Project design document form

(Version 11.0)

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

BASIC INFORMATION	
Title of the project activity	SHPs Albano Machado and Rio dos Índios CDM Project (JUN1115)
Scale of the project activity	☐ Large-scale ☒ Small-scale
Version number of the PDD	2.1
Completion date of the PDD	20/11/2020
Project participants	Rio do Lobo Energia Ltda Casa de Pedra Energia S.A. Carbotrader Assessoria e Consultoria em Energia EIRELI
Host Party	Brazil
Applied methodologies and standardized baselines	Methodology: AMS-I.D "Grid connected renewable electricity generation" - version 18.0
Sectoral scopes	Sectoral scope: 1 - Energy industries (renewable - / non-renewable sources)
Estimated amount of annual average GHG emission reductions	12,474 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

The project activity consists in the construction of the renewable energy generation Albano Machado (3.06 MW installed power) and Rio dos Índios (8.10 MW installed power) Small Hydro Power plants (SHP`s) located in Trindade do Sul and Nonoai cities in Rio Grande do Sul State, Brazil. Based on this the SHP's together has installed capacity below 15 MW (as per Type I, small-scale, AMS-I.D methodology).
There are forecasted annual average emission reductions of 12,474 tCO2e and a total of 87,316 tCO2e during the total crediting period (7 years). Since the baseline scenario is to remain electricity supply coming from Brazilian Interconnected Grid.
The purpose of the project activity is to provide electricity energy from renewable source to the Brazilian National Interconnected System (from the portuguese "*Sistema Interconectado Nacional – SIN*"), offsetting the fossil fuelled thermal generation and helping to attend the rising energy demand in Brazil.

The Albano Machado and Rio dos Índios plants were interconnected with the national interconnected grid system (SIN) and supplies energy to this electric system.

The project boundary is the area where the project is located which includes the reservoirs, dams, powerhouses included the turbines, generators, substations, metering systems and the National Interconnected Grid.

The project activity reduces emissions of greenhouse gases (GHG) and the global warming, avoiding the use of fossil fuel that would be burned in thermoelectric generating units interconnected to the grid. This initiative helps Brazil to meet its goals of promoting sustainable development.

For project participants the project activity is a sustainable alternative for electricity generation because considering that the projects consists of Small Hydropower Plants with small reservoirs, they have low environmental impacts, almost zero, even compared to large hydroelectric plants.

Also the project activity contributes to the sustainable development, because:

- It reduces the fossil fuel (non-renewable source) use. Thus the project contributes to the natural resources better utilization and makes use of clean and efficient technologies;
- It contributes to better working conditions and increases employment opportunities in the area where the project is located (rural areas in small cities);
- It contributes to the better conditions for the local economy, mainly in the rural areas from the cities involved.

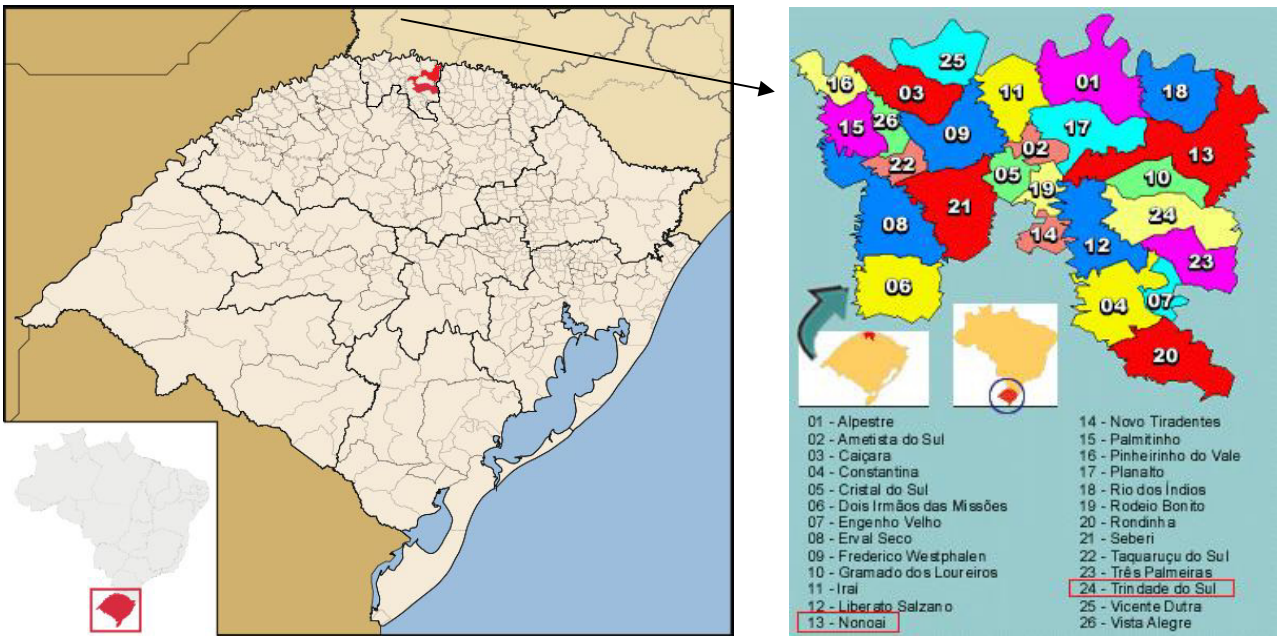
A.2. Location of project activity

The SHP Albano Machado is located at the Lajeado do Lobo river, coordinates 27º 29'48'' S and 52º 48' 13'' W (Dam), between Trindade do Sul and Nonoai cities, Rio Grande do Sul State, south region, Brazil.

The SHP Rio dos Índios is located at the Rio dos Índios river, coordinates 27°16'30"S and 52°47'38"W[1], in Nonoai city, Rio Grande do Sul State, south region of Brazil.

[1] Geographical coordinates adjusted in relation to PDD already registered (from 50°47'38" W to 52°47'38" W) it was a typographical error.

Figure 1: Trindade do Sul and Nonoai cities



Sources: Wikipedia - pt.wikipedia.org and City Brazil - www.citybrazil.com.br
More details on Section A.1. above.

A.3. Technologies/measures

The project activity consists in the use of water directly from the river to generate electricity. The potential gravitational energy of the water is used to move the turbines, and doing so, it generates electricity. It is a source of clean and renewable energy, which presents minimal impact on the environment.
The technology and equipment utilized in project activity was developed and manufactured in Brazil.

The Albano Machado and Rio dos Índios plants were interconnected with the national interconnected grid system (SIN) and supplies energy to this electric system.
The Small Hydropower Plants (SHPs) are enterprises classified as Small Hydropower Plants because according to Resolution #652 of 09/12/2003, from National Electric Energy Agency (ANEEL), to be considered a small hydroelectric central, the water reservoir area must be less than 3 km^2 (300 ha) and the generation capacity must be btween 1 MW to 30 MW. These enterprises are also called "**run of river**" plants, which does not include significant water "stocks".

The SHPs characteristics are specified below:

Table 1: Main data from the SHPs

SHP	Albano Machado	Rio dos Índios
Installed Power Capacity (MW)	3.06	8.10
Reservoir Area (Km^2)	0.0893	0.2412
Power Density (W/m^2)	34.26	33.58
Energy Assured (MWaverage)	1.66	4.336
Operation Start	11/02/2011[2]	04/05/2013[3]
Turbines Type	Francis	Francis
Turbines Quantity	2	2
Unit Nominal Power (kW)	1,566	4,125
Flow Rate (m^3/s)	1.86	1.96
Synchronous Speed (rpm)	900	720
Generators		
Generators Quantity	2	2
Nominal Power (kVA)	1,800	4,500
Effective Power (kW)	1,530	4,050
Power's Factor	0.85	0.9
Frequency (Hz)	60	60

More details on Section A.1. above.

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 (host Party)	Rio do Lobo Energia Ltda (private entity)	No
	Casa de Pedra Energia S.A. (private entity)	
	Carbotrader Assessoria e Consultoria em Energia EIRELI (private entity)	

A.5. Public funding of project activity

This Project Activity did not/will not receive any public funding from Parties included in Annex 1.

A.6. History of project activity

This PDD refers to a renewal of the crediting period (second) for this project. Using this rationale:

- The proposed CDM project activity, at the time of its first submission for registration, was neither registered as a CDM project activity nor included as a component project activity (CPA) in a registered CDM programme of activities (PoA).

[2] ANEEL Dispatch #516 of 10/02/2011

[3] ANEEL Dispatch #1,359 of 03/05/2013

- The proposed CDM project activity, at the time of its first submission for registration, was not a project activity that has been deregistered.
- The proposed CDM project activity, at the time of its first submission for registration, was not a CPA that has been excluded from a registered CDM PoA.
- 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), at the time of its first submission for registration, did not exist in the same geographical location as the proposed CDM project activity.

A.7. Debundling

Based on the information provided in Appendix C of the simplified modalities and procedures for small scale CDM activities, this small-scale renewable energy project is not part of a larger emission-reduction project, i.e., is not a debundled component of a larger project or program. It is a unique CDM project proposed by the project developer. The project participants have not registered or operated (are not therefore engaged in any way) in any other small-scale CDM project activities in hydropower or by using any other technologies within the project boundary, and surrounding the project boundary.

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

Approved baseline and monitoring methodology:

AMS-I.D – "Grid connected renewable electricity generation" -Version 18
Link: https://cdm.unfccc.int/methodologies/DB/W3TINZ7KKWCK7L8WTXFQQOFQQH4SBK

Additionally, the following tools are also applied to the second crediting period of the project activity:

- TOOL 05: "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" – Version 03.0
Link: https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v3.0.pdf

- TOOL 07: "Tool to calculate the emission factor for an electricity system", version 07.0
Link: https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v7.0.pdf

- TOOL 11: "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period", version 03.0.1
Link: https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-11-v3.0.1.pdf

B.2. Applicability of methodologies and standardized baselines

In accordance to the list of sector scopes available on the UNFCCC website, the category in which the project is classified belongs to the Sector Scope I - Energy Industries (renewable/non-renewable sources).

The project activity is applicable to type I of small-scale projects (renewable energy), methodology I.D. – Grid connected renewable electricity generation – since it is classified in applicability requirements necessary for this category.
This category encompasses renewable sources, as hydro, which supplies electricity to a national or a regional grid, with power lower than 15 MW and reservoirs that satisfies at least one of the following conditions:
• 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;

• The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the Project Emissions section, is greater than 4 W/m^2.

The project activity will supply electricity to the Brazilian National Interconnected System. the total power capacity of Albano Machado (3.06 MW) and Rio dos Índios (8.10 MW) totalizes 11.16 MW, below 15 MW, then they can be classified as Greenfield power plants. Both created new reservoirs with the Power Density (PD) greater than 4 W/m^2 (34.26 W/m^2 for Albano Machado and 33.58 W/m^2 for Rio dos Índios).

2. This methodology comprises renewable energy generation units, such as photovoltaic, hydro, tidal/wave, wind, geothermal and renewable biomass:

(a) Supplying electricity to a national or a regional grid; or
(b) Supplying electricity to an identified consumer facility via national/regional grid through a contractual arrangement such as wheeling.

Applicable, the proposed project activity comprises renewable energy generation units (hydro).

To summarize see below the applicability based on the methodology requirements:

4. This methodology is applicable to project activities that:
(a) Install a Greenfield plant;
(b) Involve a capacity addition in (an) existing plant(s);
(c) Involve a retrofit of (an) existing plant(s);
(d) Involve a rehabilitation of (an) existing plant(s)/unit(s); or
(e) Involve a replacement of (an) existing plant(s).

Applicable, since install a new power plant at sites where there were no renewable energy power plants operating prior to the implementation of the project activity (Greenfield plants – item a).

5. Hydro power plants with reservoirs that satisfy at least one of the following conditions are eligible to apply this methodology:
(a) The project activity is implemented in an existing reservoir with no change in the volume of reservoir;
(b) The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the project emissions section, is greater than 4 W/m^2;
(c) The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the project emissions section, is greater than 4 W/m^2.

Applicable, since 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/m2.

6. 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.

Not Applicable, has not renewable and non-renewable components.

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

Not Applicable, has not combined heat and power.

8. 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 distinct1 from the existing units.

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Not Applicable, the proposed project activity doesn´t involve addition of renewable energy generation units at an existing renewable power generation facility.

9. 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.

Not Applicable, the proposed project activity isn´t retrofit or replacement.

10. 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.

Not applicable to the project activity, since it does not involve landfill gas, wastewater treatment and agro-industries projects methane recovery.

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

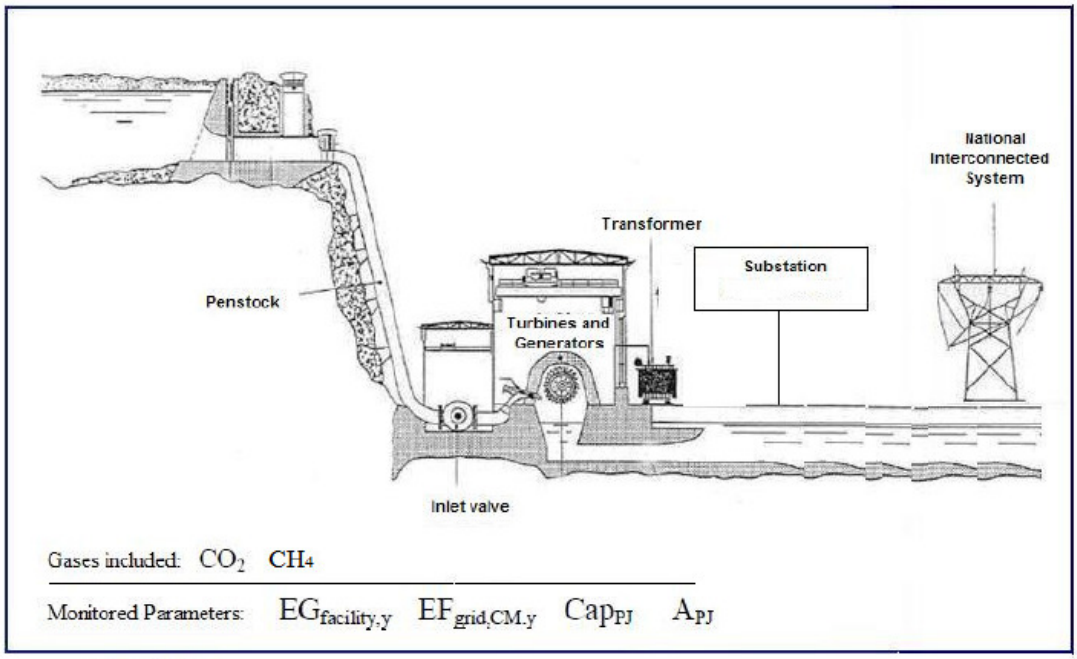
Not applicable. The project does not involve dedicated plantations to be used as fuel.

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

According to the AMS 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.

Thus, the project boundary is the area where the project is located which includes the reservoirs, dams, powerhouses included the turbines, generators, substations, metering systems and the National Interconnected Grid.

The picture below presents the project boundary for each SHP:



Regard the grid connection points, the electricity from the SHP Albano Machado (AM) is dispatched to RGE'substation (Rio Grande Energia – local energy distributor in the interconnected grid) located in Entre Rios city (RS) being this the interconnection point.
The SHP Rio dos Índios (RDI) electricity is dispatched to CELESC Distribuição S.A substation (local energy distributor in the interconnected grid) located near of Chapecó City (SC) being this is the interconnection point.

More details on Section A.1. above.

Source		GHG	Included?	Justification/Explanation
Baseline	Source 1: CO2 emissions from electricity generation in fossil fuel fired power plants that is 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	Source 1: For hydro power plants, emissions of CH_4 from reservoirs	CO_2	No	Minor emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source

B.4. Establishment and description of baseline scenario

According to the TOOL 11: "https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-11-v3.0.1.pdf" a stepwise procedure to assess the continued validity of the baseline and to update the baseline at the renewal of a crediting period is necessary.
The tool consists of two steps. The first step provides an approach to evaluate whether the current baseline is still valid for the next crediting period. The second step provides an approach to update the baseline in case that the current baseline is not valid anymore for the next crediting period.

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

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

Step 1.1: Assess compliance of the current baseline with relevant mandatory national and/or sectoral policies If the current baseline complies with all relevant mandatory national and/or sectoral policies which have come into effect after the submission of the project activity for validation or the submission of the previous request for renewal of the crediting period and are applicable at the time of requesting renewal of the crediting period, go to Step 1.2.

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

If the current baseline is not in compliance with the relevant mandatory national and/or sectoral policies or if it cannot be shown that the policies are systematically not enforced and that non-compliance with those policies is widespread in the country or region, then the current baseline needs to be updated for the subsequent crediting period.

The validity of the current baseline doesn´t need to be updated since still valid and in compliance with relevant mandatory brazilian policies.

Step 1.2: Assess the impact of circumstances

Assess the impact of circumstances existing at the time of requesting renewal of the crediting period on the current baseline emissions, without reassessing the baseline scenario.
In the situation where the baseline scenario identified at the validation of the project activity was the continuation of the current practice without any investment, an assessment of the changes in market characteristics is required for the renewal of the crediting period.
Evaluate whether the conditions used to determine the baseline emissions in the previous crediting period are still valid. Assess the availability of new fuels or raw materials and the impact of electricity or fuel prices in the identification of the current practice for the baseline emissions;

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

The circumstances at the time of requesting renewal of the crediting period are the same described for the first crediting period as described just after the TOOL 11 evaluation on this section.

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

This sub-step should only be applied if the baseline scenario identified at the validation of the project activity was the continuation of use of the current equipment(s) without any investment and, the projects proponents or third party (or parties) would undertake an investment later due, for example, to the end of the technical lifetime of the equipment(s) before the end of the crediting period or the availability of a new technology.
Assess whether the remaining technical lifetime of the equipment that would have continued to be used in the absence of the project activity, as determined in the CDM-PDD or CDM-PDD-REN, exceeds the crediting period for which renewal is requested.
Take into consideration the market penetration of different technologies. Evaluate the penetration rateof different technologies that are available in the market and evaluate how they could affect the baseline.

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

Not applicable since this is a Greenfield project activity.

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

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

Updates should be undertaken in the following cases:

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

The parameters that were only determined at the start of the crediting period and not monitored during the crediting period are still valid. And due to the TOOL 7 requirements was included as fixed parameter at the start of the second crediting period the parameter EF_{BM}.

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

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

Step 2.1: Update the current baseline

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

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

Step 2.2: Update the data and parameters

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

Applicable, the data and parameters were updated as described below and on Section B.6.3.

According to the methodology AMS.I.D. the baseline scenario is that the electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources into the grid

The electricity generation from the SHPs will provide the necessary electricity delivered to the grid by the project activity in MWh (calculation of baseline GHGs).

Also, the project activity uses as source for the Emission Factor calculation of SIN the operating margin and build margin coefficients provided by the Designated National Authority (DNA) of this host country (publicly available).
The CO_2 Emission Factor resulting from the electric energy generation verified in the SIN in Brazil is calculated based on generating records from plants centrally operated by the National Electric System Operator (from Portuguese *Operador Nacional do Sistema Elétrico* - ONS).

The method used to make this calculation is the dispatch analysis method. These informations are necessary for renewable energy projects connected to electric grid and implanted in Brazil under the CDM.
The data resultant from the ONS, Ministry of Mines and Energy and Ministry of Science and Technology work, are available to CDM project proponents. Thus, they can be applied in calculating ex-ante emissions avoided by the project activity, where the emission reduction will be ex-post calculated.

Further details of the project baseline development can be viewed through the link:
http://www.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/emissao_despacho.html

More technical details on Section A.1. above.
More baseline facilities details on Section B.5. below.

B.5. Demonstration of additionality

Table 2: SHPs Project Timeline (AM – Albano Machado and RDI – Rio dos Índios).

Date	SHP	Subject	Evidence
12/12/2006	AM	ANEEL Authorizative Resolution No. 764	http://www.aneel.gov.br/cedoc/rea2006764.pdf
12/12/2008	AM	CDM Prior Consideration (Communication delivery to the UNFCCC Secretariat through e-mail)	Email: "*Re: Electra Power project activities information*"
30/03/2009	AM	Generator Aquisition (Project Activity Start Date)	Generator purchase contract
17/04/2009	AM	Turbines Aquisition	Turbines Purchase Contract
01/05/2009	AM	SHP Construction Start	Construction Schedule
10/08/2009	AM	Instalation License Issued	Document "LI 878 / 2009-DL"
01/12/2009	AM	DOE Offer for the Validation Services	E-mail "*Proposta MDL para as PCHs Albano Machado e Rio dos Índios*"
02/12/2009	AM	CDM Local Stakeholders Consult	Letters to the Brazilian Stakeholders
22/04/2010	AM	PDD public available for global stakeholders comments	http://cdm.unfccc.int/Projects/Validation/DB/WJNOGITOOZTPB8NKK4JD63XIO1QUDD/view.html
29/09/2010	AM	Operation License Issued	Document "LO 5936 / 2010-DL"
28/10/2010	AM	SHP Construction Finalization	ANEEL Dispatch No. 3272

Date	SHP	Subject	Evidence
03/03/2009	RDI	ANEEL Autorizative Resolution No. 1826	http://www.aneel.gov.br/cedoc/rea20091826.pdf
22/12/2008	RDI	CDM Prior Consideration	Email: "*Re: Electra Power project activities information*"
01/12/2009	RDI	DOE Offer Validation Services	E-mail "*Proposta MDL para as PCHs Albano Machado e Rio dos Índios*"
02/12/2009	RDI	Local Stakeholders Consult	Letters to the Brazilian Stakeholders
22/04/2010	RDI	PDD public available for global stakeholders comments	http://cdm.unfccc.int/Projects/Validation/DB/WJNOGITOOZTPB8NKK4JD63XIO1QUDD/view.html
01/03/2011	RDI	SHP Construction Start	Forecasted in the SHP Construction Schedule "*Cronograma_RDI_rev4*"

The Albano Machado and Rio dos Índios plants were interconnected with the national interconnected grid system (SIN) and supply energy to this electric system. The commercial operation start was:

SHP Albano Machado - 11/02/2011[4]

[4] ANEEL Dispatch #516 of 10/02/2011

SHP Rio dos Índios - 04/05/2013[5]

According to the Annex A of Appendix B of the Simplified Modalities and Procedures for Small-Scale CDM Project Activities, a barrier analysis must be done in order to demonstrate the project additionality, as described below (version 08.0 of 29 September 2011):
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**: This barrier evaluates a financially more viable alternative to the project activity would have led to higher emissions;

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

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

(d) **Other barriers:** This barrier evaluates 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.

(a) Investment barrier

General Aspects

In Brazil, interest rates of financing agencies in local currency are significantly higher than the same rates in the American currency. The credit market is dominated by shorter maturities and the long-term credit lines are available only for stronger corporative borrowers and for special government initiatives.

The domestic financial markets with long-term of maturity are difficult to access. Experience has shown that in times of financial stress, the duration of the savings instruments falls to levels close to one day, with a large concentration in overnight-type bank deposits. Savers do not hold long-term financial contracts because it is not possible to determine the price of the uncertainty involved in the preservation of the value of the purchasing power.

The lack of long-term local financings results from the reluctance of financial institutions to increase the maturity of their investments. Thus, investors choose for more liquid investments and put their money into government securities instead of investing in long-term opportunities that could fund infrastructure projects.

The National Bank for Economic and Social Development, BNDES, is the sole supplier of long-term loans[6]. The financing of the BNDES debt is held mainly through commercial banks. But the high level of guarantee required, the high fees charged due to the risk associated with renewable projects and requirement of the contract for the purchase and sale of energy (CCVE), hamper the access of investors to these resources.

[5] ANEEL Dispatch #1,359 of 03/05/2013

[6] According *Jennifer Hermann* in her article "Sistematização do debate sobre “Desenvolvimento e Estabilidade” no Brasil". (free translation - Systematization of the discussion on "Development and Stability" in Brazil)

Aspects of the Project

To examine **the investment barriers** of the project, the application of a benchmark analysis[7] was used in order to perform the additionality analysis.

The suitable financial indicator selected for the proposed CDM project activity is the project's Internal Rate of Return (IRR), this data is considered adequate for this kind of Project as well decision context.

The financial/economic analysis is based on parameters that are standard in the market.

To the Benchmark was considered 5 entire years average (from January 2004 to December 2008) of the National Treasury Notes – Series C (NTN-C) with maturity in the 2031 year.

The NTN-C Brazilian Government Bonds represents a free risk rate of return available for investors. The data sources are public and easily accessible[8].

The table below presents the calculated Benchmark value:

Benchmark (Brazilian Gov. Bond Rates average)
17.13%

As mentioned the finance indicator choosen to the benchmark comparison should be the Internal Rate Return from the SHPs, being the values:

IRR without the CERs revenues	
Albano Machado	Rio dos Índios
14.59%	14.65%

Comparing the Small Hydro Power Plants IRRs with the Benchmark is it possible to conclude that the project activity is unlikely to be the most financially/ economically attractive.

The input values used in the IRR calculation are listed in the tables below. The IRR spreadsheet calculation will be presented in a separated document:

SHP Albano Machado

Investment	14,070,472	R$	OPE - Budget Standard Eletrobrás and Cap14 Page 2 from Rischbieter Engenharia e Serviços[9] SHP Project
Energy Price	155.00	R$/MWh	Project Proponent Benchmark and Energia Direta Website also 8th CCEE Energy Auction [10]
Assured Energy	1.66	MWaverage	Project Design and Brazilian Mines and Energy Ministry ("*Portaria 079 - 2007 - Anexo*")
Operation and Maintenance	2.40	% over the total asset	PP Benchmark and "Diretrizes para Estudos e Projetos de Pequenas Centrais Hidrelétricas"

[7] Other options could be the simple cost or the investment comparison analysis, but since the project activity has other revenues, like the CDM benefits, the simple cost must be discarded and there are not other investment alternatives for the project sponsors. So the benchmark analysis was adopted in order to check the additionality.

[8] in http://www.tesouro.fazenda.gov.br

9 Third Party Company responsible for the SHP project calculations http://www.rischbieter.com.br/

10 http://www.ccee.org.br/StaticFile/Arquivo/biblioteca_virtual/Leiloes/8_energia%20nova/Resultado%20por%20vendedor.pdf

(O&M)			page 14

SHP Rio dos Índios

Investment	36,745,269.82	R$	OPE - Budget Standard Eletrobrás and Project Proponent´s Investment Statement delivered to the Financing Bank.
Energy Price	155.00	R$/MWh	Project Proponent Benchmark and Energia Direta Website also 8th CCEE Energy Auction [11]
Assured Energy	4.336	MWaverage	*Rischbieter' Engenharia e Serviços* Studies page 10 and Project Proponent´s Investment Statement delivered to the Financing Bank
Operation and Maintenance (O&M)	2.40	% over the total asset	PP Benchmark and "Diretrizes para Estudos e Projetos de Pequenas Centrais Hidrelétricas" page 14

Anyway, a sensitivity analysis was performed in order to check the breakeven points for the project activity taken into account the most sensitive parameters variation, such as: Investment Value; Energy Price, Assured Energy and the Operation and Maintenance (O&M) Costs. The results are presented below:

	Albano Machado	Break Even Point	Project Value
Investment	**-18.00%**	R$ 11,537,787.04	R$ 14,070,472.00
Energy Price	**+14.90%**	178.10 R$/MWh	155.00 R$/MWh
Assured Energy	**+14.90%**	1.91 MWaverage	1.66 MWaverage
O&M	**-93.18%**	0.16% on total asset	2.40% on total assets

	Rio dos Índios	Break Even Point	Project Value
Investment	**-17.80%**	R$ 30,204,611.79	R$ 36,745,269.82
Energy Price	**+14.90%**	178.10 R$/MWh	155.00 R$/MWh
Assured Energy	**+13.65%**	4.928 MWaverage	4.336 MWaverage
O&M	**-92.97%**	0.17% on total asset	2.40% on total assets

The project sponsors considered the variation level not feasible because:

Investment Value

Regarding the Investment costs, the input values have come from the Eletrobrás Standard Budget (from the Portuguese: *Orçamento Padrão Eletrobrás* - OPE) presented by the Project Participants and developed by the "Rischbieter Engenharia e Serviços" (Third Party company and the project designer expert) also the financial statement delivered to the financial entity (BNDES Bank).
The budget follows the standard used by Eletrobras for its projects and is widely used in Brazil to assess SHP projects. The OPE is part of the executive project of the SHP, which has to be assessed by the National Electric Energy Agency (from Portuguese *Agência Nacional de Energia Elétrica* – ANEEL, sector regulatory agency in Brazil), in this way a third part agency in Brazil.

11 http://www.ccee.org.br/StaticFile/Arquivo/biblioteca_virtual/Leiloes/8_energia%20nova/Resultado%20por%20vendedor.pdf

After observe the data presented above, it can be considered that the input value for investment costs used in the financial analysis is adequate/suitable as well as conservative, considering that it reflects the input value presented at the time of validation.

Plant Load Factor

This value is based on well established calculus and formulas for these kind of project activity and also is based on the historical flow river where the SHPs shall be located (Jan/1957 to the Albano Machado and Jan/1960 to the Rio dos Índios until Dec/2006 so 49 and 46 years analysis). ANEEL has validated these by: Rio dos Índios – Dispatch 3473, 19 September 2008, and, Albano Machado - Dispatch 3,761, 5 October 2009.

Energy Price

The energy price values evidenced trough the public energy auction occurred in the CCEE brings values around R$144.00/MWh (2009):
http://www.ccee.org.br/StaticFile/Arquivo/biblioteca_virtual/Leiloes/8_energia%20nova/Resultado%20por%20vendedor.pdf

Also the ANEEL Reference Value (VR) to the 2008 year has R$ 139.44/MWh as the value to be performed.
The Reference Value is the value at which the energy distributors can afford for the energy price trough the Power Purchase Agreement to the small power generators in the concession area: http://www.ccee.org.br/StaticFile/Oficio%200312008%20SEM%20Aneel.pdf

So R$ 155.00/MWh considered by the PP is already an optimistic price level (7.6% over the currently prices). But R$ 178.10/MWh represents 23.6% over, not in line with the market prices and also not feasible.

O&M

The variance of 92.97% is not possible because represents no operation and maintenance on the ventures.

Conclusion

Based on the explanation above, the proposed CDM project activity is unlikely to be the most financially/economically attractive. It is evident that the project must become a CDM in order to join the carbon credits revenue into the project cash-flow becoming better profitability when comparing to other options that could led to the higher emissions.

The IRR from the SHPs will get better with the CERs revenues:

IRR with the CERs revenues	
Albano Machado	Rio dos Índios
15.07%	15.07%

(b) Technological barrier

Not used.

(c) Barrier due to prevailing practice

Not used.

(e) Other barriers

Not used.

Conclusion of the barriers analysis

Small hydro power plants are power plants with a reservoir area smaller than 3 km². It generally consists of a run-of-the-river hydro plant which has minimum environmental impact. This is not the business-as-usual scenario in a country where large hydro and thermal fossil fuel projects are preferred. CDM has made it possible for some investors to set up small hydro plants and sell electricity to the grid and this motivated the SHPs Albano Machado and Rio dos Índios implementation.

The registration of the proposed project activity will help the Project Participants to improve its economic performance contributing with several expenses related to the operation phase and will be an important incentive to overcome the financial barrier. Also, the project registration may have a strong impact in paving the way for similar projects to be implemented in Brazil.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

The emission reductions of project activity (ER_y) are quantified through the subtraction of project emissions ($PE_{HP,y}$) from baseline emissions (BE_y).

$$ER_y = BE_y - PE_y$$

Where:
ER_y = Emission reduction in year y (tCO_2e/year);
BE_y = Baseline emissions in year y (tCO_2e/year);
PE_y = Project emission from water reservoirs for hydro power plants in year y (tCO_2e/year)

Project emissions *($PE_{HP,y}$)*

According to the methodology ACM0002, for hydro power project activities that result in new reservoirs, project proponents shall account for CH_4 and CO_2 emissions from the reservoir, estimated as follows:

a) If the power density of the single or multiple reservoirs (PD) is higher than 4W/m² and lower than or equal to 10W/m²:

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

Where:

$PE_{HP,y}$ Emission from water reservoirs (tCO_2e/yr);
EF_{Res} Default emission factor for emissions from reservoirs of hydro power plants in year y (kgCO2e/MWh).
TEG_y Total electricity produced by the project activity, including the electricity supplied to the grid and the electricity supplied to internal loads, in year *y* (MWh).

b) If power density of project is greater than 10 W/m²:

$PE_{HP,y} = 0$

The power densities of the project activity are calculated as follows:

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

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 the implementation of the project activity (W). For new hydro power plants, this value is zero.
A_{PJ} Area of the single or multiple reservoirs measured in the surface of the water, after the implementation of the project activity, when the reservoir is full (m^2).
A_{BL} Area of the single or multiple reservoirs measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m^2). For new reservoirs, this value is zero.

Among the two power plants of project activity, "Albano Machado" and "Rio do Índios" have power densities greater than 10W/m^2:

SHP Albano Machado, PD=3,060,000–0 / 89,300–0 = 34.26 W/m^2

SHP Rio dos Índios, PD=8,100,000–0 / 241,200–0 = 33.58 W/m^2

The reservoir emissions of the SHPs Albano Machado and Rio dos Índios are zero.

Baseline Emissions *(BE_y)*

Baseline emissions (BE_y in tCO_2) are the product of the baseline emissions factor ($EF_{grid,CM,y}$ in tCO_2/MWh) multiplied by the electricity supplied by the project activity to the grid ($EG_{PJ,y}$ in MWh), as follows:

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

Where:
BE_y Baseline emissions in year y (tCO_2e/yr);
$EG_{PJ,y}$ Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year y (MWh/yr);
$EF_{grid,CM,y}$ Combined margin CO_2 emission factor for grid connected power generation in year y, calculated using the latest version of the "Tool to calculate the emission factor for an electricity system" (tCO_2/MWh).

Energy Generated ($EG_{PJ,y}$)

The project activity is the installation of three new grid-connected renewable power plants/units at sites where no renewable power plants were operated prior to the project activity implementation , thus classified as a Greenfield renewable energy power plants.

The $EG_{PJ,y}$ is based on energy estimative to be annually inputted into the grid by the Project activity, which considers the net electricity generation from the power plants, information provided by ANEEL and Brazilian Mines and Energy Ministry. Then:

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

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

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

$$EG_{PJ,y} = EG_{Albano\ Machado} + EG_{Rio\ dos\ índios}$$

$$EG_{PJ,y} = 14{,}542 + 37{,}983$$

$$EG_{PJ,y} = 52{,}525\ \text{MWh/yr}$$

B.6.2. Data and parameters fixed ex ante

Data/Parameter	$Cap_{Albano\ Machado,y}$
Data unit	W
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	Project site.
Value(s) applied	0
Choice of data or measurement methods and procedures	The methodology for which this value is applied in new hydroelectric plants.
Purpose of data	Calculation of project emissions.
Additional comment	

Data/Parameter	$Cap_{Rio\ dos\ Índios,y}$
Data unit	W
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	Project site.
Value(s) applied	0
Choice of data or measurement methods and procedures	The methodology for which this value is applied in new hydroelectric plants.
Purpose of data	Calculation of project emissions.
Additional comment	

Data/Parameter	$A_{Albano\ Machado,y}$
Data unit	m^2
Description	Area of the reservoir measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m^2). For new reservoirs, this value is zero.
Source of data	Project site.
Value(s) applied	0
Choice of data or measurement methods and procedures	Not applicable.
Purpose of data	Calculation of project emissions.
Additional comment	
Data/Parameter	$A_{Rio\ dos\ ìndios,y}$
Data unit	m^2
Description	Area of the reservoir measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m^2). For new reservoirs, this value is zero.
Source of data	Project site.
Value(s) applied	0
Choice of data or measurement methods and procedures	Not applicable.
Purpose of data	Calculation of project emissions.
Additional comment	

Data/Parameter	$EF_{grid,BM,y}$
Data unit	tCO_2e/MWh
Description	CO_2 Build Margin emission factor of the grid, in a year *y*
Source of data	Data calculated by DNA (Designated National Authority) to the year *y*.
Value(s) applied	0.1370
Measurement methods and procedures	According procedures established by the most recent version of "Tool to calculate the emission factor for an electricity system".
Monitoring frequency	calculated ex-ante using the latest data available
QA/QC procedures	
Purpose of data	Calculation of baseline emissions.
Additional comment	To the *ex-ante* estimative of the emission reductions, were used the datas related to the year 2018 (ultimate available data).

B.6.3. Ex ante calculation of emission reductions

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

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

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

STEP 1. Identify the relevant electricity system.

Considering the stated by the "Tool to calculate the emission factor for an electricity system", and the fact that the Brazilian DNA has published the Resolution nº 8 issued on May 26th, 2008, which defines Brazilian Interconnected Grid as a single system that covers all five macro-geographical regions of the country (North, Northeast, South, Southeast and Midwest), the Brazilian electricity system boundaries are clearly defined.

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

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

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

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

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

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

Where:

$EF_{grid,OM-DD,y}$ = Dispatch data analysis operating margin CO_2 emission factor in year y (tCO_2/MWh);
$EG_{PJ,h}$ = Electricity displaced by the project activity in hour h of year y (MWh);
$EF_{EL,DD,h}$ = CO_2 emission factor for grid power units in the top of the dispatch order in hour h in year y (tCO_2/MWh);
$EG_{PJ,y}$ = Total electricity displaced by the project activity in year y (MWh).
h = Hours in year *y* in which the project activity is displacing grid electricity (h)
y = Year in which the project activity is displacing grid electricity

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

For effect of ex-ante estimation to $EF_{grid,OM-DD,y}$ value, was calculated the arithmetic average of 12 months emission factors of the operating margin, published by the DNA (data available to year 2018).

Table 10: Emission Factor of Operating Margin for year 2018

OPERATING MARGIN												
Average Emission Factor (tCO_2 / MWh)												
	MONTH											
	January	February	March	April	May	June	July	August	September	October	November	December
2018	0.5652	0.5559	0.5750	0.5058	0.5461	0.6691	0.5989	0.5948	0.5718	0.5782	0.3654	0.3423

Thus, the Emission Factor of Operating Margin is:

$$EF_{grid,OM-DD,y} = 0.\ 5390$$

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

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

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

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

For the build margin emission factor $EF_{grid,BM,y}$ also will be adopted the 2018 year value published by the DNA (ultimate data available)[12].

Table 11: Latest data from Brazilian DNA to Emission Factor Build Margin (2018)

BUILD MARGIN	
Average Emission Factor (tCO_2/MWh) - **ANNUAL**	
2018	
	0.1370

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

$$EF_{grid,BM,y} = 0.1370$$

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

To calculation of combined margin emission factor (combination of operation and build margins) is used a weighted-average formula, considering w_{OM} = 0.25 and w_{BM} = 0.75 (second credit period). As a conservative approach, below is presented the emission factor calculated using four decimal places, rounded down. Thus, the result is:

$$EF_{grid,,}=0.5390 \cdot 0.25+0.1370 \cdot 0.75=0.2375 \ (tCO_2/MWh)$$

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

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

$$BE_y = 52{,}525 * 0.2375 = 12{,}474 \ tCO_2/yr$$

Moving back to the emission reductions of project activity (*ER*), we have the annual ex-ante estimated CO_2 reductions as:

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

Where:
ER = Emission reductions in year y (tCO_{2e}/yr)
BE = Baseline emissions in year y (tCO_2/yr)
PE = Project emissions in year y (tCO_{2e}/yr)

[12] For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE (TOOL07 para 72).

Considerening the emissions related to the SHP reservoirs are zero, the Project activity emissions reductions are calculated as below:

$$ER_y = 12,474 - 0 = 12,474 \ (tCO_2/yr)$$

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)
2019 July	6,236	0	0	6,236
2020	12,474	0	0	12,474
2021	12,474	0	0	12,474
2022	12,474	0	0	12,474
2023	12,474	0	0	12,474
2024	12,474	0	0	12,474
2025	12,474	0	0	12,474
2026 July	6,236	0	0	6,236
Total	87,316	0	0	87,316
Total number of crediting years	7			
Annual average over the crediting period	12,474	0	0	12,474

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data/Parameter	$EG_{Albano\ Machado,y}$
Data unit	MWh/yr
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in year y.
Source of data	Project site - Energy Meters located in a panel inside the substation at Entre Rios do Sul (one main and one backup)
Value(s) applied	**14,542**
Measurement methods and procedures	The net electricity delivered to the grid will be checked through the electricity meters (one main and one back-up). Also the electricity delivered from the grid shall be checked through the same meters since they are bidirectionals, class accuracy 0.2. For safety, the meters were sealed after calibration.
Monitoring frequency	Continuous measurement and at least monthly recording
QA/QC procedures	The meters must comply with national standards stated by ONS module 12.2 (which can be viewed through the link http://extranet.ons.org.br/operacao/prdocme.nsf/principalPRedeweb?openframeset), and industry regulation to ensure the accuracy. These data will be used to calculate the emission reductions. The data will be archived monthly (electronic) and kept archived during the credit period and two years after. The data from the energy meters will be cross checked with the CCEE databank in order to verify the coherency of the data. The periodicity of the calibration will follow the Procedure 12.3[13] of ONS.
Purpose of data	Calculation of baseline emissions.

[13] http://extranet.ons.org.br/operacao/prdocme.nsf/principalPRedeweb?openframeset

Additional comment	PP is the responsible for the measurements (check and/or cross check readings)

Data/Parameter	$EG_{Rio\ dos\ Indios,y}$
Data unit	MWh/yr
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in year y.
Source of data	Project site - Energy Meters located in a panel inside the Villa Bormann substation (one main and one backup)
Value(s) applied	**37,983**
Measurement methods and procedures	The net electricity delivered to the grid will be checked through the electricity meters (one main and one back-up). Also the electricity delivered from the grid shall be checked through the same meters since they are bidirectionals, class accuracy 0.2. For safety, the meters were sealed after calibration.
Monitoring frequency	Continuous measurement and at least monthly recording
QA/QC procedures	The meters must comply with national standards stated by ONS module 12.2 (which can be viewed through the link http://extranet.ons.org.br/operacao/prdocme.nsf/principalPRedeweb?openframeset), and industry regulation to ensure the accuracy. These data will be used to calculate the emission reductions. The data will be archived monthly (electronic) and kept archived during the credit period and two years after. The data from the energy meters will be cross checked with the CCEE databank in order to verify the coherency of the data. The periodicity of the calibration will follow the Procedure 12.3[14] of ONS.
Purpose of data	Calculation of baseline emissions.
Additional comment	PP is the responsible for the measurements (check and/or cross check readings)

Data/Parameter	$EF_{grid,CM,y}$
Data unit	tCO_2e/MWh
Description	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".
Source of data	Calculated based on data provided by DNA (Designated National Authority).
Value(s) applied	0.2375
Measurement methods and procedures	The Combined Margin is calculated through a weighted-average formula, considering the $EF_{grid,OM-DD,y}$ and the $EF_{grid,BM,y}$ and the weights w_{OM} = 0.25 and w_{BM} = 0.75. As per the "Tool to calculate the emission factor for an electricity system".
Monitoring frequency	Annually.
QA/QC procedures	As per the "Tool to calculate the emission factor for an electricity system".
Purpose of data	Calculation of baseline emissions.
Additional comment	To the *ex-ante* estimative of the emission reductions, were used the datas related to the year 2018 (ultimate available datas).

Data/Parameter	$EF_{grid,OM-DD,y}$
Data unit	tCO_2e/MWh
Description	CO_2 Operating Margin emission factor of the grid, in a year y
Source of data	Data calculated by DNA (Designated National Authority) to the year y.
Value(s) applied	0.5390
Measurement methods and procedures	According procedures established by the most recent version of "Tool to calculate the emission factor for an electricity system".

[14] http://extranet.ons.org.br/operacao/prdocme.nsf/principalPRedeweb?openframeset

Monitoring frequency	Annually.
QA/QC procedures	This data will be annually updated to be applied in ex-post calculation of the Emission Factor of Combined Margin.
Purpose of data	Calculation of baseline emissions.
Additional comment	To the *ex-ante* estimative of the emission reductions, were used the datas related to the year 2018 (ultimate available datas).

Data/Parameter	$Cap_{Albano\ Machado\ ,y}$
Data unit	W
Description	Installed capacity of the hydro power plant after the implementation of the project activity.
Source of data	Equipments plaques
Value(s) applied	3,060,000
Measurement methods and procedures	Technical specifications on the installed equipments.
Monitoring frequency	Once at the beginning of each crediting period
QA/QC procedures	Determined based on recognized standards. This data will be applied for the Power Density calculation.
Purpose of data	Calculation of project emissions
Additional comment	

Data/Parameter	$Cap_{Rio\ dos\ Índios,y}$
Data unit	W
Description	Installed capacity of the hydro power plant after the implementation of the project activity.
Source of data	Equipments plaques
Value(s) applied	8,100,000
Measurement methods and procedures	Technical specifications on the installed equipments.
Monitoring frequency	Once at the beginning of each crediting period
QA/QC procedures	Determined based on recognized standards. This data will be applied for the Power Density calculation.
Purpose of data	Calculation of project emissions
Additional comment	

Data/Parameter	$A_{Albano\ Machado,y}$
Data unit	m^2
Description	Area of the reservoir measured in the water surface, after the implementation of the project activity, when the reservoir is full.
Source of data	Reservoir in the Project site.
Value(s) applied	89,300
Measurement methods and procedures	Measured from topographical surveys, maps, satellite pictures, etc.
Monitoring frequency	Once at the beginning of each crediting period
QA/QC procedures	
Purpose of data	Calculation of the project emissions
Additional comment	This data is applied for the Power Density calculation.

Data/Parameter	$A_{Rio\ dos\ índios,y}$
Data unit	m^2

Description	Area of the reservoir measured in the water surface, after the implementation of the project activity, when the reservoir is full.
Source of data	Reservoir in the Project site.
Value(s) applied	241,200
Measurement methods and procedures	Measured from topographical surveys, maps, satellite pictures, etc.
Monitoring frequency	Once at the beginning of each crediting period
QA/QC procedures	
Purpose of data	Calculation of the project emissions
Additional comment	This data is applied for the Power Density calculation.

B.7.2. Sampling plan

Not applicable.

B.7.3. Other elements of monitoring plan

The monitoring plan for the project activity is based on the methodology AMS I.D.

1) Power generation:

General characteristics of the measurement system:

The procedures designs for monitoring electricity generation by the project activity follow the parameters and regulations of the Brazilian energy sector. The National Grid Operator (ONS) and the Electric Power Commercialisation Chamber (CCEE) are the organs responsible for specification of the technical requirements of energy measurement system for billing, which those bodies up, monitor and approve projects for accurate accounting of energy.

The agent responsible for the measurement system for billing (SMF) develop the project in accordance with the technical specifications of the measurements for billing, which should include the location of measurement points, panels of measurement, meters and systems for local and remote measurement.

The measurement system makes the measure and records the energy. This is installed in the panels of measurement, which are generally located in the control room or cabins of measurement. For this system is guaranteed the inviolability of data, which are placed stamps and seals or seals with electronic passwords.

Should be installed metering panels with two meters (the main and the backup).

The measurement system contains also a communication system that has the function to send the data of electricity dispatched for the grid to the CCEE.

Data monitoring:

The readings of meters are used for calculating the emission reductions when the Meter is in normal operation state. The monitoring steps are as follows:

(1) The data will be measured hourly and recorded monthly;
(2) The power output settlement sheet from CCEE and/or sales receipts will be used to cross check the monitored data.
(3) The project owner provides DOE with readings record of meters, access to the CCEE data measured and/or copies of sales invoices and others emission reductions calculations.

Quality control:

(1) Calibration of meters

The calibration of meters conducted by qualified organization must comply with national standards and industrial regulations to ensure the accuracy. The meters must be sealed for safety after calibration. The calibration records must be archived together with other monitoring records.
The class of accuracy in the equipment that will be used in the project activity is under the national standards (NBR 14519 from Associação Brasileira de Normas Técnicas – Brazilian Association of Technical Standards). It can be viewed in the Grid Procedures from the National Grid Operator: Module 12, Sub-module12.3 Maintenance of the Measurement System for Billing in the link:

http://www.ons.org.br/%2FProcedimentosDeRede%2FM%C3%B3dulo%2012%2FSubm%C3%B3dulo%2012.3%2FSubm%C3%B3dulo%2012.3%202016.12.pdf (Procedures from the ONS – Module 12)

(2) Emergency treatment

In case of impracticability of measures from any point of measurement, due to maintenance, commissioning or for any other reason, will be used the methodology to estimate data as the item 14.3 of the Procedure of Energy Commercialization PdC ME.01[15]

Data Management:

All the project activity issues regarding the SHPs will be treated by the SPEs (Special Purpose Entities) Rio do Lobo Energia Ltda and Casa de Pedra Energia S.A. board and the Management Sector responsible.

An operational structure for the plants was assigned and trained before the commercial operation start.

The data will be annually filed (electronic archive) should be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later.

Training Procedures:

All the training necessary for the plant operational team will be provided during the plant construction and during the plant commercial operation. Also a plant operation manual will be created in order to provide assured instructions.

Furthermore, operation, maintenance and calibration procedures will follow the national guidelines set by the National Grid Operator.

Emission Factors:

The Emission Factor related to this project activity ($EF_{grid,CM,y,}$ and $EF_{grid,OM\text{-}DD,y}$) as mentioned previously, are available by the Brazilian DNA and it can be viewed at its website (http://www.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/emissao_despacho.html). Thus, the monitoring of such data will be ex-post through periodic access to data calculated by DNA.
The emission factor $EF_{grid,BM,y}$ was fixed ex-ante for second credit period.

15 http://www.ccee.org.br/cceeinterdsm/v/index.jsp?vgnextoid=67778d3ef9a3c010VgnVCM1000005e01010aRCRD

The Area of the reservoir (A_{PJ}) and also facility capacity ($Cap_{PJ,y}$) are fixed once at the beginning of the second credit period.
See Section B.7.1.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

30/03/2009 the SHP Albano Machado construction start, evidenced trough the Generators contraction, this data is the first evidence of the SHP project implementation - related to the project activity expenditure commitment.

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

Renewable being:

02/07/2019 until 01/07/2026 the Second crediting Period

C.3.2. Start date of crediting period

The starting date of the second crediting period of the project activity is 02/07/2019.

C.3.3. Duration of crediting period

7 years and 0 months

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

With respect to regulatory permits the Albano Machado and Rio dos Índios SHPs have the following ANEEL authorizations:

- Authoritative Resolution Nº 764, issued on 12nd December 2006
- Dispatch Publication Nº 3,761, issued on 5th October 2009
- Authoritative Resolution Nº 1,826, issued on 3rd March 2009
- Dispatch Publication Nº 3,473, issued on 19th September 2008

With respect to environmental permits legislation requires issuing of following licenses:

- **Preliminary License (LP):** preliminary phase of planning activity in which concept and location of enterprise are evaluated. In this phase Environmental Impact Study (EIA) and Environmental Impact Report (RIMA) are analysed, or, depending on the case, the Environmental Control Report (RCA).
- **Installation License (LI):** authorizes implementation of enterprise. In this phase, the Environmental Control Plan (PCA) is analysed, it contains projects for systems of treatment and/or disposing of liquid and atmospheric effluents and solid residue etc.
- **Operation License (LO):** authorizes operation of enterprise after verification of compliance with measures determined in phases of LP and LI.

Thus these SHPs have the following documentation:

The **Albano Machado** Small Hydro Power Plant has the following Environmental Licenses:

- LP # 703/2004-DL – Environmental Preliminary License from Environmental Protection State Foundation – FEPAM (Fundação Estadual de Proteção Ambiental - FEPAM). Issued on 03 September 2004;
- LI # 878 / 2009-DL – Environmental Installation License from FEPAM. Issued on 10 August 2009;
- LI # 03/2010-DL - Environmental Installation License from FEPAM in 04 January 2010;
- LO # 5936/2010-DL – Operation License from FEPAM issued on 29 September 2010;
- LO #05029/2019 - Operation License from FEPAM issued on 22 July 2019.

The **Rio dos Índios** Small Hydro Power Plant has the following Environmental Licenses:

- LP # 307/2004-DL – Environmental Preliminary License from FEPAM in 23 April 2004;
- LI # 375/2008-DL – Environmental Installation License from FEPAM in 22 April 2008;
- LI # 275/2010-DL - Environmental Installation License from FEPAM in 17 March 2010;
- LO #00714/2018 - Operation License from FEPAM issued on 01 February 2018.

D.2. Environmental impact assessment

The Small Hydro Power plants (SHPs) are considered an alternative for the Brazilian electric matrix diversification. One of its characteristics is to present low negative impacts to the place of installation, when compared to the business as usual in Brazil (large hydro power plants), due mainly to the fact of do not require the flood of large land area.

Studies related to the promoted impacts were carried out as part of the process of environmental licenses issuance. Its results are comprised in the reports of prior and installation licenses request. Its results are comprised in the Environmental Simplified Report - *RAS* (from portuguese *Relatório Ambiental Simplificado*), or correspondent of each plant. Moreover, it has contained a group of activities and programs which have as main goal to minimize the negative effects and to monitor the influences of the plant installation on local water resources.

As stated by the National Environmental Council - *CONAMA (*from Portuguese *Conselho Nacional do Meio Ambiente*) on its resolution number 279 dated of 27th June 2001, the *RAS* must be performed by ventures that present low potential of environmental impacts. It is performed previously the issuance of the Previous License – LP, and only if the enterprise are in accordance to all legal and environmental requirements, the process of licensing carries on, proceeding the necessary steps to acquiring further licenses (Installation License – LI and Operation License – LO).

The project activity includes 2 Small Hydro Power plants where the environmental impacts are considered not significant when compared with the other generation power plants types (with large flooded area). The Instalation Licenses were issued by the FEPAM - Fundação Estadual de Proteção Ambiental (statual agency responsible for the environmental fiscalization during all the project activity lifetime).

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

In accordance to Ruling nº.1, dated 11 September 2003 and Ruling nº7, of the Inter-Ministry Commission on Global Climate Change (CIMGC), any CDM projects shall send a letter describing the project and request commentaries by local interested parties.

The project activity applies to more than one states of the federation, thus, the invitations of comments should be addressed to the following actors involved and affected by the project activities:

- Government of each State or Federal District involved;
- Legislative Assembly of each state involved, or, in the case of the Federal District Legislative Assembly;
- Federal environmental agency;
- State environmental agencies involved;
- Brazilian Forum of NGOs and Environmental and Development Social Movements;
- State Prosecutors Office;
- National Prosecutors Office;
- Community associations;
- State environmental body;

And additionally was delivered to the entities below:

- City Hall and City Councils;
- Municipal environmental bodies.

In order to satisfy and comply with this ruling the project proponents sent invitation letters describing the project, and requested commentaries by the following interested parties:

- City Hall of Nonoai
- Hall of Councilors of Nonoai
- Department of Planning, Development, Industry, Commerce and Tourism of Nonoai
- Department of Public Works of Nonoai
- Municipal Service Center for Children and Teenagers Adílio Daronch - CEMACAAD
- Chamber of Commerce, Cultural, Industrial, Services and Agriculture of Nonoai
- City Hall of Trindade do Sul
- Hall of Councilors of Trindade do Sul
- Department of Agriculture of Trindade do Sul
- Cooperative of Agricultural Production in Trindade do Sul
- Brazilian Forum of NGOs and Social Movements for Environment and Development (FBOMS)
- State Foundation of Environmental Protection - FEPAM
- Public Ministry of State of Rio Grande do Sul
- Prosecutor's Office in the State of Rio Grande do Sul

The interested parties above were invited to present their concerns and provide comments on project activity. The letters were delivered before the validation start and are opened for the comments.

In the letter delivered to the stakeholders, the responsible were informed that the Project Design Document, as well the Annex III from the Resolution No. 1 from the *Comissão Interministerial sobre Mudança Global do Clima (CIMGC – the Brazilian DNA)* were available for the consult in the Carbotrader website, company that belong to the project participant: www.carbotrader.com in the links: www.carbotrader.com/jun1115dcp.pdf and www.carbotrader.com/jun1115a3.pdf.

E.2. Summary of comments received

No comments were received from interested parties

E.3. Consideration of comments received

Not applicable due to the item E.2.

SECTION F. Approval and authorization

The Letter of Approval was obtained after the DOE´s Final Validation Report issuance and before the CDM Executive Board project request for registration in 23/05/2012.

Appendix 1. Contact information of project participants

Organization name	Rio do Lobo Energia Ltda
Country	Brazil
Address	Estrada Municipal Batista Favoretti, 350, Boituva City, São Paulo State, ZIP 18550-000.
Telephone	+55 15 3363-9000 – Direct: 300 9805
Fax	
E-mail	faleconosco@electraenergy.com.br
Website	
Contact person	Alvaro Augusto de Almeida

Organization name	Casa de Pedra Energia S.A.
Country	Brazil
Address	Rua Léo Neuls, 113 – Sala B – Bairro São Cristóvão, Erechim City, Rio Grande do Sul State, ZIP: 99711-102
Telephone	+55 54 3520-5200
Fax	
E-mail	alderi@creral.com.br
Website	
Contact person	João Alderi do Prado

Organization name	Carbotrader Assessoria e Consultoria em Energia EIRELI
Country	Brazil
Address	90, St Maestro Manoel Antiqueira – Jundiaí City – São Paulo State – ZIP 13216-310
Telephone	+55 11 4522-7180
Fax	
E-mail	moraes.arthur@carbotrader.com
Website	www.carbotrader.com
Contact person	Arthur Moraes

Appendix 2. Affirmation regarding public funding

There is no kyoto protocol annex 1 country public fund financing this project activity

Appendix 3. Applicability of methodologies and standardized baselines

No further information.

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

The CO_2 emission factors resulting from the generation of electricity verified in Brazilian National Interconnected System (SIN) are calculated from the power plants generation records issued centrally by the National Grid Operator, especially in thermoelectric plants. This information is

necessary to renewable energy projects connected to the national grid and implemented in Brazil under the Kyoto Protocol's Clean Development Mechanism (CDM).

The ex ante emission reductions are calculated according to the "Tool to calculate the emission factor for an electricity system". With this methodology the National Grid Operator (ONS) is tasked with explaining the SIN (National Interconnected System) operational practices regulated by the ANEEL (Brazilian Electricity Regulatory Agency) to the work group made up by the Ministry of Science and Technology (MCT) and Ministry of Mines and Energy (MME). According to this system, the CO2 Emission Factors applicable to the project activity will be calculated by the National Grid Operator (ONS) for the single system since 27th May 2008.

The latest available data of the Brazilian grid emission factor used on emissions reductions calculations is available in the link: http://www.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/emissao_despacho.html

Appendix 5. Further background information on monitoring plan

The monitoring of the project activity is based on the baseline methodology and monitoring applicable to this project and, as described in items B 7.1 and B 7.3, the metering equipments of generated energy is used for verification of renewable energy generated by the project activity.

After energy generation data has been collected, there will be a reconciliation of this data with the reports/data issued by the CCEE. We emphasize that the energy data from CCEE are audited by this entity and must not contain errors. This procedure will be adopted in order to give consistency to the data.

It should be noted that all collected data in the monitoring scope will be electronically filed and kept for at least 2 years after the last credit period or the last issuance of CERs for this project activity, whichever occurs later.

This monitoring plan is based on small scale methodology **AMS I.D. - "Grid connected renewable electricity generation" version 18.0, as well as on the "Tool to calculate the emission factor for an electricity system" version 07.0**.

Appendix 6. Summary report of comments received from local stakeholders

Not applicable.

Appendix 7. Summary of post-registration changes

The changes applicable for each SHP are summarized in the table below:

SHP Albano Machado	**Before**	**After**
Flow Rate (m^3/s)	3.57	1.86
SHP Rio dos Índios	**Before**	**After**
Installed Power Capacity (MW)	8.01	8.10
Power Density (W/m^2)	31.71	32.07
Turbines Type	Francis	Francis
Turbines Quantity	2	2
Unit Nominal Power (kW)	4,160	4,125

Flow Rate (m^3/s)	1.89	1.96
Synchronous Speed (rpm)	1,200	720
Generators		
Effective Power (kW)	4,005	4,050
Power's Factor	0.89	0.9

The reason for these changes is due to better equipments design occurred between the project design phase (also cdm registration) and project as built.

Also was included minor corrections related to PP contact information, SHP Rio dos Índios geocoordinates and start date of Crediting Period (see Appendix 1 and section C.3.1).

The change on the installed capacity of SHP Rio dos Índios (installed capacity from 8.01 to 8.10 MW) is based on an adjustment over the **power factor** described with 0.89 in the SHP datasheet versus 0.90 printed in the equipment's plaques.

The Post Registration Changes described above has been approved in the previous crediting period.

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Document information

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

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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