Zeus Hydroelectric Power Plant

Document prepared by South Pole Carbon Asset Management S.A.S.

Name of the project	*Zeus Hydroelectric Power Plant*
Project holder	*Central Hidroeléctrica Zeus S.A.S. E.S.P.*
Project holder's contact information	*Juan Felipe Posada Rojas* *Cr 43B 19-95 Oficina 1312 ED CCI, Medellín, Colombia* *juanposada@grupocolviva.com* *+57 604 4444 08 56*
Project participants	*South Pole Carbon Asset Management S.A.S.*
Version	*4.0*
Date	*24/October/2024*
Project type	*Energy sector: Renewable energy- Hydraulic power*
Grouped project	*No*
Applied Methodology	*AMS-I.D.: Grid connected renewable electricity generation --- Version 18.0*

Project location (City, Region, Country)	*Donmatías, Antioquía, Colombia*
Starting date	30/09/2020
Quantification period of GHG emissions reduction	17/05/2022 to 16/05/2029
Estimated total and average annual GHG emission reduction/removals amount	Estimated total: 162,092 tCO_2e; Annual average: 23,156 tCO_2e/yr
Sustainable Development Goals	*7, 8,13*
Special category, related to co-benefits	*NA*

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1 Project type and eligibility

1.1 Scope in the BCR Standard

The project is eligible under the scope of the BCR Standard by meeting one or more of the following conditions:

The scope of the BCR Standard is limited to:	
The following greenhouse gases, included in the Kyoto Protocol: Carbon Dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O).	X
GHG projects using a methodology developed or approved by BioCarbon, applicable to GHG removal activities and REDD+ activities (AFOLU Sector).	
Quantifiable GHG emission reductions and/or removals generated through implementation of GHG removal activities and/or REDD+ activities (AFOLU Sector).	
GHG projects using a methodology developed or approved by BioCarbon, applicable to activities in the energy, transportation and waste sectors.	X
Quantifiable GHG emission reductions generated through implementation of activities in the energy, transportation and waste sectors.	

The Zeus Hydroelectric Plant project consists of a run-of-the-river power plant that uses the waters of the Rio Grande River at an elevation of 1766 meters above sea level, with a design flow of 7 m^3/s and a gross head of 169.98 m. Although the two turbines have a total capacity of 10,196 MW, the real installed capacity of the power plant is 9.887 MW, calculated based on the maximum turbine flow of 7 m^3/s. This complies with the standard rule, which states that only small run-of-river hydropower plants between 500 and 20,000 kW of installed capacity are eligible.

1.2 Project type

Activities in the AFOLU sector, other than REDD+	

REDD+ Activities	
Activities in the energy sector	X
Activities in the transportation sector	
Activities related to Handling and disposing of waste	

1.3 Project scale

According to the system scale definitions in the Clean Development Mechanism (CDM), the project is classified as a small-scale project activity due to its total installed capacity of less than 15 MW[1].

2 General description of the project

The proposed project consists of implementing a hydroelectric plant located in the municipality of Donmatias, which lies within the Antioquia department in Colombia. The implementation of the project ensures energy security, diversifies the grid's generation mix, and leads to the sustainable growth of the electricity sector. The project consists of installing 2 Francis turbines, provided by Wasserkraft Volk, with a total installed capacity of 9.88 MW based on a feed flow of 7 m^3/s and an expected generation of 59,200 MWh per year of renewable energy.

The electricity is dispatched to the Colombian electricity grid. Prior to project implementation, no hydroelectric plant or other generation plants were installed at the site. In the baseline scenario, the energy delivered to the grid is generated by a mix of thermal and renewable power generation as reflected in the combined margin emissions factor (as per the tool applied). Hence, the project will reduce

[1] CDM project standard for project activities: Project type and eligibility. Version 3.0. (Paragraph 119.a.)

thermal power generation and GHG emissions from fossil fuel-based generation in the grid by increasing the share of renewable energy.

The project contributes to sustainable development in the following ways:

- Decreases dependence on fossil fuels, which are non-renewable and limited resources, contributing to the achievement of SDG 7 (Affordable and Clean Energy), which aims to ensure access to affordable, secure, and sustainable energy.
- Ensures productive employment, decent work, and equal pay for all, including young people and those with disabilities, contributing to SDG 8 (Decent work and economic growth).
- Reduces emissions of sulfur oxides (SOx), nitrogen oxides (NOx), carbon monoxide, particulate matter, and other pollutants, as well as carbon dioxide (CO_2) associated with fossil fuel combustion; the project contributes to SDG 13 (Climate Action).

The project does not generate any project emissions or leakage. As a result of the implementation of the project activity, annual GHG emission reductions of approximately 23,156 tCO_2 per year on full implementation are expected, and a total of 162,092 tCO_2 for the first entire crediting period.

2.1 GHG project name

Zeus Hydroelectric Power Plant.

2.2 Objectives

The project aims to generate renewable electricity to be supplied to Colombia's National Interconnected System (SIN, Spanish acronym). The energy generated by the project is currently dispatched by other power plants connected to the national grid, including fossil fuel power plants. The project activity facilitates meeting the country's electricity demand for social and economic development from a renewable energy source.

2.3 Project activities

The Zeus Hydroelectric Power Plant project (hereinafter, the project activity or Zeus project) is implemented by Central Hidroeléctrica Zeus S.A.S. E.S.P.

The project consists of a run-of-the-river power plant that harnesses the waters of the Rio Grande River at an elevation of 1766 meters above sea level, with a design flow of 7 m3/s and a gross head of 169.98 m, for an installed capacity of 9.88 MW. It includes the construction of a small hydroelectric power plant (PCH, Spanish acronym). The main works of the power plant consist of a concrete weir with a bottom intake, a relief channel, an abduction channel, a three-cell sand trap, a loading tank, a pressure conduction in GRP (Glass Reinforced Plastic Pipe), a surface powerhouse that houses two Francis turbines and their associated generation equipment, and the discharge channel that returns all the captured flow to the Rio Grande River.

Weir: To capture the usable flow of the river, a concrete weir was designed with a bottom intake at the crest of the weir; it consists of a collector channel capable of capturing at least the design flow of the plant plus the ecological flow, equipped with a grate that prevents the entry of sediments and large objects. Its geometry was defined as a thick-walled spillway (Ogee crest) with a dissipation structure composed of a "Roller Bucket" type structure.

On the right side of the weir, there is a desander to remove large particles from the water and to guarantee the ecological flow, and an adduction channel to convey the water to the desander.

Adduction channel: The adduction channel is the hydraulic structure that conveys the flow captured at the weir to the desilting cells. The flow condition in the canal will be subcritical, with a longitudinal slope of 0.3%, the lowest possible slope to minimize head losses available for generation. The channel is 69 m long, with an initial hydraulic section of 2.0 m wide by 2.8 m high, and at the end, it is divided into three channels, each with a section of 1.5 m wide by 2.9 m high.

Spillway: The spillway will receive the flow necessary for generating energy from the power plant, plus the ecological flow. Located in this structure is the orifice through which the environmental flow is reintegrated into the original course of the Rio Grande River. The spillway will also act as a relief valve with an overflow spillway to evacuate the excess flow that enters during flood events and an orifice delivering a regulated flow to the adduction channel.

Desander: The desander is a hydraulic structure that removes solid particles larger than 0.3 mm in diameter suspended in the captured flow, thus avoiding damage to the piping and electromechanical equipment. The desanding structure consists of three parallel cells, each with the capacity to operate at half the design flow rate (3.5 m3/s), to allow maintenance of one of the cells without affecting the regular operation of the plant. The purge channel was located towards the center of each desander cell, which collects the sediments and evacuates them back to the Rio Grande through a GRP pipe.

The desander was designed as a structure connected to the power plant's load tank. The desanding flow will pass through a weir from each cell of the desander to the loading tank, which was sized to ensure that the pressure conduction is submerged, i.e., that the conduction operates without air. The tank also has an overflow spillway to evacuate the captured flow in case of a partial or total shutdown of the generation equipment.

Load tank: The load tank will provide the necessary submergence to the piping to prevent air from entering the pressure piping and will also supply the required volume of water to allow the turbines to operate appropriately during variations in the flow captured for the plant, allowing a gradual increase or decrease in the flow supplied to each unit, according to the water levels reported by the sensors installed in the loading tank.

In addition, an overflow spillway was installed in the loading tank to operate in the event of a sudden shutdown of the turbines, which ends in a discharge channel that will return the water to the Rio Grande River.

GRP pressure piping: The GRP (Glass Reinforced Plastic Pipe) pressure pipeline was designed to carry water from the loading tank, attached to the sand trap, to the metal distributor at the entrance of the surface powerhouse. The entire pipeline is contemplated with buried installation and sewer type, leaving at least one meter of total thickness between the key of the pipe and the ground, which is finally formed as a protection measure.

Powerhouse: The powerhouse is configured into four zones: generation equipment room, electrical panel room, control room and service areas, and disassembly room. The project's electrical substation is on one side of the powerhouse: the transformer yard and the transmission line outlet structure. The generation area has two Francis turbines and their associated generation equipment.

The main characteristics of the turbines and generators are shown in Tables 1 and 2 below:

Table 1. Characteristics of Francis Turbines.

Main characteristics of the turbines	
Number of units	2
Type	Francis Turbine
Maximum net head	160.14 m
Design flow per turbine	3500 l/s
Design capacity per unit	5.098 MW
Nominal speed	720 rpm

Table 2. Characteristics of the Generators.

Main characteristics of the generators	
Number of units	2
Capacity per unit	5600kVA
Voltage	6900 V
Frequency	60 Hz

Substation: Connection to the National Transmission System (STN in Spanish) has been considered at the Riogrande substation in the municipality of Donmatías, Department of Antioquia, located at approximately 3.7 km, by means of a 44 kV single circuit line.

Discharge channel: A 2.5 m wide, 48.97 m long, and 1.5 m high concrete channel will be built to return the captured flow to the main channel of the Rio Grande

River, thus ensuring that the flow is adequately returned to the river. This will guarantee a permanent environmental flow of the natural riverbed. Complying with the BCR Guidelines for Energy Sector NCRE sources applicability condition 1[2].

2.4 Project location

The Zeus Hydroelectric Power Plant is located in the Rio Grande River basin, in the north of the department of Antioquia, at an approximate distance of 60 km from Medellín. Up to the site where the Zeus project is located, the Rio Grande River basin covers territories in the Donmatías and Santa Rosa de Osos municipalities.

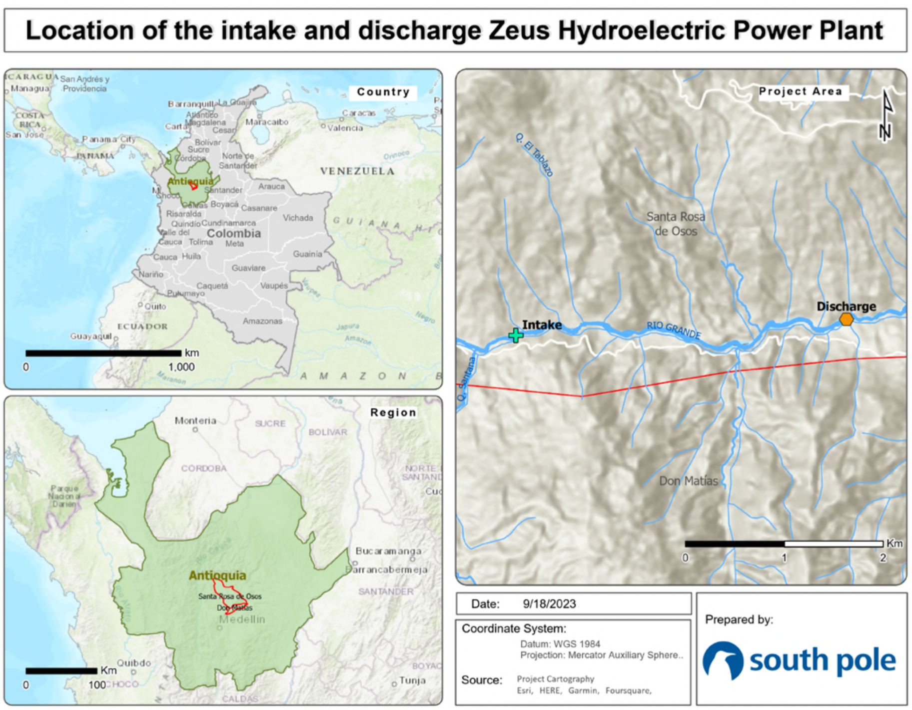

Figure 1. Map of Project location.

[2] BCR Guidelines for Energy Sector NCRE sources. Section 8. https://biocarbonstandard.com/wp-content/uploads/BCR_Guia-Sector-Energia.pdf

Table 3. Coordinates for Intake & Discharge sites.

	North (m)	East (m)
Intake	1'215.734	858.301
Discharge	1'215.886	861.623

2.5 Additional information about the GHG Project

The Zeus project is located downstream of two important hydroelectric uses of the Rio Grande River managed by Empresas Pública de Medellín (EPM). In addition to hydroelectric use, these other projects make transfers to other basins, which means that the flows at the use site proposed by the Zeus project are not regulated by the natural conditions of the entire Grande River basin but by the project's own basin, and by the provisions and operating conditions of EPM's projects.

Prior to project implementation, no hydroelectric plant had been installed on the site.

3 Quantification of GHG emissions reduction

3.1 Quantification methodology

The project activity is developed in accordance with the approved consolidated CDM baseline methodology AMS-I.D.: "Grid-connected renewable electricity generation" Version 18.0. Available at: https://cdm.unfccc.int/methodologies/DB/W3TINZ7KKWCK7L8WTXFQQOFQQH4SBK

Additionality demonstration is assessed by applying the latest versions of the CDM "Demonstration of additionality of small-scale project activities" Version 13.1. Available at: https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-21-v13.1.pdf/history_view

The emission factor of the relevant power system is determined based on the CDM procedure " Tool to calculate the emission factor for an electricity system" (Version 7.0). Available at: https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v7.0.pdf/history_view

3.1.1 Applicability conditions of the methodology

The project activity complies with all applicability conditions established by the approved CDM methodology AMS-I.D.: "Grid-connected renewable electricity generation" Version 18.0 and are listed in the following table:

Table 4. Applicability conditions of AMS-I.D.

Applicability conditions	Activities of the project
This methodology comprises renewable energy generation units, such as photovoltaic, hydro, tidal/wave, wind, geothermal and renewable biomass: (a) Supplying electricity to a national or a regional grid; or (b) Supplying electricity to an identified consumer facility via national/regional grid through a contractual arrangement such as wheeling.	The project activity consists of the installation of a new hydroelectric power plant to supply electricity to the national grid.
This methodology is applicable to project activities that: (a) Install a Greenfield plant; (b) Involve a capacity addition in (an) existing plant(s); (c) Involve a retrofit of (an) existing plant(s); (d) Involve a rehabilitation of (an) existing plant(s)/unit(s); or (e) Involve a replacement of (an) existing plant(s).	The project activity consists of a) installation of a greenfield hydroelectric power plant.

Hydro power plants with reservoirs that satisfy at least one of the following conditions are eligible to apply this methodology: (a) The project activity is implemented in an existing reservoir with no change in the volume of reservoir; (b) The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the project emissions section, is greater than 4 W/m^2; (c) The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the project emissions section, is greater than 4 W/m^2.	The project activity is a hydroelectric power plant without a reservoir; therefore, these criteria are not relevant.
If the new unit has both renewable and non-renewable components (e.g. a wind/diesel unit), the eligibility limit of 15 MW for a small-scale CDM project activity applies only to the renewable component. If the new unit co-fires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15 MW.	The proposed project activity does not involve non-renewable components. Therefore, this condition is not applicable.
Combined heat and power (co-generation) systems are not eligible under this category.	The proposed project activity does not involve combined heat and power systems. Therefore, this condition is not applicable.
In the case of project activities that involve the capacity addition of renewable energy generation units at an existing renewable power generation facility, the added capacity of the units added by the	The project activity consists of the installation of a new hydroelectric power plant.

project should be lower than 15 MW and should be physically distinct1 from the existing units.	Therefore, this condition is not applicable.
In the case of retrofit, rehabilitation or replacement, to qualify as a small-scale project, the total output of the retrofitted, rehabilitated or replacement power plant/unit shall not exceed the limit of 15 MW.	The project activity consists of the installation of a new hydroelectric power plant. Therefore, this condition is not applicable.
In the case of landfill gas, waste gas, wastewater treatment and agro-industries projects, recovered methane emissions are eligible under a relevant Type III category. If the recovered methane is used for electricity generation for supply to a grid, then the baseline for the electricity component shall be in accordance with procedure prescribed under this methodology. If the recovered methane is used for heat generation or cogeneration other applicable Type-I methodologies such as "AMS-I.C.: Thermal energy production with or without electricity" shall be explored.	The project activity is a hydroelectric power plant; therefore, these criteria are not relevant.
In case biomass is sourced from dedicated plantations, the applicability criteria in the tool "Project emissions from cultivation of biomass" shall apply.	The project does not involve biomass. Therefore, this criteria is not relevant.

In addition, the applicability conditions included in the tools referred to below apply.

Table 5. "Tool 07: For calculating the emission factor of an electricity system" applicability conditions.

Applicability Conditions	Activities of the project
This tool can be applied to estimate the OM, BM and/or CM when calculating baseline emissions for a grid-substituting project activity that is where a	The proposed project activity supplies electricity to the national grid, avoiding part

project activity supplies electricity to a grid or a project activity that results in electricity savings that have been provided by the grid (e.g., demand-side energy efficiency projects).	of the electricity generated by grid-connected power plants. Therefore, this condition is met.
With this tool, the emission factor for the project's electricity system can be calculated only for grid power plants or, as an option, it can include off-grid power plants. In the latter case, two sub-options under the step 2 of the tool are available to the project participants, i.e. option IIa and option IIb. If option IIa is chosen, the conditions specified in "Appendix 1: 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 power system is calculated only for grid-connected power plants. Therefore, this condition is met.
The tool is not applicable if the project's power system is located partially or wholly in an Annex I country.	In this case, the project's power system is located entirely in Colombia. Therefore, this condition is met.

As shown in Table 4 and Table 5, all applicability conditions are met; therefore, the Zeus project is eligible under this methodology.

3.1.2 Methodology deviations (if applicable)

There are no methodology deviations.

3.2 Project boundaries, sources and GHGs

The next sections present descriptions and explanations of the project delimitation.

3.2.1 *Spatial limits of the project*

In accordance with the AMS I.D. Version 18.0 methodology, the spatial extent of the project boundary includes the project's power plant and all power plants physically connected to the electrical system to which the Zeus project is connected.

The metering equipment is located at the project's point of interconnection with the SIN, the Rio Grande substation.

The spatial extent of the project boundary is the National Interconnected System (SIN) of Colombia. This grid's power plants are connected and can be dispatched without significant transmission constraints.

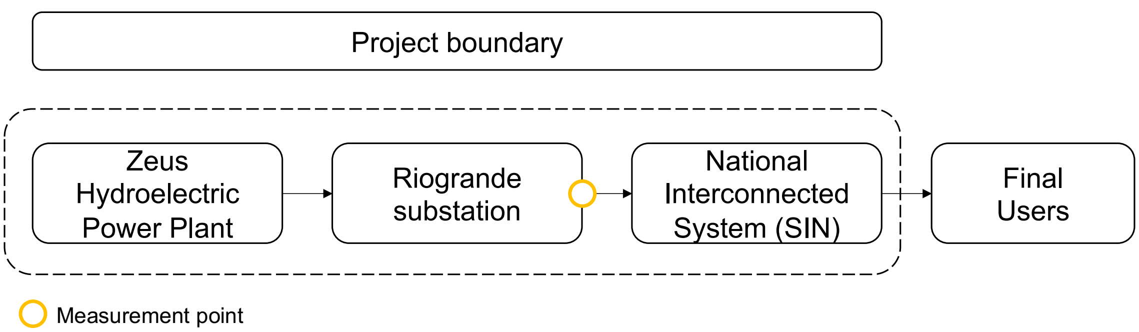

Figure 2. Project boundary and measurement point.

3.2.2 *Carbon reservoirs and GHG sources*

Source or reservoir	GHG	Included (Yes/No/Optional)	Justification
Baseline CO2 emissions from electricity generation in fossil fuel fired	CO_2	Yes	Main emission source
	CH_4	No	Minor emission source

power plants that are displaced due to the project activity	N_2O	No	Minor emission source
Project For hydropower plants, emissions of CH4 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

3.2.3 Time limits and analysis periods

Per BCR Standard version 3.4 section 11.5, the project length is the number of years from the project start date that project activities will be maintained. The project length is made up of the project quantification periods. According to this, for non-AFOLU projects, the project length may be at most seven years and shall be renewed two, for a maximum total length of 21 years.

The equipment for the Zeus Hydroelectric project is European, and the main equipment, such as the turbine and the generator, is manufactured in Germany. The supplier guarantees the equipment for five years and establishes a useful life of no less than 30 years and up to 80 years or more with an adequate maintenance plan[3]. The average lifetime for other hydroelectric plants is around 40 and 80 years for the main electrical equipment[4].

3.2.3.1 Project start date

According to BCR Standard version 3.4, Section 11.5, the start date of GHG projects is when the activities that result in actual reductions/removals of GHG emissions

[3] https://www.wkv-ag.com/en/investor-relations/
[4] https://www.enelgreenpower.com/es/learning-hub/energias-renovables/energia-hidroelectrica/faq

begin. That is when the implementation, construction, or real action of a GHG Project begins.

In accordance with the date on which the construction contract was signed, the project start date has been set as September 30, 2020.

3.2.3.2 Quantification period of GHG emission reductions/removals

According to BCR Standard version 3.4, Section 11.5, the quantification period for reductions/removals attributable to GHG Project is the period during which the project holder quantifies the GHG emission reductions or removals achieved by the project in comparison to the baseline scenario. The quantification periods shall not exceed the project length period of the project.

The Zeus hydroelectric power plant was declared commercially operational on May 19, 2022. However, as part of a testing period, the plant began delivering energy to the grid on May 17, 2022. Therefore, the emission reductions started on May 17, 2022. Then, the quantification periods for the project will be stated as:

Quantification period	Dates
First	17/05/2022 – 16/05/2029
Second	17/05/2029 – 16/05/2036
Third	17/05/2036 – 29/09/2041

3.2.3.3 Monitoring periods

Monitoring reports and verifications for the first quantification period are proposed as detailed in the following table:

Monitoring period	Verification year
17/05/2022 – 31/12/2023	2025
01/01/2024 – 31/12/2025	2027
01/01/2026 – 31/12/2027	2028
01/01/2028 – 16/05/2029	2029

It should be noted that the periods may vary according to events or post-evaluations of emission reductions.

3.3 Identification and description of the baseline or reference scenario

As stated in the approved methodology AMS-I.D. "Grid-connected renewable electricity generation," version 18.0: If the project activity is the installation of a new grid-connected renewable energy plant/unit, the baseline scenario is as follows:

"Electricity delivered to the grid by the project activity would have been generated by the operation of grid-connected power plants and by the addition of new generation sources to the grid."

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:

i. Other plants currently connected to the SIN; and.

ii. New capacity additions to the SIN.

It is identified as the continuation of common power generation practice, i.e., mainly large hydroelectric plants with reservoirs and thermal power plants that emit large amounts of carbon dioxide (CO_2) into the atmosphere.

3.4 Additionality

For demonstrating additionality, the methodology AMS-I.D. "Grid-connected renewable electricity generation" Version 18.0, and the general guidelines to the energy sector from the BCR refer to the CDM Tool 21 "Demonstration of additionality of small-scale project activities" Version 13.1. In such cases, project participants should also follow the "Non-binding practice examples to demonstrate additionality for SSC project activities"[5].

[5] "Non-binding best practice examples to demonstrate additionality for SSC project activities" (EB 35 Annex 34). https://cdm.unfccc.int/Reference/Guidclarif/ssc/methSSC_guid15_v01.pdf

According to the Guideline, the project participant shall explain how the project activity would not have occurred due to at least one of the indicated barriers.

- Investment barrier: a financially more viable alternative to the project activity would have led to higher emissions;
- Technological barrier: a less technologically advanced alternative to the project activity involves lower risks due to the performance uncertainty or low market share of the new technology adopted for the project activity and so would have led to higher emissions;
- Barrier due to prevailing practice: prevailing practice or existing regulatory or policy requirements would have led to the implementation of a technology with higher emissions;
- Other barriers: without the project activity, for another specific reason identified by the project participant, such as institutional barriers or limited information, managerial resources, organizational capacity, financial resources, or capacity to absorb new technologies, emissions would have been higher.

Investment barrier

The main challenge for the project is to overcome the investment barriers. If a more financially attractive alternative were available, it would result in higher emissions. Without the project, the electricity supplied to the grid would be generated by the existing plants and new plants that may be added to the system based on the current trend of adding capacity.

The project promoter has calculated the project's Internal Rate of Return (IRR) for the project activity, excluding the cost of financing expenses (i.e., loan repayment and interest).

Given that the project IRR has been selected as the financial indicator for the investment analysis and that the project could have been developed by an entity other than the project participant, the Weighted average cost of capital (WACC) based on parameters that are standard in the market has been selected as the appropriate benchmark.

$$WACC = r_e \times W_e + r_d \times W_d \times (1 - T_c)$$

Equation 1
(Equation 1, Tool 27)

Where,

r_e	=	Cost of equity (-)
W_e	=	Percentage of financing that is equity (-)
r_d	=	Cost of debt (-)
W_d	=	Percentage of financing that is equity (-)
T_c	=	= Corporate tax rate (-)

Cost of equity

The cost of equity was determined by selecting the values provided in the Appendix of the CDM Tool 27 "Investment analysis tool" Version 13.0[6]. Based on this provision, the present project activity utilizes the default value for the expected return on equity, expressed in real terms, for Colombian energy industry projects provided in the Appendix of the tool: 8.69 %.

Cost of debt

Given that there is no documented evidence from financial institutions about the cost of debt of financing comparable projects, the average interest rate is based on the 2018-2020 period of World Bank commercial lending interest rate in Colombia (latest data available by the time of the start date of the project) has been utilized to determine the cost of debt. Based on the Word Bank statistics, the pre-tax cost of debt in real terms is 11.3%[7]. To transform the pre-tax rate into a post-tax rate, a conversion based on best practices is utilized[8]:

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6 CDM TOOL27 Methodological tool: Investment analysis Version 13.0. https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-27-v13.pdf

7 The World Bank. (2018-2020). Lending interest rate (%) Colombia. https://data.worldbank.org/indicator/FR.INR.LEND?contextual=similar&end=2021&locations=CO&start=2003&view=chart%3B

8 https://www.investopedia.com/terms/p/pretax-rate-of-return.asp

$$k_{post-tax} = k_{pre-tax} \times (1 - tax) \qquad \text{Equation 2}$$

In Colombia, the income tax rate is 35%[9].

$$r_d = k_{post-tax} = \frac{0.121 + 0.118 + 0.99}{3} \times (1 - 35\%) = 7.3\%$$

Then, the result is a post-tax cost of debt in real terms of 7.3%.

Weighted average cost of capital (WACC)

The benchmark is based on parameters that are standard in the market, then the typical debt/equity finance structure observed in the sector of the country should be used. Nevertheless, no information about the debt/equity finance structure of these projects comparable to the project activity, was found. Thus, when the information is not readily available, 50 per cent debt and 50 per cent equity financing has been assumed as a default, according to the Tool 27.

$$WACC = 8.69\% \times 50\% + 7.3\% \times 50\% \times (1 - 35\%) = 6.73\%$$

The result is a post-tax WACC in real terms of 6.73%, which is the benchmark for investment analysis of the project activity.

Internal Rate of Return (IRR)

To demonstrate the additionality of project activities, an investment analysis compared to a Benchmark of the energy industry has been performed using national or global accounting practices and standards. It has been established that the most appropriate financial indicator for project type and decision making is IRR. The IRR is the annualized effective compounded rate of return that can be earned on invested capital. A project is a good investment proposition if its IRR is

[9] Law 2277 of 2022. Art. 240 Parr. 4. General tax rate for legal persons. https://www.funcionpublica.gov.co/eva/gestornormativo/norma.php?i=199883

higher than the rate of return that alternative investments, in this case represented by the benchmark (WACC), could earn.

The table below presents the main data used in the IRR calculation of the project.

Table 6. Financial data.

Project details	Unit	Data
Project size	MW	9.88
Location	-	Don Matías
Hydropower type	-	Run of river
Generation	MWh/y	59,200
Load factor	%	68.40%
Net Annual Generation	MWh	59,200
CAPEX		
Total CAPEX	MCOP	106,045
Property	MCOP	1,185
Civil Works	MCOP	62,247
Pipe Supply	MCOP	8,200
Electromechanical Equipment	MCOP	14,827
Transmission Line	MCOP	8,781
Designs	MCOP	2,972

Interventory	MCOP	3,250
O&M		
Total O&M (Including annual only costs)	MCOP/year	2,831
OPEX	MCOP/year	1,372
General	MCOP/year	34
Maintenance	MCOP/year	66
AOMR - Electric S/E	MCOP/year	456
Electromechanical Equipment Maintenance (Every 3 Years)	MCOP	67
Major and other maintenance (Every 5 Years)	MCOP	170
Civil Works Maintenance (Every 5 Years)	MCOP	692
Contributions	MCOP/year	10
Regulatory	MCOP/year	254
Insurance	MCOP/year	600
ICA	MCOP/year	5
Predial	MCOP/year	7
Financial Expenses	MCOP/year	26

Energy Tariff Details[10]		
Energy Tariff	COP/MWh	305,000
Energy Tariff	COP/MWh	305,000
Taxes		
Corporate Tax Rate[9]	%	38%

Over 20 years of operation period for this project, the IRR without carbon revenues (5.44%) is below the 6.73% benchmark for it to be economically viable. Therefore, it can be concluded that the revenues generated from the sale of carbon attributes are necessary to recover the investment and make the project more attractive[11].

Sensitivity analysis

Additional sensitive analysis was performed to show when the project activity would pass the benchmark or become more favorable, considering reasonable variations of the critical assumptions. Main parameters such as annual electricity generation and costs such as CAPEX, operation and maintenance, taxes, and energy tariff were considered for reasonable variations (+/-10%). The variation of the project IRR has been shown below:

Table 7. Project IRR without carbon revenues by variating parameters.

Parameter	-10%	-5%	0%	5%	10%

[10] See "Precios PPA.pdf". This value is expressed in pesos of September 2019 and will be indexed according to the next formula: Pi=Po*(IPPI/IPPo); where, Po: energy tariff of the contract; Pi: energy price of energy in the month of supply; IPPo: producer price index certified in the month of September 2019; IPPi: price index for the certified product in the month of supply.
[11] See Zeus Additionality Assessment.xlsx

Energy generation	4.01%	4.74%		6.11%	6.77%
Tax	6.12%	5.78%		5.08%	4.72%
O&M	5.67%	5.55%	5.44%	5.32%	5.20%
Energy Tariff	4.01%	4.74%		6.11%	6.77%
CAPEX	6.67%	6.03%		4.88%	4.37%

The sensitive analysis demonstrates that even considering a significant variation of the mentioned parameters, the proposed project activity is unlikely to be the most financially/economically attractive. Therefore, the additional revenues from the carbon revenues would help to overcome the threshold to move forward with the project.

3.5 Uncertainty management

The project's emission reduction calculations are based on CDM methodology AMD-I.D. As per the methodology, emission reductions are calculated based on a conservative approach, and the monitored parameters are described clearly, following the guidelines. These monitoring parameters will be robustly investigated by the auditors during the validation and verification periods.

The monitoring records and the management system are described in Section 16.

Emission reductions are based on the CDM tool to calculate the emission factor of the electric grid. The simple adjusted OM approach is used to determine Colombia's grid emission factor, where LCMR and non-LCMR plants are identified based on inputs and operating costs. As a conservative measure, all plants that do not record fuel consumption have been considered LCMR.

As an additional measure, the simple adjusted OM is calculated with an ex-post approach, determined for each year that the activity displaced grid electricity; therefore, it will be updated annually during the monitoring period.

3.6 Leakage and non-permanence

According to the methodology, there is no risk of leakage and non-permanence with the project activity since the project is a small hydropower plant.

3.7 Mitigation results

The project activity meets the applicability requirements and quantifies the emission reductions as per the AMS-I.D methodology and the requirements of the BioCarbon standard. Thus, the mitigation results achieved by the project activity are verifiable by the ISO 14064-03:2019.

CDM Validation and Verification Standard Version 3.0 defines the principles guide for the preparation, execution, and reporting of validation and verification activities under ISO 14064-3: Greenhouse gases- Part 3[12].

3.7.1 Eligible areas within GHG project boundaries (AFOLU sector projects)

Project activity is not of an AFOLU type; thus, this section is not applicable.

3.7.2 Stratification (Projects in the AFOLU sector)

Project activity is not of an AFOLU type; thus, this section is not applicable.

3.7.3 GHG emissions reduction/removal in the baseline scenario

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

[12] https://cdm.unfccc.int/Reference/Standards/accr_stan02.pdf

addition of new grid-connected power 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 tCO2e/MWh) by the electricity generated by the proposed project activity during the year y ($EG_{PJ,y}$, in MWh).

The detailed calculations and data of the baseline emissions are presented in the Excel file "Zeus Colombia Calculations.xlsx". The following section presents the relevant methodological approaches and equations.

$$E_y = EG_{PJ,y} \times EF_{grid,y}$$

Equation 3
(Equation 1 AMS-I.D)

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 project activity in year *y* (MWh/yr)
$EF_{grid,CM,y}$	=	Combined margin CO_2 emission factor for grid-connected power generation in year *y* calculated using the latest version of the CDM "Tool to calculate the emission factor for an electricity system" (tCO_2/MWh)

According to Equation (2) of AMS-I.D. (version 18.0), if the project activity is the installation of a greenfield power plant, then:

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

Equation 4
(Equation 2 AMS-I.D)

Where,

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

The combined margin emission factor ($EF_{grid,CM,y}$) is calculated following the guidance in the "Tool to calculate the emission factor for an electricity system" (version 7.0) by applying the following steps:

STEP 1. Identify the relevant electricity systems.

To determine the electricity emission factors, the project activity shall identify the relevant project electricity system. Similarly, it shall identify any connected electricity systems. The project activity delineates the project electricity system using the Option 1 for this step on the tool:

Option 2. A delineation of the project electricity system defined by the dispatch area of the dispatch centre responsible for scheduling and dispatching electricity generated by the project activity. Where the dispatch area is controlled by more than one dispatch centre, i.e. layered dispatch area, the higher-level area shall be used as a delineation of the project electricity system (e.g. where regional dispatch centres are required to comply with dispatch orders of the national dispatch centre then area controlled by the national dispatch centre shall be used).

For determining the electricity emission factors, the project electricity system is defined by the spatial extent of the power plants physically connected through transmission and distribution lines to the project activity (i.e., Zeus Hydroelectric Project), and that can be dispatched without significant transmission constraints. In this case, the project electricity system is given as the National Interconnected System (SIN) of Colombia[13], including the imports from Ecuador 230 and Ecuador 138[14].

For the purpose of determining the operating margin emission factor, the CO2 emission factor(s) for net electricity imports is chosen as zero t CO2/MWh.

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

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[13] Sinergox. Tools: "Listado de Recursos de Generación". Available at: https://sinergox.xm.com.co/_layouts/15/WopiFrame.aspx?sourcedoc={CA2AAC95-83D2-4573-AEB9-42C0CC10780C}&file=Listado_Recursos_Generacion.xlsx&action=default

[14] Sinergox. International Exchanges: Historic data. Available at: https://sinergox.xm.com.co/ntrcmb/Paginas/Historicos/Historicos.aspx

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-post* data vintage:

Ex-post option: *if the ex-post option is chosen, the emission factor is determined for the year in which the project activity displaces grid electricity,* ***requiring the emission factor to be updated annually during monitoring.*** *If the data required to calculate the emission factor for year y is usually available later than six months after the end of year y, alternatively the emission factor of the previous year y-1 may be used. If the data is usually only available 18 months after the end of year y, the emission factor of the proceeding the previous year y-2 may be used. The same data vintage (y,y-1.y-2) should be used throughout all crediting periods.*

All power plants connected to the SIN are included. Power plants registered as CDM project activities are also included as suggested by the tool. Historical data of the year in which the project activity displaces grid electricity is available from XM (grid operator and administrator[15]) and will be updated annually during monitoring.

[15] https://www.xm.com.co/

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

The simple adjusted operating margin emission factor $EF_{grid,OM\text{-}adj,y}$ (tCO2e/MWh) is a variation of the simple operating margin emission factor, where the power sources (including imports[16]) are separated in low-cost/must-run power sources (k) and other power sources (m), as follows:

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

Equation 5
(Equation 10 CDM Tool 7)

Where,

$EF_{grid,OM\text{-}adj,y}$	=	Simple adjusted operating margin CO_2 emission factor in year y (tCO_2/MWh)
λ_y	=	Factor expressing the percentage of time when low-cost/must-run power units are on the margin in year y
$EG_{m,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EG_{k,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit k in year y (MWh)
$EF_{EL,m,y}$	=	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
y	=	The relevant year as per the data vintage chosen in Step 3: in which the project activity displaces grid electricity.

The lambda factor (λ_y) is determined as:

[16] https://sinergox.xm.com.co/ntrcmb/Paginas/Historicos/Historicos.aspx

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

Equation 6
(Equation 11 CDM Tool 7)

There are two approaches to determine lambda (λ_y):

Approach 1. Use default values of lambda from Table 1 Appendix 2 (Tool 07) based on the share of electricity generation from low-cost/must-run in total generation derived using 1) the average of the five most recent years or 2) based on long-term averages for hydroelectricity production. Approach 1 can only be applied if the LASL is not less than one-third of the HASL in a project electricity/ grid system demonstrated based on the yearly data for the years used to determine the OM emission factor.

Approach 2. Lambda (λy) should be determined by applying the step-wise procedure provided in Appendix 3 (Tool 07).

According to the approach 2, the steps required to calculate λ_y are:

- Step i: The total hourly generation data of the year are presented, from high to low, in comparison to the total 8,760 hours of the year.
- Step ii: Calculate the total annual generation of low-cost/must-run plants ($\sum_k EG_{k,y}$).
- Step iii: Draw a horizontal line that crosses the line represented, so that the area under the curve represents the total generation of low-cost/must-run plants ($\sum_k EG_{k,y}$).
- Step iv: Determine value λ_y, taking into account that λ_y is calculated as X/8,760, where X represents the hours on the right of the point of intersection.

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).

The selected option for calculating the emission factor of each plant is based on the available fuel consumption and electricity generation information (option A1, Tool 07 CDM) of the different plants of the Colombian Interconnected System, with the following expression:

$$EF_{EL,m,y} = \frac{FC_{i,m,y} \times NCV_{i,y} \times EF_{CO2,i,y}}{EG_{m,y}}$$

Equation 7
(Equation 4 CDM Tool 7)

Where,

$EF_{EL,m,y}$	= CO_2 emission factor of power unit *m* in year *y* (t CO_2/MWh
$FC_{i,m,y}$	= Amount of fuel type i consumed by power unit *m* in year *y* (Mass or volume unit)
$NCV_{i,y}$	= Net calorific value (energy content) of fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO2,i,y}$	= CO_2 emission factor of fuel type *i* in year *y* (t CO_2/GJ)
$EG_{m,y}$	= Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
m	= All power units serving the grid in year *y* except low-cost/must-run power units
i	= All fuel types combusted in power unit *m* in year *y*
y	= The relevant year as per the data vintage chosen in Step 3: in which the project activity displaces grid electricity

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

Option A2. If for a power unit *m* only data on electricity generation and the fuel types used is available, the emission factor should be determined based on the CO2 emission factor of the fuel type used and the efficiency of the power unit, as follows:

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} \times 3.6}{\eta_{m.y}}$$

Equation 8
(Equation 5 CDM Tool 7)

Where,

$EF_{EL,m,y}$	= CO_2 emission factor of power unit *m* in year *y* (t CO_2/MWh

$EF_{CO_2,m,i,y}$	= 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)
m	= All power units serving the grid in year *y* except low-cost/must-run power units
y	= The relevant year as per the data vintage chosen in Step 3: in which the project activity displaces grid electricity
3.6	= Conversion factor (GJ/MWh)

If for a power unit *m* only data on electricity generation is available, Option A3 has been used as a simple and conservative approach with an emission factor of zero tCO2/MWh.

To be conservative, the power plants without fuel consumption reports are considered in the low cost-must run generation, to be consistent with the Option A3 mentioned before.

By applying Equation 7 to determine the emission factor of each power plant, the results from the lambda calculation and the main Equation 5 for the OM emission factor, and the corresponding generation weights of each year, OM emission factor is determined as shown in the table below, for the beginning of the commercial operation year.

Table 8. Characteristics of the Colombian national electrical system.

	2022
EF No LC/MR	0.6823
EF LC/MR	0.0000
Lambda	0.2006
Total Generation [MWh]	77,064,336.33
$EF_{OM\ Simple\ adjusted\ 2022}$ (tCO_2/MWh)	0.5454

The operating margin emission factor for the rest of the credit period is projected using the most recent data available for the year in which the project activity displaces grid electricity, in this case, when the project begins energy generation in 2022. It should be noted that the purpose of this value is to estimate the potential emissions reduction, and it needs to be updated annually during the crediting period.

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

In terms of the vintage of data, option 1 of the tool is chosen, i.e. the *ex-ante* approach:

Option 1: For the first crediting period, calculate the build margin emission factor ex-ante based on the most recent information available on units already built for sample group m at the time of PDD submission for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

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 (and other Carbon Standards), that started[17] to supply electricity to the grid most recently ($SET_{5\text{-units}}$) and determine their annual electricity generation ($AEG_{SET\text{-}5\text{-units}}$, in MWh);

b. Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM (and other Carbon Standards) project activities (AEG_{total}, in MWh). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of AEG_{total} (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation)

[17] The date on which the plants started to supply electricity to the grid is available on: http://paratec.xm.com.co/paratec/SitePages/generacion.aspx?q=capacidad

($SET \geq 20\%$) and determine their annual electricity generation ($AEG_{SET-\geq 20\%}$, in MWh);

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

Identify the date when the power units in SET_{sample} started to supply electricity to the grid. If none of the power units in SET_{sample} started to supply electricity to the grid more than 10 years ago, then use SET_{sample} to calculate the build margin.

As can be seen in the excel sheet of the emission factor ("Zeus Colombia Calculations.xlsx"), in this case all steps (a) to (c) need 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 (tCO_2/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 2023. The calculation is made as follows:

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

Equation 9
(Equation 15 CDM Tool 7)

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 analogously as for the operating margin by Equation 7 or other listed methods depending on the available information, in this case the 2023 data provided by XM and consulted through its virtual SINERGOX portal[18].

The detailed calculations are provided in the worksheet "Build Margin (BM)" of the Excel file "Zeus Colombia Calculations.xlsx".

The resulting BM emission factor set for the first credit period is (rounded):

$EF_{BM,2023}$	**0.2369 tCO_2/MWh**

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

The combined margin emission factor is calculated as follows:

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

Equation 10
(Equation 16 CDM Tool 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 (%)

For hydroelectric projects the weighting of operating and build margin is done as indicated in the tool for the first crediting period, i.e. w_{OM}= 0.5 and w_{BM}= 0.5.

Once calculated the CO2 OM and BM emission factor with Equation 5 and Equation 9 from this document, the combined margin emission factor for each year since the start of commercial operation is presented in the next table (rounded):

[18] https://sinergox.xm.com.co/Paginas/Home.aspx

$$EF_{grid,CM,y} = 0.5454 \times 0.5 + 0.2369 \times 0.5 = 0.3912\ tCO_2/MWh$$

Year	2022[+]	Unit
$EF_{grid,CM,y}$	0.3912	tCO_2/MWh

Actual and ex-ante baseline emissions in t CO_2 are calculated using Equation 3 of this document and tabulated below:

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

The $EF_{grid,CM,y}$ was established using the most recent data for the year the project activity displaces grid electricity, in this case, 2022, when the project began energy generation. The variations in the operating margin emission factor will update this parameter annually. The following table shows the projected baseline emissions of the crediting period.

Table 9. Ex-ante baseline emissions.

Year	Baseline emissions (tCO_2)
17/05/2022—31/12/2022	14,528
2023	23,156
2024	23,156
2025	23,156
2026	23,156
2027	23,156
2028	23,156
1/01/2029—16/05/2029	8,628

3.7.4 GHG emissions reduction/removal in the project scenario

According to the methodology AMS-I.D Version 18.0, for most renewable energy project activities, $PE_y = 0$.

Since the project activity has no reservoir, the project emissions are zero:

$$PE_y = 0\ tCO_2$$

The following table displays the estimate of the reduction of GHG emissions during the entire quantification period of the project.

Year	GHG emission reductions in the baseline scenario (tCO2e)	GHG emission reductions in the project scenario (tCO_{2e})	GHG emissions attributable to leakages (tCO_{2e})	Estimated Net GHG Reduction (tCO_{2e})
19-05-2022—31-12-2022	14,528	0	0	**14,528**
2023	23,156	0	0	**23,156**
2024	23,156	0	0	**23,156**
2025	23,156	0	0	**23,156**
2026	23,156	0	0	**23,156**
2027	23,156	0	0	**23,156**
2028	23,156	0	0	**23,156**
1-1-29—16-05-2029	8,628	0	0	**8,628**
Total	162,092	0	0	**162,092**
Annual average	**23,156**	**0**	**0**	23,156

4 Compliance with Laws, Statutes and Other Regulatory Frameworks

The structure of the Colombian energy market is based on Laws 142[19] (Public Services Law) and 143[20] (Electricity Law) of 1994, 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 to separate the power activities and the markets. An electricity spot market and the development of a long-term contract market for

[19] http://www.secretariasenado.gov.co/senado/basedoc/ley_0142_1994.html
[20] http://www.secretariasenado.gov.co/senado/basedoc/ley_0143_1994.html

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.

Law 99 of 1993 establishes the general requirements for the issuance of environmental licenses and permits and defines the role of the Ministry of the Environment and the Regional Autonomous Corporations (CAR) in the licensing process. As per Article 52 of Law 99[21] and Article 9 of Decree 2041[22], any projects smaller than 100 MW do not fall under the jurisdiction of the Ministry of Environment. Instead, they are the responsibility of the CAR, specifically for this case, the Tahamíes Territorial Office of the Regional Autonomous Corporation of the Center of Antioquia.

Per the above, on November 28, 2012, the company's legal representative presented the application to the CAR for an environmental license for the development of the Zeus Hydroelectric Power Plant, which was granted through resolution No. 1811-6435 of 2018.

As per the requirements of the Mining-Energy Planning Unit (UPME), the electricity generation project must submit a connection study report to include the plant in the National Interconnected System[23]. The Zeus Hydroelectric Power Plant commenced its testing phase on May 17, 2022, and after meeting all the necessary regulations, it was approved for commercial operation on May 19, 2022.

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[21] https://www.minambiente.gov.co/wp-content/uploads/2021/08/ley-99-1993.pdf
[22]https://archivo.minambiente.gov.co/images/normativa/app/decretos/7b-decreto_2041_oct_2014.pdf
[23] See folder "4- Estudio de conexión enviado para incorporación al SIN"

The project does not intersect or overlap with territory legally titled as Indigenous Reservations, nor with collective titles belonging to black or Afro-descendant or ethnic communities[24].

5 Carbon ownership and rights

5.1 Project holder

Individual or organization	Central Hidroeléctrica Zeus S.A.S. E.S.P.
Contact person	Juan Felipe Posada Rojas
Job position	Generation Manager
Address	Cr 43B 19-95 Oficina 1312 ED CCI, Medellín, Colombia
Phone number	+57 604 444 08 56
Email	juanposada@grupocolviva.com

5.2 Other project participants

Individual or organization	South Pole Carbon Asset Management S.A.S.
Contact person	Santiago González Hernández
Job position	Regional Lead, Technical, Sustainable Technologies, Climate Projects - Latam
Address	Carrera 46 # 7-59, Medellín, Colombia
Phone number	+57 302 461 57 68
Email	sa.gonzalez@southpole.com

[24] See "Certificación Incoder.pdf" and "Certificación Min Interior.pdf"

5.3 Agreements related to carbon rights

Central Hidroeléctrica Zeus S.A.S. E.S.P. is constituted and certified by the existence and legal representation based on the registration and registrations made in the commercial registry of the Chamber of Commerce of Medellín for Antioquia on October 19, 2022. The company's main purpose is the promotion, development, and execution, either on its own behalf or on behalf of third parties of hydroelectric generation projects; as well as the administration, operation, and maintenance of the resulting hydroelectric plants for the generation and commercialization of electrical energy.

The Environmental License for the Zeus Hydroelectric Power Plant project was granted through resolution No. 1811-6435 of November 2018, and likewise, the concession of water, discharge permit, among other authorizations and responsibilities included therein.

All carbon rights will remain within Central Hidroeléctrica Zeus S.A.S. E.S.P for the project length from 30-September-2020 to 29-September-2041.

5.4 Land tenure (Projects in the AFOLU sector)

Project activity is not of an AFOLU type; thus, this section is not applicable.

6 Climate change adaptation

Zeus Hydroelectric Plant play a role in climate change adaptation through various mechanisms:

1. Renewable energy source: Hydroelectric power is an energy source that relies on water flow to generate electricity. This means it does not deplete the water resource, making it a renewable energy source. Zeus Hydroelectric Plant reduces the reliance on fossil fuels, significantly contributing to greenhouse gas emissions. Hydroelectric plants provide a clean and sustainable energy source, essential in mitigating climate change impacts.
2. Reduced Reliance on Fossil Fuels: Zeus helps reduce the reliance on fossil fuels for electricity generation. Hydroelectricity can provide a stable and sustainable energy supply as Colombia transitions from fossil fuel-based

power generation to cleaner alternatives. This transition helps decrease the overall carbon footprint of the energy sector.

3. Stabilizing Energy Supply: Zeus provides a stable and reliable source of electricity, helping to address the challenges associated with intermittent renewable energy sources like solar and wind. This stability is crucial for adapting to climate change, where extreme weather events and changing patterns can impact energy infrastructure. Hydroelectric plants serve as a dependable base-load power source.

Water Resource Management: Effective water resource management is essential for climate change adaptation. Zeus is designed to regulate and manage water flow, helping to control flooding during heavy rainfall and ensuring a steady water supply during periods of drought. This adaptive capacity is valuable in regions facing changing precipitation patterns and increased frequency of extreme weather events.

7 Risk management

The project has conducted risk assessments and management to identify the environmental, financial, and social risks associated with the project's activities. This was done to justify the risk-management measures to ensure that greenhouse gas (GHG) emission reductions are maintained throughout the project quantification period. Table 10. Risks associated with the Zeus Hydroelectric Project. shows the risks identified in accordance with the BCR's Permanence and Risk Management Tool v1.1[25].

Table 10. Risks associated with the Zeus Hydroelectric Project[26].

Risk type	Risk	Risk level	Mitigation measure
Environmental			

[25] https://biocarbonstandard.com/wp-content/uploads/BCR_risk-and-permanence.pdf
[26] See "Licencia Ambiental.pdf"

Natural	Earthquakes	Critical	Early alarms, adequate training and recovery plan.
Natural	Mass movements	Critical	Landslides prevention and recovery plans.
Technological	Equipment failure (Turbines, generators, etc.)	Critical	Preventive maintenance of equipment.
Anthropic	Fires, explosions	Critical	Management of equipment and combustible materials. Emergency firefighting plan.
Social			
Anthropic	Malicious acts	Tolerable	Contract with a security company.
Anthropic	Non-compliance by suppliers	Tolerable	Supplier control
Anthropic	Work accidents	Critical	Adequate training. Attention to work emergencies.
Anthropic	Inadequate management of equipment and hazardous materials	Critical	Adequate training. Attention to work emergencies. Management Plan for hazardous waste.
Anthropic	Politics intervention	Tolerable	Continuous communication plan.

Financial			
Anthropic	Investor insolvency and changes in macroeconomic variables	Acceptable	Energy purchase and sale contract with indexed prices.

7.1 Reversal Risk

The Zeus contingency plan is a set of technical rules and procedures designed to ensure swift and effective action to mitigate and reverse risks related to the Project. The plan aims to protect the environment, people, and material resources before, during, and after such an events, to ensure the project maintenance over time

Table 11 summarizes the contingency plans proposed for each risk identified as critical or considered essential to take preventive measures.

Table 11. Summary of Contingency Plans for Zeus Hydroelectric.

Risk	Program	Plan	Responsible
Work accidents	Prevention of work accidents	Adequate training.	Builder/Operator
		Attention to work emergencies.	Builder/Operator
Natural Phenomena: occurrence of earthquakes	Seismic activity	Early alarms (timely information on seismic records in the area).	Builder/Operator
		Adequate training in the event of seismic events.	Builder/Operator
		Recovery plan in the event of seismic events.	Builder/Operator

Natural Phenomena: Occurrence of landslides	Damage to construction due to landslides or slope instability	Landslides prevention	Designer/builder
		Landslide recovery plan.	Builder/Operator
Equipment failure	Preventive maintenance of equipment	Maintenance: Check and review of equipment.	Builder/Operator
Fires, explosions	Management of equipment and combustible materials	Hazardous materials handling protocols.	Builder/Operator
		Active and passive protection systems, instrumentation, and maintenance.	Builder/Operator
		Emergency firefighting plan.	Builder/Operator
Third parties-malicious acts	Impact on third parties	Contract with a security company.	Builder/Operator
		Recovery plan against malicious acts.	Builder/Operator
Non-compliance by suppliers	Supplier control	Rigorous monitoring of the work plan and development of the works.	Builder/Operator

7.1.1 Loss Event Report

If an event occurs that will cause loss or reduction of VCCs, a report regarding this situation will be prepared and submitted within a year.

The loss report shall include a conservative estimate of the loss of carbon from previously verified emission reductions/removals due to loss of carbon stocks from the project based on the monitoring report.

8 Sustainable development safeguards (SDSs)

The impact of the project activity on environmental and social aspects is shown below based on BioCarbon Sustainable Development Safeguards Tool v1.0[27].

a. Environmental

Table 12. Environmental safeguards.

Potential risk	Project risk	Mitigation or preventive action[28]
Land use: Resource Efficiency and pollution prevention management		
Land degradation or soil erosion, leading to the loss of productive land.	The project will remove vegetation for construction activities and affect geotechnical and erosion stability.	PMA_MF_01._01 Study and analysis of geotechnical stability and erosive processes. _02 Control and management of erosion stability. _03 Management of uncovering and soil intervention by the project.
Air and water pollution resulting from project-related emissions, discharges, or improper waste disposal practices.	The project will generate air pollution due to construction activities. The project will generate wastewater from the construction and operation of the plant.	PMA_MF_07. _01 Emissions of particulate matter, gases and vapors control and management. _02 Explosives and blasting management.

[27] https://biocarbonstandard.com/wp-content/uploads/BCR_Sustainable_development_safeguards.pdf
[28] See "EIA.pdf"

		PMA_MF_05. Liquid waste management (domestic water waste, and construction water waste). PMS_MF_04_01. Monitoring to water purification system.
Inadequate waste management practices, leading to the improper disposal of project-related waste and potential environmental harm.	The project will generate waste from the construction, operation, and closure activities.	PMA_MF_02. Construction materials management. PMA_MF_03. Fuels and oils waste management. PMA_MF_04. Comprehensive waste management plan (domestic solid waste, hazardous waste, surplus construction, and excavation waste)
Deforestation or degradation of forested areas impacting carbon sequestration, biodiversity, and ecosystem services.	The project will remove vegetation for construction activities and affect the nearby landscape.	PMA_MB_01:_01 Vegetation removal and forestry management. _02 Forrestal compensation, ecology restoration, and landscape management.
Water		
Water pollution, including contamination of rivers, lakes, oceans, or aquifers as a result of project-related activities such as emissions, spills, or waste disposal.	The project will generate wastewater from the construction and operation of the plant.	PMA_MF_05. Liquid waste management (domestic water waste, and construction water waste). PMS_MF_04_01. Monitoring to water purification system.
Disrupting aquatic ecosystems, including marine life, river ecosystems, or	The project might disrupt the RioGrande river ecosystem	PMA_MB_03_01 Complementary studies of

wetlands due to the changes in water quality, temperature or flow patterns?	during the construction phase.	the aquatic fauna and its eating habits. _02 Ichthyofauna rescue plan.
Biodiversity and ecosystems		
Negatively impacting endangered or threatened species within the project area, either directly or indirectly through habitat changes or other disturbances.	The project might impact the local fauna.	No endangered or threatened species were found during the Environmental Impact Assessment; nevertheless, the project proposed the next management plans: PMA_MB_02_01 Management plan for endangered or threatened species. PMA_MB_02_02 Strategy for education campaign on environmental sensibilization and fauna protection.
Climate Change		
The project didn't identify any potential risk to increase climate change. The project aims to contribute to climate change adaptation by generating electricity from a renewable source and reducing the Colombian's reliance on fossil fuels.		

b. Labor and working conditions.

The project complies with Colombia's labor and human rights laws and practices[29]. It has an Internal Labor Regulation[30] that ensures compliance with relevant laws prohibiting forced labor, human trafficking, and child labor practices. The Zeus

[29] Law no. 50 of 1990, by which reforms were introduced to the Substantive Labor Code and other provision are issued. https://www.funcionpublica.gov.co/eva/gestornormativo/norma.php?i=281
[30] See "RT-02 REGLAMENTO INTERNO TRABAJO ZEUS 25052022.pdf"

Hydroelectric Plant applies the rule of social behavior, of not involving minors, established in the declaration of fundamental rights of the International Labor Organization.The staff and laborers are not asked to work in conditions that directly impact their health and safety. By signing the Employee Hiring Contract[31], the worker declares to know and is bound to comply with the obligations of the Internal Labor Regulations and the position profile[32].

The Zeus Internal Labor Regulations and the employee hiring contract clearly outline the employment rights, working hours, and health and safety protocols to be followed throughout the duration of the project activity. Employees are well-informed of their rights and responsibilities, ensuring a fair and safe working environment.

According to the Procedure for use, maintenance, and delivery of personal protection elements[33], the workers know how to use each personal protection element, the equipment, and the necessary recommendations for their conservation. The safety equipment includes security boots, hearing protection, gloves, respiratory protection, safety glasses, and overall.

c. **Gender equality and Women empowerment**

The Zeus Hydroelectric Power Plant protects the work activity of pregnant women, which is why during this period and breastfeeding, the mandates of the treating doctor are accepted; in the employment relationship, they will not carry out high-risk work, nor in dangerous, unhealthy, or activities that require efforts greater than their capacity, all by the occupational health and safety programs in force at the Hydroelectric Power Plant and ordered by the occupational risk administrator[30].

The Internal Labor Regulation includes a mechanism for preventing workplace harassment behavior aimed at generating a collective coexistence conscience. This

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[31] See "Ejemplo de contrato.pdf"
[32] See "Perfil_Cargo.pdf"
[33] See "PT-09 Procedimiento uso, mmto y conservación de los EPP.pdf"

promotes work with decent and fair conditions, harmony between those who share work life, and a good environment and protects the privacy, honor, mental health, and freedom of people at work.

d. Land acquisition, restriction on land use, displacement, and involuntary resettlement.

Zeus legally owns the land where the hydroelectric power plant is located. No local people were forcibly displaced by the project activity.

e. Indigenous peoples and cultural heritage

The project activity did not damage cultural heritage or harm indigenous people. Nevertheless, it established a Preventive archeology program[28].

f. Community health and safety

The project ensures that hazardous and domestic wastes are disposed of properly according to Colombia's regulations and the PMA_MF_04 Waste Management Plan. This includes a comprehensive waste management plan covering domestic solid waste, hazardous waste, and surplus construction and excavation waste. Proper disposal is crucial to protecting the environment and the health of the local people.

g. Corruption

There is no misuse of funds, bribery to secure contracts or permits, nepotism or favoritism in the selection of contractors, fraudulent reporting, conflicts of interest, lack of transparency, weak regulatory oversight, lack of accountability mechanisms, environmental permitting corruption, and subcontractor corruption in project activities.

h. Economic impact

During the construction and operational phases, the project created employment opportunities for the local community. By providing sustainable energy resources, the project contributes to the economic development of the region.

i. Governance and compliance

The project has a strong governance structure[34], such as clear roles and responsibilities defined[32]. Zeus Hydroelectric Power Plant got the Environmental License, concession of water, discharge permit, among other authorizations and responsibilities included therein.

9 Stakeholder engagement and consultation

The stakeholder consultation processes have been devised to solicit input from local stakeholders prior to the initiation of project activities. In accordance with the regulations outlined by the Ministry of Environment and Sustainable Development, any hydroelectric project is required to conduct a consultation inviting local stakeholders to participate in a meeting where project information, such as a project description document, is provided and their feedback is obtained[35].

The consultation provided information on the technical information, project location, environmental impacts, project benefits, and social activities[36].

This section encompasses the government and community participation strategy employed in constructing the Environmental Impact Assessment (EIA). Additionally, we detail the information-gathering process utilized to characterize and survey the Project's baseline. This process allowed for the identification of potential impacts and management measures, considering the project's scope and areas of influence.

The meetings outlined in **Error! Reference source not found.** were conducted, and field trips and visits to homes in the specific area of influence were carried out.

Table 13. Socialization meetings prior construction stage.

Activity	Date	Place

[34] See "Organigrama CHZ.png"
[35] Degree 2041 of 2014. Art. 9 and 15. https://archivo.minambiente.gov.co/images/normativa/app/decretos/7b-decreto_2041_oct_2014.pdf
[36] See "ANX-1.5-Presentación_Proyecto Zeus.pptx"

Socialization with local authorities: Santa Rosa de Osos and Donmatías	January 26, 2015	Municipal Council Auditorium Mayor of Santa Rosa de Osos
	January 29, 2015	Donmatías Municipal Palace
Socialization with ADI JAC Leaders. Santa Ana-San Isidro, San Isidro Parte Baja, Las Ánimas, Mocorongo and Sugar Loaf	January 26, 2015	Municipal Council Auditorium Mayor of Santa Rosa de Osos
	January 29, 2015	Communal booth Vereda Pan de Azúcar, Donmatías
Workshop on characterization, impacts and management measures in the ADI	June 10, 2015	Communal booth Vereda Pan de Azúcar, Donmatías
	June 11, 2015	Township House of Culture of San Isidro
	June 12, 2015	School Village San Isidro Lower Part
Dissemination of EIA results with local authorities: Santa Rosa de Osos y Donmatías	February 29, 2016	Donmatías Municipal Palace
	March 1 and 2, 2016	Santa Rosa de Osos Municipal Palace
Dissemination of EIA results with ADI villages: Santa Ana-San Isidro, San Isidro Lower Part, Las Ánimas, Mocorongo and Sugar Loaf	February 29, 2016	Township House of Culture of San Isidro
	March 1, 2016	Communal booth Vereda Pan de Azúcar, Donmatías
	March 2, 2016	School Village San Isidro Lower Part

According to the activities to be carried out in the construction stage and in compliance with the Environmental Management Plan, a meeting was held in each village of the ADI and in each municipality of the AII, where the community and local authorities were informed about the progress of the construction phase, the execution of the EMPs, progress in the attention and resolution of PQRS and the results of environmental and social management, in addition to issues specific to this stage[37].

This call was made through an invitation letter[38] and posters in strategic locations. Virtual invitations were also sent to promote the meeting. The meetings outlined in Table 14 were conducted.

[37] See "ANX-1.5-Presentación_Resultados Proyecto Zeus_.pptx"
[38] See folder "Invitaciones enviadas a consulta de partes interesadas"

Table 14. Socialization meetings during construction stage.

Municipality	Location	Date	Assistants	Place
Santa Rosa de Osos	Vereda Las Ánimas	April 19, 2022	9	Communal booth Las Ánimas
	Vereda Las Animas-Mocorongo	April 25, 2022	2	Google Meet
	Vereda San Isidro Lower Part	April 19, 2022	12	CER San Isidro Lower Part
	Vereda Santa Ana	April 20, 2022	8	Santa Ana Chapel
	Santa Rosa de Osos Town Hall	May 5, 2022	1	Municipal Building
Donmatías	Vereda Mocorongo	Not Applicable	0	Not Applicable
	Vereda Pan de Azúcar	April 21, 2022	12	Communal booth Pan de Azúcar
	Donmatías Town Hall	May 6, 2022	2	Municipal Building

Figure 3. Photographic record.

9.1 Summary of comments received

Table 15. Comments received during stakeholder consultations.

Comment/Questions	Date	Stakeholder	Response
What is the environmental entity that supervises and grants the operating permit for the project?	June 10, 2015	Community Action Board, Vereda Pan de Azúcar, Donmatías. (Contact information 3206703320)	Corantioquia is the responsible authority.
How has the company's experience been with communities in other projects?			The response has been favorable and enriching since the contributions of people are vital to the project. Mechanisms for interaction and dynamization with the community are also established.
How will the installation of the project pipelines affect us?	January 26, 2015	Community Action Board, San Isidro (Contact information 3196407334)	Zeus will install 6 km of pipeline that will be buried, it will not be possible to build in those areas, but the community can carry out sowing, livestock and other agricultural activities.
Is the project related to any other in the area?			No, it is a new project of a company from Antioquia and whose characteristics and size are different from other hydroelectric projects.
Will the catchment works leave the river without water?	June 12, 2015	Community Action Board, San Isidro (Contact information 3166676708)	According to the environmental license granted, it is stipulated that the ecological flow of the river must be left, and the remainder must be added, which allows the conservation of the river.
What will the project do if they have polluted water?	April 19, 2022	Las Ánimas Community (Contact information 3207886575)	Zeus must do water treatment before releasing the project's industrial or domestic water. We could install septic tanks with the 1% of the investment, but only with the previous authorization.
How many community initiatives can be requested by the citizen oversight?			All the initiatives that you want, we will analyze all of them and prioritize.
Can the project introduce new species for fishing activities?	April 19, 2022	San Isidro Community (Contact information 3166676708)	No, introducing new species could damage the aquatic ecosystem.

What is the useful life of the project?	April 20, 2022	Santa Ana Community (Contact information 3196407334)	The project lifetime is 50 years.
Has the project finished the construction work?	April 25, 2022	Mocorongo Community (Contact information 3146827364)	Yes, the project will start a test period in the following days to begin with the operation.
One of the most relevant issues is associated to the roads. I consider that there should be a written commitment and invite other companies present in the area and municipal authorities to sum efforts to improve that road that we all use.			Zeus will prioritize actions for each principal road within the project's area of influence. Nevertheless, there cannot be a commitment because we cannot force other companies to participate and intervene on the roads. You, as a community, can request those companies.
Could Zeus share the meeting record and the technical description of the project with the community?	May 5, 2022	Santa Rosa Community (Contact information 3103527728)	The information requested was sent by May 12, 2022.
	May 6, 2022	Don Matías Community (Contact information 6048666324)	

9.2 Consideration of comments received

To assess the effectiveness of community consultation, Zeus conducted 37 satisfaction surveys. These surveys helped to evaluate the perception and satisfaction of social organizations, communities, and municipal officials. The satisfaction scale ranged from 1 (very dissatisfied) to 5 (very satisfied). Based on the results, 97.3% of the assistants stated that the given information was satisfactory.

The resolution of the comments received during the consultations are shown in **Error! Reference source not found.**

After submitting the project to the BCR Standard for registration, there will be a 30-day consultation period for comments. The received comments will be used to adjust the project design and resolve any issues.

10 Sustainable Development Goals (SDGs)

Regarding the United Nations Sustainable Development Goals (SDGs), the project achieves the following:

SDG	SDG Target	SDG Indicator	Project Contribution
7 Affordable and Clean Energy	7.2. By 2030, increase substantially the share of renewable energy in the global energy mix.	7.2.1. Renewable energy share in the total final energy consumption.	Zeus Hydroelectric Plant will supply 59,200 MWh per year of renewable energy to the Colombia national grid.
8 Decent work and economic growth	8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value.	8.5.2 Unemployment rate, by sex, age, and persons with disabilities.	The project will generate jobs for all women and men in the construction (235), operation, and maintenance (13) of the Zeus Hydroelectric plant for the local people in its area of direct influence, contributing to the region's economic growth.
13 Climate Action	13.2 Integrate climate change measures into national policies, strategies, and planning.	13.2.2 Total greenhouse gas emissions per year.	The Zeus Hydroelectric Plant will supply 59,200 MW per year of renewable energy to the Colombia national grid, reducing 23,156tCO_2 per year by displacing other fossil-fuel-based power plants.

11 REDD+ Safeguards (For REDD+ projects)

The project activity is not a REDD+ project; thus, this section is not applicable.

12 Special categories, related to co-benefits (optional)

The project does not intend to achieve one of the special categories: “co-benefits can be divided into three additional benefits: biodiversity conservation, community benefits, and gender equity”[39]; therefore, this section is not applicable.

13 Grouped projects (if applicable)

The project activity is not a grouped project; thus, this section is not applicable.

14 Other GHG program

The project activity is not registered under other GHG programs. The project holder and participant will not apply to any other GHG programs to generate, certify, or verify emission reductions achieved from this project activity while it is active under the BioCarbon program.

15 Double counting avoidance

The BCR Tool “Avoiding Double Counting (ADC)” sets out the principles and requirements for the BCR Program, to avoid double counting of emission reductions or removals. The Tool addresses the avoidance of double claiming as referred to in CORSIA Emissions Unit Eligibility (EUC) Criteria as well as that of Article 6.2 (Paris Agreement).

As per the requirements, a letter needs to be provided to ensure that the country where the project is being conducted acknowledges that the project is reducing emissions. Additionally, the focal point should state that the project is appropriately registered in the country's public registry system.

[39] https://biocarbonstandard.com/wp-content/uploads/BCR_Standard.pdf (pp. 31)

In Colombia, the National Registry for the Reduction of Greenhouse Gas Emissions (RENARE) was established through Resolution 1447 of 2018. It is responsible for managing initiatives aimed at mitigating GHG emissions at the national level.

The letter will be sent as the registration process goes in parallel to the RENARE registration.

16 Monitoring plan

The Monitoring Plan consists of the procedures to measure the project's electricity generation delivered to the SIN (EG_{Zeus}) and monitor the combined margin CO2 emission factor ($EF_{grid,CM}$) for the grid-connected power generation each year calculated using the CDM tool "Tool 07". Since the construction margin CO2 emission factor ($EF_{grid,BM}$) was set ex-ante for the first crediting period, the $EF_{grid,CM}$ will depend only on the variation expressed by the operating margin emission factor ($EF_{grid,OM}$). Therefore, the monitoring plan consists of the following:

Electricity generation from project activity.

Monitoring procedures are implemented onsite or remotely using tele-metering technology. A main and backup meters are installed at the interconnection point of the project with the SIN. The meters installed are bi-directional, considering both the quantity of electricity supplied by the project plant to the grid and the quantity of electricity delivered to the project plant from the grid. Meters are read remotely from the control center using PrimeRead version 10 reading software, which allows you to query the status of the meters, consult their logs, download data, and store their readings in the database. Metering data backups are made every 15 days to preserve border data. The operational team is in charge of taking the measurements and reporting to XM. The energy meters in the substation are read via dedicated software every 24 hours and the report is made within a maximum period of eight hours following the day of the operation.

If a communication failure occurs during the reading process or there are difficulties in consulting the meter records that cannot be corrected remotely, the border representative is informed and applies the established contingency plan. If communication with the border cannot be re-established, a technical visit with specialized personnel will be scheduled in order to solve the problem. Emission reductions cannot be claimed during that period until the meters are functioning correctly again and reliable data is available.

As noted, there is a main electricity meter and a backup meter, which ensures correct metering in the event of a main electricity meter failure. The information recorded by the meters will be verified through a cross-consultation of the values reported by the coordinator of the national electrical network in the SINERGOX virtual portal, and the lowest value will be chosen as a conservative measure.

The data is included in an Excel spreadsheet for emission reduction calculations on a monthly basis. All data collected as part of the monitoring process are archived electronically and kept for at least two years after the end of the last crediting period.

The following scheme shows the power plants, the substation, and the metering points:

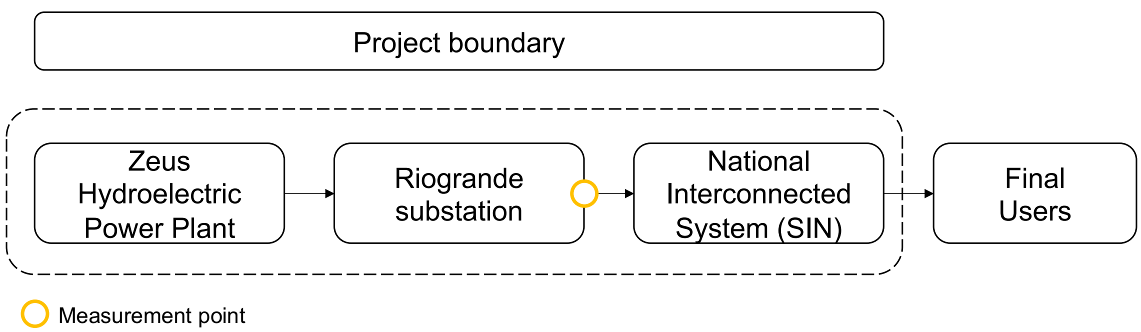

Figure 4. Simplified scheme of the monitoring boundary.

Operating margin emission factor ($EF_{grid,OM}$).

The $EF_{grid,OM}$ consists of accessing the fuel consumption and the electricity generation data from all the SIN registered plants. XM, as the Colombia Wholesale Energy Market administrator, attends the commercial transactions in the market that give the next services:

“Register the borders, that is, the energy consumption measurement systems, their location, and their representative. Settle and invoice the resulting energy exchanges between the generating and marketing agents of the market, who sell and buy on the Energy Exchange" (XM S.A. E.S.P., 2019).

Therefore, XM gives the necessary information to calculate the $EF_{grid,OM}$ for each year. It is available for the public in the XM Portal[40], a virtual platform in which data organized by SIN agents and generation units are stored. For the ex-post option, the emission factor is determined for the year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring..

QA/QC measures.

The energy measurement process is regulated under resolution CREG 038 of 2014[41], under which the guidelines that every energy-generating agent must comply with are established, in which, among others, it is established that the agent must have a Control Center Measurement Management (CGM in Spanish), for the provision of the telemetry service in each of the commercial borders for which it is responsible, guaranteeing compliance with the requirements established in CREG resolution 038 of 2014 and CNO agreement 1043 of 2018[42].

By Article 11 of that resolution, meters were calibrated prior to the operation start and will be calibrated after any repair or intervention. The calibration was and will be done by a laboratory accredited by the National Accreditation Body of Colombia (ONAC in Spanish) under the requirements of the NTC-ISO-IEC 17025 or the international equivalent. Article 28 defines that any plant whose generation is between 500 and 15,000 MWh/month or in the range of installed capacity between 1 and 30 MW must submit its measuring equipment to a maintenance process with a maximum periodicity of 4 years[43]. In case both meters fail, no emission reductions will be claimed during that period until having again data from the main or backup meter.

[40] https://sinergox.xm.com.co/ntrcmb/Paginas/Historicos/Historicos.aspx

[41] https://gestornormativo.creg.gov.co/gestor/entorno/docs/resolucion_creg_0038_2014.htm

[42] https://www.cno.org.co/content/acuerdo-1043-por-el-cual-se-aprueba-la-modificacion-del-documento-de-condiciones-minimas-de

[43] CREG Resolution 038 of 2014. Art 6. Types of measurement points; Art 28. Maintenance of the measurement system.

The CNO National Operation Council establishes in agreement CNO 981 that the maximum frequency of routine tests for current and voltage transformers to maintain measurement systems is every 12 years[44].

All activities that involve installing elements and maintenance work on the measurement system must be duly documented in the Energy Measurement Review and Installation Minutes (Circular 098 of 2014, Annex 2[45]). Personnel must make a photographic record and record the activities in the border resume. The work on the measurement chain must be carried out by qualified personnel with the respective professional registration, which must be included in the border documentation.

Personnel responsible for monitoring.

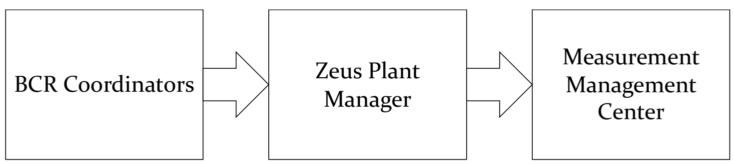

Figure 5. Operational structure of the monitoring plan.

- The BCR Coordinators supervise the monitoring process, compile the monitoring data in an Excel spreadsheet, and calculate the emission reductions of the monitoring period. They also develop the monitoring report in accordance with the BCR rules.
- The Plant Manager is responsible for verifying energy measurements. This task involves reviewing and validating the data recorded by the meters.
- Central Hidroeléctrica Zeus S.A.S. E.S.P. has an agreement with a Measurement Management Center (CGM) of Zeus Hydroelectric Power Plant for the provision of telemetry service at the commercial border,

[44] CNO Agreement 981 Annex 1: "Identification of interventions that require meter calibration tests or routine tests of TTs or TCs and the development of procedures for performing routine tests for TTs and TCs". https://www.cno.org.co/content/acuerdo-981-por-el-cual-se-aprueba-la-modificacion-del-documento-de-identificacion-de-las

[45] http://www.cac.org.co/2016/html/codigo_doc_creg.html

guaranteeing compliance with the requirements established in CREG resolution 038 of 2014 and CNO agreement 1043 of 2018. The CGM is responsible for reading the electricity generated by the project and processing the energy produced by the meters installed at the substation. The meter records are downloaded into a spreadsheet for measurement control. The data collected from the meter is stored electronically and then sent to XM.

Personnel who carry out monitoring tasks are familiar with the basic monitoring requirements and structures. New personnel must participate in basic training to get familiarized with the monitoring procedures.

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 BCR as part of the daily operation, no specific training is required. Corrective actions are carried out if any inconsistency is identified.

Below are the fixed parameters to be monitored according to the activity and the methodological approach used:

Data available at validation:

Data/ Parameter	$EF_{grid,BM,y}$
Unit	tCO_2/MWh
Description	Built margin CO_2 emission factor for grid-connected energy generation in the year and calculated with the latest version of the “TOOL07” of the CDM "Tool to calculate the emission factor for an electrical system".
Source of data	Calculated based on information provided by the XM network administrator. See “Zeus Colombia Calculations.xlsx”

Value applied	0.2369
Justification of choice of data or description of measurement methods and procedures applied	As per the most recent "TOOL07" of the CDM "Tool to calculate the emission factor for an electricity system".
Purpose of data	Calculation of baseline emissions.
Comments	The emission factor is fixed ex-ante; thus, no monitoring and recalculation of the emissions factor during the crediting period is required. For new credit periods, it is necessary to review.

Parameters to monitor during the accreditation period:

Data/ Parameter	$EG_{Zeus,y}$
Unit	MWh/year
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in the year *y*.
Source of data	Measurement in the power plant.
Description of measurement methods and procedures applied	The meters installed are bi-directional, considering both the quantity of electricity supplied by the project plant to the grid and the quantity of electricity delivered to the project plant from the grid for the captation area.
Frequency of monitoring/recording	Continuous measurement and at least monthly recording. The measured data is typically read once every 24 hours using tele-metering technology (remotely).
Value applied	To be monitored during the crediting period. The annual electricity to be injected to the grid is estimated as 59,200 MWh/y

<table>
<tr><td>Monitoring equipment</td><td>A main meter and a reserve meter were installed.
<table><tr><th>Meter</th><th>Serial</th><th>Model</th><th>Brand</th><th>Calibration date</th><th>Accuracy</th></tr><tr><td>Main</td><td>51386024</td><td>ZMD402CT44.0459 S3</td><td>LANDIS & GYR</td><td>16/nov/2021</td><td>0.2 S</td></tr><tr><td>Reserve</td><td>51386022</td><td>ZMD402CT44.0459 S3</td><td>LANDIS & GYR</td><td>16/nov/2021</td><td>0.2 S</td></tr></table></td></tr>
<tr><td>QA/QC procedures to be applied</td><td>Calibration tasks are in accordance with Colombian regulations for electricity measurement devices[41].

The meters will be calibrated a maximum of every four years according to the requirements of national regulations[35].

The information recorded by the meters will be verified through a cross-consultation of the reporting values to the coordinator of the national electrical network available in the SINERGOX virtual portal, and the lowest value will be chosen as a conservative measure.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions.</td></tr>
<tr><td>Calculation method</td><td>Net electricity supplied to the grid by the project plant in the year y= Electricity injected to the grid (MWh)-Electricity consumed from the grid (MWh)</td></tr>
<tr><td>Comments</td><td>All data collected as part of the monitoring process is archived electronically and kept at least for two years after the end of the last crediting period.</td></tr>
</table>

Data/ Parameter	$EG_{m,y}$, $EG_{k,y}$
Unit	MWh/y
Description	Net electricity generated by power plant/unit *m* or *k* in year *y*.

Source of data	SINERGOX XM Portal.
Description of measurement methods and procedures applied	The amount of energy generated by power plants during the year is recorded in the SINERGOX portal as "Generation". This system will be accessed once a year to download the data, which will be stored in an electronic spreadsheet. Each year, the project will take into account the addition of new power plants and their typology.
Frequency of monitoring/recording	a) For Simple adjusted OM (ex-post): Annually during the crediting period for the relevant year, following the guidance in Step 3 (see Section 3.7.3). b) For BM (ex-ante): for the first crediting period once, following guidance in Step 5 (see Section 3.7.3)
Value applied	See “Zeus Colombia Calculations.xlsx”
Monitoring equipment	SINERGOX XM Portal.
QA/QC procedures to be applied	The data organized and delivered to the XM network coordinator is supervised by multiple public and private entities responsible for guaranteeing the information's transparency and quality.
Purpose of data	Calculation of baseline emissions.
Calculation method	Not applicable.
Comments	-

Data/ Parameter	$FC_{i,m,y}$, $FC_{i,k,y}$
Unit	Mass or volume unit.

Description	Amount of fuel type *i* consumed by power plant/unit *m* or *k* in year *y*.
Source of data	SINERGOX XM Portal.
Description of measurement methods and procedures applied	The data available for the respective monitoring period will be consulted in the SINERGOX portal of the national XM network coordinator.
Frequency of monitoring/recording	a) For simple adjusted OM (ex-post): Annually during the crediting period for the relevant year, following the guidance in Step 3 (see Section 3.7.3). b) For BM (ex-ante): For the first crediting period once, following guidance in Step 5 (see Section 3.7.3).
Value applied	See "Zeus Colombia Calculations.xlsx".
Monitoring equipment	SINERGOX XM Portal.
QA/QC procedures to be applied	The data organized and delivered to the XM network coordinator is supervised by multiple public and private entities responsible for guaranteeing the information's transparency and quality.
Purpose of data	Calculation of baseline emissions.
Calculation method	Not applicable.
Comments	-

Data/ Parameter	$NCV_{i,y}$
Unit	GJ/mass or volume unit.

Description	Net calorific value (energy content) of fuel type *i* in year *y*.
Source of data	SINERGOX XM Portal.
Description of measurement methods and procedures applied	The SINERGOX portal of the national network coordinator XM will be used to consult data for the respective period.
Frequency of monitoring/recording	a) For simple adjusted OM (ex-post): Annually during the crediting period for the relevant year, following the guidance in Step 3 (see Section 3.7.3). b) For BM (ex-ante): For the first crediting period once, following guidance in Step 5 (see Section 3.7.3).
Value applied	See "Zeus Colombia Calculations.xlsx".
Monitoring equipment	Not applicable.
QA/QC procedures to be applied	As per the most recent "TOOL07" of the CDM "Tool to calculate the emission factor for an electricity system".
Purpose of data	Calculation of baseline emissions.
Calculation method	Not applicable.
Comments	-

Data/ Parameter	$EF_{CO2,i,y}$; $EF_{CO2,m,i,y}$
Unit	t CO2/TJ

Description	CO_2 emission factor of fuel type *i* used in power unit *m* in year *y*.
Source of data	National default values registered by UPME (Unidad de Planeación Minero Energética[46]).
Description of measurement methods and procedures applied	The data available for the respective monitoring period will be consulted on the UPME portal.
Frequency of monitoring/recording	a) For simple adjusted OM (ex-post): Annually during the crediting period for the relevant year, following the guidance in Step 3 (see Section 3.7.3). b) For BM (ex-ante): For the first crediting period once, following guidance in Step 5 (see Section 3.7.3).
Value applied	(see table below)
Monitoring equipment	Not applicable.

Fuel	Unit (t CO_2/TJ)
Gas	55.539
Fuel oil	80.460
Natural gas	55.539
Diésel (ACPM in Colombia)	74.233
Carbon	88.136

[46] Research And Innovation In Advanced Combustion For Industrial Use. Table 5. EF CO2 and uncertainties in IPCC units and EF in common units http://www.upme.gov.co/Calculadora_Emisiones/aplicacion/Informe_Final_FECOC.pdf

QA/QC procedures to be applied	As per the most recent "TOOL07" of the CDM "Tool to calculate the emission factor for an electricity system".
Purpose of data	Calculation of baseline emissions.
Calculation method	Not applicable.
Comments	-

Data/ Parameter	$EF_{El,m,y}$; $EF_{El,k,y}$
Unit	t CO2/MWh
Description	Emission factor of each plant *m* or *k*, in accordance with the type and characteristics of fuel used to obtain energy.
Source of data	Calculated
Description of measurement methods and procedures applied	As per the most recent "TOOL07" of the CDM "Tool to calculate the emission factor for an electricity system".
Frequency of monitoring/recording	Annually.
Value applied	See "Zeus Colombia Calculations.xlsx".
Monitoring equipment	Not applicable.

QA/QC procedures to be applied	As per the most recent "TOOL07" of the CDM "Tool to calculate the emission factor for an electricity system".
Purpose of data	Calculation of baseline emissions.
Calculation method	As per the most recent "TOOL07" of the CDM "Tool to calculate the emission factor for an electricity system".
Comments	-

Data/ Parameter	$EF_{grid, CM}$
Unit	t CO_2/MWh
Description	Combined margin CO_2 emission factor of the grid electricity in year *y*.
Source of data	Calculated
Description of measurement methods and procedures applied	As per the most recent "TOOL07" of the CDM "Tool to calculate the emission factor for an electricity system".
Frequency of monitoring/recording	Annually during the crediting period for the relevant year, following the guidance in Step 6 (see Section 3.7.3).
Value applied	Year: 2022 $EF_{grid,CM}$: 0.3912

Monitoring equipment	Not applicable.
QA/QC procedures to be applied	As per the most recent "TOOL07" of the CDM "Tool to calculate the emission factor for an electricity system".
Purpose of data	Calculation of baseline emissions.
Calculation method	As per the most recent "TOOL07" of the CDM "Tool to calculate the emission factor for an electricity system".
Comments	The emission factor is calculated ex-post.

Parameters to monitor project's contribution to the Sustainable Development Goals (SDGs):

SDG	7 Affordable and Clean Energy.
SDG Target	7.2 By 2030, increase substantially the share of renewable energy in the global energy mix.
SDG Indicator	7.2.1. Renewable energy share in the total final energy consumption.
Parameter monitored	$EG_{Zeus,y}$
Unit	MWh/y
Source of data	Measurement in the power plant.
Monitoring frequency	Continuous measurement and at least monthly recording. The measured data is typically read once every 24 hours using tele-metering technology (remotely).
Value	To be monitored during the crediting period.

	The annual electricity to be injected to the grid is estimated as 59,200 MWh/y
Purpose of data	Calculation of project contributions on SDG 7.

SDG	8 Decent work and economic growth.
SDG Target	8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value.
SDG Indicator	8.5.2 Unemployment rate, by sex, age, and persons with disabilities.
Parameter monitored	Demographic data of permanent jobs created by the project[47].
Unit	Number of jobs per year by sex, age and disabilities
Source of data	HR hiring data.
Monitoring frequency	Annually.
Value	To be monitored during the crediting period.
Purpose of data	Monitoring of project contributions on SDG 8.

SDG	13 Climate Action.

[47] See "Perfil_Sociodemográfico.xlsx"

SDG Target	13.2 Integrate climate change measures into national policies, strategies, and planning.
SDG Indicator	13.2.2 Total greenhouse gas emissions per year.
Parameter monitored	Net GHG Reduction.
Unit	t CO2e/y
Source of data	Calculated.
Monitoring frequency	Annually.
Value	To be monitored during the crediting period.
Purpose of data	Calculation of project contributions on SDG 13.

NOTE: This Project Document (PD) shall be completed following the instructions included. However, it is important to highlight that these instructions are complementary to the BCR STANDARD, and the Methodology applied by the project holder, in which more information on each section can be found.