



Verified Carbon Standard

FOZ DO CHAPECÓ



Document Prepared by Carbotrader

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1 PROJECT DETAILS

1.1 Summary Description of the Project

The project activity consists on the supply of clean hydroelectric energy to the Brazilian National Interconnected System (SIN) through the implantation and operation of Hydro Power Plant (HPP) Foz do Chapecó, located in the Southern Region of Brazil, between the cities of Águas de Chapecó, state of Santa Catarina (SC) and Alpestre, state of Rio Grande do Sul (RS), with an installed capacity of 855 MW (4 generation units with nominal power of 213.75 MW each and 4 francis turbines with 217.14 MW each), using a small reservoir, with low environmental impact related to its installed capacity.

Foz do Chapecó Hydro Power Plant generates electricity through clean and renewable source and it contributes to attend the growing demand for electricity in Brazil, due to the country's economical and population growth, contributing, thus, to the environmental, social and economical sustainability, by increasing the participation of clean and renewable energy in relation to the country's total consumption of electricity.

Baseline scenario establishes that electricity delivered to the grid by the project activity would have been generated otherwise by the operation of a grid-connected power plant and by the addition of new generating sources, as reflected in the combined margin (CM) calculations described in the "Tool to calculate the emission factor for an electricity system" (Version 07.0). This Tool is from the Clean Development Mechanism (CDM).

The alternative scenarios to the project activity are two situations which reflect the calculation of the combined margin of baseline scenario: (i) the continuity of the present scenario, with electricity generation happening according to the current generation composition of the National Interconnected System, more specifically of the South Subsystem and (ii) the construction of a new mineral coal thermoelectric power plant.

The power plant started the construction on 05/12/2006 has acquired the operation license on 25/08/2010 and started operation on 14/10/2010.

The exploitation concession permits the operation until 06/11/2036.

The total GHG emissions reductions or removals generated forecasted (10 years) is 7,115,229 tCO₂e (711,523 tCO₂e/year).

1.2 Sectoral Scope and Project Type

Foz do Chapecó Project fits in the category of sectoral scope 1 - Energy (renewable/non-renewable) and it is not a grouped project.

1.3 Project Eligibility

Project already registered in the VCS Program (register ID #896).

1.4 Project Design

The project is a single installation (Greenfield Hydro Power Plant).

Eligibility Criteria

Not applicable (no grouped project).

1.5 Project Proponent

Organization name	Foz do Chapecó Energia S.A.
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1.6 Other Entities Involved in the Project

Organization name	Carbotrader Assessoria e Consultoria em Energia EIRELI
Role in the project	PD Consultant
Contact person	Arthur Moraes

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1.7 Ownership

Foz do Chapecó Project has one participant. Foz do Chapecó Energia S.A.

Foz do Chapecó Energia S.A. is the owner of Foz do Chapecó Hydro Electric Plant and it is responsible, in the condition of independent producer of energy, for implanting and operating the HPP Foz do Chapecó.

Foz do Chapecó Energia has as shareholders the companies (1) CPFL Geração de Energia S.A., 51%; (2) Furnas Centrais Elétricas, 40%; (3) CEEE-GT Companhia Estadual de Geração e Transmissão de Energia Elétrica, 9%.

1.8 Project Start Date

The power plant started the construction on 05/12/2006 has acquired the operation license on 25/08/2010 and started operation on 14/10/2010 (information already included in the first PD and subsequent MRs).

1.9 Project Crediting Period

14/10/2020 to 13/10/2030 (Second crediting period valid for 10 years – renewable)

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	
Large project	X

Year	Estimated GHG emission reductions or removals (tCO ₂ e)
2020 October	150,102
2021	834,737

2022	711,523
2023	711,523
2024	711,523
2025	711,523
2026	711,523
2027	711,523
2028	711,523
2029	711,523
2030 October	561,421
Total estimated ERs	7,115,229
Total number of crediting years	10
Average annual ERs	711,523

1.11 Description of the Project Activity

Foz do Chapecó Hydroelectric Project developed by Foz do Chapecó Energia S/A consists of the installation of a hydroelectric plant with an accumulation reservoir, located in the verge of Águas de Chapecó municipality, in Santa Catarina State, and Alpestre municipality, in Rio Grande do Sul State. Total installed capacity of the Project will be 855 MW, consisting of four sets of hydroelectric Francis type turbines with nominal capacity 217.14 MW and the electricity generator nominal power is 213.75, with a predicted electricity supply to the grid of 3,742,272 MWh (49.96% plant load factor) per year. All equipments and constructions are new (greenfiled) with average lifetime of 35 years.

The following equipments are installed: 4 Generators, Alstom, model SAV 1450/132/80 with installed capacity 225,000 kVA, power factor 0.95, serial numbers TBTG 0133, TBTG 0134, TBTG 0135, TBTG 0136 and 4 Francis Turbines, Alstom with nominal potency of 217.4 MW each. In the substation, there are two energy meters (principal and backup) for each group generator.

The purpose of the Project is to use the hydrological resources of the Uruguay River in order to generate low emissions electricity for the Brazilian Interconnected System (SIN – *Sistema Interligado Nacional*), hereafter referred as the SIN, thereby displacing electricity that is relatively carbon intensive, and reducing greenhouse gas (GHG) emissions. The baseline scenario is the same as the scenario existing prior to the start of the implementation of the project activity: Electricity delivered to

the grid by the Project would have otherwise been generated by the operation of grid-connected power plants, and by the addition of new generation sources.

The participants of the project recognize that this Project activity is helping Brazil to fulfill its goals of promoting sustainable development due to the following reasons:

- Contributes to local environmental sustainability, since it decreases the dependence on fossil fuels, thus improving air quality;
- Contributes towards better working conditions and increases employment opportunities in the area where the project is located;
- Contributes towards better revenue distribution since it assists the regional/local economic development;
- Contributes to the development of technological capacity because most of the equipment of the project will be manufactured inside Brazil, consolidating the technology in the country.

1.12 Project Location

HPP Foz do Chapecó is located in Uruguay River, between the municipalities of Águas de Chapecó/SC and Alpestre/RS, in Brazil.

The geographic coordinates are: Latitude 27° 08' 24" South and Longitude of 53° 02' 36" West¹.

1.13 Conditions Prior to Project Initiation

The baseline scenario is the same as the conditions existing prior to the project initiation, more details on Section 3.4 (Baseline Scenario).

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

The project has all relevant environmental licenses and permissions issued and in compliance with Brazilian Regulation. The Preliminary License was issued by the Environmental Ministry (*Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis* – IBAMA) environmental agency, on December 13th, 2002, PL number 147. The Installation License was issued on September 21st, 2004, IL number 284 and renewed on December 5th, 2006. The Operation License n° 949/2010 was issued on 25/08/2010 by IBAMA and a renewal was issued on December 26th, 2019 (for more 10 years).

The concession contract firmed with the Brazilian Government, through the National Agency of Electric Energy (ANEEL) is a proof that the project is in compliance with the Government requirements.

¹ Available at <http://www.aneel.gov.br/cedoc/dsp2007911.pdf>

1.15 Participation under Other GHG Programs

1.15.1 Projects Registered (or seeking registration) under Other GHG Program(s)

Not applicable. Project not registered or seeking registration under any other GHG program.

1.15.2 Projects Rejected by Other GHG Programs

Not applicable. Project already registered in the VCS (PD for 2nd CP renewal).

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

Not applicable. Project doesn't reduce GHG emissions from activities that are included in an emission trading program or any other mechanism that includes GHG allowance trading.

1.16.2 Other Forms of Environmental Credit

Not applicable. Project hasn't sought or received another form of GHG-related environmental credit, including renewable energy certificates.

1.17 Sustainable Development Contributions

The participants of the project recognize that this Project activity is helping Brazil to fulfil its goals of promoting sustainable development. Specifically, the project is in line with host-country specific CDM requirements due to the following reasons:

- Contributes to local environmental sustainability, since it decreases the dependence on fossil fuels, thus improving air quality. According to ONS Santa Catarina state had between January 2020 until June 2021 almost 23% electricity consume coming from fossil fuel generation (coal and gas);
- Contributes towards better working conditions and increases employment opportunities in the area where the project is located (around 18 direct or indirect permanent jobs);
- Contributes towards better revenue distribution since it assists the regional/local economic development. Revenues taxes (ICMS tax) are locally distributed;
- Contributes to the development of technological capacity because most of the equipment of the project was manufactured in Brazil, consolidating the technology in the country (there are also software or monitoring equipments updates during the project lifetime).

1.18 Additional Information Relevant to the Project

Leakage Management

Not applicable leakage management.

Commercially Sensitive Information

Not applicable commercially sensitive management.

Further Information

Not applicable.

2 SAFEGUARDS

2.1 No Net Harm

The EIA (from portuguese *Estudo de Impacto Ambiental*, Environmental Impact Studies) and RIMA (from portuguese *Relatório de Impacto Ambiental*, Environmental Impact Document) developed for the Project Activity highlight the environmental impacts of the hydroelectric plant and the actions to minimize the adverse impacts. The environment modifications described in the EIA and RIMA were object of specific actions that aim at the correction or compensation of its negative effects, maximizing, on the other hand, its positive effects. Such actions are presented below, always related to the impacts that had determined its recommendation.

The Project Developer executed out of court amicable agreements with the people affected by the Project as actions for people resettlement. Those actions were planned together with local government and concerning local stakeholder's opinion. The objective of the document set with local government, is define the line of behavior for the treatment of the questions related to the necessary services and actions to execute the resettlement program, aiming to minimize the negative effects, assuring that the impacted population are indemnified or resettled in a satisfactory and proper form, searching life quality and access to land, natural resources and services (drinking water and infrastructure), resulting in equal or better chances that this population had before its resettlement. The process was done in participatory way and adopting procedures communication capable to clarify the affected population about the diverse stages of the resettlement process.

More details about Impacts and Programs on Section 2.3.

2.2 Local Stakeholder Consultation

During the environmental licensing process (from 13/12/2002), the Environmental Impact Report was presented to stakeholders and the stakeholders were invited to perform comments about the project. A public audience was performed coordinated by Environmental Agency. This process was performed by the entrepreneurs and comments are registered in the documents related to the licensing process². The public audience occurred in the cities of Alpestre/RS and Chapecó/SC.

The company compromised of responding to 100% of the issues received from the public audiences, through meetings to debate the topic, official communication related to the issues and visit to the site related to the claim.

Even when the company does not agree with the issue or cannot attend the claim, the company tried to clarify the issue and explain why could not address such issues.

It is noteworthy that the Agreement Term for Relocation of Affected Population was signed between Foz do Chapecó Energia and Municipal Committee Negotiating. This document guides the procedures and benefits for local communities affected by the project. Several meeting with local communities happened to include the demands of the community and to express the benefits it looks for. The Agreement Term for Relocation of Affected Population consolidates the terms agreed by entrepreneur and the local community related to relocation of people.

The communication of Foz do Chapecó with stakeholders was based on specific plans for each stage of the project (construction and operation)³. During the construction phase, was prioritized communication "face to face" with meetings in affected communities, visits to affected families and the mayors of the municipalities around the hydroelectric.

The main objective was to clarify doubts and disclosure procedures and programs linked to the implementation of the plant and the relocation of the affected population. During this period, were also used tools and channels for the transmission of information of public interest: radio bulletins, publishing informational columns in newspapers of local circulation, production of books and instructional booklets for direct distribution in the affected communities.

Other materials were produced to meet the interests of shareholders and regulators as IBAMA, Ministry of Mines and Energy and ANEEL. Included in this case the monthly newsletter sent by the company to these organs and the various reports produced to provide updated information about the project. All channels and materials are being held by the company at the stage of operation of the project for ongoing communication with local people and other stakeholders. It is also maintained its

² The minutes of meeting were provided to auditors.

³ Social Communication Program in the Environmental Basic Plan. Page 490/735.

commitment to meet the demands of meetings, hearings and communities of interest to clarify issues and receiving claims.

The company developed an intense communication dialogue with local communities and social movements. Several meetings were performed with the cities committees and Movement of Affected by Dams (From Portuguese *Movimento dos Atingidos por Barragem* – MAB). The meetings were conducted by representatives from the Government at most. This assured the democratic and transparent character of the plant implementation process

During the construction phase, there were two invasions to the plant. Both were peacefully negotiated with concessions on both sides. Otherwise, in other situations, there were registered peaceful demonstrations regarding the enterprise, which has always had its patterns of claims received by the company's board and its representatives discussed with the social movements.

All reported events resulted in meetings scheduled by the company with the Movement of Affected by Dams, and widely publicized by the media and accompanied by the leaders of the municipalities affected by the project. Foz do Chapecó also always remained available to the press to clarify issues that mobilize public opinion and providing information of interest to the press and their readers/viewers. Moreover, issues official statements during these occurrences to stand before society and reaffirm their willingness for dialogue and conflict resolution. All the actions taken by Foz do Chapecó are followed by environmental official entities and are in accordance with the applicable law. This can be evidenced by the license of operation issued by the environmental entity.

During the ongoing plant operation the channels for stakeholders communication is permanently opened through: local office in the city, website with news from project activity and also e-mail and phone contacts available. Link: <http://www.fozdochapeco.com.br/>

Several programs and activities involving the local stakeholders has being provided during the project lifetime (as recently examples we have: Water Use Program in Erval Grande City on December 2019, Several press releases material (about sustainable and environmental programs) on local newspaper during 2020 year (due to the COVID 19 pandemic was not possible in person meetings or activities, etc). Reports and pictures are public available in the project owner' website.

Also there are programs that involve the local community, for example the “PACUERA program” that accepts local community participation through sustainability projects coming from them.

2.3 Environmental Impact

As described on Section 2.1 the EIA and RIMA developed for the Project Activity highlight the environmental impacts of the hydroelectric plant and the actions to minimize the adverse impacts. Below the summary:

IMPACTS	PROGRAMS
Alteration of the Fluvial System	Limnology and Water Quality Monitoring
Water table elevation	Erosive Processes control
Alteration of water quality	Limnology and Water Quality Monitoring
Interference of Authorized Areas and Mineral Concessions with the Reservoir	Mineral Investigations
Start or acceleration of erosive processes	Erosive Processes control Recuperation of Degraded areas
Occurrence of Induced Earthquakes	Seismographic monitoring
Reduction of Biological diversity of Aquatic Ecosystems	Limnology and Water Quality Monitoring Ichthyofauna Monitoring Implantation of a Unit of Conservation and Protection of the Fauna and Flora
Alteration of the Structure of the Aquatic Fauna and of the Water Quality pry-Operational Phase	Limnology and Water Quality Monitoring. Ichthyofauna Monitoring
Alteration of the Structure of the Aquatic Fauna and of the Water Quality the Wadding Phase and the Operation of the Dam	Limnology and Water Quality Monitoring. Ichthyofauna Monitoring
Migratory routes detrimental	Limnology and Water Quality Monitoring. Ichthyofauna Monitoring
Removal of Current Vegetal Covering and Loss of Habitats	Ichthyofauna Monitoring Implantation of a Unit of Conservation and Protection of the Fauna and Flora
Increase of the Hunting	Implantation of a Unit of Conservation and Protection of the Fauna and Flora Environmental education and Social Communication
Generation of Population Expectation due to the Enterprise	Environmental education and Social Communication Population resettlement and reorganization of the remaining areas Reconstruction and improvement of Infra-structure
Change of the social cultural Behaviour Population Affected	Environmental education and Social Communication Support to resettled population Support to farming activities
Familiar Production Unit unstructured	Support to resettled population Support to farming activities

Archaeological sites interference	Heritage rescue
Healthcare amendment	Health
Amendment of the Labour Market	Health Support for Migrant Populations
Amendment of the Real Estate Market	Population Re-settlement and Re-organization of remaining areas Reconstruction and Infrastructure Improvements
Amendment of Market Goods and Regional Income and Municipal Collection	Population Re-settlement and re-organization of remaining areas Reconstruction and Infrastructure Improvements
Improvement of Transmission and Communication Systems	Reconstruction and Infrastructure Improvements
Traffic Intensification and Interference with the Road Infrastructure	Environmental Education and Social Communication Reconstruction and Infrastructure Improvements
Loss of Agricultural Production Areas	Support for Agricultural Activities
Compulsory Population Displacement	Population Re-settlement and re-organization of remaining areas Support for Migrant Populations Support for Agricultural Activities
Interference with fluvial passages	Reconstruction and infrastructure improvements
Interference with Social Infrastructure	Reconstruction and infrastructure improvements
Interference with Indigenous Communities	Monitoring of Indigenous populations

An extensive list of all mitigation actions to be implemented was included in the EIA.

2.4 Public Comments

There aren't relevant comments that could trigger update to the project design. Also the project is already under operation (PD for 2nd Credit Period).

Even though during the ongoing plant operation the channels for stakeholders communication is permanently opened through: local office in the city, website with news from project activity and also e-mail and phone contacts available. Link: <http://www.fozdochapeco.com.br/>

Also there are programs that involve the local community, for example the “PACUERA program” that accepts local community participation through sustainability projects coming from them.

More details on section 2.2.

2.5 AFOLU-Specific Safeguards

Not applicable since non-AFOLU project.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

Methodology **ACM0002** – “Methodology Consolidated for grid-connected electricity generation from renewable sources” - Version 20.0.

Link: <https://cdm.unfccc.int/methodologies/DB/XP2LKUSA61DKUQCOPWPGWDN8ED5PG>

TOOL 07: “Tool to calculate the emission factor for an electricity system” - Version 07.0.

Link: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v7.0.pdf>

TOOL11: “Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period” – Version 03.0.1.

Link: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-11-v3.0.1.pdf>

TOOL05: “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” – Version 03.0

Link: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v3.0.pdf>

3.2 Applicability of Methodology

The consolidated methodology ACM0002, version 20.0, is applicable to Foz do Chapecó HydroPower Plant VCS Project, because the project is a grid-connected renewable power plant that will consist of a new power plant at a site where no renewable power plant was operated prior to the implementation of the project activity.

Furthermore, the project activity fulfills all the applicability conditions of ACM0002, Version 20.0 in the following ways:

“ 3. This methodology is applicable to grid-connected renewable energy power generation project activities that:

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

4. The methodology is applicable under the following conditions:

- (a) The project activity may include renewable energy power plant/unit of one of the following types: hydro Power plant/unit with or without reservoir, wind power plant/unit, geothermal power plant/unit, solar power plant/unit, wave power plant/unit or tidal power plant/unit; ”

Outcome: applicability condition is fulfilled, considering that the project activity is the installation of a Greenfield power plant (a) type: “hydro power plant/unit with reservoir”.

- (b) In the case of capacity additions, retrofits, rehabilitations or replacements (except for wind, solar, wave or tidal power capacity addition projects) the existing plant/unit started commercial operation prior to the start of a minimum historical reference period of five years, used for the calculation of baseline emissions and defined in the baseline emission section, and no capacity expansion, retrofit, or rehabilitation of the plant/unit has been undertaken between the start of this minimum historical reference period and the implementation of the project activity.

Outcome: since the proposed project does not involve capacity addition, retrofits or replacements, this applicability condition is not applied.

5. In case of hydro power plants one of the following conditions must apply:

- (a) The project activity is implemented in an existing single or multiple reservoir, with no change in the volume of reservoir; or
- (b) The project activity is implemented in existing single or multiple reservoirs, where the volume of the reservoir(s) is increased and the power density, calculated using equation (7), is greater than 4 W/m²; or
- (c) The project activity results in new single or multiple reservoirs and the power density, calculated using equation (7), is greater than 4 W/m²; or
- (d) The project activity is an integrated hydro power project involving multiple reservoirs, where the power density for any of the reservoirs, calculated using equation (7), is lower than or equal to 4 W/m², all of the following conditions shall apply:
 - (i) The power density calculated using the total installed capacity of the integrated

project, as per equation (8), is greater than 4 W/m²;

(ii) Water flow between reservoirs is not used by any other hydropower unit which is not a part of the project activity;

(iii) Installed capacity of the power plant(s) with power density lower than or equal to 4 W/m² shall be:

a. Lower than or equal to 15 MW; and

b. Less than 10 per cent of the total installed capacity of integrated hydro power project.

Outcome: The project activity involves new reservoirs and the project activity of the power plant is greater than 4 W/m².

6. In the case of integrated hydro power projects, project proponent shall:

(a) Demonstrate that water flow from upstream power plants/units spill directly to the downstream reservoir and that collectively constitute to the generation capacity of the integrated hydro power project; or

(b) Provide an analysis of the water balance covering the water fed to power units, with all possible combinations of reservoirs and without the construction of reservoirs. The purpose of water balance is to demonstrate the requirement of specific combination of reservoirs constructed under CDM project activity for the optimization of power output. This demonstration has to be carried out in the specific scenario of water availability in different seasons to optimize the water flow at the inlet of power units. Therefore, this water balance will take into account seasonal flows from river, tributaries (if any), and rainfall for minimum of five years prior to the implementation of the CDM project activity.

Outcome: The project activity does not involve integrated hydro power projects. This applicability condition is not applied.

7. The methodology is not applicable to:

(a) Project activities that involve switching from fossil fuels to renewable energy sources at the site of the project activity, since in this case the baseline may be the continued use of fossil fuels at the site;

(b) Biomass fired power plants.”

Outcome: applicability condition fulfilled. The project activity is a hydro power project. It does not involve fuel switch, biomass fired power plants.

8. In case of retrofits, replacements, or capacity additions, this methodology is only applicable if the most plausible baseline scenario, as a result of the identification of baseline scenario, is the

“continuation of the current situation, i.e. to use the power generation equipment that was already in use prior to the implementation of the project activity and undertaking business as usual maintenance”.

Outcome: Since the project does not involve retrofits, replacements or capacity addition, this applicability condition is not applied.

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

- (a) “TOOL01: Tool for the demonstration and assessment of additionality” – not used.
- (b) “TOOL02: Combined tool to identify the baseline scenario and demonstrate additionality” – not used.
- (c) “TOOL03: Tool to calculate project or leakage CO2 emissions from fossil fuel combustion” – not used.
- (d) “TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”.
- (e) “TOOL07: Tool to calculate the emission factor for an electricity system”;
- (f) “TOOL10: Tool to determine the remaining lifetime of equipment” – not used.
- (g) “TOOL11: Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period”;
- (h) “TOOL32: Positive lists of technologies” – not used.

So the ACM0002 methodology is applicable and has included the standardized baseline.

3.3 Project Boundary

Source	Gas	Included?	Justification/Explanation
Baseline CO ₂ emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity	CO ₂	Yes	Main Emission Source. In the absence of the project activity, the operation of other plants connected to the SIN would cause emission of GHGs.
	CH ₄	No	Minor Emission Source.
	N ₂ O	No	Minor Emission Source.
	Other	NA	
Project For dry or flash steam geothermal power plants, emissions of CH ₄ and CO ₂ from non-condensable gases contained in	CO ₂	No	This is not applicable, as the project activity is a hydro power plant and it is not a dry or flash geothermal power plant.
	CH ₄	No	
	N ₂ O	No	

Source	Gas	Included?	Justification/Explanation
geothermal steam			
For binary geothermal power plants, fugitive emissions of CH ₄ and CO ₂ from non-condensable gases contained in geothermal steam	CO ₂	No	This is not applicable, as the project activity is a hydro power plant and it is not a geothermal power plant.
	CH ₄	No	
	N ₂ O	No	
CO ₂ emissions from combustion of fossil fuels for electricity generation in solar thermal power plants and geothermal power plants	CO ₂	No	This is not applicable, as the project activity is a hydro power plant and it is not a solar thermal or geothermal power plant.
	CH ₄	No	
	N ₂ O	No	
For hydro power plants, emissions of CH ₄ from the reservoir	CO ₂	No	Minor Emission source, the power density of HPP Foz do Chapecó is greater than 10W/m ² , so the GHGs` emissions from the project activities are zero (PEy = 0).
	CH ₄	No	
	N ₂ O	No	

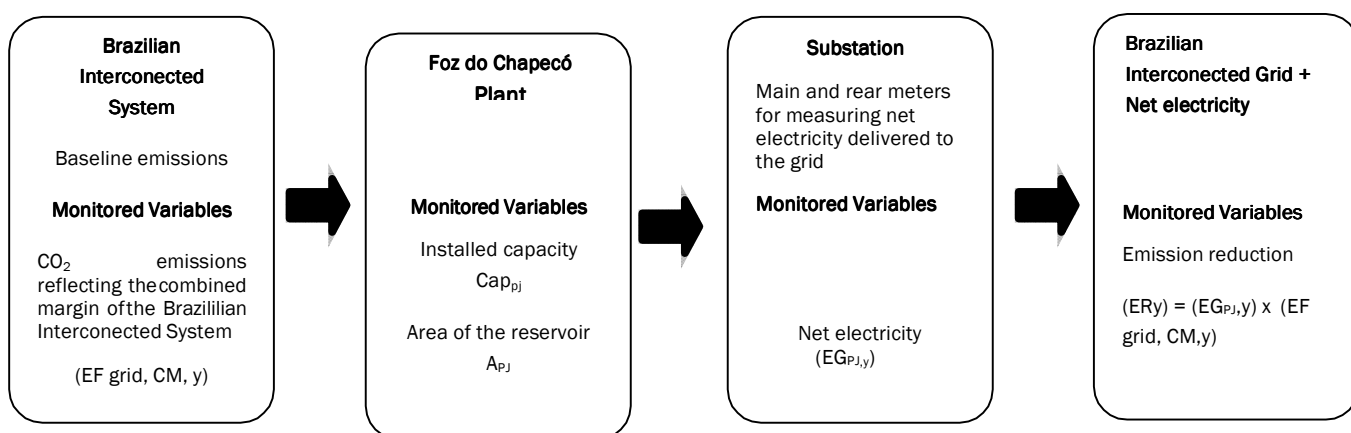
The National Interconnected System is considered as the project boundary. The National Interconnected System (*Sistema Interligado Nacional - SIN*) is managed by the National Interconnected Power System Operator (from *Operador Nacional do Sistema - ONS*), which is responsible for all activities related to the planning and management of grid operation. The ONS traditionally subdivides the National Interconnected System into four interconnected Subsystems: the South; Southeast/Midwest; the North; and Northeast. These Subsystems are related to the respective Brazilian geographic regions.

Based on the effective power generation availability and consumption behavior and demand in each region, the ONS defines the dispatch of each individual power plant, as well as the inter-regional energy exchange and mid and long term operational policies to warrant reservoir management and

energy security, i.e. the dispatch of thermal power units once reservoir levels fall below a certain security level. These operational conditions of the system are permanently monitored and data is available to the electricity industry agents.

According to ACM0002, version 20.0, the spatial extension of the project boundary includes the project power plant and all power plants physically connected to the electricity system that the VCS (originally CDM) project power plant is connected to. The Foz do Chapecó Hydro Power Plant is connected to National Interconnected System (SIN).

The diagram of the project boundary is presented in the figure below:



3.4 Baseline Scenario

In the absence of the project activity, the clean electricity supplied by Foz do Chapecó Hydro Power Plant to the Brazilian National Interconnected System (SIN) would have been generated by other existing or new power plants connected to the grid. Accordingly, the baseline scenario for new renewable grid-connected power generation plant defined by methodology ACM0002, version 20.0, is the following:

“If the project activity is the installation of a Greenfield power plant, the baseline scenario is electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin (CM) calculations described in “TOOL07: Tool to calculate the emission factor for an electricity system”.

The baseline scenario presented by the ACM0002, version 20.0, is perfectly applicable to Foz do Chapecó Hydro Power Plant. The combined margin emission factor of the National Interconnected

System will be calculated, according to the methodological tool “*Tool to calculate the emission factor for an electricity system*”, approved by the CDM Executive Board.

The Combined Margin (CM) emission factor is calculated from the generation record of all plants connected to the National Interconnected System (SIN) and centrally dispatched by the National Interconnected Power System Operator (*Operador Nacional do Sistema - ONS*). Based on this generation data as provided by the ONS, the Brazilian Designed National Authority (DNA) commonly calculates emission factors of the SIN according to the “*Tool to calculate the emission factor for an electricity system*” and makes them available to the public.

The combined margin emission factor for the National Interconnected System (for the 2nd CP) will be, therefore, used to determine the emission reductions generated as a result of project’s implementation.

Also according to the TOOL 11: “*Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period*” a stepwise procedure to assess the continued validity of the baseline and to update the baseline at the renewal of a crediting period is necessary.

The tool consists of two steps. The first step provides an approach to evaluate whether the current baseline is still valid for the next crediting period. The second step provides an approach to update the baseline in case that the current baseline is not valid anymore for the next crediting period.

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

The validity of the current baseline is assessed using the following Sub-steps:

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

If the current baseline complies with all relevant mandatory national and/or sectoral policies which have come into effect after the submission of the project activity for validation or the submission of the previous request for renewal of the crediting period and are applicable at the time of requesting renewal of the crediting period, go to Step 1.2.

If the current baseline does not comply with relevant mandatory national and/or sectoral policies, then assess based on the examination of current practice in the country or region in which the policies apply, whether those policies are systematically not enforced and that non-compliance with those requirements is widespread in the country or region.

If the current baseline is not in compliance with the relevant mandatory national and/or sectoral policies or if it cannot be shown that the policies are systematically not enforced and that non-

compliance with those policies is widespread in the country or region, then the current baseline needs to be updated for the subsequent crediting period.

The validity of the current baseline doesn't need to be updated since still valid and in compliance with relevant mandatory Brazilian policies. More details in Section 1.14.

Step 1.2: Assess the impact of circumstances

Assess the impact of circumstances existing at the time of requesting renewal of the crediting period on the current baseline emissions, without reassessing the baseline scenario.

In the situation where the baseline scenario identified at the validation of the project activity was the continuation of the current practice without any investment, an assessment of the changes in market characteristics is required for the renewal of the crediting period.

Evaluate whether the conditions used to determine the baseline emissions in the previous crediting period are still valid. Assess the availability of new fuels or raw materials and the impact of electricity or fuel prices in the identification of the current practice for the baseline emissions;

If the new circumstances make a continued validity of the current baseline not plausible, then the current baseline needs to be updated for the subsequent crediting period.

The circumstances at the time of requesting renewal of the crediting period are the same described for the first crediting period as described just after the TOOL 11 evaluation on this section. There aren't impact on the availability of new fuels or raw materials that could lead to significant fuel or electricity price alteration.

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

This sub-step should only be applied if the baseline scenario identified at the validation of the project activity was the continuation of use of the current equipment(s) without any investment and, the projects proponents or third party (or parties) would undertake an investment later due, for example, to the end of the technical lifetime of the equipment(s) before the end of the crediting period or the availability of a new technology.

Assess whether the remaining technical lifetime of the equipment that would have continued to be used in the absence of the project activity, as determined in the CDM-PDD or CDM-PDD-REN, exceeds the crediting period for which renewal is requested.

Take into consideration the market penetration of different technologies. Evaluate the penetration rate of different technologies that are available in the market and evaluate how they could affect the baseline.

If the baseline scenario of the project activity is the continuation of use of the current equipment(s) without any investment and the projects proponents or third party(ies) will undertake an investment later, but before the end of a crediting period, then the current baseline needs to be updated for that crediting period or the crediting of emission reductions should be limited to the period before the baseline equipment would cease its operation.

Not applicable since the technical lifetime of the main equipments from PA has more time than the end of the crediting period. The project proponents will not undertake an investment later before the end of crediting period.

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

Assess whether data and parameters that were only determined at the start of the crediting period and not monitored during the crediting period are still valid or whether they should be updated.

Updates should be undertaken in the following cases:

- Where IPCC default values are used, the values should be updated if any new default values have been adopted and published by the IPCC, for example, in guidelines for national GHG inventories, IPCC assessment report or special reports by the IPCC;*
- Where emission factors, values or emission benchmarks are used and determined only once for the crediting period, they should be updated, except if the emission factors, values or emission benchmarks are based on the historical situation at the site of the project activity prior to the implementation of the project and cannot be updated because the historical situation does not exist anymore as a result of the CDM project activity.*

The emission factors should be updated since there are new values available. For second credit period the build margin emission factor shall be fixed ex-ante.

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

This step is only applicable if any of the Steps 1.1, 1.2, 1.3 and/or 1.4 showed that the current baseline needs to be updated.

Step 2.1: Update the current baseline

Update the current baseline emissions for the subsequent crediting period, without reassessing the baseline scenario, based on the latest approved version of the methodology applicable to the project activity. The procedure should be applied in the context of the sectoral policies and circumstances that are applicable at the time of request for renewal of the crediting period.

Applicable, the current baseline emissions were updated for the subsequent crediting period, without reassessing the baseline scenario, based on the latest approved version of the methodology ACM0002.

Step 2.2: Update the data and parameters

If the application of Step 1.4 showed that the data and/or parameter(s) that were only determined at the start of the crediting period and not monitored during the crediting period are not valid anymore, project participants should update all applicable data and parameters, following the guidance in Step 1.4.

Applicable, the data and parameters were updated as described in Section 4.1. The build margin emission factor shall be fixed ex-ante and the operating margin shall be monitored ex-post (as per TOOL 07, see Section 5.2).

3.5 Additionality

This section is a copy from the same section on 1st PD (registered).

This section is elaborated based on the “Tool for demonstration and assessment of additionality” (version 6.0.0) of the CDM which defines a step-wise procedure to assess and demonstrate the additionality of the project.

To illustrate the context of the project development, the following table provides an overview of the project’s development timeline.

Table 01: Project Timeline

Date	Type of evidence	Evidence/Reference
1966 to 1969	Project Milestone	Hydroelectric potential identification
07/11/2001	Project Milestone	Concession of the Plant.
21/09/2004	Project Milestone	Installation License
15/12/2006	Project Milestone	Start of minor/pre-project actions (Preliminary Contract)
01/08/2007	Project Milestone	Engineering, procurement and construction contract is signed
04/09/2007	Project Milestone	Financial Closure - contract with financial agents were signed
01/11/2007	Project Milestone	1 st construction mark
25/08/2010	Project Milestone	Operation License is issued

14/10/2010	Project Milestone	The plant started commercial operation
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Step 1. Identification of alternatives to the project activity consistent with current laws and regulations

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

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

The realistic alternatives to the project activity are:

- Alternative 1: The project activity undertaken without being registered as a VCS project;
- Alternative 2: The continuation of the current situation. The additional electricity generated by the project would be generated by existing or new power plants connected to the national electric system.

Outcome of sub-step 1a: These are the identified realistic and credible alternative scenario(s) to the project activity.

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

Regulatory Surplus

Environmental licenses

The project has all the required mandatory environmental licenses for a hydroelectric project, as following below:

In Brazil, it is used a three-stage process for project licensing (Preliminary License, Installation License and Operating License), with separate procedures for granting licenses at all three stages.

This administrative procedure allows or contributes to transferring, restarting or revisiting old disputes during the three phases. Such procedure has the important function of controlling the activities that uses environmental resources.

The National Environmental Policy stipulates the need for environmental licensing of potentially polluting activities. The Federal Constitution establishes at its article 225, 1º, inc. IV, that licensing must always be preceded by an Environmental Impact Assessment (EIA) and a corresponding Environmental Impact Report (RIMA) whenever works or activities can potentially

cause significant environmental impact. Federal Decree No. 99274/90, complemented by CONAMA's Resolutions n° 1/86 and n° 237/97, set forth the three-stage process for the issuing of licenses as follows:

A Preliminary License (LP) (in Portuguese Licença Prévia) is granted during the preliminary planning stage of a project for a maximum five-year term. The license signifies approval of the location and design of the project, certifies its environmental feasibility and establishes the basic requirements and conditions to be complied with during subsequent stages of implementation.

a) The Installation License (IL) (in Portuguese Licença de Instalação) authorizes the installation of the development in accordance with the specifications contained in the approved plans, programs and projects, including environmental mitigation provisions and other conditions.

b) The Operating License (OL) (in Portuguese Licença de Operação) authorizes operation of the development in accordance with environmental mitigation measures and operating requirements. The Operating License can vary from 4-10 years and is renewable within the legal timeframe established by the competent environment agency.

The project has the necessary environmental licenses. The Preliminary License was issued by the Environmental Ministry (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis – IBAMA) environmental agency, on December 13th, 2002, PL number 147. The Installation License was issued on September 21st, 2004, IL number 284 and renewed on December 5th, 2006. The Operation License n° 949/2010 was issued on 25/08/2010 by IBAMA and it is valid until 25/08/2014.

The Regulatory Environment

The Brazilian Regulatory Framework went through important structural and conceptual changes over the past 2 decades, resulting in three different electricity regulatory models: the state-based model (until 1995); the free market model (1995 to 2003) and the new model, implemented in 2004 and valid up to date. Under the state owned model, the energy sector was dominated by almost exclusively state-owned and verticalized companies that covered the segments of generation, transmission and distribution. During the period of state monopoly, the major part of the currently existing generation capacity has been built, mostly consisting of large hydropower plants with important energy reservation capacity.

From 1995 on, due to lack of capacity to further finance the necessary investments for the expansion in energy generation, transmission and distribution, the government initiated a partial privatization process, structured by four main pillars: i) creation of a competitive environment (free market), with a gradual elimination of the captive consumers; ii) partial dismantling of the state owned verticalized companies by dividing and privatizing the segments

of generation, transmission and distribution; iii) allowing free access to the transmission lines for generators and consumers; and iv) placing the operation and planning responsibilities to the private sector.⁴

The adoption of the free market model allowed the participation of private entities and the implementation of the Concession Law (Law No 8,987 of February 13, 1995) and promoted the construction of some renewable plants in Brazil. Unfortunately, the model did not provide the investment in generation capacity needed to satisfy the growing demand and it resulted in an energy crisis in 2001, when energy consumption of consumers and industry was rationed and Brazil's economic development was badly hit. As a response to this crisis, a new regulatory framework was put in place in 2004, resulting in a more active role of Brazil's government by virtually suspending the privatization process initiated in the 1990's and centralizing the functions of electricity planning at national government level,⁵ while promoting private sector investments to fund the required expansion in generation capacity.

This new regulatory model provided a more efficient mechanism of power procurement between generators and distributors, primarily by creating two parallel electricity trading environments: the Regulated Contracting Environment, referred to as ACR (*Ambiente de Contratação Regulada*), where energy is finally contracted based on the lowest tariffs defined by a regulated auctioning process, and the Free Contracting Environment, referred to as ACL, or *Ambiente de Contratação Livre* (ACL).

When evaluating the initial effects of these regulatory changes since 2005 it must be observed that the immediate demand for energy and capacity has been satisfied mostly with the installation of thermal power plants. In fact, between 2005 and 2007, 63% of the new generation capacity added/contracted stems from fossil fuel burning plants, while non conventional resources like biomass, wind, and small hydro power plants accounted for only 3% of the new capacity under development, the rest being represented by the installation of large hydropower plants⁶. This situation only changed once additional policies and incentives for promotion of clean energies, as described below, were established.

The table below summarizes the evolution of the regulatory framework for the Brazilian electric sector:

⁴ Aguiar F.L. *Modelo Institucional do Setor Elétrico Brasileiro*, 2007, available at http://www.realestate.br/images/File/arquivosPDF/DST_FernandoAguiar.pdf, last access on March 5, 2010

⁵ For further information, please refer to *Moody's Global Infrastructure – Regulatory Environment Improves for Brazilian Electric Utilities*, August 2008

⁶ *Novas Regras e Perspectivas para os Leilões de Energia*, Luiz Henrique Alves Pazzini, CCEE Technical Adviser, presentation at Energy Summit,

Rio de Janeiro, Brazil, 12 August 2009

Table 02: Energy regulatory frameworks in Brazilian history

Former Model (until 1995)	Free Market Model (1995 to 2003)	New Model (2004)
Financing using public funds	Financing using public and private funds	Financing using private and public funds
Verticalized companies	Companies classified by activity: generation, transmission, distribution and commercialization	Companies classified by activity: generation, transmission, distribution, commercialization, imports and exports.
Predominantly State-controlled companies	Opening up of the market and emphasis on the privatization of the companies.	Coexistence between State-controlled and private companies.
Monopolies – No competition	Competition in generation and commercialization	Competition in generation and commercialization
Captive Consumers	Both Free and Captive Consumers	Both Free and Captive Consumers
Tariffs regulated throughout all sectors	Prices are freely negotiated for the generation and commercialization	Free environment: Prices are freely negotiated for the generation and commercialization
Regulated Market	Free Market	Coexistence between Free and Regulated Market
Determinative Planning – Coordinator Group for the Planning of Electricity Systems (GCPS)	Indicative Planning coordinated by the National Council for Energy Policy (CNPE)	Indicative Planning coordinated by the Energy Research Company (EPE)

It is important to clarify that the Brazilian Institutional New Model of the Electric Sector allows the private and public agents to decide the amount of energy to be hired and the investments to be realized from the participation in auctions of power plants and systems of transmission.

According to MME⁷, “it is the agents of distribution that decide and compromise themselves to pay, through contracts resulting from auctions, amounts of electrical energy coming from new installations of electric energy generation to be delivered (...). With the distributors’ information, the generators may then decide which new entrepreneurships of generation they wish to build, presenting in the auctions proposals of selling prices of their electric energy, competing for contracts of energy purchase from distributors. Additionally, the generators may also hire direct and freely with free consumers”.

It is further noticeable that the Brazilian Institutional New Model of the Electric Sector provides autonomy to the economic agents about the investments to be realized in the Brazilian electric sector, not existing, therefore, restrictions nor impositions to the project activity and to its alternatives.

Thus, the project activity fulfils all the Brazilian norms and regulations, being also plausible according to the tendencies in the country’s electrical sector.

The alternative scenario also does not suffer any restrictions and is in full compliance with Brazil’s laws and the mentioned norms and regulations.

Both the project activity and the alternative scenarios are in compliance to the applicable laws and regulations according the following entities:

- The Brazilian Electricity Regulatory Agency (Agência Nacional de Energia Elétrica - ANEEL⁸);
- The Ministry of Mines and Energy (Ministério de Minas e Energia - MME⁹);

The project has the Concession Contract signed with the ANEEL which ensures that the project is in compliance with the requirements of the agents of the Brazilian electricity sector.

Outcome of sub-step 1b: These are the identified realistic and credible alternative scenario(s) to the project activity that are in compliance with mandatory legislation and regulations taking into account the enforcement in the region or country and EB decisions on national and/or sectoral policies and regulations.

⁷ Ministério de Minas e Energia (MME) [Ministry of Mines and Energy] – Plano Decenal de Expansão de Energia Elétrica 2006-2015 [Decennial Plan for Energy Expansion 2006-2015].

⁷ Ministério de Minas e Energia (MME) [Ministry of Mines and Energy] – Plano Decenal de Expansão de Energia Elétrica 2006-2015 [Decennial Plan for Energy Expansion 2006-2015].

⁸ Available at: <http://www.aneel.gov.br/?idiomaAtual=1>, accessed on 16 January 2012.

⁹ Available at: <http://www.mme.gov.br/mme>, accessed on 16 January 2012.

Step 2. Investment analysis

Investment Barrier

The project faces capital or investment return constraints that can be overcome by the additional revenues associated with the sale of GHG credits. Project IRR is below benchmark. The investment barrier is demonstrated using the principles of the tool for the demonstration and assessment of the additionality of the CDM.

The “Tool for the demonstration and assessment of additionality” (version 6.0.0) states that project participants may choose to apply Step 2 (Investment analysis) or Step 3 (Barrier analysis) to demonstrate the additionality of the project activity. Accordingly, the investment analysis shall determine whether the proposed project activity is not:

- The most economically attractive or financially;
- Economically or financially feasible, without the revenue from the sale of certified emission reductions (CERs);

Sub-step 2a. Determine appropriate analysis method

According to the “Tool for the demonstration and assessment of additionality” (version 6.0.0) three options can be applied to conduct the investment analysis. These are the simple cost analysis (Option I), the investment comparison analysis (Option II) and the benchmark analysis (Option III). Since this project will generate financial/economic benefits other than VCS-related income, through the sale of generated electricity, Option I (Simple Cost Analysis) is not applicable.

Both Option II and Option III are applicable for the project activity, however, as the option is to invest or not to invest, Option III – benchmark analysis is the most appropriate for assessing the financial attractiveness of the project activity.

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

Identification of the financial indicator

The identified financial indicator most suitable for the project type and decision context is the project Internal Rate of Return (IRR). The project IRR calculates a return based on project cash outflows and cash inflows, irrespective of the source of financing.

Benchmark - WACC (Weighted Average Capital Cost)

According to the guidance 12 of the “Guidelines on the Assessment of Investment Analysis” (version 5)¹⁰ “local commercial lending rates or weighted average costs of capital (WACC) are appropriate benchmarks for a project IRR”. The Weighted Average Cost of Capital (WACC) is the benchmark of the project. The WACC is calculated through the composition of costs and the participation percentage of each source of capital in the company’s capital structure. The WACC was calculated according the equation below:

$$WACC = K_e * W_e + K_d * W_d \quad \text{Equation 1}$$

Where:

WACC = Weighted Average Cost of Capital (%)

K_e = Cost of equity (%)

W_e = Capital Percentage that is equity (%)

K_d = Cost of debt (%)

W_d = Capital Percentage that is equity (%)

Cost of Equity

For calculation of the cost of equity was used the CAPM Model (Capital Assets Price Model), which indicates the following equation:

$$K_e = R_{fr} + \beta * R_p \quad \text{Equation 2}$$

Where:

K_e = Cost of Equity;

R_{fr} = Rate of Return of a Risk Free Asset;

β = Beta Coefficient;

¹⁰ Available at: http://cdm.unfccc.int/Reference/Guidclarif/reg/reg_guid03.pdf, accessed on 16 January 2012.

R_p = Market Risk Premium;

Project Developers defined the cost of equity using the Capital Asset Pricing Model (CAPM) and official and publicly available parameters that are standard in the market, while taking into account the specific provisions of the “Guidelines on the Assessment of Investment Analysis (version 05)”.

According to Guidance 15, “If the benchmark is based on parameters that are standard in the market, the cost of equity should be determined either by: (a) selecting the values provided in Appendix A; or by (b) calculating the cost of equity using best financial practices, based on data sources which can be clearly validated by the DOE, while properly justifying all underlying factors.”

Based on provision (b) of this guidance, the project participants present a specific CAPM for the calculation of the cost of equity under the specific consideration of the third party financing and an industry beta which reflects the specific risk of investments in the power sector, as well as the impact of financial leverage on the equity investor’s risk.

Table below provides an overview about the calculation and the specific references that were used.

Table 03: CAPM and references for the calculation of the cost of equity for Brazilian Powerinvestments

Variable	Value	Parameter / Formula / Comment	Reference
Rf - Risk-Free Rate	8.72%	Average of Long Term Brazilian Treasury Bond (type NTN-C) of years 2003, 2004, 2005 and 2006	Brazilian Treasury ¹¹
β	0.97	Calculated from the relation between Ibovespa Index and IEE Index (Index of Energy Sector Companies)	Calculated based on data provided by BM&F Bovespa ¹²
Rp	24.92%	Average of the Real Expected Return on a Risky Asset (Market Return) – Average of the differences between Market return (IBOVESPA) and Risk Free Rate (NTN-C) of years 2003, 2004, 2005 and 2006.	Based on data supplied by Brazilian Treasury and BM&F Bovespa mentioned above.
Wd Debt / Total Capital	70.0%	Common practice of loans offered by BNDES at the time of the investment decision.	BNDES Letter
We Equity / Total Capital	30%	Common practice of loans offered by BNDES at the time of the investment decision.	BNDES Letter
T Marginal Tax Rate	34%	Applicable Brazilian Law	

¹¹ http://www.tesouro.fazenda.gov.br/tesouro_direto/historico.asp

¹² <http://www.bmfbovespa.com.br/shared/iframeHotSiteBarraCanal.aspx?altura=900&idioma=pt-br&url=www.bmfbovespa.com.br/informe/default.asp>

Ke Cost of Equity – real terms	32.88%	$Ke = Rfr + \beta \cdot Rm + Rc$	Calculated
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Cost of Debt

The cost of debt is based on conditions offered by the banks in the loans contracts that were firmed for financing the project. The average cost of debt is 9.30% per year (TJLP – 6.5% + 2.8%- Spread +BNDES Remuneration). Considering a Brazilian Target Inflation of 4.5%¹³, the cost of debt in real terms is 4.59%. Note: In order to obtain the cost of debt (Kd) in real terms, Fisher equation was used: $Real\ Kd = [(1+Nominal\ Kd) / (1 + Inflation\ Rate)] - 1$.

Weighted Average Capital Cost

The WACC of the project is presented below:

Table 04: WACC

Variable	Value	Parameter / Formula / Comment	Reference
Ke	32.88%	Cost of Equity – real terms	Calculated
%Ke	30%	Capital Percentage that is equity (%)	BNDES
Kd	4.59%	Cost of Debt – real terms	BNDES
%Kd	70%	Capital Percentage that is Debt (%)	BNDES
WACC	11.99%	WACC	Calculated

The resulting benchmark is also obtained in real terms and therefore compatible with the investment analysis as presented below.

Compatibility of the benchmark with the financial indicator calculated

As the project Internal Rate of Return (IRR) will be used as the project indicator in the additionality discussion, the financial return will be calculated accordingly, in compliance with the criteria and provisions defined by the “Tool for the demonstration and assessment of additionality”(version 6.0.0).

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

¹³ <http://www.bcb.gov.br/pec/metas/InflationTargetingTable.pdf>

The project cash flow analysis of Foz do Chapecó HPP in real terms and all underlying references and assumptions are made available to the DOE (Designated Operational Entity) that will perform validation. The assumptions are confidential and it will not be presented in the VCS PD. The effects of taxing on the cash flow were taken into consideration according to the applicable legislation. Following an overview and of the key assumptions and

features of the investment analysis in response to the key criteria, requirements and orientations as provided by the guidance of the CDM Executive Board (CDM-EB) for investment analysis.

General Features of the Investment Analysis and Calculation of the Financial Indicator

Period of Assessment: The cash flow considers an assessment period of 35 years which is in line with the concession period provided the concession contract 128/2011 signed with the Brazilian Government through the National Agency of Electric Energy (ANEEL) This is in agreement with the provisions of the Guidelines on the Assessment of Investment Analysis, version 06.0.0, item 03, which defines that the IRR calculation has to preferably reflect the expected operational lifetime of the project activity.

The value of the assets of the project activity at the end of the assessment period: the value of the assets was added as revenues in the last year of the concession period.

Depreciation: the annual depreciation tax is 2.19% over the assets value. This was defined by the Manual of Power Sector Asset Control (Manual de Controle Patrimonial do Setor Elétrico), page 209, published by the ANEEL¹⁴. Because it is an accounting item which does not involve disbursements, depreciation does not impact the project cash flow.

Project IRR Calculation: The project IRR calculation was conducted independently of the source of financing and the cost of financing expenditures (i.e. loan repayments and interest) were not included in the calculation of the project IRR.

Nature of the Cash Flow: The project cash flow has been performed in real terms, i.e. without considering the impact of inflation, and after payment of taxes. The resulting financial indicator therefore is a post-tax project IRR given in real terms and therefore compatible with the benchmark defined above.

The Project Internal Rate of Return, in real terms, resulting of the cash flow elaborated based on the assumptions is **9.87%**.

Investment analysis results

¹⁴ ANEEL (2009). Manual de Controle Patrimonial do Setor Elétrico. Annex of Normative Resolution nº 367/2009, 02 June 2009. Available at: http://www.aneel.gov.br/cedoc/aren2009367_2_primeira_Ver.pdf. Last access on 04 January 2012.

The table below shows a summary comparison between the project financial indicator and the benchmark:

Project Internal Rate of Return of 9.87% < Benchmark of 11.99%

The investment analysis was conducted according to option III of the “Tool for the demonstration and assessment of additionality” and the result shows that project’s financial indicator is less favourable than the benchmark. Consequently it can be concluded, that the project activity without VCS revenues cannot be considered as financially attractive.

Sub-step 2d. Sensitivity analysis

The main variables that can affect the project's finances are (i) revenues of the project; (ii) the CAPEX and (iii) the Operational Costs (OPEX).

The sensitivity analysis is conducted to provide a cross-check on the suitability of the assumptions used in the development of the investment analysis. The objective is to confirm how solid the financial analysis is.

Project Revenues:

The project’s revenue depends solely on two factors: the electricity generated and the electricity sales price. Variations in the result just occur if the electricity price is higher or the amount of electricity generated is higher than the assured energy. All electricity to be generated by the project is sold through long-term power purchase agreements already firmed by the project owner. At the time of the investment decision, the price of 40% of the electricity amount that could be sold was already established and the price firmed in the Power Purchase Agreement was considered for this electricity amount. The remaining amount of electricity (60% of the whole amount) would be sold in the auction that occurred after the investment decision. The price estimated for this amount was R\$ 125.00/MWh and the project owners sold electricity for the remaining amount at R\$ 131.49/MWh (5.19% higher). This scenario is covered by the sensitivity analysis.

The amount of electricity expected to be sold considered in the cash flow is assured energy. This amount of electricity considers a long term historical

series of the river's flow (since 1931) and the rainfall regime of the region. Electricity generation variability is normal once it is highly associated to rainfall regime. But, in the long-term and during all the concession period, electricity generation should be closed to the assured electricity.

ANEEL regulates that the project owners can just sold the assured energy through long term power purchase agreements. Therefore, high variability is not expected during all concession period. Sensitivity analysis shows that to reach the benchmark, the amount of electricity should be 18.6% higher that the assured energy during all concession period. This is impossible considering the historical series of the river's flow and the rainfall regime of the region.

CAPEX

Infrastructure investments are prone to cost overruns due to unforeseen events, while significant cost savings are not very common. The CAPEX presented was based on contracts already established and proposal. Also, as the plant is already in operation, the CAPEX is already performed. No reduction was observed. Consequently, a sensitivity of 10% reduction in capital expenditure is a reasonably conservative assumption in the context of the VCS. Under such a scenario, the project IRR would increase, but not reach the benchmark. This would only occur if the CAPEX was 16.40% below the original projections, which is not a realistic scenario due to the fact that construction and equipment supplying contracts were already been established and performed. On the other hand, an increase in 10% in the capital invested, which is a much more probable scenario, would further deteriorate the Project's IRR as expected in the base case.

Operational Costs

The operational costs include Transmission Costs, sectoral taxes, costs for Operation & Maintenance, regular overhaul and land lease expenses. The result of the sensitivity analysis shows that a 10% reduction in all these costs when compared to the base case assumption would not materially affect the Project's return. One of the Operational cost is a tax named CPMF. At the time of the investment decision, this tax existed. However, at the time of the PD elaboration, CPMF was finished by Brazilian Government. Therefore, one scenario without CPMF cost is presented in the sensitivity analysis.

Thus, it is unlikely that these items may undergo changes that contribute with an increase in the economic and financial attractiveness that is not covered by the variation range between 0 and 10%. Therefore the variation range between 0 and 10% cover more than the probable scenarios.

The following tables represent the results for the main parameters variations that can affect the project cash flow of the Plans.

Table 05: Sensitivity Analysis of the Project

REVENUES VARIATION	
Projected Situation	Project IRR
0%	9.87%
+10%	11.03%
18.6%	11.99%
CAPEX VARIATION	
Projected Situation	Project IRR
0%	9.87%
-10%	11.09%
-16.40%	11.99%
OPEX VARIATION	
Projected Situation	Project IRR
0%	9.87%
-10%	10.17%
-72.70%	11.99%
CPMF Exclusion	
Projected Situation	Project IRR
0%	9.87%
-100%	9.92%

The sensitivity analysis shows that the Foz do Chapecó is unlikely to be the most financially attractive once the project internal rate of return (IRR) is lower than the benchmark in all scenarios analyzed.

The tool for demonstration and assessment of additionality indicate that: If after the sensitivity analysis it is concluded that the proposed VCS project activity is unlikely to be the most financially attractive or is unlikely to be financially attractive, then proceed to the Common practice analysis.

This way, as the sensitivity analysis showed that the proposed activity is not attractive from a financial point of view, a common practice analysis must be carried out.

Outcome of step 2: If after the sensitivity analysis it is concluded that: (1) the proposed CDM project activity is unlikely to be the most financially/economically attractive or is unlikely to be financially/economically

attractive, then proceed to Step 4 (Common practice analysis). This is the case of this project activity.

Step 3. Barrier Analysis

Not applicable.

Step 4. Common practice analysis

The common practice analysis was performed using the guidance of the “Tool for the demonstration and assessment of additionality” (version 6.0.0). The following sub-steps were performed.

Analyze other activities similar to the proposed project activity:

According to the “Tool for the demonstration and assessment of additionality” (version 06.0.0), for CDM, projects are considered similar if they are in the same country/region and/or rely on a broadly similar technology, are of a similar scale, and take place in a comparable environment with respect to regulatory framework, investment climate, access to technology, access to financing, etc.

Considering the concept above and the “Tool for the demonstration and assessment of additionality” (version 6.0.0), a stepwise approach for demonstrating if the project activity represents a commonly adopted practice in the country is presented below:

The “Tool for the demonstration and assessment of additionality”, version 06.0.0, paragraph 47 step 01 defines that project participants must calculate applicable output range as +/-50% of the design or capacity of the proposed project activity. Therefore, the applicable output range for this project activity is 427.5 MW to 1,282.5 MW. Based on this recommendation 39 energy generation plants have been identified, among small hydropower plants, wind power plants, thermal plants, biomass and large hydropower plants¹⁵.

¹⁵ A full list of the plants is presented in the Excel spreadsheet “Common Practice Analysis” provided to the auditors.

The Step 02 of the paragraph 47 of the Tool requires project participants to identify in the applicable geographical area (the country where the project is located - Brazil) and within the applicable output range calculated in Step 1 the plants that started commercial operation before the start date of the project activity, excluding the project activities registered as CDM projects or undergoing validation. We considered in this step, plants that are registered as VCS Project too.

Among the 39 operational plants identified in Step 1, one plant is being developed as VCS project activities (Barra Grande HPP is registered as a VCS project activity) and, according to ANEEL, one plant have started commercial operation after the start date of the project activity.

Thus, $N_{all} = 37$.

The table below presents the amount of plants within the applicable capacity range and excluded as per Step 2:

Table 06: Operational plants within the applicable output range according to ANEEL¹⁶

Energy source/ Fuel	Quantity within the range	CDM Plants/ VCS Plants	Plants with commercial operation after the start date of the project	N_{all}
HCG	0	0	0	0
WPP	0	0	0	0
SHP	0	0	0	0
SPP	0	0	0	0
HPP	26	1	1	24
TPP	12	0	0	12
TNPP	1	0	0	1
Total	39	0	0	37

- HCG: Hydropower Plant Central Generation (Installed Capacity smaller than 1 MW)
- SHP: Small Hydropower Plant (Installed Capacity Greater than 1 MW and Smaller than 30 MW)
- HPP: Hydropower Plant (Installed Capacity Greater than 30 MW)
- TPP: Thermal Power Plant
- WPP: Wind Power Plant
- SPP: Solar Power Plant
- TNPP: Thermonuclear Power Plant

¹⁶ Source: Agência Nacional de Energia Elétrica. Available at: <http://www.aneel.gov.br/aplicacoes/capacidadebrasil/capacidadebrasil.asp>.

The “Tool for the demonstration and assessment of additionality”, version 06.0.0, paragraph 47 step 03, establishes that project participants must identify those plants that apply different technologies from the technology applied to the project activity. The Tool acknowledges that different technologies that deliver the same output and differ by at least one of the following:

- (a) **Energy Source/fuel;**
- (b) Feed Stock;
- (c) Size of installation (...);
- (iv) Investment climate in the time of the investment decision, inter alia:
 - i) access to technology;
 - ii) subsidies or other financial flows;
 - iii) promotional policies;
 - iv) legal Regulation.**
 - v) Other features, inter alia:
 - Unit cost of output (unit costs are considered different if they differ by at least 20%).

According to the Step 3 of the Tool, different technologies are also identified as the ones implemented in a different investment climate in the date of investment decision when compared to the project activity. As demonstrated in the table 06, 13 plants of the range have different energy sources/fuel (12 are thermal plants and 1 is nuclear plant).

Also 22 plants started operation before 2004, which means that they started before the new Electric Model Regulatory Framework, in a different institutional framework from Foz do Chapecó HPP. The new Regulatory framework is described in item 2.5 of this VCS PD.

Table 07: Plants started operation before the new Electric Model Regulatory Framework

Plants	Evidence
Cachoeira Dourada	Started operation before 2004 – year of the new electric model
Cana Brava	Started operation before 2004 – year of the new electric model
Capivara	Started operation before 2004 – year of the new electric model
Estreito (Luiz Carlos)	Started operation before 2004 – year of the new electric model
Furnas	Started operation before 2004 – year of the new electric model
Henry Borden	Started operation before 2004 – year of the new electric model
Itapebi	Started operation before 2004 – year of the new electric model
Luis Eduardo Magalhaes	Started operation before 2004 – year of the new electric model
Machadinho	Started operation before 2004 – year of the new electric model
Nova Ponte	Started operation before 2004 – year of the new electric model
Marechal Mascarenhas de Moraes	Started operation before 2004 – year of the new electric model
Governador José Richa	Started operation before 2004 – year of the new electric model
Salto Osório	Started operation before 2004 – year of the new electric model
Goverandor Ney Aminthas	Started operation before 2004 – year of the new electric model
Serra da Mesa	Started operation before 2004 – year of the new electric model
Sobradinho	Started operation before 2004 – year of the new electric model
Taquaraçu	Started operation before 2004 – year of the new electric model
Três Irmãos	Started operation before 2004 – year of the new electric model
Itaúba	Started operation before 2004 – year of the new electric model
Paulo Afonso II	Started operation before 2004 – year of the new electric model
Paulo Afonso III	Started operation before 2004 – year of the new electric model
Emborcação	Started operation before 2004 – year of the new electric model

There are just two HPPs in operation which are similar to Foz do Chapecó and that are not CDM/VCS project activity nor have started commercial operation after the starting date. They are Campos Novos HPP and Peixe Angical HPP.

According to the paragraph 47, step 04 of “Tool for the demonstration and assessment of additionality”, version 06.0.0, the proposed project activity is a

“common practice” within a sector in the applicable geographical area if both the following conditions are fulfilled: (a) the factor F is greater than 0.2 and (b) $N_{all}-N_{diff}$ is greater than 3. The table below shows that no condition is fulfilled.

Table 08: Parameters and values applied in the common practice analysis

Parameters	Values/Results
N_{all}	37
N_{diff}	35
$F = 1-(N_{diff}/N_{all})$	0.05
$N_{all}-N_{diff}$	2

So, the proposed project activity is not common practice within the identified sector in Brazil.

According to the Methodology ACM0002 version 13.0.0, if Sub-steps above are satisfied, (i) similar activities cannot be observed or (ii) similar activities are observed, but essential distinctions between the project activity and similar activities can reasonably be explained, then the proposed project activity is additional.

SATISFIED/APPROVED – Project is ADDITIONAL

3.6 Methodology Deviations

Not applicable.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

To monitor baseline emissions is necessary to monitor also the electricity supplied to the grid (EG_y) and the Combined Margin Emission Factor and its components.

The baseline methodology ACM0002, version 20.0, establishes that baseline emissions include only CO₂ emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity. The methodology assumes that all project electricity generation above baseline levels would have been generated by existing grid-connected power plants and the addition of new grid-connected power plants. The baseline emission is calculated as follows:

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

Where:

BE_y = Baseline Emission in year y (tCO₂/yr)

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

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

Project emission reduction is calculated according version 20.0 of ACM0002 methodology. As mentioned previously, LE_y and PE_y are zero. Therefore, emission reduction is calculated as described below:

$$ER_y = BE_y - PE_y$$

Where:

ER_y = Emission Reduction in year y (t CO₂e/yr)

BE_y = Baseline emissions in year y (t CO₂e/yr)

PE_y = Project emissions in year y (t CO₂e/yr)

The baseline methodology ACM0002, version 20.0, establishes that baseline emissions include only CO₂ emissions from electricity generation by fossil fuel fired power plants that are displaced due to the project activity. The methodology assumes that all project electricity generation above baseline levels would have been generated by existing grid-connected power plants and the addition of new grid-connected power plants. The baseline emission is calculated as follows:

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

Where:

BE_y = Baseline emissions in year y (tCO₂);

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

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

If the project activity is the installation of a new grid-connected renewable power plant/unit at a site where no renewable power plant was operated prior to the implementation of the project activity (Greenfield renewable energy power plants), then:

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

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

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

To calculate $EF_{grid, CM, y}$ it was used the data provided by the Brazilian DNA, which provides data of the operating margin emission and the build margin emission factors by dispatch analysis by using the *tool to calculate the emission factor for an electricity system*. In case the Brazilian DNA discontinues the publication of these data during the monitoring period, they will be calculated by the project participants.

The steps recommended to *Tool to calculate the emission factor for an electricity system*, version 07.0, are discussed below.

STEP 1. Identify the relevant electricity systems;

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

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

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

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

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

Step 1: Identify the relevant electricity systems

The National Interconnected System (SIN) is defined as the relevant grid to the project activity. The definition of the SIN as the relevant electricity system is also recommended by the DNA¹⁷ through Resolution N° 08 of May/2008, which defines the National Interconnected System as a single system that shall be used for the calculation of CO₂ emission factors.

This definition has been applied to Foz do Chapecó Hydro Power Plants Project.

Step 2: Choose whether to include off-grid power plants in the project electricity systems

Project participants may choose between the following two options to calculate the operating margin and build margin emission factor:

Option I: Only grid power plants are included in the calculation.

Option II: Both grid power plants and off-grid power plants are included in the calculation.

The option I was chosen for the project activity, once the operating margin and build margin emission factor calculated by the Brazilian DNA or alternatively calculated by the project developer are based on the data of plants connected to the grid.

Step 3: Select a method to determine the operating margin (OM)

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.

¹⁷ Source:

https://antigo.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/cimgc/Comissao_Interministerial_de_Mudanca_Global_do_Clima_CIMGC.html

The method chosen to the calculation Operating Margin emission factor of the Foz do Chapecó Hydro Power Plants Project is the dispatch data analysis operating margin method (c).

Step 4: Calculate the operating margin emission factor according to the selected method

The method chosen for the calculation of the operating margin emission factor of the Foz do Chapecó Hydro Power Plants Project is the dispatch data analysis calculated on an **ex-post** basis for the operating margin.

As previously stated, the emission factor OM ($EF_{grid,OM-DD,y}$) calculation based on the dispatch data analysis method is currently conducted by the Brazilian DNA, in accordance with the dispatch data provided by the Electric System National Operator (ONS).

According to the “*Tool to calculate the emission factor for an electricity system*” (version 07.0) the dispatch data analysis OM emission factor ($EF_{grid,OM-DD,y}$) is determined based on the grid power units that are actually dispatched at the margin during each hour h where the project is displacing grid electricity. This approach is not applicable to historical data and, thus, requires annual monitoring of $EF_{grid,OM-DD,y}$.

Dispatch data OM emission factors for 2021 will be used for an **ex-ante** estimation of ERs that will be generated as a result of project’s implementation.

Step 5: Calculate the build margin emission factor

In terms of the vintage of data, project participants can choose between one of the following two options:

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 VCS-PD submission to the DOE 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 to the DOE. 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.

Option 2. For the first crediting period, the build margin emission factor was updated annually, **ex-post**, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emission factor shall be calculated **ex-ante**, as described in option 1 above. For the third crediting period, the built margin emission factor calculated for the second crediting period should be used.

The option that was chosen by project participants was Option 2 for the second crediting period.

Build Margin emission factor for 2020, as published by the Brazilian DNA, will be used for an **ex-ante** estimation of CERs that will be generated as a result of project's implementation.

Step 6: Calculate the combined margin emission factor

The calculation of the combined margin (CM) emission factor ($EF_{grid,CM,y}$) is based on one of the following methods:

- (a) Weighted average Combined Margin; or
- (b) Simplified Combined Margin.

Foz do Chapecó Hydroelectric Power Plants Project used option (a) to calculate the combined margin emission factor.

The combined margin emission factor $EF_{grid,CM,y}$ is calculated as follows:

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

Where:

$EF_{grid,BM,y}$ = Build margin CO₂ emission factor in year y (tCO₂e/MWh)

$EF_{grid,OM,y}$ = Operating Margin CO₂ emission in year y (tCO₂e/ MWh)

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

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

The CO₂ emission factors of operating margin is calculated **ex-post**. CO₂ emission factors from electricity generation verified on Brazilian Interconnected System (SIN) are calculated based on the generation record of plants centrally dispatched by the **National Operator of the System** (From the Portuguese *Operador Nacional do Sistema* - ONS).

Combined Margin CO₂ Emission Factor was calculated based on data supplied by Ministry of the Science, Technology and Innovation (MCTI) (<https://antigo.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/index.html>), institution which chairs the Brazilian DNA of CDM. Operating Margin Emission Factor and Build Margin Emission Factor, necessary data to calculate the Combined Margin Emission Factor were calculated by ONS (National System Operator) and made available by MCTI.

The tool to calculate the emission factor for an electricity system recommends that the following default values should be used for W_{OM} and W_{BM} :

- Wind and Solar power generation project activities: $W_{OM} = 0.75$ and $W_{BM} = 0.25$ for the first crediting period and for subsequent crediting periods.
- All other projects: $W_{OM} = 0.5$ and $W_{BM} = 0.5$ for the first crediting period, and $W_{OM} = 0.25$ and $W_{BM} = 0.75$ for the second and third crediting period, unless otherwise specified in the approved methodology which refers to this tool.

By this way, Foz do Chapecó Hydro Power Plant will adopt the following weights:

$W_{OM} = 0.25$ and $W_{BM} = 0.75$.

The baseline methodology considers the determination of the grid emissions factor which the project activity is connected to as the core data to be determined in the baseline scenario. In Brazil, the grid is interconnected through the SIN in a single system.

More details about emission factors and default values on Section 4.4.

4.2 Project Emissions

According to ACM0002 (version 20.0) methodology, the project emissions and the power density are calculated below.

For most renewable power generation project activities, $PE_y = 0$. However, some project activities may involve project emissions that can be significant. These

emissions shall be accounted for as project emissions by using the following equation:

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

Where:

PE_y = Project emissions in year y (tCO₂e/yr)

$PE_{FF,y}$ = Project emissions from fossil fuel consumption in year y (tCO₂/yr)

$PE_{GP,y}$ = Project emissions from the operation of dry, flash steam or binary geothermal power plants in year y (tCO₂e/yr)

$PE_{HP,y}$ = Project emissions from water reservoirs of hydro power plants in year y (tCO₂e/yr)

For hydro power project activities that result in new single or multiple reservoirs and hydro power project activities that result in the increase of single or multiple existing reservoirs, project proponents shall account for CH₄ and CO₂ emissions from the reservoirs, estimated as follows:

(a) If the power density of the single or multiple reservoirs is greater than 4 W/m² and less than or equal to 10 W/m².

$$PE_{HP,y} = \frac{EF_{Res} * TEG_y}{1000}$$

Where:

$PE_{HP,y}$ = Project emissions from water reservoirs (tCO₂e/yr)

EF_{Res} = Default emission factor for emissions from reservoirs of hydro power plants in year y (kgCO₂e/MWh)

TEG_y = Total electricity produced by the project activity, including the electricity supplied to the grid and the electricity supplied to internal loads, in year y (MWh)

(b) If the power density of the project activity is greater than 10 W/m²

$$PE_{HP,y} = 0$$

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

$$PD = \frac{Cap_{PJ} - Cap_{BL}}{A_{PJ} - A_{BL}}$$

Where:

PD = Power density of the project activity (W/m²)

Cap_{PJ} = Installed capacity of the hydro power plant after the implementation of the project activity (W)

Cap_{BL} = Installed capacity of the hydro power plant before the implementation of the project activity (W). For new hydro power plants, this value is zero

AP_J = Area of the single or multiple reservoirs measured in the surface of the water, after the implementation of the project activity, when the reservoir is full (m²)

A_{BL} = Area of the single or multiple reservoirs measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m²). For new reservoirs, this value is zero.

$$PD = \frac{855,000,000-0}{80,020,000-0} = 10.68W/m^2$$

The power density of Foz do Chapecó Power Plant is 10.68 W/m². Therefore emissions from its reservoir must not be considered.

4.3 Leakage

There is no leakage for the project activity according to methodology ACM0002 (Version 20.0).

4.4 Net GHG Emission Reductions and Removals

Emission Factor calculation ($EF_{grid,CM,y}$)

For calculation of the baseline emission factor, the six steps below should be followed as described above:

STEP 1. Identify the relevant electricity system.

Considering the stated by the “Tool to calculate the emission factor for an electricity system”, and the fact that the Brazilian DNA has published the Resolution nº 8 issued on May 26th, 2008, which defines Brazilian Interconnected Grid as a single system that covers all five macro-geographical regions of the

country (North, Northeast, South, Southeast and Midwest), the Brazilian electricity system boundaries are clearly defined.

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

Since the Brazilian DNA has made available the emission factor calculation based on information of the grid power plants only, the off-grid power plants are not considered.

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

The method adopted to calculate the operating margin is “Dispatch data analysis OM”. The calculation is performed by the Brazilian DNA and made publicly available.

The Dispatch Data emission factor (OM), is summarized as follows:

$$EF_{grid,OM-DD,y} = \frac{\sum_h EG_{PJ,h} \cdot EF_{EL,DD,h}}{EG_{PJ,y}}$$

Where:

$EF_{grid,OM-DD,y}$ = Dispatch data analysis operating margin CO₂ emission factor in year y (tCO₂/MWh);

$EG_{PJ,h}$ = Electricity displaced by the project activity in hour h of year y (MWh);

$EF_{EL,DD,h}$ = CO₂ emission factor for grid power units in the top of the dispatch order in hour h in year y (tCO₂/MWh);

$EG_{PJ,y}$ = Total electricity displaced by the project activity in year y (MWh).

h = Hours in year y in which the project activity is displacing grid electricity (h)

y = Year in which the project activity is displacing grid electricity

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

For effect of ex-ante estimation to $EF_{grid,OM-DD,y}$ value, was calculated the arithmetic average of 12 months emission factors of the operating margin, published by the DNA (data available to year 2021).

Table 4: Emission Factor of Operating Margin for year 2021

January	February	March	April	May	June	July	August	September	October	November	December
0.6001	0.6023	0.5657	0.5522	0.5909	0.594	0.5824	0.6214	0.6351	0.6236	0.6331	0.5815

Thus, the Emission Factor of Operating Margin is:

$$EF_{grid,OM-DD,y} = 0.5985$$

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

The power units included in the build margin are defined by the Brazilian DNA who is responsible for the operating margin and build margin calculations. The results of these are made publicly available in its web site to consultation.

According to the used methodology, the build margin emission factor (BM) is calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_{i,m} EG_{m,y} \cdot EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

For the build margin emission factor $EF_{grid,BM,y}$ also will be adopted the 2020 year value published by the DNA.

Table 5: Latest data from Brazilian DNA to Emission Factor Build Margin (2021)

BUILD MARGIN	
Average Emission Factor (tCO ₂ /MWh) - ANNUAL	
2021	0.0540

So, we have that the Build Margin Emission Factor is:

$$EF_{grid,BM,y} = 0.0540$$

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

To calculation of combined margin emission factor (combination of operation and build margins) is used a weighted-average formula, considering $w_{OM} = 0.25$ and $w_{BM} = 0.75$ (second credit period). As a

conservative approach, below is presented the emission factor calculated using four decimal places, rounded down. Thus, the result is:

$$EF_{grid,CM,y} = 0.5985 \cdot 0.25 + 0.0540 \cdot 0.75 = 0.1901 \text{ (tCO}_2\text{/MWh)}$$

The baseline emissions would be then proportional to the electricity delivered to the grid throughout the project's lifetime. Are calculated multiplying the electricity baseline emissions factor ($EF_{grid,CM,y}$) by the electricity generation of the project activity.

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

$$BE_y = 3,742,272 * 0.1901 = 711,523 \text{ tCO}_2\text{/yr}$$

Moving back to the emission reductions of project activity (ER), we have the annual ex-ante estimated CO₂ reductions as:

$$ER_y = BE_y - PE_{HP,y}$$

Where:

ER = Emission reductions in year y (tCO_{2e}/yr)

BE = Baseline emissions in year y (tCO₂/yr)

PE = Project emissions in year y (tCO_{2e}/yr)

Considering the emissions related to SHP Paracambi's reservoir is 0 tCO₂/yr (see Section B.6.1), the Project activity emissions reductions are calculated as below:

$$ER_y = 711,523 - 0 = 711,523 \text{ (tCO}_2\text{/yr)}$$

Year	Estimated baseline emissions or removals (tCO _{2e})	Estimated project emissions or removals (tCO _{2e})	Estimated leakage emissions (tCO _{2e})	Estimated net GHG emission reductions or removals (tCO _{2e})
2020 October	150,102	0	0	150,102
2021	711,523	0	0	711,523
2022	711,523	0	0	711,523
2023	711,523	0	0	711,523
2024	711,523	0	0	711,523
2025	711,523	0	0	711,523

2026	711,523	0	0	711,523
2027	711,523	0	0	711,523
2028	711,523	0	0	711,523
2029	711,523	0	0	711,523
2030 October	561,421	0	0	561,421
Total	7,115,229	0	0	7,115,229

5 MONITORING

5.1 Data and Parameters Available at Validation

Data / Parameter	Cap _{BI}
Data unit	W
Description	Installed capacity of the hydro power plant before the implementation of the project activity. For new hydro power plant the value is zero.
Source of data	Project site
Value applied	0
Justification of choice of data or description of measurement methods and procedures applied	As HPP Foz do Chapeco is a new power plant, this value is 0 (zero).
Purpose of Data	Calculation of project emissions
Comments	-
Data / Parameter	A _{BL}

Data unit	m ²
Description	Area of the reservoir measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m ²). For new reservoirs, this value is zero.
Source of data	Project site
Value applied	0
Justification of choice of data or description of measurement methods and procedures applied	As HPP Foz do Chapeco is a new power plant, this value is 0 (zero).
Purpose of Data	Calculation of project emissions
Comments	-

Data / Parameter	$EF_{grid, BM, y}$
Data unit	tCO ₂ e/MWh
Description	CO ₂ Build Margin emission factor of the grid, in a year <i>y</i> .
Source of data	Data provided by DNA (Designated National Authority) to the year <i>y</i> .
Value applied	0.0540
Justification of choice of data or description of measurement methods and procedures applied	Not applicable.
Purpose of Data	Calculation of baseline emissions.
Comments	2021 year

5.2 Data and Parameters Monitored

Data / Parameter	$EG_{PJ, y}$
Data unit	MWh/yr

Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in year y.
Source of data	Project Activity Site (Meters).
Description of measurement methods and procedures to be applied	<p>The following parameters shall be measured:</p> <ul style="list-style-type: none"> (i) The quantity of electricity supplied by the project plant/unit to the grid; and (ii) The quantity of electricity delivered to the project plant/unit from the grid <p>Spreadsheets will be used to obtain directly from the meters the information generated hourly, or according to what will be programmed by CCEE (Câmara de Comercialização de Energia Elétrica/Electric Power Commercialization Chamber). Monthly, the information will be checked with the generation spreadsheets available at the CCEE's Website. Each Generation Unit has two specific meters (one principal and one backup) located in the substation that registers the net electricity supplied to the System by the Unit.</p>
Frequency of monitoring/recording	Continuous measurement and at least monthly recording.
Value applied	3,742,272
Monitoring equipment	Each Generation Unit has two specific meters (principal and backup) located in the substation that registers the net electricity supplied to the Grid by the Unit. Each meter has accuracy class 0,2.
QA/QC procedures to be applied	The uncertainty level for these data is low. They will be used to calculate the emission reductions. The electricity generated will be monitored by the project participants and checked by spreadsheets available at the CCEE's Website (information comparison between operation data and CCEE reports).
Purpose of data	Calculation of baseline emissions
Calculation method	The electricity supplied to the grid is calculated in a direct way

	with information controlled by the meters.
Comments	Considered for 2 nd CP 427.20 MW avg/year in accordance with ANEEL Ordinance #178 from 03/05/2017
Data / Parameter	$EF_{grid,CM,y}$
Data unit	tCO ₂ /MWh
Description	The combined margin CO ₂ emission factor for grid connected power generation in year y is calculated using the latest version of the “Tool to calculate the emission factor for an electricity system”. The combined margin CO ₂ emission factor used on Foz do Chapecó Project will be calculated based on data supplied for the National Interconnected System by Brazilian DNA.
Source of data	Ex-post emission factor will be calculated by project participants with data supplied by MCTI with the ONS data. The variables $EF_{grid,OM,y}$ necessary for $EF_{grid,CM,y}$ calculation, will also be monitored and calculated by MCTI and ONS, through the Dispatch Data of the National Interconnected System.
Description of measurement methods and procedures to be applied	As described in the most recent version of the “Tool to calculate the emission factor for an electricity system”.
Frequency of monitoring/recording	Annually
Value applied	0.1901
Monitoring equipment	Not applicable
QA/QC procedures to be applied	As described in the most recent version of the “Tool to calculate the emission factor for an electricity system”. The uncertainty level for these data is low.
Purpose of data	Calculation of baseline emissions
Calculation method	As per the “tool to calculate the emission factor for an electricity system”. Dispatch Data Analysis OM is the Operating Margin Emission Factor method used and the build margin emission factor is updated annually. Both Operating Margin Emission

	Factor and Build Margin Emission factor are supplied by MCTI.
Comments	-

Data / Parameter	EF _{grid,OM,y}
Data unit	tCO ₂ /MWh
Description	Operating Margin CO ₂ emission factor in year y
Source of data	Brazilian Interministerial Commission on Global Climate Change
Description of measurement methods and procedures to be applied	As described in the most recent version of the “Tool to calculate the emission factor for an electricity system”.
Frequency of monitoring/recording	Annually
Value applied	0.5985
Monitoring equipment	Not applicable
QA/QC procedures to be applied	As described in the most recent version of the “Tool to calculate the emission factor for an electricity system”. The uncertainty level for these data is low.
Purpose of data	Calculation of baseline emissions
Calculation method	As per the “tool to calculate the emission factor for an electricity system”.
Comments	-

Data / Parameter	Cap _{pj}
Data unit	W
Description	Installed Capacity of the hydro power plant after the implementation of the project activity.
Source of data	Project site
Description of	Determine the installed capacity based on manufacturer’s

measurement methods and procedures to be applied	specifications or commissioning data or recognized standards
Frequency of monitoring/recording	Once at the beginning of each crediting period
Value applied	855,000,000 W
Monitoring equipment	The generator capacity at the project site
QA/QC procedures to be applied	The uncertainty level for these data is low (equipments already installed)
Purpose of data	Calculate project emissions
Calculation method	The total of 4 generators capacity
Comments	-

Data / Parameter	A_{pj}
Data unit	m^2
Description	Area of the single or multiple reservoirs measured in the surface of the water, after the implementation of the project activity, when the reservoir is full.
Source of data	Project site
Description of measurement methods and procedures to be applied	Measured from topographical surveys, maps, satellite pictures, etc.
Frequency of monitoring/recording	Once at the beginning of each crediting period
Value applied	The area of the reservoir of HPP Foz do Chapecóis 79,930,000 ¹⁸ m^2 from the "principal reservoir" + 90,000 ¹⁹ m^2 from the "passage way". Total of 80,020,000 m^2 .

¹⁸ ANEEL's Dispatch 911 of 30/03/2007 for flooded reservoir area of 79.93 km^2

¹⁹ Consolidated Basic Engineering Project prepared by CENEC Engenharia S.A. "HFC-RT1P-GEG00-1001-0"

Monitoring equipment	Topographical measurement to measure the area of the reservoir
QA/QC procedures to be applied	The uncertainty level for these data is low. The reservoir area is monitored by environment regulators.
Purpose of data	Calculate project emission
Calculation method	Reservoir already installed
Comments	-

5.3 Monitoring Plan

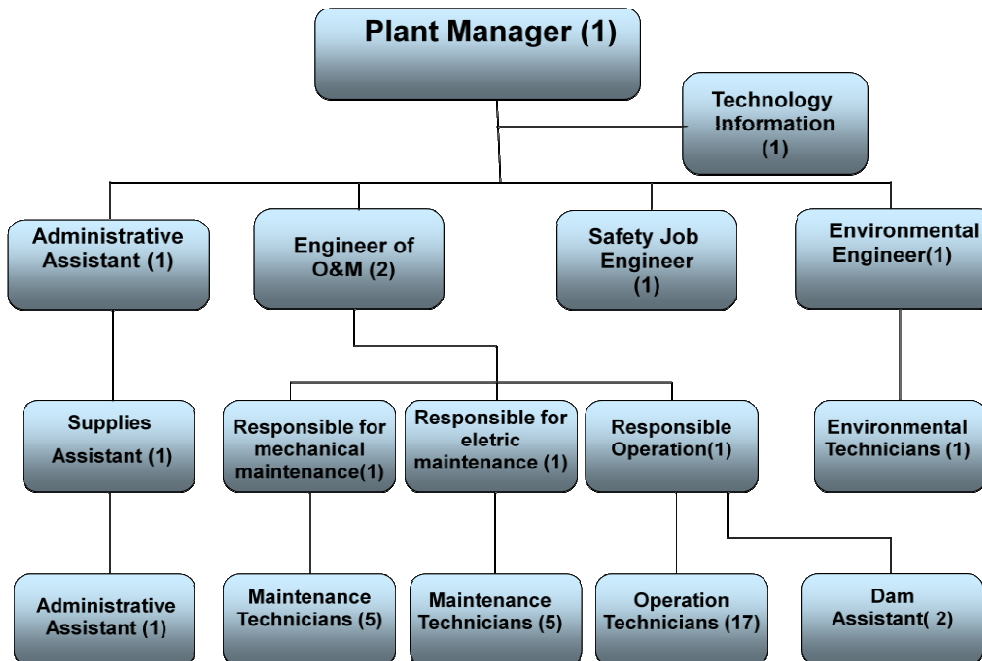
Monitoring has the objective of measuring the emission reductions achieved by the project. To elaborate the monitoring plan, it was followed the Monitoring Methodology present in consolidated baseline methodology for grid-connected electricity generation from renewable sources ACM0002, version 20.0 (methodology applied to the project).

The main parameters that are being controlled are:

- Net Electricity Supplied to the Grid (MWh);
- Emission Factor for Electricity Generation Connected to the Brazilian Interconnected Grid (tCO₂e/MWh).

HPP Foz do Chapecó Operation and Maintenance Manager is responsible for the operation and maintenance activities of the plant and for the activities of consolidation and analysis of gross and net electricity. Measurements activities are carried out by the operators of the Technology Information team.

The organizational structure of the company is presented below:



Each generator unit has three measurement instruments, Model ION8600C – Schneider (can be exchanged during the project lifetime). One of them is located in the Powerhouse and it measures the gross electricity generated by the unit and the other two, called “Principal” (Main) and “Retaguarda” (Backup), are located in the substation with the objective of measuring net electricity.

Daily, operators of Foz do Chapecó operation team collects electricity generation data from each meter. Information of net electricity supplied by the principal meters is consolidated in one spreadsheet. The frequency of monitoring/recording is continuous measurement and at least monthly recording. Information of gross electricity is consolidated in another spreadsheet.

This internal control is supplied every day for one of the shareholders (CPFL) which is responsible for the relations with CCEE.

Data of net electricity generation may be confronted with the information present in the website of the CCEE (*Câmara de Comercialização de Energia Elétrica/ Electric Power Commercialization Chamber*) Entity responsible for measurements, accounting and settlement on Brazilian electric energy market.

The emission factor for power generation is made by Ministry of Science, Technology and Innovation (MCTI) with data from National System Operator (ONS).

All meters are calibrated and they are according to the specifications of ONS. The standard used in these calibrations is calibrated in regular intervals, in INMETRO (*Instituto Nacional de Metrologia, Qualidade e Tecnologia*/National Institute of Metrology, Quality and Technology) and/or in accrediting agency by the same, with the calibration Brazilian Network Seal.

ONS Grid Procedures (<http://www.ons.org.br/paginas/sobre-o-ons/procedimentos-de-rede/vigentes>) defines the calibration frequency and other maintenance procedures. By the time of completion of this document, the frequency of calibration is a maximum of 5 years, but in the case of any changes occurred in the ONS Grid Procedures, the project owners shall follow the rules from the relevant sector organizations (e.g. ONS, ANEEL, CCEE).

In HPP Foz do Chapecó, there is a Measurement Billing System (SMF- from the Portuguese *Sistema de Medição de Faturamento*) according the technical specifications defined by ONS Grid Procedures. The communication of this SMF with CCEE occurs directly through a VPN (Virtual Private Network) and, this way, SCDE (*Sistema de Coleta de Dados de Energia Elétrica*/ Electric Power Data Collection System) has direct access to the mass memory of the electricity meters.

Monthly, HPP Foz do Chapecó operators collect, in the electricity meters mass memory, gross and net hourly generation data of generation unit referring to the previous month. This data are compiled in a unique spreadsheet which is the HPP internal control generation spreadsheet for the referred month under analysis.

SCDE spreadsheets provide electricity generation values identical to the values of the HPP internal control generation spreadsheet.

Both generation information, internally generated and through CCEE website, are electronically stored by the Operation and Maintenance Manager.

PP will cross-check internal CCEE Sinercom data access with electricity generation data publish available (e.g. Infomercado reports from CCEE).

It is important to say that electricity generation information impacts directly the revenues of Foz do Chapecó once electricity is the main product of the project. Therefore, a straight control is performed about this information. These controls follow the internal auditing processes presented in the management system of the company.

All data collected as part of the monitoring will be archived and be kept for at least 2 years after the end of the last crediting period.

The installed capacity and reservoir area will be monitored once at the beginning of CP.

The combined margin emission factor $EF_{\text{grid,CM,y}}$ is calculated in line with Section 4.4 from this VCS PD.