



**Verified Carbon
Standard**

BAESA MONITORING REPORT



Document Prepared by Ecofinance Negócios

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1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

BAESA project activity is the construction and operation of Barra Grande Hydro Power Plant (HPP), a greenfield hydro power plant implemented in single reservoir, where the power density of the reservoir calculated using the applicable methodology is greater than 4 W/m².

Barra Grande Hydro Power Plant is owned by BAESA - Energética Barra Grande S.A (BAESA). The plant generates electricity through clean and renewable source. It contributes to attend the growing demand for electricity in Brazil, due to the country's economic and population growth, contributing, thus, to the environmental, social and economic sustainability, by increasing the share of renewable energy in the country's total electricity consumption.

Barra Grande HPP is located in the Southern Region of Brazil, between the cities of Anita Garibaldi, state of Santa Catarina and Pinhal da Serra, state of Rio Grande do Sul. The plant uses hydraulic potential of Pelotas River to generate electricity with an installed capacity of 708 MW and assured energy (medium energy) of 380.6 MWh_{average}.

Prior to the implementation of the project activity no hydropower plant was operational in the location where Barra Grande HPP is implemented. Barra Grande HPP reduces GHG emissions by avoiding electricity generation from fossil fuel sources, which would be generated (and emitted) in the absence of the project. Then, the baseline scenario and the scenario without the project activity are the same.

The technology applied in the project is well established in the sector. All equipment employed have already been successfully applied to similar projects in the world. The project uses three Francis Turbines (each one with 236 MW of installed capacity). Each generation unit has three meters. One (1) meter for each turbine located at the Powerhouse measures total electricity generation and two (2) meters for each generation unit located at the substation are responsible for net electricity measurement.

The operation starting date of the first turbine was 11 January 2005 and the plant is operational since then. In March 2009, Verified Carbon Standard (VCS) registered BAESA Project as Project ID number 10. Since there, three monitoring reports were verified (from 2006 to 2015) and the second crediting period renewal was already approved.¹

The total GHG emission reductions generated during this monitoring period is 2,349,038 tCO₂e.

¹ More information about this process can be found at <https://registry.terra.org/app/projectDetail/VCS/10>.

1.2 Sectoral Scope and Project Type

The sectoral scope applied to BAESA Project is sectoral scope 1 – Energy (Renewable/Non-Renewable). BAESA Project is not a grouped project

1.3 Project Proponent

Organization name	BAESA - Energética Barra Grande S.A
Contact person	Juliano Natal or Peter Eric Volf
Title	<i>Director</i>
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Telephone	55 48 3331 0000
Email	juliano.natal@cscenergia.com.br or pvolf@baesa.com.br

Organization name	Ecofinance Negócios Eireli ² (Former Enerbio Consultoria Ltda)
Contact person	Eduardo Baltar de Souza Leão
Title	Director
Address	361, Lageado Avenue, 701. Porto Alegre/Rio Grande do Sul, Brazil. Zipcode: 90460-110
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² Ecofinance Negócios Eireli is the new name for Enerbio Consultoria Ltda. The name of the company was changed in 2012 as it can be proved by the estatutes of the company.

1.4 Other Entities Involved in the Project

Not applicable once there are no other Entities involved in the project.

1.5 Project Start Date

According to the VCS Standard, version 4.0, the project start date is the date on which the project began generating GHG emission reductions or removals. Therefore, the project start date of BAESA Project is 11/01/2005 (mm/dd/yyyy) (Operation Starting Date of the First Turbine), as VCS PD validated for the first and second crediting period.

1.6 Project Crediting Period

The project crediting period shall be a maximum of ten years which may be renewed at most twice. The first crediting period of the project was from 01 January 2006 to 31 December 2015 and the second crediting period is from 01 January 2016 to 31 December 2025.

1.7 Project Location

Barra Grande HPP is located in Pelotas River, about 43 km from its confluence with Canoas River, between the municipalities of Anita Garibaldi/SC and Pinhal da Serra/RS. The geographic coordinates are: Latitude 27°46'South and Longitude of 51°13' West. The map below shows HPP Barra Grande location:

The following map shows HPP Barra Grande location:

Map 1 – Localization of HPP Barra Grande



1.8 Title and Reference of Methodology

As the registered VCS PD for the second crediting period, the methodology applied to the Project is ACM0002: “Grid-connected electricity generation from renewable sources” (version 17.0). This methodology also refers to the following tools:

- (a) “TOOL07 - Tool to calculate the emission factor for an electricity system”, version 06.0;
- (b) “TOOL03 - Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”, version 3;
- (c) “TOOL05 - Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”, version 03.0.

1.9 Participation under other GHG Programs

Not applicable. The project is not included in any other emission trading program or mechanism.

1.10 Other Forms of Credit

Not applicable. The project has not sought or received any other form of GHG-related environmental credit, including renewable energy certificate.

1.11 Sustainable Development

BAESA Project contributes to the sustainable development once contributing to the economic growth without compromising the future generations, respecting the concept of Sustainable Development, established by Brundtland Report, elaborated by the World Commission on Environment and Development. This report defines the term “sustainable development” as “the development that satisfies the present necessities, without compromising the capacity of future generations of supplying their own necessities”³.

Through the following actions, BAESA Project contributes to the sustainable development of its region and country:

- BAESA Project supplies clean and renewable electricity to the Brazilian National Interconnected System, displacing plants that would generate electricity through fossil fuels, avoiding, thus, the greenhouse gases emission and preserving the environment to future generations. This action is aligned with the first Brazilian NDC⁴.
- More than 5,000 direct and indirect jobs were created during construction and operation of the project. Besides regional economic activities were improved with the implantation of the entrepreneurship, creating income to the communities of the municipalities. Moreover, through taxes and tributes generated by its activities to the municipalities involved and to the Union, BAESA Project provides financial resources that can be re-invested to the population of the region and of the country. It is estimated that during the construction period (1) R\$ 240 million were brought to the local, regional and state economy through the purchase of materials, payment of salaries and services hiring; (2) 8.5 million were directly applied to health, education, leisure, security and social assistance infrastructure of the cities; (3) R\$ 7.5 million were collected by the municipalities of Anita Garibaldi and Pinhal da Serra through Taxes over Services (ISSQN) and (4) R\$ 9.0 million were collected to Rio Grande do Sul and Santa Catarina states, referring to the Tax over Circulation of Goods and Services (ICMS).

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

⁴ Source: <http://www4.unfccc.int/ndcregistry/PublishedDocuments/Brazil%20First/BRAZIL%20iNDC%20english%20FINAL.pdf>

- BAESA makes considerable investments in environmental programs and actions⁵. Twenty-six programs were developed, distributed in 6 programs, which totalize an invested amount of approximately R\$ 209 million. Among the environmental projects, it can be highlighted the reforestation program that reached the goal of planting one million seedlings. To achieve this goal, BAESA implanted in 2007 a plant nursery of forest seedlings, with a production capacity of 150 thousand seedlings per year, destined to the reforestation project and environmental education. The resettlement of people affected by the entrepreneurship also must be emphasized. Some families that lived in houses nearby the river, without electricity and minimum sanitation conditions were relocated to with excellent infra-structure conditions. The participation of government and social movement representatives has contributed to the project success. The collaborative work among company, government and social movement allowed better conditions for the families involved.

- Since Barra Grande HPP is located in the rural area of Rio Grande do Sul and Santa Catarina, the project demanded training people to be hired or sub-hired in the region. Through environmental education program, BAESA Project has invested to form multipliers in the cities involved, targeting public and private school's teachers, members of the organized civil society and local authorities to spread principles and techniques of environmental education. Besides, training activities are also performed with sub-hired construction workers and educational activities with inhabitants from the reservoir's surroundings. Through this action, BAESA Project seeks to train employees to the market and contributes to the growth of knowledge and to the level of education of the cities where it acts.

⁵ More information about social and environmental programs developed by BAESA Project are presented on section 04 of this VCS PD.

2 SAFEGUARDS

2.1 No Net Harm

As described on item 5.2 of the VCS PD registered for the second crediting period, the environmental impact assessment is part of the environmental licensing, which is a legal obligation in Brazil. During construction phases, some impacts were identified, and monitoring programs were designed to mitigate these impacts.

In Barra Grande HPP Environmental Basic Project (PBA), six (6) programs and twenty-six (26) projects were designed with the objective of providing the minimum environmental impact on the region. Throughout the construction period and start up, BAESA invested approximately R\$209 million on these PBA projects and conditions of the environmental licensing, as it is demonstrated in the summary-table below. Each program is related to one potential impact identified before and during construction period.

Table 01 – Financial Resources Invested in the Programs of Environmental Basic Project

PROGRAMS OF ENVIRONMENTAL BASIC PROJECT	R\$ (thousand)
Social-economic and cultural program	129,761
Rearrangement and compensation of population	116,501
Restructure and Revitalization of surrounding communities	2,980
Recuperation and Preservation of Historical and Cultural Heritage	437
Recuperation and Preservation of Landscape Heritage	127
Recuperation and preservation of Archeological Heritage	2,597
Adequacy of the infra-structure of Municipal Services	6,446
Environmental Education	673
Hydrology, climatology and water quality Program	5,180
Hydrological Conditions Monitoring	520
Climate Conditions Monitoring	450
Limnological and of water quality conditions Monitoring	1,200
Water Macrophytes Monitoring	250
Ichthiofauna Monitoring	2,000
Hydro Sediments Conditions Monitoring	250
Integrated Actions of Soil and Water	510
Geo technology Program	10,371

PROGRAMS OF ENVIRONMENTAL BASIC PROJECT	R\$ (thousand)
Seismic Monitoring	500
Monitoring of the exploitation of Mineral Resources	8
Monitoring of aquifers	450
Monitoring of marginal slopes	230
Handling and recuperation of flora and fauna	2,500
Reforestation	3,700
Partnership with Embrapa Recursos Genéticos (Embrapa Genetic Resources)	1,500
Monitoring of <i>Dyckia</i>	650
Application of Financial Resources on Conservation Units	833
Physical environment programs	15,784
Accumulation Basin Cleanness	15,481
Management and Restructure of construction areas	303
Management program	3,730
Reservoir Management	803
Monitoring and assessment of Environmental Basic Project	827
Social communication	2,100
Conditions of ASV	23,706
Social Agreement	19,885
Total	208,417

All investments on socio-environmental programs were coordinated by a multidisciplinary staff, seeking to reach the balance between the results searched by the entrepreneurship and the social and environmental aspects. BAESA's social and environmental actions surpass the compliance of compensatory measures determined by the authorities involved. The successes of social and environmental projects that have been developed in BAESA Project are proved through polls and prizes.

Among the prizes received by the company for its outstanding socio-environmental action, it can be mentioned: Mário Henrique Simonsen Award – Excellence in Social Balance (promoted by the National Foundation of Management Support); Fitz Muller Award – category of environmental education (promoted by the Environmental Foundation of Santa Catarina); and Empresa Cidadã (Citizen Company) – category of environmental preservation (promoted by Association of Sales and Market Directors of Brazil – Division of Santa Catarina).

Furthermore, other indicator of the Environment Programs success, it is important to mention the poll carried out by the company Lupi & Associados with 621 inhabitants of the municipalities covered by the Power Plant, which points that 88.3% of them have favorable opinions about the entrepreneurship.

According to operational license 447/2005, renewed on 2014, March, just the following environmental and social programs related to impacts should be kept and carried out:

- Environmental education program;
- Water quality and hydro sedimentology management program;
- Erosive site control program;
- Monitoring program of Macrophytes;
- Seismological monitoring program;
- Climate monitoring program;
- Ichthyofauna monitoring program;
- Monitoring program of *Lontra longicaudis*;
- Implement the Environmental Conservation Plan and Water Use of the Reservoir (PCAU);
- To develop, after IBAMA demand, monitoring plan of wildlife threatened;
- Evaluate with the local government and communities' associations the reservoir touristic potential.

2.2 Local Stakeholder Consultation

The public audience is one of the environmental impact assessment phases and one of the main channels of community participation at a local level before project construction. This procedure consists on presenting to the interested parties the environmental assessment report, clarifying doubts and collecting criticisms and suggestions on the entrepreneurship and the areas to be affected.

The public audiences occur by the determination of IBAMA, whenever judged as necessary, or by social entities requirements (Public Ministry or more than 50 citizens). Public audience notice is published in Diário Oficial da União (Union's Official Journal) and in a regional or local large circulation newspaper, radios and banners. Date, hour and place of the event must be presented. The place where public audiences happen must be easily accessed by the interested parties. Therefore, due to the geographic location of the communities and interested groups, there may be more than one event about the same project.

BAESA Project was submitted to public audiences during all your licensing process. Furthermore, Project Proponents sent letters to stakeholders, inviting them to make comments about the VCS project. Following stakeholders were consulted:

- State Government of Santa Catarina
- State Government of Rio Grande do Sul;
- Legislative Council of Santa Catarina;
- Legislative Council of Rio Grande do Sul;
- IBAMA – Brazilian Institute of Environment and Renewable Natural Resources;
- Brazilian Ministry of Environment;
- Environment Foundation of State of Santa Catarina (FATMA);
- State Secretary of Sustainable Development (responsible for issues related to the Environment in the state of Santa Catarina);
- Environment Secretary of Rio Grande do Sul (SEMA);
- State Foundation of Environmental Protection Henrique Luiz Hoessler – FEPAM;
- Santa Catarina Public Prosecutors;
- Rio Grande do Sul Prosecutors;
- Federal Prosecutors;
- Brazilian Forum of NGO's and Social Movements for Environment and Development;
- FIESC – Industries Federation of Santa Catarina State;
- FIERGS – Industries Federation of Rio Grande do Sul;
- Light Brazil Institute;
- APINE –Independent Electricity Producers Association.

Stakeholders consulted were the same stakeholders required by Brazilian DNA for CDM projects. Letters were sent to the local stakeholders on September 01, 2008, before the validation process, and the VCS Project was available for comments and opinions about BAESA Project until September 30, 2008. The VCS-PD was available for local stakeholders for comments. No comments were received.

It is noteworthy to say that BAESA keeps a Service Center to attend local community to provide information about the project. This Center is also used to obtain communities' view about environmental education program and other mitigation actions carried out by the project. There was no comment, requirement or complain about the project during this monitoring period.

2.3 AFOLU-Specific Safeguards

Not applicable once for non-AFOLU projects, this section is not required.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

The Project activity is operational since 11/01/2005. Technology employed is according predicted in VCS PD registered. Barra Grande HPP uses the hydraulic potential of Pelotas River to generate electricity with an installed capacity of 708 MW and assured energy of 380.6 MW average. There are three Francis turbines with an installed capacity of 236MW each. Each generation unit have three meters. One (1) meter for each turbine located at the Powerhouse measures The total electricity produced by the project activity, including the electricity supplied to the grid and the electricity supplied to internal loads per year (TEG,y) and there are two (2) other meters for each generation unit located at the substation, responsible measurement of net electricity supplied by the project activity to the grid per year (EG,facility,y). TEG,y and EG,facility,y of this monitoring period are presented in the following table:

Table 02 – TEG,y and EG,y per year for the monitoring period

Parameter	2016	2017	2018	2019	2020	2021 ⁶
TEG _y (MWh)	3,798,095	2,682,501	2,880,049	2,834,446	1,933,240	564,605
EG _{facility,y} (MWh)	3,687,878	2,602,811	2,795,918	2,747,022	1,872,463	545,094

The expected TEG_y of the VCS PD registered for the second crediting period is 3,334,056 MWh/year and the expected EG_{facility,y} is 3,313,338 MWh/year. In 2016, TEG and EG_{facility} were higher 13.9% and 11.3% higher than VCS PD estimation, respectively. Both parameters were lower than predicted in VCS PD estimation for all other years. For TEG, values were lower as follows: -19% in 2017; -13% in 2018; -15% in 2019; -42% in 2020 and -66% in 2021 (until June). For EG_{facility}, values were also lower: -21% in 2017; -15% in 2018; -17% in 2019; -43% in 2020 and -67% in 2021 (until June). Considering the whole 4rd MP, EG_{facility} was 19% lower than estimated in the VCS PD registered for the second crediting period.

It is important to highlight that this electricity generation variability is expected once it is highly associated to rainfall regime. It depends significantly on water volume in the river basin where the plant is located. Scarce rains, floods, or any other natural factor may cause an impact on the generation capacity of the project and, consequently, may affect the emission reductions provided by it. Since 2019,

⁶ Until 30-june-2021.

Brazil has been facing rain levels below expectations. In April, May and June 2020, the Barra Grand plant did not generate electricity (in April/2020, electricity generation was minimal) due to water scarcity.

The combined margin CO₂ emission factor ($EF_{grid,CM,y}$) for plants connected to Brazilian Interconnected System (SIN) can also vary according to Operating Margin Emission Factor ($EF_{grid,OM,y}$) of each year. The Build Margin Emission Factor ($EF_{grid,BM,y}$) is a fixed parameter for the second crediting period.

Compared to combined margin CO₂ emission ($EF_{grid,CM,y}$) factor estimated at VCS PD registered for the second crediting period (0.2743 tCO₂/MWh), which was calculated based on 2016 data, was lower in all years of this MP, except from 2016, as presented in the table below.

Table 03 – $EF_{grid,CM,y}$ per year for the monitoring period

Parameter	2016	2017	2018	2019	2020	2021
$EF_{grid,CM,y}$ (tCO ₂ /MWh)	0.2743	0.2656	0.2533	0.2481	0.2321	0.2646

Emission reductions achieved during the 4th MP are 32% minor than estimated in VCS PD for the period due to underperformance of electricity generation ($EG_{facility,y}$) and minor emission factors ($EF_{grid,CM,y}$) from 2017 to 2021.

3.2 Deviations

2.3.1 Methodology Deviations

Not applicable once there is no methodology deviation.

2.3.2 Project Description Deviations

Not applicable once there is no project description deviation.

3.3 Grouped Projects

Not applicable once this is not a grouped project.

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data / Parameter	EF _{Res}
Data unit	kgCO ₂ e/MWh
Description	Default emission factor for emissions from reservoirs.
Source of data	Decision at EB 23.
Value applied	90 kgCO ₂ e/MWh.
Justification of choice of data or description of measurement methods and procedures applied	Value indicated by ACM0002 and EB23.
Purpose of Data	Calculation of project emissions
Comments	

Data / Parameter	GWP _{CH4}
Data unit	tCO ₂ e/tCH ₄
Description	Global warming potential of methane valid for the relevant commitment period
Source of data	IPCC
Value applied	25 tCO ₂ e/t CH ₄ and 28 tCO ₂ e/t CH ₄ .
Justification of choice of data or description of measurement methods and procedures applied	Default value provided by IPCC and VCS standard, version 4.1. According to VCS standard, version 4.1, For GHG emission reductions occurring on or before 31 December 2020, all ex-post calculations may be converted to CO ₂ e using either the GWP values from the IPCC Fourth Assessment Report (AR4), which is 25 tCO ₂ e/t CH ₄ or those from AR5 which is 28 tCO ₂ e/t CH ₄ . For GHG emission reductions occurring on or after 1 January 2021, all ex-post calculations shall be converted to CO ₂ e using GWP values from the IPCC Fifth Assessment Report (AR5)" which is 28 tCO ₂ e/t CH ₄
Purpose of Data	Calculation of baseline emissions (emission factors)
Comments	

Data / Parameter	Cap _{BL}
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 applied	0
Justification of choice of data or description of measurement methods and procedures applied	For new hydro power plants, this value is zero
Purpose of Data	Calculation of baseline emissions and project emissions.
Comments	

Data / Parameter	A _{BL}
Data unit	m ²
Description	Area of the reservoir measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m2). For new reservoirs, this value is zero
Source of data	Project site
Value applied	0
Justification of choice of data or description of measurement methods and procedures applied	For new reservoirs, this value is zero,
Purpose of Data	Calculation of project emissions.
Comments	

Data / Parameter	EF _{grid, BM, y}
Data unit	tCO ₂ / MWh
Description	Build margin CO2 emission factor in year y
Source of data	Ministry of Science, Technology, Innovation and Communication ⁷ and Tool to calculate the emission factor for an electricity system

⁷ Source: MCTI, 2017. <http://www.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/index.html> . Accessed on October, 2017.

Value applied	0.1581
Justification of choice of data or description of measurement methods and procedures applied	It was used 2016 data which was the latest data available at the time of the VCS PD submission for crediting period renewal. Data was calculated and published by Ministry of Science, technology, Innovation and Communication, institution that chairs Brazilian CDM DNA.
Purpose of Data	Calculation of baseline emissions
Comments	

Data / Parameter	The percentage share of total installed capacity of the specific technology
Data unit	%
Description	The percentage share of total installed capacity of the specific technology in the total installed grid connected power generation capacity in the host country
Source of data	ANEEL
Value applied	61.1%
Justification of choice of data or description of measurement methods and procedures applied	Data provided by VCS PD registered for the second crediting period.
Purpose of Data	Calculation of baseline emissions
Comments	

Data / Parameter	The total installed capacity of the technology
Data unit	MW
Description	the total installed capacity of the technology in the host country
Source of data	ANEEL
Value applied	93,216,340
Justification of choice of data or description of measurement methods and procedures applied	Data provided by VCS PD registered for the second crediting period.
Purpose of Data	Calculation of baseline emissions
Comments	

4.2 Data and Parameters Monitored

Data / Parameter	EG _{facility.y}
Data unit	MWh/yr
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in year y (MWh/yr)
Source of data	Project activity site (Meters at substation)
Description of measurement methods and procedures to be applied	Each Generation Unit has two specific meters (One principal and one rear) located in the substation that registers the net electricity supplied to the Grid by the Unit. Spreadsheets were used, obtained directly from the meters with information generated hourly, or according to what was programmed by CCEE (Câmara de Comercialização de Energia Elétrica/ Electric Power Commercialization Chamber). The information was checked with information of net electricity supplied by CCEE. CCEE is a third party responsible for electricity contracts settlements in Brazilian Market. There is a minor difference between information obtained directly from meters and information supplied by CCEE. As information supplied by CCEE is lower than information collected directly from the meters, conservatively, CCEE data was used.
Frequency of monitoring/recording	Hourly measurement and monthly recording
Value monitored	The values monitored for each year of this MP is presented below: • 2016 – 3,687,878 MWh • 2017 – 2,602,811 MWh • 2018 – 2,795,918 MWh • 2019 – 2,747,022 MWh • 2020 – 1,872,463 MWh • 2021 – 545,094 MWh
Monitoring equipment	Each turbine/generator has two specific meters (one principal and one rear) located in the Substation that registers net electricity generation supplied to the grid by the turbine/generator. Principal Meter - Turbine 01

	Supplier: Schneider Electric Type: ION 8600 Class: D (0.2%) Serial Number: PT-1201A372-01 Rear Meter - Turbine 01 Supplier: Schneider Electric Type: ION 8600 Class: D (0.2%) Serial Number: PT-1201A373-01 Principal Meter - Turbine 02 Supplier: Schneider Electric Type: ION 8600 Class: D (0.2%) Serial Number: PT-1201A394-01 Rear Meter - Turbine 02 Supplier: Schneider Electric Type: ION 8600 Class: D (0.2%) Serial Number: PT-1201A434-01 Principal Meter - Turbine 03 Supplier: Schneider Electric Type: ION 8600 Class: D (0.2%) Serial Number: PT-1201A498-01 Rear Meter - Turbine 03 Supplier: Schneider Electric Type: ION 8600 Class: D (0.2%) Serial Number: PT-1201A505-01
QA/QC procedures to be applied	The uncertainty level for these data is low. The electricity supplied to the grid is monitored by the project participants directly from the meters. The meter's information is checked with the generation spreadsheets available at the CCEE's Website (Electric Power Commercialization Chamber). Meter are calibrated according to National Operator of the System (ONS) Procedures.

Purpose of the data	Calculation of baseline emissions
Calculation method	Each Generation Unit has two specific meters located in the Substation that registers net electricity generated by the Unit to the Grid. No calculation is necessary.
Comments	

Data / Parameter	TEG _y
Data unit	MWh
Description	Total electricity produced by the project activity, including the electricity supplied to the grid and the electricity supplied to internal loads, in year y.
Source of data	Project activity site (Meters located at the turbines/generators)
Description of measurement methods and procedures to be applied	Each Generation Unit has one specific meter located in the plant (powerhouse) that registers the total electricity produced by the project activity, including the electricity supplied to the grid and the electricity supplied to internal loads, in year y.
Frequency of monitoring/recording	Continuous measurement and at least monthly recording
Value monitored	The values monitored for each year of this MP is presented below: • 2016 – 3,798,095 MWh • 2017 – 2,682,501 MWh • 2018 – 2,880,049 MWh • 2019 – 2,834,446 MWh • 2020 – 1,933,240 MWh • 2021 – 564,605 MWh
Monitoring equipment	Each turbine/generator has one specific meter located in the Powerhouse that registers total electricity generated by the turbine/generator. Meter - Turbine 01 Supplier: Schneider Electric Type: ION 8600 Class: D (0.2%) Serial Number: PT-1201A467-01 Meter - Turbine 02 Supplier: Schneider Electric

	Type: ION 8600 Class: D (0.2%) Serial Number: PT-1201A475-01 Meter - Turbine 03 Supplier: Schneider Electric Type: ION 8600 Class: D (0.2%) Serial Number: PT-1201A508-01
QA/QC procedures to be applied	The uncertainty level for these data is low. The TEG _y is monitored by the project participants directly from the meters. Meters are calibrated according to National Operator of the System (ONS) Procedures.
Purpose of the data	Calculation of project emissions
Calculation method	Each Generation Unit has one specific meter located in the Powerhouse that registers total electricity generated by the Unit. No calculation is necessary.
Comments	

Data / Parameter	Cap _{PJ}
Data unit	W
Description	Installed capacity of the hydro power plant after the implementation of the project activity.
Source of data	Project site.
Description of measurement methods and procedures to be applied	Sum of Installed capacity of the turbines (3 turbines of 236 MW) as indicated by manufacturer's specifications.
Frequency of monitoring/recording	Yearly
Value monitored	708,000,000
Monitoring equipment	Not applicable.
QA/QC procedures to be applied	Installed capacity can be cross-checked with environmental licenses, operational Handbook or manufacturer's specifications.
Purpose of the data	Calculation of Baseline Emissions

Calculation method	Not applicable.
Comments	

Data / Parameter	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	Project site.
Description of measurement methods and procedures to be applied	Measured from topographical surveys, maps, satellite pictures, etc.
Frequency of monitoring/recording	Once at the beginning of each crediting period.
Value monitored	94,000,000
Monitoring equipment	Not applicable.
QA/QC procedures to be applied	Data can be checked with the project environmental licenses
Purpose of the data	Calculation of project emissions.
Calculation method	Not applicable.
Comments	

Data / Parameter	$EF_{Grid,CM,y}$
Data unit	tCO ₂ /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	The combined margin emission factor is calculated using the procedures of the "Tool to calculate the emission factor for an electricity system". $EF_{Grid,BM,y}$ is a parameter available at validation and fixed during the second crediting period. $EF_{Grid,OM,y}$ data is supplied by Brazilian Designated National Authority (DNA) which is the Ministry of Science, Technology, Innovation and Communications.

	The combined margin emission factor used on BAESA Project is calculated based on National Interconnected System supplied by Brazilian DNA.
Description of measurement methods and procedures to be applied	As per the “Tool to calculate the emission factor for an electricity system”. Project Participants used Dispatch Data Analysis for OM and BM Emission Factor. Data supplied by Brazilian CDM DNA was used.
Frequency of monitoring/recording	Annually
Value monitored	The values monitored for each year of this MP is presented below: • 2016 –0.2743 tCO₂/MWh • 2017 – 0.2656 tCO₂/MWh • 2018 – 0.2533 tCO₂/MWh • 2019 – 0.2481 tCO₂/MWh • 2020 – 0.2321 tCO₂/MWh • 2021 - 0.2646 tCO₂/MWh
Monitoring equipment	Not applicable
QA/QC procedures to be applied	As per the “Tool to calculate the emission factor for an electricity system”.
Purpose of the data	Calculation of Baseline Emissions
Calculation method	As per the “tool to calculate the emission factor for an electricity system”. EF _{grid,BM,y} is a parameter available at validation and fixed during the second crediting period. EF _{grid,OM,y} is supplied by Brazilian CDM DNA. The combined margin emission factor considers weighting of 0.25 for EF _{grid,OM,y} and 0.75 for EF _{grid,BM,y} .
Comments	

4.3 Monitoring Plan

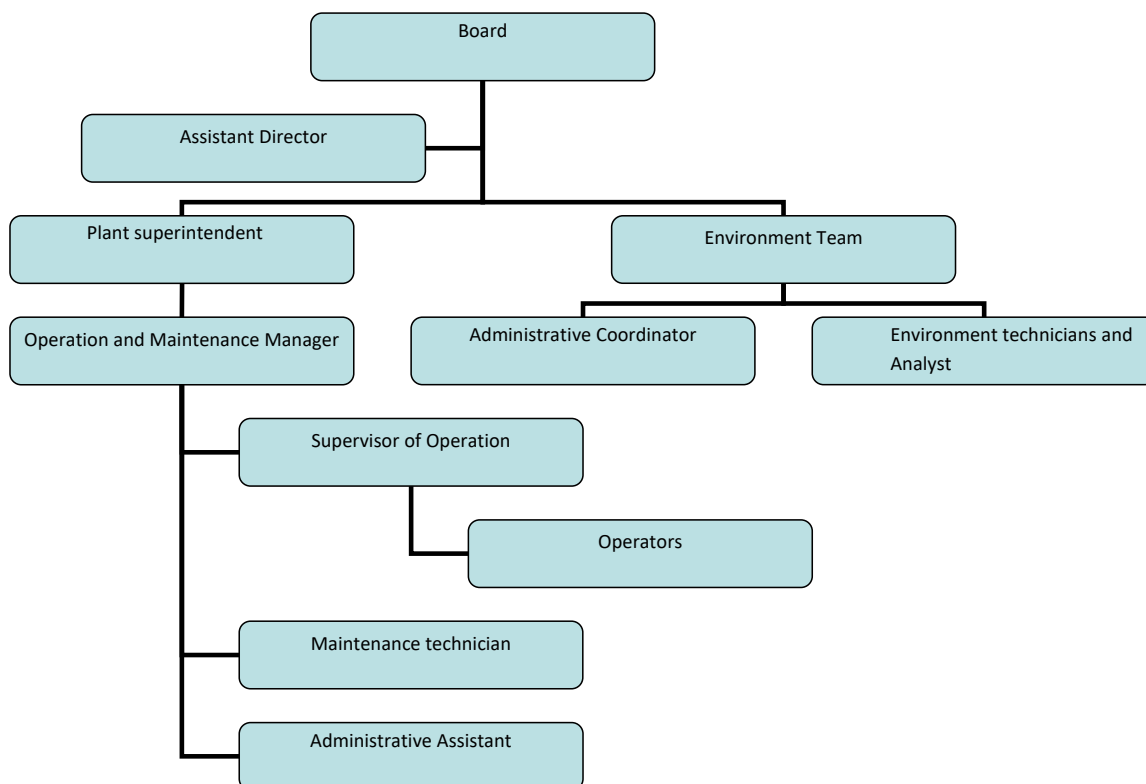
Monitoring has the objective of measuring the emission reductions achieved by the project. The monitoring plan follows the Monitoring Methodology of ACM0002: “Grid-connected electricity generation from renewable sources” (version 17.0). All data collected as part of monitoring should be archived electronically and be kept at least for two years after the end of the last crediting period. All measurements are conducted with calibrated measurement equipment according to Brazilian industry standards. The main parameters that will be monitored are:

The main parameters that were controlled were:

- Total electricity produced by the project activity, including the electricity supplied to the grid and the electricity supplied to internal loads, in year y (TEG_y);
 - Quantity of net electricity generation supplied by the project plant/unit to the grid in year y (MWh/yr) ($EG_{facility,y}$);
 - Installed capacity of the hydro power plant after the implementation of the project activity (Cap_{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 (A_{PJ});
 - Combined margin emission factor for the grid in year y ($EF_{Grid,CM,y}$).
-
- **Monitoring of TEG_y and $EG_{facility,y}$**

Operation and Maintenance Manager is responsible for the operation and maintenance activities of the plant. He is responsible for consolidating and analysing TEG_y and $EG_{facility,y}$ data. Measurement's activities are carried out by the operators of the operation team. The organizational structure of the company is presented below:

The organizational structure of the company is presented below:



Each turbine/generator has three meters. One meter for each turbine/generator is located in the Powerhouse. This meter registers TEG_y . Also, each turbine/generator has two meters located at the substation. There is one “principal” and one “retaguarda” (rear) that register $EG_{facility,y}$. ONS Grid Procedures (Sub-module 12.3) defines the calibration frequency and other maintenance procedures. All nine meters are calibrated according to Brazilian Standards.

Information about last meters calibration are provided at table 4 below:

Table 04 – Last calibration date and Company Responsible for

Calibration Date (dd/mm/yyyy)	Company Responsible for Calibration Procedure
26/02/2014 and 27/02/2014	METROWATT COMÉRCIO E MANUTENÇÃO LTDA
22/02/2016 and 23/02/2016	Metrum
22/02/2018 and 23/02/2018	Prolux Engenharia de Sistemas
18/02/2020 and 19/02/2020	Prolux Engenharia de Sistemas

Operators of BAESA operation team collects electricity generation data from each meter. Information of net electricity supplied is consolidated in one spreadsheet. Information of total electricity is consolidated in another spreadsheet.

Data of net electricity supplied to the grid may be compared with the information supplied by CCEE.

It is important to say that electricity generation information directly impacts the revenues of BAESA once electricity is the main product of the project. Therefore, a straight control is performed about this information. These controls follow the internal auditing processes presented in the management system of the company. It is important to highlight that the company is ISO 9001 and ISO 14001 certified.

Periodically, the Information Technology Area accomplishes an insurance backup for all plant data through *backup tape*.

Monitoring of $EF_{Grid,CM,y}$

The Combined margin emission factor for the grid in year y is calculated by consulting company hired by BAESA Energética Barra Grande S.A. Calculations follows the Tool to calculate the emission factor for an electricity system. Data supplied by Brazilian CDM DNA was used.

Monitoring of Cap_{PJ}

The Installed capacity of the hydro power plant after the implementation of the project activity is monitored once at the beginning of each crediting period. This parameter does not change over the project period. The value can be checked with environmental licenses, operational handbook or manufacturer's specifications.

Monitoring of A_{PJ}

Area of the single reservoirs measured in the surface of the water, after the implementation of the project activity, when the reservoir is full must be monitored once at the beginning of each crediting period. Once the reservoir is full, this area does not change. It can be checked with Operation Licenses of the project.

Monitoring of PE_y

Project emissions are calculated according ACM0002: "Grid-connected electricity generation from renewable sources" (version 17.0). It is consolidated annually by project participants. The emission of the project is calculated by consulting company Ecofinance Negócios and it is accounted in tCO₂e.

Monitoring of ER_y

Emission reductions achieved by the project are calculated by consulting company Ecofinance Negócios following ACM0002: "Grid-connected electricity generation from renewable sources" (version 17.0).

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

Baseline emissions are calculated as indicated by the methodology ACM0002: “Grid-connected electricity generation from renewable sources” (version 17.0).

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

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

Where:

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

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

If the project activity is the installation of a Greenfield power plant, as this BAESA Project, then:

$$EG_{PJ,y} = EG_{facility,y} \quad \text{Equation 02}$$

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 plant/unit to the grid in year y (MWh/yr)

EG_{facility,y} and EF_{grid,CM,y} are monitored as it was described previously. The table below provides an overview of the data used to calculate Baseline Emissions of BAESA Project for this monitoring period.

Table 05 – Baseline Emissions Parameters and Results

Year	EF _{grid,OM} * (tCO ₂ /MWh)	EF _{grid,BM} * (tCO ₂ /MWh)	W _{OM}	W _{BM}	EF _{grid,CM} * (tCO ₂ /MWh)	Net Electricity - EG _y (MWh/yr)	BE _y (Baseline Emissions) (tCO ₂ e/yr)
2016	0.6228	0.1581	0.25	0.75	0.2743	3,687,878	1,011,477
2017	0.5882	0.1581	0.25	0.75	0.2656	2,602,811	691,344
2018	0.5390	0.1581	0.25	0.75	0.2533	2,795,918	708,305
2019	0.5181	0.1581	0.25	0.75	0.2481	2,747,022	681,530
2020	0.4539	0.1581	0.25	0.75	0.2321	1,872,463	434,505
2021	0.5842	0.1581	0.25	0.75	0.2646	545,094	144,245
Total						14,251,185	3,671,406

5.2 Project Emissions

According to ACM0002, version 17.0, for hydro power project activities that result in new single or multiple reservoirs and hydro power project activities that result in the increase of single or multiple existing reservoirs, project proponents shall account for CH₄ and CO₂ emissions from the reservoirs. If the power density (PD) of power plant is greater than 4 W/m² and less than or equal to 10 W/m², emissions from the reservoirs are calculated as follows:

$$PE_{HP,y} = \frac{EF_{Res} * TEG_y}{1000} \quad \text{Equation 03}$$

Where:

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

EF_{Res} = Default emission factor for emissions from reservoirs of hydro power plants (kg CO₂e/MWh), and the default value as per EB23 is 90 Kg CO₂e/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)

If the power density of the project activity is greater than 10 W/m², PE_{HP,y} = 0.

The power density of the project activity, according to ACM0002 methodology, is calculated as demonstrated as follows:

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

Equation 05

Where:

- PD = Power density of the project activity (W/m²)
- Cap_{PJ} = Installed capacity of the hydro power plant after the implementation of the project activity (W)
- Cap_{BL} = Installed capacity of the hydro power plant before the implementation of the project activity (W). For new hydro power plants, this value is zero
- 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 (m²)
- A_{BL} = Area of the single or multiple reservoirs measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m²). For new reservoirs, this value is zero

Table 06 below shows that HPP Barra Grande has a power density greater than 4 W/m²:

Table 06: Barra Grande HPP Power Density

Item	HPP Barra Grande
Cap _{PJ}	708,000,000
Cap _{BL}	0
A _{PJ}	94,000,000
A _{BL}	0
PD	7.53

As Barra Grande HPP, presents power density greater than 4 W/m² and less than or equal to 10 W/m², project emissions are calculated using equation 4.

$$PEy = \frac{EFRes * TEGy}{1000}$$

Equation 4

Where:

PEy = Emission from reservoir expressed as tCO₂e/year;

EFRes = is the default emission factor for emissions from reservoirs, and the default value as per EB23 is 90 Kg CO₂e/MWh;

TEGy = 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).

It is important to mention that, according to ACM0002, version 17.0, for all renewable energy power generation project activities, emissions due to the use of fossil fuels for the backup generator can be neglected. Therefore, these emissions are neglected for BAESA project. Table 07 presents project emissions parameters and results.

Table 07 – Project Emissions Parameters and Results

Year	Total Electricity - TEGy (MWh/yr)	Project Emissions (PEy) (tCO ₂ e/yr)
2016	3,798,095	341,829
2017	2,682,501	241,426
2018	2,880,049	259,205
2019	2,834,446	255,101
2020	1,933,240	173,992
2021	564,605	50,815
Total	14,692,936	1,322,368

5.3 Leakage

According to ACM0002 - Consolidated baseline methodology for grid-connected electricity generation from renewable sources, version 07, there is no leakage for the project activity.

5.4 Net GHG Emission Reductions and Removals

Net GHG emission reductions of the project for this 4th MP is presented at the table below.

Table 07 – Net GHG Emission Reductions

Year	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)
2016	1,011,477	341,829	0	669,648
2017	691,344	241,426	0	449,918
2018	708,305	259,205	0	449,100
2019	681,530	255,101	0	426,429
2020	434,505	173,992	0	260,513
2021	144,245	50,815	0	93,430
Total	3,671,406	1,322,368	0	2,349,038