Project design document form for CDM project activities

(Version 07.0)

Complete this form in accordance with the Attachment "Instructions for filling out the project design document form for CDM project activities" at the end of this form.

PROJECT DESIGN DOCUMENT (PDD)	
Title of the project activity	Rio Amoyá Run-of-River Hydro Project
Version number of the PDD	6
Completion date of the PDD	20/04/2016
Project participant(s)	ISAGEN S.A. E.S.P.
Host Party	Colombia
Applied methodology(ies) and, where applicable, applied standardized baseline(s)	The ACM0002-version 12.1.0 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources"
Sectoral scope(s) linked to the applied methodology(ies)	Sectoral Scope 1: Energy industries (renewable - / nonrenewable sources).
Estimated amount of annual average GHG emission reductions	176,643 tonnes of CO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

The Rio Amoyá Run-of-River Hydro Project ("Project"), consists of a greenfield run-of-river power plant with a nominal capacity of 80 MW and an anticipated generation of approximately 513.6 GWh/year, based on the projected generation resulting from engineering studies contracted by ISAGEN S.A. E.S.P. ("ISAGEN") in 1998 and 2005[1]. The power plant will be connected to the national grid through a 18.6 transmission line. The investment in the power plant includes the mitigation costs associated with construction and operation. The plant is expected to start operation in 2011 and is expected to result in the reduction of about 1.2 million tCO2e by 2018.

The Project is considered not only as a project of electric power generation, but also as an "Environmental Services Project", since it contributes to decrease the global emissions of carbon through the substitution of polluting fuels as a source of electric power generation; and with its multiple benefits and capacity to yield and consolidate economic resources, it will contribute to the conservation and protection of the Amoyá River's basin and to the conservation of the Páramo ecosystem. About the environmental effects, the Project, thanks to its characteristics of being a run-of-river-intake project with no dam, and the simplicity involving the civil works, has a minimum environmental impact, since it involves no settlement relocation or displacement whatsoever, it has a low effect on the ecosystems in the area of influence and its land requirements are minimal.

The Project contributes to sustainable development of Colombia in the following ways:

1. First, it can show the potential of run-of-river power plants as alternative to other type of power plants, encouraging the construction of run-of-river plants in the Country. These plants produce sustainable development using small resources in different places in the Country.

2. Second, plants of this type contribute to the reduction of polluting particles in the Country, which can else be discharged by thermo power plants.

3. Third, it can develop great knowledge and nationwide experience in the construction of run-of river power plants; also strengthen the national institutional capacities focused to the consolidation of competitive advantages to participate in the international carbon market.

4. Fourth, it can demonstrate the potential value of the environmental services in the region, through the recognition of the role of the natural Páramo ecosystems in the generation of electric power and in the production and acquisition of the resources destined to their conservation and protection.

5. Fifth, the local community can obtain benefits of different social programs developed by the Project sponsor from a very early stage of its construction, becoming a key element to assure the approval, backup and participation of the community in the project and its complementary activities.

The Project will support the development of an Environmental Program, which aims to promote the conservation of the moorlands (Páramo ecosystem in the area of the project), facilitating the

[1] Back in 1998, INGETEC was hired to evaluate the hydraulic potential of Amoyá and Ambeima rivers, in order to select the best hydropower project, in terms of generating capacity, environmental impact, and costs. This study evaluated a project with a nominal capacity of 78 MW, with an average flow of 17.2 m3/s. A period of 15 years was simulated and the reported average generation level was 516 GWh/yr. To account for potential losses, the team in charge of assessing the projects economic feasibility applied 99% of 516 GWh, which corresponds to 510.7 GWh. Later in 2005, ISAGEN hired another engineering firm, SEDIC, to update and complement INGETEC‟s study. Using time series data from hydrological stations, the average flow was now set at 18.4 m3/s, the nominal capacity was increased to 80 MW, and the average generation level was estimated at 513.6 GWh/yr. The latter will be used for the ex-ante estimation of the project emission reductions.

ecosystem's ability to regulate water cycle in the surrounding area (Páramo ecosystems replenish rivers in the catchment and act as water cycle regulating systems) and to contribute to water supply and power production in the region. Furthermore, the program will contribute to the conservation of Páramo Las Hermosas ecosystem. The program also covers a water cycle study and adaptation plan for the Páramo.

The Project will support a Social Program that includes: a) Improvement of health, access to potable water, sanitation and health services; b) Improvements to infrastructure c) Access to education; d) Communication activities supporting rural development; e) Community strengthening and sustainable production; and e) Watershed conservation.

The proposed environmental and social programs are additional to what is required by law. These programs complement the mitigation investments included in the capital costs of the power plant. The environmental and social programs will be partially financed with the carbon revenue, with environment program and social program sharing the revenue equally.

A.2. Location of project activity

A.2.1. Host Party

Colombia

A.2.2. Region/State/Province etc.

Tolima, Colombia

A.2.3. City/Town/Community etc.

Municipality of Chaparral, in the lower range of the Amoyá River Basin

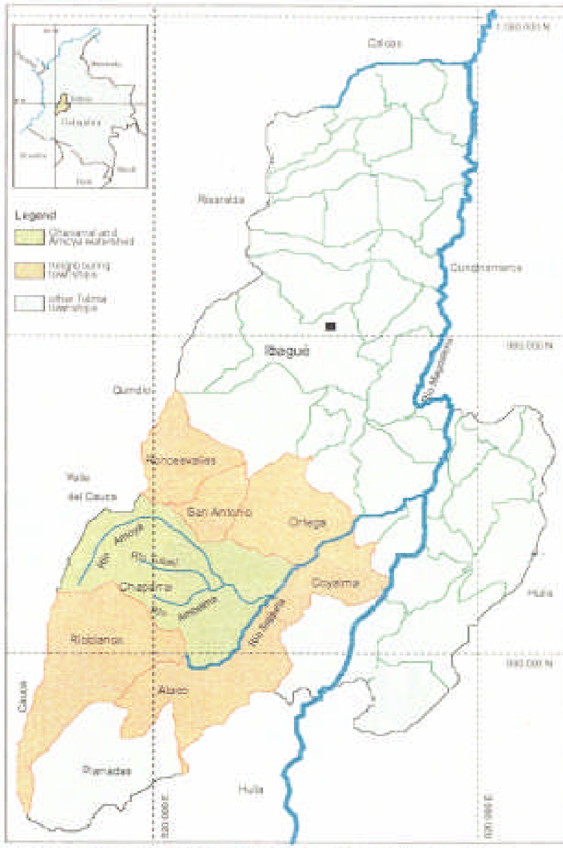
A.2.4. Physical/Geographical location

The Project is located in the middle section of the Amoyá River Basin in the municipality of Chaparral, Tolima province, Colombia. Chaparral is 262 Km from Colombia's capital, Bogota. The Amoyá River receives waters from the Páramo ecosystem of Las Hermosas.

The upper reaches of the Amoyá River basin are conformed by a Páramo. This high altitude ecosystem is considered of major importance given its great ecological value and the multiple environmental services it provides. Both reasons make the relation with the project of particular relevance. Páramos in the Amoyá area form the largest patch in the Central Cordillera. Out of the Páramo total area, 650 km^2 are under protection status in the Páramo de Las Hermosas National Park, 27% of which are in the Amoyá river basin.

Table 1: Project Coordinates

	Y	X	Latitude	Longitude
Bogotá	**N 1'000,000.000**	**E 1'000,000.000**		
Power house	N 912,781.836	E 831,653.566	3° 48' 22''	-75° 35' 35''
Intake	N 917,584.603	E 824,852.432	3° 50' 58''	-75° 39' 15''



Map 1. Location of project area: Chaparral and Amoyá river watershed in Tolima province

The works are located around the geographical coordinates 75º 40´W and 3º 50´N along the Amoyá River, at elevations between 1,486 and 939 meters above mean sea level.

A.3. Technologies and/or measures

The run-of-river plant will use kinetic and potential energy from the waters of the Amoyá river to generate electricity without the need for water storage (i.e. no reservoir is included in the design). Two turbines and other ancillary facilities will be installed underground, along one side of the river, thus minimizing impacts on the landscape. A weir will be located at 1,484 m above the sea level. The water will then be conducted through an 8.6 km long intake tunnel, running along the southern side of the river, to reach an underground power house. Most civil works will be located underground.

It is proposed to acquire about 36 hectares of land. Right of way will be obtained for the access road and the transmission line. Pelton turbines with vertical axis and a rated capacity of 40 MW each (to efficiently utilize the energy potential of the river) will be used to generate power from the kinetic energy of the fast flowing stream and the potential energy between entry and exit points of the tunnel. The state-of-the-art Pelton turbines used in the project have been widely utilized in hydroelectric projects around the world because of their efficiency levels and technical performance.

Element	Value/description	Unit
I. General Specifications		
Installed Capacity	80	MW
Design Flow	18.4	M^3/sec
Hydraulic Head	520	Meters
Annual Generation	513.6	GWh

II. Diversion Works		
Diversion structure	Concrete39W x 5H	Meters
Intake channel	Concrete, square, 105 m L	Meters
Settling tank	3 cells, 86 m L	Meters
Conduction tunnel	8,587 m	Meters
Discharge tunnel	2,894 m	Meters
III. Engine house and turbines		
Engines house	12.4 m W, 36.7 m L, 27 m H	Meters
IV. Pelton Turbines (2)		
Vertical axis (2)	40	MW
Valves (2)	1.10 m D	Meters
Synchronic generator (2)	45.7	M V A
	13.8 nominal	kV
Load bridge	800	kN
Transformers (2)	13.8/115	kV
Sub-station	115	kV

A.4. Parties and project participants

Party involved (host) indicates host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
The Republic of Colombia (host) (Ministerio de Ambiente, Vivienda y Desarrollo Territorial)	ISAGEN S.A. E.S.P.	No

A.5. Public funding of project activity

This project does not receive public funding nor Official Development Assistance (ODA) or other sources earmarked for development assistance.

SECTION B. Application of selected approved baseline and monitoring methodology and standardized baseline

B.1. Reference of methodology and standardized baseline

The ACM0002-version 12.1.0 “Consolidated baseline methodology for grid-connected electricity generation from renewable sources” is chosen as the most relevant to the project activity. This methodology, as applied in this project activity, also refers to the latest approved version of the following Tools: (i) the tool to calculate the emission factor for an electricity system (version 02), and (ii) the tool for the demonstration and assessment of additionality (version 05.2).

B.2. Applicability of methodology and standardized baseline

The consolidated baseline methodology ACM0002 – version 12.1.0 has been chosen because it applies to grid connected renewable power generation project activities. In particular, this methodology is applicable because:

1. The proposed project activity involves the installation of a new power plant at a site where no renewable power plant was operated prior to the implementation of the project activity (run-of-river power plant without reservoir).
2. The geographic and system boundaries for the relevant electricity grid can be clearly identified and information on the characteristics of the grid is available.

B.3. Project boundary

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	CO2 Emissions coming from electricity generation in fossil fuel fired power plants that are displaced due to the project activity.	CO_2	Yes	Main emission source. The thermal units in the generation grid produce GHG emissions that are avoided when the Project activity enters the grid replacing the thermal units.
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
Project scenario	For hydro power plants including run-of-river plants without a reservoir, emissions of CH4 are not considered.	CO_2	No	Minor emission source
		CH_4	No	No reservoir
		N_2O	No	Minor emission source

As referred in ACM0002 – version 12.1.0, the project boundary has to be assessed in terms of the emission sources and spatial extent. The GHG accounted for are shown in the table above.

• Emission sources:

Baseline: For the baseline determination, only CO2 emissions from electricity displaced due to the project are accounted for.

Project: As the project is a run-of-river hydro power Project, it has zero project emissions.

• Project boundary:

The spatial extent of project boundary includes the project site and all power plants of the electricity system that the project connects. The project will be linked to the Colombian national grid through an 18.6 km long transmission line. Therefore, all power plants providing electricity to the Colombian grid system are included in the project boundary.

B.4. Establishment and description of baseline scenario

Identification of the Baseline Scenario

The baseline scenario in the case of the Rio Amoyá Run-of-River Hydro Project is defined by the Electricity delivered to the grid by the project would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin (CM) calculations.

As indicated in Annex 5 the National Energy Planning Unit (UPME) of Colombia's Ministry of Mines and Energy prepares an indicative expansion plan based on expected demand and supply according to economic and demographic projection. It also identifies the most probable sources of

expansion from the database of inscribed power projects, based on the least expansion and operation cost.

The baseline might be described as the most likely scenario of capacity additions and generation private investors and plant operators would choose based on demand projections, investment costs, available technology for capacity expansions, expected price of fuels, and expected hydrologic conditions. Thus, the baseline scenario consists of the current power plants in the relevant system grid for the project boundary (which is the Colombian National Grid System) and the projected capacity expansion as it occurs in the absence of the generation of this CDM project. Specifically in the absence of the Rio Amoyá Run-of-River Hydro Project, the same level of demand for electricity would be met by the combined production of plants in the Colombian National Grid System and by the addition of new generation sources, and therefore the estimations of the baseline emissions are based on the combined margin (CM) calculations as described in section B.6.

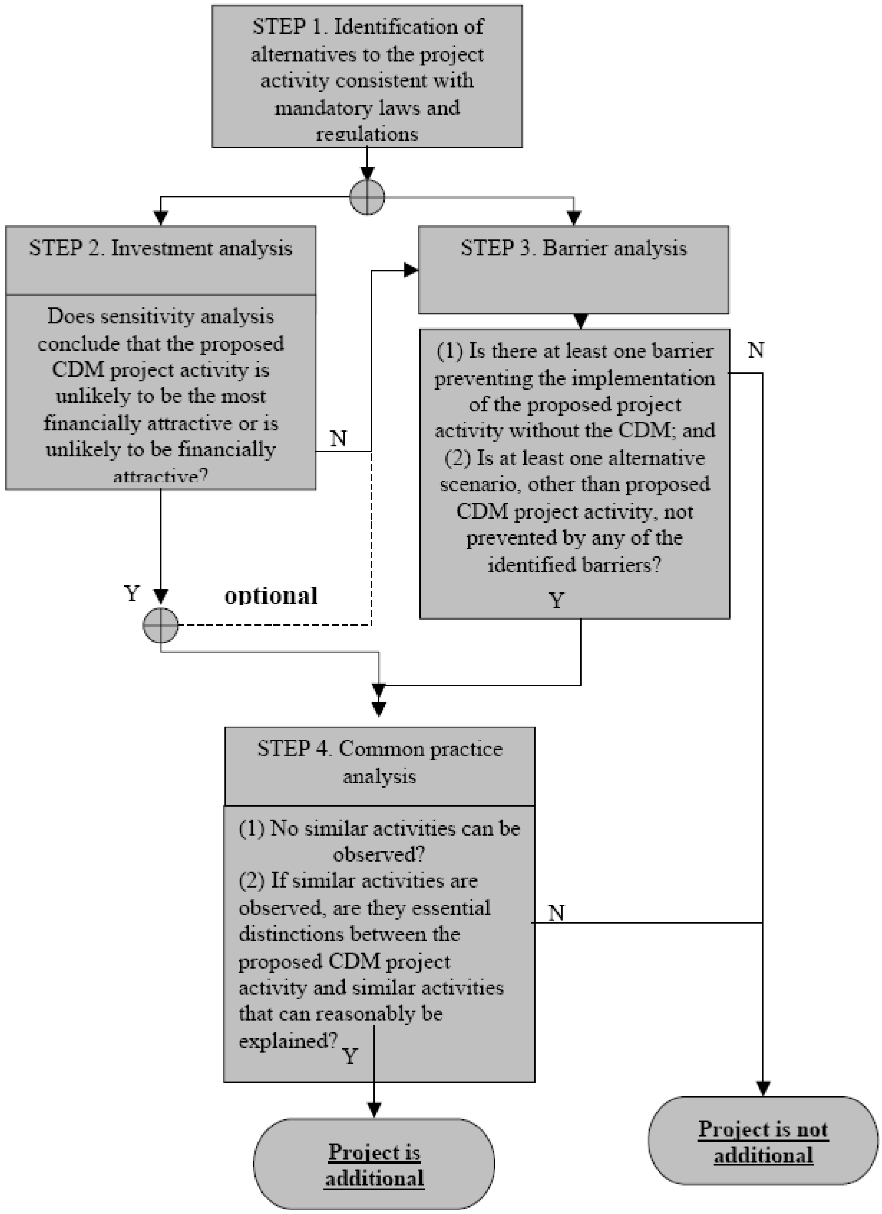
Description of the identified Baseline Scenario

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 Rio Amoyá Run-of-River Hydro Project electricity generation. In the project scenario the same electricity demand is met with the Rio Amoyá Run-of-River Hydro Project electricity generation dispatched in the base load, displacing the 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 the Rio Amoyá Run-of-River Hydro Project boundary is the Colombian National Grid System, SIN. 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 added to the System, based on different kind of fuels. Both aspects are depicted in the Combined Margin, which is calculated as shown next.

B.5. Demonstration of additionality

To demonstrate that the project activity is additional and therefore not the baseline scenario, the tool for the demonstration and assessment of additionality, version 05.2 is used. The application of this tool involves the following steps:



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

The electric system in Colombia is a competitive sector with national regulations. Although UPME prepares indicative power expansion plans, actual generation and capacity expansion is left to the decisions of the independent power producers.

Sub step 1a. Define alternatives to the 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 system expansion would occur as defined by UPME; that is the electricity will be supplied by a grid produced from another thermal or big hydro unit.

According to the Expansion Plan for the Colombian Electrical Grid 2009-2023, there are registered generation projects for a total additional capacity of 13,545.8 MW, from which 7,685.5 MW correspond to hydropower projects with a capacity of at least 20 MW; 2,884.6 MW of coal power projects; 2,520.5 MW of natural gas fired projects; 305 MW of fuel oil projects; 70.4 MW in hydraulic power projects with a capacity lower than 20 MW; 44.9 MW of co-generation projects; and 20 MW of wind power. In comparison with projects registered in the past, there are new fuel oil projects, and an increase in coal fired operations. The following table depicts the registered projects:

Table 1: Indicative Expansion Plan for the Colombian electrical grid for the period of 2009-2023

PROJECT	TECHNOLOGY	CAPACITY MW	DATE
Termocalendaria	Gas CC	586	Nov 12
Termocol	Gas	210	Dec 12
Meriléctrica	Gas CC	103	Nov 09
Termoflores IV	Gas CC	160	Nov 09
GT 23	Gas CC	100	2012
Termoandina 1	Gas	98.5	2012
Cimarron repowering	Gas	38	2009
CC Endesa 1	Gas CC	400	2012
Termo Upar	Gas	300	TBD
Termolumbi	Gas CC	300	TBD
Termo Yariguiez	Gas CC	225	TBD
Termocauca	Coal	100	TBD
Termobijao	Coal	460	2012
Gecelca 2	Coal open cycle	150	2012
Gecelca 3	Coal open cycle	150	2012
Gecelca 4	Coal open cycle	100	2012
Gecelca 7	Coal open cycle	100	2012
Termo San Fernando	Coal open cycle	165	2012
Tasajero II	Coal open cycle	155	2012
Termocaribe 1	Coal pulverized	350	2012
Termozipa 6	Coal	154.6	2012
Termosuamox	Coal	300	2012
Sinifana 1	Coal	175	2012
Sinifana 2	Coal	175	2013
Termocaribe 2	Coal	350	2015
Gecelca 14	Fuel Oil	10	2012
Gecelca 15	Fuel Oil	50	2012
Gecelca 13	Fuel Oil	10	2012
Termodial 1	Fuel Oil	25	2010

PROJECT	TECHNOLOGY	CAPACITY MW	DATE
Termocol	Fuel Oil	210	2008
Porce III	Hydro	660	2010
Amoyá	Hydro	80	2011
Miel II	Hydro	150	2011
Cucuana	Hydro	48	2011
Sogamoso	Hydro	800	2013
El Quimbo	Hydro	400	2013
Porce IV	Hydro	400	2015
Andaqui	Hydro	687	2016
Pescadero Ituango	Hydro	2400	2017
Chapasia	Hydro	800	TBD
Espiritu Santo	Hydro	700	2018
Bugalagrande	Hydro	40.5	TBD
Cañaveral	Hydro	68	TBD
Encimadas	Hydro	94	TBD
El Doce	Hydro	360	2022
Amaime	Hydro small	19.9	Dec 09
Coello 1,2,3	Hydro small	3.7	2009
Caruquia	Hydro small	9.5	Dec 09
Guanaquitas	Hydro small	9.5	Jul 09
Trasvase Guarino	Hydro small	--	Jun 10
Barroso	Hydro small	19.9	Dec 10
Trasvase Manso	Hydro small	--	Jan 11
PCH de Neusa	Hydro small	2.9	TBD
El Popal	Hydro small	19.9	Jan 13
Jouktai	Wind	20	TBD
Cogeneration IPSA	Biomass	19.9	Abr 09

Source: Plan de Expansión de referencia. Generación-transmisión, 2009-2023, República de Colombia, Ministerio de Minas y Energía, published in 2009.

Sub step 1b. Consistency with mandatory laws and regulations
All identified alternatives to the project activity are in compliance with mandatory legislation and regulations. Since all available alternatives are realistic and credible to the project participants, the Project is considered additional under Step 1.

Step 2: Investment analysis

The purpose of this step is to determine whether the project activity is economically or financially less attractive than Alternative 2 without an additional revenue/funding, possibly from the sale of certified emission reductions (CERs). The investment analysis was conducted in the following steps as specified in the additionality tool and following the “Guidelines on the assessment of investment analysis (Ver3, EB 51):

Sub-step 2a. Determine appropriate analysis method:

According to the "Tool for the Demonstration and Assessment of Additionality (Version 05.2)", 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 the guidance in the investment analysis.

Sub-step 2b. Option III. Apply benchmark Analysis

Identification of a suitable benchmark value

Under the rules guiding the electric power sector in Colombia individual investors are free to build and operate their power plants as they consider more attractive to their interests (free entry in a competitive market structure). The investment decision is therefore made by each investor based on all the options available incorporating the response of financial institutions in supporting the project activity.

Because there are no restrictions for a project of this type to be developed by an entity other than the project participant, and following the Guidance on the Assessment of Investment Analysis of the Tool for the Demonstration of Additionality, the investment analysis for demonstration of additionality relies on the use of a benchmark based on publicly available data. Because there are no sector specific benchmarks available in the country, the benchmark value for the project is derived from the estimates of the cost of financing i.e. commercial lending rates based on bankers views and private equity investors/funds" required return on comparable projects;

The Rio Amoyá Run-of-River Hydro Project which was originally sponsored by a consortium of companies including "Generadora Union", CEMEX, ISAGEN among other investors, sought investment funds through local and international investors and debt through a combination of financial mechanisms.

Project sponsors hired Santander Investments, an international banking group with considerable experience in the financial sector, to serve as the financial advisor with responsibility to (i) conduct project financial analysis by focusing on all realistic scenarios and potential local risks; and, (ii) raise investment funds and debt as required by the project.

In May 2005, after over 18 months of work, Santander Investments informed the project sponsor that they were not able to find interested investors. The investors internal rate of return (IRR) calculated at that time at 9.60% was not high enough to attract investors.

However, considering the flow of revenue from sale of carbon credits based on renegotiated emissions purchased agreement with the World Bank, ISAGEN reevaluated the project and again compared with the hurdle rate which is based on the interest rate charged by the major investor in the sector. Accordingly the benchmark considered is 16.04%, based on interest rates charged by FINDETER in June 2005 for Electricity Generation projects[2].

On the basis of above benchmark, calculation and comparison of financial indicators are carried out in sub-step 2c.

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

1) Basic parameters for calculation of financial indicators

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[2] Source: FINDETER historical interest rates, 2005. FINDETER builds its interest rate based on the interest rate of the deposits at 90 days of the Colombian Treasury (http://www.banrep.gov.co/estad/dsbb/sfin_009.xls), which was 7.18% in June 2005, adding a spread that was 8.860% for loans with a maturity between 8/12 years in June 2005.

Based on the project proposal, basic parameters considered for calculation of financial indicators are as follows:

Parameter	Value	Source
Commercial operations starting year	2009	Appraisal Report for Investment Decision[3] / Economic Model
Number of years considered in the evaluation	26 (2005-2030)	Appraisal Report for Investment Decision / Economic Model
Annual Electricity Generation	510.7 GWh/year	INGETEC Hydraulic study[4]
Total Investment	288,691 Million COP[5] (105 Million US$ at 2,749.44 COP/US$)	Appraisal Report for Investment Decision / Economic Model
Average Reference Electricity Price (tariff)	171.08 (COP/kWh)	Energy Planning Unit, Mine and Energy Ministry in the Reference Expansion Plan Generation – Transmission 2004-2018
O&M and Administration costs	24.96US$/kW/yr.	Appraisal Report for Investment Decision / Economic Model
Income tax	35%	Colombian legislation
Depreciation	Civil works: 20 years Equipment: 10 years	Colombian legislation

All inputs used for the calculations of project IRR were valid and applicable at the time when the assessment of the financial viability of the project was considered (2005)[6].

Results of the financial analysis are shown in the table below. Based on this analysis, the benefits associated with the CDM (i.e., sale of ERs and duties exemption) are not high enough to make the project financially viable. However, as it was stated before, the company used its own internal benchmark to make the decision to go ahead.

The social and environmental benefits of the project for the region have been a strong argument to proceed with project involvement.

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[3] Date of the Report: June 2005

[4] Before 2005, ISAGEN initially hired the firm INGETEC to evaluate the hydraulic potential of Amoyá and Ambeima rivers, in order to select the best hydropower project, in terms of generating capacity, environmental impact, and costs. This study evaluated a project with a nominal capacity of 78 MW, with an average flow of 17.2 m3/s. A period of 15 years was simulated and the reported average generation level was 516 GWh/yr. To account for potential losses, the team in charge of assessing the project's economic feasibility applied 99% of 516 GWh, which corresponds to 510.7 GWh. Later again in 2005, ISAGEN hired another engineering firm, SEDIC, to update and complement INGETEC"s study. Using time series data from hydrological stations, the average flow was now set at 18.4 m3/s, the nominal capacity was increased to 80 MW, and the average generation level was estimated at 513.6 GWh/yr.

[5]The total investment costs of the Project with CDM registration is 276,665 Million COP. This difference is due to the reduction on import levies of the equipment for registered CDM Projects in Colombia. However, the project is eligible to claim tax deduction only if the registration has occurred prior to the import of the equipment.

[6] Detail description of the methodology, assumptions and source of the data used for the project financial analysis are available in Spanish.

Table 2. Project Internal Rates of Return with and without CDM

Scenarios	IRR
1. With Carbon credits[7] and tax exemption	13.21%
2. Without tax exemptions and without carbon credits	12.32%
Benchmark (FINDETER rate)	16.04%

According to the VVM guidelines, the Financial Analysis is referred to the moment of taking the decision of developing the project. In addition, since a later technical study from SEDIC indicated that the annual electricity generation could reach 513.6 GWh/yr., instead of 510.7 GWh/yr. from the INGETEC initial Hydraulic study, it has been also calculated the IRR using the 513.6 GWh/yr., which is just 0.57% higher than the previous estimated value. The IRR using 513.6 GWh/yr. is 13.25% and 12.35%, with and without carbon credits respectively, instead of 13.21% and 12.32%. In both cases the value is still below the benchmark of 16.04%.

Sub-step 2d: Sensitivity Analysis
The results of a sensitivity analysis to changes in investment costs and in operation and maintenance cost is presented below.

Table 3. Sensitivity Analysis of Project IRR without CDM

Variable	Base Case (no changes)	Changes of +/- 10%		Changes of +/- 20%	
		+	-	+	-
Investment Costs	12.32%	11.50%	13.26%	10.76%	14.35%
O&M Costs	12.32%	11.62%	13.01%	10.90%	13.69%
Energy Prices	12.32%	19.05%	4.51%	25.55%	negative%

Based on this sensitivity analysis, the project IRR could exceed the relevant benchmark only if energy prices are higher than those used for the analysis (all based on publicly available data). However, in Colombia the merit order dispatch system, and the relatively large share of hydropower, reaching high prices is not a realistic assumption. Also, getting too low an IRR if prices decrease make price risk too high to depend on. The results are similar and below the benchmark value even after accounting the increased generation figures as per the later technical study from SEDIC.

Step 3. Barrier analysis

In addition to the investment analysis, barrier analysis is also used to demonstrate that the project is additional. In this step, it is determined that the proposed project activity faces barriers that: a) prevent the implementation of this type of project activity; and b) do not prevent the implementation of at least one of the alternatives.

Sub step 3a. Identify barriers that would prevent the implementation of type of the proposed project activity

The following barriers have been identified:

- **Investment barriers**: After considerable effort and a road show that included European and North American capital markets, the project did not achieved financial closure. Out of the total investment cost of the project, 60% was expected to receive debt finance. However, the projects faced major financial barriers in terms of low returns on equity

[7] Carbon credits value is based on the emission reductions estimated during the decision making process

(9.60%), high upfront need for debt financing and inability of the project revenues to produce the debt-coverage limits required by financiers. Under the BAU scenario, the project lacked ability to attract necessary finances to undertake the project (as informed by the independent financial advisor Santander Investment in May 2005).

The initial sources of financing of the Rio Amoyá Run-of-River Hydro Project are presented below. For simplicity, the sources of finances are divided in “capital investment” and “lending opportunities”.

The initial stockholder composition included: (1) 56%, ISAGEN; (2) 5%, Generadora Unión; (3) 5%, civil works contractors; (4) 1%, CEMEX; and (5) 33%, other investors. The project was planned to start in 2008. However, the project was dropped after 18 months of unsuccessful negotiations to secure financial support.

ISAGEN assumed project ownership (100% equity) after assessing the project as an independent sponsor, using its own resources and access to debt, and considering a renegotiated ERPA. The CDM benefits helped improve the project´s IRR for ISAGEN to go ahead with the project. The Government of Colombia controls ISAGEN‟s property, although the company behaves as a private company, where income is generated through energy sales. No subsidies from the government are received or taken into account when considering investment opportunities. Thus, the implementation of the project as a CDM project enables it to overcome investment barriers. It also demonstrates that the project activity is additional.

- **High risk profile of run-of-river hydropower projects**: As the river flow is variable, run-of-river hydropower projects have higher risk than other comparable sources, e.g. reservoir based hydropower, which in the Colombian electricity market brings additional revenue through *reliability charge,* a premium paid for the reliable and ready-to-use power. This reliability charge is paid for the base load that can be offered on a firm basis. In the case of run-of-river projects, the energy supplied on a firm basis is lower than their medium energy and therefore presents higher uncertainties. Renewable energy sources, such as wind farms and run-of-river plants, do not receive extra remuneration for their full amount of energy supplied, as they cannot supply guaranteed energy output to the national system.

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

The Colombian power system continues to expand based on individual power producers‟ decisions that find their investment attractive under the rules guiding the sector. It is concluded that other options are open to investors, including ISAGEN, as the Colombian interconnected system continues to expand. Other alternatives – like the installation of a thermal unit or an alternative power plant - would find conditions that enable investors and financiers to obtain financial closure under the existing conditions of availability of hydropower potential, coal and natural gas and the market demand for additional capacity to meet the growing demand.

Step 4. Common practice analysis

Sub-step 4a. Analyze other activities similar to the Rio Amoyá Run-of-River Hydro Project

Although run-of-river technology is not new in Colombia, its use is not part of the business as usual scenario mainly due to the required high up-front investment capital and relatively low energy prices, which make this type of investments long term return opportunities. Most power generation capacity is added as large hydros (52%) or thermopower (46%), while small hydro projects get to a mere 0.6%. Therefore, the Rio Amoyá Run-of-River Hydro Project is considered additional with respect to investment climate, and access to financing.

Sub-step 4b. Discussion of similar options that occur

As shown in Table 1, run-of-river investments in UPME‟s projected power generation expansion plan amount to less than 1% of total generation capacity. Most other new small run-of-river hydropower projects occur supported by CDM.

As a summary the project demonstrates additionality in the following ways:

a) Colombia adopted an open, regulated and market oriented energy sector; therefore there is no legal obligation that project has to be built;

b) The run-of-river energy involves relatively high risk compared with fossil fuel forms of energy or even big hydropower involving reservoirs because the river flow is variable and is affected by climate variability. These run-of-river plants do not receive the extra remuneration called *reliability charge,* provided by the national energy regulator as incentive for supplying reliable and ready-to–use energy to the grid so that the national energy demand can be covered. Renewable energy sources, such as wind farms and run-of-river plants do not receive this extra remuneration as they cannot assure a specific amount of energy units to the national system due to the random and uncontrolled nature of their energy source.

c) Several **barriers** individually and collectively increase the risk perception of the investors and financiers. This higher risk perception implies that for the project to be attractive to investors, it must produce higher than normal rate of return on the risk capital and high financial coverage factors for financiers‟ comfort, which combined create a strong **investment barrier**, which prevents it from being part of the capacity expansion plan, namely a limited access to equity and debt in the local and international markets, due to the high risk of investments in Colombia.

d) The financial analysis results show that the business as usual (BAU) scenario presents low returns on equity and low coverage ratios to service debt;

e) The participation of the project in the carbon market improves the leverage (i.e. stakeholder ability to reach financial closure, possibilities of attracting favorable financing conditions, higher return on investment due to the carbon revenue) and increases the project attractiveness to financiers

The project is additional because it generates emission reductions that would not occur otherwise. Considering the significant investment barriers associated with run-of-river power generation in the country, the project sponsor is unlikely to invest in the project in the absence of carbon finance.

<u>Early consideration of CDM</u>

In early 2002, the Project Entity decided to submit a Project Idea Note to the World Bank and after its consideration, a Letter of Intent was signed in September 23, 2002 to develop the project using the Clean Development Mechanism. Further documentary evidence can be made available for verification by the DOE.

The chronology of events of the project activity is presented below:

Date	**Events**	**Evidences**
April 2002	Submission of the Project Idea Note (PIN) to the World Bank by the Project Entity (HIDROGER at that moment)	World Bank, 2002
23 September 2002	Signature of the Letter of Intent (LOI) between the World Bank and the Project Entity (HIDROGER)	LOI 2002
January 2003	Project Concept Note approved by the World Bank	World Bank 2003
June 2003	World Bank environmental safeguards assessment completed	World Bank 2003
16 July 2003	Extension of LOI exclusivity period	LOI Extension

		2003
November 2003	World Bank social safeguards assessment completed	World Bank 2003
January 2004	Santander Investments began analysis on financial closure	
27 April 2004	Letter of Approval, Colombian DNA	LOA Colombia, 2004
10 May 2004	World Bank Project Appraisal Document	World Bank, 2004
27 May 2004	ERPA Signed between the World Bank and the Project Entity (HIDROGER)	ERPA 2004
May 2005	Santander Investment informed that it was not able to find interested investors	ISAGEN, 2005
8 May 2006	ISAGEN Executive Board approved the project	ISAGEN, 2006
8 May 2006	Novation and ERPA amendment signed with ISAGEN	ERPA amendment, 2006
18 December 2007	Memo signed between local authorities and ISAGEN on social benefits for the local communities	ISAGEN, 2007
21 October 2008	Change of name of the project by the DNA	LOA Colombia, 2008
7 May 2008	Civil works contract signed with Rio Amoyá consortium. CDM Project Starting Date	ISAGEN, 2008
16 June 2008	Construction of the project started	
8 May 2009	World Bank contracted ICONTEC to perform the validation of the project	World Bank, 2009
8 November 2009	PDD published for global stakeholder consultation during the period 8 Nov 2009 to 8 Dec 2009	
July 2011	Expected date of Project commissioning	

B.6. Emission reductions

B.6.1. Explanation of methodological choices

This section describes the procedures and methodology choices followed as per the approved consolidated baseline methodology for grid connected electricity generation projects (ACM0002 – version 12.1.0).

The Consolidated Baseline Methodology ACM0002 version 12.1.0 is applicable to the project and meets the applicability conditions, specifically, (i) the project involves a new power plant at a site where no renewable power plant was operated prior to the implementation of the project activity (greenfield plant), (ii) the project activity is grid-connected electricity generation from renewable energy sources, and (ii) the geographic and system boundaries for the electricity grid are clearly identified and information on the grid characteristics is available.

Based on ACM0002 version 12.1.0, the Operating Margin in the project is calculated using method (b) Simple Adjusted Method, and employing the ex-ante vintage option; the Build Margin is also calculated using the ex-ante Option 1. The cohort of power plants used correspond to the set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

The data for calculation of the Operating Margin and Build Margin Emissions Factors are collected from official sources such as the Energy and Mines Planning Unit (UPME) and Experts Company Market - XM. **XM** is in charge of planning, supervision and control of generation and transmission of the national electricity system. XM also supervises the Regional Dispatch Centers (CRDs) to ensure system’s coordination and reliability. XM preferentially dispatches the Amoyá River

Hydroelectric Plant[8]. XM registers and stores generation data by the hour in a state of the art database that can be fully accessible through the Internet.

B.6.2. Data and parameters fixed ex ante

Data / Parameter	**$EG_{m,y}$ and** $EG_{k,y}$
Unit	MWh
Description	Net electricity generated and delivered to the grid by power unit *m* or *k* in year *y*
Source of data	Data recorded, archived and supplied by XM
Value(s) applied	It varies by plant and year. XM keeps records of this variable for its users.
Choice of data or Measurement methods and procedures	The data are suitable for the calculation of the National grid emission factor following the " tool to calculate the emission factor for an electricity system" Simple adjusted OM: once for each crediting period using the most recent three historical years; 2006-2008 (*ex ante* option) for the first crediting period. BM: For the first crediting period, option 1(*ex ante*) following the guidance included in Step 5. For the second and third crediting period, the *ex-ante* BM calculation at the start of the second crediting period will be used.
Purpose of data	Calculation of baseline emissions
Additional comment	Not applicable

Data / Parameter	**$EF_{CO2,i,y}$, $EF_{EL,m,i,y}$, and $EF_{EL,k,i,y}$**
Unit	$tCO2/GJ$
Description	Emission factor of fossil fuel type i for power plant m or k in year y
Source of data	IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.
Value(s) applied	Diesel Oil = 72,600 Residual Fuel Oil = 75,500 Natural Gas = 54,300 Coal = 87,300
Choice of data or Measurement methods and procedures	The CO2 emission factor is used to calculate the CO2 emission coefficients of the power plants in the grid. Step necessary to find the baseline emission of the grid according to the "Tool to calculate the emission factor for an electricity system" Simple adjusted OM: once for each crediting period using the most recent three historical years; 2006-2008 (*ex ante* option) for the first crediting period. BM: For the first crediting period, option 1(*ex ante*) following the guidance included in Step 5. For the second and third crediting period, the *ex-ante* BM calculation at the start of the second crediting period will be used.

[8] In Colombia, the Centrally Dispatch System, as defined by Resolution 024/95, gives preference to the low cost generators. Run-of-river hydropower plants have the lowest cost in the system, operate based on available water flows, and since there is no reservoir, the water opportunity cost is zero. Therefore, it is expected that these power plants are always dispatched.

Purpose of data	Calculation of baseline emissions
Additional comment	Not applicable

Data / Parameter	$\eta_{m,y}$ and $\eta_{k,y}$
Unit	GJ/MWh
Description	Average net energy conversion efficiency of power unit *m* or *k* in year *y*
Source of data	The default values provided in the table below in Annex 1 (if available for the type of power plant)
Value(s) applied	See Annex 3
Choice of data or Measurement methods and procedures	
Purpose of data	Calculation of baseline emissions
Additional comment	Not applicable

Data / Parameter	$\mathbf{EF_{grid, CM,y}}$
Unit	tCO2/MWh
Description	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"
Source of data	Ex-ante calculations
Value(s) applied	0.3439
Choice of data or Measurement methods and procedures	As per the "Tool to calculate the emission factor for an electricity system".
Purpose of data	Calculation of baseline emissions
Additional comment	As per the "Tool to calculate the emission factor for an electricity system". This value is calculated ex-ante and will be used throughout the crediting period.

B.6.3. Ex ante calculation of emission reductions

The procedure for ex-ante calculation of emission reductions due to the Rio Amoyá Run-of-River Hydro Project is presented in this section. (Annex 4 presents the Monitoring Information and describes in detail the calculations required through a workflow diagram and the corresponding workbook)

Baseline emissions

Baseline emissions include only CO2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity. The methodology assumes that all project electricity generation above baseline levels would have been generated by existing grid-connected power plants and the addition of new grid-connected power plants. The baseline emissions are to be calculated as follows:

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

(B.6.3.1)

Where,

BE_y: Baseline emissions in year "y" (tCO_2e)
$EG_{PJ,y}$: 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 v.02"* (tCO_2e/MWh) in year "y"

Project emissions

The proposed CDM project activity is a run-of-river energy plant and does not give rise to direct GHG emissions since it does not have a reservoir. According to ACM0002, version 12.1.0 project emission calculations apply only to hydroelectric plants that result in new reservoirs or in the increase of existing reservoirs. Since these two cases do not apply to the proposed CDM project activity, a value of zero emissions is assigned to the project emissions, **$PE_y = 0$.**

Leakage

No leakage emissions are considered. The main emissions potentially giving rise to leakage in the context of electric sector projects are emissions arising due to activities such as power plant construction and upstream emissions from fossil fuel use (e.g. extraction, processing, and transport). These emissions sources are neglected, **$L_y = 0$**.

Emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \qquad \text{(B. 6.3.2)}$$

Where:

ER_y = Emission reductions in year *y* (t CO2e/yr.)
BE_y = Baseline emissions in year *y* (t CO2/yr.)
PE_y = Project emissions in year *y* (t CO2e/yr.)

Calculation of the combined margin CO2 emission factor for grid connected power generation

The combined margin CO2 emission factor for grid connected power generation in year *y* is determined using the *"Tool to calculate the emission factor for an electricity system version 02"*. The emission factor is calculated in the following steps:

***Step 1**. Identify the relevant electricity system*
The project will provide electricity to the national grid.

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

Project participant has decided to include only grid power plants in the project electricity system and hence chosen Option 1.

***Step 3**. Select a method to determine the operating margin (OM)*
The calculation of the operating margin emission factor ($EF_{grid,OM,\text{ and }y}$) is based on the *simple adjusted OM*. The data vintage chosen for the calculation is ex-ante, using a 3-year generation-weighted average, based on the most recent data available. In the case of the Amoyá project an average of the years 2006-2008 was used because data for 2009 was not available at the time of PDD submission to the DOE. As described in detail in annex 3, XM and the Mining and Energy Planning Unit at the Ministry of Energy (UPME) provided all data used to calculate the Operating

Margin (OM) and Build Margin (BM) emission factors. The recorded generation data for each power plant at hourly intervals for the chosen vintage period was downloaded from XM web page. Data will be updated for the second and third crediting period.

Step 4. *Calculate the operating margin emission factor according to selected method*
The simple adjusted OM emission factor ($EF_{grid,\ OM\text{-}Adj,\ and\ y}$) is a variation of the simple OM, where the power plants / units (including imports) are separated in low-cost/must-run power sources (k) and other power sources (m). It is calculated based on the net electricity generation of each power unit and an emission factor for each power unit, as follows:

$$EF_{grid,OM-Adj,y} = (1-\lambda_y)\frac{\sum_m EG_{m,y} * EF_{EL,m,y}}{\sum_m EG_{m,y}} + \lambda_y \frac{\sum_k EG_{k,y} * EF_{EL,k,y}}{\sum_k EG_{k,y}} \qquad \text{(B.6.3.3)}$$

Where,

$EF_{grid,\ OM\text{-}Adj,\ y}$	= 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 for power unit m in year y (tCO2/MWh)
$EF_{EL,\ k,\ y}$	= CO2 emission factor for 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 grid power units serving the grid in year y
y	= The relevant year as per the data vintage chosen in Step 3

The parameter λ_y is defined as follows:

$$\lambda_y = \frac{\text{Number of hours low-cost/must-run sources are on the margin in year y}}{\text{8760 hours per year}}$$

Lambda (λ_y) should be calculated as follows (see figure below):

Step (i) Plot a load duration curve. Collect chronological load data (typically in MW) for each hour of the year y, and sort the load data from the highest to the lowest MW level. Plot MW against 8760 hours in the year, in descending order.

Step (ii) Collect power generation data from each power plant/unit. Calculate the total annual generation (in MWh) from low-cost/must-run power plants/units (i.e. Σk EGk, y).

Step (iii) Fill the load duration curve. Plot a horizontal line across the load duration curve such that the area under the curve (MW times hours) equals the total generation (in MWh) from low cost/must-run power plants/units (i.e. Σk EGk, y).

Step (iv) Determine the .Number of hours for which low-cost/must-run sources are on the margin in year y. First, locate the intersection of the horizontal line plotted in Step (iii) and the load duration curve plotted in Step (i). The number of hours (out of the total of 8760 hours) to the right of the intersection is the number of hours for which low-cost/must-run

sources are on the margin. If the lines do not intersect, then one may conclude that low-cost/must-run sources do not appear on the margin and λy is equal to zero.

In determining λ_y only grid power units are considered.

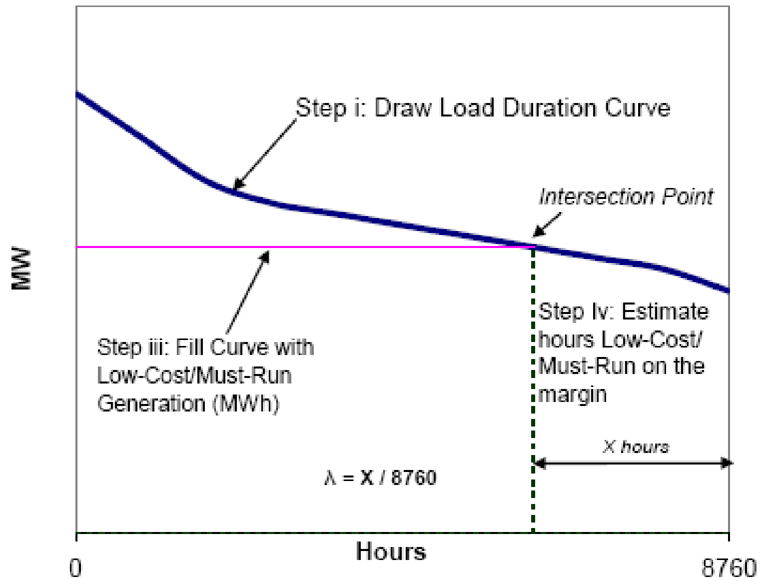


Fig 1. Illustration of lambda calculation for simple adjusted operating margin emission factor

To calculate the CO_2 emission factors $\mathbf{EF_{EL,m,y}}$ and $\mathbf{EF_{EL,k,y}}$ of power units *m and k* in year y (tCO2/MWh), Option A2 was used, as data on electricity generation and the fuel types and the efficiency of the power unit are available. Data on fuel consumption per power units are not available. Following this option, the fuel efficiency of every unit (MBTU/MWh) is converted to TJ/MWh so that the EF (tCO_2/TJ) from IPCC can be used. The following equation is applied:

$$\mathbf{EF_{EL,m,y} = EFCO2,\ i_{,m,y} * \eta_{m,y} * CONV}$$

Where

$EF_{EL,m,y}$	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
$EF_{CO2,m,y}$	CO_2 emission factor of fuel type *i* used in power unit *m* in year *y* (tCO_2/TJ) obtained from IPCC
$\eta_{,m,y}$	Fuel efficiency of power plant *m* in year y in MBTU/MWh
CONV	1 MBTU = 0.001055056TJ
i	Types of fuels used by the unit *m*

The set of emission factors of power unit *n* calculated ex-ante will be reviewed at the beginning of the next crediting period based on the official and publicly available data.

Step 5. *Identify the group of power units to be included in the build margin (BM)*

In terms of vintage of data, option 1 (ex-ante) has been chosen. This means that for the first crediting period, the BM is calculated ex-ante based on the most recent information available on units already built for sample group *m*. At the time of PDD submission to the DOE, the sample group of power units *m* used to calculate the build margin consists of the set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that are most recent, as this group presents a larger annual generation than the last 5 power units most recently built[9].

[9] See Annex 3 of the PDD for a complete list of plants built in Colombia and that are most recent

Step 6. *Calculation of the Build Margin emission factor*

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

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} * EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad \text{(B.6.3.5)}$$

Where,

$EF_{grid, BM, y}$ = Build margin CO_2 emission factor in year y (tCO2/MWh)

$EG_{m, y}$ = Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)

$EF_{EL, m, y}$ = CO2 emission factor of power unit *m* in year *y* (tCO2/MWh)

m = Power units included in the build margin

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

As indicated by the Tool, the CO2 emission factor of each power unit m ($EF_{EL, m, y}$) is determined as per the guidance in step 3 (a) for the simple method OM, using option 1 which is based on net electricity generation, the average efficiency of each power unit and the fuel type(s) used in each power unit. This is calculated using for y the most recent historical year for which power generation data is available and using for m the power units included in the build margin. The vintage data set is applied ex-ante, so it will be revised for the next crediting period.

Step 7. Calculate the Combined Margin (CM) emission factor

The combined margin emissions factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} * W_{OM} + EF_{grid,BM,y} * W_{BM} \quad \text{(B.6.3.6)}$$

Where,

$EF_{grid, BM, y}$ = Build margin CO2 emission factor in year y (tCO2/MWh)

$EF_{grid, OM, y}$ = Operating margin CO2 emission factor in year y (tCO2/MWh)

W_{OM} = Weighting of operating margin emissions factor (%)

W_{BM} = Weighting of build margin emissions factor (%)

The weights $\mathbf{W_{OM}}$ and $\mathbf{W_{BM}}$ in equation (B.6.3.6) have been given default value of 0.5 for the first crediting period.

The final results of the calculation of the Emission Factor are the following:

$EF_{grid, OM, 2008}$ = 0.47 tCO2/MWh

$EF_{grid, BM, 2008}$ = 0.2170 tCO2/MWh

W_{OM} = 0.5

W_{BM} = 0.5

$\mathbf{EF_{grid, CM, 2008}}$ = 0.3439 tCO2/MWh

Note: The data and calculations of the combined margin and of the emission factor are presented in Annex 3 of the PDD.

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

Year	Baseline emissions ($t\ CO_2e$)	Project emissions ($t\ CO_2e$)	Leakage ($t\ CO_2e$)	Emission reductions ($t\ CO_2e$)
1 July 2012 – 31 December 2012	0	88,321	0	88,321
2013	0	176,643	0	176,643
2014	0	176,643	0	176,643
2015	0	176,643	0	176,643
2016	0	176,643	0	176,643
2017	0	176,643	0	176,643
2018	0	176,643	0	176,643
01 January 2019 – 30 June 2019	0	88,321	0	88,321
Total	0	1,236,499	0	1,236,499
Total number of crediting years	3*7 = 21			
Annual average over the crediting period	0	176,643	0	176,643

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data / Parameter	$EG_{PJ,y}$
Unit	MWh
Description	Net electricity displaced by the project activity during year *y*
Source of data	Data supplied by ISAGEN for ex-ante calculation, and later by XM for verification purposes. Data supplied by ISAGEN used for ex-ante calculations.
Value(s) applied	It varies hourly and by plant. Generation of approximately 513,6 GWh/year
Measurement methods and procedures	Hourly values. XM monitors continuously the value of this variable. It also keeps records for its customers.
Monitoring frequency	Hourly measurement and monthly recording. Following Colombian regulations the electricity generation from each power plant connected to the grid will be monitored on site using metering equipment located at the commercial frontier, which will be located in Tuluní substation (Chaparral town) at the end of the 115 kV, 18.6 km transmission line connecting Río Amoyá plant with the national interconnected system. In Colombia, The Measurement Code "*Código de Medida*" establishes mandatory high technical standards, procedures for reading, registering and recording activities of electricity transactions performed in the Colombian energy market. This code is part of the CREG's resolution number 025 of 1995, which is followed for electricity output measurements.

QA/QC procedures	All metering devices used to monitor and measure data follow rules that have been summarized in resolution number 025 of 1995, (*Resolución* 025 de 1995) from CREG. This resolution specifies the technical characteristics measurement, telecommunications and back-up equipment to meet installation, testing, certification, operation and maintenance procedures. To cross-check the electricity delivered by the Amoyá Hydroelectric Power Plant to the grid, the hourly energy measured per day in the commercial frontier in Tuluní Substation, must be compared with the last XM report published.
Purpose of data	Calculation of baseline emissions
Additional comment	Not applicable

B.7.2. Sampling plan

N/A

B.7.3. Other elements of monitoring plan

The Monitoring Plan (MP) defines a standard against which to measure the Rio Amoyá Run-of-River Hydro Project performance in terms of its greenhouse gas (GHG) emissions and emission reductions that can be monitored and verified in conformity with the modalities and procedures of the Clean Development Mechanism criteria.

The MP can be updated and adjusted to meet operational requirements, provided such modifications are approved by the DOE as in line with the guidelines and procedures of CDM during the initial or periodic verification. In particular, any shifts in the applicable baseline that are identified by following this MP may lead to such amendments, which may be mandated by the Verifier. Basically the Monitoring Plan consists of three main sections as described in Annex 4 (Please see Annex 4 for the complete MP):

- *Section 2* explains principal assumptions applied in monitoring the GHG performance of the project and in calculating ERs. The section also discusses data sources and assumptions and lays out why the MP is expected to compute ERs in a conservative manner.

- *Section 3* contains instructions regarding operational and monitoring obligations the operator is expected to assume.

- *Section 4* presents the functioning of the MP electronic workbook. The workbook is implemented as Excel spreadsheets and is an integral part of the MP.

Emission reductions in the Monitoring Plan are calculated following steps described in the ACM0002, version 12.1.0. Basically, the following formula is used,

$$\mathbf{ER_y = BE_y - PE_y - L_y}$$

Where,
BE_y = Baseline emissions due to the displacement of electricity during the year *y* in tonnes of CO2e in year "y"
PE_y = Project emissions in year "*y*"
L_y = Leakage in year "*y*"

In the case of the proposed project, leakage related to transportation of materials and fuel and other up-stream activities are negligible, because higher life cycle emissions would result from the construction and operation of alternative capacity. The life cycle emissions of alternative power generation plants, in particular of fossil fuel power plants, are typically higher than those from wind power plants or hydro/run of river power plants. Therefore, no net leakage can be attributed to the project.

Operational and Management Structure

ISAGEN has formed a multidisciplinary team, coordinated by the Production Manager (*Gerencia de Producción*) which will be responsible for monitoring the parameters and will be responsible for recording and analyzing the data. Since the project will be using an Ex-Ante option for the grid emission factor, the only number to monitor for upcoming verifications is the actual electricity dispatched to the grid. This is relatively simple process, as the Colombian interconnected system relies on a highly regulated metering setup, which is required to make payments for electricity possible. This means that for the CDM project the only role for monitoring data is keeping copies of the hourly generation records that the central dispatch center maintains on file.

ISAGEN will incorporate explicitly into its internal procedures a detailed description of the activities related with the adequate management of the CDM monitoring system, including the roles and responsibilities associated with those activities.

As per the metering, each of the generating units at Amoyá is equipped with multi-function electronic metering devices, which register all information that needs to be monitored, such as exported energy, imported energy, power factor, electric tension, electric flow, etc. Such meters will be used for commercial, and maintenance purposes, in addition to the CDM reporting requirements. Before the starting of commercial energy exchanges with the wholesale market system, the equipment needs to be duly certified by authorized entities[10].

The Production Management Unit keeps a periodical maintenance and calibration program according the codes approved by law, and following recommendations by the equipment providers. Information recorded by the metering equipment is sent every 24 hours to the Commercial Exchange System, operated by XM. All energy transactions are registered every hour, in the first minute of each hour. ISAGEN transmits every day, before 8am the recorded values of the day before. According to that information, XM processes the bills and payments for all transactions performed in the wholesale market. All this information is available to the market agents and to the system control authorities.

The metering system at ISAGEN for the project is composed by software and hardware that allows for automatic recording of data collected at the meters. Using a system called PRIMEREAD, all data for outgoing and incoming energy are measured so that net electricity exports records are kept in file. For verification purposes, the data will be easily available at ISAGEN. In addition, historic records of actual energy supplied to the grid are publicly available at the XM website. For confidentiality purposes, the release of information is made available with a delay of 6 months.

B.8. Date of completion of application of methodology and standardized baseline and contact information of responsible persons/ entities

The PDD was completed on December 18, 2009 by Juan Lopez-Silva for the World Bank.

World Bank Contact: Manuel Luengo

Sources of information for the interconnected grid in Colombia include: (i) the updated operational database of XM; contact: Ms. Silvia Cossio, tel: +57 (4) 315-7885; and, (ii) UPME; Mr. Jose

[10] Following Decree 2269/93.

Vicente Dulce. Tel: +57 (1) 287-5354 the Planning Unit for the energy sector in the Ministry of Mines and Energy.

Access to XM database is available upon agreement with the XM. The operational data includes: National Energy Demand, Hourly/Daily National Generation by Plants, Hourly/Daily Plant Energy Bid prices, Energy generated to cover constraints, National Hydraulic Generation and Dam water levels among others.

All the information required to estimate the emission reductions associated with the electric interconnected system in Colombia is found in the archives operated by XM and UPME. The UPME publishes data on its website (http://www.upme.gov.co/Index4.htm) and includes: Indicative Energy and Mines Expansion Plans, Energy and Mines Statistics Bulletins, Analysis of International Electricity Prices and Colombian Electricity Market Magazine. The UPME‟s technical capacity has been used to estimate the expected emission reductions through advanced simulation methods, and periodically the estimates of i plant level emission factors based on technical information and chemical analysis of fuels used.

Information collected from stakeholders is subject to the CREG regulation and the National Regulatory Commission for Energy. The internationally accepted measuring standards have been enacted. Audits are implemented to ensure the data quality and access to all stakeholders. Colombia offers very good, accurate and reliable data from its interconnected electric grid.

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

07/05/2008

C.1.2. Expected operational lifetime of project activity

The operational lifetime of the Project is estimated as 50 years, as is common for run-of-river Projects.

C.2. Crediting period of project activity

C.2.1. Type of crediting period

7 years, renewable

C.2.2. Start date of crediting period

From 01/07/2012 or the date of registration whichever is later; the first crediting period will start with the generation and monitoring of the first emission reductions.

C.2.3. Length of crediting period

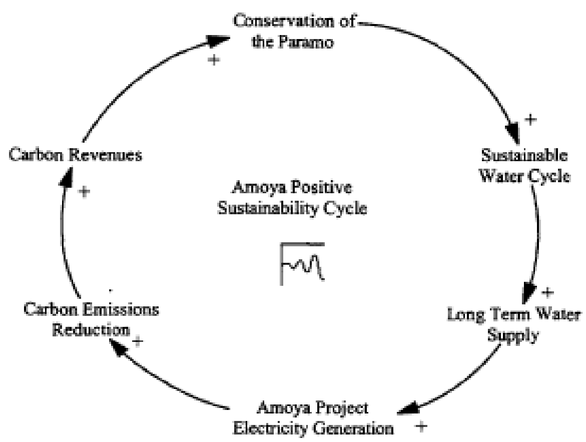
7 year, renewable.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

The project will contribute to watershed management and to the preservation of environmental services, sustainability of hydrological cycle from high mountain ecosystems. The conservation of the Rio Amoyá watershed is a major factor influencing the mountain ecosystem, the sustainability of water flow and the agricultural activities in the region.

Fig.1 Economic and environment relationships of the Rio Amoyá Run-of-River Hydro Project



A detailed environmental impact assessment has been completed. The report concludes that there are no major adverse environmental impacts. The changes in water flow in the Amoyá River over a limited stretch, potential erosion at construction sites and impacts on water quality could be addressed within the Environmental Management Plan during construction and as part of operation and maintenance (O&M) activity. The design flow has been kept at 18.4 m^3/s to guarantee a minimum of 1.0 m^3/s at all times, and considerably higher 41% of the time. Furthermore, the Environmental Impact Assessment (EIA) shows that the additional flows will add to the river flow starting at 1 km. from the intake point. Measures to control erosion are included in the construction contracts. Water quality in the project area will be improved with the implementation of water resource management and solid waste management measures. Most works will be implemented underground to minimize the environmental footprint of the project.

Environmental Management Plan: The main objective of the environmental management plan is to promote the alignment of the project activities with the environmental and community objectives. The management measures are presented as index cards highlighting the mitigation measures, indicators for monitoring, schedule of execution, people in charge, and resource commitments for tasks. Monitoring programs are designed to verify the implementation of the environmental management measures during construction and operation of the project.

Contingency Plan: A contingency plan has been designed for managing the risks from natural, human and operational hazards. A list of activities to support the implementation of contingency plan has been prepared to address the situations that need to be responded and managed.
Socio-economic impacts: In order to assess the impacts during the construction and the operation a detailed socio-economic analysis was carried out. The diagnosis included assessment of infrastructure, water and sanitation, electrification, transport, communication, land use, health, education, administrative and institutional capacity. The socioeconomic impact assessment shows that the adverse impacts are minor while the positive impacts are substantial.

CONCERTATION WITH LOCAL COMMUNITIES AND AUTHORITIES:

In addition to the prevention and mitigation actions for the works related to the construction of the hydropower plant, all of them included in the Environment Management Plan, ISAGEN will undertake the following activities. They have been agreed upon with the local communities close to the project site and local authorities through a Memorandum signed on December 18th 2007 (available upon request):

1. **Basic sanitation:** Installation of family sanitary units and septic wells in the surrounding areas of the *Amoyá* River.
2. **River basin reconstruction and protection**, in the ravines of La *Alcancía, La Virginia, San Jorge y La Arenosa*, in order to Project the remaining forest, avoid deterioration of the environment and improve the conditions of the tributaries and the *Amoyá* River.
3. **Reforestation and maintenance of forests** located in the buffer zone of the *Las Hermosas* National Natural Park. Communal greenhouses will be installed with native species with the aim to recover risk areas and make a sustainable use of natural resources.
4. **Acquisition and management** of lots to protect water springs and improve eroded land in the medium and higher lands of the Amoyá River basin.
5. **Pilot programs for the reforestation mentioned activities.**
6. **Water springs and water sources.** ISAGEN will prepare a water sources inventory, possible uses of them and potential users in the tunnel area, in order to avoid the damaging of water sources.
7. In respect to the social benefits the Project boundary is considered to be area of Las Hermosas. The mayor social investments will be directed to those areas most affected by the hydropower plant.
8. ISAGEN will carry on a construction waste management plan in order to control sediments from the excavations in the Amoyá River and will guarantee the replanting of the zones intervened and the use of organic stratum brought from other excavations within the Project.
9. Considering that the Project is located in an area of high environmental importance, ISAGEN will supersede that no other natural resources are affected by the Project.

Environmental Impacts

The findings of the environmental impact assessment of the Rio Amoyá Run-of-River Hydro Project are summarized below.

Underground Tunnel: The construction and operation of the Rio Amoyá Run-of-River Hydro Project does not present major threat to the geological, natural and cultural conditions of the middle valley, where the majority of the socioeconomic activities are clustered. The works are concentrated in the underground tunnels for channeling water flow and the caverns needed for the power plant. The rock in which excavation takes place belongs to the Ibague batholiths, which offers high stability and negligible risk of ex-filtration.

Roads: The required access road of 10,8 km is short and 50% of which is an improvement of the existing roads. The temporary access roadway from La Virginia to Window 1 require the displacement of 1 or 2 households that are in the alignment of the roadway; however, during actual construction the need to displace these houses could be avoided, especially considering the ephemeral nature of the infrastructure being built.

Surface operations: The quarries and borrow pits needed for concrete mixtures and left over materials of surface and underground excavations are categorized under the surface operations. There are 11 deposits along the roads and have a combined capacity of 1,2 million m^3, somewhat

larger than the expected volume of excess materials. The environmental management plan includes treatment of the deposits, reclamation of the area and planting of fast growing species to accelerate the land restoration.

River flow regime: As a consequence of the project, the natural regime of the Amoyá River may be modified in a short stretch below the weir. As agreed with the environmental authorities, the project design contemplates to maintain a *minimum flow for in-river needs* or *ecological flow.* The installed capacity and mean energy output of the ARPP incorporate this environmental provision.

D.2. Environmental impact assessment

The environmental impacts of the project are not considered significant. The EIA was completed in accordance with the Colombian law. The corresponding environmental license, and subsequent modifications were awarded by the local (state-wide) environmental authority, *"Corporación Autónoma Regional del Tolima – CORTOLIMA" (Resoluciones 1858 del 16 de Diciembre de 1999 y 911 del 28 de Agosto de 2006 y Resolución 1662 del 13 de Julio de 2009.)*. ISAGEN requested CORTOLIMA a change to the last modification (*Resolución 1662 del 13 de Julio de 2009*) to include certain clarifications to the environmental license. In addition, CORTOLIMA awarded the Project the environmental license to construct the transmission line that will connect the Project with the National Transmission System (*Resolución 2145 de 2009*). ISAGEN also requested CORTOLIMA to introduce some changes to this license as well. Although CORTOLIMA has not answered ISAGEN‟s requests, during the validation visit CORTOLIMA ensured that the process was about to be completed without any major complication in the near future. The national government has endorsed the project based on the official documentation issued by the Ministry of Environment, Housing and Territorial Planning.

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

Comments received from local stakeholders as part of consultation process were compiled in all the phases of the EIA and measures to address them outlined. The project promoters and ISAGEN carried out formal consultations with the local communities and several meetings were held with the government institutions. The consultations with the local community included public hearings and workshops on health and sanitation issues, including the scope of basic agreements for improvements in the access to drinking water and sanitation and health services.

Agreements were sealed in a document signed in December 18, 2007, between representatives of the community, Chaparral´s Mayor, Tolima´s Governor, Chaparral „s spokesman and ISAGEN´s General Manager.

E.2. Summary of comments received

The main concerns of local groups, authorities and communities, expressed in various meetings related to apprehensions due to loss of lands. The project minimized land requirements by designing an underground power facility. In addition, other concerns expressed were:

- Size of the project
- Benefits for the municipal government
- Employment opportunities for local labor
- End-use of the power generated from the project
- Company's management of operations
- Fear of not continuing with the prevailing cropping patterns
- Adverse impact on nearby ecosystems
- Adverse impact on some superficial water sources

• Negative impact on human health
• Potential benefits of project to the community

E.3. Report on consideration of comments received

Comments received from local communities and other stakeholders were taken into account and consultations were organized to provide detailed information on the comments. The consultation process involved meetings, workshops, and field visits. The main features of the process were:

• Expectations of the communities and institutions needs were assessed through workshops to enable communities to assess the potential benefits to the community and impacts of the project on environment.

• Meetings and workshops were held in which the proposals of the community were considered, especially for managing the impacts on the ecosystem and socioeconomic aspects pertaining to water resources, health and education.

Agreements were sealed in a document signed in December 18, 2007, between representatives of the community, Chaparral´s Mayor, Tolima´s Governor, Chaparral's spokesman and ISAGEN´s General Manager.

In addition to the activities mentioned in Section D.1., another key project that will address the concerns of the local community is the Education and Culture Project, for which ISAGEN and local communities and authorities have agreed upon the following activities:

- In response to the stakeholders requests ISAGEN has agreed on the preparation of workshops on environmental issues, such as preservation of the ecosystems, based on the specific community requests.
- The project will also support community development, training and capacity building to improve knowledge in collective work and programs, cultural events and establishment of community groups.
- ISAGEN, in partnership with the National Library and as part of the " National Plan for Reading and Libraries" will provide the Chaparral town with a new library which will contain 2,000 books, TV, DVDs, CDs, computers, archiving software and training to librarians.
- ISAGEN will support all schools and high schools in the area of influence of the Project with computer materials and office equipment. ISAGEN will also subsidize college students in the area during the three year construction period and will hand 1,000 school kits for the children up to fifth grade in the Las Hermosas' sector.
- ISAGEN will support with financial resources the preparation of community events, traditional festivities, cultural events and peace-oriented celebrations.

Furthermore, the company will also support the preservation of cultural patrimony and heritage in the region. The Archeology program will count with the authorization of the Colombian Institute of Anthropology and History-ICANH and will be implemented in order to avoid negative impacts in the patrimony on the region, using modern techniques to detect, analyze and monitor archeological material. Also, ISAGEN will support the indigenous communities in the area with the anthropological studies requested by them and by supporting them in their recognition quest with the Directorate of Ethnicities of the Ministry of Interior and Justice.

SECTION F. Approval and authorization

The letter of approval was issued by the Host Party designated national authority (DNA; Ministry of Environment, and Sustainable Development of Colombia) on April 27, 2004.

Appendix 1. Contact information of project participants and responsible persons/ entities

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	**ISAGEN S.A. E.S.P.**
Street/P.O. Box	Carrera 30 No. 10C - 280
Building	
City	Medellín
State/Region	Antioquia
Postcode	
Country	Colombia
Telephone	
Fax	
E-mail	
Website	www.isagen.com.co
Contact person	
Title	Director
Salutation	Mr.
Last name	Fehrmann Espinosa
Middle name	
First name	Adolfo
Department	
Mobile	
Direct fax	
Direct tel.	574 3256920
Personal e-mail	afehrmann@isagen.com.co

Appendix 2. Affirmation regarding public funding

N/A. There is no public funding in this project.

Appendix 3. Applicability of methodology and standardized baseline

General Data Summary

XM and the Mining and Energy Planning Unit at the Ministry of Energy (UPME) facilitated the collection of all necessary information to calculate the Operating Margin (OM) and Build Margin

(BM) emission factors. The recorded generation data for each power plant at hourly intervals was downloaded at XM web page[11].

Data for calculating the Operating Margin emission factor

The method used to calculate the OM is the simple adjusted ex-ante option. The following table summarizes the findings:

	2006	2007	2008
Electricity generation (MWh)	52,368,141	53,665,662	54,432,531
Electricity generation – low cost/must run (MWh)	42,673,812	44,386,467	46,683,838
CO2 emissions – low cost/must run (tCO_2)	0	0	0
Electricity generation – NO low cost/must run (MWh)	9,694,328	9,279,195	7,748,693
CO2 emissions – NO low cost/must run (tCO_2)	6,213,360	6,003,358	5,039,653
Lambda factor	0.2297	0.2627	0.3192
Operating Margin Emission Factor (tCO_2/MWh)	0.4936	0.4769	0.44277

The tables shown below present the emissions factors for all power plants connected to the Colombian national grid. These data are used to calculate the $EF_{grid, OM, 2008}$. Table 1 presents the list of power plants operating with natural gas and Table 2 presents power plants operating with coal. Based on this information, the calculated average Operating Margin emissions factor was calculated for 2006-2008, using hourly data for actual generation. (Detailed calculation tables are available as part of the project documentation package and have been provided for validation)

Table.1 Emissions Factor (tCO2/MWh) for power plants operating with natural gas.

Plant Name	Emission Factor (tCO2/MWh)
Barranca 1	0.7208
Barranca 2	0.7185
Barranca 3	0.7349
Barranca 4	0.6831
Barranca 5	0.7703
Barranquilla 3	0.5555
Barranquilla 4	0.5711
Cartagena 1	0.6896
Cartagena 2	0.6896
Cartagena 3	0.6726
Termo Flores 1	0.4225
Termo Flores 2	0.5839
Termo Flores 3	0.5605
Termo Guajira 1	1.1590
Merielectrica 1	0.5629
Palenque 3	0.8361
Proelectrica 1	0.4769
Proelectrica 2	0. 4769
Tebsa Total	0.4554
Termocandelaria 1	0.5576
Termocandelaria 2	0.5652
Termocentro 1	0.4505
Termodorada 1	0.5669

[11] This information can be accessed at *www.xm.com.co*

Plant Name	Emission Factor (tCO2/MWh)
Termoemcali 1	0.4111
Termopiedras	0.8634
Termosierra	0.3822
Termovalle 1	1.2
Termoyopal 1	0.8884
Termoyopal 2	0.8077

Table.2 Emissions Factor (tCO2/MWh) for power plants operating with coal.

Plant Name	Emission Factor (tCO2/MWh)
Paipa 1	1.501
Paipa 2	1.1890
Paipa 3	1.1938
Paipa 4	0.9000
Guajira 2	1.3222
Tasajero 1	0.9147
Zipaemg 2	1.2282
Zipaemg 3	0.9240
Zipaemg 4	0.8672
Zipaemg 5	0.8355

All the data presented in the above tables was provided by UPME and is considered official information.

Data for calculating the Build Margin emission factor

Total Generation during 2008: 54,432.53 GWh
20% of the total generation: 10,886.51 GWh
EF_{BM} = 0.2170 tCO2/MWh

The Build Margin Emission factor was calculated *ex ante*, based on the most recent information available on the plants built or additions to the sample *m* (Option 1 of the “tool to calculate the emission factor for an electricity system”) at the time of PDD submission.

Article I.

Article II. The sample m consists of the power plants in the electricity system built most recently and comprising 20% of the system generation (in MWh).

Plant Name	Year commissioned	Generation 2008 (MWh)	Accumulated Generation (MWh)
MENOR MORRO 2	2007	91,611,516	91,611,516
MENOR REMEDIOS	2007	2,976,427	94,587,943
MENOR CIMARRON	2007	70,934,916	165,522,859
MENOR AMALFI	2007	4,811,176	170,334,035
MENOR URRAO	2007	5,921,192	176,255,227
MENOR MORRO 1	2007	172,323,361	348,578,588
MENOR SAN JOSE DE LA MONTAÑA	2007	2,747,282	351,325,870
COGEN. COLTEJER	2006	1,442	351,327,312
MENOR CALDERAS	2006	98,355,386	449,682,698
DOLORES	2006	46,641,698	496,324,396
FLORIDA MENOR	2005	94,955,100	591,279,496
TERMOYOPAL 1	2005	58,715,768	649,995,264
MENOR LA JUNCA	2005	144,776,903	794,772,167

Plant Name	Year commissioned	Generation 2008 (MWh)	Accumulated Generation (MWh)
MENOR MIROLINDO	2004	18,025,896	812,798,063
MENOR CEMENTOS DEL NARE	2004	38,612,439	851,410,502
MERILECTRICA 1	2004	25,353,180	876,763,682
COGEN. CENTRAL CASTILLA	2004	3,167,918	879,931,600
COGEN. INGENIO RIOPAILA	2004	4,358,090	884,289,690
TERMOYOPAL 2	2004	156,190,134	1,040,479,823
MENOR OVEJAS	2004	5,002,705	1,045,482,528
MENOR TEQUENDAMA	2004	127,810,585	1,173,293,113
MENOR VENTANA A	2004	16,270,814	1,189,563,927
MENOR VENTANA B	2004	9,815,810	1,199,379,737
MENOR EL LIMONAR	2003	103,168,942	1,302,548,679
MENOR LA TINTA	2003	95,251,148	1,397,799,827
MENOR SAN JOSE	2003	2,221,703	1,400,021,530
MENOR CHARQUITO	2003	95,099,389	1,495,120,919
COGEN. INGENIO RISARALDA	2003	7,558,551	1,502,679,470
MIEL	2002	1,599,667,200	3,102,346,670
MENOR SONSON	2002	58,850,478	3,161,197,148
CHIVOR	2002	*939,692,804*	4,100,889,952
COGEN. TUMACO	2002	324,113	4,101,214,065
MENOR PUENTE GUILLERMO	2001	7,201,189	4,108,415,254
PORCE II	2001	2,191,313,455	6,299,728,709
TERMO SIERRA 1	2001	234,543,400	6,534,272,109
CHIVOR GENERADOR	2001	469,846,402	7,004,118,511
CHIVOR GENERADOR	2001	469,846,402	7,473,964,913
TERMOCENTRO 1	2000	31,269,998	7,505,234,911
TERMOCANDELARIA 2	2000	3,526,000	7,508,760,911
URRA	2000	1,355,998,500	8,864,759,411
TERMOCANDELARIA 1	2000	6,127,000	8,870,886,411
MENOR RIO PIEDRAS	2000	173,294,824	9,044,181,235
MENOR TERMOPIEDRAS	2000	5,043	9,044,186,278
COGENERADOR PROENCA	2000	5,106,049	9,049,292,327
COGENERADOR PROVIDENCIA	2000	1,705,372	9,050,997,699
COGENERADOR BIOAISE	2000	3,352,226	9,054,349,925
COGENERADOR INCAUCA	2000	25,997,957	9,080,347,882
TERMOEMCALI	1999	7,949,221	9,088,297,103
PAIPA 4	1999	760,630,824	9,848,927,927
RIO FRIO I	1999	9,786,812	9,858,714,739
RIO FRIO II	1999	64,178,074	9,922,892,813
RUMOR	1999	16,548,171	9,939,440,984
TERMOVALLE I	1998	56,623,222	9,996,064,206
TEBSA	1998	3,423,638,906	13,419,703,112

The build margin emission factor EF_{BM} has been calculated as highlighted in section B.6.3. Specifically,

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} * EF_{EL,m,y}}{\sum_m EG_{m,y}} \qquad \text{(B.6.3.5)}$$

Where,

$EF_{grid,\ BM,\ y}$ = Build margin CO2 emission factor in year y (tCO2/MWh)

$EG_{m,\ y}$ = Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)

$EF_{,\ EL,\ m,\ y}$ = CO2 emission factor of power unit *m* in year *y* (tCO2/MWh)

m = Power units included in the build margin

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

The CO2 emission factor of each power unit m ($EF_{EL,m,y}$) is determined as per the guidance in step 4 (a) for the simple method OM, using option B, using for *y* the most recent historical year for which power generation data is available and using for *m* the power units included in the build margin.

Data for calculating the Combined Emission Factor (EF_{2008})

$EF_{grid, OM, 2008}$ = 0.47 tCO2/MWh
$EF_{grid, BM, 2008}$ = 0.2170 tCO2/MWh
W_{OM} = 0.5
W_{BM} = 0.5

$EF_{grid, CM, 2008}$ = 0.3439 tCO2/MWh

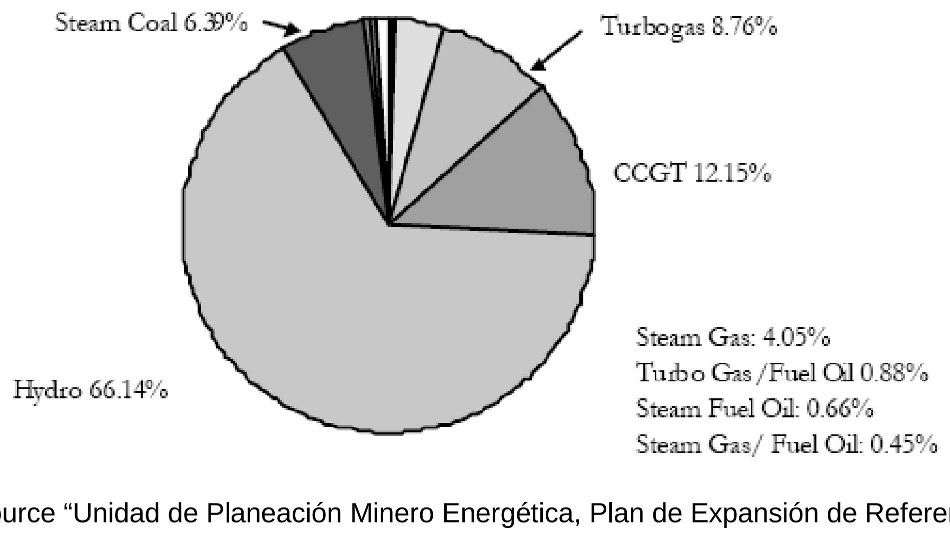
Appendix 4. Further background information on ex ante calculation of emission reductions

National and Sectoral circumstances

The following description of the national and sectoral circumstances of Colombia's renewable energy projects during the early 2000 is still valid as national circumstances have not changed significantly. The description is also applicable to the Rio Amoyá Run-of-River Hydro Project, whose planning goes back to the year 2002.

National and sectoral circumstances: The total net installed capacity of the Colombian National Interconnected System (SIN) in 2001 was 13.2 GW. Most of this installed capacity is hydro-based (about 66%) reflecting the country's high dependence on hydropower. Figure A.5.1 summarizes the power mix by source and technology.

Figure A.5.1 Installed Capacity of the Colombian Electricity Sector by Technology Composition during 2001



Source "Unidad de Planeación Minero Energética, Plan de Expansión de Referencia 2001"

Since 1980 the Colombian Electricity Supply System (ESI) has maintained a hydroelectric share in the range 55-75% and a thermal composition in the range 25 to 45%. This is reflected in the Figure A.5.2.

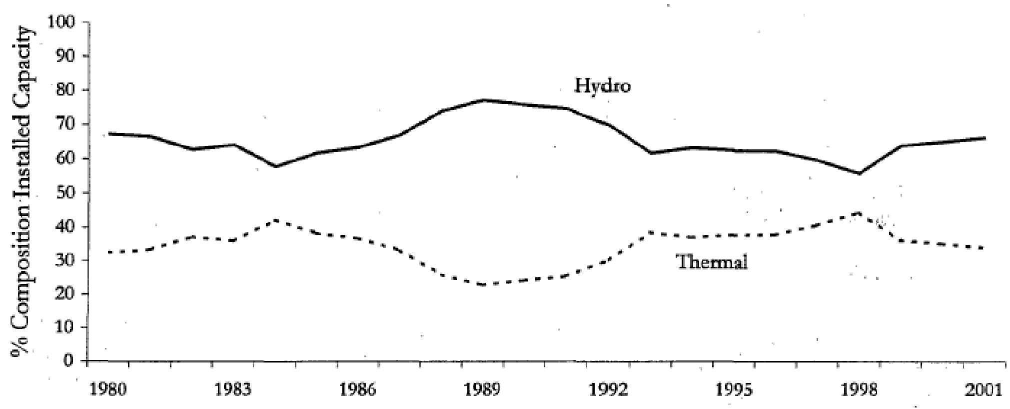


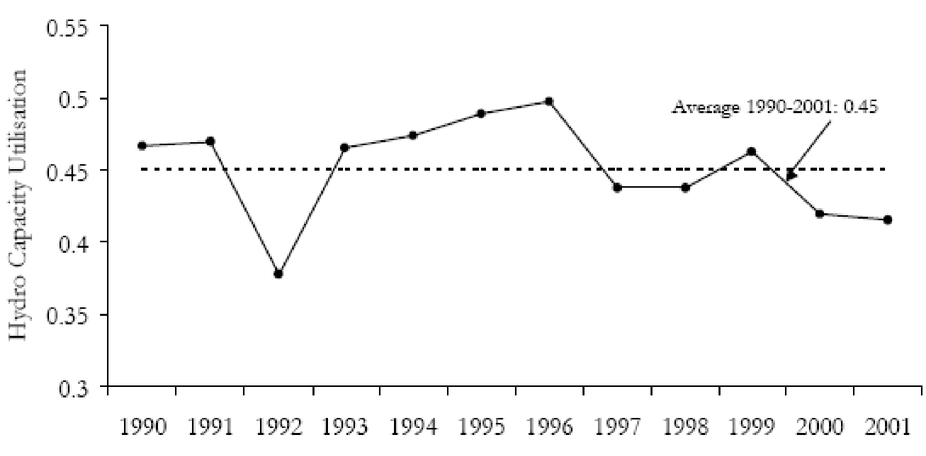
Figure A.5.2 Composition of Colombian ESI in Terms of Installed Capacity Period 1980-200
Increased reliance on thermal-based generation capacity

After severe droughts, registered during the 1990s (i.e. 1992, 1997), that caused power shortages with associated forced rationing, the system has encouraged the development of more thermal generation capacity, specifically with the intention of increasing capacity and enhancing the system's reliability. The increase in thermal share of the SIN has also been the indirect result of the withdrawal of the public sector from large investments and the reluctance of private generators to enter the hydroelectric generation and associated environmental and social requirements. Therefore, future additions to the power mix are anticipated to be thermal-based. While this responds to the need for flexibility and robustness of the system, the increase in thermal share contributes to the gradual increase of GHG emissions by the sector and the release of local pollutants (such as NOx and, SOx particulates and volatile hydrocarbons, which have been linked to health issues in exposed populations).

Hydro Availability and its Effects on the Supply/Demand Ratio of the power sector

In the period 1990-2001, five dry years, including the drought of 1992 due to El Niño phenomenon affected the electricity supply. This led efforts to diversify the sources of power, focusing on the expansion of thermal generation capacity. Figure A.5.3 shows the utilization capacity of hydroelectric plants in the system during this period. Hydro utilization capacity could be defined as the percentage of the actual Hydro capacity in use over the maximum available Hydro capacity.

Figure A.5.3 Utilization of Hydroelectric Generation Capacity in Colombia during 1990 - 2001



Source, Data from the *Unidad de Planeación Minero Energética* (UPME), International Energy Data

Market forces in Colombia strongly favor thermal power over renewable energy, resulting in a trend of increased carbon emissions per generated kWh. A greater number of private initiatives favoring thermal power projects are likely to be developed in the short term as they are faster to implement and more competitive than renewable energy projects in terms of capital costs.

Taken together, the factors presented above have resulted in a greater share of thermal energy in the SIN, and this trend is expected to continue as per the indicative expansion plan. Given its small size (80 MW) relative to the net installed capacity of the SIN (13,200 MW), the Project has no effect on the planned expansion of the SIN.

The main sources of information for the interconnected grid are: (i) the updated operational database, managed by XM; and, (ii) UPME, planning unit for the energy sector under the Ministery of Mines and Energy, serving as the technical secretariat for energy planning in the country. All the data goes through quality control checks of the official entities. In this way it can be assured that the data is reliable. Information from all stakeholders in the interconnected system is subjected to regulation by the CREG, the national regulatory commission for energy and gas. A well-developed, high quality, internationally accepted measuring standards have been enacted. Audits are commonplace to ensure the quality of the data, plus multiple interest groups have access to the data, as the transactions can only use the official data. QA/QC methods are regularly enforced. Colombia offers very good, accurate and reliable data from its interconnected electric grid.

<u>Reductions of emissions</u>: The run-of-river project is a non-GHG emitting electricity generation technology option. In the absence of the Rio Amoyá Run-of-River Hydro Project, the same level of demand for electricity would be met by the combined production of plants in the SIN, thus emitting higher GHG. Generation pricing and merit order dispatch in the Colombian power sector are based on "energy price bidding" of the generators for a day ahead based on estimated hourly demand. "Clean plants producing renewable energy" have the right to participate in the pool and benefit from pool services under a preferential dispatching option (e.g. spinning reserve). In essence, such plants can access the electricity market by selling all their available output at the wholesale market price ("precio de bolsa"), which includes a "capacity payment" component (as a floor price for the bids), and are exempt from penalties on non-delivery of electricity. Since the Rio Amoyá Run-of-River Hydro Project qualifies as a renewable energy project producing clean energy, it will preferentially dispatch its energy in the merit order, and will displace those generating units that are programmed for dispatching according to their bids. The total estimated emission reductions to be achieved by the project are 2.4 – million tons of CO_2 over 14 years (by year 2025).

<u>Baseline scenario</u>: The baseline scenario was constructed following the approved consolidated methodology, ACM0002 – Version 12.1.0. The methodology states that for project activities that do not modify or retrofit an existing electricity generation facility, as it is the case of the Rio Amoyá Run-of-River Hydro Project, the baseline scenario is defined as: *Electricity delivered to the grid by the project would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin (CM) calculations described below*. According to this approach the future scenario can be described as a combined analysis of the existing grid, its operation and recent additions. To complement the suggested analysis this section presents the information required to estimate the building margin. It also introduces the expansion plans that were defined by the Government of Colombia through the UPME.

The Government of Colombia envisioned the electric power expansion path based on three main considerations: (i) those projects already approved and under construction; (ii) project included for implementation in the near future; and, (iii) analysis of the demand growth and least costs expansion of the interconnected grid base on already included power plants. The results are summarized in Table A.1.1.

Table A.1.1 presents the plausible power expansion scenarios contemplated by the UPME. Notice that 67% of the potential additions to the interconnected grid are hydropower plants, while 32.6% are thermal units for short term scenarios. However, hydropower generation has become a less likely investment option in Colombia for various reasons related to site availability and high up-front capital investment and environmental and social impacts of reservoirs and flooding. Nevertheless, UPME has developed indicative scenarios for the expansion of the electricity supply considering specific assumptions on demand (i.e. medium growth rate), fuel prices (i.e. low price scenarios) and lower than average hydrological conditions, as well as perceived trends and registered intentions of private and public generators.

For the **short-term scenarios,** UPME concluded that **Scenario** 2 would be the most probable option given the assumptions considered, especially with regards to retirement of plants, and the fact that scenarios 1 and 4 exhibited low levels of reliability regarding security of supply relative to Scenarios 2 and 4.

UPME concludes that given the assumptions on demand and fuel prices, the system will probably only add gas-based generation in the period 2006-2010 (shown as **Scenario 1 for Long Term Expansion).** It is important to note that lower than average hydrological conditions were assumed for the four scenarios described above. Under scenarios of average hydrologic conditions, the installation of new hydroelectric plants would not occur.

Appendix 5. Further background information on monitoring plan

MONITORING PLAN

The monitoring plan is described under four sections.

1. The Monitoring Plan

1.1 Purpose of the monitoring plan

The Monitoring Plan (MP) of the project describes the systematic surveillance of the project's performance by measuring and recording indicators relevant to the project or activity operation. The Monitoring Plan forms basis for the verification and assessment of the emission reductions (ER) achieved. It also provides guidance to verify the project's conformity with all relevant regulatory criteria.

The MP is a part of the project design document and defines the standards with which the performance of the Rio Amoyá Run-of-River Hydro Project in terms of the greenhouse gas (GHG) reductions will be monitored and verified. The MP builds on information collected in the baseline study. The MP will be an integral part of the contractual agreement between the Netherlands Clean Development Mechanism Fund (NCDMF) and ISAGEN.

The MP establishes a credible and transparent data collection, measurement, recording and management methods required for verification and certification of the ERs and other project outcomes. The MP ensures environmental integrity and accuracy of crediting actual ERs to be accounted. The MP must therefore be used throughout the life of the project. It must be

- adopted as an integral part of the project planning process, and
- included in the operational manuals of the project.

The MP can be updated and adjusted to meet the operational requirements, provided such modifications are found relevant by the DOE during verification and subsequently approved by the Executive Board (EB). In particular, any change in the variables pertaining to emission reductions may lead to such amendments.

1.2 Structure of the MP

The MP document contains the following parts:

- *Section 2* explains concepts and principle assumptions applied in monitoring the GHG performance of the project and in calculating ERs. The section also discusses data sources and assumption and lays out why the MP is expected to compute ERs in a conservative manner.
- *Section 3* contains instructions regarding operational and monitoring obligations the operator is expected to assume.
- *Section 4* presents the functioning of the MP electronic workbook. The workbook is implemented as Excel spreadsheets and is an integral part of the MP.

1.3 Use of the MP by the Project Operator

The MP identifies the key performance indicators and sets out the procedures for tracking, monitoring and verifying the impacts of the project, for calculating the project ERs. Adherence to the instructions in the MP is necessary for the project operator to successfully measure and track the project impacts and prepare for the periodic audit and verification required to certify the achieved ERs. The MP is thus the basis for the production and delivery of ERs to the NCDMF or other buyers.

Specifically, the MP provides the instructions for:

- establishing and maintaining the appropriate monitoring system including spreadsheets for the calculation of ERs
- implementing the necessary measurement and management of the project operations;
- preparing for the independent, third party verification and audit.

2. Measurement and Calculation of Emission Reductions

The project is expected to be operational in July 2011 and result in the displacement of about 1 million metric tonnes of CO2e by 2018. The MP builds on the data collected as part of the baseline study. The MP presents detailed guidance on measuring project performance indicators and for calculating ERs in an efficient and transparent way.

2.1 Geographic and System Boundaries for the MP

The Rio Amoyá Run-of-River Hydro Project consists of a run-of-river power plant with a nominal capacity of 80 MW and an anticipated generation of approximately 513.6 GWh/year. The power plant will be connected to the national grid.

2.2 Geographic and System Boundaries for the MP

As referred in ACM0002 version 12.1.0 the project boundary has to be assessed in terms of the emission sources and spatial extent.

- *Emission sources*: The baseline emissions are calculated from the electricity displaced by the project and the project has zero emissions as it is a run-of-river project.
- *Spatial extent:* The project boundary includes the project site and all power plants physically connected to the Colombian national grid to which the project is connected. The Rio Amoyá Run-of-River Hydro Project is connected to the Colombian national grid through 18.6 km long line.

2.3 Baseline review

The project has opted for a 7 – year renewable crediting period (for a maximum of two additional crediting periods). Therefore, baseline review will be undertaken at the end of each crediting period.

2.4 Calculating Emission Reductions

The emission reductions from the project result from the electricity from the Rio Amoyá Run-of-River Hydro Project displacing power generated by thermal plants (coal or simple cycle or combined cycle gas) in the Interconnected System. The calculation of the emission reductions follows the guidance outlined in the ACM0002 (version 12.1.0 - "Consolidated baseline methodology for grid-connected electricity generation from renewable sources". The steps needed to calculate the emissions reduction are summarized below.

Determine the net yearly project electricity output for the period under verification from the website (the official database of XM), which can be accessed from the website, www.xm.com.co [12]

The output is available in MWh or KWh.

⇩

Use the ex-ante combined emission factor calculated as explained in this PDD.

⇩

Multiply the actual electricity output produced by the project by the Combined emission factor for the Colombian interconnected electricity grid

⇩

Total CERs generated by the project for the period is calculated as

ERy= BEy-PEy-Ly

Where PEy are the project emissions in year y and Ly refers to leakage in year y as defined in the methodology ACM0002 (ver.12.1.0-"Consolidated baseline methodology for grid-connected electricity generation from renewable sources"), *both are equal to zero (0).*

Article III. Operational and Monitoring Obligations

The operator of the Rio Amoyá Run-of-River Hydro Project will need to fulfil operational and data collection obligations in order to produce greenhouse gas emissions reductions and to ensure that sufficient information is available to calculate the ERs in a transparent manner and to allow for a successful verification of the ERs.

3.1 Operational Obligations

The operational obligations of ISAGEN are to ensure that all reasonable steps to maximize the generation of energy from the Rio Amoyá Run-of-River Hydro Project are taken thereby maximizing the GHG emissions reductions.

3.2 Data Requirements and Project Database

The data required for the MP is in line with the kind of information collected by an electricity utility. The data used in this MP will be collected by ISAGEN and comes from the following sources:

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[12] Once in this page, Access to the database "Portal BI"

- XM Web-page *www.xm.com.co*. Access to XM database is available on internet, and data on actual MWh generated by Amoyá's Hydropower Plant can be easily obtained. For updating calculations for the second crediting period, information available at XM will be used on hourly generation, split by low cost/must run and other plants.
- **Energy and Mines Planning Unit (UPME)** publishes most of its data on its website (www.upme.gov.co) and includes: Reference Energy and Mine Expansion Plans, Energy and Mine Statistics Bulletins, International Analysis of Electricity Prices, Colombian Electricity Market Magazine, among others. The UPME is in charge of presenting the Indicative Expansion Plan for the energy sector, as well as support the requirement for information from the ministry and stakeholders. The technical capacity of the UPME to support the implementation of advanced simulation methods, generation of data on plant level emission factors and chemical analysis of fuels used in the country has been taken into account. UPME's information on entry into operation of new plants will be used to update calculations for the build margin emission factor.

Table 1: Roles and Responsibilities of the different participants of the monitoring and verification processes

	Project Operator	World Bank	DOE
Monitoring system	▪ Review OMP and suggest adjustments if necessary ▪ Develop and establish management and operations system ▪ Establish and maintain monitoring system and implement OMP ▪ Prepare for initial verification and project commissioning	▪ Draft or review, clear and provide OMP as part of ER purchase agreement ▪ Ensure inclusion of relevant World Bank requirements in OMP ▪ Arrange for initial verification	▪ Review monitoring, management and operational systems.
Data Collection	▪ Establish and maintain data measurement and collection systems for all OMP indicators ▪ Check data quality and collection procedures regularly ▪ To cross-check the electricity delivered by the Amoyá Hydroelectric Power Plant to the grid, the hourly energy measured per day in the commercial frontier in Tuluní Substation, must be compared with the last XM report published		▪ Review and audit data collection systems ▪ Audit collected data for accuracy, credibility etc.
Data computation	▪ Enter date in OMP workbooks ▪ Use OMP workbooks to calculate emission reductions	▪ Review completed worksheets	▪ Verify and confirm ER computations
Data storage systems	▪ Implement record maintenance system ▪ Store and maintain records (paper trail) ▪ Implement sign off system for completed worksheets ▪ Forward monthly and annual worksheet outputs	▪ Receive copies of key records and reports ▪ Maintain World Bank records	▪ Review adequacy and operation of archiving system
Performance monitoring and reporting	▪ Analyze data and compare project performance with project targets ▪ Analyze system problems and recommend improvements (performance management) ▪ Prepare and forward periodic (monthly) reports	▪ Review reports ▪ Evaluate performance and performance management ▪ Supervise project	▪ Assist with World Bank project supervision ▪ Report to project participants as requested. ▪ Produce official

	Project Operator	World Bank	DOE
			verification report.
OMP Training and Capacity Building	▪ Develop and establish OMP training, and skills review and feedback system ▪ Ensure that operational staff is trained and enabled to meet the needs of this OMP		
Quality assurance, audit and verification	▪ Establish and maintain quality assurance system with a view to ensuring transparency and allowing for audits and verification ▪ Prepare for, facilitate and co-ordinate audits and verification process	▪ Supervise project ▪ Arrange for periodic verification	▪ Undertake audit, including of quality system ▪ Verify and certify emission reductions (if possible)

4. The Rio Amoyá Run-of-River Hydro Project Workbook

Basically, the MP electronic workbook will consist of a database to compile, specifically for the CDM project, all effectively dispatched kWh. The workbook will aggregate the data onto different timeframes: (i) daily; (ii) monthly; and (iii) yearly. Also, for verification purposes, the data will be equally organized in annual reports, taking the First Crediting Starting Date as the first day of the year. The workbook will multiply the aggregate yearly kWh by the ex-ante Grid emission factor in order to obtain the yearly emission reductions number required at verification.

Quality Assurance and Quality Control

Stringent international standards will be used to assure the quality of the information used. ICONTEC, the Colombian normative institution, certified the following management systems: the Quality Management System under ISO 9001, version 2008, the Environmental Management system under ISO 14001, version 2004, and Occupational Health and Safety Management System under OHSAS 18001, version 2007. All ISAGEN's operating power plants are part of these management systems. The QMS of the Rio Amoyá Run-of-River Hydro Project will be part of the same quality system, with the objective of being certified using ISO 9001 within two years after its commissioning, as it is stipulated in Colombian regulations (*Resolución CREG No. 005/09*) . As the enforcement of these standards is very well established no additional QA/QC action is required.

The electric metering system is calibrated every two years, following internal procedure number 0029.

Appendix 6. Summary of post registration changes

The Post - Registration Change procedure includes:

- Correction in the transmission line's distance of 18 km to 18.6 km.
- Correction in the number Reported by the synchronous generator of 43.33 MVA to 45.7 MVA.
- Correction regarding the Project Participants: according to the withdrawal registered in the UNFCCC by the International Bank for Reconstruction and Development (IBRD) as Trustee of the Netherlands CDM Facility (NCDMF), who was registered as project participant, decided to withdraw its participation. This change was notified to the UNFCCC on 13.08.2014.
- Correction of the official web site for downloading the recorded generation data for each power plant. The official web site is www.xm.com.co
- Change of the Cross-check description in the monitoring plan.
- Correction in the name National Dispatch Center (CND) by XM (Compañía de Expertos en Mercados SA ESP).

- Correction of the ex-ante emission reduction calculation due to the delay of the start date of the crediting period (Section B.6.4).
- Change to start date of crediting period from 01-07-2011 to 01-07-2012