



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

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

CDM Project Activity: “Río Luis”
PDD version 03
30/01/2012

A.2. Description of the project activity:

Río Luis is a 15.48 MW run-of-river hydro project in the Province of El Oro, located in Southern Ecuador on the river known as Río Luis. The project will generate electricity for the Ecuadorian national grid.

The hydro resource for the project is taken from the river at an elevation of approximately 1,085 meters above sea level. An ecological stream flow assures protection of flora and fauna in the river bed and its surroundings. The project’s hydro resource, after pre-treatment, is conducted through enclosed piping (3.2 km) and a tunnel (2.2 km), then a short section of high-pressure piping to the power house, located at an elevation of 791 meters above sea level. The power house contains two Pelton-type water turbines connected to generators, rated at 7.74 MW each. The authorized hydro resource is 6.1 m³/s, and is subject to respecting the required ecological stream flow (819 l/s). The project also includes a 9.8 km tie-in at 69 kV to connect the project to the nearest transmission substation.

The project includes a small reservoir with a height of 10m. The purpose of the reservoir is to create hydraulic pressure to divert the hydro resource through the pre-treatment steps. This reservoir height (10m) is minimal compared to the hydraulic height of the project (294 metres of elevation difference between the capture of the hydro resource and the downstream power house). For this reason, the project has a very high power density, being approximately 1,000 W/m² of reservoir area.

The purpose of this project activity is to generate renewable energy in the form of electricity with minimal social and environmental impacts. By maintaining an ecological stream flow and a fish ladder at the 10m dam, flora or fauna impacts are mitigated. No land-use or social impacts are expected from flooding less than two hectares from the dam associated with this project activity.

This is a Greenfield project activity. No existing installations are located on the project site.

In the absence of this project activity, grid power would be provided by other generators. Fossil fuel generators and imports account for nearly 50% of the power handled by the Ecuadorian national grid. Furthermore, over 70% of the power units that have been connected to the Ecuadorian national grid since December 2006 are fired with fossil fuels.

This project activity will reduce greenhouse gas emission by avoiding generation at other plants connected to the national grid, especially those fired with fossil fuels

This project activity will contribute to sustainable development in the following ways:



- Environmental
- Utilize a renewable energy resource in an environmentally friendly manner.
 - Avoid greenhouse gas and other emissions at more contaminating power units connected to the national grid.
 - Maintain environmental values throughout the entire river bed through the ecological stream flow and fish ladder at the small (10m) dam.
- Social
- Create jobs in a rural area during both the construction and operational phases.
 - Avoid land-use, population dislocation, archeological and other social impacts associated with some hydro projects via run-of-river technology instead of a large reservoir.
- Economic
- Generate an economic good (electricity) with nearly no environmental or social impact.
 - Create a new economic activity in a rural area.

A.3. Project participants:

Please list project participants and Party(ies) involved and provide contact information in Annex 1. Information shall be indicated using the following tabular format.

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Ecuador (host)	<ul style="list-style-type: none"> • ENERGYHDINE C.A. (Private Company)¹ 	No

(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.

A.4. Technical description of the project activity:

¹ The voluntary participation of ENERGYHDINE C.A. in this Project activity is authorized by the Letter of Approval issued by the Ecuadorian DNA on 02/08/2010



A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Ecuador

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

El Oro

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

Cantons of Portovelo and Zaruma

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

The Project is located on and near the river Río Luis in the Province of El Oro within the municipal territories of Portovelo and Zaruma. Water flow in the river is diverted to the Project at an elevation of 1,085 meters above sea level. The power house is located adjacent to the river at an elevation of 790 meters above sea level.

The Lat/Lon coordinates of the site where water will be diverted to the project are:

-3.6965, -79.5168

The Lat/Lon coordinates of the power house are:

-3.7102, -79.5543

This project activity also includes the piping and a tunnel from the point of capture to the power house.

The following maps show the location of El Oro province within Ecuador and the municipalities of Portovelo and Zaruma within El Oro.



El Oro Province Within Ecuador



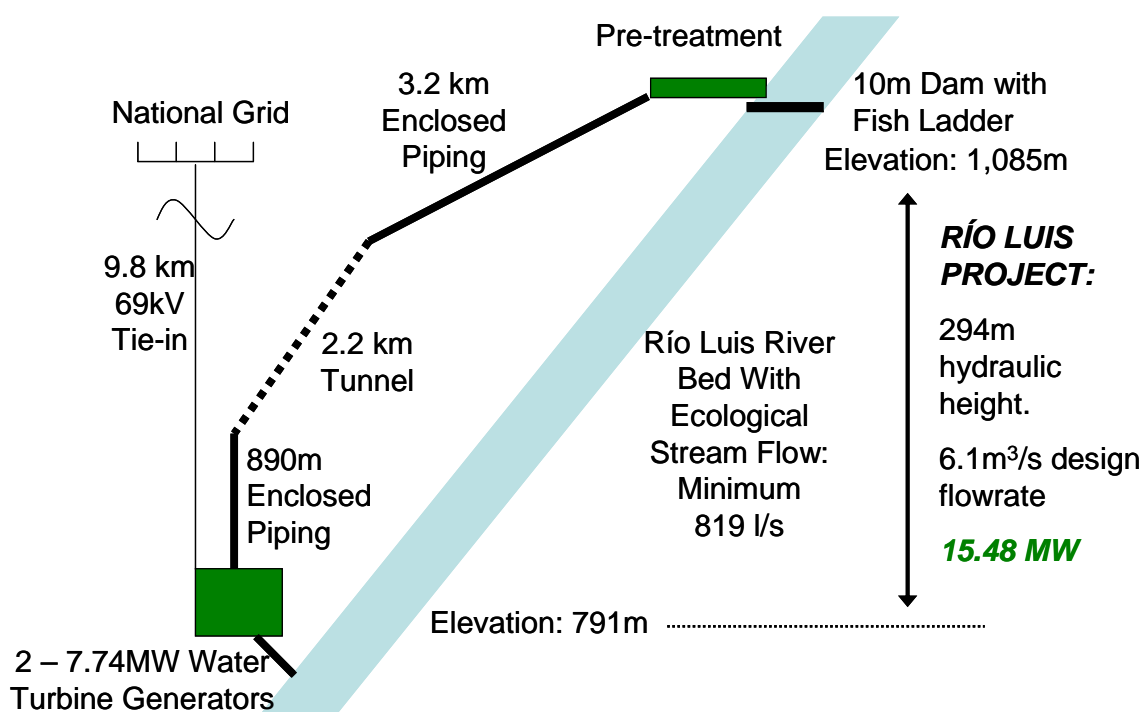
Project Location Within El Oro Province

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

The project activity is a Greenfield run-of-river hydro power plant. The project activity falls in sectoral scope number 1: energy industries (renewable - /non-renewable sources).

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

The Río Luis Project employs run-of-river hydro generation technology to generate electricity from a renewable energy source with minimal environmental and social impacts. The project configuration is depicted in the following diagram:



The renewable energy resource for the Río Luis Project is a maximum of 6.1 m³/s, diverted from the river at an elevation of 1,085 m and then conducted through over 6 km of piping and a tunnel to the powerhouse at an elevation of 791 m, thus offering a hydraulic pressure head of 294 m. The amount of water diverted from the river is controlled to assure an ecological stream flow that preserves the environmental values (especially flora and fauna) of the river and its surroundings. A small dam at the point of water capture provides hydraulic head to divert the water flow to the project, although its height is insignificant (10 m) compared to the hydraulic height of the project (294 m). The powerhouse contains 2 identical trains of water turbines and generators, each with a rated capacity of 7.74 MW. The project also includes an electrical tie-in to the closest substation of 9.8 km in length at voltage of 69 kV.



The project components are further described below²:

Water Capture: The water resource will be captured by installing a dam at the 1,085m elevation of the river. The dam has a height of 15m, five of which are foundations below the level of the river bed. The width is 20m, and the dam's geometric profile is "Wes" type. The dam is designed for a maximum flow rate through the river of 145 m³/s. On the left bank of the river adjacent to the dam is a fish ladder, designed to allow bidirectional travel. To the right of the dam are the gates to regulate the ecological stream flow. The gates are radial type, with dimensions of 2.80m x 2.80m. On the right margin of the river is the capture point, 2.74m length by 2.00m height. The design capacity of the capture point is 6.1 m³/s.

Pre-Treatment: Water pre-treatment consists of three steps: Fish protection at the capture point, debris screening and sand screening. The length of the debris screen is 16.5m. It is designed to remove branches, leaves and other debris. A channel of 79.5m follows the debris screen. The length of the sand screen is 54m. It is designed to remove particles with diameters greater than 0.2mm. The particles that are recovered are reintroduced into the river Río Luis. The treated water then enters a 978m³ surge tank.

Water Conduction: The first stage of water conduction is at low pressure within enclosed piping, 2.75m in diameter and 8mm wall thickness. The length of this first stage is 3,200m. The second stage of water conduction, also at low pressure, is within an underground tunnel. The cross-section of the tunnel is arched with a width of 2.80m and a height of 2.90m. The length of the tunnel is 2,166m. The elevation at the end of the tunnel is 1,066m. The final stage of conduction is at high pressure, since the elevation drops 272m over a length of 893m. This stage is carried out within enclosed piping in sections with diameters of 1.40m and 1.50m. Due to the length of the water conduction, a pressure vent, 3m in diameter and 33m in height, is located between the tunnel exit and the entrance to the high-pressure, third-stage piping.

Powerhouse: The powerhouse hosts a valve room on the upper floor and the two trains of turbines and generators on the lower floor. The turbines are Pelton type with three injectors. The turbines have a rated capacity of 7.98 MW each; the generators are each rated at 9.68 MVA and 7.74 MW. The powerhouse includes an overhead crane for installation and maintenance, as well as a control room. The power plant can be operated locally or remotely. Outside the powerhouse is a transformer that steps up voltage from 13.8 kV to 69 kV. A 48m channel directs the waterflow from the powerhouse back to the river Río Luis.

Tie-In: The powerhouse is located some 7km east of the town of Portovelo. The nearest substation, known as El Pache, owned by the power distributor CNEL Regional El Oro, is 1km west of Portovelo. A 9.8 km, 69kV tie-in line connects the project to the power grid.

Monitoring Equipment: The sole parameter to be monitored for this project activity (please see Section B.7) is net energy generation delivered to the grid. This parameter is regulated in

² The project description is based on detailed engineering design. The start date for this project activity is scheduled for July, 2012 (please see section C.1.1). Minor variations in specifications could occur during construction and when ordering key equipment items.



Ecuador³. Two meters will be installed for redundancy. The meters will be selected from the list of those certified by CENACE. They will be calibrated by an independent laboratory accredited by CENACE and sealed prior to installation. The meters will be recalibrated as required by CENACE regulations, at least every two years. The precision of the meters will be at least $\pm 0.2\%$ for both active and reactive energy. Readings are taken continuously and stored on a quarter hourly basis.

This is a Greenfield project. No equipment or installations exist prior to this project activity.

The baseline scenario for the Project, as described in Section B.4, is the continuing operation of the existing and future power plants connected to the Ecuadorian national grid, necessary to meet the system electricity demand, without the Río Luis Project electricity generation. In the project scenario, the same electricity demand is met with the Río Luis Project electricity generation dispatched in the base load, displacing generation from existing power plants and future power developments. Because the project uses renewable sources to produce electricity, there are no additional emissions from the project activity and the emissions reductions are generated by the displaced generation.

The key material and energy flows for this project activity depend on the flow of water through the river Río Luis. The ecological stream flow of 819 l/s will always be maintained. The estimated generation from the project is based on a detailed analysis of monthly flows through the river over the period from 1964 to 2005. The available water resource is estimated through statistical analysis to be:

Percentile	River Flow, m ³ /s
30%	9.16
50%	4.78
70%	2.91
80%	2.33
90%	1.84
95%	1.39

Engineering calculations, based on this resource average availability and the efficiencies of the project design, produce an expected annual generation of 83,065 MWh/y. Actual generation is expected to vary on a yearly basis due to rainfall variation, especially due to Niño and Niña conditions, as well as plant availability.

The participant considers this project to be environmentally safe and sound, based on the following:

- In general terms, this project's technology, run-of-river hydro, is considered more environmentally friendly than reservoir hydro.
- The ecological stream flow is respected during all conditions, even drought. Therefore, the original environmental values of the river Río Luis, especially flora and fauna, will be maintained.
- The small dam includes a fish ladder that works in both directions so that the project does not affect fish species either upstream or downstream.

³ The power sector regulator in Ecuador is CONELEC, the National Electricity Council. The system operator is CENACE, the National Electricity Control Centre.



- Due to its reduced dimensions, any methane emissions from the small run-of-river reservoir will be minimal.
- No social impacts are foreseen (dislocation of dwellings or economic activities, flooding of archaeological sites, etc.)
- The project has carried out an environmental impact analysis and has an approved environmental management plan (please see Section D.2). The environmental management plan will assure that any remain environmental impacts are minimized. The environmental license requires that this management plan be audited every two years.
- Additionally, the project is sponsoring a reforestation venture upstream within the area influenced by the river Río Luis.

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

Year	Estimation of annual emission reductions in tonnes of CO ₂ e
2015	51,517
2016	51,517
2017	51,517
2018	51,517
2019	51,517
2020	51,517
2021	51,517
2022	51,517
2023	51,517
2024	51,517
Total estimated reductions (tonnes of CO₂ e)	515,170
Total number of crediting years	10
Annual average of the estimated Reductions over the crediting period	51,517

A.4.5. Public funding of the project activity:

This project activity involves no public funding⁴.

⁴ Version 2 of the PDD for this project activity contemplated public funding, since the project participant is a wholly owned subsidiary of vehicle that invests in long-term productive assets in Ecuador to fund pensions for retired military personnel. According to paragraph 8.63 of the System of National Accounts, jointly published by the UN, IMF, OECD, European Commission and World Bank, both the project participant and its parent holding company are considered private.

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

This project activity uses approved methodology ACM0002 “Consolidated baseline methodology for grid-connected electricity generation from renewable sources” v12.2.0. This methodology requires the use of the “Tool for the demonstration and assessment of additionality” v06.0.0 and the “Tool to calculate the emission factor for an electricity system” v 02.2.1.

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

The project activity meets all of the relevant applicability criteria of ACM0002 v12.2.0:

<i>ACM0002 v12.2.0 Applicability Criteria</i>	<i>This Project Activity</i>
This methodology is applicable to grid-connected renewable power generation project activities that (a) install a new power plant at a site where no renewable power plant was operated prior to the implementation of the project activity (greenfield plant); (b) involve a capacity addition; (c) involve a retrofit of (an) existing plant(s); or (d) involve a replacement of (an) existing plant(s).	This is a run-of-river hydroelectric greenfield plant (option a), since no renewable plant exists prior to this project.
The methodology is applicable under the following conditions:	--
<ul style="list-style-type: none"> 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; 	This project activity is the installation of a new run-of-river hydro power plant.
<ul style="list-style-type: none"> In the case of capacity additions, retrofits or replacements (except for wind, solar, wave or tidal power capacity addition projects which use Option 2 on page 10 to calculate the parameter $EG_{PJ,y}$): the existing plant started commercial operation prior to the start of a minimum historical reference period of five years, used for the calculation of baseline emissions and defined in the baseline emission section, and no capacity expansion or retrofit of the plant has been undertaken between the start of this minimum historical reference period and the implementation of the project activity; 	Not applicable to Greenfield plants (this project activity)



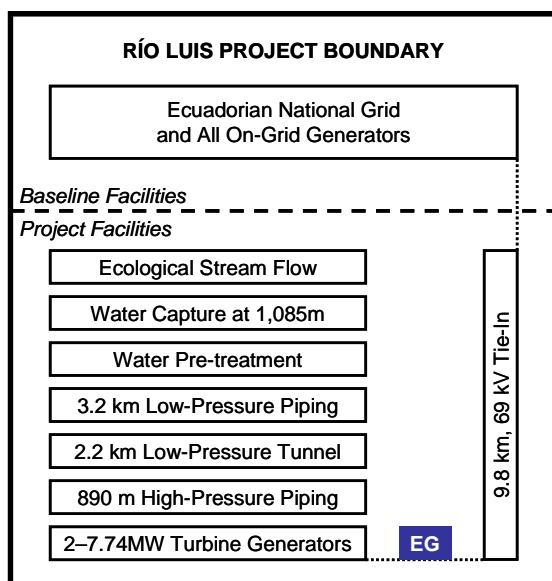
<i>ACM0002 v12.2.0 Applicability Criteria</i>	<i>This Project Activity</i>
<p>In case of hydro power plants:</p> <ul style="list-style-type: none"> • One of the following conditions must apply: <ul style="list-style-type: none"> ○ The project activity is implemented in an existing single or multiple reservoirs, with no change in the volume of any of reservoirs; or ○ 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/m²; or ○ 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/m². 	<p>The third option applies to this project activity. It includes the construction of one small dam (10m height above river bottom) to allow water flow to be diverted to the project activity. The power density of this single run-of-river reservoir is about 1,000 W/m², several order of magnitude greater than the minimum applicability threshold.</p>
<p>In case of hydro power plants using multiple reservoirs where the power density of any of the reservoirs is lower than 4 W/m² all the following conditions must apply:</p> <ul style="list-style-type: none"> • The power density calculated for the entire project activity using equation 5 is greater than 4 W/m²; • Multiple reservoirs and hydro power plants located at the same river and where are designed together to function as an integrated project that collectively constitute the generation capacity of the combined power plant; • Water flow between multiple reservoirs is not used by any other hydropower unit which is not a part of the project activity; • Total installed capacity of the power units, which are driven using water from the reservoirs with power density lower than 4 W/m², is lower than 15MW; • Total installed capacity of the power units, which are driven using water from reservoirs with power density lower than 4 W/m², is less than 10% of the total installed capacity of the project activity from multiple reservoirs. 	<p>Not applicable to hydro power plants using a single reservoir (this project activity).</p>



<i>ACM0002 v12.2.0 Applicability Criteria</i>	<i>This Project Activity</i>
<p>The methodology is not applicable to the following:</p> <ul style="list-style-type: none"> • Project activities that involve switching from fossil fuels to renewable energy sources at the site of the project activity, since in this case the baseline may be the continued use of fossil fuels at the site; • Biomass fired power plants; • A hydro power plant that results in the creation of a new single reservoir or in the increase in an existing single reservoir where the power density of the power plant is less than 4 W/m². 	<p>This project does not involve fuel switching or biomass. The power density of the new single run-of-river reservoir is about 1,000 W/m², considerably greater than the applicability threshold.</p>
<p>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 was already in use prior to the implementation of the project activity and undertaking business as usual maintenance”.</p>	<p>Not applicable to Greenfield plants (this project activity)</p>

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

As per ACM0002 v12.2.0, the project boundary includes the project power plant and all power plants connected physically to the electricity system that the CDM project power plant is connected to. This electricity system is the Ecuadorian national grid as defined and further explained in section B.6.1. The project boundary is depicted in the following flow diagram:





The sources of emissions within the project boundary and its baseline are prescribed by ACM0002 v12.2.0 and thus described in the following table:

Source		Gas	Included?	Justification / Explanation
Baseline	CO ₂ emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity	CO ₂	Yes	Main emission source
		CH ₄	No	Minor emission source
		N ₂ O	No	Minor emission source
Project activity	For hydro power plants, emissions of CH ₄ from the reservoir	CO ₂	No	Minor emission source
		CH ₄	No	Excluded by ACM0002 v12.2.0 for hydro plants with power densities greater than 10 W/m ²
		N ₂ O	No	Minor emission source

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

Since this project activity is the installation of a new grid-connected renewable power plant/unit, ACM0002 v12.2.0 defines the baseline scenario as the following:

Electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin (CM) calculations described in the “Tool to calculate the emission factor for an electricity system”.

The approved methodology ACM0002 v12.2.0 does not require the identification and evaluation of alternative baseline scenarios for new grid-connected renewable power plants.

The calculation of the CM as per the cited tool is described in section B.6.1.

Description of the Identified Baseline Scenario

The baseline scenario for the Project is the continuing operation of the existing and future power plants, necessary to meet the actual electricity demand, without the Río Luis Project electricity generation. In the project scenario, the same electricity demand is met with the Río Luis Project electricity generation dispatched in the base load, displacing generation from existing power plants and future power developments. Because the project uses renewable sources to produce electricity, there are no additional emissions from the project activity and the emissions reductions are generated by the displaced generation.

The relevant spatial extent of this project activity is the Ecuadorian National Grid System. Therefore, the baseline scenario is one where the electricity that could be supplied by the project to the network would have to be generated by other plants currently connected to the network and by new plants that would be



added to the System, based on a mix of primary energy sources. The current generation mix and new plant additions to the system are fully represented in the calculation of the CM that is provided in section B.6.1.

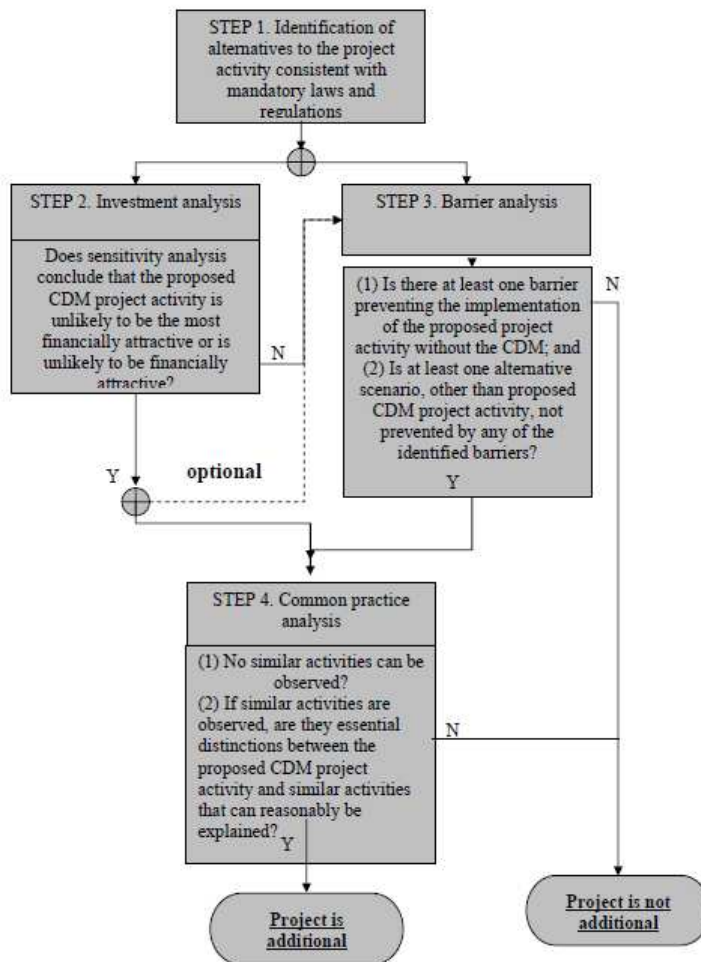
B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

Prior Consideration

The starting date of this project activity is after the Global Stakeholder Consultation undertaken at validation. Therefore, evidence that the incentive from the CDM was seriously considered in the decision to proceed with the project activity is not required as per EB41 Annex 12. Neither is prior notification to the UNFCCC required as per EB63 Annex 13. Nevertheless, this project activity has notified its intention to seek CDM status through the prior consideration form on 6 September 2011 and has communicated said intention with the Ecuadorian DNA as evidenced through the Letter of Approval dated 2 August 2010.

Demonstration and Assessment of Additionality

As indicated in ACM0002 v12.2.0, the demonstration and assessment of additionality for this project activity is carried out using the “Tool for the demonstration and assessment of additionality” v6.0.0. The tool requires a step-wise approach shown in the following diagram:



Step 1: Identification of alternatives to the project activity consistent with current laws and regulations

Define realistic and credible alternatives⁶ to the project activity(s) through the following Sub-steps:

Sub-step 1a: Define alternatives to the project activity:

Identify realistic and credible alternative(s) available to the project participants or similar project developers that provide outputs or services comparable with the proposed CDM project activity.

The following alternatives are considered realistic and credible:

1. The proposed project activity is undertaken without being registered as a CDM project activity;
2. The Ecuadorian power system would continue to operate and expand without the Río Luis project; that is the electricity will be supplied by a grid produced from a mix of



fossil-fuel and renewable generation units as well as imports. This mix is quantified below in section B.6.1.

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

Both alternatives from sub-step 1a are consistent with mandatory laws and regulations. Therefore, this sub-step does not modify either of the available alternatives.

Step 2: Investment analysis

Determine whether the proposed project activity is not:

(a) The most economically or financially attractive; or

(b) Economically or financially feasible, without the revenue from the sale of certified emission reductions (CERs).

This project activity chooses option b, demonstrating that the project activity is not economically or financially feasible without CER revenue.

Sub-step 2a: Determine appropriate analysis method

Determine whether to apply simple cost analysis, investment comparison analysis or benchmark analysis.

According to the “Tool for the Demonstration and Assessment of Additionality” v6.0.0, Option I (simple cost analysis) cannot be used as the project involves revenue generation apart from the revenue from sale of carbon credits. As the alternative to the project activity is the supply of electricity from the grid which is not to be considered an investment, option III (Benchmark analysis) is selected as per paragraph 19 of the “Guidelines on the Assessment of Investment Analysis” v05.

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

Identify the financial/economic indicator, such as IRR, most suitable for the project type and decision context.

The financial indicator selected for this benchmark analysis is equity IRR in real terms.

As per paragraph 29 of the “Tool for the Demonstration and Assessment of Additionality” v6.0.0, the value of the benchmark should be standard in the market. This is deemed suitable for this project activity, since it could be developed by others through offering equity shares in the project or arranging equity finance through a BOT scheme.

The value of the equity IRR benchmark is identified based on the cost of equity. According to Appendix A of the “Guidelines on the Assessment of Investment Analysis”



v05, the default value of the cost of equity for sectoral scope 1 (energy industries) projects in Ecuador is 17.0%.

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

Calculate the suitable financial indicator for the proposed CDM project activity

The basis of the cash flow analysis to determine the equity IRR for this project activity is:

<i>Paragraph⁵</i>	<i>Concept</i>	<i>Value / Method Applied</i>
3	Period of Assessment	10 years is chosen as the period of assessment based on the accounting lifetime of the major equipment items in the project activity ⁶
4	Residual Value	Since the technical lifetime of hydro plants can be very long, a residual value is assigned at the end of the period of assessment calculated using the perpetuity method with the last year's, after tax operational cash flow and applying the benchmark equity IRR as a discount rate.
5	Depreciation and Taxation	Depreciation is included to calculate taxes but not considered as a cash flow. Taxation is included, since the basis of the benchmark is post-tax.
6	Input Values	All input values are listed below and sourced or referenced
7	Interruption	Has not occurred in this project activity
8	Spreadsheet	Attached to this PDD
9,11	Project IRR	Not applicable since the indicator is equity IRR
10	Equity IRR	All financing cash flows are included in the analysis so that only the equity investment is considered
12-18	Benchmark	The identification and justification of the benchmark is described under sub-step 2b
19	Benchmark vs. Investment Comparison	The selection and justification of benchmark analysis instead of investment comparison is described under sub-step 2a

⁵ Refers to the paragraph of "Guidelines on the Assessment of Investment Analysis" v05

⁶ As per references for depreciation periods that follow



<i>Paragraph⁵</i>	<i>Concept</i>	<i>Value / Method Applied</i>
20	Sensitivity Analysis	A complete sensitivity analysis is provided under sub-step 2d and documented in the attached spreadsheet

Input Values

The following input values for construction costs are derived from the detailed engineering design for this project activity:

<i>Construction Costs, USD 000</i>	<i>Year -2</i>	<i>Year -1</i>	<i>Year 0</i>	<i>Total</i>
Land	334.8	111.6	53.6	500.0
Site preparation, civil works, and buildings	11,769.8	3,924.5	1,883.7	17,578.0
Fixed Equipment and Installations	8,476.5	2,826.3	1,356.6	12,659.5
Intangibles	1,494.2	498.2	239.1	2,231.6
Total	22,075.3	7,360.7	3,533.1	32,969.1

The operating and maintenance costs are estimated in the detailed engineering design studies for the project to be 542,778 USD annually.

Average electricity generation is estimated to be 83,065 MWh annually.

Electricity sales will receive a net selling price of 6.88 cents (of USD) per kWh according to applicable regulations⁷.

The following input values are accounting variables specified in Ecuadorian regulations:

<i>Data Item</i>	<i>Value</i>
Depreciation Periods in Years ⁸	
Land	--
Site preparation, civil works, and buildings	20
Fixed Equipment and Installations	10
Intangibles	5
Corporate income tax ⁹	33.7%

The following input values are specified in the non-binding offers for project finance received by ENERGYHDINE:

⁷ CONELEC Regulation 004/2011

⁸ Specified in Executive Decree 1051 of 2008

⁹ Includes the 22% tax on corporate profits specified in Executive Decree 1051 of 2008 as modified by the Production Code plus the 15% mandatory sharing of pre-tax profits with workers as per the Worker's Code. This latter is deductible against the former, thus the effective tax rate on pre-tax profits is 15% plus 22% of 85% equals 33.7%



<i>Data Item</i>	<i>Value</i>
Fraction Financed	70%
Loan Duration in years	9
Real Interest Rate (APR) ¹⁰	8.0%

The cash flow analysis is carried out on a real basis. Therefore, input values for inflation and price indices are not required.

The equity IRR of this project activity, utilizing the above input values and shown in the attached spreadsheet, is 12.36%. This value is lower than the benchmark value of 17%.

Sub-step 2d: Sensitivity analysis

Include a sensitivity analysis that shows whether the conclusion regarding the financial/economic attractiveness is robust to reasonable variations in the critical assumptions

As per the guidance in paragraph 21 of the “Guidelines on the Assessment of Investment Analysis” v05, a sensitivity analysis has been carried out to study the impact of ±10% variation on the following key variables:

- Investment cost
- Operating and maintenance cost
- Electricity generation

The sensitivity analysis is included in the attached spreadsheet and summarized in the following table:

<i>Analysis Case</i>	<i>Equity IRR</i>
Base Case	12,36%
Sensitivity +10% investment	10,08%
Sensitivity -10% investment	14,95%
Sensitivity +10% cost	12,10%
Sensitivity -10% cost	12,61%
Sensitivity +10% generation	14,94%
Sensitivity -10% generation	9,57%

In all cases, the equity IRR is lower than the benchmark value of 17.0%. The results of the sensitivity analysis demonstrate that the project activity, in the absence of CER revenues, is economically unattractive. Therefore, according to the “Tool for the Demonstration and Assessment of Additionality” v6.0.0, the following procedure is step 4.

¹⁰ The 10% nominal interest rate in USD offered in the non-binding proposal has been adjusted down by 2% into real terms, according to the long-term inflation target adopted by the Federal Reserve Bank.

**Step 4: Common practice analysis**

This project activity (renewable energy) is listed under paragraph 6 of the “Tool for the Demonstration and Assessment of Additionality” v6.0.0. Therefore, the common practice analysis is carried out according to the four-step procedure within paragraph 47 of said tool.

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

This project activity comprises one power plant with two identical power units of 7.74 MW each for a total capacity of 15.48MW. The applicable output range is thus 7.74MW to 23.22MW.

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} . Registered CDM project activities and projects activities undergoing validation shall not be included in this step;

The geographical area is defined as Ecuador, the host country by default. The following plants have been inventoried from the dataset of generation power plants in Ecuador provided to the project activity by CONELEC applying the output range from the previous step:

Power Plant	Type	Capacity, kW
Miraflores	Gas Turbine	22.800
Guangopolo	Hydro	20.920
El Descanso	Internal Combustion Engine	19.200
REPSOL YPF-SPF-2	Internal Combustion Engine	18.768
Yuralpa	Internal Combustion Engine	17.697
Guangopolo	Internal Combustion Engine	17.520
CPF	Internal Combustion Engine	15.295
Recuperadora	Hydro	14.700
Limoncocha	Internal Combustion Engine	14.569
Saymirín	Hydro	14.432
Catamayo	Internal Combustion Engine	13.910
Shushufindi	Internal Combustion Engine	12.750
Oso	Internal Combustion Engine	12.680
PGE	Steam Cycle	12.000
Secoya	Internal Combustion Engine	11.000
Alao	Hydro (Reservoir) ¹¹	10.400

¹¹ CONELEC, Reservoirs in the Ecuadorian Electricity System



Hormiguero C	Internal Combustion Engine	10.005
Celso Castellanos	Internal Combustion Engine	10.000
Yamanunka	Internal Combustion Engine	9.943
Payamino	Internal Combustion Engine	9.350
Luluncoto	Internal Combustion Engine	9.074
Agip Oil - Sarayacu	Internal Combustion Engine	9.000
REPSOL YPF-SSFD	Internal Combustion Engine	8.635
El Carmen	Hydro	8.400
Laguna	Internal Combustion Engine	8.285
Ambi	Hydro	8.000

Registered CDM projects 0142 and 0580 are not included in this list

There are a total of 26 power plants in this group. N_{all} is thus equal to 26.

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

Of the 26 power plants in the group of N_{all} , 21 are of other types as defined by CONELEC. These other types are internal combustion engine, gas turbine, and reservoir hydro. These are clearly different energy sources as defined by paragraph 9(a) of the “Tool for the Demonstration and Assessment of Additionality” v6.0.0

Of the remaining 5 power plants, 4 have capacities not more than 15MW, and thus should be considered as different technologies in application of paragraph 9(c)(ii) of the “Tool for the Demonstration and Assessment of Additionality” v6.0.0

Therefore, the number of plants with different technologies, N_{diff} , is equal to 25.

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

The factor, F, is calculated as $1-25/26 = 0.038$

According to the “Tool for the Demonstration and Assessment of Additionality” v6.0.0:

The proposed project activity is a “common practice” within a sector in the applicable geographical area if both the following conditions are fulfilled:

(a) the factor F is greater than 0.2, and

(b) $N_{all}-N_{diff}$ is greater than 3.



For this project activity, the factor F is 0.038 is clearly not greater than 0.2; as a result criteria (a) is not met. The difference $N_{all} - N_{diff}$ ($26 - 25 = 1$) is less than 3, thus not satisfying criteria (b). Since neither criteria (a) nor (b) is satisfied, then the proposed project activity is not a “common practice”.

As a result of the above analysis, this proposed project activity is additional.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

Project Emissions

ACM0002 v12.2.0 defines project emissions as follows:

$$PE_y = PE_{FF,y} + PE_{GP,y} + PE_{HP,y}$$

Where:

- PE_y = Project emissions in year y (tCO₂e/yr)
- $PE_{FF,y}$ = Project emissions from fossil fuel consumption in year y (tCO₂/yr)
- $PE_{GP,y}$ = Project emissions from the operation of geothermal power plants due to the release of non-condensable gases in year y (tCO₂e/yr)
- $PE_{HP,y}$ = Project emissions from water reservoirs of hydro power plants in year y (tCO₂e/yr)

The term $PE_{FF,y}$ only applies to geothermal and solar project activities that also combust fossil fuels. Therefore, for this project activity, $PE_{FF,y} = 0$.

The term $PE_{GP,y}$ only applies to geothermal project activities. Therefore, for this project activity, $PE_{GP,y} = 0$.

For hydro power plants with power densities (PD) greater than 10 kW/m², the term $PE_{HP,y}$ is zero. The power density of this project activity is about 1,000 kW/m². Therefore, for this project activity, $PE_{HP,y} = 0$.

As a result, $PE_y = 0$.

Baseline Emissions

ACM0002 v12.2.0 defines baseline emissions as follows:

$$BE_y = EG_{PJ,y} * EF_{grid,CM,y} \quad \text{(Equation 1)}$$

Where:

- BE_y = Baseline emissions in year y (tCO₂/yr)
- $EG_{PJ,y}$ = Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year y (MWh/yr)



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

This project activity is a Greenfield facility. The parameter $EG_{PJ,y}$ is calculated according to case (a) of AMC0002 v12.2.0:

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

Where:

$EG_{PJ,y}$ = Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year y (MWh/yr)

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

The term $EF_{grid,CM,y}$ is calculated using the “Tool to calculate the emission factor for an electricity system” v2.2.1 as follows:

STEP 1. Identify the relevant electricity systems

The “Tool to calculate the emission factor for an electricity system” v2.2.1 indicates that the default relevant electricity system for the project is the national grid. The Ecuadorian national grid is thus selected as the relevant electricity system:

- It is operated as a national grid, known as the SNI¹².
- The Ecuadorian national grid is connected to neighbouring national grids (Peru and Colombia) although imports from these other grids are less than 10% of national power demand¹³.

The geographical extent of this system covers the entire Ecuadorian continental territory. The power plants in this system are listed in Annex 3¹⁴.

The Ecuadorian power system includes connections to both the Peruvian and Colombian national grids. As per step 1 of the “Tool to calculate the emission factor for an electricity system” v2.2.1, the consideration of these connections is as follows:

¹² Acronym in Spanish for National Interconnected System

¹³ CONELEC, Ecuadorian Power Sector Statistical Bulletin, 2010

¹⁴ The power plants considered are all those owned by power sector agents (generators and distributors), including those under 1 MW that are self-despatched (as per the regulations governing despatch and operation of the SNI, published in Executive Decree Number 591, 11 February 1999). The list of power plants excludes self-generators that are not grid connected, since they do not comply with the definition of off-grid power units. The list also excludes generation units on the Galapagos Islands since they are not physically connected to the mainland grid. The list does include the Ecuadorian continental region of Sucumbios since it is physically interconnected (CONELEC, Electricity Master Plan 2009-2020), although not entirely despatched by the grid operator CENACE. It also includes the interconnections with Colombia and Peru.

Build margin: Transmission capacity to a connected electricity system may be considered as a build margin source where recent or likely future additions enable significant increases in imported electricity. The connection to the Peruvian grid has not been modified in the past 5 years (the timeframe for analyzing the build margin, please see step 5). Therefore, it is not considered. A second circuit was added to the connection to the Colombian grid at the end of 2008, thus doubling its capacity.¹⁵ Imports from Colombia in 2009, once the upgrade was operational, more than doubled those from 2008¹⁶. The upgrade to this international connection can therefore be considered significant and hence is included in the build margin.

Operating margin: A simple adjusted operating margin emission rate of the Colombian grid is calculated and used for 2010 and in the build margin. This calculation is shown in Annex 3. For other vintages if imports from the Colombian grid and for all vintages of imports from the Peruvian grid, this project activity assumes the conservative emission factor of 0 tCO₂/MWh.

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

This project activity chooses Option I, to not include off-grid power plants.

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

This project activity chooses method (b), simple adjusted OM. The ex-ante option is chosen, applying data of vintages 2008-2010, being the three most recent years of complete data available at validation.

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

As per the “Tool to calculate the emission factor for an electricity system” v2.2.1, the simple adjusted OM is calculated as follows:

$$EF_{grid,OM-adj,y} = (1 - \lambda_y) \times \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} + \lambda_y \times \frac{\sum_k EG_{k,y} \times EF_{EL,k,y}}{\sum_k EG_{k,y}}$$

Where

$EF_{grid,OM-adj,y}$ = Simple adjusted operating margin CO₂ emission factor in year y (tCO₂/MWh)
 λ_y = Factor expressing the percentage of time when low-cost/must-run power units are on the margin in year y

¹⁵ CONELEC, Electricity Master Plan 2009-2020

¹⁶ Imports from Colombia were 1,058.2 GWh in 2009, compared to 500.2 GWh in 2008, according to CONELEC, Ecuadorian Power Sector Statistical Bulletin, 2010



$EG_{m,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EG_{k,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit k in year y (MWh)
$EF_{EL,m,y}$	=	CO ₂ emission factor of power unit m in year y (tCO ₂ /MWh)
$EF_{EL,k,y}$	=	CO ₂ emission factor of power unit k in year y (tCO ₂ /MWh)
m	=	All grid power units serving the grid in year y except low-cost/must-run power units
k	=	All low-cost/must-run power units serving the grid in year y
y	=	The relevant year as per the data vintage chosen in Step 3

Since fuel consumption and electricity generation is available for each power unit in the system, $EF_{EL,m,y}$ and $EF_{EL,k,y}$ are calculated based on Option A1 of the simple OM method as follows:

$$EF_{EL,m/k,y} = \frac{\sum_i FC_{i,m/k,y} \times NCV_{i,y} \times EF_{CO_2,i,y}}{EG_{m/k,y}}$$

Where

$EF_{EL,m/k,y}$	=	CO ₂ emission factor of power unit m or k in year y (tCO ₂ /MWh)
$FC_{i,m/k,y}$	=	Amount of fossil fuel type i consumed by power unit m or k in year y (Mass or volume unit)
$NCV_{i,y}$	=	Net calorific value (energy content) of fossil fuel type i in year y (GJ/mass or volume unit)
$EF_{CO_2,i,y}$	=	CO ₂ emission factor of fossil fuel type i in year y (tCO ₂ /GJ)
$EG_{m/k,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit m or k in year y (MWh)
m	=	All grid power units serving the grid in year y except low-cost/must-run power units
k	=	All low-cost/must-run power units serving the grid in year y
i	=	All fossil fuel types combusted in power unit m or k in year y
y	=	The relevant year as per the data vintage chosen in Step 3

The following data sources are used to calculation the emission factors:

$EG_{m/k,y}$	Annual generation 2008 to 2010 for each power unit as supplied to the project activity in a dataset prepared from the database of CONELEC and shown in Annex 3.
$FC_{i,m/k,y}$	Annual fuel consumption by type 2008 to 2010 for each power unit as supplied to the project activity in a dataset prepared from the database of CONELEC and shown in Annex 3.
$NCV_{i,y}$	Values published by CONELEC and sourced from PETROECUADOR for commercial liquid fuels. For other fuels, IPCC default values at the lower limit of the uncertainty at a 95% confidence interval and shown in section B.6.2.
$EF_{CO_2,i,y}$	IPCC default values at the lower limit of the uncertainty at a 95% confidence



interval and shown in section B.6.2.

Liquid and gaseous fuel consumptions are published in volumetric units. Net calorific values are published in mass units. To be consistent, density values and unit conversions are applied. National density values are used when available. Otherwise, values published by the International Energy Agency are applied. These values are also shown in section B.6.2.

Fossil fuel generators are classified as m . Ecuador has no coal-fired generators. Hydro and other renewable generators as well as imports are classified as k .

Lambda (λ_y) is calculated in the attached emission factor spreadsheet according to the 4-step procedure, commented as follows:

- step (i) Hourly system load data for 2008-2010 are sorted in descending order. These data were provided to the project by CONELEC and sourced from the grid operator, CENACE.
- step (ii) The annual generation from all low-cost/must-run units was summed from the dataset provided by CONELEC. This dataset includes those on-grid generators that are not dispatched by CENACE. Therefore, it is conservative, compared to the hourly load dataset.
- step (iii) The attached emission factor spreadsheet postulates a horizontal line at each of the 8,760 points along the ordered load curve. The area under the postulated horizontal line is then compared to the annual generation from low-cost/must-run units identified in step (ii)
- step (iv) The number of hours is identified by summing the number of hours where the area under the postulated horizontal line is less than the sum of the low-cost/must-run generation.

The results of the Lambda calculation are shown in section B.6.2.

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

This project activity chooses Option 1, ex-ante calculation of the build margin applying data of vintage 2010, being the most recent published data available at validation.

The sample group m of power units to calculate the build margin is identified as follows:

- 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 ($SET_{5-units}$) and determine their annual electricity generation ($AE_{SET-5-units}$, in MWh);*

According to the dataset provided by CONELEC, five units started to supply grid power in 2010:

<i>Power Unit</i>	<i>Capacity, kW</i>	<i>2010 Net Generation, MWh</i>
Electrocórdova Michael Banki	200	52
Mazar Unit1	91,830	232.518



Mazar Unit2	91,830	29.770
Santa Elena	75,000	244.333
Quevedo	130,000	456.934
Total 5 units	388,860	963,607

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

The net generation of the project electricity system in 2010 was 17,642,869 MWh, including imports. Of this amount, 603,568 MWh correspond to 6 registered CDM projects¹⁷. The parameter AEG_{total} is thus equal to 17,039,301 MWh and the 20% threshold for this step is therefore equal to 3,407,860 MWh.

The set of most recent power units that supplied this threshold generation value in 2010 is:

Power Plant	Type	Power Unit	Start	2010		
				Capacity (kW)	Generation (MWh)	Cumulative MWh
Electrocórdova	Hydro	Michael Banki	Jul-10	200	52	52
Mazar	Hydro	U1	Jul-10	91,830	232.518	232.570
Mazar	Hydro	U2	Jul-10	91,830	29.770	262.341
Santa Elena	ICE	Santa Elena	Feb-10	75,000	244.333	506.673
Quevedo	ICE	Quevedo	Ene-10	130,000	456.934	963.607
Pascuales II	GT	TM1	Dec-09	22,800	98.410	1.062.017
Pascuales II	GT	TM2	Dec-09	22,800	108.048	1.170.065
Pascuales II	GT	TM3	Dec-09	22,800	105.523	1.275.588
Pascuales II	GT	TM4	Dec-09	22,800	100.484	1.376.072
Pascuales II	GT	TM5	Dec-09	22,800	98.020	1.474.092
Pascuales II	GT	TM6	Dec-09	22,800	81.775	1.555.867
Power Barge II	ICE	PB-1	Nov-09	12,500	12.230	1.568.097
Power Barge II	ICE	PB-2	Nov-09	12,500	16.280	1.584.378
Power Barge II	ICE	PB-3	Nov-09	12,500	8.897	1.593.275
Power Barge II	ICE	PB-4	Nov-09	12,500	10.818	1.604.093
Cauchiche	ICE	C6	May-09	45	26	1.604.119
Cauchiche	ICE	C7	May-09	35	29	1.604.148
Puná Viejo	ICE	U1	May-09	35	4	1.604.152
Puná Viejo	ICE	U2	May-09	35	4	1.604.156
Tiliví	Hydro	U1	May-09	120	326	1.604.482
Uravia	Hydro	U1	Feb-09	1,000	7.594	1.612.076

¹⁷ Registered CDM Projects 0141, 0142, 0210, 0580, 0614, and 4654



Colombia	Import	50%	Oct-08	270,000	397.255	2.009.331
Jivino	ICE	MAN 1	Jul-07	5,800	26.956	2.036.288
Jivino	ICE	MAN2	Jul-07	5,800	14.342	2.050.629
San Francisco	Hydro	U1	May-07	115,000	418.806	2.469.435
San Francisco	Hydro	U2	May-07	115,000	622.975	3.092.410
Termoguyas	ICE	U1	Dec-06	20,000	175.046	3.267.456
Termoguyas	ICE	U2&3	Dec-06	80,000	417.916	3.685.373

Units 2 and 3 of Termoguyas (considered a single power unit as defined in the “Tool to calculate the emission factor for an electricity system” v2.2.1, since they belong to the same plant and have identical vintages, capacity, and technology) is the marginal unit for this set and thus fully included.

The 230kV connection with Colombia was installed in 2003 and upgraded by adding a second circuit in 2008, thus doubling its capacity. Therefore, only 50% of the import through this connection is considered in the build margin.

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

SET_{sample} is identified as $SET_{\geq 20\%}$. The earliest date in the set is December 2006, clearly less than 10 years ago. SET_{sample} is thus used to calculate the build margin and steps (d) - (f) are ignored.

The build margin is calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where

- $EF_{grid,BM,y}$ = Build margin CO₂ emission factor in year y (tCO₂/MWh)
- $EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
- $EF_{EL,m,y}$ = CO₂ emission factor of power unit m in year y (tCO₂/MWh)
- m = Power units included in the build margin
- y = Most recent historical year for which electricity generation data is available

Since this project activity selects Option 1, ex-ante calculation of BM, the parameter y corresponds to vintage 2010, being the most recent data available.



The CO₂ emission factor for all power units in the system is calculated as per the guidance in Step 4 (a) for the simple OM using option A1, as described above and shown in the attached spreadsheet. The calculation of the emission factor for imports from Colombia is shown in Annex 3.

STEP 6. Calculate the combined margin (CM) emission factor

This project activity selects method (a) for determining CM, being the preferred option. The combined margin emission factor is thus calculated as follows:

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

Where

$EF_{grid,BM,y}$	=	Build margin CO ₂ emission factor in year y (tCO ₂ /MWh)
$EF_{grid,OM,y}$	=	Operating margin CO ₂ emission factor in year y (tCO ₂ /MWh)
w_{OM}	=	Weight of operating margin emissions factor (%)
w_{BM}	=	Weight of build margin emissions factor (%)

The default values of $w_{OM} = 0.5$ and $w_{BM} = 0.5$ are applied to this project activity.

Leakage

No leakage emissions are considered by ACM0002 v12.2.0.

Emission Reductions

Emission reductions are calculated as follow:

$$ER_y = BE_y - PE_y - L_y$$

Where

ER_y	=	Emission reductions in year y (tCO ₂ /y)
BE_y	=	Baseline emissions in year y (tCO ₂ /y)
PE_y	=	Project emissions in year y (tCO ₂ /y)
L_y	=	Leakage emissions in year y (tCO ₂ /y)

Project emissions and leakage are zero, as described above. These two terms can thus be ignored. The formula for baseline emissions (equation 1) is substituted into the above formula to yield:

$$ER_y = EG_{PJ,y} * EF_{grid,CM} \tag{Equation 2}$$

The subscript y for the grid emission factor from equation 1 has been omitted to reflect the choice of an ex-ante calculation of the combined margin grid emission factor.

**B.6.2. Data and parameters that are available at validation:***(Copy this table for each data and parameter)*

Data / Parameter:	$FC_{i,m,y}$ $FC_{i,k,y}$
Data unit:	t/y, gal/y, kft ³ /y
Description:	Fuel consumption of fuel type <i>i</i> for power unit <i>m</i> or <i>k</i> in year <i>y</i>
Source of data used:	Dataset provided to the project activity by CONELEC
Value applied:	Please see Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	These data are identical to those published by CONELEC in Electricity Statistics, 2008-2010
Any comment:	Liquid and gaseous fuels are reported in volumetric units. They are converted to SI through conversion factors and density.

Data / Parameter:	$NCV_{i,y}$																											
Data unit:	GJ/t																											
Description:	Net calorific value of fuel type <i>i</i> in year <i>y</i>																											
Source of data used:	1) Dataset provided to the project activity by CONELEC, referencing the NCVs for commercial liquid fuels to values published by PETROECUADOR 2) 2006 IPCC default values at the lower end of the 95% confidence interval																											
Value applied:	<table border="1"> <thead> <tr> <th>Fuel</th> <th>Source</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Crude</td> <td>2</td> <td>40.1</td> </tr> <tr> <td>Natural Gas</td> <td>2</td> <td>46.5</td> </tr> <tr> <td>LPG</td> <td>2</td> <td>44.8</td> </tr> <tr> <td>Naphtha</td> <td>2</td> <td>41.8</td> </tr> <tr> <td>Residual Oil</td> <td>1</td> <td>39.7</td> </tr> <tr> <td>Bagasse</td> <td>2</td> <td>7.62</td> </tr> <tr> <td>Fuel Oil</td> <td>1</td> <td>40.9</td> </tr> <tr> <td>Diesel</td> <td>1</td> <td>41.3</td> </tr> </tbody> </table>	Fuel	Source	Value	Crude	2	40.1	Natural Gas	2	46.5	LPG	2	44.8	Naphtha	2	41.8	Residual Oil	1	39.7	Bagasse	2	7.62	Fuel Oil	1	40.9	Diesel	1	41.3
Fuel	Source	Value																										
Crude	2	40.1																										
Natural Gas	2	46.5																										
LPG	2	44.8																										
Naphtha	2	41.8																										
Residual Oil	1	39.7																										
Bagasse	2	7.62																										
Fuel Oil	1	40.9																										
Diesel	1	41.3																										
Justification of the choice of data or description of measurement methods and procedures actually applied :	Two of the three NCV values published by CONELEC fall below the lower limit of the 95% confidence interval in the IPCC 2006 guidelines. The remaining value is lower than the IPCC default value. They are considered reliable and conservative.																											
Any comment:	These values apply to all three vintages: 2008-2010																											

Data / Parameter:	ρ_i						
Data unit:	t/m ³						
Description:	Density (or specific gravity) of fuel type <i>i</i>						
Source of data used:	1) Dataset provided to the project activity by CONELEC 2) International Energy Agency. Density of Oil Products. 2004						
Value applied:	<table border="1"> <thead> <tr> <th>Fuel</th> <th>Source</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Crude</td> <td>2</td> <td>0.8505</td> </tr> </tbody> </table>	Fuel	Source	Value	Crude	2	0.8505
Fuel	Source	Value					
Crude	2	0.8505					



	Natural Gas	1	0.00074
	LPG	2	0.5625
	Naphtha	1	0.74
	Residual Oil	1	0.86
	Fuel Oil	1	0.96
	Diesel	1	0.88
Justification of the choice of data or description of measurement methods and procedures actually applied :			
Any comment:	Density is required to convert volumetric fuel consumption data for gaseous and liquid fuels into mass units to be consistent with the net calorific values		

Data / Parameter:	EF_{CO₂,i,y}			
Data unit:	Shown below			
Description:	CO ₂ emission factor for fuel type <i>i</i> in year <i>y</i>			
Source of data used:	1) 2006 IPCC default values at the lower end of the 95% confidence interval 2) EB23 Annex05			
Value applied:	Fuel	Units	Source	Value
	Crude	tCO ₂ /TJ	1	71.1
	Natural Gas	tCO ₂ /TJ	1	54.3
	LPG	tCO ₂ /TJ	1	61.6
	Naphtha	tCO ₂ /TJ	1	69.3
	Residual Oil	tCO ₂ /TJ	1	75.5
	Bagasse	tCO ₂ /TJ	see below	0
	Fuel Oil	tCO ₂ /TJ	1	75.5
	Diesel	tCO ₂ /TJ	1	72.6
	Reservoir Hydro	tCO ₂ /MWh	2	0.09
Justification of the choice of data or description of measurement methods and procedures actually applied :				
Any comment:	Bagasse is assigned an emission factor of 0 as a biomass fuel			

Data / Parameter:	EG_{m,y} EG_{k,y}	
Data unit:	kWh/y	
Description:	Net electricity generated by power plant <i>m</i> or <i>k</i> in year <i>y</i>	
Source of data used:	Dataset provided to the project activity by CONELEC	
Value applied:	Please see Annex 3	
Justification of the choice of data or description of	These data are identical to those published by CONELEC in Electricity Statistics, 2008-2010	



measurement methods and procedures actually applied :	
Any comment:	The original dataset has been screened to include only those power units that comply with the definition of <i>Grid power plant/unit</i> as per the “Tool to calculate the emission factor for an electricity system” v02.2.1

Data / Parameter:	λ_y	
Data unit:	--	
Description:	Factor expressing the percentage of time when low-cost/must-run power units are on the margin in year y	
Source of data used:	Calculation based on the hourly system loads within the dataset provided to the project activity by CONELEC	
Value applied:	Year	Value
	2008	3.3015%
	2009	0.0342%
	2010	0.0000%
Justification of the choice of data or description of measurement methods and procedures actually applied :		
Any comment:	The calculation of Lambda is transparently shown in the attached spreadsheet that calculates EF_{grid}	

Data / Parameter:	$w_{OM} w_{BM}$	
Data unit:	--	
Description:	Weighting of operating and build margin emission factors	
Source of data used:	“Tool to calculate the emission factor for an electricity system” v02.2.1	
Value applied:	w_{OM}	0.5
	w_{BM}	0.5
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default values from the Tool	
Any comment:		

Data / Parameter:	$EF_{grid,OM,y}$	
Data unit:	tCO ₂ /MWh	
Description:	Operating margin emission factor in year y	
Source of data used:	Calculation shown in the attached spreadsheet based on data cited above	
Value applied:	2008	0.7286
	2009	0.7532



	2010	0.7664
	Average	0.7494
Justification of the choice of data or description of measurement methods and procedures actually applied :	Please see section B.6.1	
Any comment:		

Data / Parameter:	EF_{grid,BM}
Data unit:	tCO ₂ /MWh
Description:	Build margin emission factor for 2010
Source of data used:	Calculation shown in the attached spreadsheet based on data cited above
Value applied:	0.4909
Justification of the choice of data or description of measurement methods and procedures actually applied :	Please see section B.6.1
Any comment:	

Data / Parameter:	EF_{grid,CM}
Data unit:	tCO ₂ /MWh
Description:	Combined margin emission factor
Source of data used:	Calculation shown in the attached spreadsheet based on data cited above
Value applied:	0.6202
Justification of the choice of data or description of measurement methods and procedures actually applied :	Please see section B.6.1
Any comment:	

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

The ex-ante calculation of emission reductions is based on equation 2, reproduced below:

$$ER_y = EG_{PJ,y} * EF_{gridCM} \quad \text{(Equation 2)}$$

The follow values are used in the ex-ante calculation of emission reductions:

Parameter	Value	Unit	Explanation
EG _{PJ,y}	83,065	MWh/y	Expected typical annual net generation from the project



EF _{gridCM}	0.6202	tCO ₂ /MWh	Ex-ante emission factor derived in Section B.6.2
----------------------	--------	-----------------------	--

Introducing these values in the above formula yields a calculation of emission reductions estimated ex-ante to be:

$$BE = 51,517 \text{ tCO}_2/\text{y}$$

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

Year	Estimation of project activity emissions (tCO ₂ e)	Estimation of baseline emissions (tCO ₂ e)	Estimation of leakage (tCO ₂ e)	Estimation of overall emission reductions (tCO ₂ e)
2015	0	51,517	0	51,517
2016	0	51,517	0	51,517
2017	0	51,517	0	51,517
2018	0	51,517	0	51,517
2019	0	51,517	0	51,517
2020	0	51,517	0	51,517
2021	0	51,517	0	51,517
2022	0	51,517	0	51,517
2023	0	51,517	0	51,517
2024	0	51,517	0	51,517
Total (Tonnes of CO ₂ e)	0	515,170	0	515,170

B.7. Application of the monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

(Copy this table for each data and parameter)

Data / Parameter:	EG _{PJ,y}	
Data unit:	MWh	
Description:	Net electricity generation by the project delivered to the grid in year <i>y</i>	
Source of data to be used:	Continuous monitoring	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	83,065 (estimated at validation)	
Description of measurement methods and procedures to be applied:	Method	Continuous, instantaneous electronic monitoring
	Frequency	Continuous monitoring with recording of average instantaneous values every 15 minutes
	Equipment	Meters accredited by the grid operator CENACE



	Calibration	Prior to installation and calibration every two years by an independent laboratory accredited by the grid operator, CENACE
	Accuracy	Precision of $\pm 0.2\%$ or better
	Responsibility	Chief control engineer
QA/QC procedures to be applied:	<p>This measurement is regulated under CONELEC Regulation 005/06, System for Commercial Measurement in the Wholesale Power Market. This system requires redundancy, verification, use of only accredited equipment, sealing of verified meters, and other provisions to ensure accuracy.</p> <p>The data provided by the project participant for this parameter can be cross-checked against the net generation from the project activity as reported by the grid operator, CENACE.</p>	
Any comment:	This is the only parameter that is monitored in this project activity. The entire discussion in the following section (B.7.2) thus relates only to this specific parameter.	

B.7.2. Description of the monitoring plan:

Scope of the Monitoring Plan

Only one parameter is monitored in this project activity, net generation supplied to the grid ($EG_{PI,y}$). This parameter is regulated in Ecuador under CONELEC Regulation 005/06, System for Commercial Measurement in the Wholesale Power Market. This regulation covers:

- Minimum technical characteristics for the System for Commercial Measurement in the Wholesale Power Market.
- Responsibilities of the system agents (generators, distributors, suppliers, etc.) and the grid operator CENACE for meter reading, registering, recording, and exchanging information at measurement points.
- Procedures for validating, estimating and substituting information from measurement points to be applied by the grid operator CENACE.
- Procedures for verification, intervention, operation and maintenance of measurement equipment.

Following are some of the specific requirements of the regulation that will ensure accurate and precise measurement of this parameter.

<i>Para</i>	<i>Concept</i>	<i>Requirement</i>
5	Measurement Point	Bi-directional measurement equipment is to be installed at the point of connection to the grid
9	Calibration Entities	Calibration of measurement equipment must be carried out by independent entities accredited by the grid operator, CENACE
10	Initial Authorization	Prior to commencing commercial activity, a generator requires authorization from CENACE that demonstrates full compliance with the regulation. The initial equipment will be calibrated and sealed.



11, An4	Calibration	Planned calibration is carried out by an accredited entity every two years. CENACE can carry out calibration spot checks at any point in time
13-15	Recording and Information Exchange	Measurements are to be recorded every 15 minutes. Daily data sets are sent to CENACE prior to 9am the following day. Information exchange is carried out according to detailed protocols.
16, An5	Erroneous or Missing Data	Detailed, conservative procedures are published for handling erroneous or missing data
An3	Specifications	Detailed technical specifications for all measurement equipments items
An4	Intervention	Any intervention in measurement equipment that involves breaking the seal requires prior authorization from CENACE. Following the intervention, the measurement equipment must be recalibrated.

The project participant understands that compliance with this detailed regulation (29 pages, including annexes, plus technical norms referenced therein) constitutes good monitoring practice appropriate to the type of project activity.

Implementation of the Monitoring Plan

The selection, procurement, and installation of measurement equipment, as well as the first calibration and obtaining the initial authorization, will be undertaken during construction.

Once operational, the monitoring plan will be supervised by the Chief Control Engineer. Specific responsibilities will be assigned to operators and maintenance personnel as appropriate. Responsibilities for data archiving will be duplicated between the project activity and the grid operator, CENACE.

Data will be kept for a minimum of two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later.

Río Luis is a Greenfield facility. Thus all workers will be newly hired and management systems will be newly implemented. Specific training is planned for all personnel. Training required for CDM monitoring will be integrated within the training for quality control.

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

16/01/2012, completed by

CO2 Spain Innovaciones y Soluciones, S.A.
Costanilla de los Angeles, 13
28013 Madrid SPAIN

Supervised by:



Laurence W. (Larry) Philp
Managing Director

larry.philp@co2spain.com

This entity is not a project participant.

SECTION C. Duration of the project activity / crediting period

C.1. Duration of the project activity:

C.1.1. Starting date of the project activity:

The starting date of this project activity is expected to be on or about 1 July 2012, when the construction contract for the project is signed.

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

The operation lifetime of this project activity, as applies in general for hydroelectric projects, is expected to be at least 25 years and 0 months.

C.2. Choice of the crediting period and related information:

This project activity selects a fixed crediting period.

C.2.1. Renewable crediting period:

C.2.1.1. Starting date of the first crediting period:

N/A, left blank on purpose

C.2.1.2. Length of the first crediting period:

N/A, left blank on purpose

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

01/01/2015

C.2.2.2. Length:

10 years, 0 months.

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

The design of the Río Luis project minimizes environmental impacts from the generation of electricity from hydro power:

- Run-of-river technology avoids a large dam and its associated environmental and social impacts.
- An ecological stream flow maintains the environmental values, especially flora and fauna within the river Río Luis.
- A fish ladder adjacent to the small (10m high dam) allows bidirectional fish flow through the project area.

Furthermore, the operation of the project will displace other generation supplying the national grid – especially fossil fuel-fired, thermal plants. Therefore, the project participant believes that the net environmental impacts from this project activity are positive, and not insignificantly so.

Nevertheless, some residual environmental impacts will or might be produced by the project activity. These residual environmental impacts are identified in an Environmental Impact Assessment (EIA, referenced below in section D.2).

The EIA documents 22 environmental impacts associated with the project activity. Of these 22 impacts, 18 are associated with the construction phase and thus temporary. The remaining 4 environmental impacts are associated with the operational phase and thus permanent during the lifetime of the project activity. Of the 22 environmental impacts, 20 are considered minor. The two environmental impacts that are considered significant are:

- Visual impact during construction. These impacts occur at the capture point, along the conduction, and at the powerhouse. This same visual impact is considered minor during the operational phase, since natural vegetation growth within the affected areas will mitigate this impact quickly due to the climatologic conditions at the project site that promote rapid growth of native species.
- Flora and fauna impact within the Río Luis riverbed. This is a significant impact that is inherent to the project activity. It is mitigated through the ecological stream flow and the fish ladder at the small dam. It is also compensated through a reforestation program for the upper Río Luis river basin. The project participant believes that the residual impact, after mitigation measures and compensation through reforestation, is minor.

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



The Río Luis Project has obtained an environmental licence according to Ecuadorian requirements.¹⁸ Prior to issuing the license, and as a legal prerequisite, the Final Environmental Impact Assessment for Río Luis was approved.¹⁹

The legal basis for issuing the environmental license is based on the following Ecuadorian Laws and Regulations:

- Articles 19 and 20 of the Law for Environmental Management require that public or private sector projects with environmental impacts require an environmental licence issued by the Ministry for Environment.
- Article 3 of the Law for Governing the Power Sector authorizes CONELEC to approve the sector's Environmental Impact Assessments.
- Resolution 0173 of the Ministry of Environment transfers the authority to issue environmental licenses for power sector projects to CONELEC, except those in protected areas.

The principal conclusions of the environmental impact assessment are summarized above in section D.1.

A summary of the environmental impact assessment for the Río Luis project is published online by CONELEC for permanent public consultation²⁰.

The environmental impact assessment was also required by the concession to water rights in the river Río Luis²¹. Additionally, this concession requires the reforestation using native species of the area affected by the project.

The environmental impact assessment includes an environmental management plan. According to the requirements of the environmental license, the environmental management plan will be audited by a duly accredited entity every two years.

SECTION E. Stakeholders' comments

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

Local stakeholders were invited to a public meeting on December 10, 2008 in Portovelo. An information centre on the project was set up prior to the public meeting and operative from December 3 to 9, 2008. Following the public meeting, the information centre remained open to receive public comments regarding the project from December 11 to 17, 2008. The draft Environmental Impact Assessment was published via internet for local stakeholder consultation on December 3, 2008. All of these means to inform and seek comments from local stakeholders were published in a newspaper advertisement. A total of 21 persons attended the public meeting

¹⁸ CONELEC, Environmental Licence 006/09, issued through Resolution DE-09-026, 16 June 2009

¹⁹ CONELEC, Communication DE-09-0488, 7 March 2009

²⁰ <http://www.conelec.gob.ec/documentos.php?cd=3055&l=1> accessed on 21 January 2012

²¹ Concession for Water Rights, issued to the Río Luis Project by the National Council for Water Resources, Machala Agency, 19 November 2007.

**E.2. Summary of the comments received:**

Nine participants in the meeting offered a total of 14 comments or questions regarding the project. The 9 participants that commented on the project were:

<i>Name</i>	<i>Representing</i>
Jorge Torres Matamoros	PREDESUR, El Oro Region
Jaime Armijos	Township of Arca
Araldo Borja	Township of Curtincapac
Fernando Romero	Municipality of Zaruma
Arturo Sanchez	Regional Government of El Oro
José Ochoa	Municipality of Zaruma
Rubén Aguilar	Union of Drivers of Portovelo
Alonso Espinosa	Township of Morales
Walter González	Township of Güizhagüña

The 14 comments and questions can be summarized as follows:

4 questions and comments	Regarding water uses in the river Río Luis
3 questions	Regarding the participation of local municipalities in the profits from the project
2 questions	Regarding other economic benefits for local municipalities from the project
2 comments	Regarding the participation in the meeting
1 comment	Regarding water rights in the river Río Luis
1 comment	Regarding water flow in the river Río Luis
1 comment	Regarding other regional water issues

No comments or observations were received in the information centre following the public meeting.

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

All comments and questions were fully resolved by ENERGYHDINE and CONELEC during the public meeting. No negative comments were received and hence, there was no need to take due account of the comments.

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

Organization:	ENERGYHDINE C. A.
Street/P.O.Box:	Av. Coruña E25-58 y San Ignacio
Building:	Altana Plaza, 6to Piso
City:	Quito
State/Region:	Pichincha
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Represented by:	Byron Acosta Alvarez
Title:	Gerente General
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING



Power Plant	Plant Type	Unit	Net Generation (MWh)	Crude (gal)	Natural Gas (kft3)	LPG (gal)	Naphtha (gal)	Residual Oil (gal)	Bagasse (Tn)	Fuel Oil (gal)	Diesel2 (gal)
Nayón	Hydro	U2	84.176	0	0	0	0	0	0	0	0
Oyacachi 1	Hydro	U1	124	0	0	0	0	0	0	0	0
Pasochoa	Hydro	U1	12.927	0	0	0	0	0	0	0	0
Pasochoa	Hydro	U2	12.514	0	0	0	0	0	0	0	0
Alao	Hydro	Grupo 1	21.640	0	0	0	0	0	0	0	0
Alao	Hydro	Grupo 2	22.073	0	0	0	0	0	0	0	0
Alao	Hydro	Grupo 3	19.239	0	0	0	0	0	0	0	0
Alao	Hydro	Grupo 4	20.380	0	0	0	0	0	0	0	0
Nizag	Hydro	Única	324	0	0	0	0	0	0	0	0
Río Blanco	Hydro	Única	7.940	0	0	0	0	0	0	0	0
Riobamba	ICE	Única	340	0	0	0	0	0	0	0	28.978
Carlos Mora	Hydro	U1	3.786	0	0	0	0	0	0	0	0
Carlos Mora	Hydro	U2	3.888	0	0	0	0	0	0	0	0
Carlos Mora	Hydro	U3	6.799	0	0	0	0	0	0	0	0
Catamayo	ICE	U1	0	0	0	0	0	0	0	0	0
Catamayo	ICE	U10	2.009	0	0	0	0	0	0	0	168.614
Catamayo	ICE	U2	1.204	0	0	0	0	0	0	0	84.635
Catamayo	ICE	U3	0	0	0	0	0	0	0	0	0
Catamayo	ICE	U4	268	0	0	0	0	0	0	0	20.559
Catamayo	ICE	U5	175	0	0	0	0	0	0	0	15.530
Catamayo	ICE	U6	2.293	0	0	0	0	0	0	0	156.978
Catamayo	ICE	U7	0	0	0	0	0	0	0	0	0
Catamayo	ICE	U8	1.919	0	0	0	0	0	0	0	160.310
Catamayo	ICE	U9	1.867	0	0	0	0	0	0	0	147.888
ECOLECTRIC	Steam Cycle	TURBO # 5	33.186	0	0	0	0	0	181.820	0	0
ECOLECTRIC	Steam Cycle	TURBO # 6	33.186	0	0	0	0	0	181.820	0	0
ECOLECTRIC	Steam Cycle	TURBO # 7	0	0	0	0	0	0	0	0	0
Loreto	Hydro	Loreto	14.830	0	0	0	0	0	0	0	0
Papallacta	Hydro	G1	730	0	0	0	0	0	0	0	0
Papallacta	Hydro	G2	26.238	0	0	0	0	0	0	0	0
Ecudos A-G	Steam Cycle	TGE-1	4.312	0	0	0	0	0	23.957	0	0
Ecudos A-G	Steam Cycle	TGE-2	7.874	0	0	0	0	0	43.746	0	0



Power Plant	Plant Type	Unit	Net Generation (MWh)	Crude (gal)	Natural Gas (kft3)	LPG (gal)	Naphtha (gal)	Residual Oil (gal)	Bagasse (Tn)	Fuel Oil (gal)	Diesel2 (gal)
El Carmen	Hydro	U1	39.131	0	0	0	0	0	0	0	0
Noroccidente	Hydro	N.1	841	0	0	0	0	0	0	0	0
Recuperadora	Hydro	N.1	96.346	0	0	0	0	0	0	0	0
Calope	Hydro	U1	95.091	0	0	0	0	0	0	0	0
Calope	Hydro	U2	0	0	0	0	0	0	0	0	0
Lasso	ICE	U1	0	0	0	0	0	0	0	0	0
Machala	Gas Turbine	FA1	431.644	0	4.978.068	0	0	0	0	0	0
Machala	Gas Turbine	FA2	323.476	0	3.816.061	0	0	0	0	0	0
Generoca	ICE	U1	18.693	0	0	0	0	1.202.735	0	0	92.003
Generoca	ICE	U2	20.418	0	0	0	0	1.315.738	0	0	103.449
Generoca	ICE	U3	20.189	0	0	0	0	1.299.132	0	0	97.291
Generoca	ICE	U4	21.489	0	0	0	0	1.381.293	0	0	107.705
Generoca	ICE	U5	21.427	0	0	0	0	1.379.089	0	0	107.423
Generoca	ICE	U6	20.387	0	0	0	0	1.315.226	0	0	102.723
Generoca	ICE	U7	7.412	0	0	0	0	488.197	0	0	40.374
Generoca	ICE	U8	21.924	0	0	0	0	1.413.221	0	0	110.716
Hidroabanico	Hydro	U1	63.908	0	0	0	0	0	0	0	0
Hidroabanico	Hydro	U2	63.908	0	0	0	0	0	0	0	0
Hidroabanico	Hydro	U3	63.908	0	0	0	0	0	0	0	0
Hidroabanico	Hydro	U4	63.908	0	0	0	0	0	0	0	0
Hidroabanico	Hydro	U5	63.908	0	0	0	0	0	0	0	0
Marcel Laniado	Hydro	U1	206.411	0	0	0	0	0	0	0	0
Marcel Laniado	Hydro	U2	324.778	0	0	0	0	0	0	0	0
Marcel Laniado	Hydro	U3	265.635	0	0	0	0	0	0	0	0
San Francisco	Hydro	U1	511.858	0	0	0	0	0	0	0	0
San Francisco	Hydro	U2	460.528	0	0	0	0	0	0	0	0
Sibimbe	Hydro	U1	85.171	0	0	0	0	0	0	0	0
Sibimbe	Hydro	U2	0	0	0	0	0	0	0	0	0
La Calera	Hydro	Corazón	4.711	0	0	0	0	0	0	0	0
La Calera	Hydro	Cotopaxi	0	0	0	0	0	0	0	0	0
La Calera	Hydro	Rumiñahui	0	0	0	0	0	0	0	0	0
Victoria II	Gas Turbine	Victoria II	135.234	0	0	0	7.935.786	0	0	0	4.795.630



Power Plant	Plant Type	Unit	Net Generation (MWh)	Crude (gal)	Natural Gas (kft3)	LPG (gal)	Naphtha (gal)	Residual Oil (gal)	Bagasse (Tn)	Fuel Oil (gal)	Diesel2 (gal)
		GENERAL									
Macas	ICE	(2500kW)	0	0	0	0	0	0	0	0	0
Santiago	Hydro	U1	552	0	0	0	0	0	0	0	0
Angamarca	Hydro	Grupo 1	437	0	0	0	0	0	0	0	0
Angamarca	Hydro	Grupo 2	258	0	0	0	0	0	0	0	0
Catazacón	Hydro	Grupo 1	1.934	0	0	0	0	0	0	0	0
Catazacón	Hydro	Grupo 2	1.802	0	0	0	0	0	0	0	0
El Estado	Hydro	Grupo 1	3.469	0	0	0	0	0	0	0	0
El Estado	Hydro	Grupo 2	4.002	0	0	0	0	0	0	0	0
Illuchi No.1	Hydro	Grupo 1	1.016	0	0	0	0	0	0	0	0
Illuchi No.1	Hydro	Grupo 2	1.675	0	0	0	0	0	0	0	0
Illuchi No.1	Hydro	Grupo 3	7.960	0	0	0	0	0	0	0	0
Illuchi No.1	Hydro	Grupo 4	8.441	0	0	0	0	0	0	0	0
Illuchi No.2	Hydro	Grupo 1	11.132	0	0	0	0	0	0	0	0
Illuchi No.2	Hydro	Grupo 2	11.757	0	0	0	0	0	0	0	0
Ambi	Hydro	G1	5.410	0	0	0	0	0	0	0	0
Ambi	Hydro	G2	18.887	0	0	0	0	0	0	0	0
La Playa	Hydro	G1	4.918	0	0	0	0	0	0	0	0
La Playa	Hydro	G2	0	0	0	0	0	0	0	0	0
La Playa	Hydro	G3	0	0	0	0	0	0	0	0	0
San Francisco Norte	ICE	G1	4.287	0	0	0	0	0	0	0	337.505
San Gabriel	Hydro	G1	0	0	0	0	0	0	0	0	0
San Miguel de Car	Hydro	G1	17.613	0	0	0	0	0	0	0	0
Cumbayá	Hydro	U1	41.128	0	0	0	0	0	0	0	0
Cumbayá	Hydro	U2	37.219	0	0	0	0	0	0	0	0
Cumbayá	Hydro	U3	45.352	0	0	0	0	0	0	0	0
Cumbayá	Hydro	U4	36.494	0	0	0	0	0	0	0	0
G. Hernández	ICE	U1	21.520	0	0	0	0	0	0	16.709	1.309.490
G. Hernández	ICE	U2	34.253	0	0	0	0	0	0	15.478	2.144.070
G. Hernández	ICE	U3	31.218	0	0	0	0	0	0	19.061	1.925.105
G. Hernández	ICE	U4	32.228	0	0	0	0	0	0	24.022	1.987.463
G. Hernández	ICE	U5	28.917	0	0	0	0	0	0	19.998	1.799.921

**2010 Net Generation and Fuel Consumption of Power Units, in the dataset provided by CONELEC**

Power Plant	Plant Type	Unit	Net Generation (MWh)	Crude (gal)	Natural Gas (kft3)	LPG (gal)	Naphtha (gal)	Residual Oil (gal)	Bagasse (Tn)	Fuel Oil (gal)	Diesel2 (gal)
Sillunchi I	Hydro	U-100	682	0	0	0	0	0	0	0	0
Sillunchi II	Hydro	U-304	2.140	0	0	0	0	0	0	0	0
Enrique García	Gas Turbine	TG-5	310.741	0	0	0	0	0	0	0	27.601.453
Gonzalo Zevallos (Gas)	Gas Turbine	TG-4	3.685	0	0	0	0	0	0	0	433.183
Gonzalo Zevallos (Vapor)	Steam Cycle	TV-2	497.789	0	0	0	0	0	0	38.452.106	27.812
Gonzalo Zevallos (Vapor)	Steam Cycle	TV-3	490.926	0	0	0	0	0	0	37.601.625	19.119
Pascuales II	Gas Turbine	TM1	98.410	0	0	0	0	0	0	0	7.648.747
Pascuales II	Gas Turbine	TM2	108.048	0	0	0	0	0	0	0	8.330.199
Pascuales II	Gas Turbine	TM3	105.523	0	0	0	0	0	0	0	8.198.658
Pascuales II	Gas Turbine	TM4	100.484	0	0	0	0	0	0	0	7.774.823
Pascuales II	Gas Turbine	TM5	98.020	0	0	0	0	0	0	0	7.896.747
Pascuales II	Gas Turbine	TM6	81.775	0	0	0	0	0	0	0	6.471.414
Trinitaria	Steam Cycle	TV1	861.413	0	0	0	0	0	0	56.669.522	15.892
Agoyán	Hydro	U1	427.732	0	0	0	0	0	0	0	0
Agoyán	Hydro	U2	485.903	0	0	0	0	0	0	0	0
Pucará	Hydro	U1	81.609	0	0	0	0	0	0	0	0
Pucará	Hydro	U2	59.914	0	0	0	0	0	0	0	0
Mazar	Hydro	U1	232.518	0	0	0	0	0	0	0	0
Mazar	Hydro	U2	29.770	0	0	0	0	0	0	0	0
Paute	Hydro	U1	342.617	0	0	0	0	0	0	0	0
Paute	Hydro	U10	411.709	0	0	0	0	0	0	0	0
Paute	Hydro	U2	355.164	0	0	0	0	0	0	0	0
Paute	Hydro	U3	347.803	0	0	0	0	0	0	0	0
Paute	Hydro	U4	360.034	0	0	0	0	0	0	0	0
Paute	Hydro	U5	409.599	0	0	0	0	0	0	0	0
Paute	Hydro	U6	422.645	0	0	0	0	0	0	0	0
Paute	Hydro	U7	397.882	0	0	0	0	0	0	0	0
Paute	Hydro	U8	426.944	0	0	0	0	0	0	0	0
Paute	Hydro	U9	573.135	0	0	0	0	0	0	0	0
Termoesmeraldas	Steam Cycle	CTE	449.543	0	0	0	0	0	0	30.732.028	87.787



Power Plant	Plant Type	Unit	Net Generation (MWh)	Crude (gal)	Natural Gas (kft3)	LPG (gal)	Naphtha (gal)	Residual Oil (gal)	Bagasse (Tn)	Fuel Oil (gal)	Diesel2 (gal)
Saucay	Hydro	G3	41.040	0	0	0	0	0	0	0	0
Saucay	Hydro	G4	42.126	0	0	0	0	0	0	0	0
Saymirín	Hydro	G1	3.425	0	0	0	0	0	0	0	0
Saymirín	Hydro	G2	3.433	0	0	0	0	0	0	0	0
Saymirín	Hydro	G3	7.209	0	0	0	0	0	0	0	0
Saymirín	Hydro	G4	6.959	0	0	0	0	0	0	0	0
Saymirín	Hydro	G5	25.093	0	0	0	0	0	0	0	0
Saymirín	Hydro	G6	25.392	0	0	0	0	0	0	0	0
Álvaro Tinajero	Gas Turbine	G1-CAT	218.727	0	0	0	0	0	0	0	15.682.956
Álvaro Tinajero	Gas Turbine	G2-CAT	80.042	0	0	0	0	0	0	0	7.665.167
Aníbal Santos (Gas)	Gas Turbine	G1-CAS	16.022	0	0	0	0	0	0	0	1.692.543
Aníbal Santos (Gas)	Gas Turbine	G2-CAS	16.796	0	0	0	0	0	0	0	1.806.259
Aníbal Santos (Gas)	Gas Turbine	G3-CAS	5.800	0	0	0	0	0	0	0	709.833
Aníbal Santos (Gas)	Gas Turbine	G5-CAS	33.849	0	0	0	0	0	0	0	3.882.021
Aníbal Santos (Gas)	Gas Turbine	G6-CAS	14.122	0	0	0	0	0	0	0	1.728.014
Aníbal Santos (Vapor)	Steam Cycle	V1-CAS	210.340	0	0	0	0	0	0	17.272.507	0
Espejo	Hydro	U2	0	0	0	0	0	0	0	0	0
Otavaló	Hydro	U1	0	0	0	0	0	0	0	0	0
Electrocórdova	Hydro	Michael Banki	52	0	0	0	0	0	0	0	0
Electroquil	Gas Turbine	U1	158.833	0	0	0	0	0	0	0	12.151.161
Electroquil	Gas Turbine	U2	143.146	0	0	0	0	0	0	0	10.439.714
Electroquil	Gas Turbine	U3	91.649	0	0	0	0	0	0	0	6.653.164
Electroquil	Gas Turbine	U4	104.528	0	0	0	0	0	0	0	8.197.960
El Carmen	Hydro	U1	35.465	0	0	0	0	0	0	0	0
Noroccidente	Hydro	N.1	1.637	0	0	0	0	0	0	0	0
Recuperadora	Hydro	N.1	97.129	0	0	0	0	0	0	0	0
Calope	Hydro	U1	44.167	0	0	0	0	0	0	0	0
Calope	Hydro	U2	44.167	0	0	0	0	0	0	0	0
Machala	Gas Turbine	A	517.193	0	5.901.166	0	0	0	0	0	0
Machala	Gas Turbine	B	497.603	0	5.787.110	0	0	0	0	0	0
Generoca	ICE	U1	25.093	0	0	0	0	1.716.677	0	0	114.112
Generoca	ICE	U2	28.543	0	0	0	0	1.943.956	0	0	129.323



Power Plant	Plant Type	Unit	Net Generation (MWh)	Crude (gal)	Natural Gas (kft3)	LPG (gal)	Naphtha (gal)	Residual Oil (gal)	Bagasse (Tn)	Fuel Oil (gal)	Diesel2 (gal)
Generoca	ICE	U3	28.295	0	0	0	0	1.927.271	0	0	128.882
Generoca	ICE	U4	1.208	0	0	0	0	90.815	0	0	7.451
Generoca	ICE	U5	27.648	0	0	0	0	1.881.465	0	0	125.285
Generoca	ICE	U6	28.527	0	0	0	0	1.938.599	0	0	128.157
Generoca	ICE	U7	0	0	0	0	0	0	0	0	0
Generoca	ICE	U8	26.855	0	0	0	0	1.834.504	0	0	120.400
Hidroabanico	Hydro	U1	59.924	0	0	0	0	0	0	0	0
Hidroabanico	Hydro	U2	59.924	0	0	0	0	0	0	0	0
Hidroabanico	Hydro	U3	59.924	0	0	0	0	0	0	0	0
Hidroabanico	Hydro	U4	59.924	0	0	0	0	0	0	0	0
Hidroabanico	Hydro	U5	59.924	0	0	0	0	0	0	0	0
Hidrocarolina	Hydro	Hidrocarolina 1	0	0	0	0	0	0	0	0	0
Hidrocarolina	Hydro	Hidrocarolina 2	0	0	0	0	0	0	0	0	0
Marcel Laniado	Hydro	U1	189.288	0	0	0	0	0	0	0	0
Marcel Laniado	Hydro	U2	308.462	0	0	0	0	0	0	0	0
Marcel Laniado	Hydro	U3	265.109	0	0	0	0	0	0	0	0
San Francisco	Hydro	U1	418.806	0	0	0	0	0	0	0	0
San Francisco	Hydro	U2	622.975	0	0	0	0	0	0	0	0
Industrial Algodonera											
Atuntaqui	Hydro	U2	25	0	0	0	0	0	0	0	0
Industrial Algodonera											
Atuntaqui	Hydro	U3	25	0	0	0	0	0	0	0	0
Sibimbe	Hydro	U1	40.180	0	0	0	0	0	0	0	0
Sibimbe	Hydro	U2	40.180	0	0	0	0	0	0	0	0
Urvia	Hydro	U1	7.594	0	0	0	0	0	0	0	0
La Calera	Hydro	Corazón	218	0	0	0	0	0	0	0	0
La Calera	Hydro	Cotopaxi	7.181	0	0	0	0	0	0	0	0
La Calera	Hydro	Rumiñahui	200	0	0	0	0	0	0	0	0
Victoria II	Gas Turbine	Victoria II	327.943	0	0	0	14.639.680	0	0	0	13.926.963
Vindobona	Hydro	U1	10.482	0	0	0	0	0	0	0	0
Vindobona	Hydro	U2	6.823	0	0	0	0	0	0	0	0
Selva Alegre	ICE	U1	22.778	0	0	0	0	1.579.682	0	0	234.590



Power Plant	Plant Type	Unit	Net Generation (MWh)	Crude (gal)	Natural Gas (kft3)	LPG (gal)	Naphtha (gal)	Residual Oil (gal)	Bagasse (Tn)	Fuel Oil (gal)	Diesel2 (gal)
Selva Alegre	ICE	U2	22.899	0	0	0	0	1.585.345	0	0	233.708
Selva Alegre	ICE	U3	18.297	0	0	0	0	1.444.597	0	0	211.755
Selva Alegre	ICE	U4	6.210	0	0	0	0	453.865	0	0	73.450
Selva Alegre	ICE	U5	20.919	0	0	0	0	1.040.476	0	0	160.109
Selva Alegre	ICE	U6	16.960	0	0	0	0	853.136	0	0	112.656
Selva Alegre	ICE	U7	16.832	0	0	0	0	829.839	0	0	109.617
La Esperanza	Hydro	U1	0	0	0	0	0	0	0	0	0
La Esperanza	Hydro	U2	0	0	0	0	0	0	0	0	0
Poza Honda	Hydro	U1	0	0	0	0	0	0	0	0	0
Poza Honda	Hydro	U2	0	0	0	0	0	0	0	0	0
Geppert	Hydro	Geppert	1.697	0	0	0	0	0	0	0	0
Kohler	ICE	KOHLER	0	0	0	0	0	0	0	0	0
Atuntaqui	Hydro	U1	668	0	0	0	0	0	0	0	0
Atuntaqui	Hydro	U2	668	0	0	0	0	0	0	0	0
Perlabí	Hydro	U1	7.103	0	0	0	0	0	0	0	0
Interconexión											
Interconexión Perú	Interconexión	Perú	78.390	0	0	0	0	0	0	0	0
San Carlos	Steam Cycle	Turbo 1	104	0	0	0	0	0	389	0	0
San Carlos	Steam Cycle	Turbo 2	3.050	0	0	0	0	0	10.452	0	0
San Carlos	Steam Cycle	Turbo 3	40.159	0	0	0	0	0	136.381	0	0
San Carlos	Steam Cycle	Turbo 4	21.548	0	0	0	0	0	77.516	0	0
Termoguayas	ICE	U1	175.046	0	0	0	0	0	0	11.873.772	0
Termoguayas	ICE	U2	324.811	0	0	0	0	0	0	22.134.551	0
Termoguayas	ICE	U3	93.106	0	0	0	0	0	0	6.388.915	0
Termoguayas	ICE	U4	2.824	0	0	0	0	0	0	193.808	0

**Simple Adjusted OM for the Colombian Grid**

As per the “Tool to calculate the emission factor for an electricity system” v2.2.1, the simple adjusted OM is calculated as follows:

$$EF_{grid,OM-adj,y} = (1 - \lambda_y) \times \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} + \lambda_y \times \frac{\sum_k EG_{k,y} \times EF_{EL,k,y}}{\sum_k EG_{k,y}}$$

Where

- $EF_{grid,OM-adj,y}$ = Simple adjusted operating margin CO₂ emission factor in year y (tCO₂/MWh)
 λ_y = Factor expressing the percentage of time when low-cost/must-run power units are on the margin in year y
 $EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
 $EG_{k,y}$ = Net quantity of electricity generated and delivered to the grid by power unit k in year y (MWh)
 $EF_{EL,m,y}$ = CO₂ emission factor of power unit m in year y (tCO₂/MWh)
 $EF_{EL,k,y}$ = CO₂ emission factor of power unit k in year y (tCO₂/MWh)
 m = All grid power units serving the grid in year y except low-cost/must-run power units
 k = All low-cost/must-run power units serving the grid in year y
 y = The relevant year as per the data vintage chosen in Step 3

Since fuel consumption and electricity generation is available for each power unit in the system, $EF_{EL,m,y}$ and $EF_{EL,k,y}$ are calculated based on Option A1 of the simple OM method as follows:

$$EF_{EL,m/k,y} = \frac{\sum_i FC_{i,m/k,y} \times NCV_{i,y} \times EF_{CO_2,i,y}}{EG_{m/k,y}}$$

Where

- $EF_{EL,m/k,y}$ = CO₂ emission factor of power unit m or k in year y (tCO₂/MWh)
 $FC_{i,m/k,y}$ = Amount of fossil fuel type i consumed by power unit m or k in year y (Mass or volume unit)
 $NCV_{i,y}$ = Net calorific value (energy content) of fossil fuel type i in year y (GJ/mass or volume unit)
 $EF_{CO_2,i,y}$ = CO₂ emission factor of fossil fuel type i in year y (tCO₂/GJ)
 $EG_{m/k,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m or k in year y (MWh)
 m = All grid power units serving the grid in year y except low-cost/must-run power units
 k = All low-cost/must-run power units serving the grid in year y
 i = All fossil fuel types combusted in power unit m or k in year y



y = The relevant year as per the data vintage chosen in Step 3

The following data sources are used to calculation the emission factors:

- $EG_{m/k,y}$ = Annual generation 2010 for each power unit from the NEON²² database as shown below.
- $FC_{i,m/k,y}$ = Annual fuel consumption by type 2010 for each power unit from the NEON database as shown below.
- $NCV_{i,y}$ = Official values published by the system operator and used in the NEON database, since fuel consumption is reported in energy units.
- $EF_{CO2,i,y}$ = Official values published in the FECOC database.

Fossil fuel generators are classified as m . Hydro and other renewable generators are classified as k .

Lambda (λ_y) is calculated in the attached emission factor spreadsheet according to the 4-step procedure, commented as follows:

- step (i) Hourly system load data for 2010 are sorted in descending order. These data were sourced from the NEON database.
- step (ii) The annual generation from all low-cost/must-run units was summed from the NEON database.
- step (iii) The attached emission factor spreadsheet postulates a horizontal line at each of the 8,760 points along the ordered load curve. The area under the postulated horizontal line is then compared to the annual generation from step (ii)
- step (iv) The number of hours is identified by summing the number of hours where the area under the postulated horizontal line is less than the sum of the low-cost/must-run generation.

The following data are available at validation:

Data / Parameter:	$FC_{i,m,y}$ $FC_{i,k,y}$
Data unit:	TJ/y
Description:	Fuel consumption of fuel type i for power unit m or k in year y
Source of data used:	NEON Database
Value applied:	Please see below
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	Fuel consumption is reported by the system operator in energy units. The

²² The NEON database is maintained and provided by the Colombian power market operator, XM. It includes detailed hourly information for all generation units. It was accessed by this project activity to identify real, hourly system generation (to calculate Lambda) and monthly generation and fuel consumption for all on-grid generators. The monthly data was summed to arrive at annual totals for 2010 for both net generation and fuel consumption.



	parameter NCV is not required.
--	--------------------------------

Data / Parameter:	$EF_{CO_2,i,y}$			
Data unit:	Shown below			
Description:	CO ₂ emission factor for fuel type <i>i</i> in year <i>y</i>			
Source of data used:	1) FECOC Database 2) EB23 Annex05			
Value applied:	Fuel	Units	Source	Value
	Natural Gas	tCO ₂ /TJ	1	55.101
	Coal	tCO ₂ /TJ	1	97.257
	Fuel Oil	tCO ₂ /TJ	1	80.570
	Diesel	tCO ₂ /TJ	1	74.869
	Reservoir Hydro	tCO ₂ /MWh	2	0.09
Justification of the choice of data or description of measurement methods and procedures actually applied :	All of the values from the FECOC database fall within the ranges of the IPCC 2006 guidelines. They are therefore considered reasonable. Since they have been used in other registered CDM project activities in Colombia, they are considered reliable as well.			
Any comment:				

Data / Parameter:	$EG_{m,y}$ $EG_{k,y}$	
Data unit:	MWh/y	
Description:	Net electricity generated by power plant <i>m</i> or <i>k</i> in year <i>y</i>	
Source of data used:	NEON Database	
Value applied:	Please see below	
Justification of the choice of data or description of measurement methods and procedures actually applied :		
Any comment:	Only grid generators that are dispatched by the system operator are included in this database	

Data / Parameter:	λ_{2010}
Data unit:	--
Description:	Factor expressing the percentage of time when low-cost/must-run power units are on the margin in year <i>y</i>
Source of data used:	Calculation based on the hourly system loads the NEON database
Value applied:	2.6826%
Justification of the choice of data or description of measurement methods and procedures	



actually applied :	
Any comment:	The calculation of Lambda is transparently shown in the attached spreadsheet that calculates EF_{grid} for Colombia

Data / Parameter:	$EF_{grid,OM,2010}$
Data unit:	tCO ₂ /MWh
Description:	Operating margin emission factor in year 2010
Source of data used:	Calculation shown in the attached spreadsheet based on data cited above
Value applied:	0.6581
Justification of the choice of data or description of measurement methods and procedures actually applied :	Please see above and attached spreadsheet
Any comment:	For imports to Ecuador from Colombia

2010 Net Generation and Fuel Consumption of Power Units in Colombia, from the NEON database

Power Unit	Generation MWh	Subtype	Diesel TJ	Coal TJ	FO TJ	Ngas TJ
MENOR LA CASCADA-ABEJORRAL	4.182		0	0	0	0
MENOR AGUA FRESCA	51.505		0	0	0	0
ALBAN	1.865.081	Reservoir	0	0	0	0
GENERADOR PLANTA MENOR AMAIME	4.915		0	0	0	0
MENOR AMALFI	3.669		0	0	0	0
MENOR AMERICA	191		0	0	0	0
MENOR ASNAZU	4.174		0	0	0	0
MENOR AYURA	104.089		0	0	0	0
MENOR BELLO	1.877		0	0	0	0
MENOR BELMONTE	24.139		0	0	0	0
MENOR EL BOSQUE	14.754		0	0	0	0
MENOR BAYONA	2.086		0	0	0	0
COGEN. CENTRAL CASTILLA	2.414		0	0	0	0
MENOR COCONUCO	19.667		0	0	0	0
COGEN. INGENIO MAYAGUEZ	61.609		0	0	0	0
BETANIA	1.725.672	Reservoir	0	0	0	0
MENOR CALICHAL	498		0	0	0	0
CHIVOR	3.305.175	Reservoir	0	0	0	0
MENOR CIMARRON	94.861		0	0	0	0
COGEN. INGENIO PROVIDENCIA	97.078		0	0	0	0
MENOR CALDERAS	90.350		0	0	0	0
CALIMA	195.083	Reservoir	0	0	0	0
COGEN. COLTEJER	12.838		0	0	0	0



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Power Unit	Generation MWh	Subtype	Diesel	Coal	FO	Ngas
			TJ	TJ	TJ	TJ
MENOR CEMENTOS DEL NARE	38.685		0	0	0	0
MENOR CAMPESTRE (EPM)	3.228		0	0	0	0
MENOR CAMPESTRE (CALARCA)	5.015		0	0	0	0
MENOR CHARQUITO	93.060		0	0	0	0
MENOR CARACOLI	15.867		0	0	0	0
COROZO - SAN MATEO 2 230 KV	0		0	0	0	0
MENOR CASCADA	20.674		0	0	0	0
TERMOCARTAGENA 1	59.999		0	0	234	634
TERMOCARTAGENA 2	112.612		0	0	994	555
TERMOCARTAGENA 3	68.472		0	0	0	1.073
MENOR EL MORRO 1	171.560		0	0	0	0
MENOR EL MORRO 2	62.925		0	0	0	0
COGEN. TUMACO	765		0	0	0	0
GENERADOR HIDRAULICO LOS CURRUCUCUES	286		0	0	0	0
MENOR DOLORES EPM	53.428		0	0	0	0
ECUADOR-TULCÁN (ENLACE)	0		0	0	0	0
ECUADOR-POMASQUI (ENLACE)	9.745		0	0	0	0
ESMERALDA	225.738		0	0	0	0
MENOR FLORIDA	80.031		0	0	0	0
MENOR CARUQUIA	52.509		0	0	0	0
MENOR GUACAICA	2.018		0	0	0	0
MENOR GUANAQUITAS	41.560		0	0	0	0
GUATAPE	3.008.573	Reservoir	0	0	0	0
GUATRON	2.748.692	Reservoir	0	0	0	0
GUAVIO	4.306.377	Reservoir	0	0	0	0
MIEL	1.720.075	Reservoir	0	0	0	0
MENOR LA HERRADURA	116.683		0	0	0	0
COGEN. INGENIO LA CARMELITA	835		0	0	0	0
COGEN. INCAUCA	21.236		0	0	0	0
MENOR INSULA	115.545		0	0	0	0
MENOR INTERMEDIA	7.078		0	0	0	0
MENOR INZA	3.924		0	0	0	0
MENOR IQUIRA 1	12.289		0	0	0	0
MENOR IQUIRA 2	5.554		0	0	0	0
COGEN. INGENIO RISARALDA	6.119		0	0	0	0
JAGUAS	813.753	Reservoir	0	0	0	0
MENOR JULIO BRAVO	5.045		0	0	0	0
MENOR LA JUNCA	129.318		0	0	0	0
PARQUE EOLICO JEPİRACHI	38.570		0	0	0	0
MENOR NUEVO LIBARE	6.211		0	0	0	0
MENOR LA CASCADA	14.650		0	0	0	0
MENOR EL LIMONAR	96.222		0	0	0	0
MENOR EL PALO	4.228		0	0	0	0
LA TASAJERA	1.594.443	Reservoir	0	0	0	0
MENOR MIROLINDO	15.603		0	0	0	0



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Power Unit	Generation MWh	Subtype	Diesel	Coal	FO	Ngas
			TJ	TJ	TJ	TJ
MENOR MUNICIPAL	7.472		0	0	0	0
MENOR MONDOMO	3.732		0	0	0	0
MENOR MANANTIALES	12.260		0	0	0	0
MERILECTRICA 1	20.266		0	0	0	268
MENOR NIMA	30.214		0	0	0	0
MENOR NIQUIA	99.471		0	0	0	0
MENOR NUTIBARA	2.158		0	0	0	0
MENOR OVEJAS	4.854		0	0	0	0
MENOR PIEDRAS BLANCAS	5.977		0	0	0	0
PARAISO GUACA	3.724.156	Reservoir	0	0	0	0
COGEN. INGENIO PICHICHI	4.199		0	0	0	0
MENOR PAJARITO	25.589		0	0	0	0
MENOR PALMAS SAN GIL	66.532		0	0	0	0
PALENQUE 3	1.633		0	0	0	31
MENOR URRAO	5.380		0	0	0	0
PLAYAS	1.266.991	Reservoir	0	0	0	0
MENOR REMEDIOS	2.646		0	0	0	0
COGEN. PROENCA	5.723		0	0	0	0
PAIPA 1	158.787		0	2.261	0	0
PAIPA 2	288.345		0	3.878	0	0
PAIPA 3	409.257		0	5.396	0	0
PAIPA 4	999.534		0	10.017	0	0
COGEN. PAPELES NACIONALES	2.625		0	0	0	0
PORCE II	2.002.715	Reservoir	0	0	0	0
PORCE 3 GENERADOR	264	Reservoir	0	0	0	0
MENOR PRADO 4	42.371		0	0	0	0
PRADO	196.955	Reservoir	0	0	0	0
PROELECTRICA 1	156.014		0	0	0	2.547
PROELECTRICA 2	93.765		0	0	0	0
MENOR PASTALES 1	4.287		0	0	0	0
MENOR LA PITA	4.662		0	0	0	0
MENOR PATICO - LA CABRERA	5.257		0	0	0	0
MENOR PUENTE GUILLERMO	2.416		0	0	0	0
MENOR PTAR	0		0	0	0	0
MENOR PROVIDENCIA	0		0	0	0	0
MENOR RIO BOBO	14.595		0	0	0	0
MENOR RIO ABAJO	639		0	0	0	0
MENOR RIO RECIO	2.556		0	0	0	0
MENOR RIO CALI	14.023		0	0	0	0
MENOR RIO FRIO I	8.458		0	0	0	0
MENOR RIO FRIO II	50.485		0	0	0	0
MENOR RIOGRANDE I	1.734		0	0	0	0
RIOGRANDE	1.478		0	0	0	0
MENOR RIO INGENIO	41		0	0	0	0
MENOR RUMOR	14.366		0	0	0	0
MENOR RIO MAYO	110.130		0	0	0	0



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Power Unit	Generation MWh	Subtype	Diesel	Coal	FO	Ngas
			TJ	TJ	TJ	TJ
MENOR RIONEGRO	57.135		0	0	0	0
MENOR RIO PIEDRAS	148.292		0	0	0	0
COGEN. INGENIO RIOPAILA	7.296		0	0	0	0
MENOR SAN ANTONIO	82.051		0	0	0	0
MENOR SAN JOSE DE LA MONTAÑA	1.937		0	0	0	0
MENOR SAJANDI	18.669		0	0	0	0
MENOR SAN JOSE	2.260		0	0	0	0
MENOR SILVIA	1.959		0	0	0	0
SALVAJINA	1.135.290	Reservoir	0	0	0	0
MENOR SAN CANCIO	5.750		0	0	0	0
SAN CARLOS	6.448.811	Reservoir	0	0	0	0
SAN FRANCISCO	322.537		0	0	0	0
MENOR SONSON	45.352		0	0	0	0
MENOR SANTA ANA	34.064		0	0	0	0
MENOR RIO SAPUYES	8.978		0	0	0	0
GENERADOR HIDRAULICO SANTA RITA	1.690		0	0	0	0
MENOR SERVITA	2.241		0	0	0	0
MENOR SUEVA 2	30.022		0	0	0	0
TERMOBARRANQUILLA 3	146.066		0	0	517	1.562
TERMOBARRANQUILLA 4	122.322		0	0	333	1.466
TEBSA TOTAL	5.132.259		0	0	0	47.358
TERMOCANDELARIA 1	405.398		0	0	19	4.802
TERMOCANDELARIA 2	354.993		0	0	26	4.174
TERMODORADA 1	15.632		0	0	0	184
TERMOEMCALI 1	265.026		2.203	0	0	52
TERMOFLORES 1	993.797		0	0	0	9.049
TERMOFLORES 2	235.157		28	0	0	3.041
TERMOFLORES 3	463.002		0	0	0	5.584
TERMO FLORES 4	1.183		0	0	0	83
GUAJIRA 1	607.975		0	4.698	0	3.256
GUAJIRA 2	548.943		0	4.411	0	2.507
MENOR LA TINTA	0		0	0	0	0
MENOR RIOFRIO (TAMESIS)	6.934		0	0	0	0
MENOR TERMOPIEDRAS	124		0	0	0	0
MENOR TEQUENDAMA	116.375		0	0	0	0
TERMOCENTRO 1 CICLO COMBINADO	485.591		0	0	0	4.830
TASAJERO 1	817.338		0	2.943	0	0
TERMO SIERRAB	1.020.938		0	0	0	8.368
TERMOVALLE 1	593.508		1.713	0	0	3.165
TERMOYOPAL 1	148.678		0	0	0	0
TERMOYOPAL 2	221.520		0	0	0	3.218
MENOR UNION	4.200		0	0	0	0
URRA	1.482.193	Reservoir	0	0	0	0



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Power Unit	Generation MWh	Subtype	Diesel TJ	Coal TJ	FO TJ	Ngas TJ
MENOR LA VUELTA	64.642		0	0	0	0
MENOR VENTANA A	11.581		0	0	0	0
MENOR VENTANA B	14.341		0	0	0	0
CUESTECITAS - CUATRICENTENARIO 1 230 KV	0		0	0	0	0
ZIPAEMG 2	73.756		0	1.035	0	0
ZIPAEMG 3	219.669		0	2.238	0	0
ZIPAEMG 4	214.961		0	2.052	0	0
ZIPAEMG 5	282.954		0	2.601	0	0
MENOR ZARAGOZA	1.622		0	0	0	0



Annex 4

MONITORING INFORMATION
