[41] ESMAP (2011). *Peru Opportunities and Challenges for Small Hydropower Development*, p. 51.
[42] ESMAP (2011). *Peru Opportunities and Challenges for Small Hydropower Development*, p. 51.
[43] Website: http://www.coes.org.pe/.

Table 9: Operative power plants in the SEIN

Power Plant	Technology	Energy source/fuel	Installed Capacity (MW)	CDM Status
Paramonga	**TV**	**Bagasse**	**23.0**	**-**
Pías	Francis	Hydro	6.3	Registered
Platanal	Pelton	Hydro	220.0	Registered
Chimay	Francis	Hydro	142.8	-
Yanango	Francis	Hydro	42.3	-
Huanchor	**Francis**	**Hydro**	**18.4**	**-**
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	-
Charcani IV	**Francis**	**Hydro**	**15.5**	**-**
Charcani V	Pelton	Hydro	145.4	-
Charcani VI	Francis	Hydro	9.0	-
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
Chiclayo Oeste	**Diesel**	**Residual 6**	**26.7**	**-**
Chimbote	**Tg**	**Diesel 2**	**21.0**	**-**
Las Flores	Tg	Natural Gas	192.5	-
Piura	Diesel - Tg	Residual 6 - Diesel 2	34.7	-
Aricota I	**Pelton**	**Hydro**	**23.8**	**-**
Aricota II	**Pelton**	**Hydro**	**11.9**	**-**
Independencia	**TG**	**Natural Gas**	**22.9**	**-**
Mantaro	Pelton	Hydro	798.0	-
Restitucion	Pelton	Hydro	210.4	-
Emergencia Trujillo	Diesel	Diesel 2	64.0	-
Tumbes	**Diesel**	**Residual 6**	**18.7**	**-**
Yuncan	Pelton	Hydro	130.1	At validation
Chilca	TG	Natural Gas	559.8	-
Ilo1	Diesel	Diesel 2	238.6	-
Ilo2	TV	Carbón	135.0	-
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	-
Oroya	Pelton	Hydro	9.0	-
Pachachaca	Pelton	Hydro	9.0	-
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, $\mathbf{N}_{all}$ = is 9.

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 $\mathbf{N}_{diff}$.

As can be seen in table 9:

- Power plants Paramonga (bagasse), Chiclayo Oeste 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 Egasa[44], which is a public company created in 1994 under private law and is part of the FONAFE Corporation. 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)[45]. 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 company Empresa Electrica Agua Azul which is entirely private.

[44] http://www.egasa.com.pe. Web link last accessed on 12/03/2012

[45] http://www.mef.gob.pe/index.php?option=com_content&view=article&id=306&Itemid=100883. - Web link last accessed on 12/03/2012

- 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 Egesur[46] that is also part of FONAFE. In addition both projects operate with Pelton turbines while the proposed project will use Francis turbines.

Considering the previous paragraphs, 8 projects identified in Step 2 apply a different technology as per the Additionallity Tool, then $\mathbf{N_{diff}}$= is 12**.**

Step 4: Calculate factor F=1-$\mathbf{N_{diff}/N_{all}}$ 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) $F = 1 - N_{diff} / N_{all} = 1- 8/9 = 0.11$

b) $N_{all}-N_{diff} = 9 – 8 = 1$

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

As a result of the discovery of substantial gas fields in the country,[47] 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, instead, they are sporadically built as a result of special conditions. Hydropower generation only increased by 5% from 2003 to 2007[48], as almost all the increase in electricity demand has been supplied by new thermal generation[49], which is a more viable investment in terms of costs and access to finance.

Natural Gas promotion in Peru began in 1999, when the law for the Promotion of Development of the Natural Gas Industry (Law No. 27133)[50] 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

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[46] http://www.egesur.com.pe. Web link last accessed on 12/03/2012

[47] 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 12/03/2012.

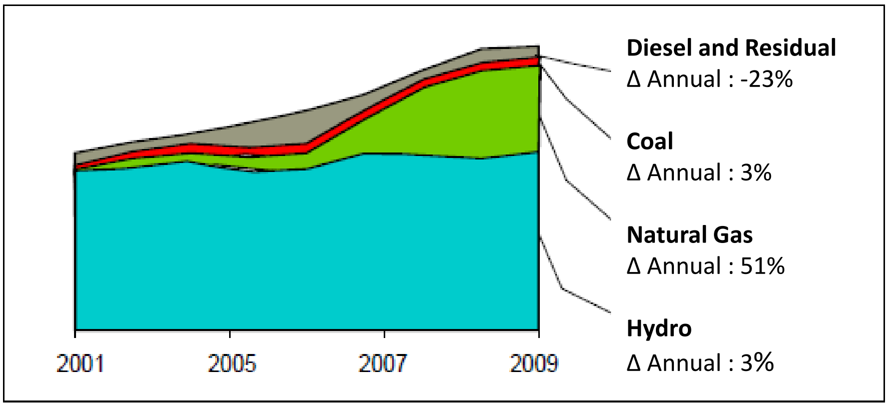
[48] ESMAP (2011). *Peru Opportunities and Challenges for Small Hydropower Development*, Page 1.

[49] ESMAP (2011). *Peru Opportunities and Challenges for Small Hydropower Development*, Page 1.

[50] http://www.minem.gob.pe/minem/archivos/file/Hidrocarburos/normas_legales/ley27133.pdf - Web link last accessed on 12/03/2012.

little compared to this. According to MINEM's 2010 report on Peru's electricity sector[51], 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 6: Evolution of the sources used for electricity generation



Source: Peru electricity sector 2010.[52]

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,[53] which is considered very low when compared to Potrero Hydropower Plant Project.

Based on these elements, 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 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, and has been registered recently on 20/06/2011.

B.6. Emission reductions

B.6.1. Explanation of methodological choices

The emission reductions are calculated following the guidance of the methodology ACM0002, as follows:

Where:

ER_y : Emission reduction in year y (tCO_2)
BE_y : Baseline Emission in year y (tCO_2)
PE_y : Project emission in year y (tCO_2)

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

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

[53] 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 project emission 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 emission 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 ($EG_{BL,y}$), 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* (tCO_2).
$EG_{PJ,y}$	:	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 CO_2 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* (tCO_2/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 CO_2 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 ($EF_{grid,OM\text{-}DD,y}$) used was provided by the Tool as follows:

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

Where:

$EF_{grid,OM\text{-}DD,y}$: 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:

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

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 CO_2 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).

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

The build margin emission factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units *m* during the most recent year *y* for which power generation data is available, calculated as follows:

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

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:

(a) Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently ($SET_{5\text{-units}}$) and determine their annual electricity generation ($AEG_{SET\text{-}5\text{-units}}$, in MWh);

(b) 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 ($AEG_{SET\text{-}\geq 20\%,}$ in MWh);

(c) From $SET_{5\text{-units}}$ 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 ($_{SETsample\text{-}CDM}$) the annual electricity generation ($AEG_{SET\text{-}sample\text{-}CDM}$, 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. $AEG_{SET\text{-}sample\text{-}CDM} \geq 0.2 \times AEG_{total}$), then use the sample group SETsample-CDM to calculate the build margin. Ignore steps (e) and (f).

Otherwise:

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

Out of $SET_{5\text{-}units}$ 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 $W_{BM}=0.5$.[54]

[54] 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.

B.6.2. Data and parameters fixed ex ante

Data / Parameter	**PE**
Unit	**tCO_2**
Description	GHG emissions produced by the project activity
Source of data	N/A (as suggested in The Methodology)
Value(s) applied	0
Choice of data or Measurement methods and procedures	The Project does not lead to any GHG emissions. Small hydropower plants without reservoirs are classified as zero emission projects, for which there are no associated emissions in the Project boundary.
Purpose of data	Calculation of project emissions.
Additional comment	--

Data / Parameter	**LEy**
Unit	**tCO_2**
Description	GHG emissions produced by leakage of the project activity
Source of data	N/A (as suggested in the Methodology)
Value(s) applied	0
Choice of data or Measurement methods and procedures	According to the Baseline Methodology, project participants do not need to consider leakage.
Purpose of data	Calculation of project emissions.
Additional comment	--

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 (tCO_2)
BE_y : Baseline emission in year y (tCO_2)
PE_y : Project emission in year y (tCO_2)

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* (tCO_2).
$EG_{PJ,y}$	:	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 CO_2 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* (tCO_2/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 2016. The net electricity generation is estimated to be 138,778 MWh per year.

$EG_{facility,y}$ = 138,778 *MWh per year*

$EG_{PJ,y} = EG_{facility,y}$ = 138,778 *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 CO_2 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.[55] 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 2011 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 one entire year. Therefore, it was assumed that the project activity will generate 138,778 MWh/year. Considering this assumption, the variables were defined as follows:

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

$$\boldsymbol{EF_{grid,OM\text{-}DD,y} = \left(\Sigma_h EG_{PJ,h} * EF_{EL,DD,h} \right) / EG_{PJ,y}}$$

[55] COES Annual Statistics Report (2010). Table Nº 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/estadanual.aspx - Web link last accessed on 10/10/2011.

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 138,778 MWh per year. $EG_{PJ,y}$ is an "estimation" of the total electricity generated by the Project in 2011.

$EG_{PJ,y} = 138{,}778\ MWh$

$EG_{PJ,h}$ is an "approximation" of the total electricity generated by the Project in each hour of 2011. It was calculated by dividing the Project's estimated generation by 8,760 hours in a year.

$EG_{PJ,h} = 138{,}778 / 8{,}760$

$EG_{PJ,h} = 15.842\ MWh$

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

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

Where:

$EF_{EL,DD,h}$	:	CO_2 emission factor for the power units at 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 the power unit *n* in hour *h* (MWh).
$EF_{EL,n,y}$	:	CO_2 emission factor of the 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 in 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 generation by grid power plants during that hour *h.*

To calculate the emission factor of the power unit ($EF_{EL,m,y}$**)**, the formula 3 of the *Tool to calculate the emission factor for an electricity system* was used (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).

Using the above formula, each emission factor has been calculated for all thermal plants, and the following table shows the $EF_{EL,m,y}$ of the all thermal units of the SEIN.

Table 9: Emission Factors for Thermal Units in the SEIN in the year 2011

POWER UNITS	TECHNOLOGY	FUEL	$\eta_{m,y}$ (%)[(1)]	$EF_{CO2,m,i,y}$[(2)] $KgCO_2/Tj$	$EF_{EL,m,y}$[(3)] (tCO2/MWh)
AGUAYTÍA TG1	GAS TURBINE / NATURAL GAS	NATURAL GAS	30.3%	54,300	0.6444
AGUAYTÍA TG2	GAS TURBINE / NATURAL GAS	NATURAL GAS	30.1%	54,300	0.6499
BELLAVISTA ALCO	DIESEL 2 / RESIDUAL	DIESEL 2	31.2%	72,600	0.8388
BELLAVISTA MAN1	DIESEL 2 / RESIDUAL	DIESEL 2	38.0%	72,600	0.6874
CHICLAYO OESTE	DIESEL 2 / RESIDUAL	DIESEL 2	35.8%	72,600	0.7292
CHILCA1 TG1	GAS TURBINE / NATURAL GAS	NATURAL GAS	35.2%	54,300	0.5559
CHILCA1 TG2	GAS TURBINE / NATURAL GAS	NATURAL GAS	34.5%	54,300	0.5658
CHILCA1 TG3	GAS TURBINE / NATURAL GAS	NATURAL GAS	33.2%	54,300	0.5891
CHILINA SULZ12	DIESEL 2 / RESIDUAL	DIESEL 2	39.3%	72,600	0.6648
CHILINA TV2	STEAM TURBINE / RESIDUAL	RESIDUAL 500	21.0%	46,200	0.7918
CHILINA TV3	STEAM TURBINE / RESIDUAL	RESIDUAL 500	22.6%	46,200	0.7351
CHIMBOTE TG1	GAS TURBINE / DIESEL	DIESEL 2	22.7%	72,600	1.1498
CHIMBOTE TG3	GAS TURBINE / DIESEL	DIESEL 2	23.5%	72,600	1.1116
CICLO COMBINADO	COMBINED CYCLE GAS - STEAM TURBINE	DIESEL 2	28.3%	72,600	0.9242
HUAYCOLORO	GAS TURBINE/LANDFILL GAS	LANDFILL GAS	39.5%	46,200	0.4211
ILO1 CATKATO	DIESEL 2 / RESIDUAL	DIESEL 2	41.7%	72,600	0.6268
ILO1 TG1	GAS TURBINE / DIESEL	DIESEL 2	30.3%	72,600	0.8617
ILO1 TG2	GAS TURBINE / DIESEL	DIESEL 2	32.7%	72,600	0.8001
ILO1 TV2	STEAM TURBINE / RESIDUAL	RESIDUAL 500	33.2%	46,200	0.5004
ILO1 TV3	STEAM TURBINE / RESIDUAL	RESIDUAL 500	35.3%	46,200	0.4712
ILO1 TV4	STEAM TURBINE / RESIDUAL	RESIDUAL 500	33.4%	46,200	0.4973
ILO2 TV1	STEAM TURBINE / COAL	COAL	40.0%	87,300	0.7861
INDEPENDENCIA	GAS TURBINE / NATURAL GAS	NATURAL GAS	37.5%	54,300	0.5207
KALLPA TG1	GAS TURBINE / NATURAL GAS	NATURAL GAS	33.3%	54,300	0.5865
KALLPA TG2	GAS TURBINE / NATURAL GAS	NATURAL GAS	33.6%	54,300	0.5817
KALLPA TG3	GAS TURBINE / NATURAL GAS	NATURAL GAS	33.8%	54,300	0.5776
LAS FLORES	GAS TURBINE / NATURAL GAS	NATURAL GAS	30.8%	54,300	0.6357
MALACAS TG1	GAS TURBINE / NATURAL GAS	NATURAL GAS	19.4%	54,300	1.0102
MALACAS TG2	GAS TURBINE / NATURAL GAS	NATURAL GAS	21.6%	54,300	0.9059
MALACAS2 TG4	GAS TURBINE / NATURAL GAS	NATURAL GAS	27.5%	54,300	0.7114
MOLLENDO	DIESEL 2 / RESIDUAL	RESIDUAL 500	42.7%	46,200	0.3897
OQUENDO	COGENERATION / NATURAL GAS	NATURAL GAS	33.6%	54,300	0.5826
PISCO TG1	GAS TURBINE / NATURAL GAS	NATURAL GAS	27.7%	54,300	0.7055
PISCO TG2	GAS TURBINE / NATURAL GAS	NATURAL GAS	27.9%	54,300	0.7016
PIURA 1	DIESEL 2 / RESIDUAL	DIESEL 2	35.7%	72,600	0.7315
PIURA 2	DIESEL 2 / RESIDUAL	DIESEL 2	30.4%	72,600	0.8604
PIURA TG	GAS TURBINE / DIESEL	DIESEL 2	19.8%	72,600	1.3172
SAN NICOLAS CUMMINS	DIESEL 2 / RESIDUAL	DIESEL 2	37.9%	72,600	0.6896
SAN NICOLÁS TV1	STEAM TURBINE / RESIDUAL	RESIDUAL 500	28.4%	46,200	0.5858
SAN NICOLÁS TV2	STEAM TURBINE / RESIDUAL	RESIDUAL 500	28.9%	46,200	0.5761
SAN NICOLÁS TV3	STEAM TURBINE / RESIDUAL	RESIDUAL 500	29.7%	46,200	0.5602
SANTA ROSA TG8	GAS TURBINE / NATURAL GAS	NATURAL GAS	34.5%	54,300	0.5660
SANTA ROSA UTI5	GAS TURBINE / NATURAL GAS	NATURAL GAS	28.7%	54,300	0.6804
SANTA ROSA UTI6	GAS TURBINE / NATURAL GAS	NATURAL GAS	26.7%	54,300	0.7312
SANTA ROSA WTG TG7	GAS TURBINE / NATURAL GAS	NATURAL GAS	30.5%	54,300	0.6413
TAPARACHI	GAS TURBINE / DIESEL	DIESEL 2	35.2%	72,600	0.7429
TRUJILLO NORTE	DIESEL 2 / RESIDUAL	DIESEL 2	37.9%	72,600	0.6898
TUMBES	DIESEL 2 / RESIDUAL	DIESEL 2	44.1%	72,600	0.5932
VENTANILLA CICLO COMBINADO	COMBINED CYCLE GAS TURBINE	NATURAL GAS	50.5%	54,300	0.3874

(1) CD COES data 2011: Eficiencia

http://www.coes.org.pe/wcoes/coes/estadistica/estadanual.aspx

(2) IPCC default values. See table 2 bellow

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:

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

$$EF_{grid,OM\text{-}DD,y} = 96{,}390.06 / 138{,}778$$

$$EF_{grid,OM\text{-}DD,y} = 0.69456\ tCO_2/ MWh$$

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

The build margin emissions factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units *m* during the most recent year *y* for which power generation data is available, calculated as follows:

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

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 units *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*, 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:

(a) Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently ($SET_{5\text{-units}}$) and determine their annual electricity generation ($AEG_{SET\text{-}5\text{-units}}$, in MWh);

(b) 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 ($AEG_{SET\text{-}\geq 20\%}$, in MWh);

(c) From $SET_{5\text{-units}}$ 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 $SET_{5\text{-units}}$ 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 10: Capacity Additions in the SEIN (2006-2011)

POWER PLANT	Date of Entry To SEIN	Technology	Installed Capacity (MW)	2011 Energy Generation (GWh)
PISCO TG1	Sep-10	Gas Turbine/Natural Gas	37.40	139.30
PISCO TG2	Sep-10	Gas Turbine/Natural Gas	37.40	161.76
INDEPENDENCIA	Sep-10	Diesel/Natural Gas	22.93	97.35
SANTA CRUZ II	May-10	Hydro	3.50	33.32
POECHOS II	Apr-10	Hydro	10.00	54.66
RONCADOR	Apr-10	hydro	3.80	19.46
LAS FLORES	Apr-10	Gas Turbine/Natural Gas	192.50	296.40
KALLPA TG3	Feb-10	Gas Turbine/Natural Gas	233.00	1,538.51
PARAMONGA	Jan-10	Gas Turbine/Biomass	23.00	84.31
EL PLATANAL	Dec-09	Hydro	220.00	1,224.11
SANTA ROSA TG8	Aug-09	Natural Gas turbine	193.18	971.63
LA JOYA	Jul-09	Hydro	10.00	27.08
CHILCA1 TG3	Jul-09	Natural Gas turbine	199.80	827.42
TRUJILLO NORTE	Jun-09	Diesel 2 / Residual	64.00	151.77
KALLPA TG2	Jun-09	Natural Gas turbine	216.00	1,359.04
SANTA CRUZ I	Feb-09	Hydro	6.20	27.43
OQUENDO	Jan-09	Natural Gas turbine	31.00	134.68
CAÑA BRAVA	Nov-08	Hydro	5.31	27.82
CARHUAQUERO IV	May-08	Hydro	10.00	76.66
CHILCA1 TG2	Jul-07	Natural Gas Turbine	179.24	1,001.80
KALLPA TG1	Jul-07	Natural Gas Turbine	180.00	1,096.10
CHILCA1 TG1	Dec-06	Natural Gas Turbine	179.24	1,001.32
VENTANILLA TG 3 & TG 4 & TV	Oct-06	Combined cycle	457.00	3,435.87
SANTA ROSA UTI 5 - UTI6	Aug-06	Natural Gas Turbine	119.20	113.52
SANTA ROSA I	Jan-06	Hydro	1.02	0.00

(1) Source: COES. Estadistica de Operaciones 2011.

In the table above 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 ($SET_{5\text{-units}}$, $SET_{\geq 20\%}$) 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 $SET_{5\text{-units}}$ power plants have an annual generation of 421.56 GWh, which represents 1.39% of the total annual generation (32,426.83 GWh). The annual generation of $SET_{\geq 20\%}$ power plants is 6,787.12 GWh, which represents 22.4%; 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 11: Selection of SET_{sample} power plants

Power Plant	Date of Entry To SEIN	Plant Type	Most recent year generation (GWh)	Most recent year generation (%)	$AEG_{SET \geq 20\%}$ (GWh)	$SET_{\geq 20\%}$ (%)	$AEG_{SET\text{-}5\text{-}units}$ (GWh)	$AEG_{SET\text{-}5\text{-}units}$ (%)
PURMACANA	Mar-11	Hydro	3.68	0.01%	3.68	0.01%	3.68	0.01%
PISCO TG1	Sep-10	Natural Gas turbine	139.30	0.46%	142.99	0.47%	139.30	0.47%
PISCO TG2	Sep-10	Natural Gas turbine	161.76	0.53%	304.75	1.01%	161.76	1.01%
INDEPENDENCIA	Sep-10	Diesel 2	97.35	0.32%	402.10	1.33%	97.35	1.33%
RONCADOR	Apr-10	Hydro	19.46	0.06%	421.56	1.39%	19.46	1.39%
LAS FLORES	Apr-10	Natural Gas turbine	296.40	0.98%	717.96	2.37%		
KALLPA TG3	Feb-10	Natural Gas turbine	1,538.51	5.08%	2,256.47	7.45%		
PARAMONGA	Jan-10	Biomass	84.31	0.28%	2,340.78	7.73%		
SANTA ROSA TG8	Sep-09	Natural Gas turbine	971.63	3.21%	3,312.41	10.93%		
CHILCA1 TG3	Aug-09	Natural Gas turbine	827.42	2.73%	4,139.84	13.66%		
KALLPA TG2	Jun-09	Natural Gas turbine	1,359.04	4.49%	5,498.88	18.15%		
TRUJILLO NORTE	Jun-09	Diesel 2 / Residual	151.77	0.50%	5,650.65	18.65%		
OQUENDO	Mar-09	Natural Gas turbine	134.68	0.44%	5,785.33	19.09%		
CHILCA1 TG2	Jul-07	Natural Gas Turbine	1,001.80	3.31%	6,787.12	22.40%		
KALLPA TG1	Jul-07	Natural Gas Turbine	1,096.10	3.62%				

Due to the fact that the SET_{sample} is $SET_{\geq 20\%}$ power plants, the BM is calculated as follows:

According to the *Tool to calculate the emission factor for an electricity system*, the BM is calculated using the following formula:

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

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.

To calculate the BM, the selected set of plants ($SET_{\geq 20\%}$) 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, the BM is 0.57749 tCO_2/MWh.

$\Sigma_m EG_{m,y} = 6,783,438.57$

$\Sigma_m EG_{m,y} * EF_{EL,m,y} = 3,917,341.21$

$EF_{grid,BM,y} = 3,917,341.21 / 6,783,438.57$

$EF_{grid,BM,y} = 0.57749 \ tCO_2/MWh$

Table 12: BM Calculation

SET_{sample} (SET≥20%)	$EG_{m,y}$ (MWh)	$EF_{EL,m,y}$ (tCO_2/MWh)
PURMACANA	3,683.49	0.00000
PISCO TG1	139,303.78	0.70554
PISCO TG2	161,759.90	0.70157
INDEPENDENCIA	97,352.36	0.52067
RONCADOR	19,461.73	0.00000
LAS FLORES	296,400.01	0.63567
KALLPA TG3	1,538,511.34	0.57756
PARAMONGA	84,307.67	0.00000
SANTA ROSA TG8	971,634.49	0.56603
CHILCA1 TG3	827,423.17	0.58907
KALLPA TG2	1,359,037.48	0.58170
TRUJILLO NORTE	151,774.14	0.68976
OQUENDO	134,675.71	0.58259
CHILCA1 TG2	1,001,796.79	0.56579

$\Sigma EG_{m,y} X EF_{EL,m,}$	3917341.21	
$\Sigma EG_{m,y}$	6783438.57	
$EF_{grid,BM,y}$	**0.57749**	(tCO2/MWh)

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

The Baseline Emission Factor was calculated as a CM, which is the simple average[56] of the OM and the BM. All margins are expressed in tCO_2/MWh.

$$\boldsymbol{EF_{grid,CM,y} = (EF_{grid,OM,y} * W_{OM}) + (EF_{grid,BM,y} * W_{BM})}$$

$$EF_{grid,CM,y} = (EF_{grid,OM,y} * 0.5) + (EF_{grid,BM,y} * 0.5)$$

$$EF_{grid,CM,y} = (0.69456 * 0.5) + (0.57749 * 0.5)$$

$$EF_{grid,CM,y} = 0.63602\ tCO_2/MWh$$

The resulting Baseline Emission Factor ($EF_{grid,CM,y}$) for the year 2011 is 0.63602 tCO_2/MWh.

Calculation of the Project's Emission Reductions Prior to Validation

I. Project emissions (PE_y)

$$\boldsymbol{PE_y = 0\ tCO_2e/year}$$

II. Leakage

Following the applied methodology, leakage was not considered.

[56] The default weights of 50%-50% were kept.

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* (tCO_2).
$EG_{PJ,y}$	:	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 CO_2 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* (tCO_2/MWh).

Due to the fact that the Project involves the installation of a new grid-connected renewable power plant/unit at a site where no other renewable power plant was operated prior to the implementation of the project activity, 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 2011. The net electricity generation is estimated to be 138,778 MWh per year.

$EG_{facility,y} = 138,778\ MWh$

$EG_{PJ,y} = EG_{facility,y} = 138,778\ MWh$

$EG_{PJ,y} = 138,778\ MWh$

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

$BE_y = 138,778 MWh * 0.63602$

$BE_y = 88,266\ tCO_2/year$

Emission Reductions (ER_y)

Finally, the emission reductions are:

$ER_y = BE_y – PE_y$

$ER_y = 88{,}266 – 0$

$ER_y = 88{,}266\ tCO_2/year$

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
2016	0	88,266	0	88,266
2017	0	88,266	0	88,266
2018	0	88,266	0	88,266
2019	0	88,266	0	88,266
2020	0	88,266	0	88,266
2021	0	88,266	0	88,266
2022	0	88,266	0	88,266
Total	**0**	**617,859**	**0**	**640,601**
Total number of crediting years	7			
Annual average over the crediting period	**0**	**88,266**	**0**	**88,266**

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

(Copy this table for each piece of data and parameter.)

Data / Parameter	$EG_{PJ,y}$ and $EG_{PJ,h}$
Unit	MWh
Description	The quantity of net electricity generated that is produced and fed into the grid as a result of the implementation of the CDM project activity in year *y* / The quantity of net electricity generated by the project plant/unit and supplied to the grid in year *y*.
Source of data	On site (measured by an electricity meter) and/or official sources (based on the information provided by COES).
Value(s) applied	138,778
Measurement methods and procedures	The net electricity supplied to the grid will be measured continuously and recorded at least each hour. A high level of accuracy of the measurements will be achieved due to the use of high-precision equipments. The project electricity meter is an electronic device with an accuracy of 0.2 (as required by COES)[57] and will be monitored in real time through a SCADA system. The meters will be located at the power plant substation. The project will measure the net electricity after the internal consumption. The proportion of data to be monitored is 100% and the data will be archived electronically.
Monitoring frequency	Daily
QA/QC procedures	Measuring equipment will be verified with calibrated pattern or calibrated according to relevant industry standards or national regulation[58]. The meter readings may be cross-checked with available internal and/or external information, such as electricity invoices or official reports.
Purpose of data	Calculation of Baseline emissions.
Additional comment	Data will be kept for at least two years after the end of the crediting period or the last issuance of CERs for this project activity, whatever occurs later. Complete information of every year during the crediting period will be available from the COES during the first six months of the following year.

[57] COES Procedure No. 20, Annex C. See http://www.coes.org.pe/coes/Procedimientos/procedimientos.asp - Web link last accessed on 05/09/2011.

[58] At the moment the verification regulation is RM Nº 496-2005-MEM/DM from the Ministry of energy and Mines.

Data / Parameter	$EF_{CO2.grid,y} = EF_{grid,CM,y}$
Unit	tCO_2e/MWh
Description	CO_2 emission factor of the grid electricity in year *y*.
Source of data	COES records and project developer records.
Value(s) applied	0.63602
Measurement methods and procedures	This value is calculated. 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".
Monitoring frequency	Annual
QA/QC procedures	Calculated using data available (emission factors and annual statistics), that is monitored 100% by COES.
Purpose of data	Calculation of baseline emissions.
Additional comment	Data will be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whatever occurs later.

Data / Parameter	$EF_{grid,OM-DD,y}$
Unit	tCO_2/MWh
Description	The Dispatch Data Analysis OM emission factor.
Source of data	Official data provided by the administrator of the grid or the relevant national authority (COES) publicly available in its web site or directly sent to the project developer. Raw data for generation is based on the 15 minute records of every power plant.
Value(s) applied	0.69452
Measurement methods and procedures	The dispatch data analysis operating margin emission factor ($EF_{OM-DD,y}$ = $EF_{grid,OM,y}$ in tCO_2/MWh) is a method which involves the power units that actually dispatch at the margin during each hour *h*, where the power units are separated into power units at the top of the dispatch *n* and other power units.
Monitoring frequency	Annual
QA/QC procedures	Calculated using data available (emission factors and annual statistics), that is monitored 100% by COES.
Purpose of data	Calculation of Baseline emissions.
Additional comment	Data will be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whatever occurs later.

Data / Parameter	$EF_{grid,BM,y}$
Unit	tCO_2/MWh
Description	The build margin emissions factor.
Source of data	Official data provided by the administrator of the grid or the relevant national authority (COES) publicly available in its web site or directly sent to the project developer.
Value(s) applied	0.57749
Measurement methods and procedures	---
Monitoring frequency	Annual
QA/QC procedures	Calculated using data available (emission factors and annual statistics), that is monitored 100% by COES.
Purpose of data	Calculation of Baseline emissions.
Additional comment	Data will be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whatever occurs later.

Data / Parameter	$EG_{PJ,h}$
Unit	MWh
Description	Electricity displaced by the project activity in hour *h* of year *y*.
Source of data	Project records and/or COES.
Value(s) applied	Data used is presented in the spreadsheet for “Grid Emission Factor calculation”
Measurement methods and procedures	Directly measured and/or based on the information provided by COES. The proportion of data to be monitored is 100% and the data will be archived electronically.
Monitoring frequency	Daily
QA/QC procedures	Information of invoices of electricity sold to the grid will be cross-checked with metered information and/or COES information. . To ensure consistency, if applicable other records may be used if necessary.
Purpose of data	Calculation of Baseline emissions.
Additional comment	Data will be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whatever occurs later.

Data / Parameter	$EF_{EL,DD,,h}$
Unit	tCO_2/MWh
Description	CO_2 emission factor of power units at the top of the dispatch order in hour *h* in year y.
Source of data	Input data provided by COES.
Value(s) applied	Data used is presented in the spreadsheet for “Grid Emission Factor calculation”
Measurement methods and procedures	To calculate $EF_{EL,DD,h}$ the second option is chosen because the data on fuel consumption and electricity generation is available. The proportion of data to be monitored is 100% and the data will be archived electronically.
Monitoring frequency	Annual
QA/QC procedures	---
Purpose of data	Calculation of Baseline emissions.
Additional comment	Data will be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whatever occurs later.

Data / Parameter	$EG_{n,h}$
Unit	MWh
Description	Electricity generated and delivered to the grid by power units *n* in hour *h*.
Source of data	Data provided by COES.
Value(s) applied	Data used is presented in the spreadsheet for “Grid Emission Factor calculation”
Measurement methods and procedures	The proportion of data to be monitored is 100% and the data will be archived electronically.
Monitoring frequency	Annual
QA/QC procedures	Official data.
Purpose of data	Calculation of Baseline emissions.
Additional comment	Data will be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whatever occurs later.

Data / Parameter	$EF_{EL,n,y}$
Unit	tCO_2/MWh
Description	CO_2 emission factor of power unit *n* in year *y*.
Source of data	Input data provided by COES.
Value(s) applied	Data used is presented in the spreadsheet for “Grid Emission Factor calculation”
Measurement methods and procedures	The $EF_{EL,n,y}$ is determined for method the simple operating margin option A.2. The proportion of data to be monitored is 100% and the data will be archived electronically.
Monitoring frequency	Annual
QA/QC procedures	---
Purpose of data	Calculation of Baseline emissions.
Additional comment	Data will be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whatever occurs later.

Data / Parameter	$EG_{m,y}$
Unit	MWh
Description	Net quantity of electricity generated and delivered to the grid by power unit m in year y.
Source of data	Data provided by COES.
Value(s) applied	Data used is presented in the spreadsheet for “Grid Emission Factor calculation”
Measurement methods and procedures	The proportion of data to be monitored is 100% and the data will be archived electronically.
Monitoring frequency	Annual
QA/QC procedures	Is official data.
Purpose of data	Calculation of Baseline emissions.
Additional comment	Data will be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whatever occurs later.

Data / Parameter	$EF_{EL,m,y}$
Unit	tCO_2/MWh
Description	CO_2 emission factor of power unit m in year y.
Source of data	Input data for calculation is provided by COES.
Value(s) applied	Data used is presented in the spreadsheet for “Grid Emission Factor calculation”
Measurement methods and procedures	The $EF_{EL,m,y}$ is determined for method the simple operating margin option A.2. The proportion of data to be monitored is 100% and the data will be archived electronically.
Monitoring frequency	Annual
QA/QC procedures	---
Purpose of data	Calculation of Baseline emissions.
Additional comment	Data will be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whatever occurs later.

Data / Parameter	$\eta_{m,y}$
Unit	---
Description	Average net energy conversion efficiency of power unit m in year y (ratio).
Source of data	Data provided by COES.
Value(s) applied	Data used is presented in the spreadsheet for “Grid Emission Factor calculation”
Measurement methods and procedures	Each year this data will be checked with the last available annual report of COES. The proportion of data to be monitored is 100% and the data will be archived electronically.
Monitoring frequency	Annual
QA/QC procedures	If the data used is significantly lower than the default value of the applicable technology, project proponents should assess the reliability of the values, and provide appropriate justification if deemed reliable. Otherwise, the default values above shall be used.
Purpose of data	Calculation of Baseline emissions.
Additional comment	Data will be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whatever occurs later.

Data / Parameter	$EF_{CO2,m,i,y}$
Unit	tCO_2 /GJ
Description	Average CO_2 emission factor of fuel type i used in power unit m in year y.
Source of data	IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.
Value(s) applied	Data used is presented in the spreadsheet for "Grid Emission Factor calculation"
Measurement methods and procedures	---
Monitoring frequency	Annual
QA/QC procedures	Every update of IPCC reports will be taken into account.
Purpose of data	Calculation of Baseline emissions.
Additional comment	Data will be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whatever occurs later.

Data / Parameter	$\mathbf{w_{OM}}$
Unit	(%)
Description	Weighting of operating margin emissions factor.
Source of data	As indicated in the "Tool to calculate the emission factor for an electricity system" v.2.2.1.
Value(s) applied	50
Measurement methods and procedures	---
Monitoring frequency	Annual
QA/QC procedures	---
Purpose of data	Calculation of Baseline emissions.
Additional comment	Data will be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whatever occurs later.

Data / Parameter	$\mathbf{w_{BM}}$
Unit	(%)
Description	Weighting of build margin emissions factor.
Source of data	As indicated in the "Tool to calculate emission factor for an electricity system" v.2.2.1.
Value(s) applied	50
Measurement methods and procedures	---
Monitoring frequency	Annual
QA/QC procedures	---
Purpose of data	Calculation of Baseline emissions.
Additional comment	Data will be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whatever occurs later.

Data / Parameter	Merit Order
Unit	Text
Description	The merit order in which power plants are dispatched by documented evidence.
Source of data	Data provided by COES.
Value(s) applied	Detailed in the grid emission factor calculation spreadsheet.
Measurement methods and procedures	For each year, the variable cost of thermal plants in the SEIN that are in effect in December will be used. The proportion of data to be monitored is 100% and the data will be archived electronically.
Monitoring frequency	Annual.
QA/QC procedures	It is official data.
Purpose of data	Calculation of Baseline emissions.
Additional comment	Data will be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whatever occurs later.

B.7.2. Sampling plan

Not applicable. The project will not implement a sampling approach to the data and parameters monitored in section b.7.1

B.7.3. Other elements of 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. The project will implement a Monitoring Plan and use pre-programmed spreadsheets for the emission reduction calculation. COES, the dispatch center, 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.

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

01/01/2013[59].

This is the date when the construction or equipment acquisition (or a PPA) contracts are signed.

C.1.2. Expected operational lifetime of project activity

50 years.[60]

59 Date might change.

60 (Empresa Eléctrica Agua Azul, 2011) Project Profile: Potrero Hydropower Plant.

C.2. Crediting period of project activity
C.2.1. Type of crediting period

Renewable crediting period – first period.

C.2.2. Start date of crediting period

01/01/2016

C.2.3. Length of crediting period

7 years, with two renewable periods.

SECTION D. Environmental impacts
D.1. Analysis of environmental impacts

In the case of Peru, according to the updated Electric Concessions Law (Law No. 25844),[61] for the development of hydroelectric power plants of over 500 kW a concession is required (Article 3), however when the generation is undertaken with renewable resources and is less than 20MW, the presentation of an Environmental Impact Assessment (EIA) is not required (Article 38) since the impacts are not considered significant. Nevertheless, the project owner is developing an EIA for the proper management of any environmental impact. In addition, as part of the Project's implementation process, the Hydrological Study undertaken for the National Water Authority (ANA) contemplates by law[62] a social and environmental description. In addition, a preliminary environmental impact assessment for the power plant is in process of development [63]

Potential environmental impacts identified by the project participants are not considered to be significant. A summary of them are listed below:

Construction Stage

- Top soil loss. Minor impacts since permanent facilities are located over a reduced size of land.
- Vegetation, flora and fauna alteration. Minor impact due to the magnitude of the affected area.
- Temporal and permanent landscape alteration. Minor impact due to the magnitude of the facilities.
- Noise and social variations due to the presence of foreign persons and different machines and equipment.

+ Generation of temporal job opportunities.
+ Increase in the economic dynamic of the surrounding areas since they have the opportunity to provide different services.

Operation Stage

- Landscape alteration for the presence of the facilities.

+ Local job creation for complementary services during the operation and maintenance of the power plant.
+ Increment of economic dynamics due to improvements in energy supply.

[61] http://www2.osinerg.gob.pe/MarcoLegal/pdf/LEYCE-DL25844.pdf - Web link last accessed on 12/03/2012.
[62] Rulebook of Administrative Procedures for the Water Use Approval. See: http://www.ana.gob.pe/media/280744/reglamento_paoua.pdf - Web link last accessed on 12/03/2012.
[63] EIA. (2012). Environmental Impact Assessment for the Potrero Hydropower Plant. Final report in May 2012.

A set of mitigation, restoration, prevention and maximization measures are part of the EIA in development in order to minimize negative impacts and increase the effects of the positive ones. In addition, a Monitoring Plan, a Contingency Plan and an Abandonment Plan will be detailed.

The hydrological study contemplates a water analysis that concludes that the current characteristics are optimal for hydro generation and that the ecological flow of the river is 4.3 m^3/s.[64] In addition, the study states that the project will benefit the local economy, increase local incomes, the environmental impact is considered not significant: the project will not modify the natural watercourse, will not create a reservoir, is not located in a protected area or over existing archeological remains. In addition between the water intake and devolution points, there are no productive activities using water for agriculture or industrial purposes.

D.2. Environmental impact assessment

The EIA developed for the project (not required by law as stated in section D.1) is in progress and the Results will be updated during the validation process.

SECTION E. Local stakeholder consultation
E.1. Solicitation of comments from local stakeholders

The project developer has presented the project activity to the local stakeholders since the beginning. During the hydrological study, a resume of the approval request document was published in the local newspapers, local Municipalities and other facilities[65]. A formal communication was also submitted to the local authorities in order to have a presence inspection[66].

To organize the Local Stakeholder Consultation of Potrero Hydropower project, informative posters were located in public places. A public announcement was made through the local newspaper on March 2nd, 2012[67]. Seventeen authorities and representatives of the communities received a written invitation for the workshop on February 28th. The public consultation was held on the Municipality of Eduardo Villanueva on Wednesday 14th, 2012 at 11:00 am.

During this meeting, the project developer shared information on climate change, the greenhouse gas effects, the Clean Development Mechanism and the environmental and social benefits of the Project, as well as a technical explanation of the Project.

They then listened to the concerns of the more than 200 inhabitants that attended the workshop (local authorities, community leaders and population). All the information gathered from the meeting and the responses given were compiled.

There was a consensus with local authorities and community leaders that the project will have a positive impact in the municipality and they agreed to have a second Workshop in the next weeks to allow the inhabitants of Eduardo Villanueva Municipality bring proposals and develop a Social Investment Plan in coordination with the representatives of Empresa Eléctrica Agua Azul.

This process is also 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.

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[64] Empresa Hidroelectrica Agua Azul (2011). Hydrological study of the Crisnejas River for the development of the Potrero hydro power plant, p.118..
[65] Compilation of evidences, invitations and publications of the Local Water Authority (ALA), Municipalities and others. 2011.
[66] ALA Crisnejas (2011). Certified copy of the inspection record dated May 12th, 2011.
[67] Panorama Cajamarquino (2012). Newspaper announcement of the LSC.

E.2. Summary of comments received

The Project has been received positively by the local stakeholders. The stakeholders' concerns and questions were discussed and answered thoroughly in this first workshop. The main topics discussed were:

- Description of the project owner (considering that the stakeholders have social problems with mining companies).
- Information about the final use of the energy and impact in the water availability for irrigation and human consumption.
- Existence of a mitigation plan in case of droughts (will they stop the operations of the plant?).
- Effects in water quality for inhabitants of the low part of the watershed.
- Development of additional workshops in different locations.

As a result of this consultation process the local authorities considered that the project does not have significant impacts since it is a renewable energy project. They agreed to support the implementation of the CDM Project. Since the project is in and early state and is developed in parallel with social conflicts with mining companies in the region, the stakeholders requested additional workshops in order to understand better the project conditions and impacts. As evidence of the workshop, there is an Act signed by local stakeholder's main authorities.

E.3. Report on consideration of comments received

The comments of the local stakeholders were taken into account and have been considered in the elaboration project development. The project owner made clear that Empresa Eléctrica Agua Azul is a private company not related to Mining Companies, and that their business line is electrical generation that will be injected to the National Interconnected System. During the event, the Project Owner clarified about low effects on water availability, as the project will only use 18 cubic meters of the river´s water flow, which has much higher water flow.

The project owner has committed to develop additional workshops in April – May 2012 in order to continue a communicational regime during the project implementation process and start the formulation of a Social Investment Plan with them.

These commitments with the local stakeholders are subject to the Project's registration as a CDM project activity.

SECTION F. Approval and authorization

The LoA is not available at the time of submitting the PDD to the validation DOE.

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Appendix 1: Contact information of project participants

Organization name	Empresa Eléctrica Agua Azul
Street/P.O. Box	La Encalada 1257, of. 1105, Lima 33, Perú
Building	
City	Lima
State/Region	Lima
Postcode	Lima 33
Country	Peru
Telephone	511-4340966
Fax	511-4377659
E-mail	
Website	
Contact person	
Title	Managing Director
Salutation	Mr
Last name	Herrera
Middle name	Soria
First name	Enrique
Department	
Mobile	511-995225541
Direct fax	
Direct tel.	
Personal e-mail	eherrera@aluzcleanenergy.com

Appendix 2:

A. Affirmation regarding public funding

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

Appendix 3: Applicability of selected methodology

Appendix 4: Further background information on ex ante calculation of emission reductions

BASELINE INFORMATION

The table below shows EF_{EL}s calculations with actual 2011 Net Energy Conversion Efficiency (NECs) from the Annual Statistics (Estadística anual de Operaciones) developed by COES. In the monitoring, EF_{EL}s should be updated using the latest Annual Statistics.

EFELs calculations 2011

POWER UNITS	TECHNOLOGY	FUEL	$\eta_{m,y}$ (%)[1]	$EF_{CO2,m,i,y}$ [2] $KgCO_2/Tj$	$EF_{EL,m,y}$ [3] (tCO2/MWh)
AGUAYTÍA TG1	GAS TURBINE / NATURAL GAS	NATURAL GAS	30.3%	54,300	0.6444
AGUAYTÍA TG2	GAS TURBINE / NATURAL GAS	NATURAL GAS	30.1%	54,300	0.6499
BELLAVISTA ALCO	DIESEL 2 / RESIDUAL	DIESEL 2	31.2%	72,600	0.8388
BELLAVISTA MAN1	DIESEL 2 / RESIDUAL	DIESEL 2	38.0%	72,600	0.6874
CHICLAYO OESTE	DIESEL 2 / RESIDUAL	DIESEL 2	35.8%	72,600	0.7292
CHILCA1 TG1	GAS TURBINE / NATURAL GAS	NATURAL GAS	35.2%	54,300	0.5559
CHILCA1 TG2	GAS TURBINE / NATURAL GAS	NATURAL GAS	34.5%	54,300	0.5658
CHILCA1 TG3	GAS TURBINE / NATURAL GAS	NATURAL GAS	33.2%	54,300	0.5891
CHILINA SULZ12	DIESEL 2 / RESIDUAL	DIESEL 2	39.3%	72,600	0.6648
CHILINA TV2	STEAM TURBINE / RESIDUAL	RESIDUAL 500	21.0%	46,200	0.7918
CHILINA TV3	STEAM TURBINE / RESIDUAL	RESIDUAL 500	22.6%	46,200	0.7351
CHIMBOTE TG1	GAS TURBINE / DIESEL	DIESEL 2	22.7%	72,600	1.1498
CHIMBOTE TG3	GAS TURBINE / DIESEL	DIESEL 2	23.5%	72,600	1.1116
CICLO COMBINADO	COMBINED CYCLE GAS - STEAM TURBINE	DIESEL 2	28.3%	72,600	0.9242
HUAYCOLORO	GAS TURBINE/LANDFILL GAS	LANDFILL GAS	39.5%	46,200	0.4211
ILO1 CATKATO	DIESEL 2 / RESIDUAL	DIESEL 2	41.7%	72,600	0.6268
ILO1 TG1	GAS TURBINE / DIESEL	DIESEL 2	30.3%	72,600	0.8617
ILO1 TG2	GAS TURBINE / DIESEL	DIESEL 2	32.7%	72,600	0.8001
ILO1 TV2	STEAM TURBINE / RESIDUAL	RESIDUAL 500	33.2%	46,200	0.5004
ILO1 TV3	STEAM TURBINE / RESIDUAL	RESIDUAL 500	35.3%	46,200	0.4712
ILO1 TV4	STEAM TURBINE / RESIDUAL	RESIDUAL 500	33.4%	46,200	0.4973
ILO2 TV1	STEAM TURBINE / COAL	COAL	40.0%	87,300	0.7861
INDEPENDENCIA	GAS TURBINE / NATURAL GAS	NATURAL GAS	37.5%	54,300	0.5207
KALLPA TG1	GAS TURBINE / NATURAL GAS	NATURAL GAS	33.3%	54,300	0.5865
KALLPA TG2	GAS TURBINE / NATURAL GAS	NATURAL GAS	33.6%	54,300	0.5817
KALLPA TG3	GAS TURBINE / NATURAL GAS	NATURAL GAS	33.8%	54,300	0.5776
LAS FLORES	GAS TURBINE / NATURAL GAS	NATURAL GAS	30.8%	54,300	0.6357
MALACAS TG1	GAS TURBINE / NATURAL GAS	NATURAL GAS	19.4%	54,300	1.0102
MALACAS TG2	GAS TURBINE / NATURAL GAS	NATURAL GAS	21.6%	54,300	0.9059
MALACAS2 TG4	GAS TURBINE / NATURAL GAS	NATURAL GAS	27.5%	54,300	0.7114
MOLLENDO	DIESEL 2 / RESIDUAL	RESIDUAL 500	42.7%	46,200	0.3897
OQUENDO	COGENERATION / NATURAL GAS	NATURAL GAS	33.6%	54,300	0.5826
PISCO TG1	GAS TURBINE / NATURAL GAS	NATURAL GAS	27.7%	54,300	0.7055
PISCO TG2	GAS TURBINE / NATURAL GAS	NATURAL GAS	27.9%	54,300	0.7016
PIURA 1	DIESEL 2 / RESIDUAL	DIESEL 2	35.7%	72,600	0.7315
PIURA 2	DIESEL 2 / RESIDUAL	DIESEL 2	30.4%	72,600	0.8604
PIURA TG	GAS TURBINE / DIESEL	DIESEL 2	19.8%	72,600	1.3172
SAN NICOLAS CUMMINS	DIESEL 2 / RESIDUAL	DIESEL 2	37.9%	72,600	0.6896
SAN NICOLÁS TV1	STEAM TURBINE / RESIDUAL	RESIDUAL 500	28.4%	46,200	0.5858
SAN NICOLÁS TV2	STEAM TURBINE / RESIDUAL	RESIDUAL 500	28.9%	46,200	0.5761
SAN NICOLÁS TV3	STEAM TURBINE / RESIDUAL	RESIDUAL 500	29.7%	46,200	0.5602
SANTA ROSA TG8	GAS TURBINE / NATURAL GAS	NATURAL GAS	34.5%	54,300	0.5660
SANTA ROSA UTI5	GAS TURBINE / NATURAL GAS	NATURAL GAS	28.7%	54,300	0.6804
SANTA ROSA UTI6	GAS TURBINE / NATURAL GAS	NATURAL GAS	26.7%	54,300	0.7312
SANTA ROSA WTG TG7	GAS TURBINE / NATURAL GAS	NATURAL GAS	30.5%	54,300	0.6413
TAPARACHI	GAS TURBINE / DIESEL	DIESEL 2	35.2%	72,600	0.7429
TRUJILLO NORTE	DIESEL 2 / RESIDUAL	DIESEL 2	37.9%	72,600	0.6898
TUMBES	DIESEL 2 / RESIDUAL	DIESEL 2	44.1%	72,600	0.5932
VENTANILLA CICLO COMBINADO	COMBINED CYCLE GAS TURBINE	NATURAL GAS	50.5%	54,300	0.3874

(1) CD COES data 2011: Eficiencia http://www.coes.org.pe/wcoes/coes/estadistica/estadanual.aspx
(2) IPCC default values. See table 2 bellow

The table above includes the emission factor formulas. Actual NECs, as well as data on technology and fuel, were obtained from COES. All this data was publicly available by COES and is published at the COES website in its annual statistics.

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 good monitoring practice.

Appendix 5: Further background information on monitoring plan

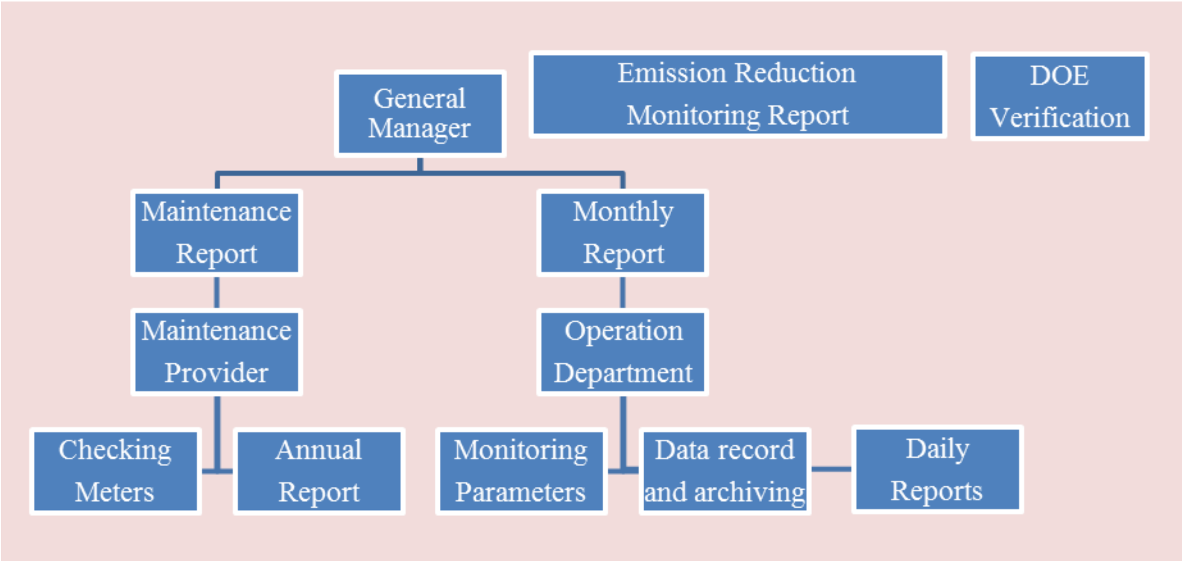
This report presents the Monitoring Plan (MP) for the Project activity. The MP defines a standard against which the performance in terms of the Project's ERs will be monitored, following the selected methodology ACM0002 (version 12.3.0) and in compliance with all relevant requirements of the CDM of the Kyoto Protocol. 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.

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:
  - √ The 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 the COES.
  - √ The net electricity generated by the power plants/units included at the top of the dispatch order, and the power plants/units included in the building margin.
  - √ The average net energy conversion efficiency of thermal power plants/units, available in the COES annual statistics report.
  - √ The marginal cost. The merit order in which power plants dispatches, available in the COES annual statistics report.
- Record and store the 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 the Project site. All the data will be kept for 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 Supervisory Control and Data Acquisition (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 at least two years after the end of the crediting period.

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

Both the power plant and 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 principal 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 the

daily/monthly data report 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 by electricity purchase/sales invoices by comparing the values of power plant and the substation.

b) The Maintenance Provider

Maintenance and calibrations of the measuring equipments will be developed as required by the methodology with a specialized firm, and will follow applicable requirements of the COES 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 analyse 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 analyse 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 CO_2 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 dispatch. 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:

Monthly data collection

	At the end of each month:
COES (Data Provider)	• Report the 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.

Appendix 6: Summary of post registration changes

Not applicable.

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History of the document

Version	Date	Nature of revision
04.0	EB 66 13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the project design document form for CDM project activities" (EB 66, Annex 8).
03	EB 25, Annex 15 26 July 2006	
02	EB 14, Annex 06 14 June 2004	
01	EB 05, Paragraph 12 03 August 2002	Initial adoption.
Decision Class: Regulatory **Document Type:** Form **Business Function:** Registration		