PROJECT CONCEPT NOTE

CARBON OFFSET UNIT (CoU) PROJECT

Title: 91 MW Sugarcane Bagasse based co-generation Energy Bioenergética AROEIRA

Version 1.0

Date March 04, 2026

First CoU Issuance Period: 11 years and 4 months

Date: Sep 01, 2014 to Dec 31, 2025

Project Concept Note (PCN)
CARBON OFFSET UNIT (CoU) PROJECT

BASIC INFORMATION	
Title of the project activity	91 MW Sugarcane Bagasse based co-generation Energy Bioenergética AROEIRA
Scale of the project activity	Large Scale
Completion date of the PCN	March 04, 2026
Project participants	AROEIRA (OWNER) FASTCARBON (AGGREGATOR)
Host Party	BRAZIL
Applied methodologies and standardized baselines	CHOOSE METHODOLOGY CDMUNFCCC Methodology ACM0006: Electricity and heat generation from biomass (Ver.16) &UCR Standard for Emission Factor
Sectoral scopes	01 Energy industries (Renewable/Non- Renewable Sources)
SDG Impacts:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16 and 17
Estimated amount of total GHG emission reductions	46,462 CoUs/yr (46,462 tCO_{2eq}/yr)

SECTION A. Description of project activity

A.1. Purpose and general description of Carbon offset Unit (CoU) project activity >>

The project titled "91 MW Sugarcane Bagasse based co-generation Energy Bioenergética AROEIRA" is composed of a sugar cane plant, located in the city of Tupaciguara in the state of Minas Gerais, Brazil.

The project originated with the authorization granted to **Usina Bioenergética Aroeira** to establish itself as an Independent Power Producer through the development and operation of the thermoelectric power plant named **"UTE 1 – Bioenergética Aroeira"**. The project included a **6 MW generator**. Shortly after, another **10 MW generator** was also authorized at UTE 1,

In May 2020, the project was expanded with the authorization of a second UTE, featuring two generating units: UG1 with **25MW** and UG2 with **10MW**, totaling **35MW** of installed capacity, christened **UTE Energética Tupaciguara**.

Finally, a third UTE was installed and authorized to begin commercial operation in June 2024, with a generating unit UG1 of **40MW**, named **UTE Triângulo Energia**."

Unit	Installed Capacity	Location	Commercial Operation Date
UTE 01 Bioenergética Aroeira	6 MW	Tupaciguara, Minas Gerais	July 2, 2014 (Dispatch nº 2,134 - ANEEL)
UTE 01 Bioenergética Aroeira	10 MW	Tupaciguara, Minas Gerais	July 4, 2014 (Dispatch nº 2,258 - ANEEL)
UTE 02 UTE Energética Tupaciguara (CET)	35 MW (25 MW + 10 MW)	Tupaciguara, Minas Gerais	May 30, 2020 (Dispatch nº 1,544 – ANEEL)
UTE 03 Triângulo Energia	40 MW	Tupaciguara, Minas Gerais	June 11, 2024 (Dispatch nº 1,755) – ANEEL)

Below are the current environmental licenses for energy production and commercialization:

UTE 01 and 02 – Operating/Environmental License - LAS Nº 1002 (Expiry date: 18/03/2030)
UTE 03 – Operating/Environmental License - LAS Nº: 1034 (Expiry date: 16/03/2031)

Purpose of the project activity:

The purpose of the activity is to generate electricity using renewable biomass (sugarcane bagasse, which is the residue from the juice extraction process for the production of ethanol and sugar), and, thus, reduce GHG emissions by displacing fossil fuel in grid-based electricity.

It is a grid-connected biomass cogeneration power plant with a high-pressure steam-turbine configuration. The high-pressure boilers are fired by bagasse to generate steam which in turn is fed to the steam turbine to generate power. The power co-generation units generate biomass-based power for captive consumption of the sugar plant and the sale of surplus power to the Brazilian electricity grid.

The UCR Project activity is the construction and operation of power plants/units that use renewable energy sources and supplies renewable electricity to the grid. The UCR project activity is thus the displacement of electricity that would be provided to the grid by more-GHG-intensive means and provides long-term benefits to the mitigation of climate change. The UCR project activity qualifies under the environmental additional positive list of pre-approved project types under the UCR carbon incentive model for issuance of voluntary carbon credits.

Usina Bioenergética Aroeira was established on October 10, 2006. Based on a modular project, the Industrial Unit was initially designed to process up to 3,000 tons of sugarcane per day, totaling approximately 2.7 million tons per harvest season in its operational phase. The effective operation of Bioenergética Aroeira began in the 2009/2010 harvest year, progressively expanding its crushing capacity.

Important Timeline:

- October 10, 2006 - Company foundation (CNPJ registration)
- July 12, 2008 - Groundbreaking ceremony (construction start)
- 2009/2010 - Industrial operations start
- June 27, 2011 - Corporate transformation to Bioenergética Aroeira S.A.

The company has experienced steady growth in its crushing capacity each year. In the 2019/2020 harvest, the mill processed 2.65 million tons of sugarcane, representing an increase of 450,000 tons compared to the previous harvest. This growth trajectory continued with significant operational milestones: in May 2024, Aroeira achieved a daily crushing record of 18,673.52 tons in a single day, surpassing the 2024 Harvest Plan target of 18,100 tons per day. Additionally, in the same month, the mill reached a monthly crushing record of 503,775.54 tons, exceeding the previous record of 463,443.50 tons achieved in July 2023.

Regarding bioelectricity generation, in 2020, the mill produced 208,200 MWh of energy, with 137,800 MWh exported to the grid, representing 66.18% of total production. In 2021, total production reached 46,173 MWh, with 34,835 MWh exported (75.4% of production). The exported energy is sufficient to supply thousands of households in the region, contributing significantly to Brazil's renewable energy matrix and reducing dependence on fossil fuels.

Tupaciguara Plant:

Usina Bioenergética Aroeira operates across multiple business segments, including the production of high-quality VHP sugar and ethanol (both anhydrous and hydrated) from sugarcane, the generation of renewable bioelectricity through biomass cogeneration power plants utilizing sugarcane bagasse, and the production of vinasse and filter cake as organic fertilizers for agricultural use.

A.2 Do no harm or Impact test of the project activity>>

There are social, environmental, economic and technological benefits which contribute to sustainable development.

- **Social benefits:**
- Creation of direct and indirect jobs (1,500+ employees), with priority for local hiring in the municipality of Tupaciguara and surrounding regions in Minas Gerais.
- Training and professional qualification programs in partnership with local educational institutions, strengthening workforce skills and technical capabilities for employees and community members.
- Health and safety initiatives, including medical and hospital assistance, dental care, pharmaceutical support, and occupational health programs for all employees.
- Improvement of local quality of life through community projects such as Projeto Futsal Aroeira (serving 6-14 year-old children), Projeto Balé Aroeira (approximately 80 children aged 8-16), and Projeto de Danças Urbanas Aroeira (approximately 40 children aged 8-16), promoting social inclusion through sports and culture.
- Infrastructure improvements for the community, including the renovation of the "Dimas Cardoso" Sports Court in Paineiras neighborhood, providing renewed spaces for sports and recreation.

- **Environmental benefits:**
- Renewable energy generation from sugarcane biomass (bagasse), reducing dependence on fossil fuels and contributing clean energy to the local grid.
- Carbon neutrality through ethanol production from sugarcane, significantly reducing greenhouse gas emissions compared to fossil fuels.
- Bonsucro certification, demonstrating compliance with global sustainability standards in sugarcane production across 53 rigorous indicators.
- Efficient waste management through co-generation systems, maximizing resource utilization and minimizing environmental impact.
  Sustainable agricultural practices that support soil health and biodiversity conservation in the Cerrado region.

- **Economic benefits:**
- Production of renewable biofuels (anhydrous and hydrated ethanol) and VHP sugar, contributing to Brazil's energy security and agricultural exports.
- Bioelectricity generation surplus sold to the national grid, providing additional revenue streams and energy reliability.
- Significant investments in local economy through direct employment, supplier contracts, and infrastructure development in Tupaciguara region.
- Tax contributions at municipal and state levels, strengthening public services in health, education, and infrastructure.
- Technology-driven efficiency improvements projected to generate R$ 100 million in value over three years through innovation initiatives.
- Implementation of modern agricultural and industrial processes aligned with international sustainability standards.
- Continuous innovation in bioenergy production, maximizing energy efficiency and resource optimization.
- Integration of sustainable farming technologies supporting long-term productivity and environmental stewardship.

Winter Clothing Drive

Technical Visit - UFU Students

Agro Women's Meeting

Fraternal Comfort Project

Composting Yard

Women of Industry' and 'Agro Energy Comes from Them' Projects

Sustainable Use of Natural Resources

Composting Yard

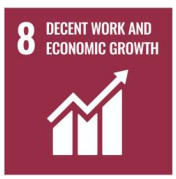
Agricultural Management System (Agrion)

Improve road safety and access to cities.

Usina Bioenergética Aroeira contributes significantly to economic, environmental and social matters, however, it stands out as it contributed to 16 SDG's.

SDG	Target	How was it achieved?
	1.1 – By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.90 a day 1.3 – Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable 1.5 – By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters	Job creation (>1,000 employees) and economic contribution to local communities through taxes, local hiring, and partnerships. Fraternal Comfort Project, a solidarity initiative focused on providing emotional comfort, care, and basic needs to vulnerable people. Maintains an ongoing donation program, in accordance with the donation policy. Winter Clothing Drive Christmas Food Basket Donations Hilda Vilela Elderly Shelter
	2.2 - By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons 2.4 - By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality	Rotary Milk Bank Campaign Adoption of sustainable agricultural practices, increase in area applied with localized vinasse and reduction in potassium chloride application, consumption of organomineral fertilizer only – planting, consumption of organomineral fertilizer only – Ratoon, reduction of nitrogen fertilizer application in fertigated areas and Reduction of trampling (soil compaction). Regenerative agricultural practice (Use of green manure).
	3.1 - By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births 3.8 - Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all	Better Maternity (prenatal monitoring, free and unlimited 24/7 care for pregnant women and newborns, plus a 100.00 card benefit after the baby's birth). Breathe Well Project (monitoring and treatment for smokers, with free supply of medication throughout the entire treatment).

	3.9 – By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination 3.a - Strengthen the implementation of the World Health Organization Framework Convention on Tobacco Control in all countries, as appropriate	EAP (Employee Assistance Program), with free medical, nutritional, and psychological consultations for employees and family members. Plus, financial and legal counseling. RPP (Respiratory Protection Program) - a means of controlling roles with respiratory risk, based on respiratory history and mask fit testing.
	4.3 - By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, at affordable prices, including university 4.4 - By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship 4.7 - By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development	Bioenergética Aroeira's Scholarship Program for employees, free short courses in partnership with colleges, and Technical Visits for UFU Students. Monte Alegre de Minas Cultural Project Year-End Presentation Sports projects, with donation of uniforms and encouragement of practice."
	5.1 – End all forms of discrimination against all women and girls everywhere 5.5 - Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life	Adoption of a Code of Ethics and Conduct and a Human Resources Policy that prohibit any type of discrimination, including gender discrimination. Campaign and publications: Women of Sugarcane, which promotes and confirms the rise of female participation in the bioenergy sector.

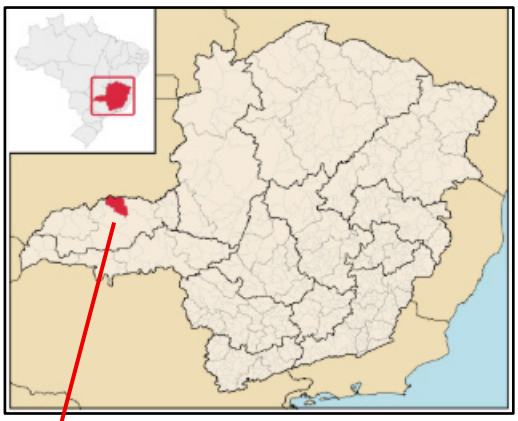
	6.3 - By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally 6.4 - By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity 6.6 - By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	Increase water-use efficiency, water reuse, smart irrigation, and water monitoring to reduce withdrawal and waste. Protect aquatic ecosystems
	7.2 - By 2030, increase substantially the share of renewable energy in the global energy mix.	Clean Energy Generation
	8.3 - Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services. 8.8 - Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment	Generation of more than 1,000 direct and indirect jobs, PAS (Safe Attitude Program) and Befit initiatives, occupational health and safety policies, HR and training. Master Cana Social Award, recognizes and encourages excellence in human resources management and social responsibility within the bioenergy sector. By honoring companies that prioritize employee well-being, safety, and professional development, the award directly promotes the protection of labor rights and the maintenance of safe and secure working environments for all employees
	9.1 - Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all	Agricultural Management System (Agrion), investments in automation, digitalization, and low environmental impact processes. Modernized processes and energy efficiency at every stage.

	9.4 - By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities	Reintroduction of industrial residues (filter cake and ash) into the production process as agricultural inputs. Innovation projects BioAroeira Technology and Innovation Week
	10.4 – Adopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality	Living wage policy, workforce covered by benefits, and salary review policy.
	11.2 - By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons 11.4 - Strengthen efforts to protect and safeguard the world's cultural and natural heritage 11.5 - By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations	Rural road rehabilitation and manteinance: the plant performs maintenance on the rural road network, which directly benefits local residents' traffic and access to the city. Holding cultural events in public squares promotes the appreciation of local culture, community leisure, and the positive use of public spaces. Fire brigades and monitoring teams that, in addition to protecting the crops, safeguard rural areas and the city of Tupaciguara against uncontrolled fires.
	12.2 - By 2030, achieve the sustainable management and efficient use of natural resources 12.4 - By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment 12.5 - By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse	100% employee environmental engagement; reduce water, energy, and fuel consumption in operations and events Sustainable use of natural resources, waste generation reduction, management of chemicals and waste. Composting Yard: recycling and reuse of industrial by-products (filter cake and ash), transforming what would be considered waste into a valuable input (fertilizer), avoiding disposal into the environment and reducing the need to purchase new chemical fertilizers.

	13.1 - Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries 13.2 - Integrate climate change measures into national policies, strategies and planning.	Production of ethanol, a less polluting fuel than others such as gasoline and diesel. Investments in energy efficiency and GHG reduction.
	15.1 - By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements. 15.5 - Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species.	Recovery and improvements in PPA (Permanent Preservation Areas) and LR (Legal Reserve) areas within compensatory measure execution zones and processes for forming ecological corridors between fragments. Fauna Monitoring Program.
	16.1 - Significantly reduce all forms of violence and related death rates everywhere 16.5 - Substantially reduce corruption and bribery in all their forms 16.6 - Develop effective, accountable and transparent institutions at all levels	Code of Ethics, Whistleblowing Channel (operated independently), ESG Committee and structured corporate governance. Whistleblowing Channel
	17.16 - Enhance the Global Partnership for Sustainable Development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the Sustainable Development Goals in all countries, in particular developing countries 17.17 - Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships	Partnerships with universities, research centers, and suppliers for innovation in ethanol, VHP sugar, and cogeneration (Innovation Week)

A.3. Location of project activity >>

Country: Brazil
District: Tupaciguara
State: Minas Gerais
Zip Code: 38200-000
Latitude: -18.7564º
Longitude: -48.6114º



A.4. Technologies/measures >>

The UCR project activity is a grid-connected bagasse-based cogeneration power plant with a high-pressure steam-turbine configuration. The UCR project activity is the electricity generation capacity and the installation of facilities for allowing captive use and export of electricity to the electricity grid.

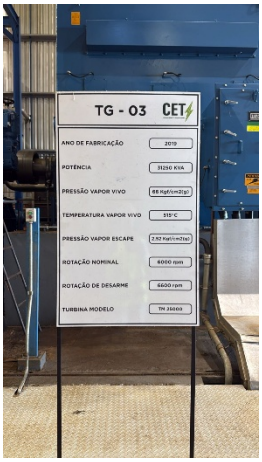
The primary technology for the project activity is direct combustion of biomass residues, and power generation using the Rankine cycle technology. Power generation through this method involves combustion of biomass residues directly in the boiler, which is capable to generate high-pressure high-temperature steam, which is fed to a steam turbine that drives a generator.

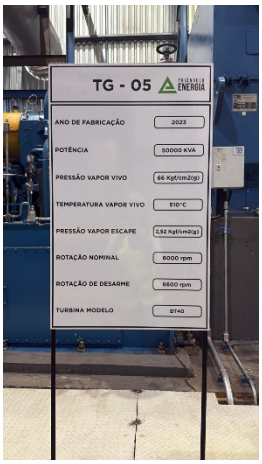
The main elements of the power plant are as follows.
- A boiler unit which converts the energy available in the fuels into thermal energy;
- A steam turbine unit which converts thermal energy into mechanical energy;
- An alternator unit, which converts mechanical energy into electrical power.

A number of other equipment components, as listed below, also form part of the biomass power plant.
- Fuel and ash handling equipment
- Water cooled condenser system for cooling the exhaust steam
- DM Water system and Air Compressor Plant
- Electrical systems and Automation system

Photographs of the Aroeira Sugarcane Mill

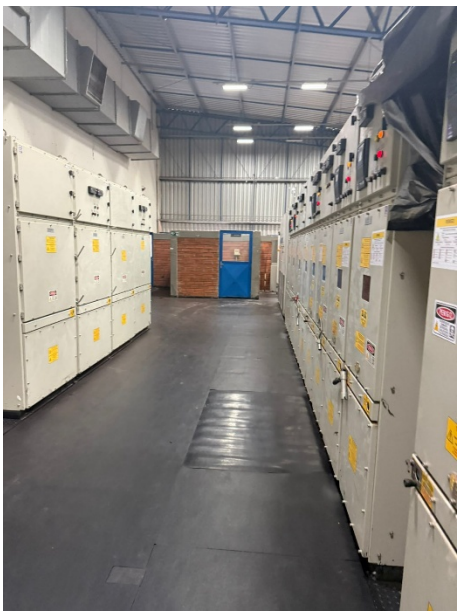
Thermal Generation Center





Generators

Boilers



Electrical Systems

Generators

Generator nº 2

Generator nº 3

Generator nº 4

Generator nº 5

The system consists of five power-generating units supplied by three boilers. Boilers nº. 1 is currently switched off and serves only as a backup in case there are any problems with the other two. For turbines 1 and 2, there is a pressure reducer from 65 to 42 kgf/cm² when fed by boilers 2 and 3.

Boiler	Nº 01	Nº 02	Nº 03
Manufacturer	MITRE	CALDEMA	CALDEMA
Capacity (Tons/h)	100	140	250
Serial number	MPB-100-09120	164 / 2018	184 / 2023
Year of manufacturer	2009	2018	2023
Maximum allowable working pressure (kgf/cm^{2}g)	48	80	80
Hydrostatic Test Pressure (kgf/cm^{2}g)	72	120	120
Pressure (kgf/cm^2)	42	67	67
Degree of super heat ºC (Steam)	400	520	520
Heating surface area (m^2)	2,200	2,686	6,881
Design Standard	ASME I -2004	ASME I -2017	ASME I -2021
category	A	A	A

Boiler nº 1

Boiler nº 2

Boiler nº 3

Alternator/ Generator	Nº 1	Nº 2	Nº 3	Nº 4	Nº 5
Year of manufacturer	August, 2013	August, 2009	November, 2019	November, 2019	May, 2023
Manufacturer	WEG	WEG	WEG	WEG	WEG
Power Rated (kVA)	7,500	12,500	31,250	12,500	50,000
Serial Number	1020139401	1004469221	1049554701	1050886711	1082268008
Voltage (V)	13,800	13,800	13,800	13,800	13,800
Current (Amps)	313.8	523	1,307	523	2,092
Power Factor (cos φ)	0.80	0.80	0.80	0.80	0.80
Efficiency (75%, 100% of load)	95.9%, 96.2%	96.9%, 97.2%	97.1%, 97.5%	96.7%, 96.9%	97.5%, 97.7%
Generator Rated Speed (rpm)	1,800	1,800	1,800	1,800	1,800
Frequency (Hz)	60	60	60	60	60
Generator Model	ST40-07C0PV	SPW800	ST41-1000	ST41-710	ST41-1120

Alternator/ Generator nº 1 – UTE 01

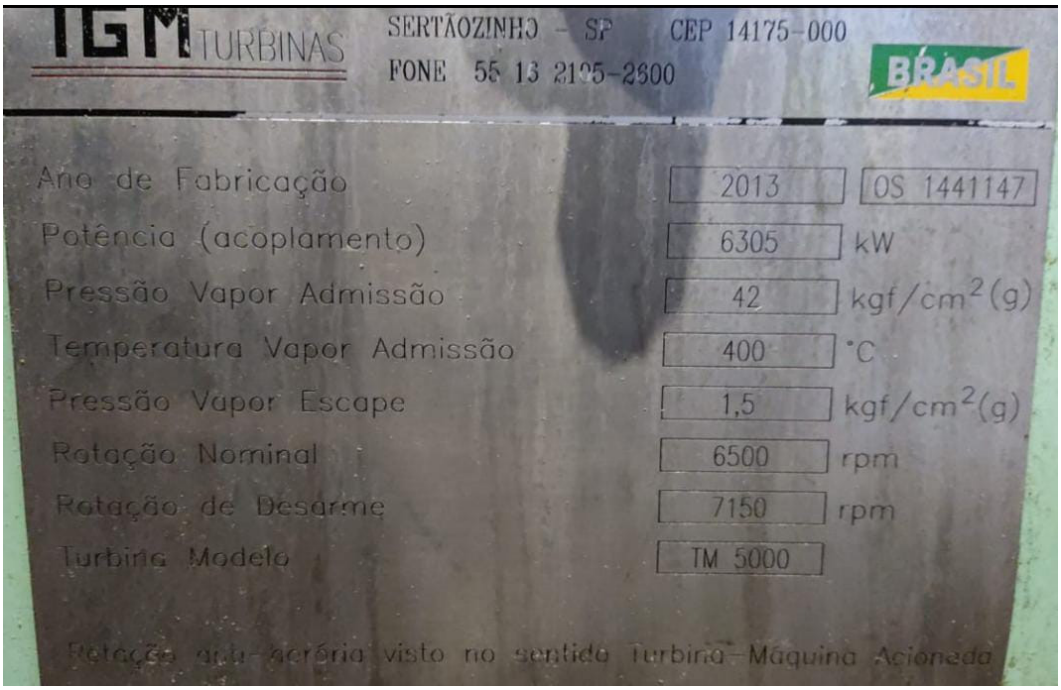
Alternator/ Generator nº 2 – UTE 02

Alternator/ Generator nº 3 – UTE 02

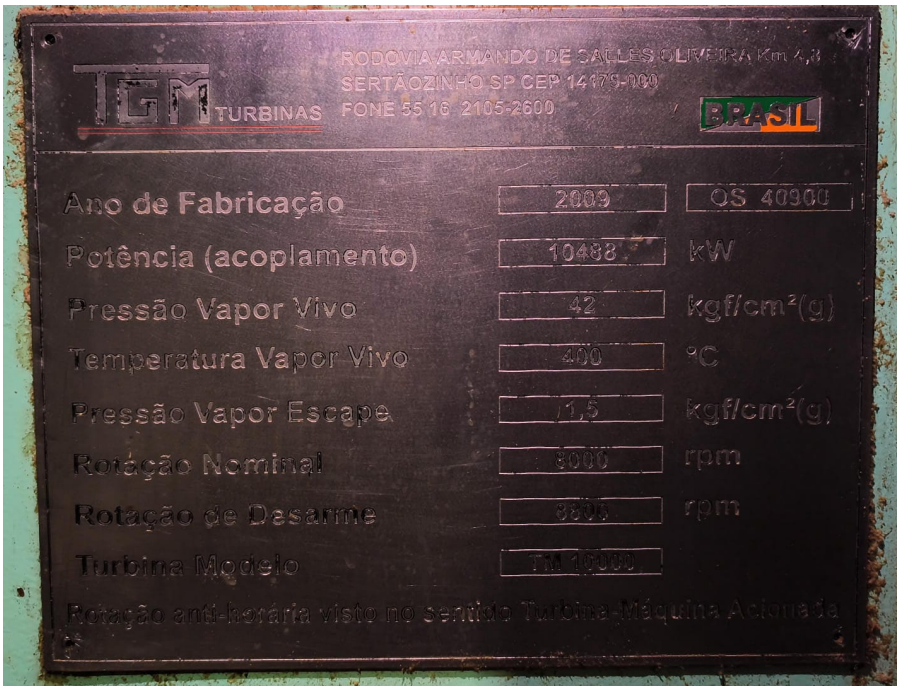
Alternator/ Generator nº 4 – UTE 02

Alternator/ Generator nº 5 – UTE 03

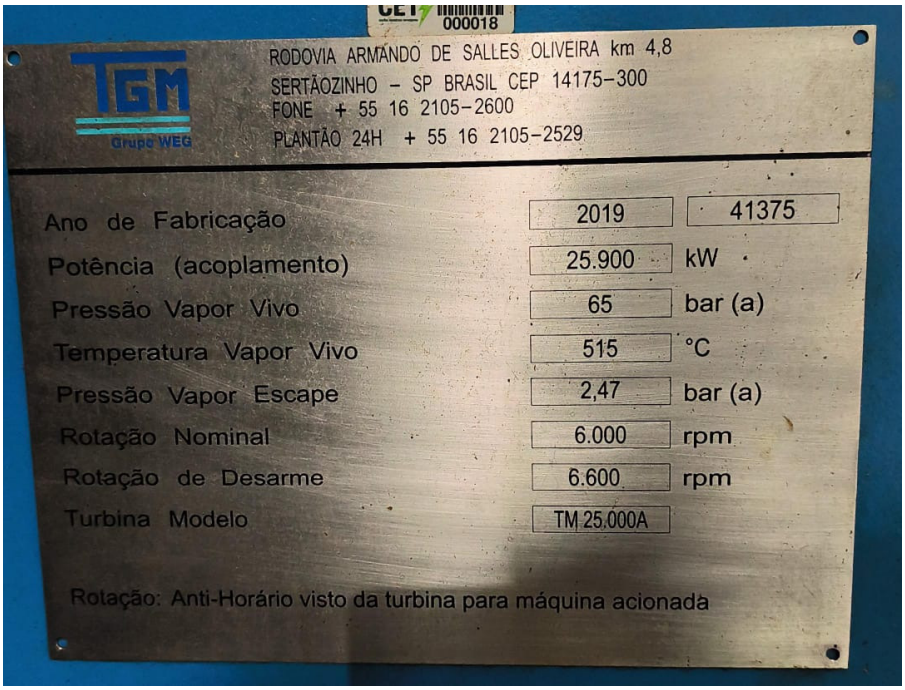
Turbine	Nº 1	Nº 2	Nº 3	Nº 4	Nº 5
Year of manufacturer	2013	2009	2019	2020	2023
Manufacturer	TGM Turbinas	TGM Turbinas	TGM Turbinas	TGM Turbinas	TGM Turbinas
Power Rated (kW)	6,305	10,488	25,900	10,456	41,549
Live Steam Pressure (Bar)	42	42	65	65	64.74
Live Steam Temperature (ºC)	400	400	515	515	510
Steam Exhaust Pressure (Bar)	1.5	1.5	2.47	0.10	2.47
Turbine Rated Speed (rpm)	6,500	8,000	6,000	9,600	6,000
Turbine Disarm Speed (rpm)	7,150	8,800	6,600	10,560	6,600
Turbine Model	TM 5000	TM 10000	TM 25.000A	CT 25F	BT40



Turbine nº 1 – UTE 01

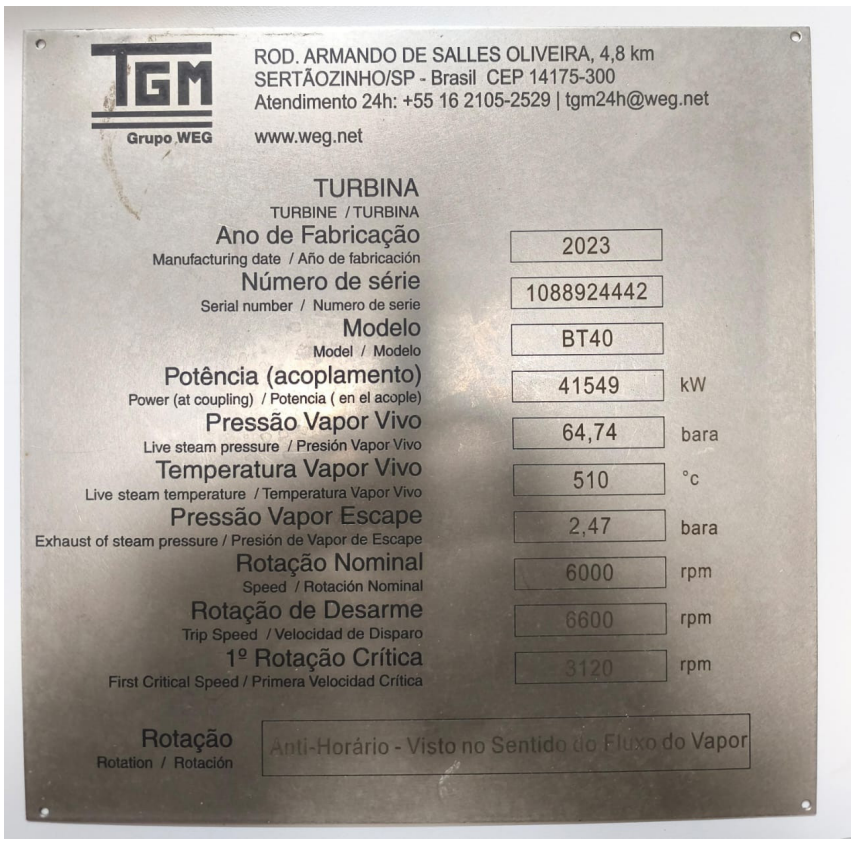


Turbine nº 2 – UTE 02



Turbine nº 3 – UTE 02

Turbine nº 4 – UTE 02



Turbine nº 5 – UTE 03

A.5. Parties and project participants >>

Party (Host)	Participants
Brazil	**Owner:** USINA BIONERGÉTICA AROEIRA Rodovia BR 452, km 77, S/N, Zona Rural., Tupaciguara - MG, Zip Code: 38480-000 https://www.bioaroeira.com.br/ **Aggregator:** FastCarbon Consultoria e Negócios Ltda Rua Viradouro, 63, conjunto 61, Itaim Bibi São Paulo/SP Zip Code: 04538-110 https://fastcarbon.com.br

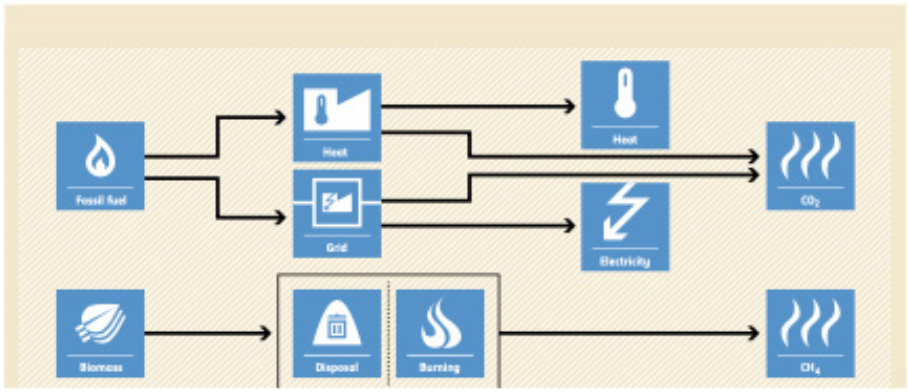
A.6. Baseline Emissions>>

The approved baseline methodology has been referred from the indicative simplified baseline and monitoring methodologies for selected large scale UNFCCC CDM project activities that involve generation of power and heat in thermal power plants, including cogeneration plants using biomass.

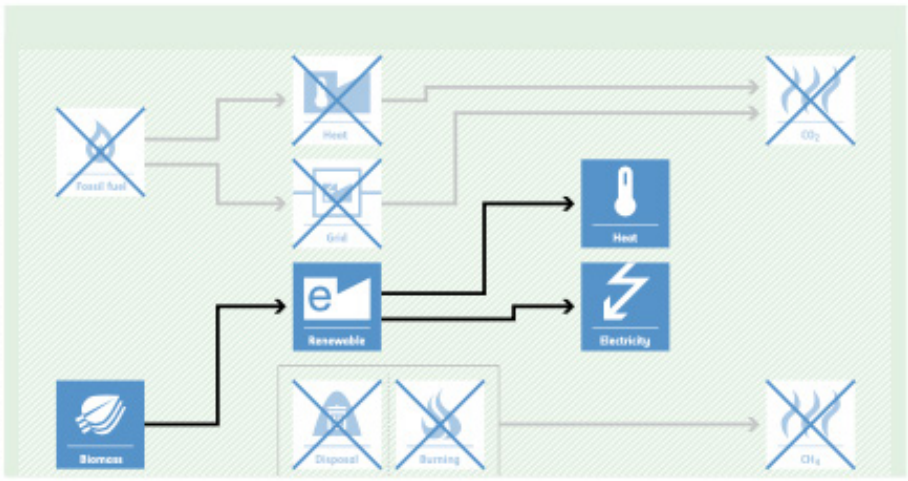
Typical activities under ACM0006 are new plants, capacity expansions, energy efficiency improvements or fuel switch projects.

ACM0006 Electricity and heat generation from biomass

BASELINE SCENARIO
Electricity and heat would be produced by more-carbon-intensive technologies based on fossil fuel or less-efficient biomass power and heat plants. Biomass could partly decay under anaerobic conditions, bringing about methane emissions.



PROJECT SCENARIO
Use of biomass for power and heat generation instead of fossil fuel or increase of the efficiency of biomass-fuelled power and heat plants. Biomass is used as fuel and decay of biomass is avoided.



A.7. Debundling>>

This “91 MW Sugarcane Bagasse based co-generation Energy Bioenergética AROEIRA” project is not a debundled component of a larger project activity.
There is no registered large-scale UCR project activity or a request for registration by another small-scale project activity:

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

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines >>

SECTORAL SCOPE - 01 Energy industries (Renewable/Non-renewable sources)

TYPE I - Renewable Energy Projects

CATEGORY - ACM0006: “Electricity and heat generation from biomass” Version 16.0

B.2. Applicability of methodologies and standardized baselines >>

This methodology is applicable to project activities that operate biomass (co-gen) fired power and heat plants.

The project activity is a power generation project using a biomass (bagasse) and displaces CO2 emissions from electricity generation in power plants that are displaced due to the project activity. Since the project activity utilizes biomass (bagasse) for the generation of power and supplies it to the local grid, it displaces fossil fuel, and hence it meets the primary applicability criteria of the methodology.
The project activity is a power plant that encompasses cogeneration plants, i.e. power plant in which at least one heat engine simultaneously generates both process heat and power. The total installed capacity of project activity is 91 MW which is acceptable as per the applied large-scale methodology.
The installation of a new biomass residue fired power generation unit, which are places existing power generation capacity fired with fossil fuel as in the project plant (power capacity expansion projects) is also included in this methodology.
For the purposes of this methodology, heat does not include waste heat, i.e. heat that is transferred to the environment without utilization, for example, heating flue gas, heat transferred to cooling towers or any other heat losses.

The biomass used by the project plant is not stored for more than one year. The biomass used by the project plant is not processed chemically or biologically (e.g. through esterification, fermentation, hydrolysis, pyrolysis, bio-or chemical degradation, etc.) prior to combustion.
The Project Activity uses biomass residues from a production process (e.g. production of sugar and ethanol), and the implementation of the project does not result in an increase of the processing capacity of (the industrial facility generating the residues) raw input (e.g. sugar and ethanol) or in other substantial changes (e.g. product change) in this process.
The project activity unit does not co-fire fossil fuel and/or does not exceed the limit of 25% co-firing fossil fuel criteria as per the UCR Protocol for such projects.
Bio-mass generated power is used for direct grid supply and for meeting the captive need facility. The project activity is involving the grid-connected bagasse-based electricity generation capacity involving the installation of facilities for all owing the export of electricity to the regional grid.
Bio-mass is not sourced from dedicated plantations. The existing installed turbo-generators are fired by bagasse, a by-product of the sugarcane processing and ethanol, a biomass residue
Bagasse is burnt in boilers as generated from the sugar mill and does not require any specific technology for its preparation before combustion. No fuel preparation equipment has been installed at site for preparation of bagasse. Hence no significant energy quantities are required to prepare the biomass residues for fuel combustion.
The project activity also does not include any GHG emissions related to the decomposition or burning of biomass. The baseline heat emissions for the project activity are not included in the project boundary nor does it claim for emission reductions from heat.

B.3. Applicability of double counting emission reductions >>

The project is not registered in any other GHG mechanism. Hence, there will not be any double counting possibility.

The biomass-based boiler and turbine have unique serial numbers which are visible on the units. The generated electricity is measured using energy meters who also has unique serial numbers. The Monitoring Report will have the details of the same and will be provided to the UCR verifier during the verification process.

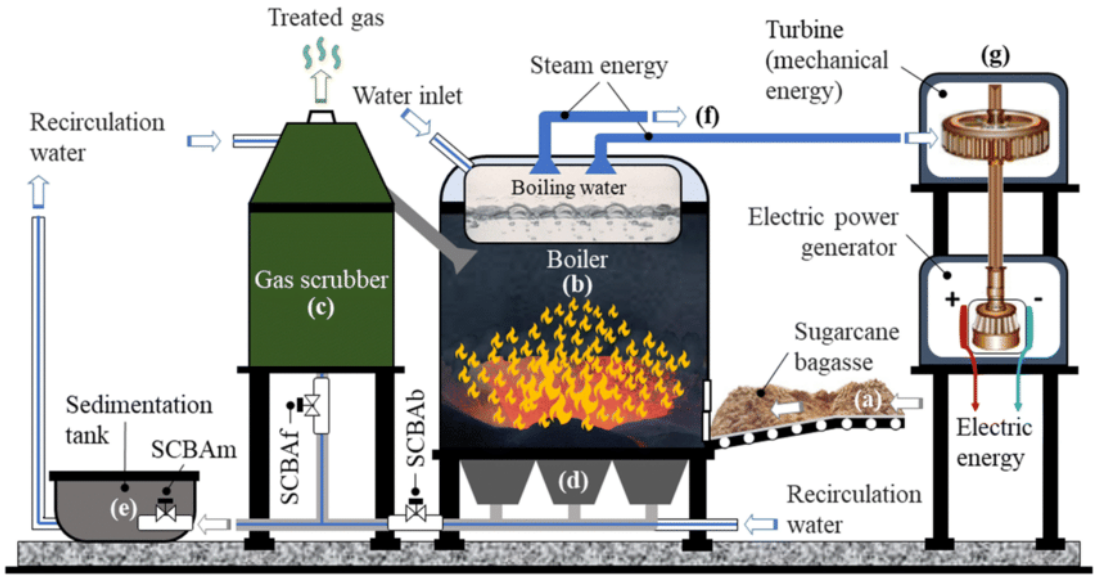
Usina Bioenergética Aroeira is also certified by Renovabio, which is the Brazilian National Biofuels Program, created to encourage the production and use of sustainable biofuels, such as ethanol and biodiesel, replacing gasoline and diesel, which are more polluting fossil fuels. The lower the carbon intensity of the biofuel, the greater the difference in relation to fossil fuels, resulting in certificates called CBIOs, which can be traded. The impact of exported energy on the number of CBIOs is very small compared to other factors such as agricultural and industrial efficiency, and it's not the focus of Renovabio certification. Exported energy is just one of many factors considered.

Although RenovaBio and the carbon credit certification system have similar objectives with regard to decarbonization, they are different programs and work in different ways, with their own regulations and mechanisms. However, to adopt a conservative position and avoid double counting, the percentage of Carbon Credits will be deducted here in this program, in the same proportion in which the exported energy boosted the generation of CBIOs, in the respective periods in which they were generated.

B.4. Project boundary, sources and greenhouse gases (GHGs)>>

The project boundary includes the physical, geographical site(s) of:

- All plants generation power located at the project site.
- All power plants connected physically to the electricity system (grid) that the projects plant is connected to.
- The means of transportation of biomass to the project site if the feedstock is biomass residues, the site where the biomass residues would have been left for or dumped.



Leakage Emissions (LE_y)

Leakage emissions is not applicable as the project activity does not use technology or equipment transferred from another activity.

Hence $LE_y = 0$

Scenario	Source	GHG	Included?	Justification/Explanation
Baseline	Grid Connected Electricity Generation	CO_2	Yes	Main emission source
		CH_4	No	Not identified in the baseline methodology
		N_2O	No	Not identified in the baseline methodology
Project Activity	Sugarcane Bagasse based co-generation Activity	CO_2	No	Zero-emissions grid connected electricity generation from renewable energy
		CH_4	No	Zero-emissions grid connected electricity generation from renewable energy
		N_2O	No	Zero-emissions grid connected electricity generation from renewable energy

Project Emissions (PE_y)
The project emissions (PEy) under the methodology may include;

N_2O Excluded simplification. conservative

This is

- CO_2 emissions from transportation of biomass residue to the project site
- CO_2 emissions from on-site consumption of fossil fuels due to project activity
- CO_2 emissions from electricity consumption at the project site that is attributable to the project activity and
- CH_4 emissions from combustion of biomass.

Where,

PET_y = are the CO_2 emissions during the year y due to transport of the biomass to the project plant in tons of CO_2,

$PEFF_{CO2,y}$ = are the CO_2 emissions during the year y due to fossil fuels co-fired by the generation facility in tons of CO_2,

PEEC,y = are the CO_2 emissions during the year y due to electricity consumption at the project site that is attributable to the project activity in tons of CO2,

GWPCH4 = is the Global Warming Potential for methane valid for the relevant commitment period and,

$PE_{Biomass},CH_4,y$ = are the CH_4 emissions from the combustion of biomass during the year y. The proposed project activity does not have any CO_2 emissions due to off-site transportation of biomass, or from fossil fuel co-firing and from electricity consumption at site. The project activity also doesn't include CH_4 emissions from the combustion of biomass.

Hence,
$PET_y = 0$, $PEFF_{CO2}$, $y = 0$, $PEEC,y = 0$ and, $PE_{Biomass},CH4,y = 0$.

Therefore, $PE_y = 0$.

B.5. Establishment and description of baseline scenario (UCR Standard or Methodology) >>

The baseline scenario identified at the PCN stage of the project activity is:

Renewable energy technology that displaces technology using fossil fuels, wherein the simplified baseline is the fuel consumption of the technology that would have been used in the absence of the project activity, times an emission factor for the fossil fuel displaced.

The baseline emissions due to displacement of electricity are determined by net quantity of electricity generation as a result of the project activity (incremental to baseline generation) during the year y in MWh times the CO_2 emission factor for the electricity displaced due to the project activity during the year y in tCO_2/MWh.

Given that power generation for internal consumption is part of the present project activity, emission reductions are only claimed from on-site incremental power generation that is injected to the grid. Therefore, the baseline scenario is the emission of GHG from the present electricity generation mix of the electricity grid.

The actual emission reduction achieved during the first issuing period shall be submitted as a part of monitoring and verification. For an ex-ante estimation for the period from 2014 to 2024, the following calculation has been submitted:

Emission Reductions are calculated as follows:

ERy = BEy – PEy – LEy Where:
ERy = Emission reductions in year y (tCO_2/y)
BEy = Baseline Emissions in year y ($t\ CO_2/y$)
PEy = Project emissions in year y (tCO_2/y)
LEy = Leakage emissions in year y (tCO_2/y)

Estimated Annual Baseline Emission Reduction: $BEy = EG_{PJ,y} \times EF_{grid,y}$

BEy = Baseline emissions in year y ($t\ CO_2$)

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

$EF_{grid,y}$ = Combined margin CO_2 emission factor for grid connected power generation in year y calculated using the latest version of the "Tool to calculate the emission factor for an electricity system" ($t\ CO_2/MWh$)

As determined by “Tool to calculate the emission factor for an electricity system – Version 7.0” for Brazil (am-tool-07-v7.0), the combined margin should be calculated using the “Weighted average CM”, as it follows:

$EF_{grid,CM,y} = EF_{grid,OM,y} \times wOM + EF_{grid,BM,y} \times wBM$ Equation (16)

Where:

$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year y (t CO_2/MWh)
$EF_{grid,OM,y}$ = Operating margin CO_2 emission factor in year y (t CO_2/MWh)
wOM = Weighting of operating margin emissions factor (per cent)
wBM = Weighting of build margin emissions factor (per cent)

Since the project is a biomass co-generation project:

wOM = 0.5
wBM = 0.5

For the Build and Operation margin emission factor, was considered the public data for the year of 2024 available in the Ministry of Science, Technology and Innovation website

OM = 0.4473

BM = 0.0523

Resulting in $EF_{grid,CM,y}$ = 0.2498

Estimated power generation per year as 208,000 MWh,

Resulting in *BEy* = 51,958 tCO_2

Since the project is a biomass co-generation project:

PEy = 0
LEy = 0

So as result *ERy* = *BEy*

Using the UCR principles of conservativeness in emission reductions quantification, prevention of over-generation of credits and based on stakeholder comments on project emissions, transport emissions are calculated by applying a net-to-gross adjustment of 10%, i.e. multiply the emission reductions determined based on the applied methodology by 0.9 to determine the final amount of emission reductions.

ERy = 51,958 x 0.9 = 46,462 tCO_2 / year

Estimated Annual emission reductions: ERy = 46,462 tCO_2 / year (46,462 CoUs /year)

B.6. Prior History>>

The project activity has not applied to any other GHG program for generation or issuance of carbon offsets or credits for the said crediting period.

Usina Bioenergética Aroeira is also certified by Renovabio, which is Brazilian National Biofuels Program, created to encourage the production and use of sustainable biofuels, such as ethanol and biodiesel, replacing gasoline and diesel, which are more polluting fossil fuels. It certifies companies based on the environmental efficiency of production, allowing them to issue CBIOs (Decarbonization Credits), which can be sold. Although RenovaBio and the carbon credit certification system have similar objectives when it comes to decarbonization, they are different programs and work in different ways, with their own regulations and mechanisms.

The CBIO is a financial instrument generated **exclusively** by the production **of biofuels**, in this case, **ethanol**. On the other hand, the carbon credits proposed in this project are generated by surplus **renewable energy exported** to the electricity grid.

- Law No. 13,576/2017 (RenovaBio Law, https://www.planalto.gov.br/ccivil_03/_ato2015-2018/2017/lei/l13576.htm): Establishes the National Biofuels Policy, **focusing on the production and use of biofuels**, without mentioning the generation of carbon credits for surplus energy.

- ANP Resolution No. 758/2018 (https://atosoficiais.com.br/anp/resolucao-n-758-2018-regulamenta-a-certificacao-da-producao-ou-importacao-eficiente-de-biocombustiveis-de-que-trata-o-art-18-da-lei-no-13-576-de-26-de-dezembro-de-2017-e-o-credenciamento-de-firmas-inspetoras?origin=instituicao&q=Resolu%C3%A7%C3%A3o%20ANP%20n%C2%BA%20758/2018): Regulates the certification of efficient production of biofuels, treating electrical energy as a co-product, **but not as a direct source of CBIOs**.

- Technical Note nº 62/2018/SBQ/ANP: Details the methodology for calculating CBIOs, reaffirming that exported electrical energy is considered only as a co-product.

In the Renovabio program, the RenovaCalc tool is used, which uses exported energy as one of the factors to calculate the plant's Energy-Environmental Efficiency Rating (NEEA), that is an indicator of the efficiency of the production process, specifically in the industrial phase. A higher NEEA indicates a more efficient process, which generally results in a lower carbon intensity. Impact on CBIOs: the amount of CBIOs generated is based on the difference between the carbon intensity of the biofuel and that of the equivalent fossil fuel. The lower the carbon intensity of the biofuel, the greater the difference compared to fossil fuel, resulting in more CBIOs generated.

Role of Exported Energy in generating CBIOs:

Exported electrical energy is considered a beneficial co-product. It "credits" the process, effectively reducing the carbon intensity attributed to the biofuel. This is because exported renewable energy replaces potentially more carbon-intensive energy on the grid.

If a plant exports more renewable energy, its NEEA tends to improve. A better NEEA generally results in a lower carbon intensity for the ethanol produced. With lower carbon intensity, the gap with fossil fuel increases. Consequently, more CBIOs are generated per unit of biofuel produced.

Whereas the impact of exported energy on the amount of CBIOs is generally marginal compared to other factors such as agricultural and industrial efficiency, exported energy is just one of the many factors considered in the NEEA calculation. However, to adopt a conservative position and avoid double counting, percentage of Carbon Credits will be deducted here in this program, in the same proportion in which the exported energy boosted the generation of CBIOs, in the respective periods in which they were generated:

$$NEEA = \left(\frac{EF_{fossil} - EF_{bio}}{EF_{fossil}} \right) \times 100$$

Where:

- EF_{fossil} = **Emission Factor of the reference fossil fuel** (gCO_2eq/MJ)
- EF_{bio} = **Emission Factor of the assessed biofuel** (gCO_2eq/MJ)

The $\boldsymbol{EF_{bio}}$ is obtained by considering all emissions from the biofuel's life cycle, including:

- Biomass production
- Transportation
- Industrial processing
- Distribution

Since the NEEA formula depends on the difference between EF_{fossil} and EF_{bio}, any reduction in EF_{bio} (through fossil fuel replacement or clean energy exports) boosts the efficiency score and allows for the issuance of more CBIOs per liter of ethanol.

The number of CBIOs (Decarbonization Credits) generated by a biofuel producer is calculated using the following formula:

$$CBIOs = \frac{V_{bio} \times \text{LCV} \times \text{NEEA} \times D}{10^3}$$

Where:

- V_{bio} = **Volume of biofuel** produced and sold (in cubic meters, m^3)
- **LCV** = **Lower Calorific Value** of the biofuel (MJ/L)
- **NEEA** = **Energy-Environmental Efficiency Score** (%)
- **D** = **Density** of the biofuel (kg/L)

So, we can conclude that NEEA is directly proportional to the generation of CBIOs. Since exported energy is one of the factors that improves the NEEA score, to be conservative, we will calculate how much the exported energy contributes to the increase in the NEEA score. Then, we will deduct this percentage from the Carbon Credits that will be generated here in this program, during the same period in which CBIOs were generated, for the issuance of carbon credits.

NEEA with exported eletricity	X
NEEA without exported eletricity	Y
Increase (%)	$\frac{(X-Y)}{Y}$
Adjustment Factor	$1-\frac{(X-Y)}{Y}$

The table shows the calculation of the adjustment factor to account for the impact of exported electricity on the NEEA score and, consequently, on CBIOs.

- **NEEA with exported electricity (X)** → Efficiency score considering exported electricity.

- **NEEA without exported electricity (Y)** → Efficiency score without considering exported electricity.

- **Increase (%)** → The impact of exported electricity on NEEA is given by:

$$\frac{(X-Y)}{Y}$$

This represents **how much the exported electricity increased the NEEA score**.

Adjustment Factor → To adjust the exported electricity for carbon credit generation without double counting with CBIOs, we apply the factor:

$$1-\frac{(X-Y)}{Y}$$

This factor can be used to **discount the fraction of Carbon Credits,** regarding exported energy that has already contributed to increasing NEEA, and respectively the CBIOs.

This percentage calculation will be applied in the specific period of issuance of the CBIO and credit year.

B.7. Changes to start date of crediting period >>

Crediting period start: Sep 01, 2014.
There is no change in the start date of crediting period.

B.8. Permanent changes from PCN monitoring plan, applied methodology or applied standardized baseline >>

There are no permanent changes from registered PCN monitoring plan and applied methodology.

B.9. Monitoring period number and duration>>

First Issuance Period: 11 years and 4 months – Sep 01, 2014 to Dec 31, 2025

B.8. Monitoring plan>>

All energy generation data is acquired through CCEE meters installed in Usina Bioenergética Aroeira substation.

Meter	Serial Number	Specification
1	MW-1809A999-02 (Main) UTE 01 – Bioenergética Aroeira	Schneider Power Logic ION8650 3 Phases 57.7 ~ 220 V 1 A /5 A (max 20 A) 60 Hz Class D kh 1,8 Wh-varh/pulse Year of manufacturer: 2018 Last Calibration: february 10,2026 Installation Code: MGUBIAUBAR101P
2	MW-1810A175-02 (Check) UTE 01 – Bioenergética Aroeira	Schneider Power Logic ION8650 3 Phases 57.7 ~ 220 V 1 A /5 A (max 20 A) 60 Hz Class D kh 1,8 Wh-varh/pulse Year of manufacturer: 2018 Last Calibration: february 10,2026 Installation Code: MGUBIAUBAR101R

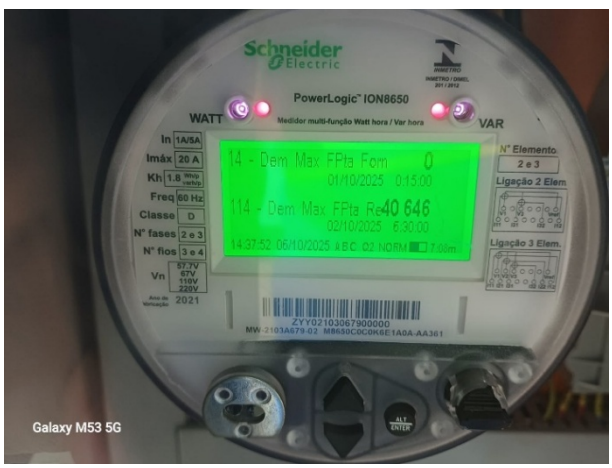
3	MW-1810A171-02 (Main) UTE 02 – Central Energética Tupaciguara	Schneider Power Logic ION8650 3 Phases 57.7 ~ 220 V 1 A /5 A (max 20 A) 60 Hz Class D kh 1,8 Wh-varh/pulse Year of manufacturer: 2018 Last Calibration: february 10,2026 Installation Code: MGUBIAUBAR202P
4	MW-1810A137-02 (Check) UTE 02 – Central Energética Tupaciguara	Schneider Power Logic ION8650 3 Phases 57.7 ~ 220 V 1 A /5 A (max 20 A) 60 Hz Class D kh 1,8 Wh-varh/pulse Year of manufacturer: 2018 Last Calibration: february 10,2026 Installation Code: MGUBIAUBAR202R
5	MW-2305A342-02 (Main) UTE 03 – Triângulo Energia	Schneider Power Logic ION8650 3 Phases 57.7 ~ 220 V 1 A /5 A (max 20 A) 60 Hz Class D kh 1,8 Wh-varh/pulse Year of manufacturer: 2023 Last Calibration: june 17,2023 Installation Code: MGUBIAUTRIA03P
6	MW-2305A492-02 (Check) UTE 03 – Triângulo Energia	Schneider Power Logic ION8650 3 Phases 57.7 ~ 220 V 1 A /5 A (max 20 A) 60 Hz Class D kh 1,8 Wh-varh/pulse Year of manufacturer: 2023 Last Calibration: june 17,2023 Installation Code: MGUBIAUTRIA03R

Meter 1 (UTE 01 – Bioenergética Aroeira - Main)

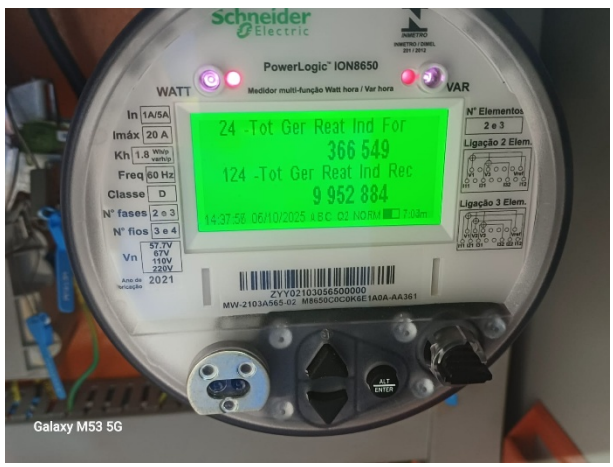
Meter 2 (UTE 01 – Bioenergética Aroeira - Check)

Meter 3 (UTE 2 – Central Energética Tupaciguara - Main)

Meter 4 (UTE 2 – Central Energética Tupaciguara - Check)



Meter 5 (UTE 3 – Triângulo Energia - Main)



Meter 6 (UTE 3 – Triângulo Energia Check)

The meters are locked and can be manipulated only under CCEE or ONS authorization. All generation data is available digitally and can be checked by the Usina Bioenergética Aroeira personnel through CCEE system at CCEE website.

Parameters being monitored or used in emission reductions determination:

Data/Parameter	$EF_{grid,y}$
Data unit	tCO2e/MWh
Description	CO_2 emission factor of the grid electricity in year y
Source of data Value(s) applied	https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/dados-e-ferramentas/fatores-de-emissao
Measurement methods and procedures	As per the requirements in "Tool to calculate the emission factor for an electricity system"
Monitoring frequency	Monthly
Purpose of data	To estimate baseline emissions

Data / Parameter:	$EG_{pj,y}$
Data unit:	MWh
Description:	Quantity of net electricity generation and export supplied by the project plant/unit to the grid in year y
Source of data:	The data provided by the Câmara de Comercialização de Energia Elétrica – CCEE (Electric Energy Trading Chamber)
Measurement procedures (if any):	This parameter is monitored using bidirectional energy meter
Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording
QA/QC procedures:	The meters and current transformers will be subjected to periodic calibrations/audits from ANEEL and CCEE to certify that electric energy injected in the grid data is reliable and precise, in a way to guarantee the reliability of the national grid and energy supply. As determined by government entity ONS (National Electric System Operator), in the "Submodule 6.16 - Maintenance of the billing measurement system" item 1.1.2, the calibration of the meters must occur every 5 years.