Project design document form
(Version 11.0)

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

BASIC INFORMATION	
Title of the project activity	Amaime Minor Hydroelectric Power Plant
Scale of the project activity	☒ Large-scale ☐ Small-scale
Version number of the PDD	03
Completion date of the PDD	23/10/2019
Project participants	Empresa de Energía del Pacífico S.A. E.S.P. (EPSA S.A. E.S.P.)
Host Party	Colombia
Applied methodologies and standardized baselines	ACM0002 - Large-scale Consolidated Methodology - Grid-connected electricity generation from renewable sources (version 19.0)
Sectoral scopes	Sector scope (1): Energy industries
Estimated amount of annual average GHG emission reductions	22,470 tCO_2

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 21.34 MW, with the aim of making use of the capacity of the Amaime 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 Amaime River Hydroelectric Power Plant project is located in the middle section of the river's basin, between points 1,400 and 1,200 meters above sea level, in the department of the Cauca Valley. The power plant obtains water at 1,394.50 meters above sea level (208 m) with a mean flow of 6.4 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 10,670 kW 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 92.4 GWh annually[1]. It will help to reduce thermal power generation in the SIN by providing renewable energy to the grid. Thus, it will contribute to sustainability by increasing the share of renewable energy and reducing GHG emissions. The expected average annual emission reductions are 22,470 tCO_2 during a renewable 7-years crediting period. The total GHG emission reductions for the chosen crediting period are 157,294 tCO_2.

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.

Type of regulation:	Run-of-river
Capacity of each distribution point (m^3/s):	6.4
Turbine design flow (m^3/s)	6
Elevation of the distribution point (meters above sea level):	1,394.50
Length of the power tunnel (m):	4,805
Final diameter of the tunnel (m):	5.60
Maximum gross drop (m):	208
Installed capacity (MW)[2]:	21.34
Number and type of turbines:	2, Francis

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 (SIN) by the power plant of Amaime 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 Amaime contributes to the fulfilment of the following national sustainable development priorities:

[1] See documents 4 - Licencia Ambiental CH Amaime.pdf and 2 - AMAIME capítulo 4 descripción Proyecto.pdf page 9.

[2] Total nameplate turbine capacity

- Reduction in the atmospheric contamination (NO_X, SO_X, COVs 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 Amaime shall add 21.34 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.

A.2. Location of project activity

The project of the Minor Hydroelectric Power Plant of Amaime is located on the middle section of the basin of Amaime River. The water flows through the river points 1,400 and 1,200 metres above sea level, in the department of the Cauca Valley, municipalities of Palmira and Cerrito, Colombia. The water intake point is located on the sector of Salinas (borough of Aují, municipality of Cerrito). The engine house is located in the sector of Cascada (borough of Aují, municipality of Cerrito).

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

	Latitude	Longitude
AMAIME RIVER WATER INTAKE POINT	3.6094°	-76.1675°

Equivalent geographical coordinates are: 03 ° 36' 33.84 "N; Longitude: 76 ° 10' 3" W.

Details of physical location

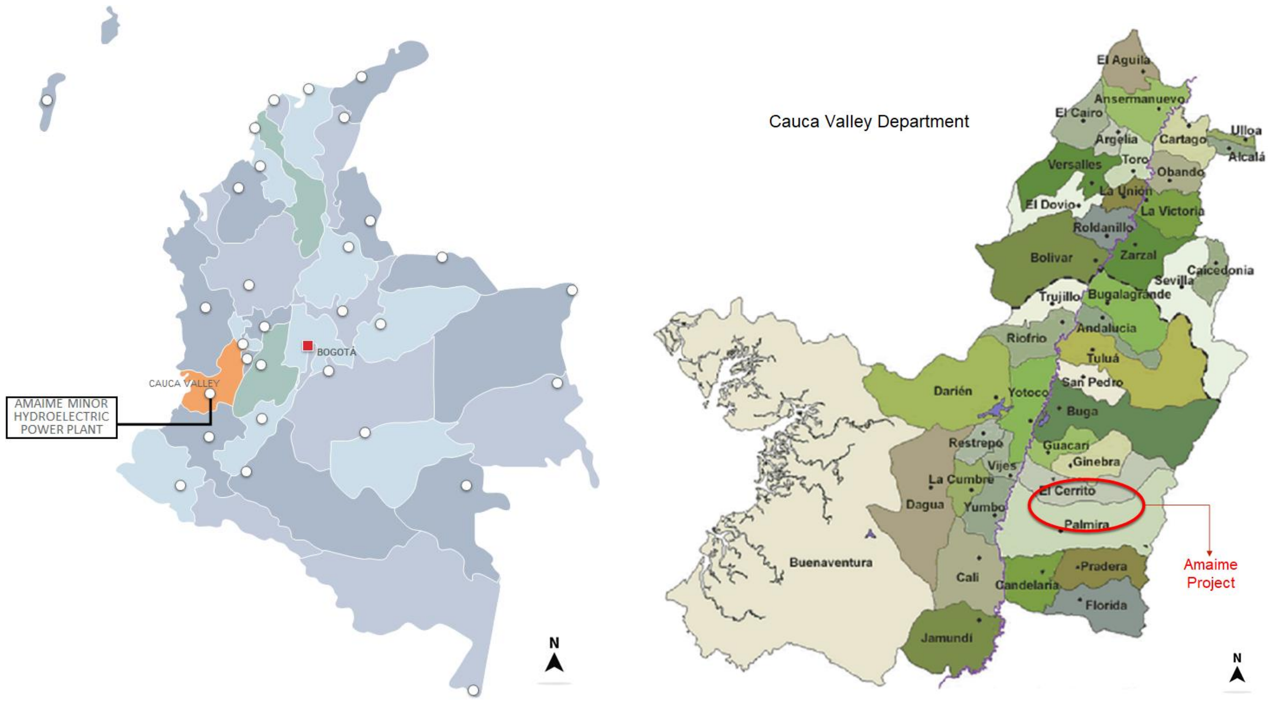


Figure 1. Project Location

A.3. Technologies/measures

This project collects the waters of the Amaime River in the point 1,394.5 metres above sea level, driving the water through an open channel to the double sedimentation basin and load chamber, moving up to a pressurised conduction tunnel up to the distributor, where it is split into three flows distributed 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 Amaime, using part of the third-order track passageway and existing distribution line passageway.

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

- **Water collection**: the water intake points, or bypass point is a lateral collection point at 1,394.5 metres above sea level, located 1,200 metres downstream of the ravine of Tigrera. The bypass works mainly involve the construction of a dam, designed to evacuate a maximum rising tide of 393 m^3/s, as well as a gravel removal system, a lateral grating, a conduction channel, a double- chamber sedimentation basin and a load chamber at the end.
- **Pressure conduction tunnel**: circular section with a partially lined tunnel and a slope of 2.45% in the first 1,400 metres and 5.20% between this point and the tunnel to complete its length of 4,805 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 turbine suction pipes discharge into the pits located under the engine house, with lateral guides to insulate them, for maintenance or repair purposes in case of faults, finally driving the water into the Amaime River through an 80-meter-long discharge tunnel. The water capacity of each turbine is the same and is thus equivalent to 50% of the total capacity of 21.34 MW.

Table 1. Technology characteristics (a)

MAIN CHARACTERISTICS OF THE TURBINES	
Number of units	2
Type	Francis, horizontal
Design net head	195.98 m
Design flow per turbine	6 m^3/s
Capacity of each unit	10.67 MW
Nominal speed	720 min^{-1}
MAIN CHARACTERISTICS OF THE GENERATORS	
Number of units	2
Type	Synchronous
Capacity of each unit[3]	10.3617 MW
Frequency	60 Hz

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

Table 2. Technology characteristics (b)

Nominal voltage	34.5 KV
Number of circuits:	Three-phase circuit, with two conductors per phase
Conductor:	ACSR 556.5 MCM DOVE CENTELSA
Cable guard	Type: Optical Ground Wire (OPGW)
Structures:	In the concrete post, with a height of 14 or 16 metres, 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:	11.7 km
Number of structures:	160

On the route section, the line was located on the opposite side with respect to the most important vegetation.

- **Complementary civil works**: access path to the entrance of the tunnel, adaptation of landfills, construction of a bridge, energy for the construction and personnel facilities for workers.

Based on the expected average generation of 92.4 GWh per year and the total turbine capacity of 21.34 MW, the plant load factor is approximately 49.43%. The lifetime of the project is expected to be 50 years[4].

The project implementation required technology and know-how transfer to the host country. The main equipment (turbine and generator) were bought from a Spanish company called ANDRITZ HYDRO. A second Spanish company called SOCOIN accompanied the project participant during the entire construction process of the project activity and provided consultancy for selection and installation of main equipment. They also carried out the operational tests and were engaged during the commissioning process. This support was key for project implementation and for

[3] Capacity factor: 0.9, Output capacity: 11.513 MVA

[4] Renewable & Sustainable Energy Reviews, “Small hydro power: technology and current status”, (pg.538) https://dspace.ist.utl.pt/bitstream/2295/296312/1/paper%2520small%2520hydro%2520power.pdf (accessed: 19/12/2012)

capacity building in order to guarantee successful and sustainable operation of the hydroelectric plant.

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)	Empresa de Energía del Pacífico S.A. E.S.P. (EPSA S.A. E.S.P.)	No

A.5. Public funding of project activity

There is no public funding for the proposed project.

A.6. History of project activity

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 two of the projects identified was carried out: Bugalagrande 1,800 and Amaime 1,400 projects.

1. PP hereby confirms that: The proposed CDM project activity is neither registered as a CDM project activity nor included as a component project activity (CPA) in a registered CDM programme of activities (PoA); The proposed CDM project activity is not a project activity that has been deregistered.

2. PP further declares that: The proposed CDM project activity was not a CPA that has been excluded from a registered CDM PoA; No registered CDM project activity or a CPA under a registered CDM PoA whose crediting period has or has not expired (hereinafter referred to as former project) exists in the same geographical location as the proposed CDM project activity.

A.7. Debundling

Not applicable

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

The project activity is developed under the approved consolidated baseline and monitoring methodology ACM0002 "Consolidated Large-scale Methodology for grid-connected electricity generation from renewable sources" (version 19.0)[5].

Also, following the ACM0002, version 19.0 guidelines, it is applied the:

a. TOOL07 "Tool to calculate the emission factor for an electricity system" (version 07.0)[6]
b. TOOL11 "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" (Version 03.0.1)[7] is also applied.

B.2. Applicability of methodologies and standardized baselines

The Consolidated Large-scale Methodology ACM0002 (version 19.0), is applicable to grid-connected renewable energy power generation project activities that:

(a) Install a Greenfield power plant;
(b) Involve a capacity addition to (an) existing plant(s);
(c) Involve a retrofit of (an) existing operating plants/units;
(d) Involve a rehabilitation of (an) existing plant(s)/unit(s); or
(e) Involve a replacement of (an) existing plant(s)/unit(s).

In this case, the proposed project activity involves grid-connected renewable energy power generation through the installation of a run-of-river Hydroelectric Plant (a Greenfield power plant).

The applicability conditions of the methodology ACM0002 are presented below together with an explanation on why each condition is met by the project activity.

Table 3. Methodology Applicability

Applicability Conditions	Project Activity
1. The project activity may include renewable energy power plant/unit of one of the following types: hydro power plant/unit with or without reservoir, wind power plant/unit, geothermal power plant/unit, solar power plant/unit, wave power plant/unit or tidal power plant/unit.	The proposed project activity involves renewable energy power generation through the installation of a hydro power plant without reservoir. Thus, this condition is met.
2. In the case of capacity additions, retrofits, rehabilitations or replacements (except for wind, solar, wave or tidal power capacity addition projects) the existing plant/unit started commercial operation prior to the start of a minimum historical reference period of five years, used for the calculation of baseline emissions and defined in the baseline emission section, and no capacity expansion, retrofit, or rehabilitation of the plant/unit has been undertaken between the start of this minimum historical reference period and the implementation of the project activity.	The proposed project activity involves the installation of a Greenfield power plant. Thus, this condition is not applicable.

[5] See document: https://cdm.unfccc.int/filestorage/5/8/I/58IAGB7SZUDEO2VN6LYM30K41HFPRQ/EB100_repan06_ACM0002.pdf?t=YUJ8cHp1azF6fDCAlsLaHY2K24_5bitbXIh4
[6] See document: https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v7.0.pdf
[7] See document: https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-11-v3.0.1.pdf

Applicability Conditions	Project Activity
3. In case of hydro power plants, one of the following conditions shall apply: (a) The project activity is implemented in existing single or multiple reservoirs, with no change in the volume of any of the reservoirs; or (b) The project activity is implemented in existing single or multiple reservoirs, where the volume of the reservoir(s) is increased, and the power density is greater than 4 W/m^2; or (c) The project activity results in new single or multiple reservoirs and the power density is greater than 4 W/m^2; or (d) The project activity is an integrated hydro power project involving multiple reservoirs, where the power density for any of the reservoirs is lower than or equal to 4 W/m^2, all of the following conditions shall apply: (i) The power density calculated using the total installed capacity of the integrated project is greater than 4 W/m^2; (ii) Water flow between reservoirs is not used by any other hydropower unit which is not a part of the project activity; (iii) Installed capacity of the power plant(s) with power density lower than or equal to 4 W/m^2 shall be: a. Lower than or equal to 15 MW; and b. Less than 10 per cent of the total installed capacity of integrated hydro power project.	The project activity is a hydro power plant without reservoir; thus, this criterion is not relevant. The power density of the project is greater than 4 W/m^2 (see section B.6.3) Even though there is no reservoir, the flooded area of the water intake has been used for the calculation of Power density in order to comply with this requirement.
4. In the case of integrated hydro power projects, project proponent shall: (a) Demonstrate that water flow from upstream power plants/units spill directly to the downstream reservoir and that collectively constitute to the generation capacity of the integrated hydro power project; or (b) Provide an analysis of the water balance covering the water fed to power units, with all possible combinations of reservoirs and without the construction of reservoirs. The purpose of water balance is to demonstrate the requirement of specific combination of reservoirs constructed under CDM project activity for the optimization of power output. This demonstration has to be carried out in the specific scenario of water availability in different seasons to optimize the water flow at the inlet of power units. Therefore, this water balance will take into account seasonal flows from river, tributaries (if any), and rainfall for minimum five years prior to implementation of CDM project activity.	The proposed project activity does not involve integrated hydro power projects. Thus, this condition is not applicable.
5. The methodology is not applicable to: (a) Project activities that involve switching from fossil fuels to renewable energy sources at the site of the project activity, since in this case the baseline may be the continued use of fossil fuels at the site; (b) Biomass fired power plants/units.	The proposed project activity does not involve switching from fossil fuels to renewable energy sources at the project site or the installation of biomass fired power plants. Thus, this condition is met.
6. In the case of retrofits, rehabilitations, replacements, or capacity additions, this methodology is only applicable if the most plausible baseline scenario, as a result of the identification of baseline scenario, is “the continuation of the current situation, that is to use the power generation equipment that was already in use prior to the implementation of the project activity and undertaking business as usual maintenance”.	The proposed project activity involves the installation of a Greenfield power plant. Thus, this condition is not applicable.

Applicability Conditions	Project Activity
7. The applicability conditions included in the tools apply.	The conditions of the "Tool to calculate the emission factor for an electricity system" are analyzed below.
7.1. This tool may be applied to estimate the OM, BM and/or CM when calculating baseline emissions for a project activity that substitutes grid electricity that is where a project activity supplies electricity to a grid or a project activity that results in savings of electricity that would have been provided by the grid (e.g. demand-side energy efficiency projects).	The proposed project activity supplies electricity to the local grid, avoiding part of the electricity generated by the grid-connected power plants. Thus, this condition is met.
7.2. Under this tool, the emission factor for the project electricity system can be calculated either for grid power plants only or, as an option, can include off-grid power plants. In the latter case, the conditions specified in "Appendix 2: Procedures related to off-grid power generation" should be met. Namely, the total capacity of off-grid power plants (in MW) should be at least 10 per cent of the total capacity of grid power plants in the electricity system; or the total electricity generation by off-grid power plants (in MWh) should be at least 10 per cent of the total electricity generation by grid power plants in the electricity system; and that factors which negatively affect the reliability and stability of the grid are primarily due to constraints in generation and not to other aspects such as transmission capacity.	In this case, the emission factor for the project electricity system is calculated for grid power plants only. Thus, this condition is met.
7.3. The tool is not applicable if the project electricity system is located partially or totally in an Annex I country.	In this case, the project electricity system is located totally in Colombia. Thus, this condition is met.

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

According to the guidance specified in the Methodology ACM0002 (version 19.0), the spatial extent of the project boundary includes the project power plant/unit and all power plants/units connected physically to the electricity system that the CDM project power plant is connected to (see Figure 2). The main measuring equipment is located at the substation Amaime.

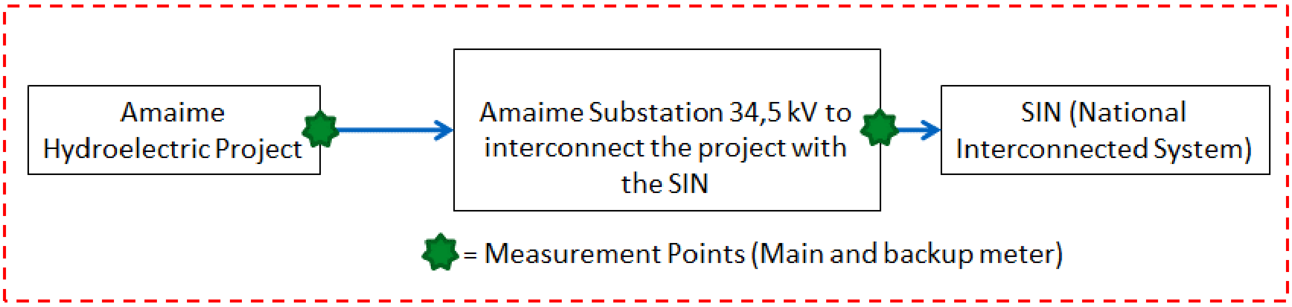


Figure 2. Project Boundary and measurement point

The spatial extension of the limits of the project includes the physical location of the project (Power Plant of Amaime) and all plants connected to the electricity system, which will be connected to the Hydroelectric Power Plant of Amaime (National Interconnected System of

Colombia -SIN[8]). The power plants of this grid are all connected and can be dispatched without significant transmission constraints.

Source		GHG	Included?	Justification/Explanation
Baseline	CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
		---	No	No other emission sources
Project activity	For hydro power plants, emissions of CH_4 from the reservoir	CO_2	No	The project has no reservoir
		CH_4	No	The project has no reservoir
		N_2O	No	The project has no reservoir
		---	No	The project has no reservoir

B.4. Establishment and description of baseline scenario

The hydroelectric power plant project of Amaime 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.

As stated in the approved methodology ACM0002 “Grid-connected electricity generation from renewable sources”, version 19.0: If the project activity is the installation of a Greenfield power plant, the baseline scenario is the following:

Electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin (CM) calculations described in the “Tool to calculate the emission factor for an electricity system – version 7.0”.

Therefore, the baseline scenario consists of the electricity that would have been generated and delivered to the grid in the absence of the proposed project activity by:

- Other plants currently connected to the SIN; and
- New capacity additions to the SIN.

Hence, the baseline scenario is identified as the continuation of the common practice of power generation, i.e. mainly large hydro power plants with reservoirs and thermal power stations (Fuel oil, natural gas and coal), that emit large quantities of carbon dioxide (CO_2) to the atmosphere.

For the second crediting period, the continued validity of the original baseline has been assessed, following the stepwise procedure, according to the TOOL11 “Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period” (version 03.0.1),

Step 1: Assess the validity of the current baseline for the next crediting period

Step 1.1: Assess compliance of the current baseline with relevant mandatory national and/or sectoral policies

[8] In Spanish: *Sistema Interconectado Nacional - SIN*

For the renewal of the crediting period, no new national and/or sectoral policies are affecting the baseline scenario. In the absence of the project activity, electricity would still have been partly generated by fossil fuel power plants or by the addition of new fossil fuel power plants connected to the grid. Also, considering that renewable energy projects have lower costs in the margin, they are always dispatched, as reported for the first crediting period.
It can be said that the project complies with the current regulations dealing with renewable sources of power generation. Specifically, the project activity is not affected by the body of actual main regulations (see Table 4).

The structure of the Colombian energy market is based on Laws 142 (Public Services Law) and 143 (Electricity Law) of 1994[9], which represent the last major reform of the power sector and establish the current regulatory framework. Since their enactment, Colombia has had a liberalized energy market, which is characterized by an unbundled generation, transmission, distribution, and commercialization scheme in order to separate the power activities and the markets. An electricity spot market and the development of a long-term contract market for electricity sales are the core of new structure to introduce a more effective framework for competition and an independent regulatory system supervised by the CREG (Regulatory Commission for Energy and Gas), created by the Law 143. This Electricity Law specifically introduced rules regarding: (i) Power sector planning; (ii) power generation; (iii) transmission and distribution; (iv) grid operation; (v) grid access fees; (vi) regime for electricity sales; (vii) concessions and contracts; and (viii) environmental issues, among others.

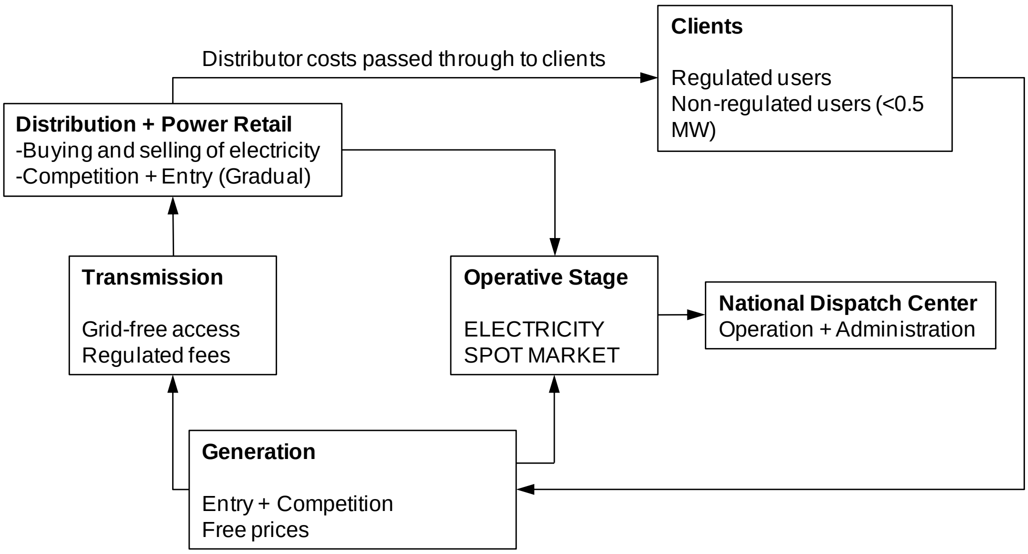


Figure 3. Simplified Scheme of the Colombian Power Market based on Electricity Law from 1994 (Law 143).

In order to construct and operate the hydroelectric plant and deliver electricity to the grid, there are several instances that are directly involved to control that the project is implemented in accordance with the regulation and legal requirements as briefly explained in the following summaries:

1. **CORPORACIÓN AUTONOMA DEL VALLE DEL CAUCA (CVC)**: Based on Article 49 of the law 99 of 1993 and article 3 of the decree 1220 of 2005 the project requires an environmental license to construct and operate the project.
   Since the project has less than 100 MW, based on Article 52 of law 99 and article 8 of

[9] Laws can be accessed on the website: http://www.creg.gov.co/cxc/secciones/documentos/leyes.htm (accessed: 12/03/2019)

decree 1220, the corresponding Regional Autonomous Corporation (in this case **CORPORACIÓN AUTONOMA DEL VALLE DEL CAUCA -CVC**) is responsible to control and supervise compliance of the project with the requirements established in the Environmental Impact Assessment – EIA, and the environmental license.

Therefore, the construction of the Project was authorized by CVC by means of the following resolutions:

- The Environmental Handling Plan has already been approved for Amaime by the CVC (competent environmental authority) and is integrated within the Environmental License.

- In accordance with resolution 0100 N0, 0720-0470 of September 25, 2007, the Environmental License is awarded to Empresa de Energía del Pacífico S.A. E.S.P. – EPSA E.S.P. for the project of the “Minor Hydroelectric Power Plant of the Amaime River 1400”. Resolution No. 0100. 0720-0144, March 4, 2008 clarifies certain aspects of the content of resolution 0100 N0. 0720-0470, September 25, 2007, relating to "permit continued occupation of channels and approval waterworks", "Clean Development Mechanisms" and "Material of underground excavations."

- The hydroelectric was licensed including its corresponding transmission lines; under the Resolution 0100 No. 0720-0470 de 2007.

2. **UPME:** It acts as a supervisory entity. Any project to be implemented and interconnected with the electricity grid needs to be registered at the UPME. There are several phases, although the only mandatory registration step is called “Phase IV”, which is emitted upon final project design and the emission of the environmental license.
3. **XM Compañía de Expertos en Mercados S.A. E.S.P.:** this is the grid administrator and operator. The entity that will buy the energy has also to be subscribed to XM and meet all applicable laws.
4. **CREG**: As the regulating entity, the CREG assures that all regulatory requirements are met. It also measures annually the capacity of the power plants.

Table 4. Policy compliance (yes √ – not X)

Policy	Impact on baseline	Validity during first crediting period	Outstanding changes since issuance
Laws 142/143 of 1994 Set the norms and procedures for the generation, interconnection, transmission, distribution, and electricity commercialization	X	√	X
Resolution 055 of 1994 - Electricity market conditions	X	√	X
Resolution 086 of 1996 - Power generation activities regulation	X	√	X
Resolution 039 of 2001 - Establish complementary conditions	X	√	X

Policy	Impact on baseline	Validity during first crediting period	Outstanding changes since issuance
Law 697 of 2001 - Promotes the development and use of rational and efficient sources of energy	X	√	X
Law 1715 of 2014 Controls the integration of non-conventional renewable energies into the National Energy System.	X	X	X

Since the project was constructed and operated in a highly regulated market that is controlled by a series of public and private actors, compliance with all applicable laws and regulatory requirements is supervised and can be guaranteed.
Therefore, it can be concluded that the fundamental elements of the baseline have not changed since the project was first registered, and the market structure, regulatory framework, and functioning remains the same.

Step 1.2: Assess the impact of circumstances

At the time of requesting renewal of the crediting period on the current baseline emissions, no impact of circumstances prevail. It can be concluded that the conditions used to determine the baseline emissions in the previous crediting period are still valid.
Law 1715 which promotes renewable energy has not modified prices or electricity availability. The enactment of that law has not enhanced the continuation of the baseline scenario at the time of validation.

Step 1.3: Assess whether the continuation of use of current baseline equipment(s) or an investment is the most likely scenario for the crediting period for which renewal is requested

Since the baseline scenario identified at the validation is the continuation of the current practice, i.e. the electricity would be supplied by the power grid in the absence of the project activity, and the baseline did not consider the use of any existing equipment by the project, because in the absence of the project activity the energy generated would have been generated by the operation of grid-connected power plants and by the addition of new generation sources to the grid, this step is not applicable.

Step 1.4: Assessment of the validity of the data and parameters

Relevant data and parameters, as the build and operating margin emission factors for the combined margin emission factor, were updated for the second crediting period according to the TOOL07 - Tool to calculate the emission factor for an electricity system - version 7.0. This update includes Grid Emission Factor and all values used in its calculation (fossil fuel emission factors etc). Other parameters were meant to be included as $CAP_{PJ,}$ CAP_{BL} and $A_{PJ,}$ A_{BL} in order to confirm that the Power Density – PD, is above 10 W/m^2. Application of Steps 1.1, 1.2, 1.3 and 1.4 above confirmed that the current baseline remains valid for the second crediting period; even though, some data and fixed parameters needed to be updated due to changes presented above. In this context step 2 is assessed below.

Step 2: Update the current baseline and the data and parameters

Step 2.1: Update the current baseline

Baseline emissions for the second crediting period have been updated in accordance with the stated above in step 1.4., without reassessing the current baseline, based on the latest approved version of the methodology ACM0002 (version 19.0). This update was applied in the context of the sectoral policies and circumstances that are applicable at the time of requesting for renewal of the crediting period, which have not changed as to affect the project dispatch.

Step 2.2: Update the data and parameters

As said in step 1.4, the parameters regarding the grid emission factor calculation have been updated for this second crediting period using TOOL07 - Tool to calculate the emission factor for an electricity system - version 7.0. The build margin emission factor was updated for the second crediting period applying the ex-ante option, and of same way, the operating margin emission factor was reevaluated applying the ex-ante option. Other parameters were meant to be included as $CAP_{PJ,}$ CAP_{BL} and $A_{PJ,}$ A_{BL} in order to confirm that the Power Density – PD, is above 10 $W/m^{2.}$ More details can be seen in section B.6 and B.7 (updated monitoring parameters).

B.5. Demonstration of additionality

It is important to clarify that the sensitivity analysis data has been maintained in accordance with the data available during the validation process, and the additionality was not evaluated during the renovation of the project.

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 (now known as Naturgy Generación S.L.U.) 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 Amaime.

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). 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, 3%, turning out to be ideal for hydro generation compared to other renewable technologies (Environmental Impact Assessment, chapter 6, page 12 and maps EIA-02 and AM-EIA-04).
- 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 150, so the consideration of solar energy as an alternative is not recommended (Environmental Impact Assessment, chapter 6, page 51-53).
- Lack of regulation for these technologies in Colombia.

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

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.

Table 5. Projects included in the Colombian Generation Expansion Plan in the short and medium-term

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 transfer	---	Hydro. (Bypass of the water from the Guarinó	Jun.-10
Amoya	78	Hydro.	Jul.-10
Porce III	660	Hidro. (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 chosen.

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 Amaime, the investment profitability analyses carried out by Unión Fenosa (now known as Naturgy Generación S.L.U.), 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.

Calculations have considered the comparison of financial indicator selected for the project activity, with and without income for CERs, and the option of building a fuel-fired power plant.

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[10]
- In the second case, revenues associated to the sale of CERs

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.

To calculate financial indicator for construction of a fuel-fired power plant, the same cash flows have been used and without take in consideration income for CERs, taking into account changes relating to the availability of such plants, the office of reliability and applications related to Act 99.

Although the environmental permit allowed a maximum supply of 118.3 GWh per year, a production of 85 GWh/y has been estimated for Amaime hydraulic plant because due to the technical characteristics of the machines to be used (turbines Vatech) production will be closer to 85GWh (work continues on the points of operation of the machines to try to increase the performance of the same), than the 118.3 that had been originally estimated. That is why we have submitted a sensitivity analysis focused on the value of 85GWh in the sub-step 2d. To obtain the environmental license, water series were developed, from which one the generation of the plant can be calculated.

The evaluation period of the projects has been seen in 50 years, so the comparison of the alternatives is uniformly, as in all cases it is enough away from the depreciation periods and

[10] Source: Bancolombia, November 2008

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 project.

EPSA has extensive experience in operating plants that have considerable seniority to reach these conclusions for this project.

As reflected in the annexes of the economic-financial models, the amortization 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 following table shows a comparison between the IRR value obtained with and without the revenue related to the CDM.

Table 6. IRR comparison values

	Case 1: Without revenues related to the sale of CERs	Case 2: With revenues related to the sale of CERs	Case 3: Fuel-fired power plant
IRR (%)	11.77	12.65/13.27	16.65

From the table above is concluded that the proposed CMD project activity is not the most financially attractive option.

The final investment decision was taken after studies dated November 2007, according to the methodology of investment analysis of Unión FENOSA. 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.

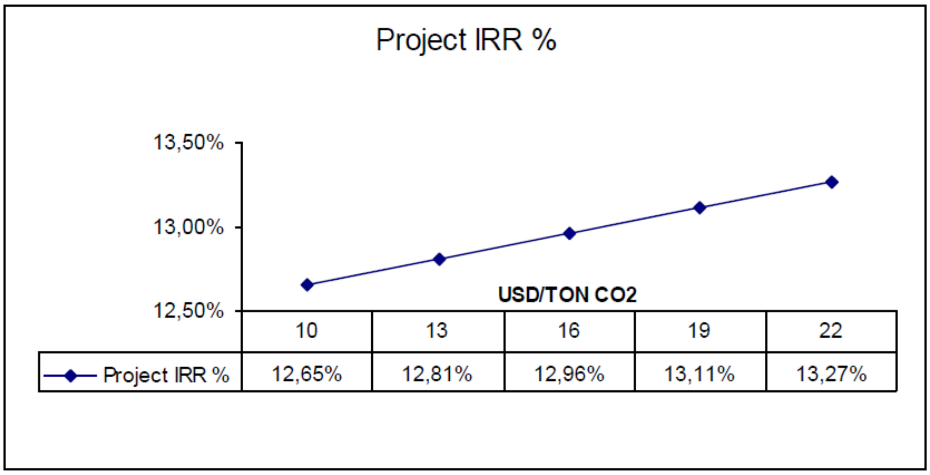
Therefore, it is necessary to consider the fact that the Amaime Minor Hydroelectric Power Plant is less attractive, in financial terms, than the options of building a fuel-fired power plant, and for its implementation needs to be registered as a CDM project to obtain financial support from the sale of 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 on climate change and the CDM objectives of the company.

Sub-step 2d. Sensitivity analysis

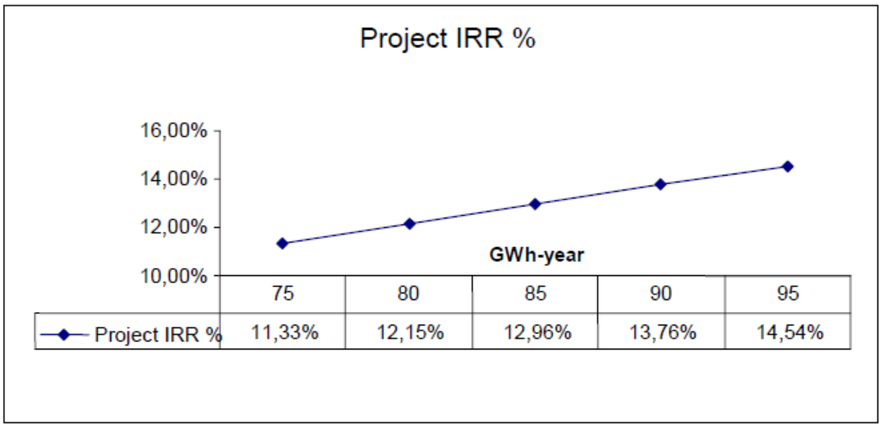
Indicators used for the sensitivity analysis have been the price of t CO_2 in organised markets, annual electricity generation (GWh per year), Investment, O&M costs, Regulatory costs, and O&M+Regulatory costs.

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

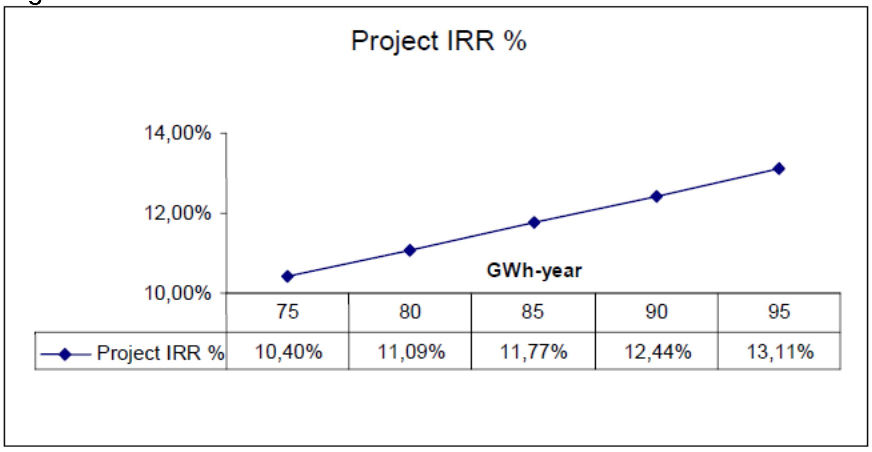
- Sensitivity analysis of the project IRR in the stage with carbon credits depending on the price of CERs



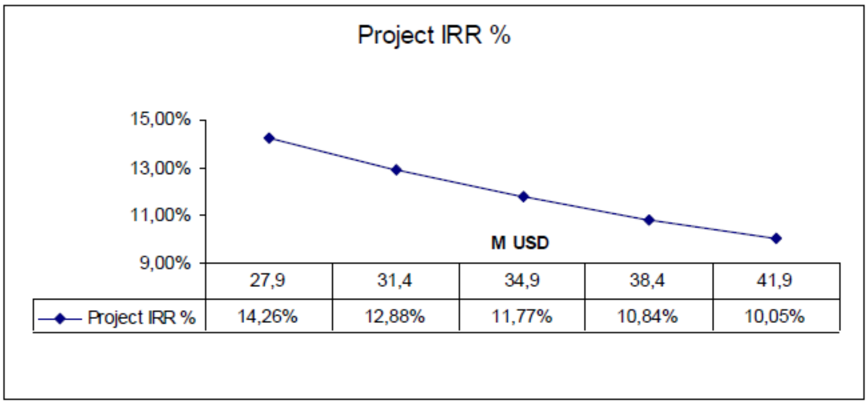
- Sensitivity analysis of the Project IRR in the stage with carbon credits depending on power generation



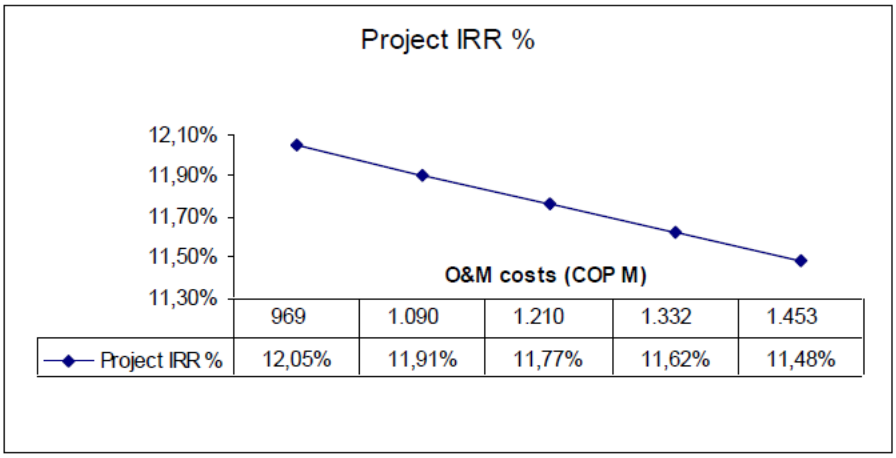
- Sensitivity analysis of the Project IRR in the stage without carbon credits depending on power generation



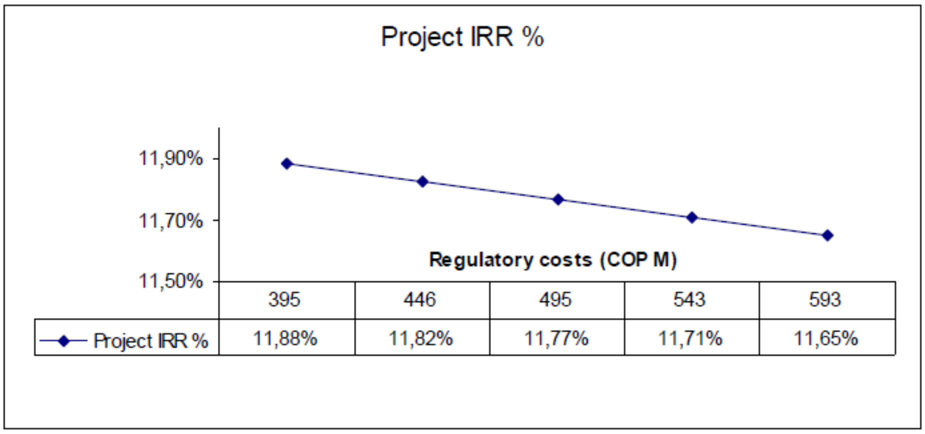
- Sensitivity analysis of the Project IRR in the stage without carbon credits depending on investment



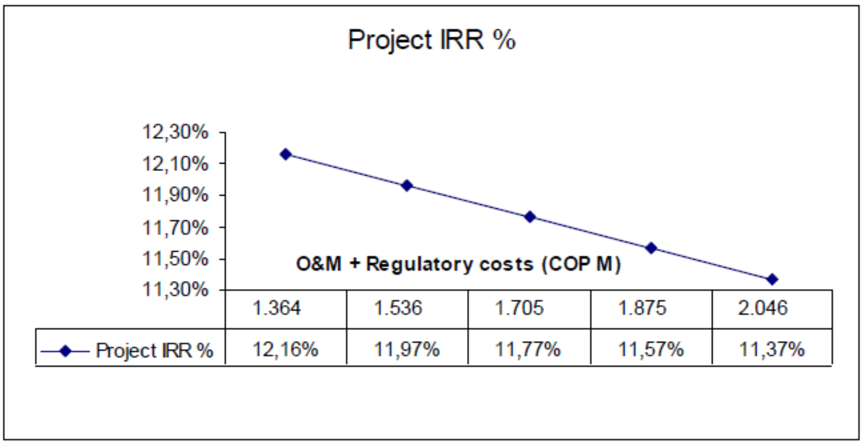
- Sensitivity analysis of the PROJECT IRR in the stage without carbon credits depending on O&M cost.



- 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



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:

- ***Barriers in the common practice***: During the last few years, the options based on thermal energy have been favoured by the deregulation process in the sector. However, run-of-river hydroelectric power plants are not common in the Colombian electricity market. Most hydroelectric power plants are associated to reservoirs, despite the fact that the national system is based on hydroenergy, since they increase the financial viability of the project, even though their infrastructure has an effect on the environment. During the year 2007, run-of-river power plants only supplied 5.12% of the total generation of the system (see step 4) and future trend is similar as can be seen in Reference Expansion Plan Generation and Transmission.

- ***Sector barriers*****:** There are also a series of uncertainties surrounding the value of sale of electricity generated[11] 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 cannot 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.

- ***Social and institutional barriers*****:** Run-of-river hydraulic power plants are located in isolated rural areas, so that they are more vulnerable to guerrilla attacks, which can attack their electric distribution systems and prevent their normal operation. For hydroelectric plants with reservoir this situation is mitigated because they usually have military protection.

- ***Political and investment barriers*****:** Since there is no reservoir, the generation of electricity of run-of-river hydraulic power plants depends on the instantaneous availability of water in the intake point. This situation adds a high uncertainty to the project's profitability, which can be modified as a consequence of the local impacts of the climate change on water

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

resources. Therefore, it is hard for promoters to attract investors or obtain finance through banks. The monetarisation of CERs obtained through the project activity plays a decisive role to overcome this barrier.

National Energy Plan (Context & Strategies) 2006-2025, edited by UPME shows that:

- The generalizations of the use of renewable sources of energy have not increased as was expected. A possible explication of this situation are the financial criteria of the electrical supply companies which favour low initial costs and permanent costs (each time higher) of fossil fuels, in places with initial high costs and low or no costs of fuels.

- In the case of the interconnected system, as well as advancing towards the identification and quantification of potential projects within the Country, the access to CDM type mechanisms should be promoted to obtain resources that allow to finance energization projects based in alternative energies for the generation of electricity (energy sources that are available, but in this country are not employed or used are so marginal and not widely traded).

- To mitigate the financially related barriers which prevent the incorporation and major use of non-conventional sources of energy, it is necessary to strengthen the cooperation schemes and national capacity to develop MDL projects.

Sub-step 3b. Justification of the fact that the barriers identified cannot 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 accumulation 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:

- ***Barriers in the common practice*****:** The need for new sources of energy that guarantee a constant supply of electricity and the fact that Colombia has a natural gas reserve for the next 34 years and 150 years in the case of carbon shows that, despite the negative social and environmental consequences associated to the use of these fuels, thermal power plants will continue to be one of the main options within the expansion trends in the generation infrastructure. Despite the high environmental and social impact, the construction of large hydroelectric power plants associated to reservoirs are a common and real practice in Colombia, so that the barriers related to the common practice do not affect the decision to build this type of power plants.

- ***Sector barriers*****:** 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. These power plants 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.

- ***Social and institutional barriers*:** Given their independence from hydrologic and topographic conditions, thermal power plants can be located in rural and urban areas. Therefore, thermal power plants are usually located near the areas where energy is needed. They reduce the vulnerability of their transmission networks to guerrilla attacks since they are in areas with a higher population density. Also, the hydroelectric plants with reservoir are strategic objectives and usually have protection.

- ***Political and investment barriers*:** The investment in conventional hydraulic and thermal power plants is more attractive than investment in minor run-of-river power plants. The latter have a lower environmental impact (less occupation of land, no emissions, less regulation of river flows, etc,) but they offer a greater operational uncertainty and are less profitable.

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 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 accumulation reservoirs and run- of-river plants, which have a greater risk to generate energy, despite the lower environmental impact, since they cannot 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.

Table 7. Common practice analysis -2007

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 10 plants of these characteristics in Colombia: Niquia (19 MW), Ayura (18 MW), Palmas San Gil (15 MW), Insula (19 MW), Charquito (19.4 MW), La Tinta (19.4 MW), El Limonar (18 MW), Río Frío II (10 MW), Tequendama (19.4 MW) and Río Piedras (19.9 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.

Table 8. Plants of its kind

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

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

Table 9. Common practice analysis since 2004 and registered as CDM

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 project's 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).

Table 10. Common practice analysis – minor hydropower plants

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 cannot be compared to the baseline scenario, characterised by the construction of hydroelectric power plants with accumulation reservoirs 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 (see www.unionfenosa.es), 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 has a specific committee to identify and assess CDM projects. The reports of committee meetings reflect the decisions regarding the different stages of MDL projects life cycle. The main reports of the CDM Committee about Amaime CDM are from year 2005 (25-May-2005, 19-September-2005, 13-December-2005, 12-January- 2006).

In addition, we must highlight that the project for the Minor Hydraulic Power Plant of Amaime has no objection letter issued by the Ministry of Environment, Housing and Territorial Development, dated September 23, 2005. Also is included in the Colombian portfolio of eligible projects of the clean development mechanism, drafted by the Ministry of the Environment, Housing and Territorial Development of the Republic of Colombia.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

The ACM0002 methodology - Version 19 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 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:

Table 11. Basic information for baseline calculation

BASIC INFORMATION FOR THE CALCULATION OF THE BASELINE	
Data	**Source**
Fuel emission factor	Source: Fuel Emissions Factor database of Colombia published by UPME (FECOCupme.xls)
Heat Rate	Associated Services Management, XM *Compañía de Expertos en Mercados S.A. E.S.P. Source: http://paratec.xm.com.co/paratec/SitePages/generacion.aspx?q=capacidad*
Total electricity generated by all power plants connected to the National Interconnected System of Colombia	XM
Total hourly generation of the System	XM
Type of fuel used in each plant	UPME / XM

The baseline scenario and the emission rate calculation are based on the electricity that otherwise would have been generated by the plants connected to the grid and by addition of future plants. According to the methodology, no leakage emissions are considered.

Baseline emissions are calculated by multiplying the combined margin emission factor ($EF_{grid,y}$, in tCO_2e/MWh) by the electricity generated by the proposed project activity during the year *y* (EG_y, in MWh).

Baseline emissions include only CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity. The methodology assumes that all project

electricity generation by the project activity would have been generated by existing grid-connected power plants and the addition of new grid-connected power plants.

The detailed calculations and data of the baseline emissions are presented in the Excel file "EF Colombia 2016-2018 Amaime v2". In the following, the relevant methodological approaches and formulas are presented.

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

Where:

BE_y	=	Baseline emissions in year *y* (tCO_2/yr)
$EG_{PJ,,y}$	=	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year *y* (MWh/yr)
$EF_{grid,,y}$	=	Combined margin CO_2 emission factor for grid connected power generation in year *y* calculated using the latest version of the "Tool to calculate the emission factor for an electricity system" (tCO_2/MWh)

Since it is a green-field project, according to Eq. (12) of ACM0002 (version 19.0),

$$EG_{PJ,y} = EG_{facility,y} \quad (2)$$

For emission factor calculation

The combined margin emission factor ($EF_{grid,CM,y}$) is calculated following the methodological tool "Tool to calculate the emission factor for an electricity system" (version 07.0) by applying the following steps:

STEP 1. Identify the relevant electricity systems;
STEP 2. Choose whether to include off-grid power plants in the project electricity system (optional);
STEP 3. Select a method to determine the operating margin (OM);
STEP 4. Calculate the operating margin emission factor according to the selected method;
STEP 5. Calculate the build margin (BM) emission factor;
STEP 6. Calculate the combined margin (CM) emissions factor.

In the following it is explained how each step is applied.

<u>STEP 1. Identify the relevant electricity systems.</u>

For determining the electricity emission factors, the project electricity system is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity Amaime Minor Hydroelectric Power Plant and that can be dispatched without significant transmission constraints. In this case, the project electricity system is given as the National Interconnected System (SIN).

For the purpose of determining the operating margin emission factor, the CO_2 emission factor(s) for net electricity imports is chosen as 0 t CO_2/MWh.

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

In accordance with the tool, this step is optional. For the proposed project activity, off-grid power plants are not included in the project electricity system (Option 1).

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

In accordance with the tool, the calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods:

(a) Simple OM; or
(b) Simple adjusted OM; or
(c) Dispatch data analysis OM; or
(d) Average OM.

For the project activity, the simple adjusted OM is applied, using the *ex-ante* option:

Ex ante option: if the ex-ante option is chosen, the emission factor is determined once at the validation stage, thus no monitoring and recalculation of the emissions factor during the crediting period is required. For grid power plants, use a 3-year generation-weighted average, based on the most recent data available at the time of submission of the PDD for validation. For off-grid power plants, use a single calendar year within the five most recent calendar years prior to the time of submission of the PDD for validation.

Therefore, the years 2016-2017-2018 have been chosen based on the most recent data available at the time of submission of the CDM-PDD for validation.

All power plants connected to the SIN are included. Power plants registered as CDM project activities are also included as suggested by the tool. The data of the most recent year is available from XM (grid operator and administrator[12]).

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

The simple adjusted operating margin emission factor $EF_{grid,OM\text{-}adj,y}$ (tCO_2e/MWh) is a variation of the simple operating margin emission factor , where the power sources (including imports) are separated in low-cost/must-run power sources (k) and other power sources (m), as follows:

$$\boldsymbol{EF_{grid,OM-adj,y}} = \left(\mathbf{1} - \boldsymbol{\lambda_y}\right) . \frac{\sum_m \boldsymbol{EG_{m,y}} \cdot \boldsymbol{EF_{EL,m,y}}}{\sum_m \boldsymbol{EG_{m,y}}} + \boldsymbol{\lambda_y} . \frac{\sum_k \boldsymbol{EG_{k,y}} \cdot \boldsymbol{EF_{EL,k,y}}}{\sum_k \boldsymbol{EG_{k,y}}} \quad \textbf{(3)}$$

Where:

λ_y	=	Factor expressing the percentage of time when low-cost/must-run power units are on the margin in year y
$EG_{m,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EG_{k,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit k in year y (MWh)
$EF_{EL,m,y}$	=	CO_2 emission factor of power unit m in year y (tCO_2/MWh)
$EF_{EL,k,y}$	=	CO_2 emission factor of power unit k in year y (tCO_2/MWh)
m	=	All grid power units serving the grid in year y except low-cost/must-run power units
k	=	All low-cost/must run grid power units serving the grid in year y

The lambda factor (λ) is determined as:

[12] www.xm.com.co

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

(4)

According to the methodology, the number of hours low-cost/must-run sources are on the margin is obtained through the following procedure (see Figure 4 below):

Step i) Plot a Load Duration Curve

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

Step ii) Organize Data by Generating Sources

Collect electricity generation data from each power plant/unit. Calculate the total annual generation (in MWh) from low-cost/must-run power plants/units.

Step iii) Fill Load Duration Curve

Fill the load duration curve. Plot a horizontal line across the load duration curve such that the area under horizontal line and the curve right from the intersection point (MW times hours) equals the total generation (in MWh) from low-cost/must-run power plants/units

Step iv) Determine the "Number of hours per year low-cost/must-run sources are on the margin"

Determine the "Number of hours for which low-cost/must-run sources are on the margin in year y. First, locate the intersection of the horizontal line plotted in Step (iii) and the load duration curve plotted in Step (i). The number of hours (out of the total of 8760 hours) to the right of the intersection is the number of hours for which low-cost/must-run sources are on the margin. If the lines do not intersect, then one may conclude that low-cost/must-run sources do not appear on the margin and lambda is equal to zero.

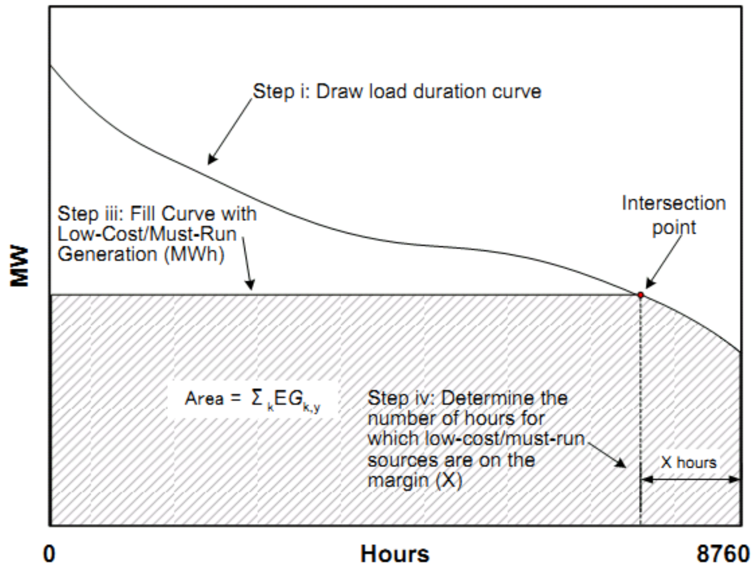


Figure 4. Illustration of Lambda calculation for simple adjusted OM method.
(Note: Step (ii) is not shown in the figure; it deals with organizing data by source.)

The detailed calculations of lambda are provided in the Excel file “EF Colombia 2016-2018 Amaime v2”. The following figures show the load duration curves and the area given by low cost/must run units, and the resulting lambda.

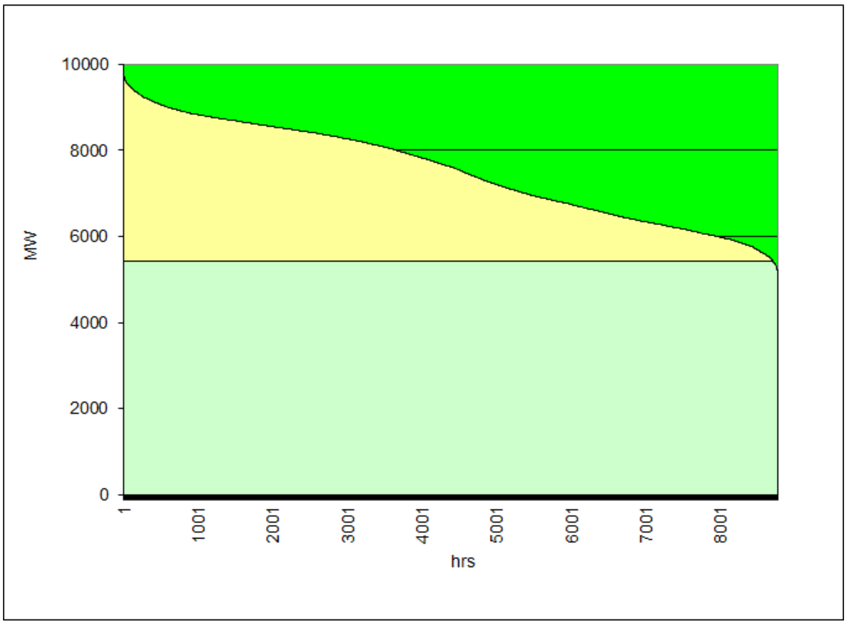


Figure 5. Load duration curve and area given by low-cost/must-run units, and the resulting lambda in year 2016.

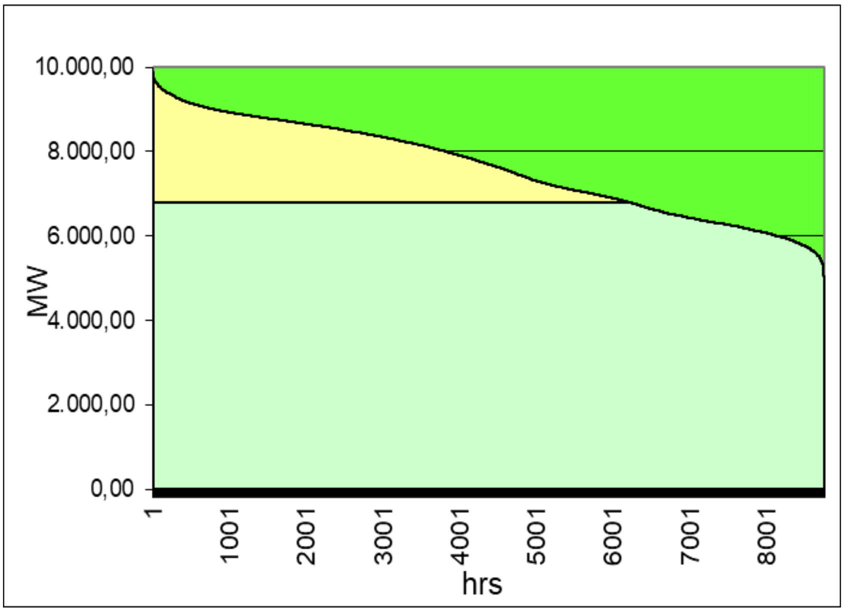


Figure 6. Load duration curve and area given by low-cost/must-run units, and the resulting lambda in year 2017.

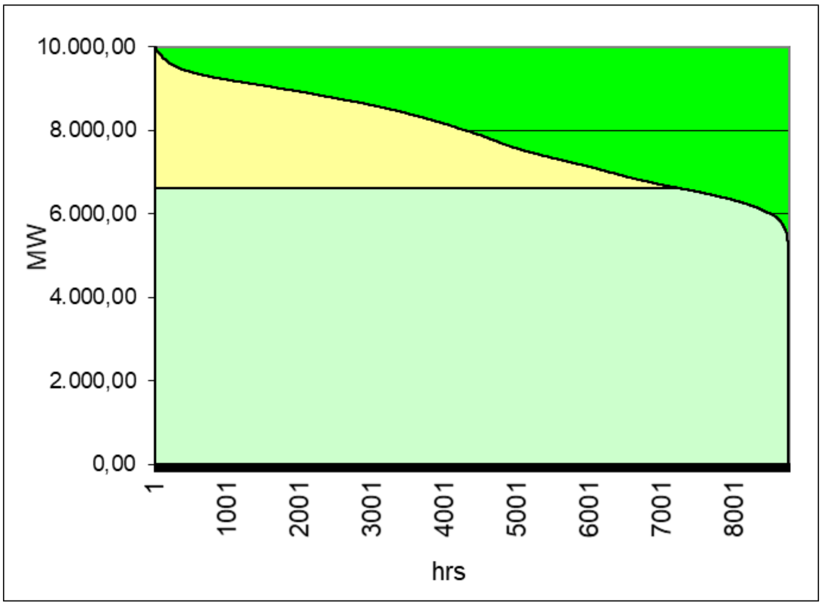


Figure 7. Load duration curve and area given by low-cost/must-run units, and the resulting lambda in year 2018.

Determination of $EF_{EL,m,y}$

The emission factor of each power unit *m* is determined as follows (power units *k* are not included, since the low-cost/must-run units have zero emissions and thus do not require calculating the emission factor):

For the simple adjusted OM "Option A: Calculation based on average efficiency and electricity generation of each plant" of the tool is chosen as the most appropriate approach. Option A2 is the appropriate method due to the availability of heat rates (efficiencies) of each plant:

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} \times 3.6}{\eta_{m,y}} \quad (5)$$

Where:

$EF_{EL.m,y}$	=	CO_2 emission factor of power unit m in year y (tCO_2/MWh)
$EF_{CO2,m,i,y}$	=	Average CO_2 emission factor of fuel type i used in power unit m in year y (t CO_2/GJ)
$\eta_{m,y}$	=	Average net energy conversion efficiency of power unit m in year y (ratio)

By applying formulae (5) to determine the emission factor of each power plant, the results from the lambda calculation and the main equation (4) for the OM emission factor, and the corresponding generation weight for each year 2016-2017-2018, the simple OM emission factor is determined as shown in Table 12.

Table 12. Simple adjusted operating margin emission factor for the years 2016-2017-2018.

Parameter	2016	2017	2018
EF No LC/MR	0.6449	0.649392	0.6600
EF LC/MR	0.000	0.000	0.000

Parameter	2016	2017	2018
Lambda	0.0089	0.2906	0.1769
EF OM [tCO_2/MWh]	**0.6392**	**0.4606**	**0.5432**
Generation [MWh]	**65,942,173**	**66,667,097**	**68,948,232**
$EF_{OM\ Simple\ adjusted\ 2018}$($tCO_2$/MWh)		**0.5472**	

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

In terms of vintage of data, option 2 of the tool is chosen, i.e. the *ex-ante* approach:

Option 2: For the first crediting period, the build margin emission factor shall be updated annually, ex post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emissions factor shall be calculated ex ante, as described in Option 2 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.

Since this calculation corresponds to second crediting period, the build margin is calculated used option 1 (ex-ante), it means that the build margin emission factor is updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE.

Capacity additions from retrofits of power plants are not included in the calculation of the build margin emission factor.

The sample group of power units *m* used to calculate the build margin is determined as per the following procedure:

(a) Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently ($SET_{5\text{-}units}$) and determine their annual electricity generation ($AEG_{SET\text{-}5\text{-}units}$, in MWh); 17,804 MWh

(b) Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEG_{total}, in MWh) 63,182,456 MWh. Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of AEG_{total} (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) (SET≥20%) and determine their annual electricity generation ($AEG_{SET\text{-}\geq 20\%}$, in MWh); 12,682,682 MWh.

(c) From $SET_{5\text{-}units}$ and $SET_{\geq 20\%}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample});

Identify the date when the power units in SET_{sample} started to supply electricity to the grid. If none of the power units in SET_{sample} started to supply electricity to the grid more than 10 years ago, then use SET_{sample} to calculate the build margin. Ignore steps (d), (e) and (f).

Otherwise:

(d) Exclude from SET_{sample} the power units which started to supply electricity to the grid more than 10 years ago. Include in that set the power units registered as CDM project activity, starting with power units that started to supply electricity to the grid most recently, until the electricity generation of the new set comprises 20% of the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation

of that unit is fully included in the calculation) to the extent is possible. Determine for the resulting set ($SET_{sample-CDM}$) the annual electricity generation ($AEG_{SET-sample-CDM}$, in MWh); If the annual electricity generation of that set is comprising at least 20% of the annual electricity generation of the project electricity system (i.e. $AEG_{SET-sample-CDM} \geq 0.2 \times EG_{total}$), then use the sample group $SET_{sample-CDM}$ to calculate the build margin. Ignore steps (e) and (f).

Otherwise:

(e) Include in the sample group $SET_{sample-CDM}$ the power units that started to supply electricity to the grid more than 10 years ago until the electricity generation of the new set comprises 20% of the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation);

(f) The sample group of power units *m* used to calculate the build margin is the resulting set ($SET_{sample-CDM->10yrs}$).

As can be seen in the excel sheet of the emission factor ("EF Colombia 2016-2018 Amaime v2"), in this case steps (a) to (c) were needed to be applied and the resulting sample group of power units *m* is the SET_{sample}.

The build margin emissions factor is the generation-weighted average emission factor (tCO2/MWh) of all power units m during the most recent year y for which power generation data is available, i.e. in this case the year 2018. The calculation is made as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \cdot EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad \textbf{(6)}$$

Where:

$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year y (tCO_2/MWh)
$EG_{m,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$	=	CO_2 emission factor of power unit m in year y (tCO_2/MWh)
m	=	Power units included in the build margin
Y	=	Most recent historical year for which power generation data is available

The emission factor of each power unit *m* in the build margin is determined analogous as for the operating margin: For all power units *m* the data on fuel consumption and electricity generation is available, therefore option A2 of the tool is chosen as the most appropriate approach (see formulae in OM).

The total generation in 2018 excluding CDM plants was 63,182,456 MWh, which means that 20% of the total generation is 12,636,491 MWh. The total generation included in the BM is 12,682,682 MWh with corresponding CO_2 emissions of 1,797,524 tCO_2.

The detailed calculations are provided in the worksheet "BM" of the Excel file "EF Colombia 2016-2018 Amaime v2".

The resulting BM emission factor is **0.1417 tCO_2/MWh**. (rounded down).

<u>Step 6: Calculate the combined margin (CM) emissions factor</u>

The combined margin emissions factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM} \qquad (7)$$

Where:

$EF_{grid,OM,y}$	=	Operating margin CO_2 emission factor in year y (tCO_2/MWh)
$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year y (tCO_2/MWh)
w_{OM}	=	Weighting of operating margin emissions factor (%)
w_{BM}	=	Weighting of build margin emissions factor (%)

The weighting of operating and build margin is done as indicated in the tool for the second crediting period, i.e. w_{OM} = 0.25 and w_{BM} = 0.75.

The combined margin emission factor is calculated as $\mathbf{EF_{grid,CM,y}}$ **= 0.2430** tCO_2/MWh (rounded down).

B.6.2. Data and parameters fixed ex ante

Data/Parameter	$\mathbf{EF_{grid,OM\text{-}adj,y}}$
Data unit	tCO_2/MWh
Description	Operating margin emission factor
Source of data	Associated Services Management, XM Compañía de Expertos en Mercados S.A. E.S.P (XM System). and Fuel Emissions Factor database of Colombia published by UPME (FECOCupme.xls).
Value(s) applied	0.5472
Choice of data or measurement methods and procedures	Calculated as per “Tool to calculate the emission factor for an electricity system, version 07.0” applying option ex-ante meaning that the emission factor is determined once at the validation stage, thus no monitoring and recalculation of the emissions factor during the crediting period is required. Therefore, it is calculated using the 3-year generation weighted average based on the most recent data 2016-2017-2018. The data is obtained from “XM System” Colombian grid operator. Please check section B.6.1 of the document
Purpose of data	Baseline emissions
Additional comment	-

Data/Parameter	$\mathbf{EF_{grid,BM,y}}$
Data unit	tCO_2/MWh
Description	Building Margin CO_2 emission factor in year y
Source of data	Associated Services Management, XM *Compañía de Expertos en Mercados S.A. E.S.P (XM).*
Value(s) applied	0.1417
Choice of data or measurement methods and procedures	Calculated as per “Tool to calculate the emission factor for an electricity system, version 07.0” applying option ex-ante using the most recent information available on units already built which means 2018-year generation. The data is obtained from “XM” Colombian grid operator. Please check section B.6.1 of the document.
Purpose of data	Baseline emissions
Additional comment	-

Data/Parameter	$\mathbf{EF_{grid,CM,y}}$

Data unit	tCO_2/MWh
Description	Combined Margin CO_2 emission factor in year y
Source of data	Associated Services Management, XM *Compañía de Expertos en Mercados S.A. E.S.P (XM System). and* Fuel Emissions Factor database of Colombia published by UPME (FECOCupme.xls)
Value(s) applied	0.2430
Choice of data or measurement methods and procedures	Calculated as per "Tool to calculate the emission factor for an electricity system, version 07.0" applying option ex-ante using the generation-weighted average of years 2016-2017-2018, based on the most recent data. The data is obtained from "XM System" Colombian grid operator. Please check section B.6.1 of the document
Purpose of data	Baseline emissions
Additional comment	-

Data/Parameter	**CAP_{BL}**
Data unit	W
Description	Installed capacity of the hydro power plant before the implementation of the project activity (W). For new hydro power plants, this value is zero
Source of data	As per methodology ACM0002 version 19.0, for new reservoirs this value is zero.
Value(s) applied	0
Choice of data or measurement methods and procedures	The project is a greenfield power plant
Purpose of data	Calculation of project emissions
Additional comment	-

Data/Parameter	**A_{BL}**
Data unit	m^2
Description	Area of the single or multiple reservoirs measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m^2). For new reservoirs, this value is zero.
Source of data	As per methodology ACM0002 version 19.0, for new reservoirs this value is zero.
Value(s) applied	0
Choice of data or measurement methods and procedures	The project is a greenfield power plant
Purpose of data	Calculation of project emissions
Additional comment	-

B.6.3. Ex ante calculation of emission reductions

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

$$ER_y = BE_y - PE_y - L_y \quad \textbf{(8)}$$

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
- LE_y represents the emissions due to leakages during year y

Project emissions – PEy

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

PE_y = Project emissions in year y (tCO_2e)
$PE_{FF,y}$ = Project emissions from fossil fuel consumption in year y (tCO_2)
$PE_{GP,y}$ = Project emissions from the operation of geothermal power plants due to the release of non-condensable gases in year y (tCO_2e)
$PE_{HP,y}$ = Project emissions from reservoirs of hydro power plants in year y (tCO2e)

In Amaime Minor Hydroelectric Power Plant:

$PE_{FF,y}$ = Project emissions from fossil fuel consumption in year y (tCO_2)

Due to the absence of a back-up generator, fossil fuel combustion that does not occur;

Therefore, $PE_{FF,y} = 0$

$PE_{GP,y}$ = Project emissions from the operation of geothermal power plants due to the release of non-condensable gases in year y (tCO_2e).

Operation of geothermal power plants due to the release of non-condensable gases are not considered, because there are not geothermal power plants connected in the Colombian grid.

Therefore, $PE_{GP,y} = 0$

$PE_{HP,y}$ = Project emissions from reservoirs of hydro power plants in year y (tCO_{2e})

As per the applied ACM0002, since the project activity plant does not have a reservoir, project proponents do not need to account for CH_4 and CO_2 emissions from the reservoir therefore the power density is far above the required 10W/m as prove bellow.

The power density of the project activity (PD) is calculated as follows:

$$PD = \frac{Cap_{PJ} - Cap_{BL}}{A_{PJ} - A_{BL}} \qquad \textbf{(9)}$$

Where:

PD	=	Power density of the project activity (W/m^2)
Cap_{PJ}	=	Installed capacity of the hydro power plant after the implementation of the project activity (W)
Cap_{BL}	=	Installed capacity of the hydro power plant before the implementation of the project activity (W). For new hydro power plants, this value is zero
A_{PJ}	=	Area of the reservoir measured in the surface of the water, after the implementation of the project activity, when the reservoir is full (m^2)
A_{BL}	=	Area of the reservoir measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m^2). For new reservoirs, this value is zero

Considering that Cap_{PJ} = 21,340,000 W, A_{PJ} = 2,895.11 m^2 [13] and A_{BL}=0.
Them PD = 21,340,000/2,895.11 = 7,371.04 (W/m^2). It is proven that the power density of the project activity is greater than 10 W/m^2.

In conclusion following the methodology PEy=0

Leakage emissions – LEy

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

Therefore, it can be concluded that:

ERy = BE_y

As explained above in Section B.6.1, emission reductions are calculated as follows:

$$ER_y = EG_{facility,y} \times EF_{grid,CM,y}$$

Where:

ER_y	=	Emission reductions in year *y* (tCO_2)
$EG_{facility,y}$	=	Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y* (MWh)
$EF_{grid,CM,y}$	=	CM CO_2 emission factor in year *y* (tCO_2/MWh)

For the ex-ante calculation of emission reductions, the quantity of net electricity supplied to the grid is estimated based on Amaime Hydropower monitoring. The proposed project activity is expected to supply an average of 92,400 MWh per year to the grid.

As shown above in Section B.6.1, the CM emission factor is calculated as follows:

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

According to the Tool, for Hydro power generation projects in their second crediting period, the weights to be applied are: w_{OM} = 0.25 and w_{BM} = 0.75.

The OM emission factor is determined as 3-year generation-weighted, based on the most recent data available at the time of submission of the project documentation to the DOE for validation. Specifically, data for years 2016-2017-2018 is used, and the resulting OM emission factor is 0.5472 tCO_2/MWh.

The BM emission factor is determined based on the most recent information available on units already built at the time of submission of the project documentation to the DOE for validation. Specifically, data from year 2018 are used, and the resulting BM emission factor is 0.1417 tCO_2/MWh.

Thus, the resulting CM emission factor is the following:

[13] See document 5 - RE_ Ortofotografía Captación CH Amaime _Renovación MDL

$EF_{grid,CM,y}$= 0.5472 tCO_2/MWh × 0.25 + 0.1417 tCO_2/MWh × 0.75 = **0.2430 tCO_2/MWh**

As a consequence, the annual value of emission reductions estimated for the project activity is the following:

ER_y = 92,400 MWh × 0.2430 tCO_2/MWh = **22,453 tCO_2**

Thus: **ER_y = 22,453 tCO_2/yr**
(Leap years with 366 days reduce 22,515 tCO_2)

In accordance with the ACM0002 / version 19 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 (Ly =0), since the plant will not have an accumulation 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

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
November – 2017	2,707	0	0	2,707
2018	22,453	0	0	22,453
2019	22,453	0	0	22,453
2020*	22,515	0	0	22,515
2021	22,453	0	0	22,453
2022	22,453	0	0	22,453
2023	22,453	0	0	22,453
November – 2024*	19,808	0	0	19,808
Total	**157,294**	0	0	**157,294**
Total number of crediting years	7			
Annual average over the crediting period	22,470	0	0	22,470

* leap years of 366 days (2020 and 2024)

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data/Parameter	**$EG_{facility, y}$**
Data unit	MWh/yr
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in year y.
Source of data	Electricity meter(s)
Value(s) applied	92,400 MWh/ year.
Measurement methods and procedures	The quantity of energy generated will be monitored by EPSA. The data obtained will be recorded once a month on a spreadsheet. In addition, the data will also be provided by the XM, which will be downloaded and recorded annually.

Monitoring frequency	The quantity of energy generated will be monitored by EPSA each hour. Continuous monitoring and monthly recording and invoicing. EPSA is responsible for downloading the information 4 times a day. Every day, EPSA prepare a generation report, which must coincide with that reported in the XM portal (grid operator and administrator).
QA/QC procedures	Cross check measurement results with records for sold electricity: 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 or at least every 4 years according to Resolution CREG 038-2014.

Measurement point type	Consumption or energy transfer (MWh-month)	Installed capacity (MW)
1	C ≥ 15.000	CI ≥ 30
2	15.000 > C ≥ 500	30 > CI ≥ 1
3	500 > C ≥ 50	1 > CI ≥ 0,1
4	50 > C ≥ 5	0,1 > CI ≥ 0,01
5	C < 5	CI < 0,01

Measurement point type	Calibration frequency (years)
1	2
2 y 3	4
4 y 5	10

Project activity	Installed capacity (MW)	Calibration frequency (years)
Amaime	21.34	4

QA/QC procedures (cont.)	The measurement data registered by the personnel of EPSA will be compared with the data provided by the XM to detect possible error. The meters have an accuracy class of 0.2S or grater.
Purpose of data	Baseline emissions
Additional comment	-

Data/Parameter	**CAP_{PJ}**
Data unit	W
Description	Installed capacity of the hydro power plant after the implementation of the project activity (W)
Source of data	The installed capacity is determinate with the manufacture plate attach to the generation units- EPSA S.A. E.S.P.
Value(s) applied	21,340,000
Measurement methods and procedures	The measurement method for this parameter is the revision of the manufactures plate.
Monitoring frequency	Once at validation stage
QA/QC procedures	Measurement just at validation stage
Purpose of data	Calculation of project emissions
Additional comment	Monitored just at validation stage

Data/Parameter	**A_{PJ}**
Data unit	m^2
Description	Area of the single or multiple reservoirs measured in the surface of the water, after the implementation of the project activity, when the reservoir is full (m^2)
Source of data	Aerial photos taken by a DRON at the project activity site.

Value(s) applied	2,895[14]
Measurement methods and procedures	Measured from aerial photo taken by a DRON. The area estimation is made with a graphical scale in the processing software of the image.
Monitoring frequency	Once at validation stage
QA/QC procedures	Measurement just at validation stage
Purpose of data	Calculation of project emissions
Additional comment	Monitored just at validation stage

B.7.2. Sampling plan

Not Applicable

B.7.3. Other elements of 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 organized from the start, in terms of data gathering and maintenance, as required to obtain realistic GHG emission data.

Electricity generation and monitoring procedures

Monitoring procedures of the Minor Hydroelectric Power Plant of Amaime are implemented onsite or remote, using Advance Metering Reading - AMR technology. The EPSA-CELSIA measurement operational team is in charge of taking the measurements and reporting to XM. A main and backup meters are installed at the interconnection point of the project with the SIN (which is where the commercial frontier registered with the Administrator of the electrical interconnected system - XM- will be established). The energy meters in the Amaime substation are read via dedicated software every 6 hours. A daily automatic generation report is sent to XM from the substation by the Measurement Management Center – CGM operated by EPSA-CELSIA (see Figure 8).

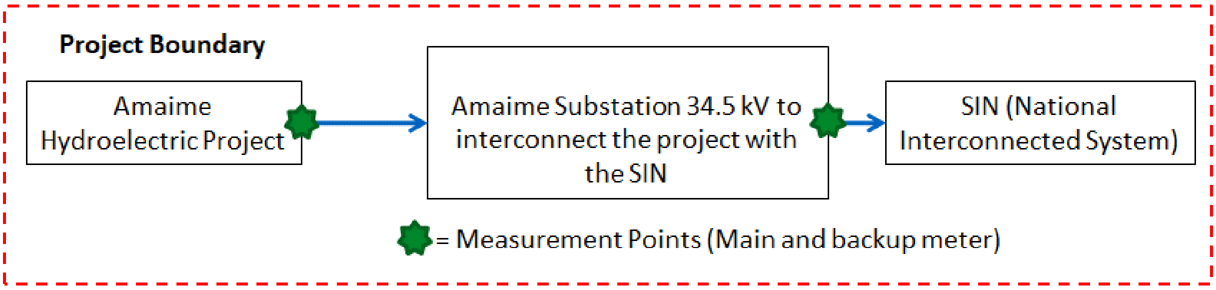


Figure 8. Project Boundary – Monitoring Plan

The counter of Amaime Substation is the one that marks the energy that enters the SIN[15], which is remunerated and on which the charges of the Wholesale Energy Market (MEM) are charged. The way to transmit the information between the CGM[16] (Measurement Management Center - operated by EPSA-CELSIA) and the hydroelectric power station is via AMR (data system), then the CGM transmits the information to XM (Experts in Markets – Expertos en Mercados S.A. E.S.P.) in real

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[14] See document 5 - RE_ Ortofotografía Captación CH Amaime _Renovación MDL

[15] In the Colombian regulation, this is called “commercial boundary” or in Spanish: “frontera comercial”. The substation is Amaime 34.5 kV.

[16] In Spanish - Centro de Gestión de Medida - CGM

time through the web-service. This process includes the interaction with ASIC[17], the Administrator of the Trade Exchanges System-XM in charge of the registration of contracts, liquidation and the billing of all the transactions carried out in this market. With the web-service the report is made to ASIC.

Generation data by regulation is stored for two years (According to resolution CREG 038), and for EPSA-CELSIA internal policies they are stored for 3 years. The data acquisition software is called PRIME READ and the management software is MDM Energy IP, likewise, the report software is MITHRA (through this software the data is sent to XM).

As indicated, at every measurement point there is a main electricity meter and a backup meter, which assures correct measurement in case of failures of the main electricity meters (See Table 13). If any other emergency would not allow measuring correctly the power generation of the plant or if data would be missing as a result of a failure in the monitoring process, no emission reductions shall be claimed during that period until guaranteeing again correct function of the meters and having reliable data. In general monitoring equipment characteristics will follow the specifications required by the CREG measurement code.

Table 13. Monitoring Equipment and calibration frequency

Project	Description	Localization	Calibration Frequency
AMAIME	Commercial Measurement System (SMC) 01: Main Meter	Substation Amaime 34.5 kV	Every four (4) years according to CREG Measurement Code - 038 of 2014
	Commercial Measurement System (SMC) 02: Backup Meter	Substation Amaime 34.5 kV	

QA/QC measures

All meters must comply with the standards established by the CREG, in terms of its specifications and calibrations. According to Resolution CREG 038 of 2014[18], article 11 and 28, it is established that by the installed capacity of the power plant Hydroelectric Amaime (30>CI>1 MW) the measurement point is recognised as type 2 of the commercial boundary. According to this, the calibration of the equipment should be done at least every four years and must be certified by a body endorsed by XM.

The same resolution indicates that the system measurement elements must have a valid calibration certificate, issued by a certifying body approved by ONAC[19] (National Accreditation Body of Colombia).

Calibration tasks also follow national standards and are in accordance with the calibration instructive specified in Colombian standard NTC 4856 for electricity metering devices. In case both meters fail, no emission reductions will be claimed during that period until having again data from the main or backup meter.

The accuracy of the measuring equipment depends on the classification of the type of measurement according to table 1, article 6 Res CREG 038-2014. The required precision is found in Table 2, Article 9, Resolution. CREG 038-2014.

[17] In Spanish - Administrador del Sistema de Intercambios Comerciales - ASIC

[18] See document *9 - Resolucion-CREG-038-de-2014-codigo-de-medida.pdf*

[19] In Spanish – Organismo Nacional de Acreditación - ONAC

Supervision and accountability policies monitoring activities

The processes of supervision and accountability are made according to the existing regulation. EPSA-CELSIA as the CGM operator must submit annually a report with the operation of the measurement management system, according to the guidelines of resolution 038-2014, annex 3 and Circular 049 of 2015.

Data readings of the generated energy are made every 15 minutes. The CGM is responsible for downloading the information 4 times a day. Every day, the CGM make reports with the information from the previous day's generation, which must coincide with that reported in the XM portal.

The CGM data verification is performed checking data that comes from the main meter, matches those of the backup meter. Also, that the 96 data collected in the day (data corresponding to the readings that are made every 15 minutes), is within the normal ranges (not exceeding the capacity of the plant, not negative data, etc.).

Personnel responsible for monitoring

Figure 9 shows the organizational chart of the monitoring.

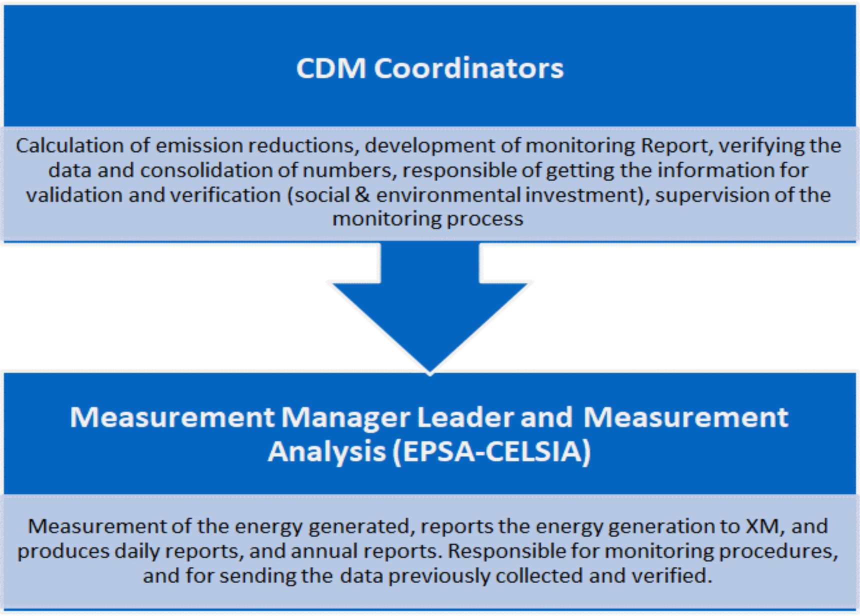

Figure 9. Operational structure of the monitoring plan

Responsible personnel:

- The CDM Coordinators supervise the monitoring process and are in charge of compiling the monitoring data in an excel spreadsheet and calculating the emission reductions of the monitoring period. They also watch over the Monitoring Report, usually developed by an external consultant in accordance with the CDM rules.

- The Operational Team at EPSA-CELSIA, which includes Measurement Manager Leader and Measurement Analysis is responsible for electricity generation reading and for processing the energy produced by the project from the meters installed at the substation. Records of the meter are downloaded in a spreadsheet for measurement control and the data discharged from the meter is stored electronically.

Personnel who carry out monitoring tasks are familiar with the basic monitoring requirements and structures. Since the main monitoring tasks, i.e. the measurement of the energy production, the calibration of energy meters, and the reporting of the energy generation, are carried out independently from the CDM project as part of the daily operation, no specific training is required. The CDM project Coordinators are supported by an external consultant if necessary, in order to assure correct application of the monitoring procedures. They also carry out corrective actions if any inconsistency is identified and train the internal personnel if necessary.

Other monitoring information

Likewise, the Plant's Operation Reports will be used as a reference and be made available for any inspections carried out during the second 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 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.

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

- Quantity of electricity generated by the Minor Hydroelectric Power Plant of Alto Tuluá each hour. The measurement data registered by the personnel of EPSA will be compared with the data provided by the XM 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.

All data and parameters will be recorded in accordance with the quality systems on place, with their corresponding quality control and assurance procedures.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

15/04/2008

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 (Second crediting period)

C.3.2. Start date of crediting period

18/11/2017 (Second crediting period)

C.3.3. Duration of crediting period

7 years and 0 months (renewable)
18/11/2017 – 17/11/2024

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

This assessment has been made during the validation of the PA (it does not represent new information).

EPSA S.A. E.S.P. Empresa de Energía del Pacífico requested Hidroccidente S.A. and INTEGRAL Ingeniero Consultores the “Study of the Environmental Impact of the Minor Hydroelectric Power Plant of Amaime", 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 EHP is structured in a series of technical handling files, including the following: objective, activities that generate impacts, mitigation and control measures, place of implementation, applicable regulations, time of execution, monitoring or follow-up indicators and monitoring supervisors. In addition, it presents a six-monthly chronogram, as close as possible to the excepted results for the construction and project operation stages.

Specifically, seventeen Environmental Handling and eight follow-up and monitoring files will be used, they are structured as follows:

- Geotechnical handling
- Handling of solid waste
- Handling of surface and underground water
- Handling of the quality of air
- Handling of the biota (terrestrial flora and fauna)
- Hydro-biological handling
- Social handling (economic and socio-cultural aspects)

The eight files of the Follow-up and Monitoring Plan can be used to establish the qualitative and quantitative indicators for the social and environmental management, guaranteeing the efficiency and efficacy of the processes associated to construction, operation and dismantling.

The Environmental Handling Plan has already been approved for Amaime by the CVC (competent environmental authority) and is integrated within the Environmental License.

In accordance with resolution 0100 N0, 0720-0470 of September 25, 2007, the Environmental License is awarded to Empresa de Energía del Pacífico S.A. E.S.P. – EPSA E.S.P. for the project of the “Minor Hydroelectric Power Plant of the Amaime River 1400”. Resolution No. 0100. 0720-0144, March 4, 2008 clarifies certain aspects of the content of resolution 0100 N0. 0720-0470, September 25, 2007, relating to "permit continued occupation of channels and approval waterworks", "Clean Development Mechanisms" and "Material of underground excavations."

D.2. Environmental impact assessment

This assessment has been made during the validation of the PA (it does not represent new information).

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

a) during the current period, when the cumulative existing impacts were identified
b) during the period when the works execution was projected, assessing the potential impacts associated to construction processes
c) during the operation and dismantling of the project

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.

The existing impacts are associated to the structure and use of the different socio-productive spaces and their dynamics. Basically, they are derived from the constructions aimed at satisfying the population's needs (roads, service network, livestock farming, agriculture, exploitation of other resources). In addition, there are other impacts associated to the natural conditions of the region, such as the areas tectonized by the southwest fault systems, which affect part of the basin, as well as the conditions in the landscape, such as the erosion and landslides, which are sometimes increased by man-induced activity.

Human activity can produce micro-climate consequences in the area, but there are no studies that provide enough evidence. As regards the water flows, there is an intervention of flows that have generated the increase in the dragging of currents, contaminating the flow by organic and inorganic materials and bypassing the flows for socio-economic uses. The introduction of fauna and flora and the alteration of native landscapes have affected the native flora and fauna, decreasing the quantity of species and/or number of individuals. In socio-cultural terms, the populations cannot easily access resources and have plenty of technical deficiencies in their delivery, in addition to the unequal distribution of them throughout the basin. In general, these impacts have a cumulative character.

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,

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 is structured in a series of technical handling files and a six-monthly chronogram for the construction, operation and dismantling stages.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

This assessment has been made during the validation of the PA (it does not represent new information).

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 Study of the Project of the Minor Hydroelectric Power Plant of Amaime to draw up the design, impact and environmental handling plan studies.

This rapprochement to the local communities materialised in informative meetings of the project called by EPSA and HIDROOCCIDENTE, with the participation of the chairmen of the community action committees of each borough.

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 fourteen information and project validation meetings were held with the communities, as shown on the following table:

Table 14. Stakeholder consultations

Meeting No,	Place	Participating community	Date
1	Chamber of Commerce of Palmira	Entities, institutions and the community in general	February 11, 2006
2	Borough of Tablones	Community of Tablones	February 22, 2006
3	Community Action Committee Premises of Toche	Communities of Combia, Toche, Cabuyal and Teatino	March 1, 2006
4	Premises of Jac Cabuyal	Community of Cabuyal	May 8, 2006
5	School of Auji	Community of Aují	May 10, 2006
6	Hernando Borrero Cuadros School	Community of the basin of the Amaime River	June 6, 2006
7	School of El Moral	Community of El Moral	June 7, 2006
8	School of Tenerife	Community of Tenerife	June 27, 2006
9	Community Premises of Combia	Communities of Toche, Combia, Cabuyal and Teatino	June 28, 2006
10	School of Auji	Communities of Aují and Regaderos	July 14, 2006

Meeting No,	Place	Participating community	Date
11	Premises of Jac el Moral	Community of El Moral	July 22, 2006
12	Premises of Jac Toche	Communities of Toche and Santa Luisa	August 12, 2006
13	Premises of Jac Combia	Community of Combia	September 2, 2006
14	Premises of Boyoca	Communities of Boyaca, Tablones and Areneros	September 15, 2006
15	Premises of Jac Cabuyal	Community of Cabuyal	May 8, 2006
16	School of Auji	Community of Aují	May 10, 2006
17	Hernando Borrero Cuadros School	Community of the basin of the Amaime River	June 6, 2006
18	School of El Moral	Community of El Moral	June 7, 2006

The representatives of the different institutions participated in these meetings, 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.
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E.2. Summary of comments received

This assessment has been made during the validation of the PA (it does not represent new information).

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 opinions about the project is shown next, which were gathered from the minutes of the meetings held, as explained in the previous chapter:

- Water must not be privatized with the project: it must be a resource for everyone and must be controlled
- Adequate conservation of water
- The projects' benefits must be agreed directly with the communities
- The transfer resources must be included in the community actions, as shown in a plan that includes the community's participation
- The EPSA must take into account the community when offering employment at the construction work site and the services associated
- The project offers employment opportunities for men and women of the community
- The arrival of external personnel will bring income that will be invested in the region, thus benefiting from the growth of tourism
- The project will increase the standard of living of the community
- The labour of the project must be hired from the community and this must be a condition for contractors

- The system rooms can be used to train adults,
- The county of La Tigrera has 12 houses with no energy supply, they request to the project and EPSA the revision of their situation and ask for support in the electrification of their homes
- The project is very positive, we hope that it is executed as soon as possible
- The project should help reforest the highest areas to maintain the water levels, since they drop during the summer, and the CVC and municipality must invest the resources of this project
- Commitments and agreements must be signed to make sure that all of the tasks promised by EPSA are carried out
- Support is requested to improve the aqueduct of Carrizal
- The project is positive, provided that it is executed as what they presented
- The project should be started as soon as possible, since it will be very positive for the community if all commitments are satisfied

E.3. Consideration of comments received

This assessment has been made during the validation of the PA (it does not represent new information).

The company Energía del Pacífico, EPSA is committed to the following, based on the projects identified and prioritised in the meetings held with the communities and their representatives:

- Support and promote the training of members of the community who are interested in becoming part of the project, in accordance with the requirements and availability of posts required for the development of the works; these will be adapted to the positions made available by the construction firm that is the winning bidder in EPSA's construction tender.
- Participation in the meetings held by the delegates to receive information related to the progress of the construction works, provided that their purpose is to supply information about the activities to be developed, which are in relation to the everyday community tasks.
- Proactive support to the implementation and follow-up of the communication strategy defined, with the purpose of maintaining a communication space permanently between the community, EPSA and the construction firm, with the creation, operation and operation of the committee that supervises and follows-up on the compliance with the agreements, regulations and the execution of the EHP.
- Promote the implementation of communication strategies between leaders and delegates that can foster the creation of official communication channels, to facilitate the arrangement and improvement of social relations between counties and EPSA in relation to the project.
- Participate, promote, support and/or stimulate inter-institutional programs defined for the integral improvement of the basin of the Amaime River, led by the hand of the community organisations of the basin.
- Respect the priorities in the use of water, in accordance with the current regulations, whereby human consumption will be the main priority.

SECTION F. Approval and authorization

The letter of approval given by Colombian Ministry of Environmental, Housing and Territorial Development, has an approval date the 30/05/2008 for the Amaime Minor Hydroelectric Project[20].

[20] See document 3 - Amaime Letter of Approval of Colombia.pdf

Appendix 1. Contact information of project participants

Organization name	Empresa de Energía del Pacífico S.A. E.S.P. (EPSA S.A. E.P.S.)
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Appendix 2. Affirmation regarding public funding

Not applicable

Appendix 3. Applicability of methodologies and standardized baselines

Not applicable

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

Not applicable

Appendix 5. Further background information on monitoring plan

Not applicable

Appendix 6. Summary report of comments received from local stakeholders

Not applicable

Appendix 7. Summary of post-registration changes

The following permanent changes from the initially registered PDD (version 03.6 from March 10, 2009) were made in the PDD version 06:

Corrections (as per section 12.8.3.1 of the CDM Project Standard, version 02.1)

The following corrections were made to the PDD:

- The table with GHG included in the project boundary in section B.3. was completed since some fields were empty in the original PDD.

- The project scheme/diagram in section B.3. was replaced by Figure 1 which includes additional information on monitoring parameters (no relevant information was modified, but only complementary information added)
- The coordinates in section A.2. were changed from "Datum Bogotá" to geographical coordinates in decimal degree (using the powerhouse as the reference point)
- Some new information was added due to the requirements in the new PDD form applied (version 04.1) and that was not required in the previous PDD form, e.g. in section B.7.1 the "Purpose of data" was added for all monitoring variables and the information about the Letters of Approval was included in Section F.
- Some other minor formal corrections were made in several parts of the PDD.

Changes to the start date of the crediting period (section 12.8.3.2) of the CDM Project Standard, version 02.1)

As per section C.2.1.1 of the registered PDD (version 03.6), the start date of the project activity was expected to be August 1, 2010[21]. This start of the crediting period has been adjusted to November 18, 2010, which is the real start of the operation of the power plant and generation of emission reductions.

Since the project activity was registered on 29/10/2009, this change is in line with the paragraphs 214 to 217 of the Project Standard, version 02.1.

The new start date of 18/11/2010 has been included in this revised PDD version 06

Permanent changes from the registered monitoring plan or applied methodology (as per section of the CDM Project Standard, version 02.1)

In the registered PDD version 03.6, there were two monitoring parameters called "Social and environmental investments" and "Investments related to obtaining CERs". These are not relevant for emission reduction calculations and are not required as per the applied methodology ACM0002 (version 07). Therefore, they have been removed in the revised PDD version 06.

Changes to the project design of a registered project activity (as per section 12.8.3.4 of the CDM Project Standard, version 02.1)

The installed capacity of the power plant in the registered PDD version 03.6 from 10/03/2009 (registration date 29/10/2009) was 18 MW (defined as the capacity at the interconnection point in the substation after power losses in equipment's and transmission of 11.7 km), considering a turbine capacity of 19.176 MW (two units with 9.588 kW each). These were estimated values based on the expectations during project planning. After full project implementation, the resulting capacity at local conditions onsite was higher: the maximum capacity at the interconnection point with current equipment that has been reached since project start was 19.17 MW and the total turbine capacity of 21.34 MW (two units with 10.67 MW).

Analysis of additionality of the project activity with increased capacity

The additionality analysis in the registered PDD is made based on a comparison of different alternatives (Option II of the "Tool for the demonstration and assessment of additionality" Version 05.2). The most attractive investment alternative is a fuel-fired power plant with an IRR of 16.65%, which is used as the benchmark. The project activity's IRR is calculated as 11.77%. In the original IRR calculation, this result does not depend on the project capacity due to the

[21] On the UNFCCC website, this date was erroneously published as October 29, 2010.

formulas applied, but only on the annual energy generation[22]. Thus, the energy generation shall be varied to analyse the potential impact of the capacity increase on project additionality by comparing the new IRR to the benchmark of 16.65% (i.e. the same criteria are applied). All other variables that do not depend on the capacity are kept identically as in the original analysis.

For this revised PDD, the installed capacity is defined as the total turbine capacity of 21.34 MW (two units with 10.67 MW). However, as explained, this variable is not directly linked to additionality in the original Excel spreadsheet, but the annual generation. Therefore, the generation and not the capacity is varied for this analysis. It is also important to take into account that the turbine capacity alone does not define the plants real generation capacity, since the power generator has a smaller capacity and acts as a bottleneck. Additionally, there are some power losses in transformers and transmission to the interconnection point at the substation (distance 11.), where the energy meters are installed. Actually, the power capacity at that interconnection point is more relevant for generation and invoicing, and thus for additionality.

Despite of this capacity increase, the **average power generation that can be expected is very similar as in the PDD** and is not significantly influenced by the capacity change. The main reasons are the following:

- **Regulatory conditions:** The environmental licence allows the project capturing up to a maximum of 12 m^3/s of the river. Besides, an ecological flow of at least 20% of the river discharge has to be guaranteed. Moreover, the environmental permit limits the generation to a maximum of 118.3 GWh per year. This value was also included in the PDD version 03.6 and presents an upper limit that is not allowed to be surpassed.

- **Water available**[23]: Typically, the power plant does not operate at full capacity due to the availability of water. Most of the time it generates less than 18 MW (interconnection), which means that the increase capacity of the equipment has no influence on energy generation.

Since the impact of the capacity increase on annual generation is negligible, the average generation remains very similar as expected in the registered PDD version 03.6, i.e. 85 GWh/year. In this case, since no parameters vary, the IRR remains the same (11.77%) and the additionality is not affected.

In order to further sustain this analysis, several scenarios with different levels of energy generation are developed and the impact on the original additionality analysis is evaluated (CERs contribution is not analysed, since it is not relevant).

Therefore, it can be concluded from the scenario analysis that the project would not reach an IRR of 16.65% and thus in any case this main additionality criterion is not affected by the change.

There was a complementary benchmark analysis included in the investment analysis. This was only used to reinforce the main analysis, but it is not decisive because there are other arguments that are not influenced by the change and are still valid additionality criteria.

[22] see financial spreadsheet “090203_PDD Amaime_Financial_Comparison”
[23] All data and calculations of the values in this paragraph can be found in the Excel file “Generation Amaime 1st verification”

Conclusion

As can be seen, the change to the project design in the registered PDD version 03.6 does not impact additionality as presented in the original PDD. In none of the analysed scenarios -which include very optimistic scenarios- the project activity's IRR would reach the IRR of the alternative chosen in the comparison analysis. Even if the generation reaches the maximum of 118.23 GWh allowed in the environmental licence and which is way above expected average generation, it still does not reach the IRR of the alternative. Moreover, all barriers of the original PDD do not depend on the capacity and are still valid, thus it can be concluded that additionality is not impacted by the capacity increase.

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Document information

Version	*Date*	*Description*
11.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Make editorial improvements.
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.

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

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Business Function: Registration
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