Project design document form
(Version 11.0)

BASIC INFORMATION	
Title of the project activity	CDM Project SHP Santa Carolina
Scale of the project activity	☐ Large-scale ☒ Small-scale
Version number of the PDD	3
Completion date of the PDD	11/12/2020
Project participants	Multilagos Geração de Energia Ltda Carolina Geração de Energia Ltda Enerbio Consultoria Ltda-ME
Host Party	Brazil
Applied methodologies and standardized baselines	AMS I.D – Grid connected renewable electricity generation (Version 18.0)
Sectoral scopes	1
Estimated amount of annual average GHG emission reductions	8,980

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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The CDM Project SHP Santa Carolina (hereafter referred to as “Santa Carolina Project”) consists of the supply of clean hydropower electricity to the Brazilian National Interconnected System (SIN) through the implantation and operation of the Small Hydropower Plant (SHP) Santa Carolina, located in the state of Rio Grande Do Sul, Southern Region of Brazil. The SHP has total installed capacity of 10.56 MW and uses a small reservoir, with low environmental impact. According to CDM Project Standard for Project Activities, renewable energy project activities with a maximum output capacity[1] of 15 MW (or an appropriate equivalent) qualifies as small-scale CDM project activity Type I. Santa Carolina SHP maximum Output is 10.56 MW, as can be evidenced by equipment installed at the plant. Therefore, CDM Project SHP Santa Carolina is a CDM project activity Type I.

SHP Santa Carolina has the main objective of helping to fulfill the increasing demand for electricity in Brazil, due to economic and population growth. Contributing, thus, for the environmental, social and economic sustainability, through the increase of clean and renewable electricity participation in relation to the total country consumption.

The project activity reduces the emissions of greenhouse gases (GHGs) by preventing the electricity generation by fossil fuel sources with consequent CO_2 emissions that would be generated if the project did not exist. The baseline scenario is that 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 into the grid.

During the second crediting period, the project activity is expected to reduce 8,980 tCO2e annually and 62,860 tCO2e during the whole new crediting period of 7 years. Table below show main milestones of project implementation.

Table 1 – Main Milestones of Project Implementation

Date (dd/mm/yyyy)	Milestone	Evidence/Reference
16/04/2012	CDM Registration date	Registration on CDM EB as CDM Project Activity[2].
06/11/2012	Signing of contract for Turbines/Generators Supply	Contract for Turbine/Generators Supply
11/03/2016	Operation starting date of Santa Carolina SHP Generator Unit 02	Operational starting date as authorized by ANEEL through ANEEL Dispatch 609, issued on 10/03/2016
14/05/2016	Operation starting date of Santa Carolina SHP Generator Unit 01	Operational starting date as authorized by ANEEL through ANEEL Dispatch 1,252, issued on 13/05/2016
15/10/2020	Post-registration changes approved (PRC-6042-001).	Post-registration changes were approved on 15 October 2020 (PRC-6042-001)

SHP Santa Carolina contributes for sustainable development of country and of region once it provides economic development, without compromising the future generations, being aligned with the concept of Sustainable Development, established by the Brundtland Report, created by the

[1] According to CDM Project Standard for Project Activities Output” is the installed/rated capacity as indicated by the manufacturer of the equipment or plant, irrespective of the actual load factor of the plant. The installed/rated capacity of renewable electricity generating units that involve turbine generator systems shall be based on the installed/rated capacity of the generator;

[2] https://cdm.unfccc.int/Projects/DB/BVQI1334253365.85/view .

World-wide Commission on Environment and Development, that defines the term as: "the development that satisfies the current needs, without compromising the capacity of the future generations of supplying its own necessities" [3]..

Santa Carolina Project contributes for sustainable development by the following actions:

(a) Clean and renewable electricity is dispatched to the Brazilian National Interconnected System, displacing possible enterprises that generate energy through fossil fuel burning, preventing, thus, the emission of pollutant gases to the atmosphere.

(b) The construction of SHPs like SHP Santa Carolina brings positive impacts on the local economy, once it provides a growth of the average consumption in the region, developing social and economic activities of the region where the Project is located. The operation and maintenance of the Project require the consulting of service providers of the region, from the most different areas. The Project fosters, mainly, the third sector economy, contributing once more for job generation, tax revenues increase and local economic development.

(c) The project implementation can attract investment to the region and to promote an increase in industrial presence in the cities around the Project. Direct and indirect jobs were created both in the construction phase and the operation phase of the enterprise. This economical dynamic causes an increase in the available wealth in the region, generating local development and subsistence.

(d) The electricity supply of Santa Carolina Project creates a great incentive to rise new ventures and businesses in the region. This can create job and wealth generation to the cities involved, also increasing the generation reliability in the electrical system of the Rio Grande do Sul state and, consequently, a minor electricity dependence on other states.

(e) SHP Santa Carolina presents low environmental impact, with a small reservoir formation and high power density. In addition, project participants carried out considerable investments in environmental programs and actions. It was developed a series of mitigation actions in the physical, biotic, anthropic environment in order to reduce and monitor the possible impacts of the project, according to the current environmental laws of the country. It is important to point that no family was relocated with the enterprise construction, proving the sustainability of the Santa Carolina Project.

(f) The implementation of SHP Santa Carolina presupposes the acquisition of high-technology equipment, which was acquired through the manufacturers settled in the national territory. The use of this equipment demands training and capacity for the local workers, coming from the manufacturers themselves. With this, companies obtained more experience, and the technology becomes more widely spread and consolidated in the region and in the country as a whole.

(g) The implementation of the enterprise provides the increment of tax revenues of the cities, state and country where the project is located. This increase can be invested directly in social benefits to the local community.

[3] WCED [CMMAD], 1987. Our Commom Future [Nosso Futuro Comum]. The World Commission on Environment and Development [Comissão Mundial sobre Meio Ambiente e Desenvolvimento]. Oxford University Press.

A.2. Location of project activity

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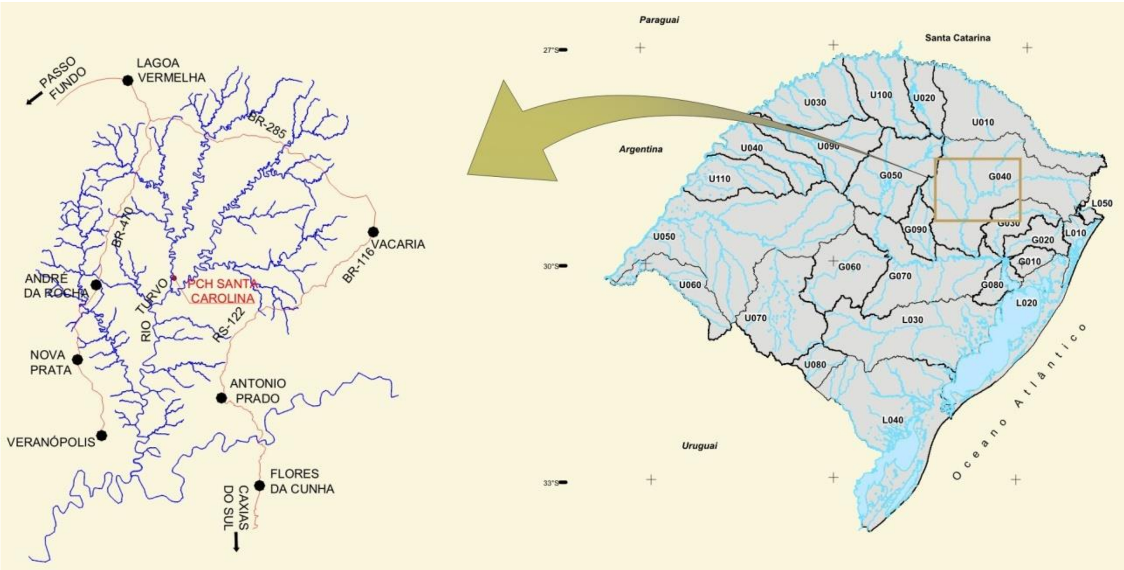
SHP Santa Carolina is located in the state of Rio Grande do Sul, southern region of Brazil. It is implanted in the city of André da Rocha and Muitos Capões, in Taquari-Antas, basin 8 and sub-basin 86, at Turvo River. The coordinates of the entrepreneurship's housepower are Latitude –28.619218 and Longitude -51.401466 (Datum: SIRGAS 2000).

The access to the power plants of these SHPs is done according to the description below. The access to both margins of SHP Santa Carolina happens by private property lands. The right margin is accessed by road, distant by 6.5km from the district of Chimarrão, and the left margin is also accessed by road, located 7 km in the south of Ituim district.

Map 1 – Santa Carolina Project Location



A.3. Technologies/measures

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The Project SHP Santa Carolina fits the category I.D. used for a greenfield renewable energy power plant connected to a national grid that is constructed and operated at a site where no renewable energy power plant was operated prior to the implementation of the project activity.

SHP Santa Carolina uses the hydraulic potential of the river to generate electricity with an installed capacity of 10.56 MW. Santa Carolina SHP is a run-of-river hydroelectric power plant with small reservoir formation. It has a medium electricity generation potential of 5.13 MW. The medium electricity was defined by Ministry of Mines and Energy through Ordinance 29 issued at 15/05/2012.

The energetic studies were developed considering the historic flow series of the river in the period between January, 1939 and December, 2003. The series of monthly average flow for SHP Santa Carolina was generated from two fluvial stations situated in Prata River and one fluvial station situated in Turvo River. The latest was used as the base for the study. Statistic methods were used to study the hydraulic potential of the river.

The motorization simulation was based in the classical methodology of incremental cost/benefit, with the investigation of the installation cost for each installed capacity. The table below presents the main technical parameters of SHP Santa Carolina:

Table 2: Technical Characteristics of SHP Santa Carolina.

Technical Characteristics	SHP Santa Carolina
Installed Capacity (MW)	10.56
Reservoir Area (km^2)	0.0930
Power Density (W/m^2)	113.54
Medium Electricity (MW)	5.13
Plant Load Factor	0.48
Turbines	
Quantity	2
Type	Francis
Number of Generators	2
Dam	
Type	Concrete
Maximum Height (meters)	9
Power House	
Type	Sheltered

The equipment and technologies employed in the project is developed in Brazil and was successfully applied to similar projects in the country and in the world. The enterprise implantation was responsibility of national companies, providing, therefore, development and employment of national workforce.

The average lifetime of the equipment is 30 year based on industry standards.

A.4. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Brazil	Private Entity: Multilagos Geração de Energia Ltda Private Entity: Carolina Geração de Energia Ltda Private Entity: Enerbio Consultoria Ltda-ME	No

A.5. Public funding of project activity

No public funding for the CDM project activity was solicited by parties involved in Annex I.

A.6. History of project activity

CDM Project SHP Santa Carolina (Project 6042) was registered by CDM Executive Board on 16 April 2012. Post-registration changes were approved on 15 October 2020. This PDD is being submitted to request the renewal of its crediting period for the second crediting period.

The Project Participants confirm that:

1. The proposed CDM project activity is not included as a Component Project Activity (CPA) in a registered CDM Programme of Activities (PoA);

2. The proposed CDM project activity is not a project activity that has been deregistered;
3. The proposed CDM project activity is not a CPA that has been excluded from a registered CDM PoA;
4. The proposed CDM project activity is not a registered CDM project activity or a CPA under a registered CDM PoA whose crediting period has or has not expired (hereinafter referred to as former project) exists in the same geographical location as the proposed CDM project activity.

A.7. Debundling

According to Appendix C of the simplified modalities and procedures for small-scale CDM project activities, a small scale project is considered part of a large project if there is a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:

- With the same project participants;
- In the same project category and technology/measure; and;
- Registered within the previous 2 years; and
- Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point.

In relation to the Santa Carolina Project, there is no other small scale project activity which fits the criteria mentioned above; therefore, the proposed project activity is not a debundled component of a large project activity. For more information: http://cdm.unfccc.int/EB/036/eb36_repan27.pdf

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

The CDM Project Standard for Project Activities, version 02.0, item "a" says that the "*project participants shall use the valid version of the methodologies and methodological tools applied in the registered PDD, that is, the latest version at the time of the submission of the request for renewal of crediting period or the previous version if the submission of the request for renewal of the crediting period is still within the grace period of the previous version for use*".

Therefore, the following methodology was applied:

- Version 18.0 of AMS I.D – "Grid connected renewable electricity generation"[4].

This methodology also refers to some latest approved versions of methodologies and tools that can be applied to the project activity. The following methodologies/tools referred by the AMS I.D. (Version 18.0) that could be applied to this project activity are:

- ACM0002: "Grid-connected electricity generation from renewable source" (Version 20.0)[5];
- "TOOL07: "Tool to calculate the emission factor for an electricity system" (Version 7.0)"[6]
- "TOOL11: "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" (Version 03.0.1)[7];

[4] https://cdm.unfccc.int/methodologies/DB/W3TINZ7KKWCK7L8WTXFQQOFQQH4SBK

[5] https://cdm.unfccc.int/methodologies/DB/XP2LKUSA61DKUQC0PIWPGWDN8ED5PG

[6] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v7.0.pdf

[7] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-11-v3.0.1.pdf

The TOOL01 “Tool for the Demonstration and Assessment of Additionality (Version 7.0)” and “TOOL02: Combined tool to identify the baseline scenario and demonstrate additionality” (Version 7.0) are also used by the project activity.

However, according to the CDM Project Standard for Project Activities (version 02.0) “*for renewal of crediting period of a registered CDM project activity, the project participants are not required to reassess the additionality of the project activity nor update the section of the PDD relating to additionality*”. Therefore, as this PDD refers to the second crediting period of the project, the “Tool for the demonstration and assessment of additionality” (TOOL01) and the “Combined tool to identify the baseline scenario and demonstrate additionality” (TOOL02) will not be used.

B.2. Applicability of methodologies and standardized baselines

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In this section, Project Participants will describe the applicability conditions of methodology AMS I.D, version 18.0 to CDM Project SHP Santa Carolina.

Santa Carolina Project install a Greenfield plant that results in new reservoirs and the power density of the power plant greater than 4 W/m2, as demonstrated at section A.3.

The metodology AMS I.D, version 18.0 is applicable to project activities that:

(a) Install a Greenfield plant;

(b) Involve a capacity addition in (an) existing plant(s);

(c) Involve a retrofit of (an) existing plant(s);

(d) Involve a rehabilitation of (an) existing plant(s)/unit(s); or

(e) Involve a replacement of (an) existing plant(s).

Hydro power plants with reservoirs that satisfy at least one of the following conditions are eligible to apply this methodology:

(a) The project activity is implemented in an existing reservoir with no change in the volume of reservoir;

The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the project emissions section, is greater than 4 W/m_2;

(c) The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the project emissions section, is greater than 4 W/m_2.

Santa Carolina Project installs a greenfield plant with power density higher than 4 W/m2 that supplies electricity to Brazilian National Interconnected System. Therefore, this methodology is applicable to Santa Carolina Project.

The methodology AMS I.D, version 18.0 still says that:

- If the new unit has both renewable and non-renewable components (e.g. a wind/diesel unit), the eligibility limit of 15 MW for a small-scale CDM project activity applies only to the renewable component. If the new unit co-fires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15 MW.

Santa Carolina Project does not have non-renewable components and it does not co-fire fossil fuels.

- Combined heat and power (co-generation) systems are not eligible under this category.

Santa Carolina Project does not have combined heat and power systems.

- In the case of project activities that involve the capacity addition of renewable energy generation units at an existing renewable power generation facility, the added capacity of the units added by the project should be lower than 15 MW and should be physically distinct[1] from the existing units.

Santa Carolina Project does not involve the capacity addition of renewable energy generation units at an existing renewable power generation facility. The project installs a greenfield plant.

- In the case of retrofit, rehabilitation or replacement, to qualify as a small-scale project, the total output of the retrofitted, rehabilitated or replacement power plant/unit shall not exceed the limit of 15 MW.

Santa Carolina Project is a greenfield plant. It does not involve retrofit, rehabilitation or replacement of power units.

- In the case of landfill gas, waste gas, wastewater treatment and agro-industries projects, recovered methane emissions are eligible under a relevant Type III category. If the recovered methane is used for electricity generation for supply to a grid then the baseline for the electricity component shall be in accordance with procedure prescribed under this methodology. If the recovered methane is used for heat generation or cogeneration other applicable Type-I methodologies such as “AMS-I.C.: Thermal energy production with or without electricity” shall be explored.

Santa Carolina Project comprises a greenfield hydro power plant. This condition is not applicable.

11. In case biomass is sourced from dedicated plantations, the applicability criteria in the tool “Project emissions from cultivation of biomass” shall apply.

Santa Carolina Project installs a greenfield hydro power plant. This condition is not applicable.

As presented at section A.1., according to CDM Project Standard for Project Activities, renewable energy project activities with a maximum output capacity[8] of 15 MW (or an appropriate equivalent) qualifies as small-scale CDM project activity Type I. Santa Carolina SHP maximum Output is 10.56 MW, as can be evidenced by equipment installed at the plant. Therefore, CDM Project SHP Santa Carolina is a CDM project activity Type I, remaining within small scale threshold.

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

According to the methodology I.D, the spatial extent of the project boundary includes the project power plant and all power plants connected physically to the electricity system that the CDM project power plant is connected to.

[8] According to CDM Project Standard for Project Activities Output” is the installed/rated capacity as indicated by the manufacturer of the equipment or plant, irrespective of the actual load factor of the plant. The installed/rated capacity of renewable electricity generating units that involve turbine generator systems shall be based on the installed/rated capacity of the generator;

In May 2008, through the resolution nº 8, Brazilian DNA defined that the National Interconnected System should be considered a unique electricity system and that this configuration is valid for calculating the emission factors of CO_2 used to estimate the emissions reductions of greenhouse gases of energy generation connected to the national interconnected grid CDM projects. Santa Carolina SHP is connected to the National Interconnected System was considered as one.

The greenhouse gases and emission sources included in or excluded from the project boundary are presented in the table below:

Source		GHG	Included?	Justification/Explanation
Baseline	CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity.	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
Project activity	For dry or flash steam geothermal power plants, emissions of CH_4 and CO_2 from non-condensable gases contained in geothermal steam	CO_2	No	Not applicable to this project activity
		CH_4	No	Not applicable to this project activity
		N_2O	No	Not applicable to this project activity
	For binary geothermal power plants, fugitive emissions of CH_4 and CO_2 from non-condensable gases contained in geothermal steam	CO_2	No	Not applicable to this project activity
		CH_4	No	Not applicable to this project activity
		N_2O	No	Not applicable to this project activity
	For binary geothermal power plants, fugitive emissions of hydrocarbons such as n-butane and isopentane (working fluid) contained in the heat exchangers	Low GWP hydrocarbon/ refrigerant	No	Not applicable to this project activity
	CO_2 emissions from combustion of fossil fuels for electricity generation in solar thermal power plants and geothermal power plants	CO_2	No	Not applicable to this project activity
		CH_4	No	Not applicable to this project activity
		N_2O	No	Not applicable to this project activity
	For hydro power plants, emissions of CH_4 from the reservoir	CO_2	No	Not applicable to this project activity
		CH_4	No	Not applicable to this project activity once the power density is higher that 10 W/m^2.
		N_2O	No	Not applicable to this project activity

B.4. Establishment and description of baseline scenario

Methodology AMS-I.D, version 18.0, defines that the baseline scenario for greenfield power plants is the electricity delivered to the grid by the project activity that otherwise would have been generated by the operation of grid-connected power plants and by the addition of new generation sources.

Baseline

According to the version 18.0 of methodology AMS I.D, baseline emissions include only CO_2 emissions from electricity generation in power plants that are displaced due to the project activity. The methodology assumes that all project electricity generation above baseline levels would have been generated by existing grid-connected power plants and the addition of new grid-connected power plants.

The baseline emissions are calculated as follows:

$BEy = EGPJ,y \times EFgrid,y$ **Equation 01**

Where:

BE_y = Baseline Emission in year y (t CO_2e/year);
$EG_{PJ,y}$ = 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)
$EF_{grid,y}$ = Combined margin CO_2 emission factor for grid connected power generation in year *y* calculated using the latest version of the “Tool to calculate the emission factor for an electricity system” (t CO_2/MWh)

The emission factor is calculated in a transparent and conservative manner using a combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the “Tool to calculate the emission factor for an electricity system”.

According to the “Tool to calculate the emission factor for an electricity system”, in case the DNA (Designated National Authority) of the project’ host country has published a delineation about the project’s electricity systems and about the connected electricity system, these delineations must be used. Brazilian DNA defined that the National Interconnected System must be considered as a Unique Electricity System and that this configuration will be valid for calculating the emission factors of CO_2 used to estimate the emission reductions of the greenhouse gases from CDM projects of electricity generation energy connected to the national interconnected grid.

The CO_2 emission factors from electricity generation verified in the Brazilian National Interconnected System (SIN) are calculated based on the generation record of plants centrally dispatched by ONS.

Therefore, both operating margin (OM) and build margin (BM) are calculated by the Brazilian DNA using the electricity generation verified in the National Interconnected System and are published in tCO_2e/MWh.

According to items 283 and 286 of the CDM Project Standard (Version 2.0):

“*To demonstrate the validity of the original baseline or its update, project participants are not required to re-assess the baseline scenario. Instead, project participants shall assess the GHG emission reductions that would have resulted from that scenario (…)*

(…)If data and parameters used for determining the original baseline, that were determined ex ante and not monitored during the crediting period, are no longer valid, the project participants shall update such data and parameters in accordance with the “Methodological tool: Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period”.

The methodological tool 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) provides a stepwise procedure to assess the continued validity of the baseline and to update the baseline at the renewal of a crediting period, as required by paragraph 49 (a) of the modalities and procedures of the clean development mechanism.

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 “Procedures for the renewal of the crediting period of a registered CDM project activity” approved by the CDM Executive Board require assessing the impact of new relevant national and/or sectoral policies and circumstances on the baseline. 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

As mentioned before, the baseline scenario for greenfield power plants is “the electricity delivered to the grid by the project activity that otherwise would have been generated by the operation of grid-connected power plants and by the addition of new generation sources”.

There are no relevant mandatory national and/or sectoral policies which have come into effect after registration of the project activity that impact the baseline scenario. The current baseline complies with relevant mandatory national and/or sectoral policies.

In the first crediting period, the project electricity system was the National Interconnected System (SIN), defined as the relevant grid to the project activity. The definition of the SIN as the relevant electricity system is recommended by Brazilian DNA[9] 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 CO_2 emission factors. This Resolution is still valid.

Brazilian DNA calculates the CO_2 emission factors and publishes it through its website[10]. In the second crediting period, the project activity will follow the same definition of the project electricity system and use emission CO_2 emission factors published by Brazilian DNA.

Step 1.2: Assess the impact of circumstances

According to Methodology AMS-I.D, version 18.0, the baseline scenario for greenfield power plants is the electricity delivered to the grid by the project activity that otherwise would have been generated by the operation of grid-connected power plants and by the addition of new generation sources. There are no circumstances that impact the baseline scenario.

During the second crediting period, the combined margin emission factor of the National Interconnected System will be calculated, according to the latest version of “TOOL07: Tool to calculate the emission factor for an electricity system”.

The Combined Margin (CM) emission factor is calculated based on data 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 ONS, the Brazilian Designed National Authority (DNA) calculates OM emission factors of the SIN according to the “TOOL07: Tool to calculate the emission factor for an electricity system” and makes them available to the public.

For the second crediting period, the build margin emission factor is calculated ex ante and fixed for the whole crediting period, according to option chosen by project participants using the TOOL07: “Tool to calculate the emission factor for an electricity system” (Version 7.0). All details about steps

[9] Source: http://antigo.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/cimgc/Comissao_Interministerial_de_Mudanca_Global_do_Clima__CIMGC.html.

[10] Source: http://antigo.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/emissao_despacho.html.

of this Tool are presented at section B.6. This section presents the emission factors and baseline calculations, following TOOL07: Tool to calculate the emission factor for an electricity system.

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 step does not apply, since in the absence of the project, the electricity would be generated by grid connected power plants. Power plants connected to the system would continue to supply energy independently of the technical lifetime of the equipment applied to the project.

Regarding the project lifetime, the project has 30 years of expected operational lifetime, as indicated by registered PDD. The operational starting date of the first plant was 11 March 2016. Therefore, the remaining lifetime exceeds the end of second crediting period.

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

Detailed description of data, parameters and emission factors used to baseline calculations are presented at section B6.

According to 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), project participants shall assess whether data and parameter that were only determined at the start of the crediting period and not monitored during the crediting period are still valid,

At the PDD registered, data and parameter determined at the start of the crediting period and not monitored during the crediting for Santa Carolina Project were: Installed Capacity before the implementation (Cap_{BL}) and Reservoir area before the implementation (A_{BL}). These data are still valid.

At the PDD registered, $EF_{CO2,y}$ is a monitored parameter. PDD registered establishes that it is ex - post calculated by project participants based on $EF_{grid,OM,y}$ and $EF_{grid,BM,y}$ published by Brazilian DNA.

For the second crediting period, $EF_{grid,BM,y}$ is calculated ex ante and fixed for the whole second crediting period, according to TOOL07: "Tool to calculate the emission factor for an electricity system" (Version 7.0). $EF_{grid,OM,y}$ will still be calculated on ex-post basis according to TOOL07: "Tool to calculate the emission factor for an electricity system" (Version 7.0).

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

The application of Steps 1.1, 1.2, 1.3 and 1.4 confirmed that the current baseline is still valid for the subsequent crediting period. The baseline scenario does not need to be reassessed.

However, for the second crediting period, $EF_{grid,BM,y}$ is calculated ex ante, according to TOOL07: "Tool to calculate the emission factor for an electricity system" (Version 7.0).

The build margin emission factor is calculated by the Brazilian DNA[11]. Data from 2019 will be used for the Build Margin emission factor, which is calculated and published by the Brazilian DNA. The 2019 data vintage was adopted for the build margin calculation as these are the latest data made publicly available by the Brazilian DNA. The value is 0.1020 tCO2e/MWh.

[11] For more information: http://antigo.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/emissao_despacho.html

The Operating Margin (OM) Emission Factor will be ex post calculated and it is a monitored parameter.

Baseline emissions had to be updated using the most updated values published by Brazilian DNA..

Step 2.1: Update the current baseline

The application of Steps 1.1, 1.2, 1.3 and 1.4 confirmed that the baseline scenario is still valid. There is no need to be updated.

According to 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), project participants shall update the current baseline emissions for the subsequent crediting period, without reassessing the baseline scenario.

Ex ante baseline emission estimation was updated according to "Tool to calculate the emission factor for an electricity system" Version 07.0. Equations and values applied are presented at section B.6. Table below summarizes ex ante baseline emission estimation for the second crediting period:

Table 3: Ex ante baseline emissions estimation

Year	SHP Santa Carolina BE_y (t CO2 e)
2020	5,987
2021	8,980
2022	8,980
2023	8,980
2024	8,980
2025	8,980
2026	8,980
2027	2,993
Total	**62,860**

Step 2.2: Update the data and parameters

Brazilian DNA provides yearly updated data about emissions from National Interconnected System power generation. The latest available data are from 2019 and were used to undertake the emission factors updates.

According to the methodological tool "Tool to calculate the emission factor for an electricity system" Version 07.0, for hydropower generation project activities the Weighting of operating margin emissions factor and the Weighting of build margin emissions factor are, respectively, 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. Therefore, for the second crediting period, it will be used W_{OM} = 0.25 and W_{BM} = 0.75

At PDD registered for the first crediting period, 2009 data of $EF_{grid,OM}$ and $EF_{grid,BM}$ were used to calculate ex ante emission reduction estimation. For the second crediting period, for ex ante emission reduction estimation, 2019 values were used for $EF_{grid,OM}$.: 0,51809 tCO2e/MWh For $EF_{grid,BM,y}$, 2019 value is also used which it is a fixed value for the whole second crediting period: 0.1020 tCO2e/MWh.

B.5. Demonstration of additionality

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According to the CDM Project Standard for Project Activities (version 02.0) "*for renewal of crediting period of a registered CDM project activity, the project participants are not required to reassess the additionality of the project activity nor update the section of the PDD relating to additionality*". Therefore, this section is not applicable for the renewal of the crediting period. The original demonstration of additionality presented at PDD registered is presented as follows.

According to the Annex 46 of the Report of 41st meeting of the CDM Executive Board, Project activities with start date on 2nd August 2008 or after should inform to the Host Party DNA at the beginning of the Project activity about its start date and its intention to become a CDM project activity.

Multilagos Geração de Energia Elétrica Ltda. sent an official communication to the Brazilian DNA in 22nd May 2009, communicating its intention to turn SHP Santa Carolina into a CDM Project activity and informing about the previous consideration and the importance of revenues originated from CERs selling to the Project feasibility and existence. The reception was confirmed by the Brazilian DNA in 27th May 2009, through a letter sent to Enerbio Consultoria. In 1st July 2009, a similar document in English was sent to the CDM EB, which confirmed the reception in 2nd July 2009.

The Annex A of attachment B of Simplified modalities and procedures for small-scale CDM project activities establishes that the project participants shall provide an explanation to show that the Project activity would not have occurred anyway due to at least one of the following barriers:

(a) Investment barrier: a financially more viable alternative to the Project activity would have led to higher emissions;

(b) Technological barrier: a less technologically advanced alternative to the Project activity involves lower risks due to the performance uncertainty or low market share of the new technology adopted for the Project activity and so would have led to higher emission;

(c) Barrier due to prevailing practice: prevailing practice or existing regulatory or policy requirements would have led to implementation of a technology with higher emissions;

(d) Other barriers: without the Project activity, for another specific reason identified by the Project participant, such as institutional barriers or limited information, managerial resources, organizational capacity, financial resources, or capacity to absorb new Technologies, emissions would have been higher.

Before analyzing the barriers faced by Santa Carolina Project, it is necessary to describe the alternative scenarios that would probably take place in the absence of the project activity.

The realistic alternatives to the project activity are:

- The continuity of the current situation, with electricity being generated by the current composition of generation of the National Interconnected System;
- The construction of new thermal power plant;
- The implementation of project without the CDM incentives.

In order to provide an ample view on the alternative scenarios, it is valid to sketch a panorama of the current Brazilian electrical sector and its projection for the future.

Based on the Aneel (National Energy Agency) Electricity Generation Database[12], the Brazilian installed capacity, at the moment of PDD development, was as described on table below:

[12] Source: http://www.aneel.gov.br/aplicacoes/capacidadebrasil/capacidadebrasil.asp. Accessed in Septembery 22h, 2009.

Table 4: Generation Capacity in Brazil – Enterprises in Operation

Enterprises in Operation		
Type	Power (kW)	%
CGH	169,224	0.16
EOL	550,680	0.52
SHP	**2,923,739**	**2.72**
SOL	20	0
HPP	75,150,827	71.40
UTE	26,846,533	23.29
UTN	2,007,000	1.91
Total	**107,648,023**	**100**

Caption for table 2:

- *CHG: Hydro Power Plant Central Generation (Installed capacity minor than 1 MW)*
- *EOL: Wind Power Plant*
- *SHP: Small Hydro Power Plant (Installed capacity greater than 1 MW and less than 30 MW)*
- *HPP: Hydro Power Plant (Installed capacity greater than 30 MW)*
- *UTE: Thermal Power Plant*
- *UTN: Nuclear Thermal Plant*
- *SOL: Solar Power Plant*

Through the analysis of table 4, it can be noticed that only 2.72% of the country's installed capacity are generated through small hydroelectric power plants and that the main types of entrepreneurships responsible for the greatest parcel of contribution to the country's installed capacity are: large scale hydroelectric power plants (71.4%) and the thermoelectric power plants (23.29%).

Most of hydroelectric power plants (HPPs) were implemented through investments state-owned investments, when the electric sector was still centrally regulated. They present the characteristic of using great reservoir areas [13], with high socio-environmental impacts, once the Brazilian legislation was still soft in the past concerning the implantation of entrepreneurships for energy generation. Big reservoirs usually provide more emission of greenhouse gases by the decomposition of biomass.

In the case of thermoelectric energy generation, according to table 5[14], it can be noticed that 72.66% of the fuels used in Brazil are from fossil sources, which emit a higher quantity of Greenhouse gases.

[13] Atlas of Electric Energy in Brazil / National Agency of Electric Energy, pages 45-46. (*Atlas de Energia Elétrica do Brasil / Agência Nacional de Energia Elétrica, Páginas 45-46. – Brasília: ANEEL, 2002.*)

[14] Source: http://www.aneel.gov.br/aplicacoes/capacidadebrasil/Combustivel.asp (22/09/2009)

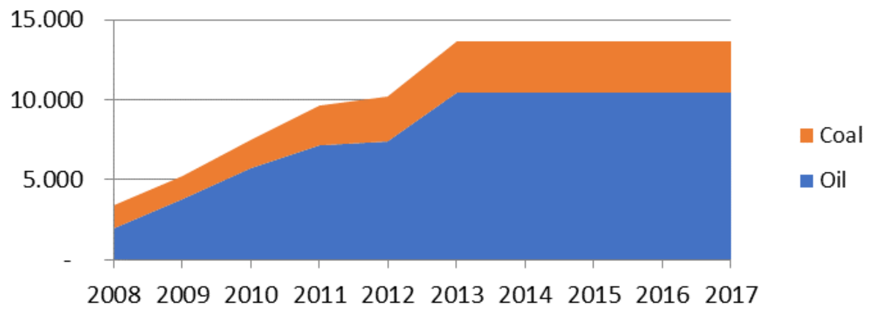
Table 5: Sources of Energy Explored in Brazil

Class of FuelsTypes Used in Brazil – Entrepreneurships in Operation			
Fuel	**Quantity**	**Power (kW)**	**%**
Biomass	334	5,737,443	23.41
Fossil Fuel	907	17,809,558	72.66
Others	23	962,483	3.93
TOTAL	**1,264**	**24,509,484**	**100**

Tables 4 and 5 present current data of national matrix. In 2008, the Ministry of Mines and Energy elaborated the Decennial Plan for Electric Energy Expansion to the period of 2008 a 2017[15], establishing an expansion scenario about energy generation in Brazil.

The MME projection estimates a growth in the electricity supply from fossil fueled plants in the next years. The projection points to a total growth of 8,479 MW in oil-fired Thermoelectric Plants and 1,760 Coal Fired between 2008 and 2017.[16] On the following graph, it is shown the expansion in the installed capacity of fossil fueled enterprises, according to the Decennial Plan for Electric Energy Expansion.

Graph 1: Evolution of Fossil Fueled Installed Capacity (MWh)
Decennial Plan for Electric Energy Expansion 2008-2017



Source: Ministry of Mines and Energy (Decennial Plan for Electric Energy Expansion), chapter 8. page 12

Observing the graph 1 above, it can be concluded that the supply of non-renewable electricity sources tends to a strong growth in the next years. The total oil-fire plants installed capacity should grow 427%, as well as the coal-fired plants should grow 124%, bearing in mind the baseline of 2008.

The projection forecasts also a growth of 39.27% of the installed capacity by Hydro Projects, including big hydropower plants and small hydropower plants. However, it is important to highlight that the hydro share in Brazilian Matrix is going to fall almost 8.70%, while the share of oil fired plants and coal plants will growth 4.77% and 0.63%, respectively. This relative growth of the fossil fuel sources of electricity in the Brazilian Energetic Matrix will contribute for more emission in the whole interconnected system.

It is also important to highlight that there are currently 8 thermoelectric plants in Brazil, operating with mineral coal, totalizing an installed capacity of 1,455 MW, according to the table[17] below:

[15] Available at: http://www.mme.gov.br/mme/menu/todas_publicacoes.html .Acessed in 22th September 2009.

[16] Page 45 of Decennial Plan for Electric Energy Expansion, elaborated by Ministry of Mines and Energy.

[17] Source: Aneel - http://www.aneel.gov.br/aplicacoes/capacidadebrasil/GeracaoTipoFase.asp?tipo=2&fase=3

Table 6: Coal Thermoelectric Power Plants in Operation in Brazil

Power Plant	Capacity (MW)	State
Figueira	20	Paraná
Charqueadas	72	Rio Grande do Sul
Pres. Médici A e B	446	Rio Grande do Sul
São Jerônimo	20	Rio Grande do Sul
Jorge Lacerda I e II	232	Santa Catarina
Jorge Lacerda III	262	Santa Catarina
Jorge Lacerda IV	363	Santa Catarina
Alunorte	40	Pará
Total	**1,455**	

In Brazil, 7 of the 8 thermo electric entrepreneurships that generate electricity by coal are located at the south region, where Santa Carolina Project is located.

Traced a panorama of the current energetic matrix in Brazil and its perspective for the future, it can be established with more precision the barriers faced by the project.

<u>Barriers</u>

The first barrier faced by the project is the financial one. The implementation of the project activity without CDM is not financially feasible, since the cost of equity of SHP Santa Carolina is considerably above the Equity Internal Rate of Return (IRR).

The cash flow of the Project is based on the following premises:

- Total Gross Electricity Generated per Year – Result of the multiplication between 8760 annual hours and the Medium Electricity Generated per Hour of 5.49 MWh;
- The Medium Electricity Generated of 5.49 MW was defined, considering the Medium Electricity expected at the PDD registered (5.46 MWh) plus the growth percentage of installed capacity between effective installed capacity of the project (10.56 MW) and the installed capacity expected at the PDD registered (10.5 MW).
- 3% of Commercial Losses – It is considered that will occur 3% of transmission commercial losses and internal consumption. This is an assumption commonly used in the national electrical sector.
- Net Electricity Generated per Year = Total Gross Electricity Generated per Year – Commercial Losses;
- The energy tariff of R$ 140.00 / MWh is based on the results published by CCEE in the 1st Electricity Auction from Renewable Sources, realized in 2007[18];
- Total Investment = **R$ 51,931,989**, distributed as:
    - **R$ 46,861,693** related to the Consolidated Basic Project, developed by MEK Engenharia, a third part engineering company hired by Project Owners to develop the project. This budget is related to the Total Cost excluded the Interest incurred during the construction;
    - **R$ 3,802,685** related to the transmission line budget. This budget is estimated accordingly the budgets elaborated by the company "JAPCON", consulting

[18] The average price negotiated at the auction was R$134.99 /MWh, but Project Participants will conservatively use R$140.00 /MWh for this project.

company hired to develop the budget of the transmission line. JAPCON provided to the Project Owners 8(eight) budgets for the transmission line considering different scenarios. It was used the less costly scenario. It is important to say that the real cost of this transmission line is at least R$ 23,286,500 as evidenced to the DOE through a budget supplied by JAPCON of the transmission line. Project Owners plans to share the costs of this transmission line budget with other 5 (five) entrepreneurs of other projects that are located near the place where the project will be constructed. The cost of the transmission line will probably be shared between these five entrepreneurs accordingly the installed capacity of each project. The contract between the Project Owner and JAPCON already considered these assumption and the costs were shared between these five entrepreneurs. SHP Santa Carolina has 17.5% of the installed capacity of these five projects. The process to start the investment in the transmission line is under negotiation. To be conservative, Project Owners considered the minimum budget presented by JAPCON multiplied by its participation of 17.5%.

   - **R$ 1,266,609** related to expenses with the financial arranger, the agent responsible for the funding intermediation. This cost can be evidenced by the Contract established between Project Owners and the company "Z&Zen Assessoria Empresarial Ltda". The second clause establishes the cost of 2.5% of Total Investment.

- **<u>Cost of Debt</u>:** Entrepreneurs of SHP Santa Carolina has not signed loan contract for this project yet. The cost of debt for Santa Carolina Project is based on the costs of funding, related to projects for small hydroelectric plants in Brazil, through funding from National Bank of Economic and Social Development, BNDES. The cost of loan financing from BNDES is usually indexed to the Interest Rate Term (6.00% per year.[19]), plus a basic remuneration of BNDES (0.9% a.a.) plus the Risk of Credit from BNDES (3.0% per year). The risk rate charged by the BNDES maximum credit for renewable energy projects is 3.57% per year as information available at the site of the Bank[20]. Conservatively, an estimated rate of 3.0% per year was considered. The estimated rate for financing is then 9.90% per year with an amortization period of 14 years as indicated by information in the website of the BNDES
- <u>This method of calculating the cost of funding is indicated by the BNDES, as its website:</u> http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Institucional/Apoio_Financeiro/Produtos/FINEM/energias_renovaveis.html<u>. The company estimates that 70% of the amount needed for total investment will be financed by BNDES, the National Bank of Economic and Social Development;</u>
- The taxes (PIS/COFINS/CSLL/IR) follow the Brazilian taxation of Presumed Profit;
- The ANEEL supervision tax was estimated according to Guidelines for SHP Projects, developed by Eletrobrás;
- The CCEE tax was estimated taking into account the ANEEL supervision tax;
- The RGR tax was based on Resolution nº 23 from 5th February 1999;
- The expenditures with insurance were estimated as being 0.5% of the total project investment. The projection was realized taking into account the previous experience of Multilagos' team;
- The cost of administration and O & M (Operation and Maintenance) was estimated as 2% of the Investment Amount as recommended by the Guidelines for Small Hydropower Plants[21], elaborated by Brazilian Ministry of Mines and Energy, ;

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[19] http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Institucional/Apoio_Financeiro/Custos_Financeiros/Taxa_de_Juros_de_Longo_Prazo_TJLP/index.html. Accessed in 20/07/2010.

[20] The risk rate charged by the BNDES maximum credit for renewable energy projects is 3.57% a.a. as information in the Bank's website: http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Institucional/Apoio_Financeiro/Produtos/FINEM/energias_renovaveis.html

[21] Chapter 9, Page 07.

- The spending on TUSD (Tariff of Use of Distribution System) were estimated based on Resolution Nº 810 of 14th April 2009;
- The IRR calculation follows the Guidance on the Assessment of Investment Analysis, present in Tool for the demonstration and assessment of Additionality.;
- The period of the expected operation of the underlying project activity is concession period that ANEEL gives to the Project Owner of Small Hydropower Plants Projects in Brazil: 30 years.

The equity cash flow of the SHP Santa Carolina used in the financial projection, based on the assumptions described above, provides equity IRR of 6.50%.

Benchmarking - Cost of Equity

Benchmarking chosen for the project is the cost of equity. The cost of equity was calculated using the following equation.

$K_e = GB + PE_g$ **Equation 2**

Where:

- Ke = Cost of equity.
- GB = Risk Free Rate (Rf) + Country Risk Premium (ERP)
- PE_g = *Global Equity Risk Premium*

Adopted equation corresponds to equation 4B of the option 03 *"Draft tool to determine the weighted average cost of capital (WACC)"*. Although this tool is not approved at the time of PDD elaboration, it corresponds to a calculation method accepted by financial models and as it is suggested by the UNFCCC on a draft methodological, it is understood that it represents an appropriate way to calculate the cost of equity according to the Executive Board.

To calculate the cost of equity using equation 3, the parameters used were as follows:

- GB = 3.36% +7.50% = 10.86%.
  - R*f* = 3.36% => Average Rate of Return on U.S. Treasury bond (T-Bond) of 30 years[22] in the past 03 years (2007, 2008 and 2009) prior to preparation of the PDD;
  - ERP = 7.50% => Risk Premium in Brazil, based on data from Moody's, as calculated by Professor Aswath Damodaran[23].
- PE_g = 4.1% => Global Equity Risk Premium is provided by the article "The worldwide equity premium: A smaller puzzle Elroy Dimson, Paul Marsh and Mike Stautun of London Business School[24].

The nominal cost of equity of SHP Santa Carolina is 14.96%. Discounted rate of inflation of 2.70%[25], the cost of equity is 11.93%.

The following table shows a summary comparison between the project financial indicators and the benchmarking:

[22] Based on data from Standard & Poors. Available at http://pages.stern.nyu.edu/~adamodar/. To access it, you should enter the link Updated Date and thereafter on the link “Updtaed Data and the option “Historical Returns on Stocks, Bonds and Bills – United States” . Accessed in July, 19th 2010.

[23] Available at: http://www.stern.nyu.edu/~adamodar/pc/datasets/ctryprem.xls . Accessed in July, 19th 2010.

[24] This article is indicated in *Draft tool to determine the weighted average cost of capital (WACC).*

[25] Measured by Consumer Price Index (CPI). Available at: ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt . Accessed in July, 19th 2010.

Table 7: Financial Indicator Project x Benchmarking

Equity IRR	Cost of Equity
6.50%	11.93%

Thus, it is perceived that the Equity IRR of SHP Santa Carolina is lower than its cost of equity, indicating that the SHP Santa Carolina is not financially attractive without the incentives of the CDM. So the revenues from the sale of Certified Emission Reductions are essential to the financial attractiveness of the project and its development

Thus, the most financially viable alternative to the project activity would be to not develop the project activity. This decision would provide greater emissions through: (i) continuity of the current situation, with electricity being generated by the current generation composition of the National Interconnected System, or (ii) the construction of new thermoelectric power plants in the Southern Region.

To confirm how solid is the presented investment analysis, the participants of the project present below the sensitivity analysis for each scenario that collaborate to increase the financial and economic attractiveness of the project, varying the most important parameters of SHP Santa Carolina cash flow: (i) electricity price, (ii) the total amount of investment, (iii) the O&M and Administration cost of the plant , the (iv) Plant Load Factor and the (v) Loan Cost.
.
These parameters were used because:

- The electricity price and the assured energy (or the load factor) are the unique parameters that can influence the revenues of the project.;
- The total amount of investment represents the most important cash outflow of the project;
- It is projected that 70% of the investment is financed by BNDES. With that financial expenses are one of the most relevant expense during 14 years of the cash flow.
- The operational expenses of the project are, in general, taxes and spending defined by regulators. Regarding the O&M Cost, it is important to say that this item does not significantly affect the cash flow of the project, but as the variation of this item was required by CDM EB in other processes conducted by the Project Developer, therefore, its variation was also included in the sensitivity analysis. The O&M Cost (Operation and Maintenance Cost) can suffer changes, but its variance does not affect significantly the IRR;

The electricity price was based in the first auction of renewable energy where the highest price was R$ 135.00. Project Owners used an estimated price of R$ 140.00 per MW. The scenario where Project Owners sell this energy 10% above the price of R$ 140.00 is very unlikely to happen. The total amount of investment is estimated in the budgets that the company received. Regarding the O&M Cost, it can be seen that its variation does not affect significantly the project cash flow. This item can be very controlled and it does not suffer high changes during the project. The medium electricity (PLF Factor) variation was approved by ANEEL. Hardly, it will be changed. Loan Cost is based on BNDES indication. As it is going to be a long-term loan based on TJLP, the cost of debt will hardly fall 10%.

Therefore, it is unlikely that these items can suffer alteration that will contribute to a different increase in the project's financial and economic attractiveness that will not be covered in the range of variation between 0% and 10%. Therefore the range of variation between 0% and 10% covers more than the probable scenarios.

Table 8: Sensitivity Analysis of Santa Carolina Project

ELECTRICITY PRICE VARIATION		
Projected Situation	**MWh Price**	**Equity IRR**
0%	**R$ 140.00**	**6.50%**
5%	R$ 147.00	**7.55%**
10%	R$ 154.00	**8.60%**

TOTAL INVESTMENT AMOUNT VARIATION		
Projected Situation	**Investment (R$ thousand)**	**Equity IRR**
0%	**R$ 51,931**	**6.50%**
-5%	R$ 49,334	**7.59%**
-10%	R$ 46,738	**8.82%**

O&M AND ADMINISTRATIVE COST VARIATION		
Projected Situation	**Percentage of the Investment Amount**	**Equity IRR**
0%	**5%**	**6.50%**
-5%	4,75%	**6.68%**
-10%	4,50%	**6.87%**

PLANT LOAD FACTOR VARIATION (PLF)		
Projected Situation	**Medium Electricity (PLF)**	**Equity IRR**
0%	**5.49**	**6.50%**
+5%	5.76	**7.55%**
+10%	6.04	**8.60%**

LOAN COST VARIATION		
Projected Situation	**Loan Cost**	**Equity IRR**
0%	**9.90%**	**6.50%**
+5%	9.41%	**6.81%**
+10%	8.91%	**7.13%**

The sensitivity analysis confirms that the SHP Santa Carolina is not financially attractive, once its Internal Rate of Return is lower than its cost of equity, for all analyzed scenarios.

(C) Barriers due to prevailing practice

As seen in the description of the current Brazilian energy matrix projection of and the future scenario, established by the Brazilian Ministry of Mines and Energy, there is a clear predominance of large hydroelectric and thermoelectric power plants to fossil fuels in national energy matrix.

According to the Aneel[26] Electricity Generation Database, the generation of hydroelectric power in Brazil is composed mainly by large enterprises. According to this database, the country's 24 hydroelectric plants with capacity of 1000 MW or higher correspond to 65.18% of its installed capacity. Enterprises of this size have, by their electricity generation capacity and consequent

[26] Available at: http://www.aneel.gov.br/aplicacoes/capacidadebrasil/GeracaoTipoFase.asp?tipo=1&fase=3 Accessed in 26th May 2009

revenue generation, higher economic viability. Historically, this kind on enterprise was motivated by the government.

Also according to Aneel[27], historically the use of hydraulic potential in Brazil for electricity generation required the formation of large reservoirs and the flooding of large areas. These constructions had used, in most cases, the accumulation of water reservoirs and regularization of flows that cause changes in water regimes and the formation of microclimates, facilitating, impairing or even extinguishing species. These large reservoirs, in general, also provide more emission of CH_4 from the decomposition of the vegetation submerse.

It is also known that only one (1) of the total coal-fired plants it is located outside the southern region of the country. Furthermore, according to Brazilian Electric Energy Atlas[28], 89.25% of coal national of in the country are concentrated in Rio Grande do Sul state, where the state SHP Santa Carolina is located, providing, therefore, better conditions for the development of new UTEs by coal.

The projection for the period 2008-2017, elaborated by MME, described previously points to a growth of the thermal capacity and a fall in the hydro share in the energetic matrix of Brazil. This relative increase is already happening and it can be seen in the last results of the auctions organized by ANEEL

ANEEL organizes auctions where the electricity distributing companies can buy the necessary electricity for its demand. The auction is driven by the minimum price. Prices of thermal electricity are, in general, less than prices of hydro electricity. Table below provides the results of the last 5 auctions of new electricity that happened in Brazil between 2007 and 2009 (Source: CCEE).

Table 9: Results of the Last Auctions of New Electricity in Brazil

%	4º Auction - 2007	5º Auction - 2008	6º Auction - 2008	7º Auction - 2008	8º Auction - 2009
Hydro	0%	30.93%	0%	3.87%	9.09%
Thermal	100%	69.07%	100%	96.13%	90.91%

The policy established for these auctions brings advantage for thermal plants that require less investment and therefore, can sell electricity with fewer prices. This kind of policy leads to the implementation of a technology with higher emissions.

SHP Santa Carolina is a small enterprise with small installed capacity and power generation, not similar, therefore, to the major national hydroelectric power and not having, therefore, the enormous revenue potential for this type of enterprise. Moreover, the SHP Santa Carolina is a run-of-river plant with low environmental impacts and considers in its planning a series of investments in environmental programs and actions that did not exist when the occurred the deployment of most of the hydroelectric plants of the South the country.

Thus, the implementation of this project does not have substantial income like the large Brazilian hydroelectric enterprises and has minimal environmental impacts that require investment, and having these characteristics, its cash flow presents rates of return below the market reference rates and the revenues from the sale of certified emission reductions (CERs) becomes important to make the project feasible. The configuration of enterprises like SHP Santa Carolina, with small reservoir, can avoid higher emission provided by the huge reservoirs of big hydropower plants.

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[27] Atlas of Electric Energy in Brazil / National Agency of Electric Energy, page 32. (*Atlas de Energia Elétrica do Brasil / Agência Nacional de Energia Elétrica, Página 32. – Brasília: ANEEL, 2002.*)

[28] Atlas of Electric Energy in Brazil / National Agency of Electric Energy, pages 45-46. (*Atlas de Energia Elétrica do Brasil / Agência Nacional de Energia Elétrica, Páginas 45-46. – Brasília: ANEEL, 2002.*)

Besides that, the fact that projects in this configuration, without the additional revenue from selling the CERs are not attractive from a financial point of view and are not common in the country can be proved through the creation, by the Federal Government by Law No. 10.438, 26 April 2002, of the PROINFA Program.

PROINFA is a government program that seeks to motivate, in the financial point of view, the development of enterprises that use renewable technologies, due to difficulties in financing, the offer of guarantees to lenders and the need for high investments, considering small organizations.

Thus, the Federal Government tries to encourage project financing through different lines, and minimum revenue guarantees through the commitment of the from long-term contracts for the purchase of energy (PPAs) to be signed with a company of mixed economy, Eletrobras, which ensures a minimum return to the enterprise of 70% of the energy contracted during the period of the funding and full protection to the exposure risks of the market in the short term. The contracts have duration of 20 years and involve selected projects that should come into operation until December 2006. Projects from small hydroelectric plants are one of the types of projects eligible to participate in PROINFA.

SHP Santa Carolina does not participate in PROINFA and, this way, considers the revenue from the sale of CERs as an important factor to realize the investment. The existence of this kind of program proves that an economic incentive is important to motivate small hydro plants. Without this kind of program, thermal plants and big hydro plants tends to maintain its predominance, providing more emission of greenhouse gases. .

As a consequence of this fact, the organization has to deal with the difficulties inherent to the small agents of the Brazilian electrical sector as: (i) small power of attraction for potential buyers, before the small amount of electricity being produced and marketed, (ii) excess of collateral requirements by banks for financing to undertake the long-term financial liquidity of the company, (iii) the bureaucracy inherent in the process of building a small hydroelectric central, since its beginning until its effective entry into operation.

Moreover, the percentage related to the installed capacity of enterprises similar to Santa Carolina Project in the Rio Grande do Sul state's energy matrix is very small, as table below:

Table 10: Generation Capacity of the Rio Grande do Sul state[29]

Enterprises into Operation		
Type	**Power (kW)**	**%**
CGH	20,317	0.29
EOL	150,000	2.11
SHP	287,551	4.04
HPP	4,977,270	69.88
UTE	1,687,839	23.70
TOTAL	**7,122,977**	**100**

In this way, through the data and information presented, it is perceived that the establishment of small hydroelectric plants is not a prevailing practice in the country and that this kind of enterprise faces barriers (as small power of attraction for potential buyers, thus to the small amount of electricity being produced and marketed, (ii) excess of collateral requirements by banks for financing, etc) commonly surpassed by Governmental Program and Projects.

[29] Electricity Generation Database. Available at: http://www.aneel.gov.br/aplicacoes/ResumoEstadual/CapacidadeEstado.asp?cmbEstados=RS:RIO%20GRANDE%20DO%20SUL.. Accessed in 22th September 2009.

The continuity of the current situation, with electricity being generated by the current composition of generation of the National Interconnected System is not affected by the prevailing practice due to fact that the thermal and hydro plants in operation counted on with the conditions described that does not exist anymore (PROINFA, Less Environmental demands, etc). It is important to highlight that the dispatch order for Brazilian Interconnected System is: hydroelectric power plants, wind, nuclear, imports from other systems in ascending order of cost, thermoelectric power plants in ascending order of generation cost. With the economic growth that requires more electricity, if new renewable plants are not constructed, generation will be supplied by thermal plants that are in operation or that will be constructed as described in the MME Projection presented before.

Furthermore, the fact that PROINFA does not exist anymore does not have any influence in the scenario of new thermal power plant once the Program was focused on renewable energy.

The non-implementation of SHP Santa Carolina would promote (i) the continuity of the current situation, with electricity being generated by the current generation of composition of National Interconnected System, specifically the South Subsystem (with great presence of coal-fired and oil-fired plants) or (ii) the construction of new thermoelectric power plants.

Thus, the implementation of the Santa Carolina Project provides emission reductions, which would not occur in the absence of the Project.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

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According to the methodology AMS-I.D, version 18.0, there is no leakage at Santa Carolina Project. The project does not either provide emission because the power density is higher than 10 W/m^2. Therefore, the emission reductions are calculated through the baseline emissions.

<u>Baseline emissions</u>

$$BEy = EG_{PJ,y} * EF_{grid,y}$$ **Equation 01**

Where:

BEy **=** Baseline Emission in year y (t CO_2e);
$EG_{PJ,y}$ = Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year *y* (MWh)
$EF_{grid,y}$ = Combined margin CO_2 emission factor for grid connected power generation in year *y* calculated using the latest version of the “Tool to calculate the emission factor for an electricity system” (t CO_2/MWh)

SHP Santa Carolina is a Greenfield Power Plant. Therefore, as indicated by AMS-I.D, version 18.0, if the project activity is the installation of a greenfield power plant, then:

$$EG_{PJ,y} = EG_{PJ,facility,y}$$ **Equation 03**

Where:

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

The $EG_{PJ,facility,y}$ is continuously monitored by the project participants and corresponds to its main product: the electricity generation. The medium energy of SHP Santa Carolina minus 3% projected

for transmission losses and internal consumption was considered for the *ex-ante* estimation of the project baseline emissions.

The emission factor shall be calculated in a transparent and conservative manner as follows:

(a) A combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the “Tool to calculate the emission factor for an electricity system”; or

(b) The weighted average emissions (in t CO_2/MWh) of the current generation mix. The data of the year in which project generation occurs must be used.

This project activity will used during the second crediting period option “(a)”: A combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the “Tool to calculate the emission factor for an electricity system”.

To calculate $EF_{grid,y}$, it will be used data supplied by the Brazilian DNA. The Combined Margin (CM) emission factor is calculated based on data 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) calculates the BM and OM emission factors of the SIN according to the “TOOL07: Tool to calculate the emission factor for an electricity system” and makes them available to the public.

The following steps of the TOOL07: “Tool to calculate the emission factor for an electricity system” (Version 7.0)” were applied:

Step 1. Identify the relevant electric power system

According to the “TOOL07: Tool to calculate the emission factor for an electricity system”, version 07.0, project participants may delineate the project electricity system using any of the following options:

(a) Option 1. A delineation of the project electricity system and connected electricity systems published by the DNA or the group of the DNAs of the host country(ies), In case a delineation is provided by a group of DNAs, the same delineation should be used by all the project participants applying the tool in these countries;

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

(c) Option 3. A delineation of the project electricity system defined by more than one independent dispatch areas, e.g. multi-national power pools.

Option 1 is chosen. 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 DNA 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 CO_2 emission factors.

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

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 Operation 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.

The Brazilian DNA publishes[30] the emission factor calculation based on Option (i) above.

The option chosen by project participants was Option 1

Step 3. Select an operating margin (OM) method

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

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

The method chosen to calculate Operation Margin emission factor is the dispatch data analysis operation margin method.

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

The method chosen for operation margin emission factor calculation is the dispatch data analysis calculated on an ***ex-post*** basis.

As previously stated, the Operating Margin (OM) emission factor ($EF_{grid,OM-DD,y}$) calculation based on the dispatch data analysis method is currently conducted by the Brazilian DNA, in accordance with the dispatch data provided by the National Interconnected Power System 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 2019 will be used for an ***ex-ante*** estimation of CERs for the second crediting period.

<u>Step 5: Calculate the build margin emission factor</u>

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 CDM-PDD 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

[30] Source: http://antigo.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/emissao_despacho.html

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

Option 2 was chosen by project participants.

The build margin emission factor is calculated by the Brazilian DNA[31]. Data from 2019 will be used for the Build Margin emission factor, which is calculated and published by the Brazilian DNA. The 2019 data vintage was adopted for the build margin calculation as these are the latest data made publicly available by the Brazilian DNA.

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.

Santa Carolina Project used option (a) to calculate the combined margin emission factor.

The combined margin emission factor is calculated according to the following equation:

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

Equation 04

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

According to *Tool to calculate the emission factor for an electricity system*", version 07.0, the following default values should be used for W_{OM} and W_{BM}: (a) Wind and solar power generation project activities: W_{OM} = 0.75 and W_{BM} = 0.25 (owing to their intermittent and non-dispatchable nature) for the first crediting period and for subsequent crediting periods; (b) 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.

Therefore, the following values will be used during the second crediting period: **W_{OM} = 0.25 and W_{BM} = 0.75.**

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[31] For more information: http://antigo.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/emissao_despacho.html

<u>PE_y Calculation (project emissions in year y (tCO_2e/yr))</u>

According to ACM0002 methodology, version 20.0, 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 as project emissions by using the following equation:

$$PE_y = PE_{FF,y} + PE_{GP,y} + PE_{HP,y}$$ **Equation 05**

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

For Santa Carolina Project $PE_{FF,y}$ and $PE_{GP,y}$ are zero.

For hydro power project activities that result in new reservoirs and hydro power project activities that result in the increase of existing reservoirs, project proponents shall account for CH_4 and CO_2 emissions from the reservoir. The methodology establishes that if the power density of the project activity is greater than 10 W/m^2, $PE_{HP,y} = 0$. The power density of the plant was calculated as follows:

$$PD = \frac{Cap_{PJ} - Cap_{BL}}{A_{PJ} - A_{BL}}$$ **Equation 06**

Where:

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

Cap_{PJ} is 10,560,000 W and the reservoir area is 93,000 m^2. Therefore, the power density is 113.54 W/m^2.

Therefore $PE_{HP,y} = 0$ and the project does not generate any associated project emissions ($PE_y = 0$).

<u>Emissions Reductions</u>

According to AMS-I.D, version 18.0, project emissions reductions are calculated in accordance with the following equation:

$$ER_y = BEy - PEy - LEy$$ **Equation 07**

Where,

ER_y = Emission reductions in year y (t CO_2/y)
BE_y = Baseline Emissions in year y (t CO_2/y)
PE_y = Project emissions in year y (t CO_2/y)

LE_y = Leakage emissions in year y (t CO_2/y)

As demonstrated, this project will not provide any emissions neither leakage, therefore PE_y and LE_y are zero. With that, $ER_y = BE_y$.,

In summary, the emission reduction of the project during the second crediting period will be calculated based on the equation 2 of this PDD, where the 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* will be multiplied by the combined margin emission factor calculated according to dispatch data analysis. OM emission factor will be *ex-post* calculated and BM Emission Factor is ex ante defined: 0.1020 tCO_2/MWh*. To* calculate the combined margin emission factor the following weights will be used during the second crediting period: W_{OM} = 0.25 and W_{BM} = 0.75.

B.6.2. Data and parameters fixed ex ante

Data/Parameter	**Installed Capacity before the implementation (** Cap_{BL} **)**
Data unit	MW
Description	Installed Capacity of the hydro power plant before the implementation of the project activity. For new hydro power plants, this value is zero.
Source of data	The Previous License of the enterprise shows that SHP Santa Carolina is a new plant, which means that it has no capacity installed before implementation.
Value(s) applied	As SHP Santa Carolina is a new plant, the value is zero.
Choice of data or measurement methods and procedures	For new reservoirs, this value is zero.
Purpose of data	To calculate project emissions.
Additional comment	-

Data/Parameter	**Reservoir area before the implementation (** 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	The previous license, because the SHP Santa Carolina is a new plant and it does not have a reservoir before implementation.
Value(s) applied	As SHP Santa Carolina will create a new reservoir, the value is zero.
Choice of data or measurement methods and procedures	For new reservoirs, this value is zero.
Purpose of data	To calculate project emissions.
Additional comment	-

Data/Parameter	**Build margin emission factor (** $EF_{grid,BM\ y}$ **)**
Data unit	tCO_2/ MWh
Description	Build margin CO_2 emission factor in year *y*
Source of data	Brazilian DNA
Value(s) applied	0.1020
Choice of data or measurement methods and procedures	2019 data is the latest data published by Brazilian DNA.
Purpose of data	Baseline Emissions Calculations
Additional comment	-

B.6.3. Ex ante calculation of emission reductions

It follows below the description about emissions reduction provided by Santa Carolina Project.

According to AMS I.D, project emissions reductions are calculated in accordance with the following equation:

$ER_y = BE_y - PE_y - LE_y$ **Equation 07**

Where,

ER_y = Emission reductions in year y (t CO_2/y)
BE_y = Baseline Emissions in year y (t CO_2/y)
PE_y = Project emissions in year y (t CO_2/y)
LE_y = Leakage emissions in year y (t CO_2/y)

As this project does not provide emissions neither leakage, PE_y and LE_y are zero. Therefore, ER_y=BE_y.,

BEy Calculation

For BE_y calculation it was applied the equation as follows:

$\mathbf{BE_y = EG_{PJ,y} * EF_{grid,y}}$ **Equation 01**

As the project is a greenfield power plant, $\mathbf{EG_{PJ,y} = EG_{PJ,facility,y}}$

Tables below shows step by step the components of equation applied for BE_y Calculation.

$EG_{PJ,facility,y}$ Calculation

Table 11: $EG_{PJ,facility,y}$ Calculation

Year	SHP Santa Carolina
	$EG_{PJ,facility,y}$
2020	29,060
2021	43,590
2022	43,590
2023	43,590
2024	43,590
2025	43,590
2026	43,590
2027	14,530
Total	**305,130**

Assumptions:

- $EG_{PJ,facility,y}$ projection was assuming power plant operation during 8,760 hours per year;
- The second crediting period is from 01 May 2020 to 30 April 2027.
- The electricity generation of Santa Carolina Project is projected according to its medium electricity, minus the estimated percentage with transmission losses and internal consumption (3%), resulting 4.9761 MWh.

As presented in the item B.6.1, the $\mathbf{EF_{grid,y}}$ is calculated as equation 02 below.

$EF_{CO2,grid,y} = EF_{grid,CM,y} = EF_{grid,OM,y} * w_{OM} + EF_{grid,BM,y} * w_{BM}$ **Equation 04**

The values used for ex-ante estimation are presented in the following table:

Table 12: $EF_{CO2, Grid}$ Calculation

Emission Factor	2019
$EF_{grid,OM}$ (tCO_2/MWh)	0.51809
$EF_{grid,BM}$ (tCO_2/MWh)	0.1020
W_{OM}	0.25
W_{BM}	0.75
$EF_{grid,CM}$ (tCO_2/MWh)	**0.2060**

Notes:

- The hourly, daily and monthly data for operation margin emission factor is available at: http://antigo.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/emissao_despacho.html
- Annual $EF_{grid,OM,y}$ used for emission reductions projections was calculated through the simple arithmetic average of the monthly $EF_{grid,OM,y}$ published by Brazilian DNA

The emission factor which will be used for *ex-ante* estimation of emission reduction of Santa Carolina Project is 0.2060, which was obtained from data of the National Interconnected System supplied by Brazilian DNA.

According to the methodology AMS-I.D, version 18.0, there is no leakage at Santa Carolina Project. And as mentioned at section B.6.1, for Santa Carolina SHP, Cap_{PJ} is 10,560,000 W and the reservoir area is 93,000 m^2, therefore, the power density is 113.54 W/m^2 higher than 10 W/m^2. Thus, $PE_{HP,y} = 0$. According to the methodology, $PE_{FF,y}$ and $PE_{GP,y}$ are zero. Therefore, $PE_y = 0$.

The ***ex-ante*** Emission Reductions estimation is presented in the table below:

Table 13: E*x-ante* estimation of Santa Carolina Project Emission Reductions (tCO_2 e)

Year	SHP Santa Carolina (t CO2 e)
2020	5,987
2021	8,980
2022	8,980
2023	8,980
2024	8,980
2025	8,980
2026	8,980
2027	2,993
Total	**62,860**

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

Year	Baseline emissions ($t\ CO_2e$)	Project emissions ($t\ CO_2e$)	Leakage ($t\ CO_2e$)	Emission reductions ($t\ CO_2e$)
2020	5,987	0	0	5,987
2021	8,980	0	0	8,980
2022	8,980	0	0	8,980
2023	8,980	0	0	8,980
2024	8,980	0	0	8,980
2025	8,980	0	0	8,980
2026	8,980	0	0	8,980
2027	2,993	0	0	2,993
Total	**62,860**	0	0	**62,860**
Total number of crediting years	7 years			
Annual average over the crediting period	**8,980**	**0**	**0**	**8,980**

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Based on the methodology AMS - ID, this section presents parameters to be monitored by project participants.

Electricity measurement is essential to monitor and verify the GHGs emission reduction. It is necessary, then, the use of measurement equipment to record and verify the energy generated by the unit.

All data collected as part of the monitoring will be archived electronically and kept for at least two (2) years after the last crediting period. All measurements are conducted with calibrated measurement equipment according to Brazilian industry standards. The following data and parameters will be monitored:

Data/Parameter	$EG_{PJ,facility,y}$
Data unit	MWh
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y*
Source of data	Electricity Meters
Value(s) applied	For *ex-ante* emission reductions, Project Participants used a yearly value of 43,590 MWh.

Measurement methods and procedures	This parameter will be monitored using bi-directional energy meter. It will be used spreadsheets obtained monthly directly from the meter. The information will be confronted with reports provided by CCEE - Electric Energy Commercialization Chamber[32].
Monitoring frequency	Continuous monitoring, hourly measurement and at least monthly recording
QA/QC procedures	The level of uncertainty of these data is low. They will be used to calculate emission reductions. The generated electricity will be monitored continuously by the project participants.
Purpose of data	Baseline emissions calculation
Additional comment	-

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
Value(s) applied	10,560,000
Measurement methods and procedures	Value is based on manufacturer’s specifications or commissioning data or recognized standards
Monitoring frequency	Once at the beginning of each crediting period
QA/QC procedures	The level of uncertainty of these data is low. Information is based on manufacturer’s specifications or commissioning data or recognized standards.
Purpose of data	Baseline emissions calculation
Additional comment	-

Data/Parameter	$\mathbf{A_{PJ}}$
Data unit	m^2
Description	Area of the reservoir measured in the surface of the water, after the implementation of the project activity, when the reservoir is full.
Source of data	Licenses can be used to prove the value adopted by the Project.
Value(s) applied	93,000
Measurement methods and procedures	Measured from topographical surveys, maps, satellite pictures, etc. The flooded area of the reservoir is monitored by the local environmental agency in the licensing process and it can be proved by licenses of the project.
Monitoring frequency	Once at the beginning of each crediting period
QA/QC procedures	The level of uncertainty of these data is low. The reservoir area is measured by environmental regulator entity during the license process.
Purpose of data	Project emission calculations
Additional comment	-

[32] Entity responsible for power purchase agreements settlement in Brazil.

Data/Parameter	$EF_{grid,OM-DD,y}$
Data unit	tCO2/MWh
Description	Dispatch data analysis operating margin CO2 emission factor in year *y*
Source of data	Calculated applying equation of the most recent version of the "Tool to calculate the emission factor for an electricity system" and using hourly data supplied by Brazilian DNA.
Value(s) applied	0.51809
Measurement methods and procedures	As described in the most recent version of the "Tool to calculate the emission factor for an electricity system".
Monitoring frequency	Annual
QA/QC procedures	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 once is based on data supplied by Brazilian DNA.
Purpose of data	Baseline emissions calculation
Additional comment	-

Data/Parameter	**$EF_{grid,y}$**
Data unit	tCO_2e/kWh
Description	CO_2 emission factor of the grid electricity in year y
Source of data	*Ex-post* emission factor will be calculated by project participants through ONS data supplied by Brazilian DNA. OM necessary for $EF_{Grid,y}$ calculation will also be monitored and calculated through the Dispatch Data of the National Interconnected System.
Value(s) applied	The values of ($EF_{grid,CM,y}$) Combined Margin CO_2 Emission Factor which were used for *ex-ante* estimation of emission reduction of Santa Carolina Project is 0.2060 which was obtained from data of the National Interconnected System supplied by Brazilian DNA as described in the item B.6.3.
Measurement methods and procedures	As described in the most recent version of the "Tool to calculate the emission factor for an electricity system".
Monitoring frequency	Annual
QA/QC procedures	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	Baseline emissions calculation
Additional comment	-

B.7.2. Sampling plan

>>

Not applicable.

B.7.3. Other elements of monitoring plan

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Carolina Geração de Energia Ltda team is responsible for the operation and maintenance of SHP Santa Carolina. It is responsible for consolidation and analysis of electricity generation data.

The quantity of net electricity supplied to the grid in year y is measured by two meters: one principal and one rear, located in the plant substation.

The calibration of the energy meters follows the rules established by the National System Operator (ONS). ONS Sub module 12.3 - Maintenance of the measurement system for billing (called ONS Sub Module 12.3) establishes that **meters calibration should happen each 5 (five) years**.

If during any monitoring period, ONS – Sub module 12.3 changes the periodicity or meters calibration, the project shall follow this rule because this is the official requirement of Brazilian National System.

Below, it is presented below the description of how it the Measurement System is structured, and the responsibilities of those agents involved in the process.

It is presented below some information about how the Measurement System is structured and the responsibilities of those agents involved in the process.

- **Measurement System**

As the Commercialization Convention approved by ANEEL Resolution No 109 of 26 October 2004 determines, CCEE is responsible for the specification, guidance and determination of the issues concerning the adequacy of measurement systems billing (SMF), and the deployment, operation and maintenance of SCDE - Data Collection System for Energy, in order to facilitate electricity data collection for use in the Accounting and Settlement System - SCL, to ensure data accuracy.

Data Collection System for Energy - SCDE

The SCDE is the system responsible for daily electricity data collection and measurement. The acquisition of these data is carried out automatically, directly from the meter or through the agent database (UCM). This system allows the execution of logical checks with direct access to the meters and providing greater reliability and accuracy of data obtained.

The SCDE allows the daily monitoring of the information sent. CCEE directly reads the meters, either by normal collection, either by logical inspection of the Collection Service Unit - UCM.

The collected data are processed in SCDE for electricity accounting by CCEE. Data is sent to ONS and is turned available for all market players for control of their own billings.

- **Responsibility of the SHP Santa Carolina Team**

SHP Santa Carolina team has the responsibility to maintain SCDE in operation and available for CCEE daily collection and inspection.

- **Data Consolidation at CCEE:**

CCEE consolidates data from electricity generation of the previous month. If there is any inconsistency or error in the collected data, it generates an e-mail, informing the agent about the missing or inconsistent data and asks the agent team adjustment of these data in SCL - Accounting and Settlement System.

In case of reading unavailability of any measurement point, due to maintenance, commissioning or any other reason, electricity data will be estimated as item 14.3 of the Commercialization Procedure PDC ME.01. (Source: www.ccee.org.br).

- **Data Consolidation at SHP Santa Carolina:**

SHP Santa Carolina team monthly collects, in the energy meters, data of quantity of net electricity supplied to the grid of the previous month. Monthly data is consolidated in a spreadsheet that is the internal spreadsheet for electricity generation control.

- **Comparison of information from internal generation reports with a third party**

The information obtained from the meters by SHP Santa Carolina team is confronted to CCEE reports, available at CCEE website for Energy agents. Conservatively, the lowest values of each month found will be used for emission reduction calculation.

- **Information Storage**

The generation of information, both internal and the CCEE's are stored by SHP Santa Carolina team. All data collected as part of the monitoring is archived and maintained for at least two years after the last crediting period.

- **Training of the Operation and Maintenance Team:**

All operators of the SHP are trained to ensure the quality, safety and reliability in the operation of the plant.

- **Emission Reductions Calculation**

Emission reductions calculation is carried out by consulting company.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

01/02/2012

C.2. Expected operational lifetime of project activity

30 years and 0 months.

C.3. Crediting period of project activity

C.3.1. Type of crediting period

The project activity uses renewable crediting period.

C.3.2. Start date of crediting period

01/05/2020

C.3.3. Duration of crediting period

7 years and 0 months.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

The Brazilian legislation requires the development of an environmental licensing process for enterprises that involve polluting or potentially polluting activities. In the State of Rio Grande do Sul, the State Environmental Protection Foundation Henrique Luiz Roessler (FEPAM) is legally responsible for the licensing process, which begins with the environmental impact assessment conducted by the entrepreneur and follows with the prior analysis (preliminary studies) undertaken by the local environmental agency.

In the state of Rio Grande do Sul, the electricity sector entrepreneurs are required to develop an Environmental Impact Assessment (EIA) for enterprises that have installed capacity greater than 10 MW. If the enterprise has installed capacity below 10 MW, the environmental impact assessment could be simplified, and called Simplified Analysis Report (RAS). After the enterprise feasibility is validated, the process must go through three stages before obtaining all permits necessary for its operation.

In the first phase, consultation to federal and state environmental legislation is required to verify the environmental viability of the enterprise and to impose the legal conditions. If the FEPAM have a good understanding of the concepts of environmental concepts, the Previous License (LP) is issued.

After the LP is obtained, it shall be submitted the physical and operational project of the enterprise, if necessary, demonstrating how will be attended the restrictions imposed by the LP. In order to obtain the environmental Installation Permit (LI) is necessary to present: (a) information about the previous environmental assessment (b) a new simplified evaluation (RDPA – Detailed Report of the Environmental Programs), or (c) the Basic Environmental Project (PBA), as resolution of the environmental agency’s decisions, reported on LP.

If all Project requirements expressed in the LP were satisfied, the enterprise obtains the approval to start the project development through the Environmental Installation License (LI) issue.

The third and last stage of the environmental process provides the authorization for the operational start of the enterprise with the dispatch of Environmental Operating License (LO). The LO issue is the confirmation that the enterprise construction was run according to the submitted project and is licensed, with the service conditions and environmental restrictions.

By the time of the PDD development, the SHP's Santa Carolina Previous License was issued, according to data below. Licenses and environmental studies will be delivered to the DOE that perform the project validation.

The latest license issued for the project was Operation License 7921/2015 DL. In November/2019, project owners required renewal of this license once this operation license expired at 23 november 2019. This process was not analyzed by the time this PDD was completed. According to Brazilian Law (CONAMA Resolution 237/1997), "*The license expire day is automatically extended until de final analysis of the responsible environmental agency*".

D.2. Environmental impact assessment

The SHP Santa Carolina has a small, flooded area and it did not significantly alter the environment. Thus, according to the EIA, the enterprise presents a low environmental impact. The project has quite high indicators of efficiency, related to the environmental perspective of enterprise. The power density, which measure the ratio between the amount of generated electricity and flooded area of the project, is equal to 114.03 MW / km², attesting to the high environmental efficiency of the project. Other evidence about the low impacts caused by the enterprise is that no family will be relocated for the construction of SHP Santa Carolina, producing low social impacts and facilitating the process of land acquisition.

Notwithstanding, there are initially planned activities and programs for monitoring, control and repair of possible negative and positive impacts.

Aiming to identify the possible environmental impacts caused by the SHP the study called Environmental Impact Assessment was realized. At this study, all environmental impacts produced, in the physic, biotic and anthropic perspectives was described and explained. There were also some social and environmental projects developed with the objective of mitigating the impact generated by the enterprise, though small.

At this section, there is a description of some programs to be developed in the Santa Carolina Project implementation:

The **Program for Limnologic Monitoring and Water Quality** has its focus in maintaining the biological integrity of aquatic communities and ensuring the multiple uses of the river Turvo, during and after the implementation of SHP Santa Carolina. The monitoring of water quality begins in the pre-filling of the reservoir assessing all phases of the construction works and continues in the post-filling. After each step, there will be an analysis of results for a program adaptation.

The **Implementation Program of the Conservation Plan and Use of the Reservoir Surroundings** seeks to reconcile the use reservoir and the surrounding areas with environmental and heritage preservation of them, seeking the ideal conditions for generation, conservation, and security of local people.

The **Recovery Program of Degraded Areas** provides restoration of all areas affected by the works of SHP's Santa Carolina implementation: work area, accommodation, road services, quarries, lending areas, sand, and other going-outside, seeking conservation of soil and water sources, avoiding the occurrence of erosion processes and siltation. This program also promotes the reintegration of these landscape areas (natural revegetation or return to the production process) and the creation of new habitats for wildlife.

The **Social Communication Program** seeks to inform all those involved in the enterprise, directly and indirectly, on the work development and its compensative programs, prioritizing to disseminate the proceedings caused by their implementation and operation, contributing to the adaptation of the affected areas' population. Together with **Environmental Education Program** aim to give knowledge to communities, in an integrated manner, about the concepts related to the environment and assist in the attitudes development that trigger improvements to the environment and life quality. Other issues to be addressed, relating to environmental education, are related to the exploitation of natural resources that surround the local communities, bearing in mind the

understanding to adopt procedures regarding the preservation of the environment in which they live.

The **Program of Environmental Action Management** aims to organize, systematize, integrate, synchronize, and manage all activities related to the environment, throughout the implementation and operation of the SHP Santa Carolina.

In the social scope, positive impacts can be noted, as the increase in job demand, especially for low-qualified labour, present in the region, boosting the local growth due to a scenario of lack investment choices. Changes also occurred in the local goods and public services market and in the regional income and municipal tax revenues. There were changess in the local community, once the reservoirs provide new recreational opportunities like fishing, camping and the use of space as a balneary site, which can lead to a tourism exploration of the region.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

This section was copied from registered PDD used for the first crediting period.

Referring to resolutions published by the Brazilian Designated National Authority and consolidated in the Manual for Submission of Project Activities under the CDM, developed by the Brazilian Designated National Authority, local actors should be invited to perform comments on CDM project activities.

Thus, the following local stakeholders were invited, through letters:

City of André da Rocha:

- André da Rocha City Hall
- Municipal Assembly of André da Rocha
- Municipal Secretariat of Agriculture and Environment
- Rural Workers' Union of André da Rocha
- Rural Union of André da Rocha

City of Muitos Capões:

- Muitos Capões City Hall
- Municipal Assembly of Muitos Capões
- Municipal Secretariat of Industry, Commerce, Tourism and Environment
- Rural Workers' Union of Muitos Capões

Other Stakeholders:

- State Environmental Agency (FEPAM)
- Brazilian NGO Forum (FBOMS)
- State Federal Attorney of Public Interest
- Federal Attorney of Public Interest

E.2. Summary of comments received

The project did not receive any comment from local stakeholders.

E.3. Consideration of comments received

It is not applicable because the project did not receive any comment.

SECTION F. Approval and authorization

Party involved in the project activity is Brazil. Letter of approval is available at: https://cdm.unfccc.int/Projects/DB/BVQI1334253365.85/view

Appendix 1. Contact information of project participants

Organization name	Multilagos Geração de Energia Ltda
Country	Brazil
Address	Cristóvão Colombo Avenue, 2360
Telephone	55 51 3276-6043
Fax	55 51 3276-6046
E-mail	leao@multilagos.com.br
Website	
Contact person	Luiz Antônio Leão

Organization name	Carolina Geração de Energia Ltda
Country	Brazil
Address	Rodovia Presidente Kennedy, BR 386, Km 35
Telephone	55 55 3744 4687
Fax	55 55 3744 4687
E-mail	juridico@creral.com.br
Website	
Contact person	Joao Alderi do Prado

Organization name	Enerbio Consultoria Ltda-ME
Country	Brazil
Address	Antônio Carlos Berta Street, 475, 1904
Telephone	55 51 3392-1500
Fax	55 513392-1504
E-mail	eduardo@enerbio-rs.com.br
Website	www.grupoenerbio.com.br
Contact person	Eduardo Baltar

Appendix 2. Affirmation regarding public funding

No public funding coming from Annex I countries was used in this project

Appendix 3. Applicability of methodologies and standardized baselines

Not applicable. This section is intentionally left blank.

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

The monthly values[33] of the Operating Margin Grid Emission Factor ($EF_{grid,OM,y}$) used for emission reductions ex-***ante*** estimation of Santa Carolina CDM Project are available below. All data is provided by the Brazilian DNA.

Annex Table 01 –Monthly Operating Margin Emission Factors of 2019 - Brazilian Interconnected Grid System

OPERATING MARGIN												
Average emission factor (tCO2/MWh) - MONTHLY												
2019	Month											
	January	February	March	April	May	June	July	August	September	October	November	December
	0,3540	0,5573	0,5075	0,5095	0,4794	0,4175	0,5914	0,5312	0,5606	0,5370	0,5720	0,5997

Appendix 5. Further background information on monitoring plan

All monitoring information is provided on item B.7 of the PDD.

Appendix 6. Summary report of comments received from local stakeholders

Not applicable. This section is intentionally left blank.

Appendix 7. Summary of post-registration changes

There are changes to the project design of the project activity that were approved by the Board on 15 October 2020 (PRC-6042-001). The post-registration changes approved were[34]:

1. Changes in the installed capacity of the project activity: Turbine and Generator implemented in the project produces a nominal installed capacity of 10.56 MW which it is 0.06 MW (0.57%) higher than originally predicted in PDD registered (10.5 MW). This fact impacted power density result which was also updated. Because of this change, the following updates were done:
   - Changes in Medium Electricity of the project: The Medium Electricity approved by Ministry of Mines and Energy through Decree 29 issued at 15/05/2012 is 5.13 MW_{medium}. PDD registered considered 5.46 MW_{medium}. Despite the slight increase in the installed capacity, the amount of electricity allowed to be sold under power purchase agreements (Medium Energy) is 6% lower than expected in the registered PDD.

[33] Available at: http://antigo.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/emissao_despacho.html.

[34] https://cdm.unfccc.int/Projects/DB/BVQI1334253365.85/history

- Considering changes mentioned at item 2, ex ante calculation of emission reduction was updated considering new Medium Electricity, assuming a conservative emission reduction projection.
- Considering changes mentioned at items 1 and 2 above, financial analysis of item B.5 was updated. Despite, the Medium Electricity approved by Brazilian regulator is lower than projected at PDD registered, Project Participants (PPs) adopted a conservative approach to show that these changes did not affect additionality analysis. Instead reducing the official approved Medium Electricity at financial analysis, which would reduce the revenues, PPs increased over the original Medium Electricity (5.46 MW_{medium}) used at the PDD registered, the growth percentage in the installed capacity (0.57%). Sensitivity analysis was also updated and results showed that changes in the additionality analysis are minimal and the project remains additional.

In the post-registration changes approved on 15 October 2020[35] (PRC-6042-001), there was a typographic error at the value applied for the parameter A_{pj} in section B.7.1. Value was corrected (comma instead point).

There was no: (i) temporary deviations from the registered monitoring plan, applied methodologies, standardized baselines or other methodological regulatory documents; (ii) Changes to the start date of the crediting period; (iii) Inclusion of monitoring plan; (iv) permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents.

Document information

Version	*Date*	*Description*
11.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Make editorial improvements.
10.1	28 June 2017	Revision to make editorial improvement.
10.0	7 June 2017	Revision to: • Improve consistency with the “CDM project standard for project activities” and with the PoA-DD and CPA-DD forms; • Make editorial improvement.
09.0	24 May 2017	Revision to: • Ensure consistency with the “CDM project standard for project activities” (CDM-EB93-A04-STAN) (version 01.0); • Incorporate the “Project design document form for small-scale CDM project activities” (CDM-SSC-PDD-FORM); • Make editorial improvement.
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the “Standard: Applicability of sectoral scopes” (CDM-EB88-A04-STAN) (version 01.0).

[35] https://cdm.unfccc.int/Projects/DB/BVQI1334253365.85/history

Version	*Date*	*Description*
06.0	9 March 2015	Revision to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Make editorial improvement.
05.0	25 June 2014	Revision to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from F-CDM-PDD to CDM-PDD-FORM; • Make editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	13 March 2012	Revision required to ensure consistency with the “Guidelines for completing the project design document form for CDM project activities” (EB 66, Annex 8).
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

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