Project design document form
(Version 10.1)

Complete this form in accordance with the instructions attached at the end of this form.

BASIC INFORMATION	
Title of the project activity	Bajo Tuluá Minor Hydroelectric Power Plant
Scale of the project activity	☒ Large-scale ☐ Small-scale
Version number of the PDD	4.0
Completion date of the PDD	02/04/2019
Project participants	EPSA S.A. E.S.P. Gas Natural SDG S.A.
Host Party	Colombia
Applied methodologies and standardized baselines	ACM0002 ver. 10 - Consolidated methodology for grid-connected electricity generation from renewable sources
Sectoral scopes linked to the applied methodologies	1: Energy industries (renewable - / non-renewable sources)
Estimated amount of annual average GHG emission reductions	41,430 tonnes CO_2 equivalent per annum

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

The purpose of this project is to build a Hydroelectric Power Plant, with a total installed capacity of 23.5 MW, with the aim of making use of the capacity of the Tuluá river. The ultimate objective of the project is not to simply build a power plant to cover the expected increase in demand for electricity, but to contribute to the improvement in the efficiency of the electricity system in general; increasing the electricity service in the department of the Cauca Valley, while contributing to the sustainable development of the region with the reduction of CO_2 emissions.

The Bajo Tuluá Hydroelectric Power Plant project in the Tuluá River, is located in the middle section of the river's basin, between points 1,477 and 1,247 metres above sea level, in the department of the Cauca Valley. The power plant obtains water at 1,474.7 metres above sea level with a mean flow of 12 m^3/s. At this point, the water flow will be driven with pressure systems to the engine house, where two Francis turbines with a design power of 12.04 MW each will make use of the kinetic energy to generate electrical energy through a clean energy system that is free from greenhouse gas emissions. The power plant will supply to the Colombian electricity system 117.4 GWh annually.

Said electrical energy with a hydraulic origin will replace energy that, in the absence of the power plant, would be partially produced by fossil fuel consuming plants that emit greenhouse gases. Therefore, the result of the commissioning of this power plant will reduce the global greenhouse gas emissions of the Colombian power plant infrastructure, reducing its contribution to the global climate change.

The power plant's characteristics are as follows:

Type of regulation: ....Run-of-river
Capacity of each distribution point (m^3/s): 12
Turbine design flow (m^3/s) 6
Elevation of the distribution point (metres above sea level): 1,474.7
Length of the conduction tunnel (m): 5,657
Final diameter of the tunnel (m): 3.00
Maximum gross drop (m): 225
Installed capacity (MW): 20
Number and type of turbines: .... 2 turbines, Francis

The spatial extension of the project boundary includes the physical location of the project (Bajo Tuluá power plant) and all plants connected to the electricity system (National Interconnected System of Colombia). The electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin, which is considered the baseline scenario.

The project activity is expected to reduce 41,430 t CO_2 per year and 290,010 t CO_2e during the first crediting period of 7 years.

Project Background

In the past, there have been many attempts to use the tributaries of the Cauca River for the generation of hydroelectric energy, some of which have materialised since the past century in the form of projects, such as the Cali River project (1925) and other projects throughout the basin of the Cauca River, such as the minor power plants of Ovejas, Palos, etc

Forty-three projects can be identified in the general electrification plan of the OLAP, but minor projects became outdated as a result of the construction of larger projects. In 1989, the studies to encourage the implementation of this type of power plant projects were started again. In 1996, after

the increase in the demand for energy in the Cauca Valley, EPSA defined the Minor Hydroelectric Power Plant Study Plan for plants with a capacity under 100 MW, although these could not be executed due to budget problems.

During 2003, the portfolio of existing projects was revised and hydroelectric power plant projects with the following characteristics were identified: derivation to run-of-river plants, installed capacity below 50 MW, cost that does not exceed 50 million US $, quick execution (less than 3 years), minimal environmental problems and economic viability, considering the new finance framework resulting from the trade of certified emission reductions (CERs). Within this portfolio, the viability study of the Alto Tuluá (1,800 metres above sea level) and Bajo Tuluá (1,440 metres above sea level) projects was carried out.

Contribution to Sustainable Development

Hydroenergy is a source of energy that is free of greenhouse gas emissions, so that the on-site project emissions are almost zero. The electric energy generated from renewable energy sources supplied to the National Interconnected System (NIS) by the power plant of Bajo Tuluá will partially shift the energy coming from thermal power plants. Since the fossil fuel consuming plants will stop operating or will decrease their rate of activity, the project shall entail a global reduction of the greenhouse gas emissions in the Colombian infrastructure of electric energy generation plants.

In particular, the Project of the minor hydroelectric power plant of Bajo Tuluá contributes to the fulfilment of the following national sustainable development priorities:

- Reduction in the atmospheric contamination (NO_X, SO_X, COV_s and suspended particles) and contamination of water.

- Reduction in the consumption of fossil fuels.

- Increase in the use of renewable energy sources.

To sum up, the minor Hydroelectric Power Plant of Bajo Tuluá shall add 23.5 MW of installed power to the Colombian electricity generation system and will provide a response to the following objectives set forth:

- To cater for the electricity generation and supply requirements of the Cauca Valley with an environmentally sustainable method and with the use of non-intensive carbon energy resources in the area, thus preventing the dependence on fossil fuels.

- Contribute towards the sustainable development priorities of the Department of the Cauca Valley with the corresponding environmental and economic benefits for the country in general and for the project area in particular, both in the medium and long-term.

- Stimulate the transfer of clean technologies from the most developed countries, while attracting investment flows to Colombia, thus encouraging the sustainable development of the country.

- Reduce the level of global greenhouse gas emissions from the national Colombian electricity system, thus mitigating the medium and long-term effects of the global climate change. Therefore, this type of project will establish the bases to share the financial burden derived from the need to assume an active role in the fight against the global climate change between developed and developing countries.

The power plant will be of the run-of-river type with the purpose of minimising environmental impact. Therefore, the water collection area will not require a reservoir. The absence of regular reserves of water will condition the production of electricity to the availability of water. However, the power plant

will generate a lower visual impact and enable the Tuluá River to maintain its environmental and social functions.

The project also has an important social component. The power plant will be located in an area with a low standard of living, with a very low level of community equipment[1], and thus the basic needs (sanitation, education, etc.) will not be adequately satisfied in the area. The project contributes to regional development, consolidating the local and regional administrations in institutional terms. Its operation will provide direct financing to the municipalities that are directly affected[2] , which will allow them to assume the development of their own projects, thus contributing directly to the improvement in the standard of living of the communities affected.

Apart from the said financing schemes, the execution of the project will contribute to the creation of jobs. Therefore, the project will offer jobs in three areas:

1- Construction: the offer will include 316 direct jobs (266 workers, 41 technicians and 9 professionals). For the operating phase, 20 direct jobs will be created, including administrative and operating staff. Moreover, it is foreseen that 8 of these jobs will be assigned to people from the community.
2- Execution of activities of the Environmental Handling plan: 10 direct and 20 indirect jobs will be created.
3- Execution of 1% of the Investment Plan: 15 direct and 15 indirect jobs will be created for the execution of the plan, using local labour for some of these jobs.

Relating to the sustainable contribution, EPSA is going to make different kinds of donation. Some of them are mandatory by the national regulation and others are voluntary and include the investment in social projects identified and prioritised by the community.

1. Investment in communities, environment and protection of the river basin
- Performance of the Mandatory Plan of the 1%: provide support to the formulation of the handling plan of the river basin, environmental training, institutional strengthening of the cleaning up policies and conservation of the river basin
- Environmental Handling Plan (mandatory): physic, biotic and socioeconomic components and the monitoring plan.
- Voluntary investment plan: electrification, revenue generation projects and security in feeding (cultivation of vegetables, fish farming, agro-industrial processes, milk trade, extraction of materials from the river by hand), infrastructure projects in education, main cleaning up and potable water (construction of children's parks, rural aqueducts, irrigation district, septic tanks) and environmental projects (water source isolation, tree planting). The voluntary investment plan is approximately 875,500,000COP.
2. Transferences to CVC, municipalities and communities
- Mandatory transferences by the law 99/1993: within the mandatory contributions, it will be transferred a 3% of the investment (380,383,800 COP) to the affected municipalities (Tuluá, Buga and San Pedro) and a 3% of the investment (380,383,800 COP) to the *Corporación Autonómica Regional del Valle del Cauca, CVC*.
- CDM benefits (voluntary): additionally, EPSA will donate to the affected communities a 25% of the revenue obtained from the sale of the Certificate Emission Reductions (CERs).

---

[1] For example, we can highlight that 3 out of 10 children with school age in the direct area of influence of power plant 3 are out of the educational system and in most nearby towns and villages the supply systems do not have a treatment plant and the community infrastructures are restricted to a community hut.

[2] In this sense, we can highlight article 45 of Act 99 of 1993, which establishes that the energy generation companies must transfer, in the case of hydroelectric power plants, up to 6% of the gross energy sales of each power plant to the municipalities and regional autonomous corporations that are located on the area of the hydrographical basin that supplies the reservoirs and which are on the reservoir areas. Therefore, the power plant's operation will generate an amount for local corporations, so that they can exploit the sustainable development advantages.

Therefore, the minor hydroelectric power plant project of Bajo Tuluá contributes from the social, environmental and economic point of view to the development of the Cauca Valley, so that we can affirm that this is an eligible project in terms of the methods and procedures of the clean development mechanism (CDM) set forth by the UNFCCC.

The participant of the host country is EPSA, *Empresa de Energía del Pacífico* (Pacific Energy Company). It is a public Colombian company, incorporated in 1995 with the purpose of assuming the electric energy generation, transmission, distribution and marketing functions. This company is the distribution network operator in the municipality of Tuluá in the department of the Cauca Valley. From its origins, the Company has been very beneficial to the region, while delivering other benefits to its strategic partners.

GAS NATURAL SDG is the other participant, a Spanish energy company that was incorporated in 1982, with a presence in 13 countries and which offers its services to almost 8.7 million clients that consume 51,000 million kWh of electricity and more than 30,000 million kWh of gas.

The active environmental policy is integrated within the company's guidelines. In this sense, we can highlight the certification of all production centres under the UNE-EN ISO 14.001 standard and, in particular, the use of CDM for the development of projects with a big environmental component which would not be viable without this instrument. In fact, GAS NATURAL SDG has been the first Spanish company in registering the project activity with the Executive Commission: "Los Algarrobos Hydroelectric Project (Panama)". Subsequently, the company has registered the following projects: "Project for the Refurbishment and Upgrading of Dolega Hydropower Plant (Panama)", "Project for the Refurbishment And Upgrading Of Macho De Monte Hydropower Plant (Panama)" and "La Joya Hydroelectric Project (Costa Rica)".

A.2. Location of project activity

A.2.1. Host Party(ies)

Republic of Colombia

A.2.2. Region/State/Province, etc.:

Department of the Cauca Valley

A.2.3. City/Town/Community, etc.:

Municipalities of Tuluá, Buga and San Pedro

A.2.4. Details of physical location, including information allowing the unique identification of this project activity (maximum of one page):

The project of the Minor Hydroelectric Power Plant of Bajo Tuluá is located on the middle section of the basin of the Tuluá River. The water flows through the river points 1,477 and 1,247 metres above sea level, in the department of the Cauca Valley, municipalities of Tuluá, Buga and San Pedro. The water intake point is located on the left margin in the Crucero Nogales borough, Crucero Nogales district at the height of the Cristalina ravine, municipality of Buga. The engine house is located in the height 1,247, and the discharge is above the mouth of La Esmeralda ravine into the Tuluá River, in the Esmeralda district, in the municipality of San Pedro. The electrical distribution line starts in the engine house and finish in the Tuluá sub-station and it pass through the municipalities of Buga, San Pedro and Tuluá.

In particular, the water intake point is located on the following coordinates (in decimal format):

	Latitude	Longitude
ALTO TULUÁ RIVER WATER INTAKE POINT	3.925272°	-76.087950°

Equivalent geographical coordinates are: Latitude: 03 ° 55' 30.98 ''N; Longitude: 76 ° 05' 16.62'' W.

A.3. Technologies/measures

This project collects the waters of the Tuluá River in the point 1,477.7 metres above sea level in the municipality of Buga. With the construction of a small dam that is 50 metres wide in the Tuluá River at this point (1,477.7 metres above sea level), a damming will be created and it will allow water collection through a lateral collection point. The lateral collection point has a reception tank that drives water flow to a 110 metres long adduction channel which connects with a triple sedimentation basin. This one has an exit and a delivery channel which gives flow to the conduction tunnel which connects with the load tank. The pipe who feeds the power plant stars in the load tank and it split into two flows to distribute to two Francis turbines. The turbines are hosted in a surface machine house with their respective generators, valves and control panels. The engine house also hosts the connections yard.

The electrical energy distribution line is rated at 34.5 KV and it is connected to the sub-station of Tuluá. The distribution line shares 16 km with the line designed for the Alto Tuluá project, until it arrives to the sub-station of Tuluá. The line walkway usually has parallel paths and therefore it is

guaranteed ease of access, construction material's displacements and transport and worker's maintenance and entry. Moreover, the line walkway passes through lands with moderated slopes that make accessibility easier.

A small explanation of each stage and unit mentioned in the previous paragraph is included below:

- **Dam**: it is located in the point 1,477.7 metres above sea level and its function is to generate a small damming that will allow the water collection from the river above an established sill (its function is not to store water but to make easier the collection of water).
- **Water collection**: the water intake point or bypass point is a lateral collection point at 1,474.7 metres above sea level. The collection is formed by a grating port that avoids the pass of thick materials that are being transported by the river. Downstream of the grating port there is a reception tank that calms water flow.
- **Desilting canal**: it functions is to establish a fast flow in front of the lateral collection point that will allow sweeping all the sediments aggraded in front of it.
- **Ecological flow channel**: it is a structure with a fixed port controlled by a sliding gate that allows guaranteeing the ecological flow. This flow has priority to the flow collected through the water intake point.
- **Calming tank**: it connects through an orifice with the adduction channel.
- **Adduction channel**: it starts in the calming tank and it is 110 metres long until it connects with the sedimentation basin.
- **Sedimentation basin**: it is a triple sand trap. The water generated is collected in a small calming tank from where it starts the conduction tunnel.
- **Conduction tunnel**: horseshoe section with a partially lined tunnel and 5,657 metres in length from the start of the conduction to the load tank or holder.
- **Load tank**: from here starts the pipe which feeds the power plant and it is 560 metres long and has a diameter of 1.80 metres.
- **Engine house**: house of the superficial type that integrates the spaces required to host the two sets of generators with Francis turbines and the connection's yard. The engine house is composed by the following equipment: inlet valve, two Francis turbines with horizontal axis and a throttle, generators, insulated phase bars, generator's switches, potential transformers, auxiliary mechanical equipment, auxiliary electrical equipment and bridge crane. Finally, water is driven into the Tuluá River through a discharge tunnel. The water capacity of each turbine is the same, and is thus equivalent to 50% of the total capacity of 23.5 MW (generators capacity).

MAIN CHARACTERISTICS OF THE TURBINES	
Number of units	2
Type	Francis, horizontal
Level of water in the load tunnel	1,475.3 metres above sea level
Level of water discharged by the turbine	1,244 metres above sea level
Level of injectors	1,243 metres above sea level
Gross drop	225 m
Maximum net drop	194.39 m
Design flow per turbine	6 m^3/s
Design power per unit	12.04 MW
Expected efficiency at 100% opening	93 %
Nominal speed	720 m^{-1}
Submergence	+1 m

- **Electrical distribution line**: The line that enables the connection of the energy generated between the engine house and the sub-station of Tuluá has the following characteristics:

Nominal voltage	34.5 KV
Number of circuits:	Simple three-phase circuit
Conductor:	ACSR 556,5 MCM DOVE DOVE
Cable guard	Type: Optical Ground Wire(OPGW)

Structures:	In the concrete post, with a height of 14 metres and metallic small towers, with a configuration for the one three-phase circuit, with steel cable holding lines, where necessary.
Insulating elements:	Polymer based, of the post or suspension type.
Length of the line:	16 km
Number of structures:	66

The distribution line will be shared with the one from the hydroelectric power plant of Alto Tuluá. This one starts at the point 1,500 metres above sea level and arrives to the Bajo Tuluá's engine house. From here, both projects share 16 km of distribution line. The line walkway is close to paths which will be built inside the project's area of influence and therefore it is guaranteed ease of access, construction material's displacements and transport and worker's maintenance and entry. Moreover, the line walkway passes through lands with moderated slopes that make accessibility easier.

- **Complementary civil works**: access path to the collection, load tank-Holder, engine house, adaptation of landfills, construction of two bridges (one located in La Esmeralda ravine and one shared with Alto Tuluá project in San Marcos river), rehabilitation of current routes, expansion of energy networks for the construction and personnel facilities for workers.

A.4. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Colombia (Host)	EPSA S.A. E.S.P.	No
Spain	Gas Natural SDG S.A.	No

A.5. Public funding of project activity

This project does not include Public finance sources.

A.6. History of project activity

A.7. Debundling

SECTION B. Application of selected methodologies and standardized baselines

B.1. Reference to methodologies and standardized baselines

If we take into account the Colombian energy grid, the type of data available and the CDM project activity, this project activity will be developed in accordance with the consolidated ACM0002 baseline methodology / Version 10 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources"[3]. The application of said methodology has been complemented according to the version 02 of the document "Tools to calculate the emission factor for an electric system"[4].

[3] http://cdm.unfccc.int/filestorage/N/F/9/NF9EDAOV5K382HW0JR14GS7XYQUMCP/EB47_repan07_ACM0002_ver10.pdf?t=M2V8cHAzZW1jfDCnrDh7o2VorhBG0iz0bDiJ

[4] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.pdf

The application of said methodology includes the project's additionality analysis, in accordance with version 05.2 of the document "Tool for the demonstration and assessment of additionality"[5] proposed by the CDM Executive Committee".

B.2. Applicability of methodologies and standardized baselines

The consolidated ACM002 methodology / version 10 is applicable to the generation activities that use renewable sources and comply with a series of requirements. The project activity proposed complies with all conditions required for its application, since:

1) The project activity is the installation of a run-of-river hydroelectric power plant (without reservoir).

2) Due to it is a run-of-river hydroelectric power plant, the reservoir is the river (the volume of the current reservoir does not change): if the river does not have enough flow, the hydroelectric power plant will not work.

3) The limits of the electric energy supply network, to which the project activity supplies the electric energy generated (National Interconnected System of Colombia), can be clearly identified, with all available information about the system to make a precise forecast of the reduction of emissions associated to the project activity.

4) It is not a landfill gas project.

5) The project entails an additional electric energy generation capacity after the commissioning of a new hydroelectric power plant. It is not a modification of an existing project. Therefore, it is not possible to have information about the power plant for the last 5 years.

6) The project does not replace the use of fossil fuels by renewable energies in the site where the project activity is carried out.

7) It is not a project with biomass combustion.

8) The current hydroelectric power plant project works with run-of-river and does not require new water reservoirs, neither to increase the current ones.

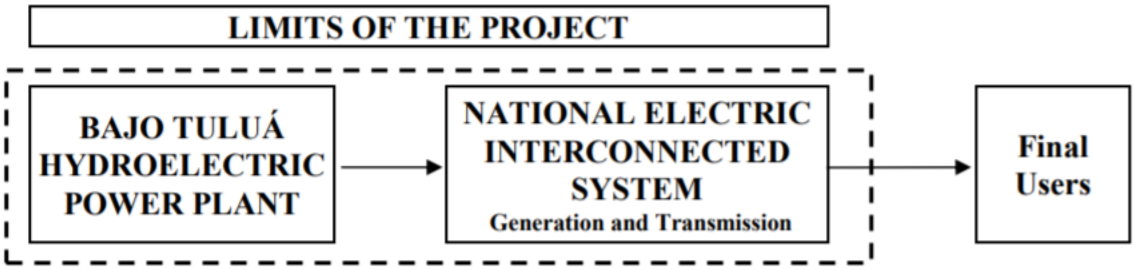
B.3. Project boundary, sources and greenhouse gases (GHGs)

In accordance with the ACM002 methodology / version 10, the calculation of GHG emissions associated to the project only consider the emissions of CO_2 of the generation of energy in fossil fuel combustion plants that are shifted by the activity of the CDM project. This approach provides a set of calculations that are truly conservative, since the thermal power plants shifted by the operation of the power plant use fuels with a high level of leakage (methane leakages, from the natural gas distribution chain, liberation of methane associated to carbon mining, etc,) which exceed those associated to the operation of a hydroelectric power plant without a reservoir.

[5] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v5.2.pdf

	Source	GHG	Included?	Justification/Explanation
Baseline	Shifted thermal power plants that consume fossil fuels	CO_2	Yes	Following the guidelines established by the ACM002, the baseline must only consider the CO_2 emissions from fossil fuel consuming plants that are shifted by the CDM project activity
		CH_4	No	
		N_2O	No	
Project activity	For hydropower plants, emissions of CH_4 from the reservoirs	CO_2	No	The hydroelectric power plant of the present project does not have a reservoir
		CH_4	Yes (but they are 0)	
		N_2O	No	

The spatial extension of the limits of the project includes the physical location of the project (Power Plant of Bajo Tuluá) and all plants connected to the electricity system, which will be connected to the Hydroelectric Power Plant of Bajo Tuluá (National Interconnected System of Colombia), as shown on the following figure:



B.4. Establishment and description of baseline scenario

The hydroelectric power plant project of Bajo Tuluá is based on the construction of a new plant that will be integrated in the National Interconnected System of Colombia. The system is composed of a combination of power plants that consume fossil fuels and plants that use renewable energy sources. In accordance with the growth of the expected demand, the system will grow with the integration of new power plants. Therefore, the baseline scenario is one where the electricity supplied by the project to the network will be generated by the operation of the plants that are currently connected to the network and by new plants added to the System, based on the current trends in the sector. Both aspects are depicted in the Combined Margin, which is calculated as shown in the last version of the “Tool to calculate the emission factor for an electricity system” and which calculation is described afterwards.

B.5. Demonstration of additionality

Early consideration of CDM

The following timeline shows the main actions and milestones that prove the priori and parallel consideration of the CDM to the project activity. In order to assure that continued and real actions were taken, the long term decisions and commitments are evidenced:

Timetable including relevant information

Date	Key Event	Evidence
09/2005	Early consideration of implementing the project as a CDM project	No Objection Letter by Colombian DNA
28/05/2007	First Local Stakeholders Consultation Meeting	PDD, Section E.

November 2007	Union Fenosa Strategic Plan (BIGGER). Approval of Investment: decision date	BIGGER approval
18/04/2008	Environmental Impact Assessment	Ingetec S.A.
13/06/2008	Agreement with CDM consultant	Socoin S.A.
18/06/2008	Agreement with DOE for validation services	AENOR
21/07/2008	Initial adoption of PDD submitted to DOE for Validation	Gas Natural SDG
02/08/2008	Public Consultation	UNFCCC website
15/01/2009	Starting Date of project activity	Date of purchase of equipment by EPSA
10/02/2009	Beginning of access works	Chronogram

As stated above, the additionality of the project activity has been analysed with the use of the latest version of the “Tool for the demonstration and assessment of additionality”, version 05.2. These are the steps followed:

Step 1. Identification of the alternatives of the project’s activity in compliance with the current legislation and regulations

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

The alternatives defined are the following:

- Continuation of the current trend to add capacity to the system (baseline scenario).
- Execution of the project without its registration as CDM.
- Construct a 25 MW fuel-fired power plant in order to supply this electricity to the Interconnected System.

Initially, a coal plant of 350 MW was selected as an alternative project, according to the usual parameters of profitability that requires Unión Fenosa projects, but it was finally removed from the PDD because it would not be comparable with the project activity due to a much higher installed capacity. Smaller coal power plants, close to 60-80 MW, tend to respond to residual applications or complementary businesses (such plants use residual miners) that would not be objectively comparable with the project activity, as the scheme of cost-benefit not only responds to the business of power generation such as the CH of Bajo Tuluá.

Building and evaluating a Fuel Power Plant has been considered as an option for supplying energy to the system, as indicated in Reference Expansion Plan Generation - Transmission, 2008-2022, UPME (Chapter 4)[6]. It is also necessary to mention that Colombia is a country with high quality coal and high reserves of this resource (7,063.58 million tons of coal, which correspond to resources and reserves measures, as indicates the Reference Expansion Plan).

Other renewable technologies, as wind or solar, have not been considered in the additionality assessment since these technologies are not suitable in the area for the following reasons:

- The slope of the river is high, turning out to be ideal for hydro generation compared to other renewable technologies.
- Tough orography in the area, so the consideration of wind energy as an alternative is not recommended.
- The average number of days with rain in the area is high, so the consideration of solar energy as an alternative is not recommended.
- Lack of regulation for these technologies in Colombia.

Sub-step 1b. Compliance with the current legislation and regulations

[6] See Document number 7 from the referentes list that is included in Annex 5 “Additional Documentation”

The aforesaid alternatives and the project's activity comply with the applicable regulatory and planning requirements. The Colombian electricity sector plan is established in the Reference Expansion Plan 2008-2022. This document establishes the guidelines for the evolution of the Colombian energy generation infrastructure. The following table shows the short and medium-term actions considered in generation expansion in Colombia, according with this document.

Projects included in the Colombian Generation Expansion Plan in the short and medium-term			
PROJECT	CAPACITY (MW)	TYPE	FORECASTED DATE OF COMMISSIONING
Tebsa	45	Gas	Dec.-07
Cartagena 2	63	Fuel-oil	Feb.-08
Mayaguez	18	Cogeneration	Nov.-08
Argos	51	Coal	Dec.-09
Bugalagrande	40.5	Hydro	Dec.-09
Amaime	18.6	Hydro	Dec.-09
Flores IV	160	Gas/Vapor	Dec.-09
Termocol	210	Fuel-oil	Dec.-09
Guarinó tranfer	---	Hydro. (Bypass of water from the Guarinó river)	Jun.-10
Amoya	78	Hydro	Jun.-10
Porce III	660	Hydro (reservoir)	Sep.-10/Ene .-11/Apr.-11/Jul.-11
Manso transfer	---	Hydro (Bypass of the water to Miel I Reservoir)	May.-11
El Manso	27	Hydro	May.-11
Quimbo	400	Hydro (reservoir)	2015
Porce IV	---	Hydro (reservoir)	2015
Sogamoso	840	Hydro (reservoir)	2015

Source: Reference expansion plan Generation and transmission, 2008-2022, UPME.

Step 2. Analysis of the investment

The main analysis in order to assess the additionality of the project activity is the "investment analysis" according to the step 2 of the "tool for the demonstration and assessment of additionality" version 05.2. In addition, it has been considered the "barrier analysis" as an argument to strengthen the additionality assessment according to the criteria of the tool.

Sub-step 2a. Determination of the appropriate analysis method

Option I (simple cost analysis) is not applicable in this case, since the project will generate other economic and financial benefits that are different to those related to CDM incomes, with the sale of the electricity generated. Option II (investment comparison analysis) has been evaluated but removed since input values would be based on information subject to confidentiality. Option III: "Benchmark analysis" has been chosen. As reinforcement of the investment analysis "barrier analysis" will also be evaluated.

Sub-step 2b. Option III

The financial indicator used has been the Project IRR.

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

During the decision-making process of the project of the Hydroelectric Power Plant of Bajo Tuluá, the investment profitability analyses carried out by Unión Fenosa, as the project promoter, included

the comparison of the financial indicators listed below and monetization of the CO_2 credits (i,e,, certified reductions of emissions or CERs) derived from the project activity.

The cash flows included the following subjects:

- Investment costs (equipment, land, engineering, administration and environmental management and civil works)
- Fixed and variable operating and maintenance costs, from the experience of EPSA in the maintenance and operation of similar plants.
- Regulatory costs, which include the costs of the National Dispatch Center, financial transactions costs associated with Act 99, Ac 56 and Fazni.
- Other costs associated with municipal funds and the special commission structure.
- Revenue obtained from the sale of electricity. The calculations took into account its change over time depending on the CPI[7]
- In the second case, revenues associated to the sale of CERs

Bajo Tuluá power station has an effective capacity of 23.5 MW under regular operation. Therefore, production is 117.4GWh, which can be obtained based on 67% of the power station load factor. These operation hours result from the studies derived from the EIA and the subsequent estimates made when the design of the basic components of the power station was revised. The 121 COP/MWh sell price is that considered as the price of the first year of commercial operation and it is indexed to the CPI. This reference results from the analysis of the Colombian market made by EPSA and it can be observed that it is a value included in the scenarios considered by the UPME (Mining-Energy Planning Unit) (Documents for System and Forecast Unit Expansion) on its web site.

The tax deductions considered include the deduction of 40% of the value of investments in fixed assets productive (Law 1111 of December 27, 2006). In the case of the analysis with revenue of CERs, the investment is lower due to saving from VAT on equipment imported under the tax law in Article 424-5.

The evaluation period of the project has been seen in 50 years. This period is enough away from the depreciation periods and presently there are many plants both in Colombia and internationally with periods of use of this order. Currently, this period is the one that reflects more accurately the expectation of life with which undertakes the projects. EPSA has extensive experience in operating plants that have considerable seniority to reach these conclusions for this project.

Bajo Tuluá Hydroelectric Power Plant has neither income nor expenditure because its capacity is lower than 23.5 MW. The power sales income has been indicated, as well as the income associated with CERs. The sales price of these CERs is 22 USD/Ton and a sensitivity analysis of the price considered in the PDD has been included.

The Operation and Maintenance costs are estimated based on EPSA's experience in operating and maintaining similar power stations in Colombia. The values are referred to year 2007 current COP, and indexed to CPI. Administration costs have not been included since EPSA absorbs them in the administration of other power stations.

Regulatory costs include:

- Centro Nacional de Despacho SIC (National Distribution Centre, Trading System, CREG 110), published on January 2007 and indexed on a monthly basis to the PPI (224 COP/kW-month, year 2007)
- Property (premises associated to the project), 6‰ over 150% of property's commercial value · 4‰ (4 per thousand tax) on financial transactions
- Ley 99 (Act 99), to be applied on 6% of total energy sales (CREG 135), valued at 52.7 COP/kWhmonth (2007) and indexed to the CPI • Ley 56 (Act 56, Industry and Commerce tax), valued at 336 COP/kW (Jan. 2007) and indexed yearly to the CPI

---

[7] Source: Bancolombia, November 2007

- FAZNI (Financial Aid Fund for the Provision of Energy Services to Interconnected Areas), valued at 1 COP/kWh (2007) and indexed yearly to the CPI

The line indicated as other costs are special municipal funds plus the structure commission; if income is derived from CERs, it has been considered different, since part of this income will be used to invest in the area.

As reflected in the annexes of the economic-financial models, the amortizations period for machinery and civil works have been considered 20 years and 5 years for the rest of the concepts of investment. It is clear therefore that the residual value is considered to be zero.

The tax imposed is 33% on investment and, during the first years, it provides a tax benefit accumulated and consumed as profits are generated. With CERs, thanks to savings from VAT on imported equipment obtained by virtue of the tax law, Section 424-5, investment is lower.

The following table shows a comparison between the IRR value obtained with and without the revenue related to the CDM.

	Case 1: Without revenues related to the sale of CERs	Case 2: With revenues related to the sale of CERs
IRR (%)	11.67	13.10/13.59

Table: Parameters for IRR calculation

Parameter	Unit	Value
Installed Capacity	MW	23.5[8]
Annual Generation	GWh/year	117.4
Average Sale Price	$COP/kWh	121
Investment	COP M	112,227
Annual O&M + Regulatory costs	COP M	1,705
Project Life	Years	50
Amortization Period: Plant & Equipment	Years	20
Amortization Period: Other Investment concepts	Years	5
CPI	%	3.18
Income Tax Rate	%	33
Project IRR	%	11.67

Source: Project Developer

Discount rate required

Basically, the model says that the return to be expected on an asset (or investment) must equal the return on an asset (or investment) with no risk plus the average market risk multiplied by the specific risk factor of said investment. The Barrier-IRR is derived from Colombian sovereign bonds as they are debt instruments and therefore safer than investment-type assets. For the determination of the IRR barrier, in addition to include the sovereign risk (which includes premium for credit risk and country risk), a premium for the market risk (that is given by the greatest risk facing the bong you have to invest in an asset generation) has also been included; said risk comes from the higher risk against the bond that has to invest in a generation asset.

[8] This value is not directly used in the IRR calculation, but the annual generation which is based on long term hydrological studies and is not influenced by the said installed capacity.

The following bonds have been used for the calculation of the IRR barrier, with these instructions:

- American bond to 30 years, is the bond that represents the best long-term assets without risk, is clearly the case of this plant and project of similar characteristics.
- 2020 Colombian Bond (emission date: July 2005), is the bond that represents the best long-term assets.

The financial indicator more suitable for the decision context is the IRR post-tax, since in Colombia, in the case of the analysis with revenues from CERs, the investment is lower due to the savings from VAT on equipment imported and therefore the final profitability comes not only because of the CERs issued but also from the taxes avoided.

In order to have a valid comparison, the Barrier-IRR post-tax has been also calculated (weighted average cost of capital, WACC) by means of using a cost of capital after taxes when determining the market risk premium.

Taking into consideration that Colombia's government bonds have a yield of approx. 10.05%[9] (active without risk) and that the premium market to face the investment risks, have been estimated in 2.54%, IRR barrier to carry out this type of investment from Union Fenosa (now Gas Natural SDG) is 12.59%The best investment profitability, in terms of Project IRR, is obtained from the project scenarios considering the monetization of CERs generated by project activity (13.11% - 13.60% depending on CER price levels), with respect to the other project scenario in which the monetization of CERs generated by project activity was not considered (11.67%). (See sub-step 2d Sensibility analysis).

It seems clear that IRR of the project without CERs incomes is not attractive enough to implement the project.

The final investment decision was taken after studies dated November 2007, according to the methodology of investment analysis of Union Fenosa (now Gas Natural SDG). Hence, the input values used in all the investment analysis are valid and applicable at the time of this investment decision taken by the project participant.

Therefore, it is necessary to consider the fact that the Bajo Tuluá Minor Hydroelectric Power Plant is less attractive, in financial terms, than the options of building a fuel-fired power plant, and for its implementation needs to be registered as a CDM project to obtain financial support from the sale of CERs. In that case, and considering the monetization of the CERs and the tax deductions, the increase in the IRR is big enough to implement the project, and acquires a strategic value that makes it possible to strengthen the strategic positioning of Union Fenosa (now Gas Natural SDG) on climate change and the CDM objectives of the company.

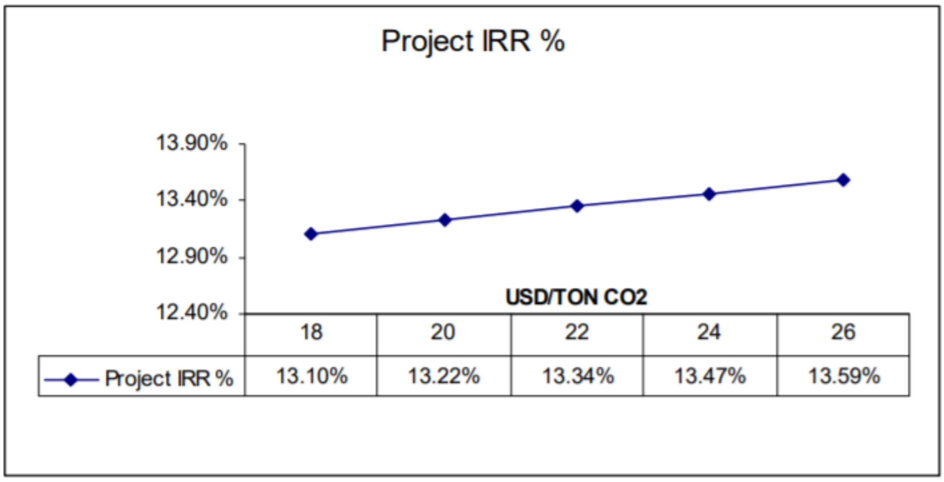
Sub-step 2d. Sensitivity analysis

Indicators used for the sensitivity analysis have been the price of t CO_2 in organised markets and annual electricity generation (GWh per year).

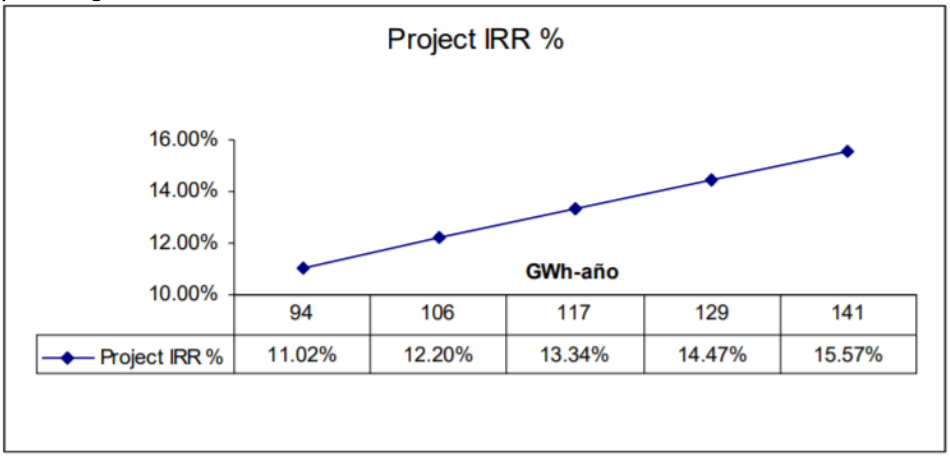
The increases in the Project IRR for the different scenarios are shown on the graphs and corresponding tables.

- Sensitivity analysis of the Project IRR in the stage with carbon credits depending on the price of CERS

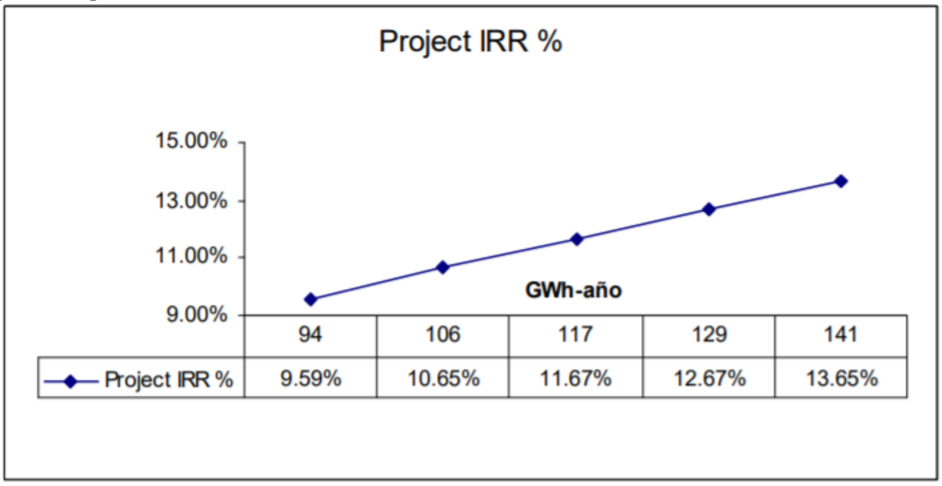
[9] Source: Bancolombia, November 2007



- Sensitivity analysis of the Project IRR in the stage with carbon credits depending on power generation



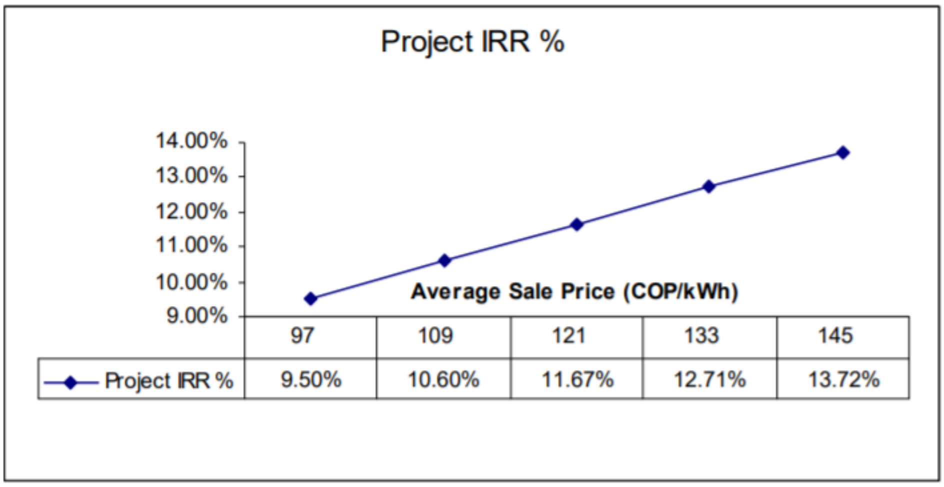
- Sensitivity analysis of the Project IRR in the stage without carbon credits depending on power generation



This sensitivity analysis is focused on the value of 117.4 GWh according to the water series developed to obtain the environmental license. Considering these head and flow rates of the river during the same period as well as the turbine-generator parameters it was carried out a hydroelectric simulation, obtaining as a result an average annual production of 117.4 GWh. As shown in the Annex 5 -Additional documentation, Reference 18 – Energy production, the probability of exceeding in a 10% the estimated energy production during the first five years

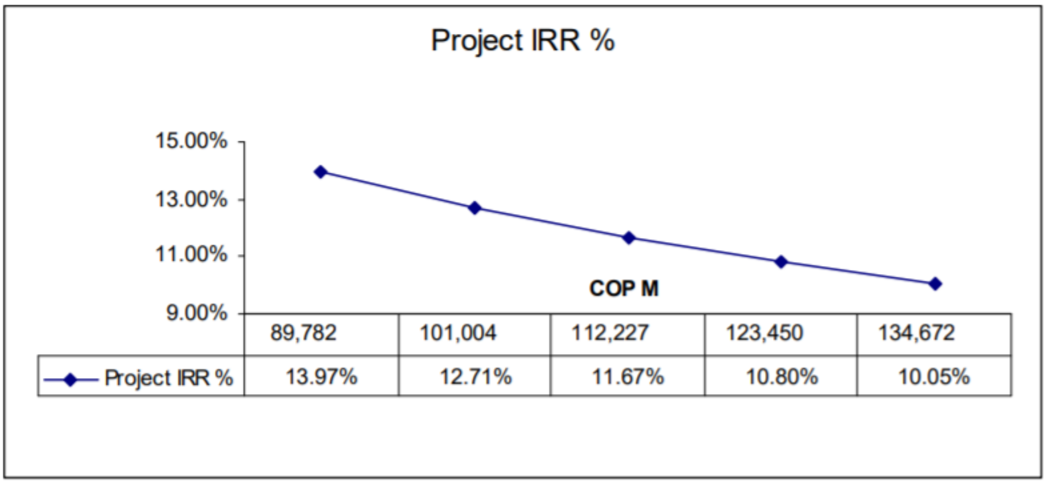
of commercial operation is 0.7%. The sensibility analysis included was considering the overproduction during the whole operating period, not only the first five years. Hence, the conclusion is that is almost impossible to reach that level of production for the project.

- Sensitivity analysis of the Project IRR in the stage without carbon credits depending on the average sale price of electricity



As it can be seen with an increase of a 10% in the Average Sale Price of energy, the project IRR without CERs is higher than the Barrier IRR. In any case, this should be considered only as a theoretical exercise because the values of energy prices hardly vary from the expected as it can be checked in all the scenarios outlined by the UPME in the Expansion Plan Generation-Transmission 2008-2022. Unless specific values (spikes of a month or two on a horizon of 24 years) never exceeds the price indicated for Bajo Tulua.

- Sensitivity analysis of the Project IRR in the stage without carbon credits depending on Investment

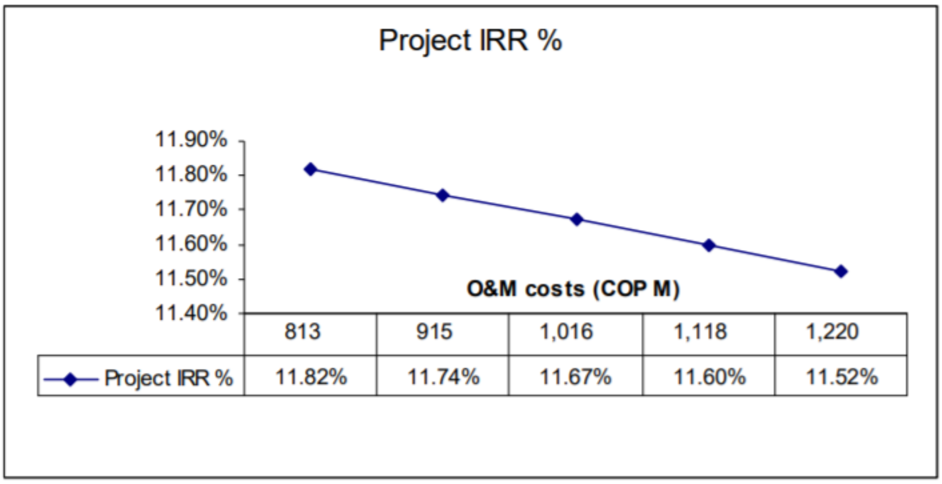


This graphic shows the sensitivity analysis of the Project IRR in the stage without carbon credits depending on the investment in accordance with the Tool for the demonstration and assessment of additionality, version 05.2, that is to say, with a symmetric interval of ±10%[10]. However, reality shows that the most probable stage concerning the investment cost will be

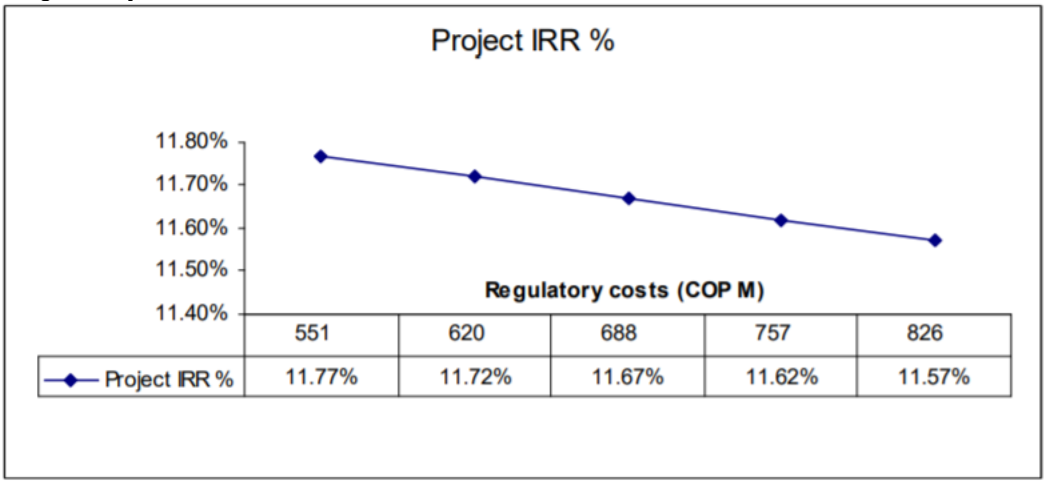
[10] In the Tool for the demonstration and assessment of additionality, version 05.2, page 15, it is said that "… as a general point of departure, variations in the sensitivity analysis should at least cover a range of +10% and -10%…".

close to the medium point or above it, conclusion that can be obtained from several contracts, such as the main equipment contract[11].

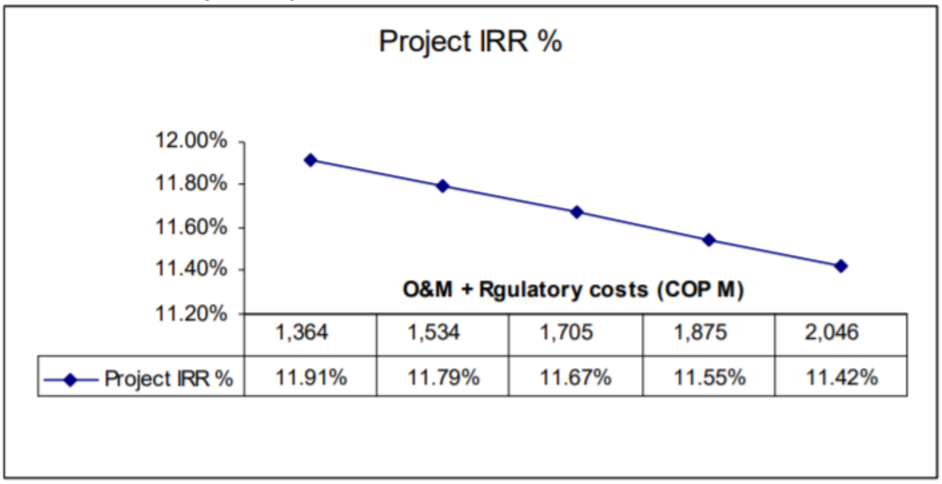
- Sensitivity analysis of the Project IRR in the stage without carbon credits depending on O&M cost



- Sensitivity analysis of the Project IRR in the stage without carbon credits depending on Regulatory costs



- Sensitivity analysis of the Project IRR in the stage without carbon credits depending on O&M cost + Regulatory costs.



[11] The main equipment contract is included in Annex 5 – Additional Documentation, Reference 13

Step 3. Analysis of barriers

This section analyses how the project activity has a set of barriers that hinder its execution and make the baseline scenario more attractive, so that the project must be considered as an additional project.

Sub-step 3a. Identification of the barriers that could prevent the implementation of the project activity proposed

The barriers identified are the following:

- ***Sector barriers***: There are a series of uncertainties surrounding the value of sale of electricity generated[12] and the values charged by capacity, which are also related to the availability and price of fuels and the reliability of the Interconnected System (which can not be mainly based on hydroelectric energy because of hydro-geologic uncertainties). Extreme weather events caused by climate change, such as "El Niño" or increasing periods of drought affecting the availability of hydropower plants.

Sub-step 3b. Justification of the fact that the barriers identified can not prevent the implementation of at least one of the alternatives (except the project activity proposed)

The current trend to add plants to the system is characterised by the construction of thermal power plants and large hydraulic power plants associated to reservoirs. These alternatives offer true advantages as regards run-of-river power plants, since they do not have to face the following barriers when they are added to the system.

- ***Sector barriers***: Historically, critical drought conditions are linked to El Niño events, such as those of 1991–1992 and 2002–2003 when severe energy rationing occurred when pool prices reached very high spot prices, forcing regulatory changes in the market. The Colombian electricity market includes a reliability payment for each resource based on its ability to generate energy during unusually dry periods, which is called firm energy. This firm energy is expected to meet user demand under 50 critical conditions (when the wholesale market price is larger than the scarcity price). This is found in CREG Resolution 071 2006. In 2008, Colombia introduced an innovative and effective market in which auctions are held to commit enough firm energy to cover its needs (Cramton and Stoft 2007, 2008).The firm energy market coordinates investment in new resources to assure that sufficient firm energy is available in dry periods. Currently the economic signal favors conventional thermal power plants. Thermal power plants powered with fossil fuels do not depend on the hydrologic conditions. Under any circumstance, these installations can participate in the dispatch system, provided that they have enough fuel for their operation and depending on their efficiency and price. Therefore, if the system has a price that is sufficiently high, the thermal power plant will be in operation selling the electricity generated. Hydraulic power plants with a reservoir can manage water resources, so that they are more reliable source of energy than run-of-river power plants, which have a high dependence on the current hydrologic conditions. The hydraulic power plants with a reservoir do not have such a high degree of uncertainty in the operation of the energy distribution system and they are a more attractive and safe investment than run-of-river plants. In addition, the influence of climate change on extreme weather events ("El Niño") and increasing periods of drought are barriers that prevent the implementation of the project activity and do not prevent the implementation of conventional thermal power plants. Since cash flow predictability is critical for investment planning and decision making, variable resources such as minor run-off-river hydro power plants, which are not eligible to receive the same reliability payment than conventional hydro and thermal power plants, are facing sectoral barriers that could affect its development. For instance, if Bajo Tulua Minor Hydroelectric Power Plant were eligible to receive a reliability payment

[12] During the 1996-2006 period, the stock exchange price has varied between less than 40 $/kWh and more than 275 $/kWh.

associated with a default yearly firm energy rating of 35% of total generation (Art. 37, Resolution CREG-071, 2006), the project developers could receive an additional, transparent and stable annual compensation of 575,178 USD (on average), according to the Firm Energy price of USD 13.998 per MWh currently in force. (http://www.superservicios.gov.co/MEM/archivos/informesexpert/informe29.pdf). Income from CERs would alleviate the identified barrier that prevent the proposed project activity from occurring.

Therefore, the analysis of barriers shows how the alternative to continue with the current trend of adding capacity to the system (conventional hydroelectric power plants and thermal plants) is the option with the lowest number of barriers, but it is not the best option to contribute to sustainable development and mitigate the climate change. Despite this situation, EPSA has opted to build a run-of-river plant that must face a series of more complex and important barriers. The main objective of the project activity proposed is to provide a clean energy, thus contributing to the improvement in the electricity service and regional development, aspects which are integrated in the environmental and social policy of this company with a public origin, committed with society and the environment of the Department of the Cauca Valley. Therefore, the project activity can be considered as an additional activity, especially when the registration of the project as CDM contributes to reduce some of the barriers faced by the project.

Step 4. Analysis of common practices

Sub-step 4a. Analysis of other activities similar to those of the project

As stated above, the Colombian electricity sector is dominated by thermal and hydroelectric power plants. Within the latter, we can distinguish between power plants with a reservoir and run-of-river plants, which have a greater risk to generate energy, despite the lower environmental impact, since they can not regulate the availability of water resources to guarantee the level of production.

During the year 2007, the run-of-river hydroelectric plants generated 5.16% of the total energy generated by the system and they represented 4.41% of the total installed capacity for the whole Interconnected System of Colombia.

ANALYSIS OF THE IMPORTANCE OF RUN-OF-RIVER HYDRAULIC POWER PLANTS DURING 2007		
Total capacity of the SIC	13,415,430	kW
Capacity of run-of-river hydroelectric power plants	591,430	kW
% Capacity of run-of-river hydroelectric power plants	4.41	%
Total generation of the SIC	53,665,662,570	kWh
Generation of run-of-river hydroelectric power plants	2,769,175,603	kWh
% Generation of run-of-river hydroelectric power plants	5.16	%

Source: Calculations based on data dispatch from NEON database

Sub-step 4b. Discussion about other similar options used

In addition to the trend described, analysis of similar activities to the project activity has been conducted, considering minor run-of-river plants in Colombia with similar capacities, between 10-20 MW.

Until 2003 there were only 9 plants of these characteristics in Colombia: Niquia (19 MW), Ayura (18 MW), Palmas San Gil (15 MW), Insula (19 MW Year 1951), Charquito (19.4 MW), La Tinta (19.4 MW), El Limonar (18 MW), Río Frío II (10 MW), and Tequendama (19.4 MW).

Since 2004, in addition have been build 3 plants of this kind (La Vuelta, La Herradura and Santa Ana) that have been considered as CDM. Plants closed or modified have not been considered in the analysis because would not be similar to the project activity or would not be included in project boundary. Closed plants do not supply energy to the Colombian National Interconnected System

meanwhile modified plants have different building risk, investment and recovery than a new construction plant and therefore they would not be comparable.

Name of the plant	Installed capacity (MW)	Date of commissioning	Comments
La Vuelta	12.00	18-12-2004	CDM
La Herradura	20.00	01-04-2004	CDM
Santa Ana	13.43	11-05-2006	CDM

Analyzing the generation and power of these three plants regarding the total power and generation of the system, the following percentage values are obtained:

ANALYSIS OF RUN-OF-RIVER HYDRAULIC POWER PLANTS WITH 10-20MW CAPACITY BUILT SINCE 2004 AND REGISTERED AS CDM		
Total capacity of the SIC	13,415,430	kW
Capacity of run-of-river hydroelectric power plants with 10-20 MW since 2004 and registered as CDM	45,430	kW
% Capacity of run-of-river hydroelectric power plants with 10-20 MW since 2004 and registered as CDM	0.34	%
Total generation of the SIC	53,665,662,570	kWh
Generation of run-of-river hydroelectric power plants with 10-20 MW since 2004 and registered as CDM	224,484,383	kWh
% run-of-river hydroelectric power plants with 10-20 MW since 2004 and registered as CDM	0.42	%

Source: Calculations based on data dispatch from NEON database

Therefore, considering recent projects of a similar nature, virtually all of them have been claimed as CDM, whatever its capacity, so that we can guarantee that the development of such projects activity, without consideration as CDM, is not a common practice in Colombia. According to the information contained in the Plan Expansion reference Generation - Transmission 2008- 2020, the Ministry of Environment, Housing and Territorial Development of Colombia has a portfolio of 113 potential projects eligible under the CDM mechanism. Of these projects, 31 relate to the energy sector at different stages of development, having a total of 11 projects for minor hydropower plants (minor than 20 MW) (see table below).

Project	Number of projects
Hydroelectric under 20 MW	11
Hydroelectric over 20 MW	10
Eolic plants	2
Biomass plants	3
Increased capacity and efficiency in thermal power generation	2
Bypass of water	1
Reduction of losses in transmission lines	2
Total	31

Source: Reference expansion plan Generation and Transmission, 2008-2022, UPME,

Therefore, the application of the additionality tool shows that proposed project activity is additional because:

1. The project activity can not be compared to the baseline scenario, characterised by the construction of hydroelectric power plants with a reservoir and thermal power plants

2. Other similar activities cannot be observed in Colombia

3. The project activity has important barriers that are not present in the baseline scenario or which are not as important

4. These barriers can be partially overcome with the registration of the project as a CDM

5. The monetarisation of the sale of CERs is required to make the investment attractive

6. As a consequence of the greater contribution to local sustainability and the mitigation of the climatic change, EPSA has opted for the development of the project activity in lieu of other options that were more attractive in economic terms

Due of the strategic character of CDM projects in order to achieve specific objectives of the company, the importance of CDM incentive in the decision-making about development of the project has been taken into account from project design stage. Union Fenosa (now Gas Natural SDG) had a specific committee to identify and assess CDM projects. The reports of committee meetings reflect the decisions regarding the different stages of CDM projects life cycle.

In addition, we must highlight that the project for the Minor Hydraulic Power Plant of Bajo Tuluá is in procedure to receive the no objection letter issued by the Ministry of Environment, Housing and Territorial Development.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

As stated above, the hydroelectric project of Bajo Tuluá will be integrated in the National Interconnected System of Colombia. The system is characterised by the generation of conventional hydroelectric energy and the generation of thermal power plants, which represent more than 96% of the installed power and energy generated during 2007. Minor plants based on renewable energies play a minor role and represent 5% of the energy generated and represent less than 4% of the capacity installed[13].

Therefore, the Hydroelectric Power Plant of Bajo Tuluá will shift electricity from the supply network that would be supplied and generated by conventional power plants, including GHG producing thermal power plants. The commissioning of the plant will thus entail a lower degree of CO_2 emissions of the system.

The ACM0002 methodology / Version 10 is applied with the purpose of quantifying the reduction of emissions generated by the project's activity. In accordance with this methodology, the reduction of emissions is the difference between the baseline emissions (characterised by their absence from the project) and the emissions of the project. In this type of renewable energy projects, the direct emissions are non-significant. Likewise, since there is no reservoir, leakages can also be considered as very low. Therefore, the calculation for the reduction of emissions associated to the operation of the project activity only considers the baseline emissions. Their calculation is carried out with a combined margin factor, resulting from the weighting of the two factors calculated before:

- Operating margin emission factor: shows the emissions avoided as a consequence of the electrical energy previously transferred to the system by thermal power plants and which is shifted after the commissioning of the new plant.

- Build margin emission factor: introduces the calculation of GHG emissions avoided as a result of the effects of increasing the capacity by adding plants to the system.

The National Dispatch Centre, which coordinates the electricity market trade and the operations of the National Interconnected Electricity System of Colombia, and the Mining-Energy Approach Unit

[13] Source: Report of Operation and Administration System Market 2007, XM. See Annex 5, reference 16.

of the Ministry of Mines and Energy provides the data required for the calculation of these two emission factors. With these and other sources, the following information has been gathered:

BASIC INFORMATION FOR THE CALCULATION OF THE BASELINE	
Data	**Source**
Fuel emission factor	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2,
Heat Rate	Associated Services Management, XM Compañía de Expertos en Mercados S.A. E.S.P
Total electricity generated by all power plants connected to the National Interconnected System of Colombia	NEON
Total hourly generation of the System	NEON
Type of fuel used in each plant	UPME / XM

The option I at the step 2 of the baseline methodology procedure, included in the “tool to calculate the emission factor for an electricity system” version 02, has been chosen. This option reflects that only grid power plants are included in the calculation of the operating margin emission factor.

The method selected to calculate the **operating margin emission factor** is the Simple Adjusted OM, called “option B” of the “Tool to calculate the emission factor for an electricity system", version 02, document included in the ACM002 / version 10 methodology. The Simple Adjusted OM provides a formula of the sources for calculating the emission factor taking into account the hourly generation system and the % provided by the low-cost/must-run plants.

The operating margin emission factor can be calculated:

- Calculation ex-ante: calculated from the average value obtained for the past three years for which data are available, without the need for monitoring or its recalculation in the credit period.
- Calculation ex-post: calculated for one year, being monitored and recalculated for the remaining years of the crediting period.

In this case, the calculation ex-post has been selected for calculating the operation margin emission factor, so it will be recalculated annually.

In the case of the **build margin emission factor**, it has been chosen “option 2” from the selected tool. Therefore, it must be updated annually with an ex-post approach during the first crediting period, while the factor will be calculated with an ex-ante approach during the following crediting periods.

In accordance with the version 02 of the document “Tool to calculate the emission factor for an electricity system” included in the ACM002/ Version 10 methodology, the baseline factor ($EF_{grid,CM,y}$) for the first crediting period is calculated as the weighted mean of the operating margin emission factor ($EF_{grid,OM,y}$) and the build margin emission factor ($EF_{grid,BM,y}$). The weighting factors selected are identical for both factors (w_{OM}=w_{BM}=0.5). For the second and third crediting period, the values of these factors are w_{OM}= 0.25 and w_{BM}=0.75.

A detailed description of the methodological options selected for the calculation of these factors is shown below.

a) Calculation of the operating margin emission factor ($EF_{grid,OM,y}$): Simple Adjusted OM

The option of the “Tool to calculate the emission factor for an electricity system” is applicable to electrical systems, where % of the mean generation during a period of five years for low-cost/must-run plants exceeds the 50% value, as is the case of the Colombian System. The main difference with the simple method lies in that this method takes into account this type of plants, differentiating them in the calculation of the emission factor from the rest of plants.

The plants registered as CDM project activities have been taken into account for the calculation of the operating margin emission factor, as established by the tool. Then, the procedure followed for the calculation of the operating margin includes the following stages:

1. The selected option for calculating the emission factor of each plant is based on efficiency (option B2) of the different plant of the Colombian Interconnected System, with the following expression:

$$EF_{EL,m,y} = \frac{EF_{CO_2,m,i,y} \times 3.6}{\eta_{m,y}} = Heat\ rate_m \times \ EF_{CO_2,m,i,y} \qquad \textbf{[Equation 1]}$$

Where:

- $EF_{EL,m,y}$ is the emission factor of plant m in year y in tCO_2/MWh.
- $\eta_{m,y}$ is the average net energy conversion efficiency of power unit m in year y (%)
- *Heat rate*$_m$ is the inverse of the efficiency of the power unit m (GJ/MWh)[14]
- $EF_{CO2,m,i,y}$ (t CO_2/GJ) is the average CO_2 emission factor o fuel type i used in power unit m in year y (tCO_2/GJ)[15]

However, for the calculation of the emission factor of each power unit m, the following options should be considered as well according to the availability of information:

Option A1. If for a power unit m data on fuel consumption and electricity generation is available.

If for a power unit m only data on electricity generation is available, **Option A3** is to be used as a simple and conservative approach with an emission factor of 0 tCO_2/MWh.

2. Value λ_y must be calculated before the calculation of the operating margin emission factor, using the following expression:

$$\lambda_y(\%) = \frac{\text{Nº hours low} - \text{cost/must} - \text{run sources are on the margin during the year y}}{8760\ hours..per..year} \qquad \textbf{[Equation 2]}$$

The steps required to calculate λ_y are:

- Step i: The total hourly generation data of the year are presented, from high to low, in comparison to the total 8,760 hours of the year.

- Step ii: Calculate the total annual generation of low-cost/must-run plants ($\sum_k EG_{k,y}$).

---

[14] The values of all the plants operating were obtained through the Dirección Servicios Asociados, XM Compañía de Expertos en Mercados S.A. E.S.P in units of MBTU / MWh and through an exchange of units have been transformed to GJ / MWh to include in this term. In the case of cogeneration, the Dirección Servicios Asociados, XM Compañia de Expertos en Mercados S.A. E.S.P. does not provide such data, so for cogeneration using bagasse fuel, fuel oil and coal + bagasse have been selected the heat rates "Promediios horarios de emission para el cálculo de la metodología consolidada de línea base ACM002 para proyectos de generación de escala completa" published by the Energy Minino Planning Unit of the Ministry of Mines and Energy of the Republic of Colombia. For cogeneration using coal as fuel and gas has been taken respectively the average value of all Colombian centrals that use such fuels.

[15] In this case, the values shown on table 1.4 of page 1.23 of the document "2006 IPPC Guidelines for National Greenhouse Gas Inventories" have been used, with the factor applied to each plant, in accordance with the fuel used and the characteristics of the site of origin. In the specific case of the thermal power plants that use carbon, the variety used by each plant has been obtained from the document "The Carbon Chain" of the Energy-Mining Planning Unit of Colombia.

- Step iii: Draw a horizontal line that crosses the line represented, so that the area under the curve represents the total generation of low-cost/must-run plants ($\sum_k EG_{k,y}$).

- Step iv: Determine value λ_y, taking into account that λ_y is calculated as X/8,760, where X represents the hours on the right of the point of intersection.

3. The next step involves the calculation of the quantity of carbon dioxide emissions produced by energy unit generated by the system. The said emission factor ($EF_{DD,h}$) is obtained with the following expression:

$$EF_{grid,OM-adj,y} = \left(1-\lambda_y\right) \times \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} + \lambda_y \times \frac{\sum_k EG_{k,y} \times EF_{EL,k,y}}{\sum_k EG_{k,y}} \quad \textbf{[Equation 3]}$$

Where:

- $EF_{grid,OM-adj}$, y is the annual operating margin emission factor, and
- EG_m, y , EG_k , y is the net electricity generated and supplied to the grid by plant m or k during the year and in MWh, where k are plants low-cost/must-run and m the others one.
- $EF_{EL,m}$, y , $EF_{EL,k}$, y is the emission factor of plant m or k, during year y and in t CO_2/MWh. It is calculated with equation No. 1.

After downloading the data corresponding to the year 2007 from NEON and applying the previous steps, we have obtained the following value for the operating margin emission factor:

$EF_{grid,OM,2007}$ = 0.469 kg CO_2/kWh

Appendix 4 includes more information about the calculations that have been carried out.

b) Build margin emission factor ($EF_{BM,y}$)

Option 2 of the "Tool to calculate the emission factor for an electricity system" version 02 has been used for the calculation of the build margin emission factor, which states that the build margin emission factor during the first crediting period must be updated using an annual ex-post approach to the year when the actual generation and reduction of project emissions takes place. The factor will be calculated with the most recent information about plants that have already been built during the presentation of the PDD (exante) for the rest of crediting periods.

The set of plants used for the calculation of the build margin factor is made up of the alternative that represents the greatest quantity of energy between the five plants that have been built recently, which generated 20% of the system's energy[16].

Both cases have not included the plants registered as CDM project activities, as established in the tool. Once the option of the number of plants to use is selected, the build margin emission factor will be calculated with the following equation:

$$EF_{grid,BM,y} = \frac{\sum_{i,m} EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad \textbf{[Equation 4]}$$

Where:

[16] While the PDD was being drafted, the five plants built most recently generated less than 20% of the system's energy, so that, to carry out the ex-post calculations of the build margin emission factor, the set of plants that have been built recently and generated 20% of the system's energy during 2007 was selected to carry out the ex-post calculations of the build margin emission factor.

- $EF_{EL,m,y}$ is the emission factor of plant m in $kgCO_2$/MWh fuel i, of the set of plants selected for the calculation of the build margin emission factor and it is obtained from equation 1
- $EG_{m,y}$ is the quantity of energy generated by plant m in year y, This calculation uses the annual plant generation information, provided by the CND through the NEON system

The same units described for OM emission factor calculations have been applied for the equation.

For the year 2007, following the previous steps, we have obtained the following build margin emission factor:

$EF_{grid,BM,2007}$ = 0.237 $kgCO_2$/kWh

Appendix 4 includes more information about the calculations that have been carried out.

c) Combined margin emission factor ($EF_{grid,CM,y}$)

The baseline emission factor (EF_y) is obtained with the combination of the operating and build margin emission factors:

$$EF_{grid,CM,y} = w_{OM} \times EF_{grid,OM,y} + w_{BM} \times EF_{grid,BM,y}$$ **[Equation 5]**

Where:

- $EF_{grid,CM,y}$ is the baseline emission factor during year y
- w_{OM} is the weight of the operating margin emission factor, A value of 0.5 has been taken. For the second and third crediting period this factor has a value of 0.25.
- $EF_{grid,OM,y}$ is obtained in Equation 3
- w_{BM} is the weight of the build margin emission factor. A value of 0.5 has been taken. For the second and third crediting period this factor has a value of 0.75.
- $EF_{grid,BM,y}$ is obtained in Equation 4

The following global emission factor is obtained with the combination of the aforesaid factors for 2007:

$EF_{grid, CM,2007}$ = 0.353 $kgCO_2$/kWh

B.6.2. Data and parameters fixed ex ante

Data/Parameter	$EF_{CO2,i,y}$
Data unit	kg CO_2/TJ
Description	CO2 emission factor of fossil fuel type i in year y
Source of data	Table 1.4 on page 1.23 of the document “2006 IPPC Guidelines for National Greenhouse Gas Inventories”. Chapter 1, Volume 2, taking the lowest value for a confidence level of 95%
Value(s) applied	See Appendix 4
Choice of data or measurement methods and procedures	Document “Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual” does not provide specific emission factors per thermal energy unit for Colombia, so that the general values stated in Volume 2 of the “2006 IPPC Guidelines for National Greenhouse Gas Inventories” have been used
Purpose of data	-
Additional comment	These values will be revised when relevant bibliography is available

Data/Parameter	Installed capacity of the Hydroelectric Power Plant of Bajo Tuluá
Data unit	MW
Description	-
Source of data	EPSA S.A. E.S.P.
Value(s) applied	23.5
Choice of data or measurement methods and procedures	-
Purpose of data	-
Additional comment	-

B.6.3. Ex ante calculation of emission reductions

The ex-ante calculations for the reduction of emissions are the following:

$$ER_y = BE_y - PE_y - L_y \quad \textbf{[Equation 7]}$$

Where:

- ER_y is the reduction of emissions (tCO_2e) during year y
- BE_y are the baseline emissions during year y
- PE_y are the project emissions during year y
- L_y represents the emissions due to leakages during year y

In accordance with the ACM0002 / version 10 methodology, there are no forecasted project emissions related to the generation of energy based on renewable sources (PE=0). Likewise, the emissions caused by leakages are very low (L_y =0), since the plant will not have a water reservoir, so that they should not be calculated.

Therefore, the calculation of the reduction of emissions only takes into account the baseline emissions. Its calculation will be carried out in accordance with the procedure stated in section B.6.1.

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

During the first seven-year crediting period, the project has a reduction potential of 41,430 tCO_2/year. According to the version 02 of the document "Tools to calculate the emission factor for an electric system" included in the ACM0002/ Version 10 methodology.

Based on the data we already know, we estimate that the following reduction in emissions will be attained during the first crediting period of the project activity:

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
2011 (from 29th November 2011)	3,452	0	0	3,452
2012	41,430	0	0	41,430
2013	41,430	0	0	41,430
2014	41,430	0	0	41,430
2015	41,430	0	0	41,430
2016	41,430	0	0	41,430
2017	41,430	0	0	41,430
2018 (up to 29th November 2018)	37,978	0	0	37,978
Total	290,010	0	0	290,010
Total number of crediting years	7 (renewable twice until 21 years are completed)			
Annual average over the crediting period	41,430	0	0	41,430

B.7. Monitoring plan

The project uses the approved ACM0002 monitoring methodology "Consolidated monitoring methodology for zero-emissions grid-connected electricity generation from renewable sources", version 10, May 28, 2009. In the case of the Minor Power Plant of Bajo Tuluá[17], this document establishes that the following data must be monitored:

1. Electricity generated by the project's activity
2. Data required to recalculate the operating margin emission factor
3. Data required to recalculate the build margin emission factor

All data required for the verification and issue of CERs will be stored in electronic format during at least two years after the end of the crediting period or the last issue of CERs for the project.

EPSA has a Quality Improvement System that has been certified by the ISO 9001 standard and is applied to the Energy Generation, Transmission, Distribution and Retail Marketing processes, as well as Diverting Processes and Support Processes that could have an impact on the quality of the products or services supplied by EPSA, E.S.P. To ensure employee training the procedure PR.GRH.07.002, "Procedure for the Develop of Competencies" is available.

The general operation of the plant of Bajo Tuluá and the Monitoring Plan for the reduction of GHG emissions will be integrated within the System, being subject to an audit by a third part that will guarantee its correct implementation.

B.7.1. Data and parameters to be monitored

Data/Parameter	$EG_{BajoTulua, y}$
Data unit	kWh
Description	Quantity of net electricity generation supplied by the project "Hydroelectric Power Plant of Bajo Tuluá" to the grid in the year y.
Source of data	It will be measured every hour by EPSA,
Value(s) applied	117,400,000 kWh/ year.
Measurement methods and procedures	-
Monitoring frequency	The quantity of energy generated will be monitored by EPSA each hour. The data obtained will be recorded once a month on a spreadsheet. In addition, the data will also be provided by the NEON system, which will be downloaded annually and recorded on a different spreadsheet
QA/QC procedures	The measurement units of the energy transferred from the plant to the network will be calibrated periodically in accordance with the standards established by the national authorities. The measurement data registered by the personnel of EPSA will be compared with the data provided by the NEON system to detect possible error. There is the procedure PR.PRO.03.0001, "Procedure for control of the production equipment", to carry out the calibration and verification (internal and external) of measuring equipment.
Purpose of data	-
Additional comment	-

Data/Parameter	$EG_{n, y}$, $EG_{n, y}$

[17] This plant does not have a reservoir or water reserve to operate during at least 10 days.

Data unit	kWh
Description	Net electricity generated and supplied to the National Interconnected System of Colombia by plant n or k during the year y, where k are plants low-cost/must-run and n are other power sources.
Source of data	NEON system
Value(s) applied	The data obtained from the NEON system and corresponding to the year 2007 have been applied. It has conducted the annual amount of generation from all low-cost/must-run plants and the others plants, obtaining a value of: Low-cost/must-run (kWh): 44,340,373,748.6 Thermal (kWh): 9,325,288,821.6
Measurement methods and procedures	-
Monitoring frequency	The quantity of energy generated by the power plants during the year is registered in the NEON System as "Real Generation". This system will be accessed once a year to download data, which will be stored in an electronic spreadsheet. It should take into account each year adding new power plants and their typology
QA/QC procedures	The hourly data of the total generation of the system and the hourly data corresponding to each plant will be downloaded. The sum of all individual data will be checked, in order to ensure that it is similar to the total system generation data. In case there are differences between the two types of data, the reasons and sources will be analysed and errors will be corrected
Purpose of data	-
Additional comment	Plants n will be used for the calculation of the operating margin emission factor and plants m will be used for the calculation of the build margin emission factor. The calculation of the operating margin emission factor will not use the "Real generation" data directly, but rather that of energy that can be shifted, i,e,, that generated with a flexible approach and which can thus be shifted by the generation of the project activity. This piece of data is calculated automatically by the spreadsheets designed to monitor the project, based on the procedure stated in Appendix 4 of this document

Data/Parameter	$EG_{grid,\ y}$
Data unit	kWh
Description	Net electricity generated and supplied to the National Interconnected System of Colombia by all power sources.
Source of data	NEON system
Value(s) applied	The data obtained from the NEON system and corresponding to each hour of the year 2007 have been applied
Measurement methods and procedures	-
Monitoring frequency	The quantity of energy generated by the System is registered in the NEON System as "Real Generation". This system will be accessed once a year to download data, which will be stored in an electronic spreadsheet
QA/QC procedures	-
Purpose of data	-
Additional comment	-

Data/Parameter	(m)
Data unit	Text
Description	Identification of the plants for the calculation of the build margin emission Factor
Source of data	Regulator of the electricity market (currently the Associated Services Management, XM Compañía de Expertos en Mercados S.A. E.S.P.)
Value(s) applied	The data has been provided by XM for the ex-ante calculations (see Appendix 4)

Measurement methods and procedures	-
Monitoring frequency	The information about new plants built and those commissioned in the National Interconnected System of Colombia will be gathered each year. The data will be registered in an electronic spreadsheet
QA/QC procedures	Comparison of the plants used in previous years to detect potential errors. The differences found will be analysed one by one
Purpose of data	-
Additional comment	The NEON system can be used to detect the plants that have been in operation throughout a year, so that we can assess the plants that have been operating. However, these can be repotentiated, refurbished, have modified their name, etc. Therefore, the first option of such data will be requested once a year to the electricity market regulator. In case the data is not obtained from this source, it will be requested to NEON to establish the plants that can be included in the calculation of the build margin emission factor

Data/Parameter	η_{m},y, Average net energy conversion efficiency of power unit m in year y
Data unit	%
Description	Heat Rate in MBTU/MWh of the different plants connected to the National Interconnected System of Colombia is provided by the “Dirección Servicios Asociados, XM Compañía de Expertos en Mercados S.A. E.S.P.”, but this information is not provided for cogeneration. So, for cogeneration using bagasse fuel, fuel oil and coal + bagasse have been selected the heat rates “Promedios horarios de emission para el cálculo de la metodología consolidada de línea base ACM002 para proyectos de generación de escala completa” published by the Energy Mining Planning Unit of the Ministry of Mines and Energy of the Republic of Colombia. For cogeneration using coal as fuel and gas has been taken respectively the average value of all Colombian centrals that use such fuels.
Source of data	Associated Services Management, XM Compañía de Expertos en Mercados S.A. E.S.P.
Value(s) applied	See Appendix 4
Measurement methods and procedures	The unit of the data provided by the “Dirección Servicios Asociados, XM Compñía de Expertos en Mercados S.A. E.S.P.” concerning the heat rate of each power plants is MBTU / MWh. Through a change of units, according to the conversions indicated in the spreadsheet for calculating the operating margin emission factor (first sheet, FE power station), whose detailed explanation is found in Appendix 5 of this document, the average efficiency of each of central of the Colombian Interconnected System is obtained.
Monitoring frequency	-
QA/QC procedures	-
Purpose of data	-
Additional comment	The data will be updated in accordance with the latest information facilitated by the Colombian electricity authorities. In the case of cogeneration, their information will be request and a new update of the document that has been extracted will be sought.

Data/Parameter	$EF_{El,m,y}$
Data unit	$kgCO_2$/KWh
Description	Emission factor of each plant, in accordance with the type and characteristics of the fuel used to obtain energy
Source of data	-
Value(s) applied	See Appendix 4
Measurement methods and procedures	-
Monitoring frequency	It will be calculated once a year with the application of Equation 1 of section B.6.1.
QA/QC procedures	-

Purpose of data	-
Additional comment	The data will be updated in accordance with the latest information facilitated by the Colombian electricity authorities

Data/Parameter	$EF_{grid,OM,y}$
Data unit	kg CO_2/kWh
Description	Operating margin emission factor
Source of data	-
Value(s) applied	0.469
Measurement methods and procedures	-
Monitoring frequency	Calculated once a year, as specified in section B.6.1.
QA/QC procedures	-
Purpose of data	-
Additional comment	-

Data/Parameter	$EF_{grid,BM,y}$
Data unit	kg CO_2/kWh
Description	Build margin emission factor
Source of data	-
Value(s) applied	0.237
Measurement methods and procedures	-
Monitoring frequency	Calculated once a year, as specified in section B.6.1.
QA/QC procedures	-
Purpose of data	-
Additional comment	-

Data/Parameter	$EF_{grid,CM,y}$
Data unit	kg CO_2/kWh
Description	Baseline emission factor
Source of data	-
Value(s) applied	0.353
Measurement methods and procedures	-
Monitoring frequency	Calculated once a year, as specified in section B.6.1.
QA/QC procedures	-
Purpose of data	-
Additional comment	-

Data/Parameter	Social and environmental investments
Data unit	USD (COP)
Description	Investments in social and environmental projects in local communities
Source of data	-
Value(s) applied	-
Measurement methods and procedures	-
Monitoring frequency	The information will be counted once a year according with registries obtained from expenditure and will be noted and recorded the amount for each project

QA/QC procedures	The implementation will carry out in accordance with the commitments that EPSA will acquire with the community during the operation stage, once obtained the approval of the project as a CDM. Others voluntary investment projects different from those derived from the sale of certified emission reductions will agree with the commitments acquired by EPSA after socialization meetings
Purpose of data	-
Additional comment	-

Data/Parameter	Investments related to obtaining CERs
Data unit	USD (COP)
Description	USD (COP) for environmental projects over the total USD (POP) obtained by CERs generated by the project
Source of data	-
Value(s) applied	-
Measurement methods and procedures	-
Monitoring frequency	The information will be counted once a year according with registries obtained from expenditure
QA/QC procedures	-
Purpose of data	-
Additional comment	EPSA will study with the local communities to assign a percentage of the profits in: reforestation, improvement of biodiversity in the basin, in accordance with the projects of the POMCH, PBOT, Municipal Development Plan and approved by the competent authorities, in accordance with the validation of the communities of the area of influence of the project

B.7.2. Sampling plan

B.7.3. Other elements of monitoring plan

Description of the monitoring plan:

This section describes the tasks that will be developed with the purpose of carrying out the regular monitoring of the project activity. In this sense, a monitoring plan has been designed with the purpose of guaranteeing that the project activity is correctly organised from the start, in terms of data gathering and maintenance, as required to obtain realistic GHG emission data.

Therefore, the Supervisor of the project activity maintenance tasks will be defined prior to the start of the crediting period, who shall assume the development and execution of the monitoring plan.

To obtain the measurements required, the project activity will be supervised throughout the crediting period with the measurement systems that will provide the official flow, energy and power measures.

The Minor Hydroelectric Power Plant of Bajo Tuluá shall deliver its energy to the interconnected system in the sub-station of Tuluá, which is where the commercial frontier registered with the Administrator of the electrical interconnected system - XM- will be established. The information will be recorded each day by a measurement unit with a precision of 0.2 and the active energy dispatched the previous day must be reported at 8:00 in the morning.

The energy control department will be responsible for the maintenance and supervision of the measurement equipment, which will monitor the deviations presented with its verification and energy balancing systems.

The complete revision of the measurement equipment is carried out once a year and the industrial measurement area is in charge of coordinating these processes with the production management area.

To guarantee the ecologic flow in the river section, two measurements will be taken: one will measure the total flow before its collection and the other one will be taken in the bypass channel. The difference between these values will give the natural river flow volume. To guarantee that the ecologic flow is 22% of the total before its collection, the measurements taken on these two points will be recorded on a system that is in charge of processing the information and adjusting the gate automatically to guarantee the flows required.

The plant will have all equipment required for the instantaneous measurement of the active and apparent power, power levels, current per phase, power factor and energy delivered per turbine generator group, These measurements will be local and remote from the EPSA E.S.P. control centre.

Likewise, the Plant's Operation Reports will be used as a reference and be made available for any inspections carried out during the crediting period, including the following aspects:

- Annual electricity production, broken down by month, which will become part of the Plant Operation Log, with all real and reactive power production data.

- Annual and monthly plant factor.

- Maximum annual and monthly demand.

- Annual and monthly load factor.

- Annual and monthly consumption of turbines.

- Relevant events during the year.

The Project Manager will be responsible for the implementation and update of all data and parameters monitored, included in the previous section, ensuring that the emission reduction calculations obtained are realistic and based on evidence. Likewise, said Supervisor will be in periodical contact with the person responsible for the execution of the Environmental Handling Plant of the Minor Hydroelectric Power Plant of Bajo Tuluá, with the purpose of guaranteeing the execution of the project and that it contributes to the social and environmental development of the Cauca Valley.

In addition, the following data which are necessary to calculate the baseline will be downloaded annually from the NEON system:

- Quantity of electricity generated by the Minor Hydroelectric Power Plant of Bajo Tuluá each hour. The measurement data registered by the personnel of EPSA will be compared with the data provided by the NEON system to detect possible error.
- Annual electricity generated by each plant of the National Interconnected System of Colombia.
- Electricity generated by the National Interconnected System of Colombian hourly.
- New plants built and those commissioned in the National Interconnected System of Colombia, in order to update the list of the plants that can be included in the calculation of the build margin emission factor. This data will be downloaded from the NEON system if the Electricity Market Regulator does not provide such information.

Annually, it will also be updated the calculation of:

- Annual electricity generated by low-cost/must-run power plants and the rest of the power plants.
- Average net energy conversion efficiency each power unit. For this, it is necessary to update the information about the heat rate of each power plant connected to the SIC that is provided

by the *“Dirección de Servicios Asociados, XM Compañía de Expertos en Mercados S.A. E.S.P.”*, especially in the case of the cogeneration for which data is not provided and it has been found in different sources as detailed in section B.7.1.

- Emission factor of each plant.
- Operating margin emission factor.
- Build margin emission factor.
- Baseline emission factor.

A set of spreadsheets has been designed to automate the process for the calculation of the emission factors with the purpose of facilitating the calculations required in the follow-up and monitoring tasks, which will be analysed in Appendix 5 of this document. The successive calculation of the reduction of emissions in these spreadsheets will be summarised in monitoring and follow-up reports that will be subject to third-party verification.

All data and parameters will be recorded in accordance with the quality systems of the companies participating in the project, with their corresponding quality control and assurance procedures, Likewise, there will be a record of the Power Plant Operation reports, in accordance with these procedures.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

15/01/2009

C.2. Expected operational lifetime of project activity

50 years and 0 months

C.3. Crediting period of project activity

C.3.1. Type of crediting period

Renewable crediting period and first crediting period

C.3.2. Start date of crediting period

29/11/2011

C.3.3. Duration of crediting period

7 years and 0 years

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

The impacts of the Minor Hydroelectric Power Plant of Bajo Tuluá in the area of construction of the project have been assessed methodologically in four different scenarios or periods:

a) during the current period, when the cumulative existing impacts were identified
b) during the construction period
c) during the operation period
d) during the closing and abandonment period

The identification and assessment of each impact associated to each project stage is structured by the correlation between the project activities with the components and processes of the environment.

During the previous period to the construction, identified impacts are the affectation of economic activities, generation of employment, restriction of use in small rural properties, generation of expectation and conflicts caused by disinformation

The potential impacts associated to the geological issues in the construction of the project are associated to: destabilisation of natural embankments, landfills, dump sites, mass clearing during excavations; and are associated to the following water issues: alteration of underground drainages, quality of water, use of this natural resource for leisure purposes; and they are also associated to the quality of air as regards: increase in particles, gases and noise. The terrestrial and aquatic niches of the biota can also be affected. The socio-economic component is especially affected by the displacement caused during the construction works, as in the case of a small increase in the demand for services of the labour population and the effects on the historic cultural resources of the subsoil.

The impacts associated to the operation are thus associated to the bypassing of the flow and some unexpected implications of the hydroelectric generation activity,

A table where the main identified impacts are detailed as well as the associated control program proposed in the environmental handling plan is showed next:

IDENTIFIED ENVIRONMENTAL IMPACTS		HANDLING - PROGRAMS
PHYSICAL	Loss of land due to construction	Land handling program
	Alteration of the flow's regime of the Tuluá River	Operating handling program
	Alteration of the ground-water level due to the tunnel construction	
	Morphological changes and river's bed degradation in the Tuluá River	
	Alteration of the water quality of the Tuluá River	Water quality handling program Handling of areas of excavation's excess deposit program Solid waste handling program Restoration in areas of temporal use handling program
	Generation of potentially unstable areas	Handling of potentially unstable areas and grounds program
	Alteration of air and noise quality	Air and noise quality handling program
	Generation of excavation's residues	Handling of areas of excavation's excess deposit program
	Generation of domestic and industrial solid waste	Solid waste handling program
BIOTIC	Vegetable coverage loss	Vegetable coverage handling program Handling of grounds program Handling of areas of excavation's excess deposit program Material's sources handling program
	Affectation of land fauna	Land habitats handling program Vegetable coverage handling program
	Alteration of hydro-biologic communities	Water quality handling program Handling of areas of excavation's excess deposit program Solid waste handling program Hydro-biologic communities handling program
SOCIAL	Affectation of agricultural and economic activities	Help and reestablishment of agricultural activities program Institutional and territorial strengthening program
	Affectation of land's use in small properties	Help and reestablishment of agricultural activities program

	Temporal generation of employment	Employment policy program
	Generation of expectations and conflicts	Information and participation program Institutional and territorial strengthening program
	Alteration and loss of the archaeological patrimony	Preventive archaeology program

The existing and potential impacts can be analysed to structure and optimise the Handling Plan, with the purpose of giving coverage and even mitigating the potential negative impacts and turning them into socially and environmentally positive products. The Handling Plan has been drafted to guarantee the environmental sustainability of the project and the environment where it will be located and operated. In addition, the Handling Plan will be structured in a series of technical handling files and a six-monthly chronogram for the construction, operation and dismantling stages. The total cost of the environmental handling plan during the construction and operation stages, projected in 5 years, will be 2,518,320,127 pesos.

D.2. Environmental impact assessment

EPSA S.A. E.S.P., Empresa de Energía de Pacífico, requested Ingetec S.A. the "Environmental Impact Assessment of the Minor Hydroelectric Power Plant of Bajo Tuluá", which has been used to define the prevention and mitigation measures, as well as the projects required to control, compensate and prevent the negative impacts and effects that the project generates, in addition to maximising the positive impacts derived from the construction of the Minor Hydraulic Power Plant. In addition, it is aimed at guaranteeing the correct use of resources and minimise (or avoid, when possible) their negative impact.

The Environmental Impact Assessment includes the Environmental Handling Plan, Monitoring Plan, Contingency Plan and Abandonment and Recovery Plan.

The EHP is structured in a series of technical handling files, including the following: objective, aim, project's stage, environmental impact to control, measure, action plan, application's place, population that will benefit, monitoring supervisors, chronogram, quantification and costs. It is also detailed the Socio-Environmental Management Unit of the Project (*Unidad de Gestión Socio-Ambiental del Proyecto, UGSA*) who will guarantee that the proposed objectives of the different programs included in the EHP are carried out.

The environmental and social handling plans are formulated to establish the strategies and activities which allow to reduce, prevent and mitigate the impacts generated by the project. The Environmental Handling Plan includes 7 control programs concerning the physical component, 2 programs concerning the biotic component and 5 programs concerning the socioeconomic component, according to:

- Physical Component:
    - Liquid residues handling program
    - Handling of potentially unstable areas and land program
    - Handling of areas of excavation's excess deposit program
    - Operating handling of the captation program
    - Solid waste handling program o Air and noise quality handling program
    - Restoration in areas of temporal use handling program
- Biotic Component:
    - Vegetable coverage and land habitats handling program
    - Hydro-biologic communities handling program
- Socioeconomic Component:
    - Help and reestablishment of agricultural activities program
    - Employment policy program
    - Information and participation program
    - Institutional and territorial strengthening program
    - Preventive archaeology program
        - I. Basic archaeology subprogram

II. Archaeological spreading subprogram

The total cost of the environmental handling plan is 2,518,320,127 pesos.

The monitoring plan allows the supervision and the feedback of the actions applied in the development of the environmental handling plan. These monitoring programs consider the physical, biotic and socioeconomic component and each program is structured including: objective, handled impacts, affected systems and components, impact's handling measures and monitoring measures with its activities and indicators. The following actions are included:

- Physical component:
  - Disposal of excavation's excess and erosive process monitoring program: residues disposal in the river bed is not allowed, not only in compliance with the restricted use of the area, but also to avoid their destabilization or dragging by a torrential rising tide of the river[18].
  - Air and noise quality program
  - Domestic and dangerous solid waste's disposal monitoring program
  - Level of currents that are affected by the construction of the tunnel monitoring program
- Biotic component:
  - Vegetable coverage and land habitats monitoring program: in the EIA it has been identified that the ecosystem in the project's area is composed by a tropical dry forest or *subserofítico and subandino*. Vegetation is open with pasture, shrub and dispersed small trees with small and coraceas leafs, usually thorny. This ecosystem is identified in a national level as a priority one in which it is necessary to develop conservation actions (*Plan de Acción Nacional de Lucha contra la Desertifiación y la Sequía en Colombia*). In the project's area there are no protected areas of a National order. However, there are local and municipals process such as the Jicaramata enclave, which is identified in the Tuluá's POT and in the process of prioritizing local process for the north centre table of the Protected Areas Departmental System (*Sistema Departamental de Áreas Protegidas, SIDAP*). In addition, the National Forest Reserve of Tuluá is in the project's influenced areas. Therefore, if this area is affected it is necessary to go to the Ministry, who has the duty of verificating, assessing and approving any process that modifies these National Reserves.
  - Hydro-biologic communities and water quality monitoring program: after studying the ichthyology of the river, it was concluded that the only specie with an ecologic significance was the Sabatela, which is migratory specie able to overcome 1.50 metres high obstacles and which swims upriver to reproduce during the rainy season. Other identified species are Tarpon, Leporinus, Brycon and Astvanax. The dam is not designed to allow the Sabatela's jumps but to allow and make easier its upriver's going during its normal migration. Once the construction of the structure that allows the fish's pass starts, it will be directly observed to assess the effectiveness of said structure and the possible improvements that could be carried out in case there is any difficulty during the operation. In addition, the environmental license establishes it is necessary to restock the middle and low part of the Tuluá River with 10,000 specimens of young Sabatela (Brycon henni).[19]
- Socioeconomic component: }
  - Monitoring of the information and participation program
  - Monitoring of the institutional and territorial strengthening program
  - Monitoring of the help and reestablishment of agricultural activities program
  - Monitoring of the labour's entailment and employment policy program
  - Monitoring of the Preventive archaeology program

---

[18] See Environmental License (Annex 5, reference 4, pg 40) or Memorandum No. 0660-09-52936-2008-01, October 31, 2008

[19] See Environmental License (Annex 5, referente 4, pg 31)

The total cost associated with the monitoring program of the environmental management plan for the project of Bajo Tuluá is 556,834,150 pesos,

The eventuality plan presents the identification of the extern and intern dangers, the evaluation of these dangers, the vulnerability and the level of risk, and finally it formulates the contingency plan with its requirements, answers and it identifies the emergency scenes for the project. Threats that can affect the projects have a natural or an anthropic cause. Natural threats are seismic threat (earth tremor and earthquakes), geotechnical threat (landslide and collapse) and the hydrologic threat (excessive rains, flooding); anthropic threats are for instance inappropriate constructive procedures, bad relationships with community and workers and unfavourable political situations in both fields regional and national. There are 8 contingency plans in total:

- Contingency plan for earthquakes
- Contingency plan for landslide and collapse
- Contingency plan for flooding
- Contingency plan for fires and explosions
- Contingency plan for spillage of fuel
- Contingency plan for failure in the diesel storage tanks
- Contingency plan for terrorism and public order
- Public health contingency plan

The direct cost associated with the purchase of necessary equipment to implement the contingency plans is 286.9 millions of pesos.

Finally, the abandonment and recovery plan presents two programs, each of them with its: objectives, aims, stages, environmental impacts, measures, actions to develop, supervisor and chronograms. These programs are:

- Program of dismantling and use of the areas and installations of the project at the end of operation.
- Program of closing of the social management.

The Environmental Handling Plan for the Minor Hydroelectric Power plant of Bajo Tuluá has been approved by the CVC (competent environmental authority) and is integrated within the Environmental Impact Study which has also been approved.

The resolution 0100 No. 0730-0606 dated November 14, 2008 gives the Environmental License to Empresa de Energía del Pacífico S.A. E.S.P. – EPSA E.S.P.. for the project of the “Minor Hydroelectric Power Plant Bajo Tuluá 1440”. The resolution clarifies aspects relating to “license of surface water”, “permit for continued occupation of channels”, ,“dumping permit”, “atmospheric emissions by fixed sources permit”, “forestall exploitation authorization”, “access paths” and “Clean Development Mechanisms”

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

Different socialisation meetings were held with the communities within the direct and indirect area of influence of the project during the drafting of the Environmental Impact Assessment of the Project of the Minor Hydroelectric Power Plant of Bajo Tuluá to draw up the design, impact and environmental handling plan studies, the Kyoto Protocol and the projects under the CDM modality.

During the fieldwork and within the consultation with the authorities, neither ethnic communities nor collective territories were found.

This approchement to the local authorities materialised in informative meetings of the project called by EPSA and INGETEC S.A., with the participation of the chairmen of the community action

committees of each borough, the mayors and some secretaries of the municipalities of Tuluá, Buga and San Pedro, councilors and the CVC

The following was addressed during each meeting:

- The general technical characteristics and scope of the project, both in terms of the works and potential impacts
- The environmental impact studies required by the Colombian legislation, which were presented to the Competent Environmental Authority for their analysis and decision
- Results of the environmental impact studies and the Environmental Handling Plan (EHP)
- The potential compensatory, voluntary and legal projects
- The possible CDM projects

A total of eighteen information and project validation meetings were held with the communities, as shown on the following table:

Meeting No,	Place	Participating Community	Issues/ Meeting Activity	Date
1	EPSA Auditory-Tuluá	San Marcos Community, La Esmeralda	Information and participation about the project	May 28, 2007
2	Office of the City Hall of San Pedro	City Hall of San Pedro	Information and participation about the project	June 25, 2007
3	Community House	La Siria School and Communities of Crucero Nogales, La Esmeralda and La Siria	Information and participation about the project	July 1, 2007
4	Monteloro Community House	Communities of Monterolo, Piedritas, La Diadema, San Marcos and La Mansión	Information and participation about the project	July 2, 2007
5	EPSA Auditory-Tuluá	Community of La Esmeralda	Information and participation about the project	July 5, 2007
6	EPSA Auditory-Tuluá	Community of La Esmeralda	Delivery of La Esmeralda community notification	July 12, 2007
7	Río Frío plant and EPSA Auditory-Tuluá	Community of Monteloro	Visit to the Río Frío plant and information and participation about the project	July 16, 2007
8	Río Frío plant and EPSA Auditory-Tuluá	Communities of Monteloro, San Marcos and Crucero Nogales	Visit to the Río Frío plant and information and participation about the project	July 21, 2007
9	La Siria school	La Sirira, Esmeralda, Crucero Nogales, La Florida	Socialization of the project and visit to Río Frío II plant	September 5, 2007
10	El Placer school	Communities of El Placer, Crucero Nogales, Los Bancos, Florida, Rosario and Beachs of San Agustín	Presentation and analysis of the advances of EIA	January 12, 2008
11	Los Bancos School	Communities of Florida, La Mesa, Los Bancos, Rosario and San Agustín	Presentation and analysis of the advances of EIA	January 27, 2008
12	Río Frío plant and EPSA Auditory-Tuluá	Town Hall and Municipal Council of Tuluá	Visit and presentation of	April 1, 2008

			initial results of EIA	
13	Río Frío plant and EPSA Auditory-Tuluá	Town Hall and Municipal Council of San Pedro	Visit and presentation of initial results of EIA	April 2, 2008
14	Community Hall of Monteloro	Communities of Monteloro, Piedritas and San Marcos	Presentation and analysis of the initial results of EIA	April 5, 2008
15	El Picacho School	Communities of El Brasil, El Picacho, La Ribera, La Coca, El Vergel and Marabeles	Presentation and analysis of the initial results of EIA	April 6, 2008
16	Río Frío plant and EPSA auditory-Tuluá	Town Hall and Municipal Council of Buga	Visit and presentation of initial results of EIA	April 9, 2008
17	El Placer School	Communities of Crucero Nogales, Los Bancos, Jicaramata, El Placer, Florida and Rosario	Presentation and analysis of initial results of EIA	April 12, 2008
18	La Esmeralda School	Communities of La Altania, La Esmeralda and La Siria	Presentation and analysis of initial results of EIA	April 13, 2008

Participants of these meetings were representatives of the different institutions such as the CVC, the Municipal Town Council, Municipal council, Leaders, Community action committees and associations of the communities that belong to the area of influence of the project. These meetings showed how important the project was for them, as an opportunity for the development of the region and improvement in the standard of living of the population.

E.2. Summary of comments received

The communities have openly expressed their understanding of the project, having been informed about its dimensions, scope and opportunities. In addition, they consider that the Environmental Handling Plan has included all aspects that are sensitive to the project receiving environment and have designed the adequate measures to mitigate, correct and/or avoid these potential impacts.

The list of the main issues about the project that were treated in the meetings held, as well as questions, concerns, explanations of the communities and contributions about the knowledge of the area and the hydroelectric project proposed, is shown next:

- Places for materials from the excavation
- Profit for the communities derived from the project
- Use of the water in the project- Ecologic flow
- Reforestation of the Tuluá river basin
- Access paths: rehabilitation, maintenance and new ones.
- Jobs and policy of the company
- Energy for the paths
- Supply of resources that must been transferred by law in order to help the investment's projects that are defined in the development plans (aqueducts, water treatment plants, etc)
- Take care of impacts and effects that are derived from the build and operating activities
- Differences between the Social Management Plan in the EHP of the project and the voluntary investment programs of the company derived from its responsibility policy.

E.3. Consideration of comments received

The law establishes a plan of a 1% investment in the unique paragraph of the Article 43, law 99 dated 1993 "… All project that will use water taken directly from natural sources for human consumption, entertainment, irrigation or any industrial or agricultural activity, must spend no less than 1% of the total investment for the restoration, preservation and control of the hydrographic basin which is the water source…".

In accordance with the 1% law, the EPSA company, based on the projects identified and prioritised in the meetings held with the communities and their representatives, is committed to the following:

- Provide economic support to the program that supports the formulation of the handling plan of the Tuluá river basin, including:
    - Support to restoration, conservation and protection programs of the territorial flora in the tributaries basins.
    - Project for the stabilization of sectors subject to erosion.
    - Environmental training by: strengthening of the ecologic groups, PRAES's advise and formation of teaching staff.
    - Institutional strengthening of the cleaning up policies of the municipal town halls.

- The economic resources of the previous program will amount to an inversion of 642,340,000 pesos.
- Respect the priorities in the use of water, in accordance with the current regulations, whereby human consumption will be the main priority.
- In case the Project of the Minor Hydroelectric Power Plant of Bajo Tuluá 1440 obtains the reduced emission certificates, EPSA is able to study with the local communities to assign a percentage of the profits in: reforestation, improvement of biodiversity in the basin, in accordance with the projects of the POMCH, PBOT, Municipal Development Plan and approved by the competent authorities, in accordance with the validation of the communities of the area of influence of the project. The potential benefits can be executed while the plant is producing energy and for a limited period of time, as established in the protocol.

SECTION F. Approval and authorization

The Letter of Approval was issued in 15/07/2009 by the Colombian DNA.

Appendix 1. Contact information of project participants

Organization name	Empresa de Energía del pacifico S.A. E.S.P
Country	Colombia
Address	Calle 15 #29B-30 Autopista Cali - Yumbo
Telephone	3210070
Fax	3210000 op, 8 ext, 52083
E-mail	pelondono@epsa.com.co
Website	www.epsa.com.co
Contact person	Pablo Emilio Londoño Blandón

Organization name	GAS NATURAL SDG
Country	España
Address	Avda. de América, 38
Telephone	(0034) 91 589 99 73
Fax	(0034) 91 589 33 25
E-mail	rmsanz@gasnatural.com
Website	www.gasnatural.com
Contact person	Rosa María Sanz

Appendix 2. Affirmation regarding public funding

This project does not include Public finance sources.

Appendix 3. Applicability of methodologies and standardized baselines

N/A

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

The emission factors (effective CO_2 emission factor) assumed in all calculations have been obtained from table 1.4, page 1.23 of Document "*2006 IPPC IPPC Guidelines for National Greenhouse Gas Inventories*", taking the lowest value for a confidence level of 95%

CO_2 Emission factors	
Type of fuel	**Effective emission factor (kg/TJ)**
Natural Gas	54,300
Other bituminous carbons	89,500
Sub-bituminous carbon	92,800

Heat rates and type of fuel used in each thermal power plant

Name of the plant	Heat Rate (MBTU/MWh)	Main fuel
Barranquilla 3	11.8104	Gas
Barranquilla 4	11.522	Gas
Cartagena 1	9.6359	Gas
Cartagena 3	13.4904	Gas
Flores 1	12.2191	Gas
Flores 2	12.2715	Gas
Flores 3	9.2513	Gas
Guajira 1	14.3162	Gas
Guajira 2	8.1684	Sub-bituminous carbon
Merieléctrica 1	8.1684	Gas
Paipa 1	6.3751	Sub-bituminous carbon
Paipa 2	9.4663	Sub-bituminous carbon
Paipa 3	7.8000	Sub-bituminous carbon
Paipa 4	10.0025	Sub-bituminous carbon
Palenque 3	9.6021	Gas
Proeléctrica 1	9.9691	Gas
Proeléctrica 3	9.9695	Gas
Tasajero 1	9.5477	Other bituminous carbons
Tebsab	9.6806	Gas
Termocandelaria 1	7.0872	Gas
Termocandelaria 2	9.7103	Gas
Termocentro 1 Ciclo	6.4732	Gas
Termodorada 1	7.3752	Gas
Termoemcali 1	9.8036	Gas
Termosierrab	13.7	Gas
Termovalle 1	6.579	Gas
Termoyopal 1	12.7056	Gas
Zipaemg 2	12.7586	Other bituminous carbons
Zipaemg 3	9.6027	Other bituminous carbons
Zipaemg 4	9.0118	Other bituminous carbons
Zipaemg 5	8.6793	Other bituminous carbons
Termoyopal 2	11.0451	Gas
Termopiedras 1 Gener	12.7057	Sub-bituminous carbon
Morro 1	12.4000	Gas
Morro 2	13.8400	Gas
Cimarrón	13.8400	Gas

Source: Associated Services Management, XM *Compañía de Expertos en Mercados S.A. E.S.P.* In the case of TermoPiedras 1 Generates has been used the average value of the gas-fired heat because its heat rate has not been provided.

Emission factors by plant

The combination of the data of the two tables shown above can be used to obtain the following factors of emission per kWh generated for the thermal power plants.

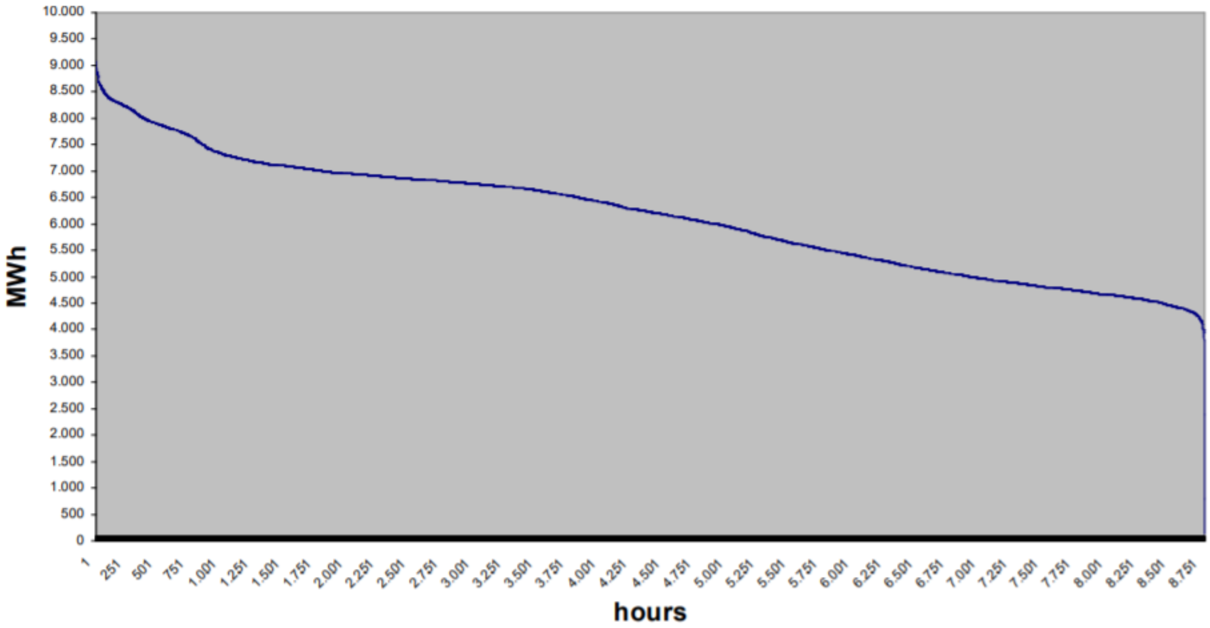
Name of the plant	Emission Factor (kg CO_2/kWh)
Barranquilla 3	0.556
Barranquilla 4	0.571
Cartagena 1	0.677
Cartagena 3	0.660
Flores 1	0.423
Flores 2	0.573
Flores 3	0.550
Guajira 1	0.562
Guajira 2	1.341
Merieléctrica 1	0.552
Paipa 1	1.321

Paipa 2	1.196
Paipa 3	1.202
Paipa 4	0.906
Palenque 3	0.820
Proeléctrica 1	0.468
Proeléctrica 3	0.468
Tasajero 1	0.927
Tebsab	0.447
Termocandelaria 1	0.547
Termocandelaria 2	0.555
Termocentro 1 Ciclo	0.406
Termodorada 1	0.556
Termoemcali 1	0.371
Termosierrab	0.365
Termovalle 1	0.377
Termoyopal 1	0.728
Zipaemg 2	1.205
Zipaemg 3	0.907
Zipaemg 4	0.851
Zipaemg 5	0.820
Termoyopal 2	0.728
Termopiedras 1 Gener	1.081
Morro 1	0.710
Morro 2	0.793
Cimarrón	0,793
Central Tumaco Cogenerador	0.699
Cogen. Ingenio Providencia	0.000
Cogeneración Colteger	1.068
Cogenerador Bioaise	0.570
Cogenerador Central Castilla	0.699
Cogenerador Incauca	0.550
Cogenerador Ingenio Riopaila	0.699
Cogenerador Ingenio Risaralda	0.699
Cogenerador Proenca	0.000

Calculation of λ_y

- Step i: The total hourly generation data of the year are presented, from high to low, in comparison to the total 8,760 hours of the year. Here is the graphs obtained for 2007 in which the operating margin emission factor has been calculated:

LOAD CURVE MWh



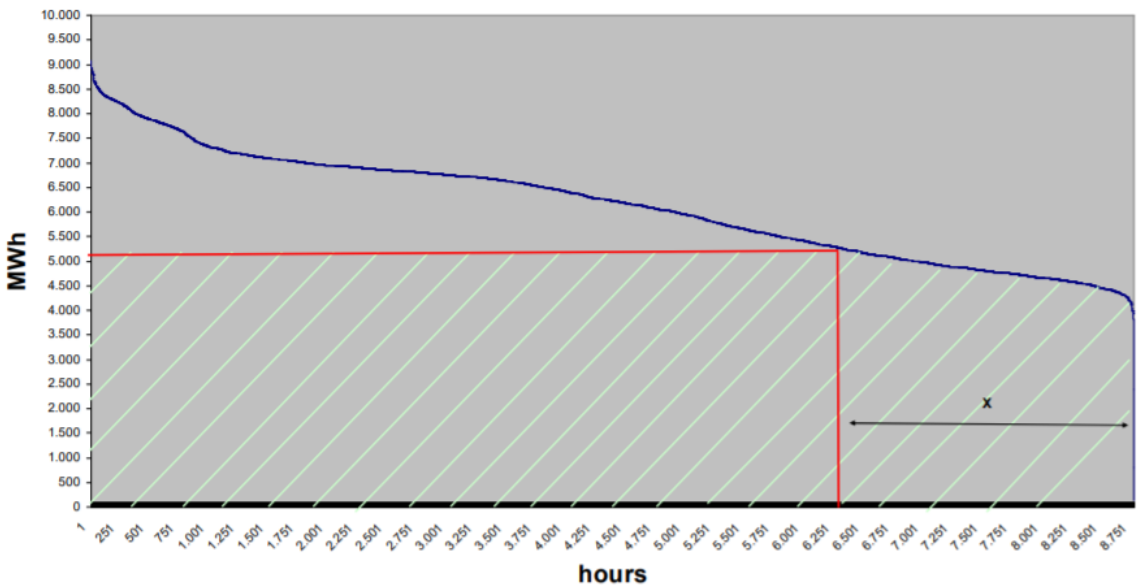
- Step ii: Calculate the total annual generation of low-cost/must-run plants ($\sum_k EG_{k,y}$).

  In accordance with the data for the total generations for the year 2007, the total quantity generated by low-cost/must-run plants (values for $\sum_k EG_{k,y}$) is shown below.

Year	Total Generation (MWh)	$\sum_k EG_{k,y}$ (MWh)
2007	53,665,662.6	44,340,373.75

- Step iii: Draw a horizontal line that crosses the line represented, so that the area under the curve represents the total generation of low-cost/must-run plants ($\sum_k EG_{k,y}$).

LOAD CURVE MWh



- Step iv: Determine value λ_y, taking into account that λ_y is calculated as X/8,760, where X represents the hours on the right of the point of intersection.

$$\lambda_{y\ 2007} = \frac{8{,}760 - 6{,}462}{8{,}760\ hours..per..year} = 0.262$$

Operating margin emission factor

	2007		
POWER PLANT	**kWh**	**$kgCO_2/kWh$**	**$kgCO_2$**
MENOR LA CASCADA-ABEJORRAL	1,515,720.0	0.000	0.00
ALBAN	2,001,690,655.5	0.000	0.00
MENOR AMALFI	2,079,284.0	0.000	0.00
MENOR AMERICA	341,775.0	0.000	0.00
MENOR ASNAZU	3,840,029.0	0.000	0.00
MENOR AYURA	114,959,293.0	0.000	0.00
COGEN, BIOAISE	3,261,010.0	0.570	1,859,437.60
MENOR BELLO	1,901,014.0	0.000	0.00
MENOR BELMONTE	13,864,581.0	0.000	0.00
MENOR EL BOSQUE	7,290,651.0	0.000	0.00
MENOR BAYONA	3,343,468.3	0.000	0.00
COGEN, CENTRAL CASTILLA	4,518,150.3	0.699	3,156,379.78
MENOR COCONUCO	13,821,245.0	0.000	0.00
BETANIA	2,013,310,329.1	0.000	0.00
MENOR CALICHAL	423,168.0	0.000	0.00
CHIVOR	3,997,676,637.1	0.000	0.00
MENOR CIMARRON	31,525,154.12	0.793	24,996,935.02
MENOR CALDERAS	92,320,951.8	0.000	0.00
CALIMA	159,090,107.9	0.000	0.00
COGEN, COLTEJER	2,666.0	1.068	2,846.00
MENOR CEMENTOS DEL NARE	42,805,737.0	0.000	0.00
MENOR CAMPESTRE (EPM)	2,231,054.0	0.000	0.00
MENOR CAMPESTRE (CALARCA)	5,368,415.8	0.000	0.00
MENOR CHARQUITO	53,666,073.0	0.000	0.00
MENOR CARACOLI	19,545,116.0	0.000	0.00
COROZO - SAN MATEO 2 230 KV	0.0	0.000	0.00
MENOR CASCADA	20,853,585.2	0.000	0.00
TERMOCARTAGENA 1	18,205,720.9	0.677	12,318,730.12
TERMOCARTAGENA 2 (INACTIVA)	0.0	0.000	0.00
TERMOCARTAGENA 3	18,277,383.89	0.660	12,065,223.11
MENOR MORRO 1	107,611,427.98	0.710	76,449,303.35
MENOR MORRO 2	7,268,109.59	0.793	5,763,031.72
COGEN, TUMACO	30,824.20	0.699	21,533.79
MENOR DOLORES EPM	46,232,756.00	0.000	0.00
ECUADOR-TULCÁN (ENLACE)	152,960.40	0.000	0.00
ECUADOR-POMASQUI (ENLACE)	38,239,618.71	0.000	0.00
ESMERALDA	189,713,243.87	0.000	0.00
MENOR FLORIDA	88,638,500.00	0.000	0.00
MENOR GUACAICA	6,458,530.00	0.000	0.00
GUATAPE	3,570,426,745.0	0.000	0.00
GUATRON	2,822,997,571.4	0.000	0.00
GUAVIO	5,339,817,742.0	0.000	0.00
MIEL	1,461,814,352.0	0.000	0.00
COGEN, INCAUCA	42,832,681.2	0.550	23,557,974.66

COGEN, INGENIO PROVIDENCIA	1,510,684.0	0.000	0.00
MENOR INSULA	126,705,224.7	0.000	0.00
MENOR INTERMEDIA	6,761,792.5	0.000	0.00
MENOR IQUIRA 1	17,197,056.0	0.000	0.00
MENOR IQUIRA 2	8,763,120.0	0.000	0.00
COGEN, INGENIO RISARALDA	8,660,842.0	0.699	6,050,464.22
JAGUAS	848,160,082.0	0.000	0.00
MENOR JULIO BRAVO	6,451,860.4	0.000	0.00
MENOR LA JUNCA	126,056,329.0	0.000	0.00
MENOR LIBARE	23,830,146.0	0.000	0.00
MENOR EL LIMON	5,731,562.0	0.000	0.00
MENOR EL LIMONAR	87,554,765.0	0.000	0.00
MENOR EL PALO	8,332,084.0	0.000	0.00
LA TASAJERA	1,790,490,036.0	0.000	0.00
MENOR MIROLINDO	17,989,762.0	0.000	0.00
MENOR MUNICIPAL	8,620,980.0	0.000	0.00
MENOR MONDOMO	2,441,225.0	0.000	0.00
MENOR MANANTIALES	13,347,703.0	0.000	0.00
MERILECTRICA 1	55,704,240.0	0.552	30,752,044.20
MENOR NIMA	36,891,465.5	0.000	0.00
MENOR NIQUIA	98,819,667.0	0.000	0.00
MENOR NUTIBARA	2,725,851.0	0.000	0.00
MENOR OVEJAS	7,027,971.0	0.000	0.00
MENOR PIEDRAS BLANCAS	17,468,477.0	0.000	0.00
MENOR PIEDRAS	2,729,535.0	0.000	0.00
PARAISO GUACA	3,565,166,002.0	0.000	0.00
MENOR PAJARITO	29,462,529.0	0.000	0.00
MENOR PALMAS SAN GIL	73,435,302.6	0.000	0.00
PALENQUE 3	606,566.4	0.820	497,507.42
MENOR URRAO	2,531,697.0	0.000	0.00
PLAYAS	1,648,935,288.0	0.000	0.00
MENOR REMEDIOS	982,277.0	0.000	0.00
COGEN, PROENCA	7,334,980.0	0.000	0.00
PAIPA 1	62,726,332.0	1.321	82,854,541.55
PAIPA 2	301,820,617.5	1.196	361,101,856.81
PAIPA 3	295,752,774.5	1.202	355,359,621.37
PAIPA 4	1,003,019,661.0	0.906	908,560,412.07
PORCE II	2,037,516,524.0	0.000	0.00
MENOR PRADO 4	30,958,376.6	0.000	0.00
PRADO	156,885,019.2	0.000	0.00
PROELECTRICA 1	41,656,798.0	0.468	19,494,690.00
PROELECTRICA 2	44,767,748.0	0.468	20,950,562.96
MENOR PASTALES 1	2,669,003.0	0.000	0.00
MENOR LA PITA	10,576,737.0	0.000	0.00
MENOR PATICO - LA CABRERA	5,847,042.0	0.000	0.00
MENOR PUENTE GUILLERMO	5,672,807.0	0.000	0.00
MENOR PTAR	0.0	0.000	0.00
MENOR PROVIDENCIA	15,252,148.0	0.000	0.00
MENOR RIO BOBO	13,485,048.0	0.000	0.00
MENOR LA REBUSCA	3,084,660.0	0.000	0.00
MENOR RIO ABAJO	6,085,050.0	0.000	0.00
MENOR RIO RECIO	2,667,650.0	0.000	0.00
MENOR RIO CALI	13,421,690.9	0.000	0.00
MENOR RIO FRIO I	7,023,536.2	0.000	0.00
MENOR RIO FRIO II	59,812,567.0	0.000	0.00
MENOR RIO GRANDE	2,816,364.0	0.000	0.00
RIOGRANDE	70,661,304.0	0.000	0.00
MENOR RIO INGENIO	70,865.2	0.000	0.00
MENOR RUMOR	15,281,548.7	0.000	0.00
MENOR RIO MAYO	113,586,200.0	0.000	0.00

MENOR RIONEGRO	29,840,217.0	0.000	0.00
MENOR RIO PIEDRAS	152,130,992.8	0.000	0.00
COGEN, INGENIO RIOPAILA	4,450,078.0	0.699	3,108,824.49
MENOR SAN JOSE DE LA MONTAÑA	1,343,483.0	0.000	0.00
MENOR SAJANDI	16,578,359.0	0.000	0.00
MENOR SAN JOSE	2,283,875.8	0.000	0.00
MENOR SILVIA	2,458,524.0	0.000	0.00
SALVAJINA	1,176,788,523.0	0.000	0.00
MENOR SAN CANCIO	12,948,218.1	0.000	0.00
SAN CARLOS	7,216,389,988.0	0.000	0.00
SAN FRANCISCO	261,650,556.4	0.000	0.00
MENOR SONSON	93,095,024.0	0.000	0.00
MENOR RIO SAPUYES	9,764,535.0	0.000	0.00
MENOR SERVITA	3,035,321.4	0.000	0.00
MENOR SUEVA 2	30,919,274.0	0.000	0.00
TERMOBARRANQUILLA 3	25,585,070.2	0.556	14,212,718.39
TERMOBARRANQUILLA 4	23,993,984.8	0.571	13,704,689.79
TEBSA TOTAL	3,894,720,467.8	0.447	1,740,461,208.80
TERMOCANDELARIA 1	156,139,000.0	0.547	85,408,994.83
TERMOCANDELARIA 2	8,756,000.0	0.555	4,856,254.98
TERMODORADA 1	14,402,790.1	0.556	8,012,586.49
TERMOEMCALI 1	11,059,819.4	0.371	4,101,668.08
TERMOFLORES 1	531,514,216.5	0.423	224,585,720.54
TERMOFLORES 2	49,855,176.6	0.573	28,570,133.62
TERMOFLORES 3	58,295,424.0	0.550	32,069,644.27
GUAJIRA 1	121,183,830.0	0.562	68,064,978.23
GUAJIRA 2	89,582,280.0	1.341	120,166,739.65
MENOR LA TINTA	114,867,113.0	0.000	0.00
MENOR TAMESIS	8,939,529.0	0.000	0.00
MENOR TERMOPIEDRAS	11,702.7	1.081	12,656.04
MENOR TEQUENDAMA	113,864,225.0	0.000	0.00
TERMOCENTRO 1	408,882,041.0	0.406	166,022,204.82
TASAJERO 1	762,308,010.0	0.927	706,565,366.86
TERMO SIERRA 1	386,747,280.0	0.365	141,256,266.10
TERMOVALLE 1	19,840,340.6	0.377	7,478,292.73
TERMOYOPAL 1	73,588,081.2	0.728	53,567,271.82
TERMOYOPAL 2	158,042,650.3	0.728	115,043,724.96
MENOR UNION	3,281,538.6	0.000	0.00
URRA	1,466,593,500.0	0.000	0.00
MENOR VENTANA 2	11,711,549.0	0.000	0.00
MENOR VENTANA 1	16,233,462.0	0.000	0.00
CUESTECITAS - CUATRICENTENARIO 1 230 KV	1,146,936.0	0.000	0.00
ZIPAEMG 2	111,361,027.0	1.205	134,169,223.93
ZIPAEMG 3	96,505.0	0.907	87,510.43
ZIPAEMG 4	77,607,046.0	0.851	66,043,389.80
ZIPAEMG 5	289,017,293.0	0.820	236,878,250.80
MENOR ZARAGOZA	7,650,194.6	0.000	0.00
MENOR LA HERRADURA	124,066,333.0	0.000	0.00
PARQUE EOLICO JEPIRACHI	49,890,974.9	0.000	0.00
MENOR LA CASCADA	7,833,587.5	0.000	0.00
MENOR SANTA ANA	49,920,512.0	0.000	0.00
MENOR LA VUELTA	50,497,538.0	0.000	0.00
MENOR GRANADA	1,389,360.00	0.000	0.00
	53,665,662,570.2	-	5,920,261,416.2

Marginal build factor

The calculation of the marginal build factor involved the calculation of 20% of the total energy generated during the year 2007, obtaining a value of 10,733 GWh, The plants were classified, in accordance with the most recently built plants, adding the energy generated per plant during 2007, so that the total would provide a value equal to or above 10,733 GWh and which would include a complete plant, for calculation purposes, as stated in the methodology.

PLANTS BUILT THAT REPRESENT 20% OF THE TOTAL MWh DURING 2007					
COMMERCIAL COMMISSIONING DATE	**GENERATING PLANT**	**NOMINAL CAPACITY (MW)**	**MWh**	**t CO_2**	**t CO_2/MWh**
19/09/2007	REMEDIOS	1.00	982.28	0.00	0.000
19/08/2007	MORRO 2	17.00	7,268.11	5,763.03	0.793
18/08/2007	CIMARRON	17.00	31,525.15	24,996.94	0.793
5/08/2007	AMALFI	1.00	2,079.28	0.00	0.000
30/07/2007	URRAO	1.00	2,531.70	0.00	0.000
24/07/2007	CASCADA GENERADOR	3.00	20,853.59	0.00	0.000
23/05/2007	MORRO 1	20.00	107,611.43	76,449.30	0.710
25/03/2007	COGENERADOR CENTRAL TUMACO 1	0.00	30.82	21.53	0.699
30/01/2007	SAN JOSE LA MONTAÑA	1.00	1,343.48	0.00	0.000
1/01/2007	CALDERAS	20.00	92,320.95	0.00	0.000
1/09/2006	COGENERADOR COLTEJER 1	5.00	2.67	2.85	1.068
11/03/2005	TERMOYOPAL 1	19.00	73,588.08	53,567.27	0.728
1/01/2005	LA JUNCA 1	19.00	126,056.33	0.00	0.000
1/09/2004	CEMENTOS DEL NARE 1	5.00	42,805.74	0.00	0.000
16/08/2004	MERILECTRICA 1	169.00	55,704.24	30,752.04	0.552
15/08/2004	COGENERADOR CENTRAL CASTILLA 1	1.00	4,518.15	3,156.38	0.699
8/08/2004	COGENERADOR INGENIO RIOPAILA 1	2.00	4,450.08	3,108.82	0.699
29/07/2004	TERMOYOPAL 2	30.00	158,042.65	115,043.72	0.728
10/04/2004	TEQUENDAMA 1	19.00	113,864.23	0.00	0.000
10/04/2004	TEQUENDAMA 2				
6/12/2003	EL LIMONAR 1	18.00	87,554.77	0.00	0.000
6/12/2003	LA TINTA 1	19.00	114,867.11	0.00	0.000
16/11/2003	SAN JOSE 1	0.00	2,283.88	0.00	0.000
16/11/2003	SAN JOSE 2				
22/08/2003	CHARQUITO 1	19.00	53,666.07	0.00	0.000
15/08/2003	COGENERADOR INGENIO RISARALDA 1	6.00	8,660.84	6,050.46	0.699
1/12/2002	MIEL I 1	396.00	1,461,814.35	0.00	0.000
1/12/2002	MIEL I 2				
1/12/2002	MIEL I 3				
1/06/2002	SONSON 21	19.00	93,095.02	0.00	0.000
3/05/2002	CHIVOR 1	1,000.00	999,419.16	0.00	0.000
3/05/2002	CHIVOR 2				
1/09/2001	PUENTE GUILLERMO 1	1.00	5,672.81	0.00	0.000

29/06/2001	PORCE II 3	405.00	2,037,516.52	0.00	0.000
6/05/2001	PORCE II 2				
8/04/2001	PORCE II 1				
27/01/2001	TERMOSIERRAB	405.00	386,747.28	141,256.27	0.365
5/01/2001	CHIVOR 8	1,000.00	999,419.16	0.00	0.000
4/01/2001	CHIVOR 7	0.00	0.00	0.00	0.000
30/11/2000	TERMOCENTRO 1 CICLO COMBINADO	280.00	408,882.04	166,022.20	0.406
13/07/2000	TERMOCANDELARIA 2	157.00	8,756.00	4,856.25	0.555
16/06/2000	URRA 4	338.00	366,648.38	0.00	0.000
3/06/2000	TERMOCANDELARIA 1	157.00	156,139.00	85,408.99	0.547
13/05/2000	URRA 3	338.00	366,648.38	0.00	0.000
1/04/2000	URRA 2	338.00	366,648.38	0.00	0.000
31/03/2000	RIO PIEDRAS 1	20.00	152,130.99	0.00	0.000
14/02/2000	URRA 1	338.00	366,648.38	0.00	0.000
1/01/2000	TPIEDRAS 1	4.00	11.70	0.00	0.000
16/07/1999	TERMOEMCALI 1	229.00	11,059.82	4,101.67	0.371
1/07/1999	COGENERADOR INGENIO PROVIDENCIA 1	1.00	1,510.68	0.00	
8/01/1999	PAIPA 4	150.00	1,003,019.66	908,560.41	0.906
1/01/1999	RIOFRIO II GENERADOR	10.00	59,812.57	0.00	0.000
1/01/1999	COGENERADOR BIOAISE 1	0.00	3,261.01	1,859.44	0.570
1/01/1999	COGENERADOR PROENCA 1	4.00	7,334.98	0.00	0.000
1/01/1999	COGENERADOR INCAUCA 1	10.00	42,832.68	23,557.97	0.550
1/01/1999	RIOFRIO I GENERADOR	0.00	7,023.54	0.00	0.000
1/01/1999	RUMOR GENERADOR	1.00	15,281.55	0.00	0.000
17/12/1998	TERMOVALLE 1	3.00	19,840.34	7,478.29	0.377
20/10/1998	TEBSAB	791.00	3,894,720.47	1,740,461.21	0.447
			14,354,506	3,402,475.074	0.237

If we analyse the energy generated by the last five plants installed, we can see that the energy generated is lower than that generated by the plants that make up 20% of the total energy in 2007, so that, in accordance with the methodology, the plants that make up 20% of the total are selected. The table shown next includes the energy generated by the last five plants, to justify the selection.

LAST 5 PLANTS BUILT DURING 2007					
COMMERCIAL COMMISSIONING DATE	GENERATING PLANT	NOMINAL CAPACITY (MW)	MWh	t CO_2	t CO_2/MWh
19/09/2007	REMEDIOS	1.00	982.28	0.00	0.000
19/08/2007	MORRO 2	17.00	7,268.11	5,763.03	0.793
18/08/2007	CIMARRON	17.00	31,525.15	24,996.94	0.793
5/08/2007	AMALFI	1.00	2,079.28	0.00	0.000
30/07/2007	URRAO	1.00	2,531.70	0.00	0.000
			44,386.52	30,759.97	0.693

Consideration of exports and imports

The methodology ACM 0002/Version 10 establishes that the electricity imported from other connected systems must be considered as another plant when calculating the operating margin factor. Colombia establishes an account with electrical connections with Venezuela, Ecuador and, in the near future, also with Panama. However, as a consequence of its high hydroelectric component, Colombia has a clear electric energy exporting character and only 0.074% of the almost 52,787 GWh of demand addressed by the NIS during the year 2007 came from other countries.

2007 General NIS Data	
Data	**GWh**
Generation	53,624.1
Imports	39.5
Exports	846.5
National demand addressed	52,787.0
National demand not addressed	64.3
NIS Demand	52,951.3

Source: XM

Taking into account this situation, we can determine how imports can complicate the calculation of the baseline and monitoring operations, greatly modifying the values of the factors obtained with negative results, increasing the degree of uncertainty in the calculations while not providing a greater precision. Therefore, the import data has not been included in the calculation of GHG emissions. If we establish that imports can have an impact on the operating margin emission factor in the future, the monitoring plan will be modified to include hourly values (in kWh), its price of participation in the system (in $/kWh) and its emission factor (in kgCO_2/ kWh) in the baseline calculations. In the tool, for the imports from another country, an emission factor of 0 kgCO_2/kWh is applied, so its inclusion only affect the total amount of electricity, which due to its low value , it is assumed negligible compared to the total amount of energy generated in the system.

Appendix 5. Further background information on monitoring plan

The Monitoring Plan established can be used to calculate the reduction of GHG emissions generated by the project's activity with a simple process. The calculations will be mainly based on the gathering of data on the electricity generated by all plants connected to the National Interconnected System, including that corresponding to the Minor Hydroelectric Power Plant of Bajo Tuluá. The data will be gathered throughout the duration of the project activity and the crediting period, which is composed by a period of 7 years and which can be extended for another two 7-year periods.

The plant's emissions will be zero, since it will not use fossil fuels or have a reservoir, so that the project's activity emissions will not have to be monitored. Likewise, the leakages associated to the project will be practically zero. Therefore, only the baseline emissions must be calculated.

These are mainly composed by the CO_2 emissions of the thermal power plants that use carbon and natural gas and which are shifted by the generation of the Minor Power Plant of Bajo Tuluá. To assess their performance, the operating and build margin factors will be calculated, as explained next:

The calculation of **the operating margin emission factor** will use one spreadsheets with four sheets to guarantee the dynamic and automatic monitoring of the reduction of GHG emissions attained after the implementation of the project:

- The emission factors of each plant are calculated in kg CO_2/kWh in the first sheet, with the heat rate values of the power plant, provided by the Associated Services Management, XM *Compañía de Expertos en Mercados S.A. E.S.P.* with the emission factors obtained from

table 1.4 of page 1.23 of the document “2006 IPPC IPPC Guidelines for National Greenhouse Gas Inventories”, taking into account the lowest value with the 95% interval confidence.

- The second spreadsheet must include the following hourly data of total system generation provided by the NEON system.
- The next sheet is sorted generation hourly total system from top to bottom and are represented in terms of the 8,760 hours a year. In addition it is estimated the area under the curve for different times of year, to calculate the value of λ.
- The last sheet, the operating emission factor is calculated taking into account the value of λ, the generation of each power plant and their emission factors.

In the case of the **build margin emission factor**, there is a spreadsheet used to enter the new plants commissioned, which takes into account those that complete 20% of the year’s generation, updating the said factor.

Appendix 6. Summary report of comments received from local stakeholders

See section E.

Appendix 7. Summary of post-registration changes

The original PDD registered on 09/03/2011 (v3.5) included a total installed capacity of 20 MW. This PDD was registered before clearer guidance on the definition of the installed capacity was provided.

As per the current CDM rules, the installed capacity should be determined based on the nameplate generator capacity, which in this case is 23.5 MW.

This permanent change has been made in the revised PDD (v4.0). However, it is important to understand that this is not actually an increase of the power plant’s capacity as explained in the following.

The installed capacity of 20 MW defined in the original PDD refers to the “effective capacity” of the project at the interconnection with the grid, not the generator capacity. Bajo Tuluá is a minor power plant as defined by the CREG Resolution - 086 of 1996, which means that its maximum effective capacity must be below 20 MW. The official capacity of this project is 19.9 MW: http://paratec.xm.com.co/paratec/SitePages/generacion.aspx?q=capacidad
This means that the installed generator capacity does not impact the effective output of the project, which cannot exceed the 19.9 MW given by the regulation.

On the other hand, in section B.6.1 in step 4, **option A1** of the “tool to calculate the emission factor of an electrical system” was added as an approach to calculate the emission factor of each plant m based on fuel consumption and electricity generation, as this information is available to the public in the database of the national interconnected system: http://informacioninteligente10.xm.com.co/oferta/Paginas/HistoricoOferta.aspx. When there is only information on electricity generation, **Option A3** should be considered as a conservative approach to determine the value of the emission factor of each plant in accordance with the tool.

- - - - -

Document information

Version	Date	Description
10.1	28 June 2017	Revision to make editorial improvement.
10.0	7 June 2017	Revision to: • Improve consistency with the “CDM project standard for project activities” and with the PoA-DD and CPA-DD forms; • Make editorial improvement.
09.0	24 May 2017	Revision to: • Ensure consistency with the “CDM project standard for project activities” (CDM-EB93-A04-STAN) (version 01.0); • Incorporate the “Project design document form for small-scale CDM project activities” (CDM-SSC-PDD-FORM); • Make editorial improvement.
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the “Standard: Applicability of sectoral scopes” (CDM-EB88-A04-STAN) (version 01.0).
06.0	9 March 2015	Revision to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Make editorial improvement.
05.0	25 June 2014	Revision to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from F-CDM-PDD to CDM-PDD-FORM; • Make editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	13 March 2012	Revision required to ensure consistency with the “Guidelines for completing the project design document form for CDM project activities” (EB 66, Annex 8).
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b

Version	*Date*	*Description*
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

Decision Class: Regulatory
Document Type: Form
Business Function: Registration
Keywords: project activities, project design document