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Project design document form
(Version 11.0)

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

BASIC INFORMATION	
Title of the project activity	Trupan Biomass Power Plant in Chile
Scale of the project activity	☒ Large-scale ☐ Small-scale
Version number of the PDD	Version 05
Completion date of the PDD	03/09/2019
Project participants	Celulosa Arauco y Constitución S.A.
Host Party	Chile
Applied methodologies and standardized baselines	ACM0006 (Version 14.0), “Large-scale Consolidated Methodology: Electricity and heat generation from biomass.”
Sectoral scopes	Scope 1.
Estimated amount of annual average GHG emission reductions	131,433 tCO_{2e}

Description of project activity

A.1. Purpose and general description of project activity

The proposed project activity consists in the installation of a new biomass cogeneration power plant in the Trupan Complex site. The new cogeneration plant is equipped with a new 170 ton/hr fluidized bed biomass power boiler and a 30 MW condensing/extracting turbo generator unit. The project is designed so that approximately 60% of the power is destined to serve the internal needs of the Trupan Complex, while the remaining power is injected to the grid (CEN).

The project is presented by Celulosa Arauco y Constitución S.A. (from now on, Arauco) a leading forestry and pulp-producing company in Chile, but the project itself was realized by Maderas Arauco S.A[1]. a MDF/wood panel board producing company in Chile, subsidiary of Arauco.

The project activity is designed to use biomass from industrial operations (sawdust and bark, mainly from sawmills) and biomass from forestry operations (from harvesting, thinning and pruning operations) for electric power generation. In the absence of the project activity, such biomass would be burned uncontrollably in the open air or left in piles to natural decay.

The new cogeneration power plant was part of the expansion project of the Trupan wood panel mill (Trupan Line N°2). Before this project, Trupan had steam generation capacity but no electric power generation capacity, so the Complex sourced all its electric power requirements from the grid[2]. However, when the Trupan management evaluated the expansion project, it considered the surplus of biomass residues available in the region, and decided to build a new on-site biomass power plant with enough capacity to supply all the power needs of the Trupan Complex and additional power to the grid. From a technical perspective, this decision involved installing a high-pressure boiler and a steam turbine which meant going clearly beyond the traditional practice of the wood panel industry in Chile. Given that utilizing a high-pressure boiler implied a significant increase in cost compared to the more conventional low pressure boiler solution, the decision of building such power plant was based on the possibility of not relying on the local grid for power, on selling excess power to the grid and on the benefits from being a CDM project activity.

The project activity assists Chile's sustainable growth by providing electricity to the Trupan Complex and to the CEN grid through biomass power generation. Without the Trupan power plant, not only there would have been no new clean energy injection to the CEN, but the Trupan Complex itself would have had to continue sourcing its power requirements from the grid. In addition, this project accomplishes an additional greenhouse gas (GHG) reduction benefit derived from a reduced disposal or uncontrolled burning of biomass residues, which results into less methane emissions.

The Trupan project activity participants believe that biomass power generation constitute a sustainable source of power generation that brings clear advantages to mitigate global warming. Using the available natural resources in a rational way, the Trupan project activity helps to enhance the development of renewable energy sources in Chile, in particular the use of biomass generated as a by-product of the forest industry, which has a significant potential in the country. The proposed project is a good example to demonstrate the viability of power generation as a source of revenue not only to the wood panel industry, but to all forest-related industries. Very few wood-panel producing facilities in Chile have on-site electric power generation capacity[3], making the Trupan cogeneration power plant facility quite unique and particular in its type. Although this technological improvement is consistent with Arauco's internal policy of energy efficiency, this initiative must be recognized as an activity that goes beyond the common practice of the wood panel industry in Chile.

The Trupan project activity (Ref. 0259) was successfully registered in the CDM in June 06, 2006. This PDD is developed to apply for the third crediting period renewal of the project activity and the estimated amount of annual average GHG emission reductions is 131,433.

[1] In September, 1st, Paneles Arauco S.A. change name to Maderas Arauco S.A.
[2] Trupan had an energy contract with Endesa, one of the largest power companies in Chile.
[3] The other (comparable) facilities that have on-site power generation capacity are all registered CDM Project activities.

A.2. Location of project activity

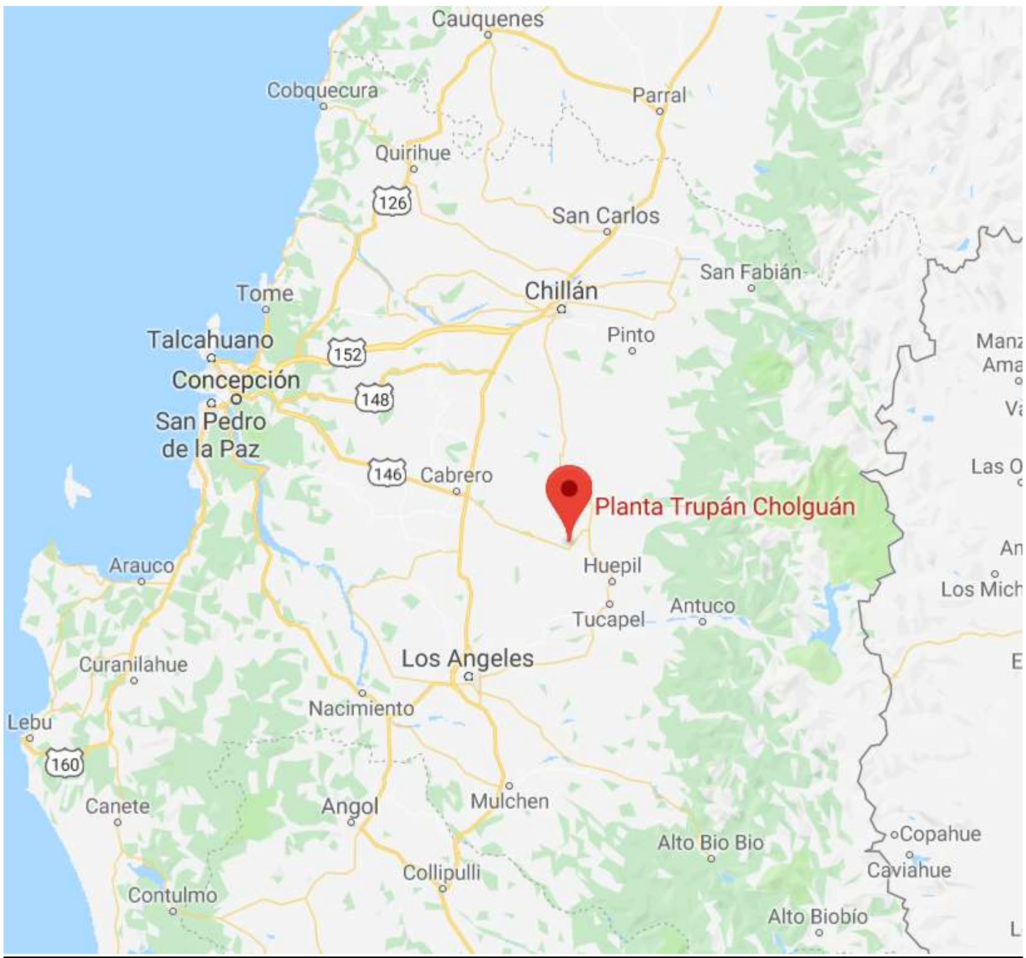
Chile, South America.VIII Region of Bio Bío, Province of Ñuble. Cholguan road (no number), Yungay.

The project activity is located in the Trupan Industrial Complex site, located 8 km north from Yungay, a city located in the Ñuble Province, in the Bio Bío Region (VIII Region), about 120 km south east from the Region's Capital city, Concepción. The Bio Bío Region can be directly accessed from Santiago through the Panamericana Sur highway (or 5 Sur).

The Bio Bío Region holds 10% of the total Chilean population of 18,751,045 inhabitants, the second most populated after the Metropolitan Region. Its economy is basically on exports of steel and pulp, wood, fish meal and frozen products.

The approximate coordinates of the project activity location are provided in the table below:

Figure 1: Geographical location of the project activity



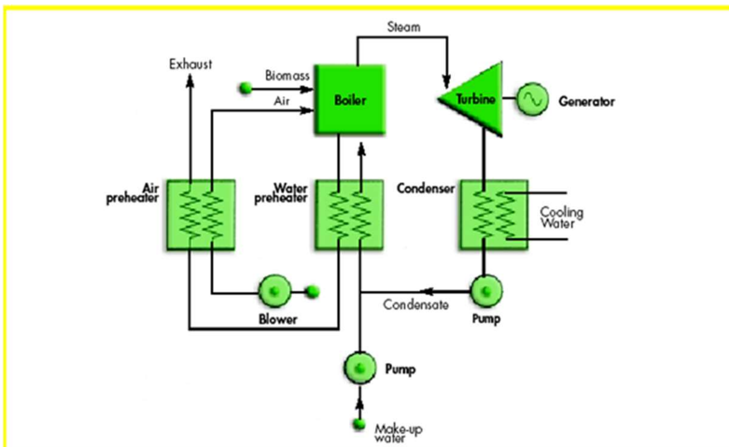
A.3. Technologies/measures

The predominant technology in all parts of the world today for generating megawatt (MW) levels of electricity from biomass is the steam-Rankine cycle, which consists of direct combustion of biomass in a boiler to generate steam, which is then expanded through a turbine. The steam-Rankine technology is a mature technology, having been introduced into commercial use about 100 years ago. Most steam cycle plants are located at industrial sites, where the waste heat from the steam turbine is recovered and used for meeting industrial-process heat needs. Such combined heat and power (CHP), or cogeneration systems provide greater levels of energy services per unit of biomass consumed than systems that generate electric power only.

The steam-Rankine cycle involves heating pressurized water, with the resulting steam expanding to drive a turbine-generator, and then condensing back to water for partial or full recycling to the boiler. A heat exchanger is used in some cases to recover heat from flue gases to preheat combustion air, and a deaerator must be used to remove dissolved oxygen from water before it enters the boiler.

Steam turbines are designed as either “backpressure” or “condensing” turbines. CHP applications typically employ backpressure turbines, wherein steam expands to a pressure that is still substantially above ambient pressure. It leaves the turbines, wherein steam expands to a pressure that is still substantially above ambient pressure. It leaves the turbine still as a vapour and is sent to satisfy industrial heating needs, where it condenses back to water. It is then partially or fully returned to the boiler. Alternatively, if process steam demands can be met using only a portion of the available steam, a condensing extraction steam turbine (CEST) might be used. This design includes the capability for some steam to be extracted at one or more points along the expansion path for meeting process needs (Figure 2). Steam that is not extracted continues to expand to sub-atmospheric pressures, thereby increasing the amount of electricity generated per unit of steam compared to the backpressure turbine. The non-extracted steam is converted back to liquid water in a condenser that utilizes ambient air and/or a cold water sources as the coolant.

Figure 2: Schematic diagram of a biomass-fired steam-Rankine cycle for a cogeneration using a condensing-extracting steam turbine.



Source: Williams & Larson, 1993 apud Kartha & Larson, 2000, p. 101.

Since the Trupan power plant was built in conjunction with the Trupan Complex expansion project (Trupan Line N°2) the best way to outline and describe the equipments related to the project activity is to describe how the mill would have been expanded if such expansion would have maintained the conventional “business as usual” design, without electric power generation capacity. To do so, Arauco requested a specialized consultant to design an alternative plant expansion project, without electric power generation capacity. The differences between these two project alternatives are presented and described in Table 1, below.

Table 1: Detailed description of the Trupan power plant project activity

Department	Changes
Biomass Boiler	• In the alternative without power generation configuration, the biomass boiler would have been designed for a smaller (130 t/h) capacity. With the current configuration, the biomass boiler is a fluidized bed biomass boiler of 160 t/h to 170 t/h depending on the fuel moisture content. • Without the turbogenerator the superheating of steam would have not been required and the boiler would have been designed for saturated steam or just a very small degree of superheating. The HP steam data

	would have been about 38 bar(a) 250°C, since the only benefit of the higher steam data is the possibility to generate power. The current higher steam data of 81 bar(a) and 490°C results in a higher investment cost and could also result in higher maintenance costs. Lower steam pressure also means less power consumption for the feed water pumps. • Without extra power generation capacity, the feed water temperature would have been reduced from 135°C to 110°C, since the only reason to have a high feed water temperature would have required a smaller and cheaper boiler economizer.
Alternative with Thermal Oil Boiler	• Conventionally an MDF press is heated by thermal oil. Normally there would be a small biomass boiler to generate the heated oil. The old MDF plant in Trupan has this kind of press heating. • In the alternative without power generation configuration, it has not been considered any such boiler, but has been assumed that the press would have been heated in the same way as it is in the current configuration. The influence on the biomass consumption should be quite marginal. Most probably the larger steam boiler would have somewhat higher efficiency saving some fuel. • With a thermal oil boiler the generation capacity of the steam boiler could have been reduced with about 10 t/h of steam. • In case there would have been a thermal oil plant, the pressure in the steam boiler could have been reduced as it is the MDF press that has the highest process steam pressure demand. The boiler pressure would have been about 26 bar(a). The steam temperature would have been about the same 250°C.
Boiler Water System	• The feed water tank should have the same size, but could be designed for a lower pressure in the conventional case. • The demineralization plant would have been the same as in the current with power generation configuration. With regards to the boiler steam data and the absence of a steam turbine, there would have been no demand for a mixed bed system. This could have been omitted.
Steam Distribution System	• Under the current with power generation configuration, steam is primarily consumed in four pressure levels: medium pressures MP3, MP2, MP and low pressure LP. In the alternative case, the MP pressure levels should have been the same, but the LP pressure level would have been selected somewhat higher. It is also possible that the LP system would have been completely omitted and replaced by the MP steam. This would have resulted in less expensive equipment by the LP consumers as they would need less heat transfer surface. • It may also be that some of the different MP and MP2 consumers could have been lifted to a higher pressure level to reduce the heat transfer surface demands. However, in the balance calculations for the case without power generation, it has been kept a LP system with the same pressure. This would have had no influence on the biomass fuel demand. • Given that the steam temperature from the boiler would be so low in the alternative no power generation configuration, there would be no need for de-superheating of the different MP steam systems. For the LP steam, however, it would still be necessary if the process equipment would have not been designed for a high temperature.

	Overall, the steam distribution system of the alternative no power generation configuration would have been simpler.
Turbogenerator	• In the alternative without power generation configuration, there would have been no 30 MW turbogenerator and hence, no additional equipment such as the condenser cooling system with its cooling system with its cooling tower.
Process Equipment	• In the alternative configuration, there would not have been major changes in the process equipment. One exemption could be the MDF press as earlier mentioned and maybe also some reduced heating surfaces by higher steam pressures.
Electrical Equipment	• As a result of no turbogenerator, the mill electrical systems would have been simpler. • Without any own electrical power generation, all necessary power would have been imported from the external grid.

It must be noted that the alternative BAU (Business As Usual) MDF mill would have had the same capacity of the real MDF mill and would have contemplated the installation of a power boiler that would have been designed to generate the same amount of process-steam that the MDF mill would have required. The BAU MDF mill simply corresponds to a standard modern new line of MDF panel board, and as such; it contemplates all the standard equipment used in the MDF industry. The differences between the two project alternatives are exclusively due to the on-site electric power generation capacity contemplated in the proposed CDM project activity.

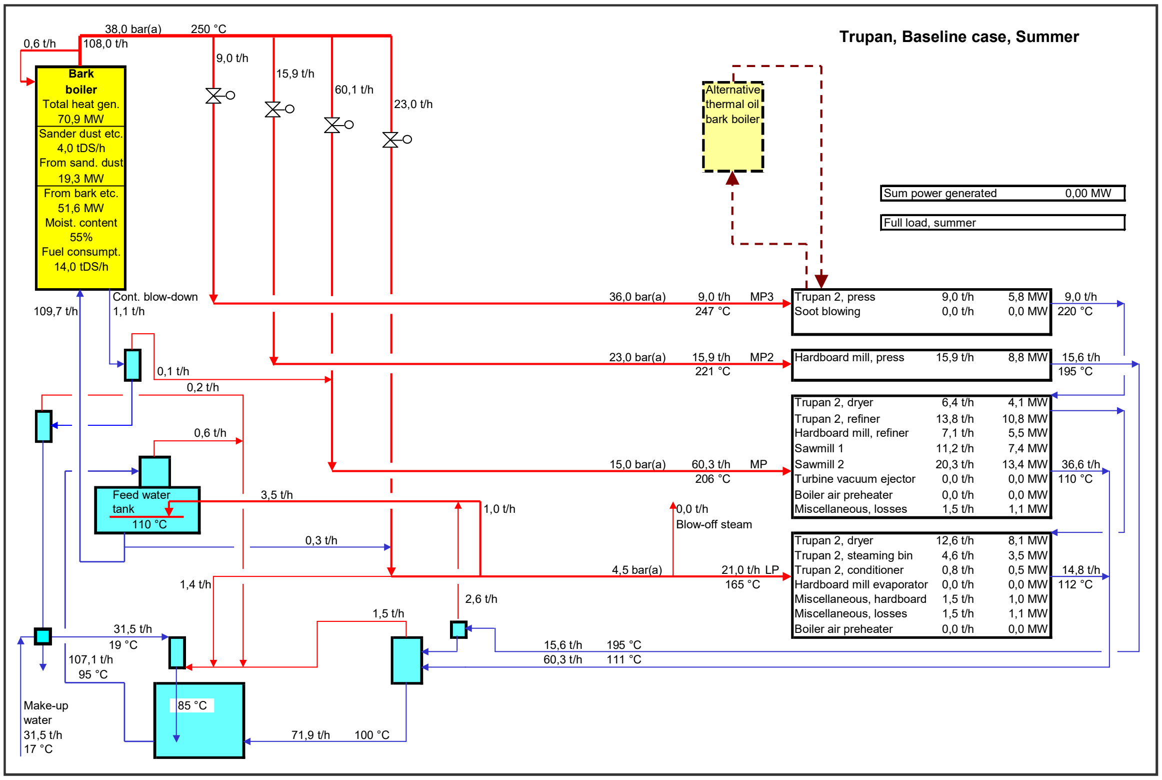
Table 2 below presents the operational data that results from implementing the real mill “with CDM project” option, and the conventional BAU mill expansion, “without CDM project” option.

Table 2: Summary of Operational Data

		Real mill		Base case	
		Winter	Summer	Winter	Summer
Steam generation:					
HP steam	t/h	160.0	170.0	117.7	108.0
Soot blowing steam	t/h	1.2	1.2	0.6	0.6
Fuel consumption:					
Sander dust etc.	tDS/h	4.0	4.0	4.0	4.0
Bark etc.	tDS/h	30.7	30.8	16.8	14.0
Sum	tDS/h	34.7	34.8	20.8	18.0
Heat generation:					
Sander dust etc.	MW	19.3	19.3	19.3	19.3
Bark etc.	MW	105.9	113.7	57.9	51.6
Total heat to steam	MW	125.3	133.0	77.3	70.9
Power generation	MW	24.1	27.9	0.0	0.0

The following diagrams below show the energy/mass balances of the conventional BAU power plant and the real power plant. As mentioned above, the energy/mass balances of the two project alternatives show the same steam flow consumptions for the MDF mill expansion project. The high-pressure steam generation capacity of the CDM project alternative is for on-site electric power generation.

Figure 3: Trupan Power Plant lay-out without electric power generation capacity



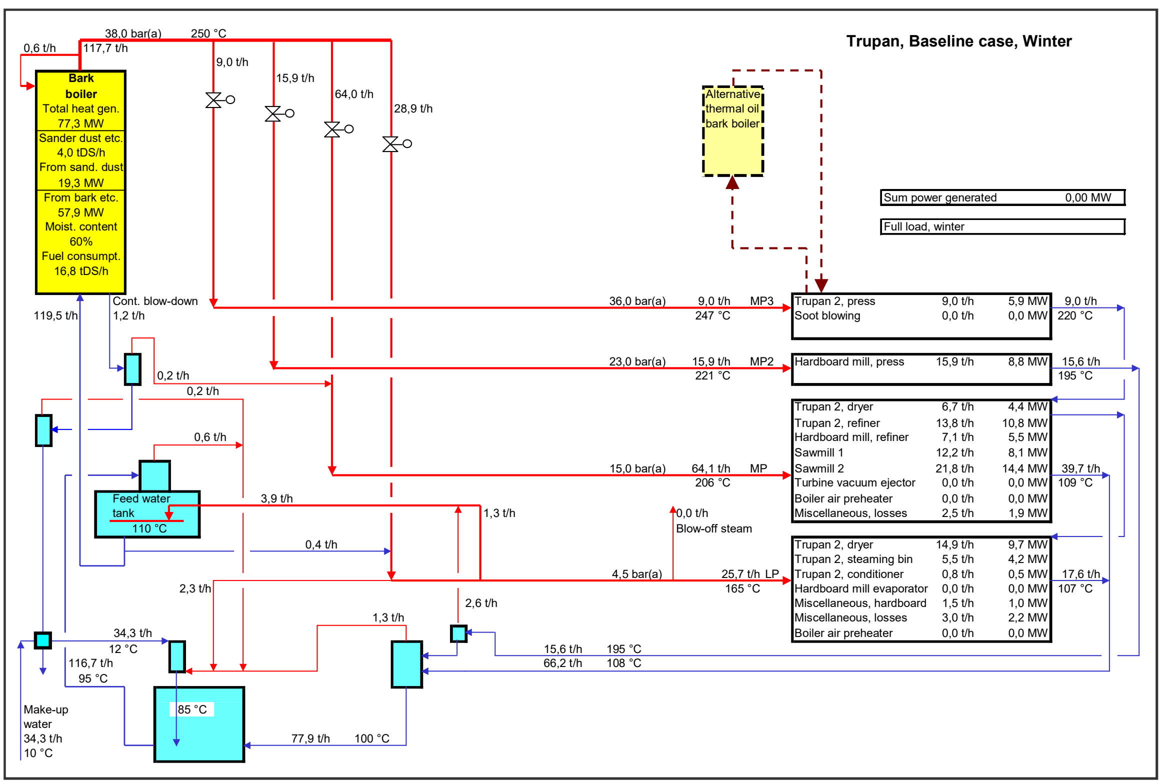
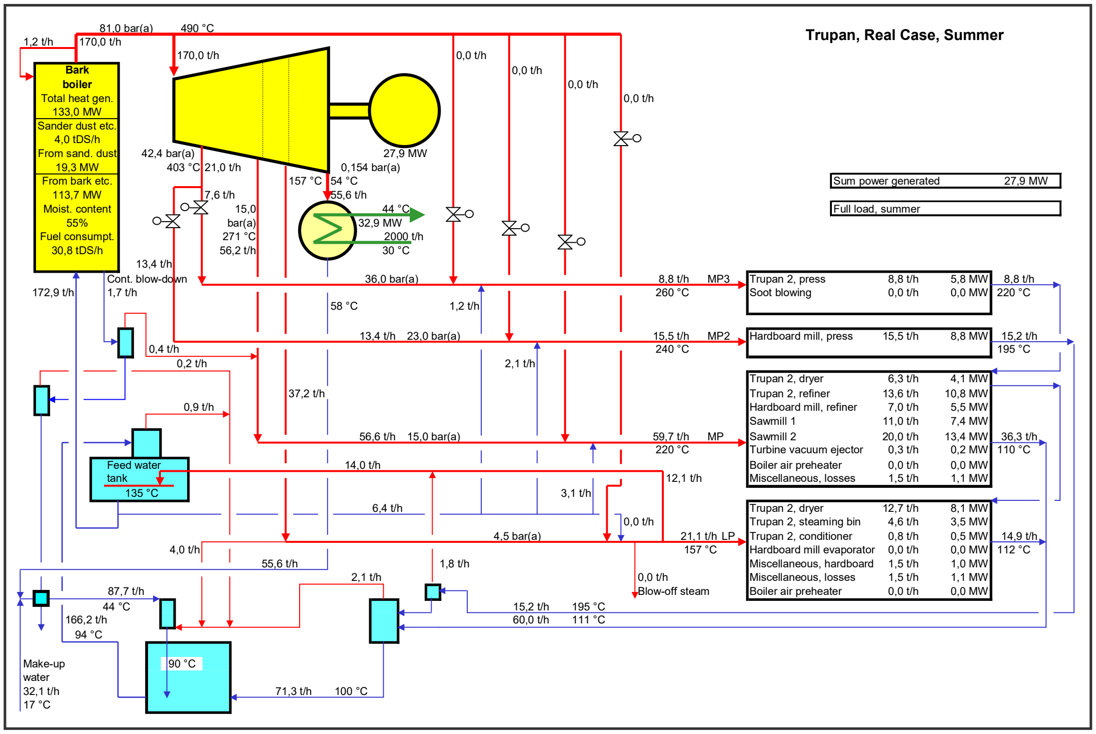
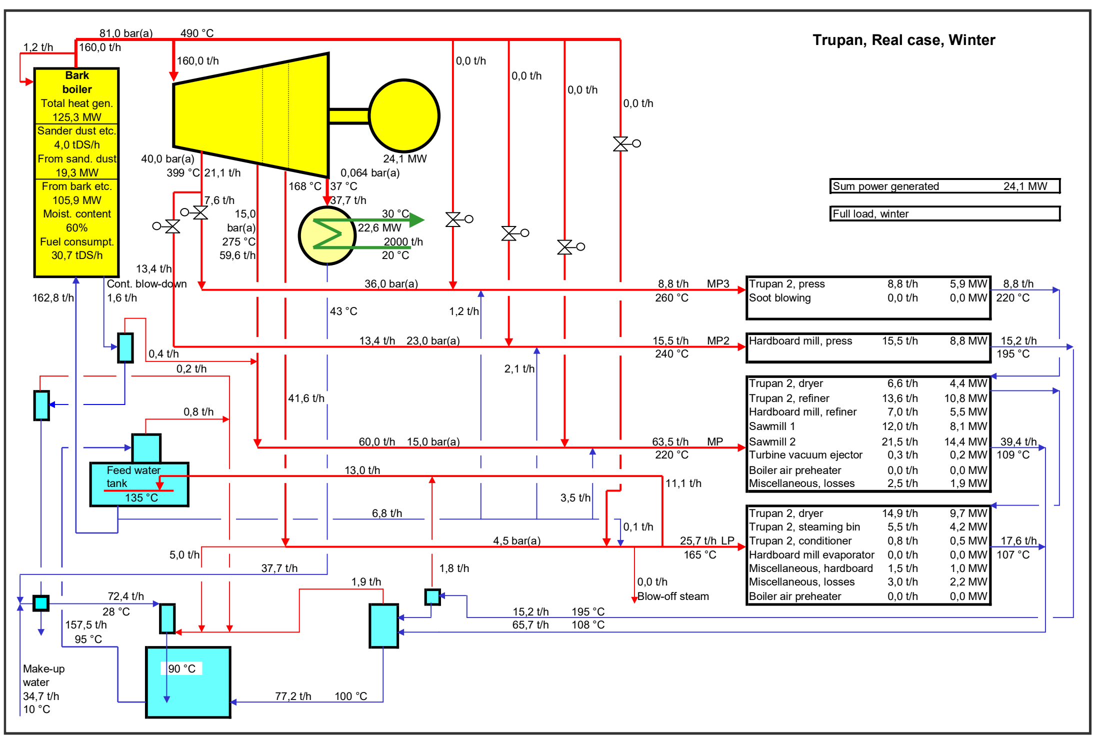


Figure 4: Trupan Power Plant lay-out with electric power generation capacity





A.4. Parties and project participants

Party involved (host) indicates host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Chile	Celulosa Arauco y Constitución S.A.	No
United Kingdom of Great Britain and Northern Ireland	Celulosa Arauco y Constitución S.A.	No

A.5. Public funding of project activity

The financial plans for the project activity do not involve public funding. The investment made in the Trupan biomass power plant project was financed with Arauco's own resources.

A.6. History of project activity

The Project participant confirms that the proposed CDM project activity is registered as a CDM project activity, but it was not included as a component project activity (CPA) in a registered CDM programme of activities (PoA).

A.7. Debundling

Not applicable.

SECTION B. Application of methodologies and standardized baselines

B.1. Reference of methodologies and standardized baselines

The name of the approved baseline methodology applied to the proposed project activity is:

ACM0006 (Version 14.0), "Consolidated methodology, electricity and heat generation from biomass".

The proposed project activity also relies on the application of the latest versions of the following methodological tools (referenced in the methodology ACM0006 (Version 14.0)).

TOOL07: "Tool to calculate the emission factor for an electricity system (Version 07.0)".

TOOL03: "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion (Version 03.0)".

TOOL09: "Determining the baseline efficiency of thermal or electric energy generation systems (Version 02.0)".

TOOL05: "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (Version 03.0)".

"TOOL16: Project and leakage emissions from biomass (Version 04.0)

Since this PDD is designed to revalidate the crediting period of the Trupan Biomass Power Plant in Chile project activity, the document also relies on the last versions of the following procedures/tools:

Tool11: "Assessment of the validity of the original/current baseline and update the baseline at the renewal of a crediting period (Version 03.0.1)".

TOOL12: "Project and leakage emissions from transportation of freight (Version 01.1.0)".

B.2. Applicability of methodologies and standardized baselines

The Trupan CDM project activity consist in the construction of a new biomass cogeneration power plant that generates electricity and heat from renewable energy sources.

Paragraph 48 of the Marrakesh Accords stipulates that:

"In choosing a baseline methodology for a project activity, project participants shall select from among the following approaches the one deemed most appropriate for the project activity taking into account any guidance by the executive board, and justify the appropriateness of their choice:

a) Existing actual or historical emissions, as applicable; or,
b) Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment;
c) The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20 percent of their category.

Since the project activity will serve to reduce emissions from existing emission sources and that biomass is not normally used to generate electric power, approach a) seems to be the applicable option in selecting the baseline scenario for the Trupan project activity.

The project activity consists in the installation of a new biomass residue power plant in a site where no power and heat was generated before. The proposed project activity is a **Greenfield power generation project**.

The project activity fully complies with all the applicability criteria of the ACM0006 (Version 14.0):

- **No other biomass types than biomass residues are used in the project plant**. The project activity uses biomass residues (mix of sawdust and bark, sludge) generated from on-site and off-site nearby industrial operations and from forestry operations.
- **Fossil fuel may be co-fired in the project plant. However, the amount of fossil fuels co-fired does not exceed 80% of the total fuel fired on an energy basis**: Some fossil fuels may be co-fired due to operational reasons (e.g. start-up operations, shut down operations, etc.) and to a limited extent to enhance the economic performance of the plant.
- **For projects that use biomass residues from a production process (e.g. production of sugar or wood panel boards), the implementation of the project does not result in an increase of the processing capacity of raw input (e.g. sugar, rice, logs, etc.) or in other substantial changes (e.g. product change) in the process**: The biomass residues generated in the Trupan complex is determined by the capacity of the MDF lines, which have already been established and will not change due to the implementation of the project activity. The MDF production is determined by the MDF wood panel market conditions and not by the existence of the cogenerations power plant. In addition, the power unit uses biomass residues that are already available from third parties. Therefore, it is not required to increase the local generation of biomass residues to generate power or increase the power generation of the power plant.

- **The biomass residues used by the project facility are not stored for more than one year**: The biomass residues used in the boiler (mix of sawdust and bark from industrial operations and biomass from forestry operations) is stored in a dedicated place near to the Trupan power plant. The residence time of the stored biomass (total biomass residues stored/biomass residues consumption rate of the power plant) is not meant to surpass six months max (250,000 m^3st.) at most. The biomass stockpile is conveniently managed in order to avoid that part(s) of the pile get stored for too long and suffer the consequent degradation of its calorific value as fuel.
- **The biomass residues used by the project facility are not obtained from chemically processed biomass (e.g. through esterification, fermentation, hydrolysis, pyrolysis, bio- or chemical-degradation, etc.) prior to combustion. Moreover, the preparation of biomass-derived fuel does not involve significant energy quantities, except from transportation or mechanical treatment so as not cause significant GHG emissions**. The Trupan biomass power plant only contemplates biomass transportation to the power plant and, eventually, some mechanical processing of the biomass from forestry operations.
- **No fuel switch activities are considered part of the proposed project activity**.
- **No biogas is considered as part of the project activity in power and/or heat generation**.
- **No dedicated energy biomass plantations are considered part of the proposed project activity**.
- **The methodology is only applicable if the most plausible baseline scenario, as identified per the "Selection of the baseline scenario and demonstration of additionality" section hereunder is**:
    - For power generation: Scenario P2 to P7, or a combination of any of those scenarios.
    - For the generation: Scenarios H2 to H7, or a combination of any of those scenarios.

  When using biomass residues, the alternative scenarios of the biomass residues in the absence of the project activity shall be determined following the guidance in the methodological tool "Project and leakage emissions from biomass":

    - For biomass residues use: Scenarios B1 to B5, or any combination of those scenarios

  In addition to the alternative scenarios included in the methodological tool "Project and leakage emissions from biomass", the alternative scenarios shall include:

  B5: The biomass residues are used for power or heat generation at the project site in new and/or existing plants.

  As will be shown in subsequent sections of this PDD, the corresponding baseline scenarios for power, heat and biomass use are:

Project type	Baseline scenario		
	Power generation	Use of biomass	Heat generation
Power greenfield projects	P7	B5 and B1	H5

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

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	Electricity and heat generation	CO_2	Included	Main emission source. It must be noticed though, that the project activity does not claim emission reductions due to heat displacement. Heat generation is not influenced by the project activity and in the cogeneration facility it is accomplished using renewable, carbon neutral biomass residues.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Uncontrolled burning or decay of surplus biomass residues	CO_2	Excluded	All biomass used in the project activity come from renewable sources. It is assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Included	Surplus biomass (mix of sawdust and bark) if not used for power generation is normally left in piles for uncontrolled burning or natural decay.
		N_2O	Excluded	Excluded for simplification. This is conservative. Note also that emissions from natural decay of biomass are not included in GHG inventories as anthropogenic sources [a].
Project scenario	On-site fossil fuel consumption	CO_2	Included	This emission source is considered by the Project Participant.
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be small [b].
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be small [b].
	Off-site transportation of biomass.	CO_2	Included	This emission source is considered by the Project Participant.
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be small [b].
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be small [b].
	Combustion of biomass for electricity and heat.	CO_2	Excluded	It is assumed that CO_2 emissions from surplus biomass do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Included	This emission source must be included if CH_4 emission from uncontrolled burning or decay of biomass residues in the baseline scenario are included.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be small [b].

	Waste water from treatment of biomass residues	CO_2	Excluded	It is assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Excluded	This emission source shall be included in cases where the waste water is treated (partly) under anaerobic conditions. Since the proposed project activity does not contemplate waste water treatment under anaerobic conditions this emission source is excluded in this case.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be small [b].
	Cultivation of land to produce biomass feedstock	CO_2	Excluded	Excluded. No dedicated energy biomass plantations are considered part of the project activity.
		CH_4	Excluded	Excluded. No dedicated energy biomass plantations are considered part of the project activity.
		N_2O	Excluded	Excluded. No dedicated energy biomass plantations are considered part of the project activity.

a. Note that the emission factors for CH_4 and N_2O emissions from uncontrolled burning or decay of dumped biomass residues are highly uncertain and depend on many site-specific factors. Quantification is difficult and may increase transaction costs significantly. Note also that CH_4 and N_2O emissions from the natural decay or uncontrolled burning are, in some cases (e.g. natural decay of forest residues) not anthropogenic sources of emission included in Annex A of the Kyoto Protocol and should not be included in the calculation of baseline emissions pursuant to paragraph 44 of the modalities and procedures for the CDM.

b. CH_4 and N_2O emission factors depend significantly on the technology (e.g. vehicle type) and may be difficult to determine for project participants. Exclusion of this emission source is not a conservative assumption; however, it appears reasonable, since CH_4 and N_2O from on-site use of fossil fuels and transportation are expected to be very small compared to overall emission reductions, and since it simplifies the determination of emission reductions significantly.

B.4. Establishment and description of baseline scenario

According to the ACM0006 (Version 14.0) the Project Participant shall identify the most plausible baseline scenario and demonstrate additionality using the steps outlined in the section of the methodology: “Selection of the baseline scenario and demonstration of additionality”

Step 1: Identification of alternative scenarios.

Sub-step 1a requires the Project Participant to define alternative scenarios to the proposed CDM project activity.

According to ACM0006 (Version 14.0) Project Participant should identify realistic and credible alternative scenarios that are available to Project Participants that can provide outputs or services with comparable quality, properties and application areas as the proposed CDM project activity and that have been implemented previously or are currently underway in the relevant geographical area. It is also recommended that the relevant geographical area should include preferable ten facilities (or projects) that provide outputs or services with comparable quality, properties and application areas as the proposed CDM project activity. In case less than ten facilities (or projects) are found in the region/host country, the geographical area may be expanded accordingly.

In the host country, Chile, the relevant geographical area for the proposed CDM project activity, between V and X region[4], does count with more than ten projects similar and comparable to the proposed project activity without considering the implementation of the CDM project activity. These facilities correspond mostly to Sawmill and Panel board industries.

As will be shown in subsequent sections of this PDD, panel board/plywood mills consume local biomass residues in low-pressure boilers to generate heat for their internal processes, while electric power is sourced from the local grid.

The alternative scenarios should specify:

- How electric power would be generated in the absence of the CDM project activity;
- How heat would be generated in the absence of the CDM project activity;
- If the project activity generates mechanical power through steam turbines: How the mechanical power would be generated in the absence of the CDM project activity; and
- What would happen to the biomass residues in the absence of the project activity?

Table 3: How electric power would be generated in the absence of the CDM project activity

Scenario	Scenario description	Feasibility in the context of the proposed project activity
P1:	The proposed project activity not undertaken as a CDM project activity.	Yes.
P2:	The continuation of power generation in an existing biomass residue fired power plant at the project site, in the same configuration, without retrofitting and fired with the same type of biomass residues as (co-) fired in the project activity.	No. There was no biomass residue fired power plant at the project site before the implementation of the project activity. Power was obtained from the grid.
P3:	The continuation of power generation in existing power plants at the project site. The existing plants would operate with different conditions from those observed in the most recent three years prior to the starting date of the project activity.	No. There was no power plant at the project site before the implementation of the project activity. Power was obtained from the grid.
P4:	The retrofitting of an existing power plant at the project site. The retrofitting may or may not include a change in fuel mix.	No. There was no power plant at the project site before the implementation of the project activity. Power was obtained from the grid.
P5:	The installation of a new power plant at the project site different from those installed under the project activity.	Yes.
P6:	The generation of power in specific off-site plants, excluding the power grid.	No. There was no existing captive power plant at the project site running on fossil fuels in the Trupan Complex. There is none even to date.
P7:	The generation of power in the power grid.	Yes. This was the situation before the implementation of the project

[4] X region “Los Lagos” was divided in 2010 in two regions.

		activity. This is also the situation in conventional Sawmill/Plywood mill boiler.

According to the above, the feasible baseline scenarios for power generation would be: P1, P5, and P7.

Table 4: How heat would be generated in the absence of the CDM project activity

Scenario	Scenario description	Feasibility in the context of the proposed project activity
H1:	The proposed project activity not undertaken as a CDM project activity.	Yes.
H2:	The continuation of heat generation in existing plants at the project site. The existing plants would operate at the same conditions (e.g. installed capacities, average load factors, or average energy efficiencies, fuel mixes, and equipment configuration) as those observed in the most recent three years prior to the project activity.	No. There was no power plant at the project site before the implementation of the project activity.
H3:	The continuation of heat generation in existing plants at the project site. The existing plants would operate with different conditions from those observed in the most recent three years prior to the project activity.	No. There was no power plant at the project site before the implementation of the project activity.
H4:	The retrofitting of existing plants at the project site. The retrofitting may or may not include a change in fuel mix.	No. There was no power plant at the project site before the implementation of the project activity.
H5:	The installation of new plants at the project site different from those installed under de project activity.	Yes.
H6:	The generation of heat in specific off-site plants.	No. External heat sources are not available in Chile on a normal basis. It was not available in the context of the Trupan project activity.
H7:	The production of heat from district heating.	No. External heat sources are not available in Chile on a normal basis. It was not available in the context of the Trupan project activity.

According to the above, the feasible baseline scenarios for heat generation would be: H1 and H5.

Table 5: How the mechanical power would be generated in the absence of the CDM project activity

Scenario	Scenario description	Feasibility in the context of the proposed project activity
M1:	The proposed project activity not undertaken as a CDM project activity.	No. Since mechanical power would not be generated in the absence of the project activity.
M2:	The continuation of mechanical power generation from the same steam turbines in existing plants at the project site.	No. There was no mechanical power generation at the project site before the implementation of the project activity.
M3:	The installation of new steam turbines at the project site.	No. Since mechanical power would not be generated in the absence of the project activity.
M4:	The continuation of mechanical power generation from electrical motors in existing plants at the project site.	No. There was no mechanical power generation at the project site before the implementation of the project activity.
M5:	The installation of new electrical motors at the project site.	No. Since mechanical power would not be generated in the absence of the project activity.

Table 6: What would happen to the biomass residues in the absence of the project activity?

Scenario	Scenario description	Feasibility in the context of the proposed project activity
B1:	The biomass residues are dumped or left to decay mainly under aerobic conditions. This applies, for example, to dumping and decay of biomass residues on fields.	Yes.
B2:	The biomass residues are dumped or left decay under clearly anaerobic conditions. This applies, for example, to landfills which are deeper than 5 meters. This does not apply to biomass residues that are stocks-piled or left to decay on fields.	Yes.
B3:	The biomass residues are burnt in an uncontrolled manner without utilizing it for energy purposes.	Yes.
B4:	The biomass residues are used for energy or non energy applications, or the primary source of the biomass residues and/or their fate cannot be clearly identified.	Biomass used for energy: **No.** The generation of biofuels using forestry biomass residues (sawdust and bark) is not developed at an industrial scale in Chile (and in the world) to date. Biomass used for non-energy applications: **No.** The biomass residues used for energy generation purposes are not the same as the biomass residues used for feedstock for pulp and paper production.

		Primary source of biomass residues and/or their fate cannot be clearly identified: **No.** Though there is a market for biomass residues in the region, considerable surplus still remains which is not commercialized, but disposed in piles or burned in the open air. For this reason, this baseline is not really applicable for the biomass types considered under this project activity
B5:	The biomass residues are used for power or heat generation at other sites in new and/or existing plants.	Yes.

According to the above, the feasible baseline scenarios would be: B1, B2, B3 and B5.

Given that steam generation for big-scale sawmills and plywood mills is part of the BAU practice in the respective industries, this project activity only claims emission reductions from on-site electric power generation and the use of biomass that would otherwise be left in piles or burned in the open air. As a result, the project options presented below only correspond to alternative scenarios for power generation and biomass usage.

In each option, it is mentioned the feasibility of becoming the baseline scenario for the proposed project activity and also it is addressed what would happen to any difference in power generation and biomass usage between each alternative and the project plant, in the absence of the proposed project activity.

1. **A conventional Sawmill/Plywood mill boiler, without power generation capacity:**

This is the standard practice in the Sawmill/Plywood mill/MDF panel wood mill industries in Chile and in the world.

<u>Technical assumptions:</u>

Under this scenario, installed capacity, load factor, energy efficiencies, fuel mixes and equipment configuration correspond to the ones considered under baseline scenario. Therefore, the technical specifications will be not presented again in this section.

The Project Participant would like to note that technical assumptions can be seen in a detailed energy/mass balance carried out and presented in this PDD.

<u>Power generation:</u>

The technology for these plants is proven and fully developed. In fact, Arauco has 14 sawmills and 7 wood processing plants in Chile, and only the ones related to the CDM have been deliberately designed with electric power generation in mind; the rest are sourced from the local grid.

The applicable baseline scenario for power would be:

- The power required would be obtained from the power grid: P7

Biomass residues:

Use biomass residues as fuel for heat generation purpose (mainly wood drying in Sawmill and drying and presses in panel board/plywood mills) (B5) while a considerable surplus of biomass remains unused in the region, which is mostly dumped or left to decay (B1)

The applicable baseline scenarios for biomass types would be:

1) Sludge from on-site industrial operations: B5
2) Mix of sawdust and bark from on-site industrial operations: B5
3) Mix of sawdust and bark from on-site industrial operations: B1
4) Mix od sawdust and bark from off-site industrial operations: B1
5) Mix of sawdust and bark from off-site forest operations: B1

2. Conventional Sawmill and Panel board/Plywood mill, with a conventional fossil fuel power unit as back-up

This alternative is similar to the previous one.

Technical assumptions:

This option is similar to the previous one with the distinction that a conventional fossil fuel power unit would be contemplated as back-up.

Power generation:

The Sawmill and Panel board/Plywood mills would consume electric power from the grid on a regular basis, however in this case the consumption is backed with Natural gas, Diesel or Fuel oil power unit. This alternative has three advantages over the previous one:

1) It provides electric power back-up, which can be used under contingencies (i.e. stoppages and maintenances);
2) It represents a good business, since the low price of a used/new fossil fuel power back-up units can be rapidly repaid solely on the basis of the firm power revenues (i.e. the unit does not have to operate to repay the investment, just be available to the system);
3) It can generate surplus power to the grid when the spot price of electricity is sufficiently high.

The applicable baseline scenario for power would be:

- The power required by conventional Sawmill and Panel board/Plywood mill would be obtained from the power grid: P7
- The surplus of electric power to the grid: P5 and P7 (it is possible that part of surplus power generated by project plant would be also generated by grid-connected plants, since the surplus power generation would depend on the spot price level).

Biomass residues:

Use biomass residues as fuel for heat generation only (mainly wood drying in sawmill and presses and drying in panel board mill).

The applicable baseline scenarios for biomass types would be:

6) Sludge from on-site industrial operations: B5
7) Mix of sawdust and bark from on-site industrial operations: B5
8) Mix of sawdust and bark from on-site industrial operations: B1
9) Mix od sawdust and bark from off-site industrial operations: B1
10) Mix of sawdust and bark from off-site forest operations: B1

3. **Sawmill/Plywood mill with on-site electric power generation at lower efficiency or at a later stage, not undertaken as a CDM project activity.**

As the project activity, this is also a possible alternative, however from the project participant's point of view; such undertaking would not constitute the usual practice in the relevant industries either. It would face similar barriers as the proposed project and therefore, would most likely not happen without the incentives of the CDM: Additionally, a less efficient biomass power plant would have slightly lower investment cost than the more efficient plant. This would make the project less attractive from a financial point of view and therefore less viable. No such project has been implemented in sawmills, plywood mills or MDF board mills in Chile (or very few –if any- in the world) up to date.

Technical assumptions:

Under this scenario installed capacities, load factors, energy efficiencies, fuel mixes and efficiencies values (i.e. heat engine and heat generator) would be lower than those contemplated in the project activity. This would mean that this alternative would still have generated on-site electric power generation but would generate less surplus power to the grid.

Installed capacity:

- Power boiler: heat to steam capacity 107.2 MW and max high-pressure steam of 171 (t/h) on wood base fuels.
- Condensing with extraction heat engine: 24.3 MW

Load factor:

- Heat generator (biomass power boiler): 0.80
- Heat engine (condensing with extraction heat engine): 0.80

Efficiency:

- Heat generator (based on NCV-dry basis): 72.7% this efficiency corresponds to an efficiency of 86.8% on LHV based on wet fuel mixture.
- Heat engine (Condensing with extraction heat engine): specific power generation of 0.042648 (MWh/GJ)

Note that energy/mass balance contemplated the default value of 95% as mechanical/electrical efficiency according to the methodology.

Fuel mixes: Sludge 14,569 (BDt/yr)

- Biomass residues from own site production: 100,549 (BDt/yr)
- Biomass residues (industrial) from off-site production: 109,322 (BDt/yr)
- Biomass residues (forestry) from off-site production: 106,400 (BDt/Yr)

The Project Participant would like to note that figures presented above were taken from a detailed energy/mass balance carried out specifically for this alternative configuration. Compared to the project activity this Sawmill/Plywood would generated on-site electricity but there would generate less surplus power to the grid.

Power generation:

The applicable baseline scenario for the power would be:

- The power required by the Sawmill/Plywood mill: P5
- The surplus power to the grid: P7 (Since the power boiler is less efficient that the one proposed under the project activity part of the surplus electric generated by the project activity would be produced by grid-connected power plants).

Biomass residues:

In this case, biomass residues would be used, in the absence of the project activity, for power (heat and electricity) generation in a higher pressure boiler at the project site. The applicable baseline scenarios for biomass types would be:

1) Sludge from on-site industrial operations: B5
2) Mix of sawdust and bark from on-site industrial operations: B5
3) Mix of sawdust and bark from on-site industrial operations: B1
4) Mix of sawdust and bark from off-site industrial operations: B1
5) Mix of sawdust and bark from off-site forest operations: B1

4. Sawmill/Plywood mill boiler with additional electric power generation capacity based on fossil fuels:

Fossil fuels are considerably more expensive than biomass residues; however, biomass generation capacity including fuel preparation is extremely more expensive than fossil fuel capacity. In the Trupan project, this alternative could be implemented by installing a power boiler with additional high pressure steam generation capacity based on fossil fuel.

Technical assumptions:

The sawmill/plywood mill would be equipped by installing a power boiler similar to the one that would be installed in the baseline case but with an additional high pressure steam generation capacity based on fossil fuel.

Additional installed capacity:

- Power boiler: 44.8 MW, max high-pressure steam capacity of 73 8t/h) on fossil fuel.
- Condensing with extraction heat engine: 19.8 MW

Load factor:

- Heat generator (biomass power boiler): 0.71
- Heat engine (condensing with extraction heat engine): 0.79

Efficiency:

- Heat generator (based on fossil fuel): 90%
- Heat engine (Condensing with extraction heat engine): specific power generation of 0.096821 (MWh/GJ)

Note that energy/mass balance contemplated the default value of 95% as mechanical/electrical efficiency according to the methodology.

Fuel mixes consumed for additional high pressure steam generation:

- Fuel oil: 38,232 (ton/yr)
- Diesel: 0 (ton/yr) as an alternative fuel option

The Project Participant would like to note that figures presented above were taken from a detailed energy/mass balance carried out specifically for this alternative configuration. An additional high pressure steam generation capacity based on fossil fuel would be installed to generate surplus power to the grid.

Power generation:

The applicable baseline scenario for power would be:

- The power required by the sawmill/plywood mill and a fraction of the surplus power to the grid contemplated under the proposed project activity: P5

- The remaining surplus power to the grid: P7 (part of the surplus of electricity generated by the project activity would be produced by grid-connected power plants)

Biomass residues:

The applicable baseline scenarios for biomass types would be:

1) Sludge from on-site industrial operations: B5
2) Mix of sawdust and bark from on-site industrial operations: B5
3) Mix of sawdust and bark from on-site industrial operations: B1
4) Mix of sawdust and bark from off-site industrial operations: B1
5) Mix of sawdust and bark from off-site forest operations: B1

According the ACM0006 (version 14.0) when defining plausible and credible alternative scenarios for biomass usage, biomass residues should be separately identified for different categories, covering the whole amount of biomass residues supposed to be used in the project activity during the crediting period, and consistently with the alternative scenarios selected for power (P) and heat generation (H).

B1: The biomass residues are dumped or left to decay mainly under aerobic conditions. This applies, for example, to dumping and decay of biomass residues on fields.

Biomass residues (mix of sawdust and bark) from on-site and off-site industrial operations: This type of biomass residues are normally used as fuel to generate heat for wood drying in sawmills, presses, and drying process in the panel board industries. However, a considerable surplus of this type of biomass residues remains unused in the region; the additional biomass consumed by the proposed project activity would most likely be left in piles for natural (aerobic) decomposition.

Sludge from on-site industrial operations: This is a solid waste generated in the pulp production process, which is an industrial activity. In the absence of the proposed project activity, sludge would be fully combusted in a low-pressure boiler for heat generation. As a result, this baseline is not applicable in this case.

Mix of sawdust and bark from forest operations: As a current practice in Chile, residues from harvesting, pruning and thinning operations are mostly left in piles to natural decay.

B2: The biomass residues are dumped or left to decay under clearly anaerobic conditions. This applies, for example, to deep landfills with more than 5 meters. This does not apply to biomass residues that are stock-piled or left to decay on fields.

Mix of sawdust and bark from on-site and off-site industrial operations: This type of biomass residues are normally used as fuel to generate heat (i.e. for wood drying) in sawmills and panel board industries. Considering landfills are so far away from the project plant that is uneconomical to transport and dispose these residues in this way. As a result, this baseline is not applicable in this case.

Sludge from on-site industrial operations: In the absence of the proposed project activity, this residue would be either fully combusted in a low-pressure boiler for heat generation or would be dumped in a dedicated land field. As a result, this baseline is not applicable in this case.

Mix of sawdust and bark from forest operations: Biomass residues from harvesting, pruning and thinning operations are mostly left in piles to natural (aerobic) decay. As a result, this baseline is not applicable in this case.

B3: The biomass residues are burnt in an uncontrolled manner without utilizing them for energy purposes.

Mix of sawdust and bark from on-site and off-site industrial operations: In the absence of the proposed project activity part of this biomass would be combusted in a conventional low pressure boiler for heat generation purpose. Since a considerable surplus of this type of biomass residue remains unused in the region, the additional biomass consumed by the proposed project activity would most likely be left in piles for natural decay, and in some particular cases, the biomass would be burned in the open-air in an uncontrolled manner.

Sludge from on-site industrial operations: In the absence of the proposed project activity, this residue would be fully combusted in a low-pressure boiler for heat generation purpose. As a result, this baseline is not applicable in this case.

Mix of sawdust and bark from forest operations: Biomass residues from harvesting, pruning and thinning operations are mostly left in piles to natural decay. Only in some particular cases, the biomass would be burned in the open-air in an uncontrolled manner.

B4: The biomass residues are used for energy or non-energy applications, or the primary source of the biomass residues and/or their fate cannot be clearly identified.

Biomass residues used for energy applications:

This option is not available to the proposed project activity. In this case, the technology required to generate for instance, biofuels using forest biomass residues (mix of sawdust and bark) is not developed at an industrial scale in Chile (and in the world) to date. As a result, this baseline scenario is not applicable to any of the biomass types involved in the project activity.

Non-energy applications:

The biomass residues used for energy generation purposes are not the same as the biomass residues used for feedstock in the process of pulp and paper industry. Although these biomass residues could be used as fertilizers, they must be previously stabilized. As a result, this baseline scenario is not a likely or realistic baseline scenario for these biomass residues types.

Primary source of the biomass residues and/or their fate cannot be clearly identified:

Though there is a market for biomass residues in the region, a considerable surplus still remains. This surplus of biomass residues is not commercialized, but disposed in piles or burned in the open air. For this reason, this baseline is not really applicable for the biomass types considered under the Nueva Aldea Phase 1 CDM project activity.

B5: The biomass residues are used for power or heat generation at other sites in new and/or existing plants.

Mix of sawdust and bark from industrial operations: Considering the surplus amount of biomass residues available in the region, the additional biomass consumed by the proposed project activity would most likely be left in piles for natural decay (aerobic). As a result, this baseline scenario is not applicable in this case.

Sludge from on-site industrial operations: In the absence of the proposed project activity, this residue would be either fully combusted in a low-pressure boiler for heat generation purpose. As a result, this baseline is not applicable in this case.

Mix of sawdust and bark from forest operations: Biomass residues from harvesting, pruning and thinning operations are mostly left in piles to natural decay. This type of biomass is the least available/most costly biomass residue to be consumed. As a result, this baseline is not applicable in this case.

Considering the analysis above, the baseline scenarios for the biomass residues can be established as follows.

	Biomass residues category (n)	Biomass residues type	Biomass residues sources	Biomass residues fate in the absence of the project activity	Biomass residues use in project scenario	Consumption before project activity		Biomass consumption in the new power plant	
(+) Most Available/least Costly (-)						BDt	%	BDt	%
	1	Sludge from industrial operations.	On-site production.	The biomass residues are used for power or heat generation at the project site in new and/or existing plants. (B5)	Heat generation.	**14,569**	13.2%	**14,569**	6.21%
	2	Mix of sawdust and bark from industrial operations.	On-site production.	The biomass residues are used for power or heat generation at the project site in new and/or existing plants. (B5)	Heat generation.	**96,217**	86.8%		0.00%
	3	Mix of sawdust and bark from industrial operations.	On-site production.	The biomass are dumped or left to decay mainly under anaerobic conditions. This applies for example, to dumping and decay of biomass residues on fields. (B1)	Power generation	**0**		**4,332**	1.85%
	4	Mix of sawdust and bark mix from industrial operations.	Off-site production.	The biomass are dumped or left to decay mainly under anaerobic conditions. This applies for example, to dumping and decay of biomass residues on fields. (B1)	Power generation	**0**		**109,322**	46.59%
	5	Mix of sawdust and bark from forest operations.	Off-site production.	The biomass are dumped or left to decay mainly under anaerobic conditions. This applies for example, to dumping and decay of biomass residues on fields. (B1)	Power generation	**0**		**106,400**	45.3%
	Total					**110,785**		**234,622**	

As can be seen from table above, biomass residues types (sludge, mix of sawdust and bark) would be used for heat generation purpose in the baseline scenario. The rest would be simple dumped or left to decay under aerobic conditions.

For biomass types of categories N°3, N°4 and N°5 for which the corresponding baseline scenario is (B1) the Project Participant should demonstrate that this is a realistic and credible alternative scenario, and may choose one among the procedures presented in the ACM0006 (Version 14.0) to demonstrate to this.

According to the analysis presented above, for biomass residues types of categories N°3, N°4 and N°5 for which the corresponding baseline scenario is B1, the following can be concluded:

- It is clear that in this particular case the proposed project activity implies an additional consumption of mix of sawdust and bark from on-site and off-site industrial operations from nearby sawmills and panel board/plywood mills, and to a less extent some mix of sawdust and bark from forest operations (harvesting, pruning and thinning operations) for electricity generation.
- Though part of the mix of sawdust and bark generated in some Sawmills is used as fuel for energy purpose, a significant surplus still remain unused in the region. This surplus has no other use than to be left in piles to natural (aerobic) decomposition and in some cases, burned in the open-air, in order to avoid the risk of forest fires.

The same baseline analysis as the one presented above for mix of sawdust and bark from industrial operations is valid for mix of sawdust and bark from forest operations. There is a considerable surplus of this type of biomass that is not used for energy purposes and therefore, simply left in piles for natural decay.

In order to demonstrate that there would be no leakage to be account for biomass types of categories N°3, N°4 and N°5, subsequently the Project Participant will demonstrate that there is an abundant surplus of mix of sawdust and bark from industrial and from forest operations in the region of the project activity which is not utilized. This will be done by demonstrating that the quantity of available biomass residues type of categories N°3, N°4 and N°5 in the region is at least 25% larger than the quantity of biomass residues that are utilized (Refer to Project and leakage emissions from biomass (Version 04.0).

Consequently, there would be no leakage to be account for biomass types of categories N°3, N°4 and N°5 presented in table above.

Project scenarios for biogas use

The proposed project activity does not imply the generation of wastewater from biomass treatment under anaerobic conditions. Therefore, no biogas is generated.

Sub-step 1b requires assessing the consistency with mandatory applicable laws and regulations.

For each project scenario, it is established its compliance with the current mandatory and applicable laws and regulations in Chile.

Table 7: Consistency of project scenarios for power generation

Scenario	Consistency with mandatory laws and regulation in Chile	Yes/No
P1	Once the corresponding permits are obtained from the national authorities, this project scenario is consistent with the mandatory laws and regulations in Chile. Currently, there are other similar projects that operate in Chile (as registered CDM projects) without restriction.	Yes.
P5	Once the corresponding permits are obtained from the national authorities, this project scenario is consistent with the mandatory laws and regulations in Chile.	Yes.
P7	This project scenario is consistent with the mandatory laws and regulations in Chile.	Yes.

According to the above, the project scenarios: P1, P5 and P7 would be in compliance with the mandatory laws and regulations in Chile.

Table 8: Consistency of project scenarios for heat generation

Scenario	Consistency with mandatory laws and regulation in Chile	Yes/No
H1	Once the corresponding permits are obtained from the national authorities, this project scenario is consistent with the mandatory laws	Yes.
H5	Once the corresponding permits are obtained from the national authorities, this project scenario is consistent with the mandatory laws and regulations in Chile.	Yes.

According to the above, the project scenarios: H1 and H5 would be in compliance with the mandatory laws and regulations in Chile.

Table 9: Consistency of project scenarios for biomass use

Scenario	Consistency with mandatory laws and regulation in Chile	Yes/No
B1	This is part of the normal practice in the forest industry in Chile. It is consistent with the mandatory laws and regulations in Chile.	Yes.
B2	This is part of the normal practice in the forest industry in Chile. It is consistent with the mandatory laws and regulations in Chile.	Yes.
B3	This is part of the normal practice in the forest industry in Chile. It is consistent with the mandatory laws and regulations in Chile.	Yes.
B5	This is part of the normal practice in the forest industry in Chile. It is consistent with the mandatory laws and regulations in Chile.	Yes.

According to the above, the project scenarios: B1, B2, B3 and B5 would be in compliance with the mandatory laws and regulations in Chile.

Step 2: Barrier analysis

Sub-step 2a requires the identification of a set of barriers that would prevent the implementation of alternative scenarios.

The Project Participant identified the following set of barriers that prevent the alternative scenarios to occur:

Investment barriers:

- With the current prevailing conditions in Chile, biomass power generation projects are normally not viable from a financial perspective. This is supported by the low share of this type of technology in the Chilean power matrix. Depending the particular case and context, there are difficulties in accessing credit for this type of projects.
- The Trupan project activity contemplates the construction of a new grid-connected biomass power plant in the Trupan Complex site. This implies additional risks and/or costs for Arauco. For example, any contingency in the power system (e.g. black-out) normally translates into an economic penalty that is applied to all power producers in the system, regardless of which company was responsible for the contingency[5]. To date, Arauco has paid around US$130,000 in fines to the corresponding national authority. The original amount, however, was approximately 7 times higher. In each case, Arauco had to appeal to the corresponding national authority.

Given the limited amount of information related to penalties available from other power companies (this information is not publicly available) and the high level of uncertainty related to the fines actually paid by the companies (court disputes with the national authority are private) it is not possible to reliably translate this risk into an additional cost, in order to incorporate it into the financial evaluation of this type of projects.

Technological barriers:
Being biomass power cogeneration a technology not common in the context of the Sawmills and wood Panel board industries in Chile, projects using cogeneration face several technological barriers:

Skilled and/or properly trained labour to operate and maintain grid-connected cogeneration plants is not really available in Chile. This translates into additional risks of underperformance, malfunctioning or accident.

[5] Historically, penalties have been applied in proportion to the owner's total generation capacity. Some penalizations that have been applied to Arauco can be found in RE 1433, pages 13-14, RE 809, page 16 and RE 1114, pages 13-14.

A cogeneration power plant is considerably more sophisticated and complex to operate than a conventional low pressure boiler. According to specialized literature[6], poor operational and maintenance skills generally translate into improper operation, which in the long-run result into early deterioration and failure of the power generation equipment. Skilful and fully involved personnel are crucial to achieve optimal plant operation and a low breakdown rate.

The required skills to operate and maintain this kind of cogeneration plants is not readily available in Chile and particularly in the Panel board industry, since power generation is not part of the common practice in this industry. There are not many big-scale biomass cogeneration facilities operating as power plants in Chile[7] and other than Arauco, there is no other company in Chile that operates a cogeneration facility as a self-power producer[8] in the grid.

Furthermore, according to national statistics[9], people tend not to accept or stay long in job positions that are based in another country region. This restricts the universe of potential candidates and contributes to a high-job rotation, which tends to perpetuate the lack of experience problem for high-level technical positions. As a result, it is usual that the power plant owner ends up hiring people with lower competencies, who are not sufficiently qualified for the job.

Risk of technological failure:
The integration of a high-pressure extracting turbine with low-pressure steam equipment such as sawmills and panel board mills present higher operational risks than those observed in conventional facilities. Heat in wood panel mills is used for panel pressing and drying, which is normally done in batches. This translates into high fluctuations in steam demand for heating and have the following adverse effects:

- The high steam demand fluctuations make the turbo generator to operate in areas of low efficiencies. In some extreme cases, low stream flows through the turbo generator may cause system trips. This can be clearly seen in the efficiency versus steam load chart of a turbo generator machine (provided by turbo generator vendors).
- The fluctuations also compromise the power generation capacity of the cogeneration plant, forcing the power plant to reduce its power generation to the grid. If this situation happens during a peak power demand period, the plant may be penalized on its future power revenues by the Dispatch Center for non-compliance with the dispatch program. This is not a minor issue, considering that currently approximately 25% of the annual revenue of a power plant of this type corresponds to firm power sales.
- It must be noted that since there are very few Panel Board mills in Chile that integrate cogeneration power plants in their operation (see official statistics below), it is not possible to reliably translate these barriers into additional cost. However, the low occurrence of this type of projects in Chile (even in the context of other big forest companies) clearly demonstrates that these barriers are real.

Previous experience of the Project Participant:
According to the "Guidelines for objective demonstration and assessment of barriers" (Version 01) approved in the EB 50, it is suggested that the Project Participant should complement the information provided above with information related to the nature of the company, the organization and its ownership, as well as its previous experience with similar projects as this project activity.

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[6] For example, refer to chapter 14 of the "Handbook for cogeneration and combined cycle power plants" by Dr. Meherwan P. Boyce, P.E, 2002 or public papers in the field such as "Assessment of Training Needs for Cogeneration Technology in Schuykill County" by Gary D. Geroy and David L. Passmore, 1987.

[7] Please refer to the list of grid-connected biomass power plants in the CEN interconnected system in Chile in Annex 3 of this PDD.

[8] A self-power producer is a modality contemplated in the CDEC-CEN Dispatch Center regulation, under which a company that has surplus power generating capacity is allowed to operate as a grid-connected power plant in the grid, declaring only its surplus power capacity to the system.

[9] Please refer to 1992-2002 migration study by the National Statistics Institute (INE, Spanish abbreviation).

Arauco is a leading forest company in Chile and has the following business units:

- Forest division.
- Pulp division.
- Sawmill division.
- Wood panel division.
- Power division: This division was created to provide commercial services to the other divisions for selling the additional power to the grid (e.g. from other power generation CDM projects).

Arauco is fully owned by COPEC, a leading fuel distribution company in Chile. Arauco owns another biomass power generation project in Chile which is similar to this project activity: The Nueva Aldea Biomass Power Plant Phase 1 (Ref. 0258), which is also registered in the CDM.

Arauco's past experience with this type of projects does contribute to mitigate some of the technological barriers outlined above. However, some of the barriers still persist, since they are structural to the industry contexts to which this type of projects are related (e.g. Sawmill and Panel board industries) and tend to prevail regardless of the project participant's past experience (e.g. high steam demand fluctuation, turbo generator efficiency range, etc.).

The significance of the technological barriers mentioned above can be substantiated by considering the marginal use of the biomass power cogeneration technologies in the Power and Forest (e.g. Sawmill and Panel board) industries in Chile.

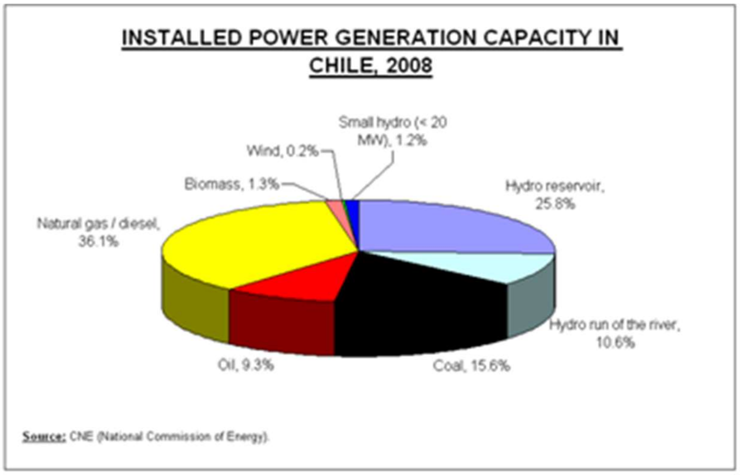
Use of the biomass power generation technology in the Power industry in Chile:
According to the most recent national statistics available, non-conventional renewable power generation capacity accounts for just 3% of the total power generation capacity installed in Chile. Furthermore, biomass power generation (available to the grid) merely represents 1.3% of the total power generation capacity in Chile. This is illustrated in the following table and graph below:

Power generation capacity per technology type in Chile, 2008

		Interconnected transmission systems				
Source		**SIC**	**SING**	**Magallanes**	**Aysén**	**Total**
Hydro (> 20 MW)	(MW)	4,781	0	0	0	4,781
Fossil fuels	(MW)	4,292	3,589	99	28	8,008
Total conventional	**(MW)**	**9,073**	**3,589**	**99**	**28**	**12,789**
Hydro (< 20 MW)	(MW)	129	13	0	21	163
Biomass	(MW)	166	0	0	0	166
Wind	(MW)	18	0	0	2	20
Total non-conventional renewable power	**(MW)**	**313**	**13**	**0**	**23**	**349**
Total natinonal level	**(MW)**	**9,386**	**3,602**	**99**	**51**	**13,138**
Percentage ERNC	(%)	3.3%	0.4%	0.0%	45.1%	2.7%
Percentage Biomass	(%)	1.8%	0.0%	0.0%	0.0%	1.3%

Source: CNE statistics for 2008. Available at: <http://www.cne.cl/cnewww/opencms/06_Estadisticas/energia/ERNC.html>.

Installed power generation capacity in Chile, 2008



Use of the biomass power generation technology in the forest industry in Chile (e.g. Sawmill and Panel board industries):

The significance of the barriers for biomass power cogeneration can also be verified in the Sawmill and Panel board industries:

- According to INFOR (in English: National Forestry Institute)[10], in 2007 there were 1,310 sawmills in Chile. Of these, only 2 have implemented power cogeneration at a comparable scale to the one considered by the proposed project activity. These two cogeneration power plants are registered CDM project activities. At a lower scale (not comparable to the proposed project activity), the number of sawmills that count with on-site cogeneration in Chile are no more than 2 or 3. In all, the number of sawmills that count with cogeneration technology do not surpass 0.4% of the total existing sawmills in Chile (including registered CDM projects).
- According to INFOR, in 2007 there were 21 panel board mills in Chile. Of these, only 2 have integrated cogeneration technology. In both cases, the cogeneration power plants are registered CDM project activities.

Lack of prevailing practice barrier:
As previously mentioned and shown, the utilization of the cogeneration technology in the context of the Sawmill and Panel board industries is marginal (e.g. less than 10% in each case) and clearly departs from the conventional practice in these industries. For that reason, the implementation of this kind of projects face barriers related to the lack of the prevailing practice in these industries (e.g. one of the few of its kind in Chile[11]).

Cultural barriers:
A company's culture in the forestry sector is very much influenced by the commodities: wood-products and pulp, which differs from the culture in the electric power sector. This has the following implications:

- Commercial implications: Unlike forestry products, electric power cannot be stored in order to speculate on price. Power Purchase Agreements require different negotiation skills, which are not part of the competencies of companies that sell commodities such as metals, paper, wood, etc. In the case of Arauco, this is quite evident, since unlike other power companies in Chile, Arauco only has 30% of its available power capacity engaged in long-term contracts.

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[10] See, statistical bulletin N° 123, "La industria del aserrío 2008", page 10, Table 11.

[11] The only similar project in Chile is the Nueva Aldea phase 1 Power Plant. This project (Ref: (0258) is currently registered under the CDM.

The usual standard in the Power generation sector in Chile is higher than 60%. This makes Arauco more vulnerable to spot market fluctuations than other power companies.

- Operational implications: As mentioned above, cogeneration power plants are far more sophisticated than conventional low pressure steam boilers and therefore, require trained and experienced personnel to operate them. This is not valid only for the cogeneration plant operators, but also for the operators of the facilities that use the steam for heating purposes such as sawmills and panel board mills. According to Arauco's experience, people-training is possible, however since there are two types of equipment operating at the same site (e.g. two operational standards coexist at the same site) the operational problems tend to prevail in time. This has been confirmed by external consultants hired be Arauco, who have detected these kinds of problems in other facilities (similar projects currently under the CDM) that have been in operation for some years.
- The cultural barriers can be further substantiated by considering that in Chile, there are two big players in the forest industry (e.g. comparable to Arauco) and none of them have developed the biomass power cogeneration technology to the point of becoming a self-power producer in the grid, to date. All the initiatives currently under development by other players in the forest industry (both big and small) consider the use of the CDM. Evidence supporting this argument can be found in the corresponding Annual Reports of these companies and in the Environmental Impact Assessment studies of new cogeneration projects that are publicly available[12].

Regulatory barriers in the Power industry:
The proposed project activity also faces regulatory barriers in the Power industry; some of which are mentioned and explained below:

Technical barriers faced by self-power producers derived from the Electric law:

- Article 3-8 of the Technical Norm (RM 40, May, 2005) establishes the frequency range in which all grid-connected power plants (including self-power producers) must operate grid-connected. Unfortunately, this range is set too wide and the norm does not allow self-power producers to disconnect their facilities from the grid until the frequency limits have been exceeded. As a result, self-power producers are not capable of re-establishing their internal power supply and go to island operation in case of extreme frequency fluctuations. This situation exposes the self-power producer production processes to instability and power outages, which translate into additional downtime and start-up operations. This problem has been addressed by external consultants the company has hired (see below).
- As a result of the low flexibility allowed in the Technical Norm for self-power producers, the configuration of the protection system is crucial to efficiently deal with the fluctuations observed in the grid system. Since there are no other self-power producers than Arauco in Chile, there are no local companies capable of designing a suitable protection system for self-power producers in the country. Furthermore, the protection equipment that is available in the market is designed to react upon an external system failure and not to give the required time to the power producing facility to stabilize its electric system and go to island operation. In the case of Arauco, the company has to hire specialized consulting companies abroad and redesign the protection system of its power plants every time it modifies or install a new facility that functions as a self-power producer in the grid.

[12] Please see < http://www.e-seia.cl/busqueda/buscarProyecto.php>.

Commercial barrier faced by self-power producers derived from the Electric law:

- Unlike some developed countries in which biomass cogeneration receives favourable treatment and incentives (e.g. Finland, Germany, Sweden, etc.), in Chile, when a cogeneration system is not operational due to maintenance, the developer of cogenerated electricity needs to purchase electricity from the grid. A similar situation happens in case of a technical problem, even if it means stopping the cogeneration plant for just 15 minutes (the minimum period in which the electric distributors measure the peak power consumption). In that case, if the cogeneration facility registers peak power consumption during peak power time, the consuming plant not only has to pay for the electricity (MWh) consumed during this period, but also for the maximum power demand (MW) for the entire billing period. Moreover, while the billing period is monthly, the billing peak demand remains at the maximum demand for 12 months at a time. Thus, if the cogeneration facility is not operational even for a short period of time a year, the industrial customer must pay the demand charge all year long. This is described in CDEC-CEN Dispatch Center rules, Article 118, page 47.
- Despite the regulatory authorities have recently incorporated some measures[13] to promote the use of non-conventional renewable energy sources, the RM17 of 2004 introduced a new algorithm for the firm power calculation for self-power producing companies. This new algorithm introduced a new penalization factor that lowered the firm power for these power producers, which is not present in the calculation of the firm power of conventional power producers. This measure negatively affects biomass cogeneration facilities such as the Nueva Aldea Biomass Power Phase 1, given that this cogeneration facility falls under this power plant category.

Other barriers faced by self-power producers derived from the Electric law:

- The coordination with other generating/distribution/transmission companies also constitutes another barrier for cogeneration power plants such as the Nueva Aldea Biomass Power Phase 1. To be able to sell electric power to the CEN grid and obtain the benefits of a power generating company, Arauco must be part of the CDEC-CEN, the Dispatch Center of the CEN grid. This constitute an operational barrier, since the cogeneration power plant needs to comply with both internal and external energy requirements, compared to pure power plants units in the system, which only need to coordinate with external CDEC instructions. This duality represents a higher operational complexity for the owner of the cogeneration facility, who cannot tune the power plant to exclusively maximize the return on electric power generation assets.
- An argument that ratifies and complements the above, refers to the fact that in the CEN system, the non-conventional renewable energy technologies represent less than 5% of the total energy generated in the system. In addition, the electric power industry is highly concentrated, with mainly four power companies concentrating over 60% of the total energy generated in the CEN grid. The low share of non-conventional renewable energy technologies, the high leverage of conventional power generators and the insufficient incentives for renewable sources in the electric law make these barriers structural and relatively permanent for prospective non-conventional energy producers and current players such as Arauco.
- The coordination with sub-distribution, distribution and transmission companies also becomes more complicated when an industrial facility not only consumes power from the grid but also injects power to the grid. Sometimes the system to which the cogeneration plant must connect is not capable of handling the additional power injected by the power plant. This implies additional investments (reinforcement of sub-transmission lines and new protection systems), which in some occasions can translate into additional (and costly) start-ups delays[14].

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[13] Short Law I in March 2004 and Short Law II in May 2005.

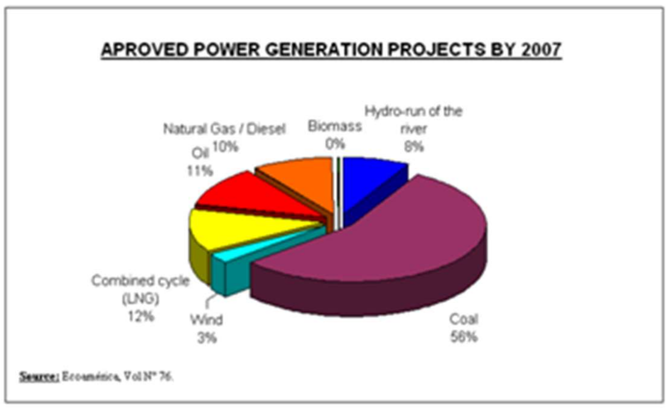
[14] In some cases, these additional costs are hard to anticipate and estimate ex-ante.

It must be noted that:

- The regulatory barriers outlined above are structural to the country as they equally apply to all kind of companies, regardless of their size and/or previous experience with this type of projects.
- The regulatory barriers cannot be reliably translated into additional cost due to the limited amount of information available. However, the best way to confirm the existence and significance of these barriers is by noting the low development of the cogeneration technology in the Power industry.

Finally, at a more macro level, the current regulatory incentives are not enough to make the use of renewable sources more prevalent in Chile. As a result:

- There is a lack of awareness of the multiple benefits of decentralized energy and therefore, the considerable potential to develop micro power plants in the south of the country remains to be exploited. According to several studies, Chile has considerable electric power generation potential in small-hydraulic, wind and biomass renewable sources.
- Regulations for the electric sector are mostly oriented around centralized large-scale and conventional power generation. This can be substantiated by national statistics. The following graph below shows the new power generation projects that have been approved by the corresponding national authority in 2007:



As can be seen, the development of future power generation in Chile is primarily aiming at coal technology in the mid to long term.

Node price of electricity still does not make the development of non-conventional energy sources economically feasible.

Unlike some more developed countries, the current initiatives that have been implemented by the government to promote non-conventional renewable energy projects do not reflect all the positive externalities related to these technologies.

As a ratification of the above, the Project Participant would like to note that all (or most) of the barriers presented in this analysis have been also addressed by sectoral studies in Chile, carried out by reputed third parties (not the Project Participant) and explicitly mentioned in articles of the specialized press:

1. The study: "Evaluaciones del Desempeño Ambiental Chile" (Environmental Performance Review study for Chile)[15], published by the OECD in 2005, addresses the difficulties faced by renewable power generation projects in Chile. In particular, the study identifies the following barriers:

a) Current power prices and policies do not reflect the externality costs caused by more polluting power generation technologies (page 19).

b) There is insufficient promotion of low-contaminating power generation technologies (page 33).

c) Non-conventional renewable power generation projects must compete in the same terms and conditions as conventional power generation projects (page 63).

2. The study: "Aporte Potencial de Energías Renovables no Convencionales y Eficiencia Energética a la Matriz Eléctrica, 2008 – 2025" (Potential contribution of non-conventional renewable power sources and energy-efficiency to power generation, 2008 – 2025) [16], June 2008, developed by Universidad de Chile and Universidad Técnica Federico Santa María. Chapter 8 of the study addresses the barriers faced by non-conventional renewable power generation technologies in Chile. In particular, the study mentions the following barriers:

a) Poor identification/insufficient information about the available energy resources.

b) The geographical situation of Chile (extremely long and narrow country) makes it difficult for mini/micro power plant to interconnect to the CEN (main transmission system).

c) Lack of skilled labour, experience and technological development.

d) Insufficient incentives.

e) Current power prices do not truly reveal the cost of externalities.

f) Lack of negotiating capacity with equipment suppliers and long waiting times.

g) (For biomass power generation only) The dispersed availability of the biomass residues limits the size biomass power plants. This increases the biomass transportation costs (logistics) and compromises the financial viability of the power generation projects (e.g. the interconnection cost becomes more relevant for a smaller plant).

3. The report: "Chile Energy Policy Review 2009" [17], October 2009, developed by the International Energy Agency. Chapter 7 is dedicated to renewable energy sources and in page 165, box 7.1 the study explicitly mentions the barriers faced by non-conventional renewable energy sources:

a) Lack of information on energy sources.

b) Uncertainty in processing permits for new technologies.

c) Regulatory barriers: Regulatory framework under development (first drafts started only in 2004).

d) Technological barriers: Weak infrastructure (especially access to some resources).

e) Investment barriers: Difficulty in accessing credit (capital-intensive with long pay-back periods).

f) Technological barriers: Uncertainty regarding technological options, their costs and performance.

g) Operational barrier: Need to adapt systems (e.g. the grid) to operate with more intermittent (power) sources.

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[15] Available at: http://www.bcn.cl/carpeta_temas_profundidad/copy3_of_temas_profundidad.2007-05-02.5434448168/documentos_pdf.2007-06-28.4716180007/archivos_pdf.2007-06-28.5843705619/carpeta_temas_profundidad/temas_profundidad.2007-07-25.4772415999/documentos_pdf.2007-06-28.4716180007/archivos_pdf.2007-06-28.5843705619/archivo1

[16] Available at: <http://www.freewebs.com/infoenergia/Informe%20Ejecutivo%20Consolidado.pdf>.

[17] This study is publicly available in the IEA web page.

4. The article "Inversiones por US$ 3,000 millones en energías verdes estarían en riesgo por rigidez de la ley" (Investments for US$ 3,000 million would be at risk due to law rigidities), published in November 25th, 2009 in "Electricidad Interamericana", a specialized journal that focus on the Chilean electric power sector. The article describes that investment in future "green" (non-conventional and renewable) power generation projects would be at risk due to rigidities of the Chilean electric law. In particular, the article mentions the following problems/barriers:

a) Restrictions imposed by the current law to non-conventional renewable power generation technologies make them less competitive compared to other conventional power generation technologies.

b) The current law does not provide enough incentives to develop non-conventional renewable power generation technologies in Chile.

c) Current power prices and policies do not reflect the externality costs caused by more polluting power generation technologies.

d) The presence of commercial restrictions for non-conventional renewable power generation technologies.

e) Financing restrictions for non-conventional renewable power generation technologies.

It must be noted that in each of the references presented above, the barriers mentioned are structural and inherently related to the country. The significance of the barriers is not altered or diminished by the type/size of the entity/company behind these kinds of projects. Once again, this can be demonstrated by considering:

- The low share (3.86 %) of non-conventional renewable power generation in Chile. In particular, for biomass power generation technology, this share is less than 1.10%.
- The marginal implementation of the cogeneration technology (clearly less than 10%, including CDM projects) in the Sawmill and Panel board industries in Chile.
- The fact that other relevant players in the forest industry in Chile (comparable to Arauco) have not developed this technology without the aid of the CDM. All the initiatives currently underway by these companies (and smaller companies as well), consider the CDM to overcome the barriers outlined in this section of the PDD.

Sub-step 2b requires the project participant to eliminate the alternative scenarios which are prevented by the identified barriers.

This is done in the table below for all the feasible power, heat generation and biomass use baseline scenarios.

<u>Baseline assessment for Power generation</u>

Scenario	Barriers that prevent the implementation of the alternative scenarios	Likely baseline candidate?
P1	• Investment barriers. • Technological barriers. • Barriers due to the prevailing practice. • Cultural barriers. • Regulatory barriers.	No.
P5	• Investment barriers. • Technological barriers. • Barriers due to the prevailing practice. • Cultural barriers. • Regulatory barriers. The integration of a cogeneration facility to Sawmill and/or Wood Panel board mills is not common practice in Chile. Therefore, they do not contemplate the generation of power on-site.	No.
P7	This project option would not face barriers and is consistent with the common practice of the sawmill industry in Chile.	Yes.

<u>Baseline assessment for Heat generation</u>

Scenario	Barriers that prevent the implementation of the alternative scenarios	Likely baseline candidate?
H1	• Investment barriers. • Technological barriers. • Barriers due to the prevailing practice. • Cultural barriers. • Regulatory barriers.	No.
H5	This project option would not face barriers and is consistent with the common practice of the Sawmill and Wood Panel board industries in Chile. Since, the generation of heat in boilers using mix of sawdust and bark from industrial and forest operations is consistent with the common practice of the Sawmill and Panel board/Plywood industries in Chile, as it was stated above, the proposed project activity only claims emission reductions from on-site electric power generation and the use of biomass that would otherwise be left in piles to natural decay.	Yes

<u>Baseline assessment for Biomass usage:</u>

Scenario	Barriers that prevent the implementation of the alternative scenarios	Likely baseline candidate?
B1	This project option would not face barriers and is consistent with the common practice in the Sawmill and/or Wood Panel board industries in Chile.	Yes.
B2	This project option would not face barriers and is consistent with the common practice in the Sawmill and/or Wood Panel board industries in Chile.	Yes.
B3	This project option would not face barriers and is consistent with the common practice in the Sawmill and/or Wood Panel board industries in Chile.	Yes.
B5	This project option would not face barriers and is consistent with the common practice in the Sawmill and/or Wood Panel board industries in Chile.	Yes

As can be seen, the likely baseline project options for power generation, heat generation and biomass use are the following:

Baseline scenario options for power generation

Scenarios	Scenario description
P7	The generation of power in the grid.

Baseline scenario options for heat generation

Scenarios	Scenario description
H5	The installation of a **new** power plant at the project site different from those installed under the project activity.

Baseline scenario options for biomass use

Scenarios	Scenario description	Associated emissions (1=lowest, 3=highest)
(B1) or	The biomass residues are dumped or left to decay mainly under aerobic conditions. This applies, for example, to dumping and decay of biomass residues on the fields.	2
(B2) or	The biomass residues are dumped or left to decay under clearly anaerobic conditions. This applies, for example, to landfills which are deeper than 5 meters. This does not apply to biomass residues that are stock-piled or left to decay on fields.	3
(B3)	The biomass residues are burnt in an uncontrolled manner without utilizing it for energy purposes	1

and

(B5)	The biomass residues are used for power or heat generation at the project site in new and/or existing plants.

According to the baseline analysis described above, a combination of baseline scenarios that would qualify as a likely baseline candidate for the proposed project activity is provided below:

Baseline scenarios for power, heat generation and biomass usage, relevant for the proposed project activity				
P7	The generation of power in the grid.			
H5	The installation of new plants at the project site different from those installed under the project activity.			
Biomass residues category (n)	Biomass residue type.	Biomass residue source.	Biomass residues fate in the absence of the project activity.	Biomass residues use in project scenario.
1	Sludge from industrial operations.	On-site production.	The biomass residues are used for heat generation at the project site (B5)	Heat generation.
2	Mix of sawdust and bark from industrial operations.	On-site production.	The biomass residues are used for heat generation at the project site (B5).	Heat generation.
3	Mix of sawdust and bark from industrial operations.	On-site production.	The biomass residues are dumped of left to decay mainly under aerobic conditions (B1).	Power generation.
4	Mix of sawdust and bark from industrial operations.	Off-site production.	The biomass residues are dumped of left to decay mainly under aerobic conditions (B1).	Power generation.
5	Mix of sawdust and bark from forest operations.	Off-site production.	The biomass residues are dumped of left to decay mainly under aerobic conditions (B1).	Power generation.

This baseline scenario would be translated into the alternative (baseline) project Option 1, presented in section B.4 of this PDD, consisting in:

• **A conventional sawmill / plywood mill boiler, without power generation capacity:**
The installation of a new low pressure boiler on biomass fuels for heat generation (no cogeneration) in the Trupán complex site. This is the standard practice in the Sawmill / Plywood mill / MDF Panel Wood mill industries in Chile and in the world.

To complement the analysis above, the Project Participant would like to present information that further ratifies and substantiates the selection of the baseline scenario of the proposed project activity. This information is provided in the tables below:

Electric power generation baseline

Industry	Current practice in Chile	Documentation/reference	Description of the technology used in the absence of the proposed project activity
Electric power generation industry	• Electric power generation through conventional technologies. • Biomass co-generated power accounts for merely 1 to 2 % of the total energy generated into the grid for external consumption in the country.	• CDEC CEN and CDEC-SING Dispatch Centers annual generation statistics.	• The additional power generated by the Trupan Biomass Power Plant would be generated in other conventional power plants connected to the CEN grid. The power generation technologies in the CEN grid include mainly: hydro, combined cycle, open cycle and conventional coal.
Sawmill and Panel board industries	• Sawmills and Panel board mills do not integrate cogeneration power plants to their facilities and therefore do not contemplate the generation of power on-site.	• Baseline solution design for the Trupan Biomass Power Plant (see section A.4.3 of this PDD). • Other industry players company information in their web pages, Annual Reports and Sustainability Reports.	• Conventional low-pressure boiler for heat generation. This technology used under the chosen baseline scenario is the one normally used in the Sawmill and Panel board mills in Chile. • For more details, please see section A.4.3 of this PDD.
Pulp industry	• Pulp mills in Chile tend to be (not all currently are) self-sufficient in electric power generation. Modern pulp mills achieve this by burning black liquor in their recovery boilers. • It is also part of the business-as-usual practice to have a small boiler for heat generation (e.g. to aid start-up operations). These boilers usually run on biomass fuels (from the debarking section of the mill) or fossil fuels.	• AF-Celpap baseline mill design for several Arauco pulp mill projects. • Pulp industry publications such as ATCP Chile. • DIA and EIA studies of pulp mills in Chile by other industry players. SEIA and CONAMA web pages. • Other industry player's company information in their web pages. Other industry player's Annual Reports and Sustainability Reports. • International documentation on best practices in the pulp industry: Please see table 2.46 of the BREF document (the "European IPPC Bureau. 2001. Integrated Pollution Prevention and Control (IPPC), Reference Document on Best Available Techniques in the Pulp and Paper Industry, p 111."The link: http://eippcb.jrc.es/reference/BREF/ppm_bref_1201.pdf.	• Conventional low-pressure boiler for heat generation running on biomass or fossil fuels. No cogeneration.

Heat generation baseline

In the Sawmill and Panel board industries, heat generation using biomass residues is a common practice. As a result, the proposed project activity does not claim emission reductions due to this source.

Industry	Current practice in Chile	Documentation/reference	Description of the technology used in the absence of the proposed project activity
Sawmill industry	• Use biomass residues as fuel for heat generation (mainly wood drying).	• Company information of other relevant Sawmill players in Chile. • Forest industry publications such as Lignum, Ecoamérica and Infor reports.	• Conventional low pressure boiler on biomass residues for heat generation. No cogeneration.
Panel board industries	• Use biomass residues as fuel for heat generation (presses and drying).	• Company information of other relevant Panel board players in Chile. • Forest industry publications such as Lignum, Ecoamérica and Infor reports.	• Conventional low pressure boiler on biomass residues for heat generation. No cogeneration.
Pulp industry	• Pulp mills in Chile tend to be (not all currently are) self-sufficient in electric power generation. Modern pulp mills achieve this by burning black liquor in their recovery boilers. • It is also part of the business-as-usual practice to have a small boiler for heat generation (e.g. to aid start-up operations). These boilers usually run on biomass fuels (from the debarking section of the mill) or fossil fuels.	• AF-Celpap baseline mill design for several Arauco pulp mill projects. • Pulp industry publications such as ATCP Chile. • DIA and EIA studies of pulp mills in Chile by other industry players. SEIA and CONAMA web pages. • Other industry player's company information in their web pages. Other industry player's Annual Reports and Sustainability Reports. • International documentation on best practices in the pulp industry: Please see table 2.46 of the BREF document (the "European IPPC Bureau. 2001. Integrated Pollution Prevention and Control (IPPC), Reference Document on Best Available Techniques in the Pulp and Paper Industry, p 111." The link: http://eippcb.jrc.es/reference/BREF/ppm_bref_1201.pdf	• Conventional low-pressure boiler for heat generation running on biomass or fossil fuels. No cogeneration.

Unused biomass baseline

The following table establishes the baseline of the additional biomass that will be burned in the Nueva Aldea Biomass Power Plant Phase 1, as a result of implementing the project activity. The baseline is established using a per-industry analysis.

Industry	Current practice in Chile	Documentation/reference	Description of the technology used in the absence of the proposed project activity
Sawmill and Panel board industries	• Use part of the biomass residues generated internally as fuels to generate heat (i.e. for wood drying), sell the remaining residues if possible. Still, a considerable surplus of biomass remains unused in the region, which is dumped or burned in an uncontrolled manner.	• Sawmill and Panel board industries information in Chile. • Forest industry publications such as Lignum, Ecoamérica and Infor reports.	• The additional biomass consumed by the proposed project activity would most likely be left in piles for natural decay. In some particular cases, the biomass would be burned in the open-air in an uncontrolled manner.
Forest industry	• Residues from harvesting, pruning and thinning operations are mostly left in piles to natural decay. In some particular cases the residues are burned in an uncontrolled manner.	• Conventional forest management practices of Arauco and other forest companies of comparable size in Chile. • Forest industry publications such as Lignum, Ecoamérica and Infor reports.	• The additional biomass consumed by the proposed project activity would most likely be left in piles for natural decay. In some particular cases the residues would be burned in an uncontrolled manner.
Pulp industry	• Pulp mills in Chile tend to be (not all currently are) self-sufficient in electric power generation. Modern pulp mills achieve this by burning black liquor in their recovery boilers. • It is also part of the business-as-usual practice to have a small boiler for heat generation (e.g. to aid start-up operations). These boilers usually run on biomass fuels (from the debarking section of the mill) or fossil fuels.	• AF-Celpap baseline mill design for several Arauco pulp mill projects. • Pulp industry publications such as ATCP Chile. • DIA and EIA studies of pulp mills in Chile by other industry players. SEIA and CONAMA web pages. • Other industry player's company information in their web pages. Other industry player's Annual Reports and Sustainability Reports. • International documentation on best practices in the pulp industry: Please see table 2.46 of the BREF document (the "European IPPC Bureau. 2001. Integrated Pollution Prevention and Control (IPPC), Reference Document on Best Available Techniques in the Pulp and Paper Industry, p 111." The link: http://eippcb.jrc.es/reference/BREF/ppm_bref_1201.pdf	• The additional biomass consumed by the proposed project activity would most likely be left in piles for natural decay. In some particular cases the residues would be burned in an uncontrolled manner.

Currently there is some demand for biomass residues (mix of sawdust and bark) from industrial operations i.e. from sawmill operations, which mainly is related to heat generation in big-scale sawmills, and some isolated examples of small-scale electric power generation. However, there is virtually no use for biomass generated from forestry operations (thinning, pruning and harvesting operations), which is mainly left on the ground to natural decay and in some cases, burned in the open-air in order to avoid forest fires. As a result, the baseline for these biomass types is that the

biomass would be dumped in piles to natural decay and in some cases, burned in the open air to avoid the risk of forest fires.

To complement the analysis above, table below shows the expected consumption amount per categories of biomass before and after the implementation of the project activity and the corresponding baselines for each type of biomass used.

	Biomass residues category (n)	Biomass residues type	Biomass residues sources	Biomass residues fate in the absence of the project activity	Biomass residues use in project scenario	Consumption before project activity		Biomass consumption in the new power plant	
						BDt	%	BDt	%
(+) Most Available/least Costly (-)	1	Sludge from industrial operations.	On-site production.	The biomass residues are used for power or heat generation at the project site in new and/or existing plants. (B5)	Heat generation.	**14,569**	13.2%	**14,569**	4.40%
	2	Mix of sawdust and bark from industrial operations.	On-site production.	The biomass residues are used for power or heat generation at the project site in new and/or existing plants. (B5)	Heat generation.	**96,217**	86.8%	**96,217**	29.08%
	3	Mix of sawdust and bark from industrial operations.	On-site production.	The biomass are dumped or left to decay mainly under anaerobic conditions. This applies for example, to dumping and decay of biomass residues on fields. (B1)	Power generation	**0**		**4,332**	1.31%
	4	Mix of sawdust and bark mix from industrial operations.	Off-site production.	The biomass are dumped or left to decay mainly under anaerobic conditions. This applies for example, to dumping and decay of biomass residues on fields. (B1)	Power generation	**0**		**109,322**	33.04%
	5	Mix of sawdust and bark from forest operations.	Off-site production.	The biomass are dumped or left to decay mainly under anaerobic conditions. This applies for example, to dumping and decay of biomass residues on fields. (B1)	Power generation	**0**		**106,400**	32.2%
	Total					**110,785**		**330,839**	

This clearly and unequivocally demonstrates that the baseline scenario chosen for the Trupan Biomass Power Project is still valid. Further evidence of this will be shown in the section below, in which the Project Participant applies the last version of the tool used to assess the validity of the chosen baseline scenario.

<u>Step 3</u>: Investment analysis

Not chosen.

According to ACM0006 (Version 14.0), if there is only one alternative scenario that is not prevented by any barrier, and if this alternative is not the project activity and the CDM does alleviate the barriers identified for the proposed project activity, the Project Participant must now proceed to Step 4.

<u>Step 4</u>: Common practice analysis

According to the ACM0006 (Version 14.0), the previous steps shall be complemented with an analysis of other project activities that are of similar scale, take place in a comparable environment with respect to the regulatory framework and are undertaken in the relevant geographical area, as defined in Sub-step 1a above. Other registered CDM project activities should not be included as part of this analysis.

Arauco is the only company to have developed big-scale biomass cogeneration technology to the point of becoming a net power exporter to the grid in Chile. It is also the only company to have integrated the cogeneration technology to industrial facilities, which normally do not use this technology to generate power.

<u>Other company's initiatives:</u>

A relevant competitor in the pulp industry in Chile installed a biomass (bark) power boiler (150 t/h at 60 bar) inside one of its pulp mills. This initiative was mainly oriented towards the generation of steam for a future wood products mill that will be installed near the pulp mill area. It also provided additional steam to increase the electric power generation capacity inside the pulp mill to make it (and other company's interconnected pulp mills in the region) self-sufficient in electric power generation.

Today it is a common practice in the pulp industry not to rely in external electric power sources, but to generate all power internally. Older pulp mills were less energy efficient (both in energy consumption and generation capacity) so they were not necessarily self-sufficient in electric power generation.

The rest of the biomass cogeneration initiatives in Chile are definitely not comparable to the proposed project activity, since they are significantly smaller scale (i.e. < 50 t/h, saturated or near saturated steam at 45 bar, <10 MW, etc.) than this project activity.

As it was mentioned above, the project activity is probably the only large scale biomass cogeneration initiative integrated to Sawmill and Plywood mill in Chile. The most relevant features that distinguish this biomass cogeneration power plant from other initiatives are:

The type and capacity of the heat generator:

- Power boiler (steam) capacity:

The power boiler has the following maximum continues capacities, without soot blowing in operation:

Max. High-pressure steam on wood based fuels.[(a)]	t/h	170
Max. High-pressure steam combined with auxiliary fossil fuel.[(b)]	t/h	250

The Project Participant would like to note the following:

Max. steam rate production based on design solid fuel mixture (sawdust, bark and sludge) without considering auxiliary fossil fuel consumption. Refer to the project case energy/mass balance stated in this PDD.

Max. steam rate production based on design solid fuel mixture (sawdust, bark and sludge) (w=56%) with auxiliary Fuel Oil #6 with a design Fuel Oil burning capacity of 120 (t/h).

Design parameters of the Power boiler:

- Steam pressure at main steam stop valve 85 bar(g)
- Steam temperature 485 +/- 10 °C.
- Feed water temperature at economizer inlet 136.6 °C.

The Project Participant would like to note that the design parameters previously presented have been chosen in order to maximize the electric power generation at the facility.

This project activity has been designed to generate surplus (approximately 15 MW) to the local grid. Other biomass cogeneration initiatives have been presented and discussed in the preceding section. From the Project participant’s point of view, these initiatives present clear differences that make the proposed project activity particular and unique in its type. However, even in the case these cogeneration initiatives were considered similar to the proposed project activity, biomass cogeneration would still not be the common practice in any of the industries in which the proposed project activity is involved:

Electric power industry: The following table shows the biomass power generation situation in the CEN grid and in Chile:

		2002	2003	2004	2005	2006	2007	2008
Total power generation in Chile	(GWh)	42,636	45,409	48,970	50,937	53,916	56,279	56,679
Total biomass power generation in Chile	(GWh)	374	429	649	516	571	744	884
Biomass power generation / total power generation in Chile	(%)	0.9%	0.9%	1.3%	1.0%	1.1%	1.3%	1.6%
Nº of biomass power plants in the SIC (and in Chile)	(Number)	4	5	7	8	8	10	10
Total Number of power plants in the SIC	(Number)	54	56	60	67	70	90	106

Sources: CNE, <http://www.cne.cl/>, CDEC-SIC.

Note: Biomass power generation includes all types of biomass. 2008 includes 4 Arauco biomass power generation projects registered under the CDM.

From the table above, it is possible to see the extremely low share of biomass-generated power compared to the total power generation in Chile. Furthermore, the table above does not consider some still non-registered CDM projects from Arauco. In other words, in the last years there has not been any other new biomass power plant added to the CEN, other than the ones built by (mostly) Arauco under the CDM.

Wood Panel industry: Plywood mills and other wood panel producing mills are not designed to operate with high pressure steam, so on-site power generation is not considered a normal practice either. Normal practice in these industries contemplates the generation of heat from biomass residues (mix of sawdust and bark) from industrial operations. Heat is baCENally used for wood panel pressing and drying.

Sawmill industry: As mentioned in the preceding section of this PDD, in 2007 there were 1,310 sawmills in Chile. According to INFOR, the typical process flow chart of a well-established sawmill includes an artificial drying stage of the sawn timber. It must be mentioned that in 2007 stage was applied to 54.2% of the total sawn timber produced in Chile. In addition, only the “Very big scale” sawmills are capable of implementing this process and they do it in 64.6% of their total output

Artificial drying is accomplished using two techniques. The first one uses traditional drying chambers in which the wood is dried at approximately 70ºC and ambient pressure. The energy required to heat the chamber is normally generated by a saturated steam boiler fuelled by the wood residues from the same saw-milling process. The second consists in vacuum drying, in which the wood is dried in a vacuum chamber at ambient temperature. This system is more efficient than the previous one, but implies the consumption of electric power, which is supplied from the grid. On-site electric power cogeneration from biomass sources is not considered (even hardly mentioned) as normal practice in this industry[18].

Pulp industry: Though cogeneration is widely used in the Pulp industry and part of the business as usual (BAU) practice, only modern pulp mills tend to be self-sufficient in thermal and electric power generation. In these mills, all internal thermal and electric power requirements are served by burning black liquor in the recovery boiler (not biomass from industrial and/or forest operations), which is part of the Kraft cycle. In some cases, a small (50 to 80 ton/hr) biomass (bark) Power Boiler to supplement internal thermal and electric power generation is also considered a normal practice. However, it is not the common practice in Chile (or in the world) that a pulp mill becomes a net electric power exporter and operates as a power plant in the grid to which it is connected. Even today, there are examples of pulp mills recently built in Chile that are not self-sufficient in electric power generation, and must rely on power from the grid to serve their internal power requirements on a normal basis.

According to the analysis above, the following conclusions can be drawn:

- The proposed project activity is one of the few of its kind in Chile.
- Biomass cogeneration projects in the forest industry context (Panel board and Sawmill industries) are not observed as common initiatives.
- Biomass cogeneration projects in the Power industry are equally unique and therefore not observed as common initiatives either.
- The utilization of the biomass cogeneration technology in the Pulp industry context is normally found and justified to the point of making the pulp mill facility self-sufficient in heat and electric power generation; not to generate surplus power to the grid. In addition, there are sufficient differences in scale and context to make this project activity not comparable to power generation initiatives in the Pulp industry.

For these reasons, the proposed project activity is still not part of the common practice in the relevant (and comparable) industries in Chile and therefore, considered additional from a common practice perspective analysis.

[18] Refer to “Boletín Estadístico 123”, “La Industria del Aserrío, Chile 2008”, that provides a description of the Sawmill industry in Chile.

B.5. Demonstration of additionality

The project will reduce anthropogenic GHG emissions by:

- Replacing fossil fuel-based electricity with GHG - free biomass CHP power generation. The project will reduce about 920,034 (tCO_2e) for the third crediting period, an average of 131,433 (tCO_2e).
- The project will assist Chile with greenhouse gas (GHG) reduction by curbing methane emissions from biomass degradation derived from wood-related industries (Sawmills, Wood Panel/Plywood mills and forest companies).

To do so, the Project Participant built a large scale biomass cogeneration initiative that is integrated to Sawmill and Panel board/Plywood mills and has been designed to generate surplus to the power grid. For reasons presented in previous section, the project activity is still not part of the common practice in the relevant (and comparable) industries in Chile and therefore, considered additional from a common practice perspective.

The Project Participant clearly demonstrated the additionality of the proposed project activity in the preceding section by following the stepwise approach of the ACM0006 (Version 14.0). For that reason, the Project Participant will not repeat this analysis in this section of the PDD.

Starting date of Trupan Biomass Power Plant in Chile:

The Trupan Power Plant construction started on April 2001 and it began operating on June 2003, which is before the date of validation and registration (June 6th, 2006) of the CDM project activity.

Considering the above and according to EB 66 Report, Annex 8, "Guidelines for Completing the Project Design Document" establishes in point B.5 that if the starting date of the project activity is before the date of validation, then evidence must be provided in order to show that the CDM was seriously considered in the decision to proceed with this project activity and therefore to demonstrate its additionality.

Evidence of serious consideration of Climate Change and the CDM in the Trupan project activity:

- Arauco first considered the CDM principles in cogeneration initiatives in 1998. A study called "Estudio de Factibilidad de Cogenerar en Chile" [19] carried out by SERCOR S.A., a research company; subsidiary of Arauco explicitly considered the benefits related to power cogeneration: mainly higher efficiency and lower CO_2 emissions. It must be noted that unlike the environmental regulations in other countries, the Chilean and Argentinean environmental regulations do not consider CO_2 a pollutant and therefore, they do not contemplate any emission restriction at all. As a result of this study and other subsequent studies in the coming years, Arauco introduced the sustainability criteria in power generation and made it part of its Environmental Corporate Policy of Sustainable Development. As a highly integrated conglomerate in the forest industry, Arauco consistently and systematically applied this policy throughout all the business areas in which the company participates: forest management, wood processing (sawmills), Hardboard/MDF/Plywood panel manufacturing, pulp producing and power generation. Evidence that explicitly mentions Arauco's Environmental Corporate Policy and its compromise towards sustainable development in all of its business areas and subsidiaries can be found in Arauco's 1997 to 2011 Annual Reports and in the Environmental and Social Responsibility Reports.
- Arauco first considered the incentives of the CDM in 1999. In the study "Proyecto de fijación de carbono en plantaciones de Pinus Radiata en la VI y VII regiones, Chile" [20], carried out by

[19] "Feasibility Study of Cogeneration in Chile", the English translation.
[20] "Carbon capture project from Radiata Pine plantation in the VI and VIII regions, Chile", the English translation.

the FIA (Foundation for Agriculture Innovation). This study was a result of a shared initiative of FIA, CONAF (National Forestry Corporation) and Forestal Celco (an Arauco subsidiary related to forest management) and was aimed at developing a participative mechanism that allowed small land owners located in the coastal dry lands of the south of Chile to reforest abandoned and/or eroded lands. The study evaluated the financial feasibility of the reforestation program and explicitly considered the carbon revenues derived from the reforestation program. As a result of this initiative, Forestal Celco and later on, Licancel (an Arauco subsidiary related to pulp production) implemented the reforestation program. Since in those years the CDM was in its early beginnings, Arauco was unable to certify the emission savings from this reforestation project. As a result, the company maintained the reforestation program until 2002, the year in which it was no longer feasible to maintain the program without the economic incentives of the CDM.

- The Trupan EID (Environmental Impact Declaration) explicitly mentions that one of the objectives of the Trupan project is to achieve high power generation efficiency and to curb gaseous emissions. The EID is an official and public study that is mandatory by the Chilean Environmental Regulation for all projects of a certain scale in Chile.
- During 2002, SERCOR S.A. developed the study “Bonos de Carbono” [21] about the Kyoto Protocol, the CDM and the Carbon Market possibilities available at that time. This study was presented to members of the Arauco board and contributed to foster the interest in the CDM and the Kyoto Protocol.
- During 2003, considering that still no baseline methodology suitable for Arauco’s biomass projects had been developed, Arauco decided to develop its own internal CDM competencies and develop a CDM baseline methodology that suited its biomass cogeneration projects. The first methodology calculations are dated June/July 2003. As a result of these developments, Arauco finally presented the first CDM grid-connected baseline methodology for biomass projects in Chile (the NM0081) in October 28th 2004, and got the approval by the Executive Board by the end of February 2005[22]. The successful development of this methodology clearly proves Arauco’s serious commitment with the CDM principles and its intention to continue developing biomass power cogeneration initiatives in the future.

The CDM would alleviate the identified barriers in the following way:

The CDM brings significant benefits to the Trupan Complex. However, these benefits do not only circumscribe to the Complex itself, but also to Arauco for overcoming the associated barriers to carry out the proposed project to final completion, and to any other company in Chile who decides to follow Arauco’s lead in biomass cogeneration in the future.

The main areas in which the CDM would alleviate the identified barriers are mentioned below:

- The financial benefit derived from the sale of CERs to Annex I countries is a strong incentive to develop the CDM project activity to Arauco. The additional investment related to a biomass electric power generation capacity is about 2 to 3 MMUS$ per installed MW (depending on the project context), which is significant. The barriers that must be overcome to implement such projects are not minor either. As previously mentioned, they cannot be easily/reliably quantified ex-ante, but they invariably end up translating into additional costs, deteriorating and compromising the financial performance of this type of projects ex-post.
- The proposed project activity will unquestionably reduce anthropogenic greenhouse emissions by generating electric power via a clean energy source. This is consistent with Arauco’s Corporate Policy of Sustainable Development and its current stand of combating

[21] “Carbon Bonds”, the English translation.

[22] Most of the supporting evidence mentioned here has not been included in this PDD, however the evidence will be made fully available at the validation stage of this project activity.

Climate Change[23]. The CDM has allowed the company to leverage its energy-efficiency policy, by making the big-scale biomass cogeneration technology feasible. As a result, the company has developed this technology in a way no other company has done it in Chile to date.

- This has positively contributed to position Arauco as an "environmental friendly" company not only in Chile, but also in the international context. This is relevant to Arauco, since approximately 60% of the company's consolidated annual sales come from exports to countries that have a high environmental consciousness and care about the use of sustainable technologies. The registration of the proposed project in the CDM will definitely acknowledge Arauco's effort of using high-end environmental-friendly technology, giving the company a competitive edge in this field.

The prospects of a project that will generate CERs, attract financiers who would normally not finance this kind of projects without CDM. The Project Participant would like to mention the following evidence that supports this argument:

- Every year, the Chilean Economic Development Agency (CORFO) organizes the International Conference on Renewable Energy Investments and CDM. The event provides the opportunity for networking by bringing together private investors, carbon market intermediaries, national project developers, service suppliers, banks, public agents and experts in the renewable energy and CDM sectors. One of the main aims of this event is to provide the possibility of Project Participants of renewable power generation projects to meet potential investors and financiers. The great success and continued growth in importance of this conference over the last years demonstrates that the CDM is in fact a mechanism that attracts potential investors and financiers who would normally not finance this kind of projects without the aid of this mechanism.
- In the case of the proposed project activity, from the moment Arauco started the validation of the proposed project activity, the company received several communications from financial institutions and investors who manifested interest in financing the project.
- Finally, in the last 20 years, Chile has had a sound macroeconomic management and as a result, Chile is regarded today as one of the most attractive countries to do business with in Latin America. With the approval of free-trade agreements with USA and the European Union, Chile has a very open and world-integrated economy, which relies heavily on its exports (approximately 40% of its GNP). This makes the Chilean economy very sensitive to external shocks and currency fluctuations. The CDM provides a new/additional hard-currency cash flow stream for the proposed project activity that positively contributes to mitigate the effects of inflation and exchange rate fluctuation.

<u>Revalidation of the baseline for Trupan Biomass Power Plant project activity</u>

Considering that this PDD corresponds to the second renewal of the Trupan Biomass Power Plant's crediting period, the Project Participant will follow the "CDM project standard for project activity (Version 02.0)".

To do so, the Project Participant will include in this section of the PDD the application of the tool "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" (Version 03.0.1).

The tool above requires two steps to be followed. Each of them will be presented below:

[23] Arauco's Corporate Policy of Sustainable Development and the role of the CDM in combating Climate Change has been widely described in the Company's annual reports, sustainability reports, internal company bulletins and several presentations and papers prepared for national and international seminars, discussion tables and industrial guild events.

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

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

As can be seen from the baseline analysis previously presented, the current baseline for electricity (P7), heat (H5) and biomass use (B5 and B1) complies with all relevant mandatory national and/or sectorial policies which have come into effect after the submission of the Trupan Biomass Power Plant for validation. In particular:

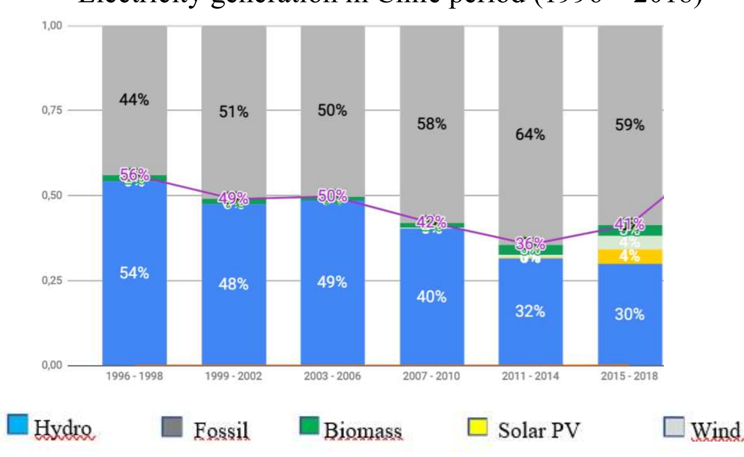
- Electricity: The sourcing of electric power from the grid (P7). There have been no new regulations or policies that prevent Sawmill and Panel board mills or other forest industrial facilities from obtaining electric power from the grid, since the date in which the proposed project activity was submitted for validation.
- Heat: The generation of heat inside forest industrial facilities, using biomass residues (H5). As in the previous case, there have been no new regulations or policies that prevent Sawmill and Panel board mills or other forest industrial facilities that prevent them from generating heat using biomass residues, since the date in which the proposed project activity was submitted for validation.
- Biomass use: The natural decay or uncontrolled burning of unused biomass residues (B1). There have been no new regulations or policies that prevent the dumping or the uncontrolled burning of biomass residues in the open air, since the date in which the proposed project activity was submitted for validation.

Step 1.2: Assess impact of circumstances

The current circumstances at the date of requesting crediting period renewal have change to some extend to those that prevailed at the date of sending the proposed project activity to validation.

The changes that the energy sector has experienced in recent years have been significant. At general level, the integration of very low-cost renewable energies, such as solar and wind, has contributed to transform energy matrices in many countries. In Chile, solar and wind energy took quickly place them as the most relevant sources among new projects, given their low costs, Chile 's natural conditions and a regulatory framework and favorable bidding. In recent years there has been a significant increase in installed capacity, especially solar and wind, displacing biomass and mini-hydraulics. This can be explained as energy production costs (or materials) from biomass is complex due to regional variability in the production costs and supply of raw materials and the wide variety of biomass conversion technologies.

Electricity generation in Chile period (1996 – 2018)



Source: Data 1996 – 2017: Average data based on public information, CNE

At sectorial level the internal and electric power generation for internal consumption is part of the BAU in the Pulp and Paper industry and therefore, conventional self-sufficient pulp mill, without surplus power generation capacity is the standard practice in the pulp mill industry in Chile and geographical area.

In conclusion, Chile´s natural conditions and regulatory framework have recently been promoting the increase in the installed capacity of solar and wind projects displacing biomass to energy project's installed capacity. This can partially be explained due to the increase in costs of production and supply of raw material, in this case biomass residues and to the downward trend in electric energy prices. It is expected that these conditions will be maintained in the future.

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

This assessment is not applicable; since in the case of the proposed project activity the equipment that would have been used in the baseline scenario (a low pressure biomass power boiler for heat generation only; no power generation) does not exist. This equipment did not exist at the date the project activity was started.

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

- The proposed project activity uses some IPCC default factors. At the time the project activity was submitted for validation, the IPCC default factors came from the 1996 IPCC Guidelines. For the current version of the PDD, the Project Participant has replaced all the 1996 IPCC default factors for the ones available in the 2006 IPCC Guidelines. These default factors are presented in sections B.6.2. "Data and parameters fixed ex ante" and B.7.1 "Data and parameters to be monitored" of this PDD.
- The registered PDD for the first crediting period used a CH_4 emission factor for uncontrolled burning of biomass for the baseline emission calculation related to the additional biomass used for power generation. This factor was measured in September, 2006, in the south part of Chile. In order to update this emission factor for subsequent crediting periods, the Project Participant decided to carry out a new measurement at the beginning of 2009. The 2009 measurement was carried out at the end of the dry season (summer), in which the piled biomass residues are drier. This facilitates the combustion of the biomass residues, which leads to a lower methane emission factor than if biomass residues were more humid (as if happened with the 2006 measurement). This new measurement included the determination of the baseline CH_4 emission factor for biomass residues (mix of sawdust and bark) from on-site and off-site from industrial and from forest (harvesting, pruning and thinning operations) operations. These new CH_4 emission factors associated to both biomass types biomass used in this project activity are presented in section B.6.2." Data and parameters fixed ex ante" of this PDD.
- All other monitored parameters have been updated according to the new monitoring methodology of the ACM0006 (Version 14.0).

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

Step 2.1: Update the current baseline

This version of the PDD considers a fully updated baseline based on the latest approved version of the methodology applicable to the project activity.

Step 2.2: Update the data and parameters

All data and parameters determined at the start of the first crediting period for the Trupan Biomass Power Plant project have been updated.

The new emission reduction calculation for the third crediting period of this project activity fully considers all the parameter updates and latest default factors from the IPCC mentioned above. This calculation is in full compliance with the monitoring plan of the latest approved version of the baseline methodology applicable to the project activity

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

According to ACM0006 (Version 14.0), the Project Participant was requested to provide the following information:

For each plant generating power and /or heat that has been operated at the project site within the most resent three years prior to the start of the project activity:	
The type and capacity of the heat generator (s):	There were no heat and/or power plants operating at the project site before the implementation of the project activity.
The type and quantities of fuels which have been used in the heat generator (s):	Not applicable, see the answer above.
The type and capacity of the heat engine (s):	Not applicable, see the answer above.
Whether the equipment continues operations after the start of the project activity:	Not applicable, see the answer above.

For each plant generating power and /or heat installed under the project activity:	
The type and capacity of the heat generator (s):	The boiler has the following maximum continues capacities, without soot blowing in operation: 170 ton high-pressure steam per hour (t/h) on wood based fuels. 147.5MW heat to steam capacity. 250 ton high-pressure steam per hour (t/h) on combined steaming capacity with auxiliary fuel (Fuel Oil #6 or alternatively Diesel).
The type and quantities of fuels used in the heat generator (s):	Power Boiler: Sludge from on-site production for heat generation: 14,569(BDt[24]/y). Mix of sawdust and bark from on-site production from industrial operations for heat generation: 96,217(BDt/y) and for power generation: 4,332BDt/y). Mix of sawdust and bark from off-site production from industrial operations for electric power generation: 109,332(BDt/y). Mix of sawdust and bark from forest operations for electric power generation: 106,400(BDt/y). Diesel: 127(ton/y) equivalent to 151,321(l/y) (See note below). Fuel Oil: 0(ton/y) or alternatively Diesel.

[24] BDt stands for "Bone-dry ton" and means 100% dry biomass.

	LPG: 1.375 (ton/y) equivalent to 2,500 (l/y) The Project Participant would like to note the following: As a reasonable (average) estimate, the Project Participant has contemplated the total fossil fuel consumption of 151,321 (l/y), in this case Diesel, based on measurements conducted in previous monitoring periods.
The type and capacity of the heat engines and direct heat extractions:	One condensing with extraction turbine: Capacity of the heat engine: 29.940(MW) Design capacity of the inlet flow: 180.8(ton/h). Design capacity of the heat extraction N°1: 65(ton/h), medium pressure bleeding flow. Design capacity of the heat extraction N°2: 30(ton/h), medium pressure bleeding flow. Design capacity of the heat extraction N°3 40(ton/h), low pressure steam. Design capacity at the tail of the turbine: 60(ton/h) exhaust flow. (Refer to the project case energy/mass balance on this PDD)

For each plant generating power and /or heat that would be installed in the absence of the project activity:	
The type and capacity of the plant:	• There would have been only one low pressure boiler on biomass fuels for heat generation (no cogeneration) plus back-up fossil fuel consumption (See below). • There would have been no heat engine in the Power Plant: 0 MW
The type and capacity of heat generator (s):	• There would have been a smaller boiler with nominal installed capacity of 150 (t/hr.) on biomass and 190 (t/h) on combined steaming capacity with auxiliary fossil fuel Diesel or alternatively Fuel oil.
The type and capacity of the heat engine (s) and electric power generator (s):	• There would have been no heat engine and electric power generator in the Power Plant.
The types and quantities of fuels which would be used in each heat generator:	Power boiler: • Sludge from on-site production for heat generation: 14,569 (BDt/y) • Mix of sawdust and bark from on-site production from industrial operations for heat generation: 96,217 (BDt/y) and for electric power generation: 0 (BDt/y) • Mix of sawdust and bark from off-site production from industrial operations for electric power generation: 0(BDt/y). • Mix of sawdust and bark from forest operations for electric power generation: 0(BDt/y). • Diesel: 26(ton/y) equivalent to 31,372(l/y) (See note below) • Fuel Oil: 0(ton/y), or alternative to Diesel. • LPG: 0.285 (ton/y) equivalent to 518 (l/y) The Project Participant would like to note the following: The fossil fuel amount that would be consumed in the baseline scenario, in this case Diesel, is determined as follows: total fossil fuel consumed in the project multiplied by the ratio (biomass that would be consumed in the baseline / total biomass residues in the project) (Refer to Step 3 of this PDD for additional information).

The average amounts of electricity and heat import from off-site sources that would happen in the absence of the project activity on a yearly basis and the forecast for the project scenario:	
Average amount of electricity and heat import from off-site sources in the absence of the project activity:	Electricity imports: 14.6 (MW). The most likely and conservatively scenario that reflects how the electric power would have been generated in the absence of the project activity is a conventional sawmill /plywood mill complex without on-site electric power generation which have had to source its energy requirements from the local grid (i.e. Interconnected Central System. Heat imports: 0 (GJ/y). The baseline plant would be self-sufficient in heat generation. External heat sources (such as, heat generation in specific off-site plants and heat production from district heating) would not be available in the context of the baseline scenario.

Average amount of electricity and heat import from off-site sources under the project activity:	Electricity imports: 70,501(MWh/y). This project activity includes the possibility to import electricity from the grid. However, this project activity is designed to generate surplus of electricity to the grid and therefore, only under particular circumstances the project activity might be sourced from the grid such as, start-up operations and maintenance circumstances. As a reasonable (conservative) estimate, the Project Participant has contemplated an import amount of 70,501 (MWh/y) in the emission reduction calculations based on measurements conducted in previous monitoring periods In addition to the above the Project Participant would like to note that events such as internal clients demand for electricity (sawmill and log processing mill) during maintenance periods and operational events, such as trips are not contemplated in this estimation, since these are unpredictable circumstances. Heat imports: 0(GJ/y). The situation would not be different from the baseline scenario; therefore, the project plant would be self-sufficient in heat generation.

Equations used to calculate emissions reductions:

The net emission reductions of the proposed project activity are calculated through equation 1 of the ACM0006 (Version 14.0):

$$ER_y = BE_y - PE_y - LE_y$$

Where:

ER_y	=	Emissions reductions in year y (tCO_2e/y)
BE_y	=	Baseline emissions in year y (tCO_2e/y)
PE_y	=	Project emissions in year y (tCO_2e/y)
LE_y	=	Leakage emissions in year y (tCO_2e/y)

Baseline Emissions

Baseline emissions are calculated based on the most plausible baseline scenario identified in the section “Selection of the baseline scenario and demonstration of additionally” of the ACM006 (Version 14.0). This calculation is performed taking into account how power and heat would be generated and how the biomass residues would be used in the absence of the project activity. In addition and following the baseline methodology ACM0006 (Version 14.0), the Project Participant shall adopt in this calculation a conservative approach considering biomass residues as a priority (to fossil fuels) for the generation of power and heat.

Considering the above, baseline emissions for the proposed project activity are calculated through the equation 2 of the ACM0006 (Version 14.0):

$$BE_y = EL_{BL,GR,y} \cdot EF_{EG,GR,y} + \sum FF_{BL,HG,y,f} \cdot EF_{FF,y,f} + EL_{BL,FF/_{GR},y} \cdot min(EF_{EG,GR,y}, EF_{EG,FF,y}) + BE_{BR,y}$$

Where:

BE_y	=	Baseline emissions in year y (tCO_2).
$EL_{BL,GR,y}$	=	Baseline minimum electricity generation in the grid in year y (MWh).
$EF_{EG,GR,y}$	=	Grid emission factor in year y (tCO_2/MWh).
$FF_{BL,HG,y,f}$	=	Baseline fossil fuel demand for process heat in year y (GJ).
$EF_{FF,y,f}$	=	CO_2 emission factor for fossil fuel type f in year y (tCO_2/GJ).
$EL_{BL,FF/_{GR},y}$	=	Baseline uncertain electricity generation in the grid or on-site in year y (MWh)
$EF_{EG,FF,y}$	=	CO_2 emission factor for electricity generation with fossil fuels at the project site in the baseline in year y (tCO_2/MWh).
$BE_{BR,y}$	=	Baseline emissions due to disposal of biomass residues in year y (tCO_2e).
y	=	Year of the monitoring period
f	=	Fossil fuel type

The Project Participant will use the algorithm presented in figure 2 of the ACM0006 (Version 14.0) to calculate the baseline emissions.

- Step 1: determine the biomass availability, generation and capacity constraints, efficiencies and power emission factors;
- Step 2: Determine the minimum baseline electricity generation in the grid;
- Step 3: Determine the baseline biomass-based heat and power generation;
- Step 4: Determine the baseline demand for fossil fuels to meet the balance of process heat and the corresponding electricity generation;
- Step 5: Determine the baseline emissions due to uncontrolled burning or decay of biomass residues;
- Step 6: Calculate baseline emissions.

In the following section, the Project Participant will present an explanation of the methodological choices and the equations considered to calculate the baseline emissions of the proposed project activity.

Step 1: Determine biomass availability, generation and capacity constraints, efficiencies and power emission factors in the baseline

Step 1.1 to determine total baseline process heat generation

According to ACM0006 (Version 14.0), the amount of process heat refers to the heat utilized to meet process heat demand of industrial mills in the baseline ($HC_{BL,y}$) [25].

The process heat demand that would be generated in the baseline in year y ($HC_{BL,y}$) is determined as the difference of the enthalpy of the process heat (steam) supplied to the process heat loads in the project activity minus the enthalpy of the feed-water, the boiler blow-down and any condensate return to the heat generators.

The respective enthalpies will be determined based on the mass flows, the temperatures and, in case of superheat steam, the pressure. Steam tables and/or appropriate thermodynamic equations will be used to calculate the enthalpy as a function of temperature and pressure. The process heat will be calculated net of any parasitic heat used for drying of the biomass residues.

Step 1.2 to determine total baseline electricity generation

The amount of electricity that would be generated in the baseline scenario is calculated using equation 3 of the ACM0006 (Version 14.0):

$$EL_{BL,y} = EL_{PJ,gross,y} + EL_{PJ,imp,y} - EL_{PJ,aux,y}$$

Where

$EL_{BL,y}$	=	Baseline electricity generation in year y (MWh).
$EL_{PJ,gross,y}$	=	Gross quantity of electricity generated in all power plants which are located at the project site and included in the project boundary in year y (MWh).
$EL_{PJ,imp,y}$	=	Project electricity imports from the grid in year y (MWh).
$EL_{PJ,aux,y}$	=	Total auxiliary electricity consumption required for the operation of the power plant at the project site in year y (MWh).
y	=	Year of the crediting period.

According to ACM0006 (Version 14.0), total auxiliary electricity consumption ($EL_{PJ,aux,y}$) shall include all the electricity required for the operation of equipment related to the following activities:

- Preparation, storage and transport of biomass residues:

Item	Description of the auxiliary equipment
Transport of biomass residues to the power boiler.	Auxiliary electricity consumption related to biomass transported is estimated bae on nominal consumption.
Preparation and storage of biomass residues.	Not applicable since for preparation and storage of biomass residues only fossil fuel will be consumed instead of electricity.

[25] The estimate amount of process heat demanded in the baseline case is the same as the amount contemplated in the project case. The only difference between baseline and project case would be exclusively derived from the on-site electric power generation capacity attributable to this CDM project activity (Refer to section A.3.Technologies and/or measures, energy and mass balance diagrams.).

- Operation of power and/or heat generation plants (located in the project site and included in the project boundary):

Item	Description of the auxiliary equipment.
Power boiler, Turbo generator and ash treatment.	Auxiliary electricity consumed in the power boiler, turbine and ash treatment, attributable to the project activity, will be measured and contemplated in the emission reductions calculation.

Step 1.3 to determine baseline capacity of the electricity generation

According to the baseline methodology ACM0006 (Version 14.0), the Project Participant should determine the total capacity of electric power generation available in the baseline scenario.

In the baseline scenario, there would be one low-pressure boiler on biomass fuels for heat generation purpose, and there would be no cogeneration-type heat engine (i.e. $CAP_{EG,CG,i}$= 0) and no power-only type heat engine on-site. (i.e. $CAP_{EG,PO,j}$= 0)

Step 1.4 to determine the baseline availability of biomass residues

According to the baseline methodology ACM0006 (Version 14.0), the Project Participant should determine the baseline availability of biomass based on the monitored amounts of biomass residues used for power and/or heat generation for which (B5) is the most plausible baseline scenario ($BR_{B5,n,y}$).

- All biomass residues types identified under the baseline scenario would be burned exclusively in a low pressure boiler for heat generation (B5). The other (additional) amount of biomass residues that would be used as fuel in a biomass power boiler under the project activity would be dumped or left to decay under clearly aerobic conditions (B1). These are described in table below:

Category n	Type/source of the biomass residues	Fate of the biomass residues in baseline.	Fate of the biomass residues in the project scenario
$BR_{B5,1,y}$	Sludge from on-site industrial operations.	Biomass residues would be burned in the low pressure power boiler for heat generation B5).	Heat generation.
$BR_{B5,2,y}$	Mix of sawdust and bark from on-site industrial operations.	Biomass residues would be burned in the low pressure power boiler for heat generation (B5).	Heat generation.
$BR_{B1,3,y}$	Mix of sawdust and bark from on-site industrial operations.	Dumped or left to decay under clearly aerobic conditions (B1).	Power generation.
$BR_{B1,5,y}$	Mix of sawdust and bark from on-site foresty operations.	Dumped or left to decay under clearly aerobic conditions (B1).	Power generation.

According to the ACM0006 (Version 14.0), in the case that one biomass residues type from one particular source has two different fates in the baseline scenario, this biomass residue used under the project shall be allocated to one of the following fates:

- Power or heat generation (B5), or
- Dumping, leaving to decay or burning (B1, B2 and/or B3), or
- Other fates (B4).

- In the case of the baseline scenario, the biomass residues (mix of sawdust and bark) would be obtained from one particular source (on-site production) and would have had two different fates: Part would be used for heat generation (B5) purpose and the rest (additional) would be dumped to natural decay (B1).

- In the case of the project scenario, the biomass residues (mix of sawdust and bark) obtained from one particular source (on-site production): part would be allocated to heat generation and the rest (additional) would be allocated to power generation, as can be seen in table above.

According to the baseline methodology ACM0006 (Version 14.0), the Project Participant should specify and justify in a transparent manner how the relevant allocations of biomass residues should be made and should be adhered to the following rules:

- The sum of biomass residues types consumed in the baseline for power or heat generation in all heat generators shall be equal to the total amount of biomass residues consumed under the project activity and for which the baseline scenario is (B5).

- In the case of this project activity, the difference between the baseline and the project scenario configuration (Refer to section A.3 technologies/measures of this PDD) would be exclusively derived from the on-site electric power generation capacity attributable to this CDM project activity.

  Considering the above, the higher (additional) consumption of biomass residues types under the project scenario would exclusively due to its electricity generation capacity, and therefore, the biomass residues types and total amount that would be used in the baseline for heat generation (B5) shall be equal to the total amount of biomass residues consumed for the same purpose under the project activity.

- The allocation of biomass residues should be undertaken in a conservative manner which in case of uncertainty an allocation rule should be applied that tends to result in lower emission reductions.

  The Project Participant will follow the conservative approach to prioritize the use of biomass residues over the use of any fossil fuels for heat generation purpose in the baseline scenario. This will tend to result in lower emission reductions.

  The Project Participant will allocate in a clearly and transparently manner the biomass residues according to their types (and the corresponding amounts) and sources by following marginal algorithm described as follows:

  The biomass residues of types (and the corresponding amounts) used in Complex will be ranked from the most available/less costly (on-site production) to the least available/most costly (off-site production) from third parties industrial and forest operations. The biomass residues type ranking is presented as follows:

	Biomass residues category (n)	Biomass residues type	Biomass residues sources	Biomass residues fate in the absence of the project activity	Biomass residues use in project scenario
(+) Most Available/least Costly (-)					
	1	Sludge from industrial operations.	On-site production.	The biomass residues are used for power or heat generation at the project site in new and/or existing plants. (B5)	Heat generation.
	2	Mix of sawdust and bark from industrial operations.	On-site production.	The biomass residues are used for power or heat generation at the project site in new and/or existing plants. (B5)	Heat generation.
	3	Mix of sawdust and bark from industrial operations.	On-site production.	The biomass are dumped or left to decay mainly under anaerobic conditions. This applies for example, to dumping and decay of biomass residues on fields. (B1)	Power generation
	4	Mix of sawdust and bark mix from industrial operations.	Off-site production.	The biomass are dumped or left to decay mainly under anaerobic conditions. This applies for example, to dumping and decay of biomass residues on fields. (B1)	Power generation
	5	Mix of sawdust and bark from forest operations.	Off-site production.	The biomass are dumped or left to decay mainly under anaerobic conditions. This applies for example, to dumping and decay of biomass residues on fields. (B1)	Power generation

- In the case of biomass residues type from one particular source which part it of has been used prior to the implementation of the project activity partly in heat generators at the project site (B5), and the rest (additional) has been dumped, left to decay or burnt (B1 or B2 or B3), and if this situation would still continue in the baseline scenario, then use, as conservative approach to address the uncertainty associated with such allocation, the maximum value among approaches presented in the methodology for the quantity of biomass residues of category n allocated to scenario (B5).

  This is not applicable as the project activity is a Greenfield power generation project, (i.e. no previous operational history), which consisted in the installation of a new biomass residues fired power plant in a site where no power and heat was generated before.

Step 1.5 to determine the efficiencies of heat generators, and efficiencies and heat-to-power ratio of heat engines.

Efficiencies of heat generator and heat engines:

According to the ACM0006 (Version 14.0), the Project Participant should calculate the efficiencies of heat generators and heat engines using one of the options stated in the ACM0006 (Version 14.0):

- Option 1: Default values. Use Option F in the latest approved version of “Determining the baseline efficiency of thermal or electric energy generation systems (Version 02.0)”.
- Option 2: Manufacturer´s data.
- Option 3: Only applicable to heat generators and heat engines that were operated at the project site for at least three calendar years prior the date of submission of the PDD.

Considering that the project activity is a Greenfield power generation project (i.e. no previous operational history), the Project Participant will use Option 1 to determine the biomass-based heat generation efficiency of the single heat generator that would be part of the baseline.

Efficiencies and heat-to-power ratio of heat engines:

Not applicable in this case.

Step 1.6 to determine the emission factor of on-site electricity generation with fossil fuels.

This assessment is not applicable since there is no fossil fuel based for power generation identified as part of the baseline scenario. Note that in the baseline scenario a low pressure biomass power boiler would be installed for heat generation purpose, as a result the Project Participant will do:

$$EF_{EG,FF,y} = EF_{EG,GR,y}$$

Where:

$EF_{EG,FF,y}$	=	CO_2 emission factor for electricity generation with fossil fuels at the project site in the baseline in year y (tCO_2/MWh).
$EF_{EG,GR,y}$	=	CO_2 emission factor of the fossil fuel type that would be used for power generation at the project site in the baseline (tCO_2/GJ).

Step 1.7 to determine the emission factor of grid electricity generation

According to the ACM0006 (Version 14.0) the Project participant will determine the emission factor of the electricity grid as the combined margin (CO_2) emission factor to which the project activity is connected in year y.

This parameter will be calculated following the “Tool to calculate the emission factor for an electricity system” (Version 07.0). According to this Tool the following steps shall be followed:

Step 1: Identify the relevant electricity systems.

The tool establishes that the Project Participant should use the electricity grid to which the project activity is connected to and provide evidence there are no significant transmission constraints.

The project activity is connected to the “Sistema Eléctrico Nacional” (SEN). The SEN is composed by the transmission lines and the interconnected power plants that operate from “Arica” in the North (XV Region), to “Isla Grande de Chiloé” in the South (X Region). The SEN is the largest of the 3 existing transmission systems in Chile, accounting for about 99,3% of the power generation capacity of the country. Additionally, note that this system has no interconnection with any other transmission system in Chile or in the region.

According to the criteria indicated in the tool for establishing the presence of significant transmission constraints, the project participant verified that none of the conditions are satisfied in the case of the SEN system. In particular, the Project Participant verified that there are no transmission constraints proving that the following criteria is met:

a) The transmission line is operated at 75% or less of its rated capacity during 90% or more of the hours of the most recent year for which information is available (at least one year data is required) using the algorithm below:

a. For every hour of the year check whether the transmission line is operated at 75 per cent or less of its rated capacity.
b. Each hour of the year when the transmission line was operated at 75 per cent or less of its rated capacity should be counted as zero.
c. Each hour of the year when the transmission line was operated at 75 per cent or more of its rated capacity should be counted as one.
d. There is no transmission constraint if the total sum is less than ten percent of the hours of the year.

According to the article N° 80 of the law “ Servicios Eléctricos Generales” , annually, this law mandates the “Coordinador Eléctrico Nacional” (CEN) shall prepare and make publicly available in his website the expected technical available capacity of the dedicated transmission systems of the SEN for the next years. This study is presented during the validation process as evidence to support that in there is no transmission constrains in the transmission system in the coming years.

The absence of significant transmission constraints in the transmission systems can be further substantiated by the Short Law N° 1 (March, 2004). This law mandates transmission companies to assess their transmission systems every four years and make all the necessary investments in order to secure the quality and safety of the transmission service.

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

This is not applicable in this case, since no off-grid power plants would have been identified so far.

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

The "Tool to calculate the emission factor for an electricity system" offers four options to calculate the Operating Margin emission factor:

a) Simple OM,
b) Simple Adjusted OM
c) Dispatch Data Analysis OM
d) Average OM

Considering the characteristics of the CEN system (e.g. low-cost/must run power generation) and availability of information, the Project Participant will choose option b) to calculate the Operating Margin (OM).

The Simple Adjusted OM method is a variation of the simple OM, where the power plants/units (including imports) are separated in low-cost/must run power sources (k) and other power sources (m). As under Option A of the simple OM, it is calculated based on the net electricity generation of each power unit and the emission factor for each power units, as follows:

$$EF_{grid,OM-adj,y} = \left(1-\lambda_y\right) \cdot \frac{\sum_m EG_{m,y} \cdot EF_{EL,m,y}}{\sum_m EG_{m,y}} + \lambda_y \frac{\sum_k EG_{k,y} \cdot EF_{EL,k,y}}{\sum_k EG_{k,y}}$$

Where:

$EF_{grid,OM-adj,y}$	=	Simple adjusted operating margin CO_2 emission factor in year y (tCO_2/MWh).
λ_y	=	Factor expressing the percentage of time when low-cost/must-run power units are on the margin in year y.
$EG_{m,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh).
$EG_{k,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit k in year y (MWh).
$EF_{EL,m,y}$	=	CO_2 emission factor of power unit m in year y (tCO_2/MWh).
$EF_{EL,k,y}$	=	CO_2 emission factor of power unit k in year y (tCO_2/MWh).
m	=	All grid power units serving the grid in year y except low-cost/must run power units.
k	=	Al low-cost/must-run grid power units serving the grid in year y.
y	=	The relevant year as per the data vintage chosen in Step 3.

The procedures for determining λ, are stated in equation N°11 of the "Tool to calculate the emission factor for an electricity system" (Version 07.0) and therefore, will be not presented in this section.

According to the baseline methodology, it is possible to calculate the Operating Margin (OM) using data vintages for year(s) y:

Ex-ante option: The emission factor is determined once at the validation stage, thus no monitoring and recalculation of the emissions factor during the crediting period is required, or

Ex-post option: The emission factor is determined for the year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring.

The Project Proponent will use the Ex-ante option to calculate the OM; that is, the OM will be calculated once at the validation stage. As a result, no monitoring and recalculation of the emissions factor during the crediting period is required.

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

For the calculation of the Operating Margin (OM), the Project Participant will use:

- Option A to calculate the $EF_{grid,OM\text{-}adj,y}$: Use information based on the net electricity generation and a CO2 emission factor for each power unit.

For the determination of the emission factor of each power unit m, $EF_{EL,m,y}$ the Project Proponent will choose:

- Option A1: Use information based on fuel consumption and electricity generation for each power unit m.

Note that in this case, the information that is directly available from the Dispatch Centre is the net generation of each power unit m and the corresponding fossil fuel consumption rate.

Step 5: Calculate the Build Margin (BM) emission factor.

In terms of data vintage, the Project Participant will choose Option 2:

- For the first crediting period, the Build Margin (BM) emission factor shall be updated annually, ex-post, including those units build up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units build up to the latest year for which information is available.

- For the second crediting period, the Build Margin (BM) emission factor shall be calculated ex ante, as previously described in Option 1.

- For the third crediting period, the Build Margin (BM) emission factor calculated for the second crediting period should be used.

The calculations are shown in section B.6.3. step 1.7 of this PDD. Additionally, further background information on ex ante calculation can be found in Appendix 4 of this PDD.

Step 6: Calculate the combined margin emissions factor.

In this case, the combined margin emission factor is calculated according to the following option:

- *Weighted average calculation*:

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

Where:

$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year y (tCO_2/MWh).
$EF_{grid,OM,y}$	=	Operating margin CO_2 emission factor in year y (tCO_2/MWh).
W_{OM}	=	Weighting of operating margin emission factor (%).

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

According to the guidance provided by the tool for calculating the grid emission factor, in this case the Project Participant will use the following default values for W_{OM} and W_{BM}:

Defaults values for the second and third crediting periods	*Weights*
W_{OM}	0.25
W_{BM}	0.75

This is done in section B.6.3. step 1.7.

Step 2: Determine the minimum baseline electricity generation in the grid

According to equation 13 of the baseline methodology ACM0006 (Version 14.0), $EL_{BL,GR,y}$ corresponds to the baseline minimum electricity that would be generated in the grid in the baseline:

$$EL_{BL,GR,y} = \max\left(0, EL_{BL,y} - CAP_{EG,TOTAL,y}\right)$$

Where:

$EL_{BL,GR,y}$ = Baseline minimum electricity generation in the grid in year y (MWh).

$EL_{BL,y}$ = Baseline electricity generation in year y (MWh).

$CAP_{EG,TOTAL,y}$ = Baseline electricity generation capacity in year y (MWh).

y = Year of the crediting period.

Step 3: Determine the baseline biomass-based heat and power generation

Step 3.1 to determine the baseline biomass-based heat generation

According to the general principles suggested by the methodology ACM0006 (Version 14.0), the Project Participant will contemplate in the calculation of the baseline the amount of biomass-based heat generation following project-specific conditions:

- The Project Participant will prioritize the use of biomass residues types for which scenario (B5) has been identified as the baseline scenario ($BR_{B5,n,y}$) over the use of any fossil fuels amount, and will monitor the equivalent amount of heat ($HG_{BL,BR,y}$,) that would be generated using these biomass residues types.
- According to the energy and mass balance of the baseline scenario (Refer to section A.3 of this PDD), there would be one low pressure biomass power boiler for heat generation purpose (no cogeneration type heat engine). Additionally, this heat generator would run on the following biomass residues types for which the baseline scenario (B5) has been identified:

  a. Sludge from on-site production.
  b. Mix of sawdust and bark from on-site production.

The Project Participant would like to note that biomass residues types previously presented would be consumed in one heat generator available in the baseline scenario, low pressure biomass power boiler.

According to the ACM0006 (Version 14.0), the Project Participant shall identify the fossil fuel types and corresponding amounts required due to technical constraints of the heat generator. These

amounts will be added to the parameter FF $_{BL,HG,y,f}$., and the corresponding heat generated in the monitoring parameter (HG $_{BL,BR,y.}$).

- In the case of the baseline scenario, the heat generator would have included the possibility of co-firing some fossil fuels due to technical constraints. Hence, the Project Participant will define the fossil fuel type (s) and the corresponding amount based on the plant´s historical range of fossil fuel consumed in previous monitoring periods.

    a. Fossil fuel type(s): Diesel, LPG and Fuel Oil.
    b. As a reasonable estimate the Project Participant contemplates average fossil fuel consumption based on measurements conducted in previous monitoring periods.

The Project Participant informs that the estimate of Diesel and LPG consumed for operational reasons is due to start-ups and for maintaining the heat generator temperature, especially in winter, when the biomass has a higher humidity.

Fossil fuel co-fired per unit of combusted biomass due to technical constraints:

Considering the above, the fossil fuel amount co-fired per unit of biomass residues used in the power boiler is:

- Diesel: average estimate index of Diesel consumption of 0.4 (l/tons on dry basis)

An alternative to Diesel might be consumed Fuel Oil.

Allocation of biomass residues and fossil fuels:

According to the baseline scenario ACM0006 (Version 14.0), the Project Participant should calculate the amount of heat generated with biomass residues, based on the allocation rules established previously, using the equation 14:

$$HG_{BL,BR,y} = \sum_{h} \sum_{n} \left(BR_{B5,n,h,y} \cdot NCV_{BR,n,y} \cdot \eta_{BL,HG;BR,h} \right)$$

Subject to the following conditions:

The biomass residues used in each heat generator should not exceed the total amount of biomass residues available. This is stated in equation 15:

$$\sum_{h} \sum_{n} BR_{B5,n,h,y} = \sum_{n} BR_{B5,n,y}$$

The heat generation in each heat generator should not exceed the total capacity of the heat generator. This is stated in equation 16:

$$\sum_{n} \left(BR_{B5,n,h,y} \cdot NCV_{BR,n,h,y} \cdot \eta_{BL,HG,BR,h} \right) \leq LOC_{y} \cdot CAP_{HG,h} \cdot LFC_{HG,h}$$

Where:

$HG_{BL,BR,y}$	=	Baseline biomass heat generation in year y (GJ)
$BR_{B5,n,h,y}$	=	Quantity of biomass residues of category n used in heat generator h in year y with baseline scenario B5 (tone on dry-basis).
$NCV_{BR,n,y}$	=	Net calorific value of biomass residue of category n in year y (GJ/tone on dry-basis).
$\eta_{BL,HG,BR,h}$	=	Baseline biomass-based heat generation efficiency of heat generator h (ratio).

$BR_{B5,n,y}$	=	Quantity of biomass residues of category n used in the project activity in year y for which the baseline scenario is B5: (tone on dry-basis).
LOC_y	=	Length of the operational campaign in year y (hour).
$CAP_{HG,h}$	=	Baseline capacity of heat generator h (GJ/h).
$LFC_{HG,h}$	=	Baseline load factor of heat generator h (ratio).
y	=	Year of the crediting period.
h	=	Heat generator in the baseline scenario.

Step 3.2 to determine the baseline biomass-based cogeneration of process heat and electricity and heat extraction.

In the case of this project activity, the baseline scenario would contemplate process heat generated by one conventional low pressure biomass power boiler and there would be no cogeneration of process heat and electricity (no-cogeneration type-engines available in the baseline).

Considering the previously paragraph, this section is not applicable, in this case.

Step 3.3 Determine the baseline biomass-based electricity generated in power-only mode.

As is above mentioned, no-cogeneration type-engines available in the baseline. This section is not applicable as well.

Step 5: Determine the baseline emissions due to uncontrolled burning or decay of biomass residues.

According to ACM0006 (Version 14.0) the emissions should be determined separately for biomass residues categories for which scenarios B1 and B3 (aerobic decay or uncontrolled burning) apply, and for biomass residues categories for which scenario B2 (anaerobic decay) apply, using equation 31 as follows:

$$BE_{BR,y} = BE_{BR,B1/B3,y} + BE_{BR,B2,y}$$

Where:

$BE_{BR,y}$	=	Baseline emissions due to disposal of biomass residues in year y (tCO_{2e}).
$BR_{B1/B3,n,y}$	=	Baseline emissions due to aerobic decay or uncontrolled burning of biomass residues in year y (tCO_2).
$BE_{BR,B2,y}$	=	Baseline emissions due to anaerobic decay of biomass residues in year y (tCO_2).

In the case of the project activity, the Project Participant will consider the baseline emissions due to uncontrolled burning or decay of biomass residues, only determined for those categories for biomass residues for which (B1), (B2) or (B3) have been identified as the most plausible baseline scenario. From this equation stated above is simplified to the following:

$$BE_{BR,y} = BE_{BR,B1/B3,y}$$

Step 5.1 to determine $BE_{BR,B1/B3,y}$

According to the ACM0006 (Version 14.0), in cases where the most likely scenario for the use of biomass residues is that the residues would be dumped or left to decay under mainly aerobic conditions (B1) or burnt in an uncontrolled manner without utilizing them for energy purposes (B3), the corresponding baseline emissions must be calculated assuming that the biomass residues would

be burnt in an uncontrolled manner. Therefore, the baseline emissions are calculated using equation 32 of the ACM0006 (Version 14.0):

$$BE_{BR,B1/B3,y} = GWP_{CH_4} \cdot \sum_{n} BR_{B1/B3,n,y} \cdot NCV_{BR,n,y} \cdot EF_{BR,n,y}$$

Where:

$BE_{BR,B1/B3,y}$	=	Baseline emissions due to aerobic decay or uncontrolled burning of biomass residues in year y (tCO_2).
GWP_{CH_4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2/tCH_4)
$BR_{B1/B3,n,y}$	=	Quantity of biomass residues of category n used in the project activity in year y for which the baseline scenario is B1: or B3: (tones on dry-basis).
$NCV_{BR,n,y}$	=	Net calorific value of biomass residue of category n in year y (GJ/tone on dry-basis).
$EF_{BR,n,y}$	=	CH_4 emission factor for uncontrolled burning of the biomass residues category n during the year y (tCH_4/GJ).
n	=	Biomass residue category.

The Project Participant measured once at the start of the project activity rather than use a default methane emission factor provided by the baseline methodology. The result of measurements performed by type of biomass residues are informed in section Data and parameter fixed ex ante under **Table / Parameter table 26.**

Step 5.2 to determine BE $_{BR,B2,y}$

This assessment is not applicable, since no biomass residues would be dumped under clearly anaerobic conditions (B2) in the baseline scenario.

Step 6: Calculate baseline emissions (BE_y)

Baseline emissions are calculated using the equation 2 stated in the methodology ACM0006 (Version 14.0).

<u>Calculate project emissions (PEy)</u>

Project emissions are calculated using equation 33 of the ACM0006 (Ver 14.0):

$$PE_y = PE_{FF,y} + PE_{GR\ \ ,y} + PE_{GR2,y} + PE_{TR,y} + PE_{BR,y} + PE_{ww,y} + PE_{BG2,y} + PE_{BC,y}$$

Where:

PE_y	=	Project emissions in year y (tCO_2).
$PE_{FF,y}$	=	Emissions during the year y due to fossil fuel consumption at the project site (tCO_2).
$PE_{GR1,y}$	=	Emissions during the year y due to grid electricity imports to the project site (tCO_2).
$PE_{GR2,y}$	=	Emissions due to a reduction in electricity generation at the project site as compared to the baseline scenario in year y (tCO_2).
$PE_{TR,y}$	=	Emissions during the year y due to transport of the biomass residues to the project plant (tCO_2).

$PE_{BR,y}$ = Emissions from the combustion of biomass residues during the year y (tCO_2e).

$PE_{ww,y}$ = Emissions from wastewater generated from the treatment of biomass residues in year y (tCO_2e).

$PE_{BG2,y}$ = Emissions from the production of biogas in year y (tCO_2e).

$PE_{BC,y}$ = Emissions associated with the cultivation of land to produce biomass in year y (t CO_2)

In view of the particular circumstances of this project activity, the following simplifications apply to equation 33 previously presented:

- The project activity will not imply anaerobic treatment of waste water generated from the treatment of biomass residues as a result, associated project emissions from waste water treatment are considered zero ($PE_{WW,y} = 0$).
- In this case, the amount of electricity generation on-site in the baseline will not exceed the amount of electricity generated in the project activity scenario as a result, associated project emissions are considered zero ($PE_{GR2} = 0$)
- The project activity will not imply the production of biogas as a result, associate project emissions are considered zero ($PE_{BG2} = 0$).
- The project activity will not imply the cultivation of land to produce biomass in year y (t CO^2, associate to project emissions are considered zero ($PE_{BC,y} = 0$)

Considering the above simplifications the equation 33 of the ACM0006 Version 14.0) results as follows:

$$PE_y = PE_{FF,y} + PE_{GR1,y} + PE_{TR,y} + PE_{BR,y}$$

<u>Determination of $PE_{FF,y}$</u>

According to the ACM0006 (Version 14.0), the Project Participant shall use the last version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (Version 03). According to this tool and considering the availability of information in the country in which the project activity is implemented, the Project Participant will use the following approach for determining CO_2 emissions:

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \cdot COEF_{i,y}$$

Where:

$PE_{FC,j,y}$ = CO_2 emissions from fossil fuel combustion in process j during the year y (tCO_2/y).

$FC_{i,j,y}$ = Quantity of fuel type i combusted in process j during the year y (mass or volume unit/y).

$COEF_{i,y}$ = CO_2 emission coefficient of fuel type i in year y (tCO_2/mass or volume unit).

j = fuel types combusted in process j during the year y.

The CO_2 emission coefficient $COEF_{i,y}$ will be calculated using <u>Option B</u> of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (Version 03), which consists in calculating the coefficient based on the net calorific value and CO_2 emission factor of the fuel type i, as follows:

$$COEF_i = NCV_{i,y} \cdot EF_{CO_2,i,y}$$

Where:

$COEF_{i,y}$	=	CO_2 emission coefficient of fuel type i in year y (tCO_2/mass or volume unit).
$NCV_{i,y}$	=	Weighted average net calorific value of the fuel type i in year y (tCO_2/GJ).
$EF_{CO_2,i,y}$	=	Weighted average CO_2 emission factor of fuel type i in year y (tCO_2/GJ).
i	=	Fuel types combusted in process i during the year y.

For weight average net calorific values ($NCV_{i,y}$) and weight average CO_2 emission factors ($EF_{CO2,i,y}$) of fossil fuels type i, the Project Participant will use IPCC default values for the emission reduction calculation registered in this PDD. Subsequently monitoring periods, the Project Participant may use other sources, in accordance with the guidance of the monitoring methodology ACM0006 (Version 14.0) and the corresponding tool.

For fossil fuels type i density, the Project Participant will use reliable and documented National Energy Statistics (National Energy Commission, energy balance).

Project emissions will be determined for the following combustion processes j:

- *Emissions from on-site fossil fuel consumption for the generation of electric power and heat:* In the case of this project activity, emissions will corresponds to the possibility of co-firing some fossil fuel under technical constrains circumstances of the power boiler, at the project site, such as start-ups maintenance, and heat generation to maintain the power boiler temperature, especially in winter when biomass is too wet, etc.

- *Emissions from on-site fossil fuel consumption of auxiliary equipment and systems related to the generation of electric power and heat:* In the case of this project activity, emissions will corresponds to fossil fuel amount required for the operation of auxiliary equipment related to the preparation, storage and on-site transportation of biomass residues from wood handling to the power boiler area, attributable to this project activity.

Determination of $PE_{GR1,y}$

This project activity includes the possibility to imported electricity from the grid to the project site. Considering this project activity is designed to generate surplus of electricity to the grid, only under some particular circumstances (such as, start-up operations, maintenance periods and other exceptional circumstances), it might be required to import a certain amount of electric power from the grid. In such situations, this parameter will be monitored and the corresponding emissions will be accounted for as project emissions, and calculated using equation 34 of the ACM0006 (Version 14.0):

$$PE_{GR1} = EF_{EG,GR,y} \cdot EL_{PJ,imp,y}$$

Where:

$PE_{GR1,y}$	=	Emissions during the year y due to grid electricity imports to the project site (tCO_2).
$EL_{PJ,imp,y}$	=	Project electricity imports from the grid in year y (MWh).
$EF_{EG,GR,y}$	=	Grid emission factor in year y (tCO_2/MWh).

Determination of $PE_{TR,y}$.

This project activity contemplates the use of additional biomass residues from industrial and forest operations sourced from third party providers. Since the transportation of such biomass to the plant is done by vehicles (e.g. heavy trucks) the Project Participant will use the latest version of the tool “Project and leakage emissions from transportation of freight” (Version 01.1.0) to determine the emissions from transportation of freight to the project plant.

According to this tool the Project Participant should document in this PDD which type of freight transportation will occur under the project activity including for each transportation activity the following information:

- The origin and destination of the freight: In the case of this project activity, the Project Participant will document the origin and destination of freight based on previous monitoring period, based on available information at the validation stage, under the title: "Documentation of freight transportation activities under the project activity" (See Appendix 5 of this PDD). In the case new origins of freight are used by this project activity, the Project Participant will contemplate them in the monitoring stage and therefore, registered in the Monitoring Report.
- The type (s) of freight that is planned to be transported: In the case of this project activity, the Project Participant will contemplate to transport one type of freight: Mix of sawdust and bark from industrial and forest operations.
- The planned number of trips and/or the planned quantity of freight that should be transported shall be documented in this PDD: As a reasonable estimate, the Project Participant considers the quantity of freight transported based on measurements conducted in previous monitoring periods.

In this case, the Project Participant will choose Option B to calculate $PE_{TR,y}$, according to the latest version of the tool "Project and leakage emissions from transportation of freight". Under this option, the Project Participant shall monitor separately for each freight transportation activity f the following data in order to estimate the project emissions:

- The quantity of freight transported ($FR_{f,m}$).
- The origin and destination of the freight transported and the road distance between the origin and the destination ($D_{f,m}$);
- The vehicle class used. This tool defines two vehicle classes based on their gross vehicle mass. Light vehicles with GVM being less or equal to 26 tonnes; and heavy vehicles with GVM being higher than 26 tons. In the case of this project activity, heavy vehicles with GVM being higher than 26 tons will be used for freight transportation to the plant.

Project emissions related to this source will only be accounted for the (additional) consumption of biomass residues (mix of saw dust and bark) from industrial and forest operations from third party providers attributable to electric power generation of the project activity. The way in which the quantity of (additional) biomass residues is calculated is described in section B.6.3 Ex-antes calculation of emission reductions.

$$\sum_{f} D_{f,m} \cdot FR_{f,m} \cdot EF_{CO_2,f} \cdot 10^{-6}$$

Where:

$PE_{TR,y}$	=	Project emissions from transportation of freight monitoring period m (tCO_2).
$D_{f,m}$	=	Return trip road distance between the origin and destination of freight transportation activity f in monitoring period m (km).
$FR_{f,m}$	=	Total mass of freight transported in freight transportation activity f (gCO_2/km).
$EF_{CO_2,f}$	=	Default CO_2 emission factor for freight transportation activity *f* (g CO_2/t km).
f	=	Freight transportation activities in the project activity in monitoring period m.

Determination of $PE_{BR,y}$

Since the Project Participants decided to include emissions due to uncontrolled burning or decay of biomass residues ($BE_{BR,y}$) in the calculation of the baseline emissions, then emissions from the

combustion of biomass residues in the power boiler shall be included and calculated using equation 36 of the ACM0006 (Version 14.0):

$$PE_{BR,y} = GWP_{CH_4} \cdot EF_{CH_4,BF} \cdot \sum_{n} BR_{PJ,n,y} \cdot NCV_{BR,n,y}$$

Where:

$PE_{BR,y}$	=	Emissions from the combustion of biomass residues during the year y (tCO_2e).
GWP_{CH_4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2/tCH_4).
$EF_{CH_4,BR}$	=	CH_4 emission factor for the combustion of biomass residues in the project plant (tCH_4/GJ).
$BR_{PJ,n,y}$	=	Quantity of biomass residues of category n used in the project activity in year y (tonnes on dry-basis).
$NCV_{BR,n,y}$	=	Net calorific value of biomass residue of category n in year y (GJ/tonne on dry-basis).

According to the baseline methodology ACM0006 (Version 14.0), the Project Participant may either conduct measurements at the plant site or use IPCC default values, as provided in Table 4 of this methodology. In the case of this project activity, the Project Participant decided to use from Table 4: Default CH_4 emission factor for combustion of biomass residues. Additionally, the conservativeness factor will be determined from Table 5 of this methodology.

Leakage emissions

According to the methodological tool “Project and leakage emissions from biomass (Version 04.0)” where the most likely baseline scenarios for which potential leakage is relevant is B4: the Project Participant shall demonstrate that the use of biomass does not result in increased fossil fuel consumption elsewhere.

To assess possible leakage emissions for the categories of biomass residues whose baseline scenario has been identified as B5 the Project Participant shall calculate leakage emissions according to the methodological tool “Project and leakage emissions from biomass”, using equation (9) of tool as follows:

$$LE_y = EF_{CO2,LE} * \sum_{n} BR_{B5/B6,n,y} * NCV_{BR,n,y}$$

Where:

$LE_{BR,y}$	=	Leakage emissions in year y (tCO_2).
$EF_{CO2,LE}$	=	CO_2 emissions factor of the most carbon intensive fossil fuel used in the country (tCO_2/GJ).
$BR_{PJ,n,y}$	=	Quantity of biomass residues used in the project site and included in the project boundary in year y (tonnes on dry-basis).
$NCV_{,n,y}$	=	Net calorific value of biomass residue of category n in year y (GJ/tonne on dry basis).
n	=	Categories of biomass residues for which B5 has been identified as the alternative scenario.
y	=	Year of the crediting period.

In this case, the leakage emissions are not relevant as this project activity will contemplates the utilization of biomass residues for which the most likely (applicable) baseline scenario would be for heat generation purpose (B5), dumped or left to decay under mainly aerobic conditions (B1), and in some particular cases biomass burnt in an uncontrolled manner without utilizing them for energy purposes (B3).

SUPPLY/DEMAND SITUATION

(According to the "L2" criteria to establish leakage in the ACM0006 baseline methodology)

TRUPAN INFLUENCE AREA SUPPLY/DEMAND SITUATION

Biomass supply

		2017
Industrial Operations Biomass residues	(m^3st/yr)	14.273.702
Forestry Operations Biomass residues	(m^3st/yr)	3.074.192

Biomass demand

		2017
Industrial Operations Biomass residues	(m^3st/yr)	7.562.017
Forestry Operations Biomass residues	(m^3st/yr)	1.442.137

Industrial Biomass residues generated/Industrial Biomass residues consumption	**(number)**	**1,8876**
Forestry Biomass residues generated/Forestry Biomass residues consumption	**(number)**	**2,1317**

TRUPAN INFLUENCE AREA SUPPLY/DEMAND SITUATION

Biomass supply

		2016
Industrial Operations Biomass residues	(m^3st/yr)	14.945.838
Forestry Operations Biomass residues	(m^3st/yr)	3.074.192

Biomass demand

		2016
Industrial Operations Biomass residues	(m^3st/yr)	8.808.403
Forestry Operations Biomass residues	(m^3st/yr)	1.442.137

Industrial Biomass residues generated/Industrial Biomass residues consumption	**(number)**	**1,6968**
Forestry Biomass residues generated/Forestry Biomass residues consumption	**(number)**	**2,1317**

Default values

In this section, the Project Participant will provide the default values used in the emission reduction calculations of this project activity.

According to step 1.5 of the methodology ACM0006 (Version 14.0), the Project Participant shall provide the default values of the efficiencies of heat generators and heat engines available in the baseline to be used in the emission reduction calculation.

The Project Participant would like to note that only one heat generator would be available in the baseline and no heat engines and from the options presented only Option 1: “Default values should be chosen” is applicable, in this case. Subsequently, this option automatically refers to Option F: “Use a default value” of the latest “Tool to determine the baseline of thermal or electric energy generation systems” at the date of revalidation of this project activity.

Default value types	Name	Unit	Value	Justification/comment
Heat efficiency of the power boiler (heat generator)	$\eta_{BL,HG,BR,h}$	%	85	Option F: Use a default value, in this case, 85% efficiency of a new biomass fired boiler (on dry biomass basis), according to table 1 “Default efficiency for thermal applications”, appendix Default efficiency factors, methodological tool “Determining the baseline efficiency of thermal or electric energy generation systems.”
CH4 emission factor for the combustion of biomass residues in the project plant.	$EF_{CH4,BR}$	(tCH_4/ GJ)	41	Default value is based on the 2006 IPCC Guidelines, Volume 2, Chapter 2, Tables 2.2 to 2.6
Default CO2 emission factor for freight transportation activity f.	$EF_{CO_2,f}$	g CO_2 / t km	129	Emission factor has been derived from based on custom design transient speed-time-gradient drive cycle (adapted from the international FIGE cycle), vehicle dimensional data, mathematical analysis of loading scenarios, and dynamic modelling based on engine power profiles, which, in turn, are a function of gross vehicle mass (GVM), load factor, speed/acceleration profiles and road gradient. The following assumptions on key parameters have been made: an average driving speed of 30 km/h, an average gradient of 15, and a load factor attained when biomass is transported were assumed.

<u>Methane emission factor for uncontrolled burning of biomass:</u>

According to the baseline methodology ACM0006 (Version 14.0), the Project Participant may undertake measurements or use referenced default values to calculate the methane emission factor from uncontrolled burning of biomass residues in the baseline. In this case, in order to accomplish a higher accuracy in the baseline emission calculations, the Project Participant conducted a local measurement of this factor at the start of the project activity instead of using the default factor provided by the methodology. These values are already presented in section B.6.2 “Data and parameters fixed ex ante” of this PDD. As a result, values will be not presented again in this section. (Refer to Appendix 5 of this PDD).

B.6.2. Data and parameters fixed ex ante

Data and parameters not monitored for ACM0006 (Version 14.0)

Data /Parameter table 11

Data / Parameter	$CAP_{HG,h}$
Unit	(GJ/h)
Description	Baseline capacity of heat generator h
Source of data	Reference plant design parameters.
Value(s) applied	Low pressure power boiler (heat generator): 364.23(GJ/h)
Choice of data or Measurement methods and procedures	This parameter reflects the design maximum heat generation capacity (in GJ/h) of the baseline heat generator h. It is based on the installed capacity of the heat generator. In the case of this project activity, the applied value is based on plant design data for the baseline scenario: $$CAP_{HG,h}: 364.23\ (GJ/h) = 130\ (ton/h) \cdot 2.80178\ (GJ/ton)$$ Where: According to the plant design for the baseline scenario there would be a smaller low-pressure power boiler installed with a max high-pressure steam capacity of 130 (t/h) consuming biomass residues. The applied value for the enthalpy is determined based on thermodynamic conditions of saturated steam generated or near-saturated steam at predefined operational set points: 250 °C, pressure at 38 bar (a).
Purpose of data	Used in restriction equation in baseline scenario.
Additional comment	Refer to section A.3. Technology/measures under the energy/mass balance of conventional BAU power plant.

Data /Parameter table 12

Data / Parameter	$LFC_{HG,h}$
Unit	Ratio
Description	Baseline load factor of heat generator h
Source of data	Reference plant design parameters.
Value(s) applied	Low pressure power boiler (heat generator): 0.87
Choice of data or Measurement methods and procedures	This parameter reflects the maximum load factor (i.e. the ratio between the actual heat generation of the heat generator and its design maximum heat generation along one year of operation) of the baseline heat generator h, taking into account downtime due to maintenance, seasonal operational patterns, and any other technical constraints. The load factor is defined as the ratio between the average load and the maximum design capacity for the baseline situation. $$LFC_{HG,h} = \frac{\left[108\frac{t}{h} * \left(24hr * \frac{354}{2}d\right) + \frac{117.7t}{h} * \left(24hr * \frac{354}{2}d\right)\right]}{130\frac{t}{h} * (24hr * 354d)}$$
Purpose of data	Used in restriction equation in baseline scenario.

Additional comment	The value informed results from the weight average calculation between summer (108 t/h) and winter (117.7 t/h) of steam flow generation. The design steam flow (130 t/h) for baseline power boiler informed in the registered PDD. This calculation considers downtime due to maintenance and seasonal operational patterns.

Table / Parameter table 19

Data / Parameter	GWP_{CH_4}
Unit	tCO_2e/tCH_4
Description	Global Warming Potential for CH_4.
Source of data	IPCC.
Value(s) applied	25 for the second commitment period. Shall be updated according to any future COP/MOP decisions.
Choice of data or Measurement methods and procedures	Until the next COP/MOP decision, it is the accepted value for emission reduction calculations in CDM project activities.
Purpose of data	Baseline emissions calculations.
Additional comment	--

Table / Parameter table 26

Data / Parameter	$EF_{BR,n,y}$
Unit	tCH_4/GJ
Description	CH_4 emission factor for uncontrolled burning of the biomass residues category n during the year y (tCH_4/GJ)
Source of data	Conduct measurements.

Value(s) applied	The Project Participant measured once at the start of the project activity rather than use a default methane emission factor provided by the baseline methodology. The result of measurements performed by type of biomass residues is presented as follows:

Biomass residues category n	Biomass residues type.	Biomass residues source.	CH_4 factor for biomass uncontrolled burning ($KgCH_4/TJ$)	Conservativeness factor (%) (Note)	Adjusted CH_4 default factor
3	Mix of sawdust and bark from industrial operations.	On-site production	930 +/- 167	0.94	874.20
4	Mix of sawdust and bark from industrial operations.	Off-site production.	930 +/- 167	0.94	874.20
5	Mix of sawdust and bark from forest operations.	Off-site production.	114 +/- 114	0.82	93.48

	The Project Participant would like to note that the conservativeness factor has been obtained from Table 3 of the ACM0006 (Version 14.0).
Choice of data or Measurement methods and procedures	The Project Participant measured once at the start of the project activity. The CH_4 measurement shall be performed for each type of biomass residues consumed, as a result of the implementation of this project activity.
Purpose of data	For the purpose of ex-ante calculation of emission reductions in section B.6.3.
Additional comment	The Project Participant would like to note that differences between IPCC default values and measurements conducted are mainly due to the compactness level of the biomass residues burned. In the case of the mix of sawdust and bark from industrial operations, it was densely packed allowing for very little oxygen in the combustion process, which leads to high methane emission factors. In the case of the mix of sawdust and bark from forest operations, since these are mainly branches allow for plenty of oxygen during the combustion, which leads to much lower methane emission factors. (For additional information see Appendix 5 of this PDD).

Table / Parameter table 28

Data / Parameter	$EF_{CH4,BR}$
Unit	tCH_4/GJ
Description	CH_4 emission factor for the combustion of biomass residues in the project plant (tCH_4/GJ)
Source of data	Default values
Value(s) applied	

Biomass residues category n	Biomass residues type.	Biomass residues source.	CH4 factor for biomass controlled burning ($KgCH_4/TJ$).	Conservativeness factor (%).	Adjusted CH4 default factor.
4	Sludge from industrial operations.	On-site production.	30.0	1.37	41.1
5	Mix of sawdust and bark from industrial operations.	On-site production.	30.0	1.37	41.1
6	Mix of sawdust and bark from industrial operations.	On-site production.	30.0	1.37	41.1
7	Mix of sawdust and bark from industrial operations.	Off-site production	30.0	1.37	41.1
8	Mix sawdust and bark from forest operations.	Off-site production.	30.0	1.37	41.1

Choice of data or Measurement methods and procedures	ACM0006 v14. Table 4 and 5.
Purpose of data	Calculation of project emissions.
Additional comment	Monitoring of this parameter for project emissions is required, since in this case CH_4 emissions from biomass combustion are included in the project boundary. A conservative factor will be applied, as specified in the baseline methodology.

<u>Non- monitored parameters from the “Tool to calculate the emission factor for an electricity system (Version 07.0)”:</u>

Data / Parameter	$\mathbf{EF_{grid,BM,y}}$
Unit	tCO_2/MWh
Description	CO_2 Build Margin emission factor of the grid.
Source of data	CDEC-CEN Dispatch Centre reports. Ministry of Energy reports. IPCC lower calorific values.
Value(s) applied	0.4244 (tCO_2/MWh) The Build Margin (BM) will remain fixed for the second and third crediting periods.

Choice of data or Measurement methods and procedures	The build margin is calculated according to the last version of the "Tool (version 07.0) to calculate the emission factor for an electricity system", which must be used in this case. All information required for the calculation of this emission factor is provided in Appendix 4 of this PDD.
Purpose of data	Baseline emission calculations.
Additional comment	--

Data / Parameter	$EF_{grid\ OM,y}$
Unit	(tCO_2/MWh)
Description	Simple adjusted operating margin CO2 emission factor in year y.
Source of data	– CDEC-SIC Dispatch Centre reports. – Ministry of Energy reports. – IPCC lower values.
Value(s) applied	Generation weight average Operating Margin: 0.7666 (tCO2/MWh). This is determined ex-ante option considering the last 3-years data available. (See Appendix 4 of this PDD)
Choice of data or Measurement methods and procedures	The Operating Margin is calculated according to the last version of the "Tool to calculate the emission factor for an electricity system", which must be used in this case.
Monitoring frequency	The Project Proponent will use the ex-ante option to calculate the OM; that is, the OM will be calculated once at the validation stage. As a result, no monitoring and recalculation of the emissions factor during the crediting period is required.
Purpose of data	Baseline and project emission calculations.
Additional comment	In this case, since the ex-ante option is chosen, this emission factor is determined once at the validation stage, thus no monitoring and recalculation of this emission factor during the crediting period is required.

Data / Parameter	$EF_{grid,CM,y}$
Unit	(tCO_2/MWh)
Description	CO_2 emission factor for grid electricity during year y.
Source of data	The project participant will use the latest version of the "Tool to calculate the emission factor for electricity system (version 07.0)"
Value(s) applied	The applied value is: 0.5099(tCO_2/MWh). The Build margin (BM), in this case 0.4244(tCO_2/MWh) will remain fixed for the second and third crediting periods. The Operating margin (OM), in this case, 0.7666 (tCO_2/MWh) will remain fixed for the second and third crediting period.

Choice of data or Measurement methods and procedures	The CM is calculated according to the last version of the "Tool to calculate the emission factor for an electricity system", which must be used in this case.
Monitoring frequency	The Project Proponent will use the ex-ante option to calculate the CM; that is, the CM will be calculated once at the validation stage. As a result, no monitoring and recalculation of the emissions factor during the crediting period is required.
Purpose of data	Baseline and project emission calculations.
Additional comment	---

Data / Parameter	$FC_{i,m,y}$, $FC_{i,k,y}$
Unit	Mass or volume unit.
Description	Amount of fuel type i consumed by power plant/unit m and k in year y. In this case, "m" denotes all grid power units serving the grid in year y except low-cost/must-run power units and "k" denotes all low-cost/must run grid power units serving the grid in year y.
Source of data	Utility or government records or official publications.
Value(s) applied	See Annex 4 of this PDD.
Measurement methods and procedures	Calculation of power unit emission factors ($EF_{EL,m,y}$, $EF_{EL,k,y}$), as per equation (2) of the corresponding tool, in cases where fuel consumption and electricity generation data is available for each power unit m and k.
Monitoring frequency	Monitoring frequency, simple adjusted OM: will remain fixed for the second and third monitoring period. Monitoring frequency, BM: For the first crediting period, annually ex-post. For the second and third crediting period, only once ex-ante at the start of the second crediting period.
Purpose of data	Calculation of baseline emissions.
Additional comment	--

Data / Parameter	$NCV_{i,y}$
Unit	(GJ / mass or volume unit)
Description	Net calorific value (energy content) of fuel type i in year y.

<table>
<tr><td>Source of data</td><td>The following data sources may be used in the relevant conditions apply:
<table><tr><td>Data source</td><td>Conditions for using the data source</td></tr><tr><td>Values provided by the fuel supplier of the power plants invoices.</td><td>If data is collected from power plant operators (e.g. utilities).</td></tr><tr><td>Regional or national average default values.</td><td>If values are reliable and documented in regional or national energy statistics / energy balances.</td></tr><tr><td>IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.</td><td>--</td></tr></table>
In this case, there exist reliable and documented national energy statistics therefore; the source used for the emission reduction calculation was the CNE (National Energy Commission) Energy Balance for 2012.</td></tr>
<tr><td>Value(s) applied</td><td>Diesel: 45.6 (GJ/ton)
IFO 180: 44.0 (GJ/ton)
Natural Gas: 39.1 (GJ/ton)
Coal: 29.3 (GJ/ton)
Pet coke: 29.3 (GJ/ton)
Butane: 39.1 (GJ/ton)
Propane: 39.1 (GJ/ton)</td></tr>
<tr><td>Measurement methods and procedures</td><td>---</td></tr>
<tr><td>Monitoring frequency</td><td>Monitoring frequency simple adjusted OM: will remain fixed for the second and third monitoring period.
Monitoring frequency BM: For the second and third crediting period, only once ex-ante at the start of the second crediting period.</td></tr>
<tr><td>QA/QC procedures</td><td>---</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions.</td></tr>
<tr><td>Additional comment</td><td>The gross calorific value (GCV) of the fuel can be used, if gross calorific values are provided by the data sources used. In such cases, also a gross calorific value basis will be used for CO_2 emission factor.</td></tr>
</table>

Data and parameters not monitored for the Tool "Project and leakage emissions from transportation of freight (Version 01.1.0)".

<table>
<tr><td>Data / Parameter</td><td>$EF_{CO_2,f}$</td></tr>
<tr><td>Unit</td><td>g CO_2 / t km</td></tr>
<tr><td>Description</td><td>Default CO_2 emission factor for freight transportation activity f.</td></tr>
<tr><td>Source of data</td><td><table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>Emission factor was obtained from empirical data from European vehicles.</td><td>Light vehicles</td></tr>
<tr><td>Emission factor has been derived from based on custom design transient speed-time-gradient drive cycle (adapted from the international FIGE cycle), vehicle dimensional data, mathematical analysis of loading scenarios, and dynamic modelling based on engine power profiles, which, in turn, are a function of gross vehicle mass (GVM), load factor, speed/acceleration profiles and road gradient. The following assumptions on key parameters have been made: an average driving speed of 30 km/h, an average gradient of 15, and a load factor attained when biomass is transported were assumed.</td><td>Heavy vehicles</td></tr>
</table></td></tr>
<tr><td>Value(s) applied</td><td><table>
<tr><th>Vehicle class</th><th>Emission factor (g CO_2 / t km)</th></tr>
<tr><td>Light vehicles</td><td>245</td></tr>
<tr><td>Heavy vehicles</td><td>129</td></tr>
</table></td></tr>
<tr><td>Choice of data or Measurement methods and procedures</td><td>--</td></tr>
<tr><td>Purpose of data</td><td>Project emissions calculation from transportation of freight.</td></tr>
<tr><td>Additional comment</td><td>Applicable to Option B of the Tool "Project and leakage emissions from transportation of freight" (Version 01.1.0).</td></tr>
</table>

B.6.3. Ex ante calculation of emission reductions

The Project Participant would like to note the following:

1. According to the ACM0006 (Version 14.0), the way in which the emission reduction calculation is carried out can present several variations depending on the operational behaviour of the project plant. In this case, the Project Participant will contemplate in the emission reduction calculations of the project activity monitored data from previous monitoring periods.
2. In some cases where it is required, the Project Participant will use design parameters of the baseline and project case in the emission reduction calculations. In other cases, the Project Participant will use data from the energy/mass balance[26] from which emission calculations

[26] The energy/mass balances of the baseline and project case were performed using average steam flows based on yearly average data.

draw some information. These calculations, then, shall be considered only as a reference, as long as the project plant behaves as expected.

3. Following on what was described in paragraphs above, in case the operational of the project plant departs from the probable scenario, the Project Participant will apply the ACM0006 (Version 14.0) and follow all the indications and guidelines provided by the methodology.
4. Note that differences in baseline and project emission calculations included in tables below are due to the fact that all calculations are done directly in excel spread sheets, which implies a decimal precision that is not carried over onto word formatted tables because decimals are truncated and rounded down. Therefore, exact resulting values can be viewed directly in emission reduction calculation spread sheet

Calculation of Baseline Emissions (BEy)

Emissions due Baseline electricity generation

Step 1.1 Determine total baseline process heat generation.

According to the ACM0006 (Version 14.0), the process heat amount that would be generated in the baseline in year y ($HC_{BL,y}$) shall be determined as the difference of the enthalpy of the process heat (steam or hot water) supplied to process heat loads in the project activity minus the enthalpy of the feed-water, the boiler blow-down and any condensate return to the heat generators.

The baseline scenario of this project activity would have had the same output as the real scenario (with the CDM project activity) since the former would have contemplated the installation of a power boiler dimensioned to meet the same process heat demand[27] of the internal clients i.e. Sawmill and Panel/Plywood mills of the real plant.

Considering the above, the estimate amount of process heat generation is determined based on measurements conducted in previous monitoring periods. The Project Participants will use medium and low pressure steam flows (average) measurements and its thermodynamic conditions (i.e. enthalpies, Pressure and Temperature) calculated as a function of temperature and pressure of steam. This will lead to a more accurate and realistic determination of the process heat that would be generated in the baseline scenario than using design values.

Data:

	Medium pressure line
1)	Process heat enthalpy (MDF2 medium pressure line) Process heat enthalpy (HB medium pressure line)
2)	Feed and make up-water, boiler blow-down and condensate enthalpy
	Low pressure line
3)	Process heat enthalpy (MDF2 low pressure line) Process heat enthalpy (HB low pressure line) Process heat enthalpy (Sawmill pressure line) Process heat enthalpy (MDF2 cleaning station low pressure line)
4)	Feed and make up-water, boiler blow-down and condensate enthalpy

Calculations:

[27] The difference between the energy/mass balance of the baseline scenario and the CDM project case presented in section A.3 of this PDD would be exclusively derived from the high-pressure steam generation capacity of the CDM project case for on-site electric power generation.

Total baseline process heat generation	**$HC_{BL,y}$**	**[(1) - (2) + (3) - (4)]**	**1,798,198**

Step 1.2 Determine total baseline electricity generation.

According measurements performed by Project Participants in previous monitoring periods, using equation 3 of the ACM0006 (Version 14.0), the baseline electricity generation in the grid can be calculated as follows:

Data:

(1) Gross quantity of electricity generated.[(a)]	**$EL_{PJ,gross,y}$**	217,147 (MWh/y)
(2) Project electricity imports from the grid.[(a)]	**$EL_{PJ,imp,y}$**	70,501 (MWh/y)
(3) Auxiliary electricity consumption required for the operation of the power plants.[(a)]	**$EL_{PJ,aux,y}$**	35,632 (MWh/y)

Notes:
[(a)] The applied values are based on measurements conducted in previous monitoring periods.

Calculations:

(4) Baseline electricity generation capacity in year y	$EL_{BL,y}$	(1) + (2) - (3)	252,016 (MWh/y)

Step 1.3 Determine baseline capacity of electricity generation.

According to the baseline plant design, there would be one low pressure boiler i.e. heat generator, no cogeneration type heat engine ($CAP_{EG,CG,I}$ = 0) and no power-only-type heat engine ($CAP_{EG,PO,j}$ = 0) in the baseline scenario.

Baseline electricity generation capacity of heat engine i	$CAP_{EG,total,y}$	0(MWh)

Step 1.4 Determine the baseline availability of biomass residues.

The baseline scenario includes the use of biomass residues types for heat generation purpose. According to the algorithm of biomass consumption previously described in which types of biomass residues are ranked from the most available/less costly (on-site operations) to the least available/most costly (off-site operations), the expected consumption of biomass residues types that would be available for heat generation in the baseline are the following:

Category n	**Biomass residues types**		**Units**	**Average amounts**
1	Sludge from on-site industrial operation. (see note)	$BR_{B5,1,y}$	(BDt/y)	14,569
2	Mix of sawdust and bark from on-site industrial operations.	$BR_{B5,2,y}$	(BDt/y)	96,217

Notes: Biomass residues type most available /least costly.

The Project Participant would like to note the following:

- According to the common practice in the Sawmill and Panel board industries in Chile, there is normally one fate for the biomass residues identified above: Sludge and mix of saw dust and bark from on-site industrial operations are used as fuel for heat generation, mainly for wood and presses drying.

- Since in the baseline scenario, there would be one heat generator i.e. a conventional low-pressure boiler, then (all) the biomass residues types identified in table above can be completely allocated to this heat generator.

Step 1.5 Determine the efficiencies of heat generators and efficiencies and heat-to-power ratio of heat engines.

Efficiencies of heat generator and heat engines in the baseline: According to Tool 09 (Methodological tool: Determining the baseline efficiency of thermal or electric energy generation systems, Version 02.0) Option F can be used to determine a constant efficiency. Project participant use the default values for the applicable technology from the appendix "Default efficiency factors" as constant efficiency.

Default efficiency for thermal applications in table 1 for a low pressure power boiler (baseline scenario) is:

Heat generator in the baseline		Value
Low pressure power boiler	$\eta_{BL,HG,BR,low\ pressure\ boiler}$	85%

The Project participant would like to note that in this case there was no cogeneration-type heat engine in the baseline scenario.

Step 1.6 Determination of the emission factor of on-site electricity generation with fossil fuels.

In this case no fossil fuel based power generation was identified as part of the baseline scenario, as a result, according to ACM0006 (Version 14.0) the Project Participant will do:

$$EF_{EG,FF,y} = EF_{EG,GR,y}$$

Step 1.7 Determination of the emission factor of grid electricity generation.

According to the ACM0006 (Version 14.0), the monitored parameter $EF_{EG,GR,y}$ should be determined as the combined margin CO_2 emission factor for the grid to which the project activity is connected in year y, calculated using the latest approved version of the "Tool to calculate the emission factor for an electricity system". The calculation procedure is presented below:

<u>Operating Margin calculation</u>:

According to the explanation given in section B.6.1 in this PDD, the Operating Margin ($EF_{OM,y}$) will be calculated according to Option B ($EF_{grid,OM-adj,y}$) of the alternatives presented in the tool to calculate the emission factor for an electricity system.

The Project Proponent will use the ex-ante option to calculate the OM; that is, the OM will be calculated once at the validation stage. As a result, no monitoring and recalculation of the emissions factor during the crediting period is required.

For the calculation of the Operating Margin (OM), the Project Participant will use:

- Option A to calculate the $EFgrid_{,OM-adj,y}$: Use information based on the net electricity generation and a CO_2 emission factor for each power unit.

For the determination of the emission factor of each power unit m, $EF_{EL,m,y}$ the Project Proponent will choose:

- Option A1: Use information based on fuel consumption and electricity generation for each power unit m.

Note that in this case, the information that is directly available from the Dispatch Centre is the net generation of each power unit m and the corresponding fossil fuel consumption rate.

For the Operating Margin calculation informed in this PDD, the Project Participant will use ex-ante option which considers the last 3-years data available 2017, 2016 and 2015. This was the last information available at the date this PDD was reviewed and finished.

From the data that generates the curve (See Appendix 4 of this PDD), it is possible to determine the fraction of the year in which low-cost/must-run sources are on the margin for the years 2017, 2016 and 2015:

$$\lambda_y = \lambda_{2017} = 0.000000$$

$$\lambda_y = \lambda_{2016} = 0.000000$$

$$\lambda_y = \lambda_{2015} = 0.000000$$

The rest of the parameters used to calculate the $EF_{grid,OM\text{-}adj,y}$ for 2017, 2016 and 2015, were obtained from the CDEC-CEN dispatch centre (official and public information). In some cases, the project participant also used information from power company's web pages. The calculation is as follows:

1. CO_2 emissions of non-low cost/must-run power sources for 2017, 2016 and 2015.

2017

$$\sum_m EG_{m,y} \cdot EF_{EL,m,y} = 17{,}256{,}288\ (tCO_2/yr)$$

2016

$$\sum_m EG_{m,y} \cdot EF_{EL,m,y} = 19{,}309{,}717\ (tCO_2/yr)$$

2015

$$\sum_m EG_{m,y} \cdot EF_{EL,m,y} = 19{,}619{,}686\ (tCO_2/yr)$$

2. Total power generation in the CEN by non-low-cost/must-run power sources in 2017-2016 and 2015.

2017

$$\sum_m EG_{m,y} = 23{,}869\ (GWh/yr)$$

2016

$$\sum_m EG_{m,y} = 26{,}146\ (GWh/yr)$$

2015

$$\sum_m EG_{m,y} = 23{,}405\ (GWh/yr)$$

3. CO_2 emissions of low-cost/must run power sources in 2017-2016 and 2015. Since in Chile low-cost/must-run power sources include mostly hydro energy, the total emissions for this part of the equation are low.

2017

$$\sum_k EG_{k,y} \cdot EF_{EL,k,y} = 379{,}865\ (tCO_2/yr)$$

2016

$$\sum_k EG_{k,y} \cdot EF_{EL,k,y} = 433{,}095\ (tCO_2/yr)$$

2015

$$\sum_k EG_{k,y} \cdot EF_{EL,k,y} = 545{,}449\ (tCO_2/yr)$$

4. Total power generation in the CEN by low-cost/must-run resources for 2017-2016 and 2015.

2017

$$\sum_k EG_{k,y} = 29{,}512\ (GWh/yr)$$

2016

$$\sum_k EG_{k,y} = 26{,}286\ (GWh/yr)$$

2015

$$\sum_k EG_{k,y} = 29{,}582\ (GWh/yr)$$

Replacing the above values in the equation used to calculate the $EF_{grid,OM-adj,y}$ for the year 2017, the operating margin results:

For 2017

$$EF_{grid,OM-adj,y} = (1-0.000) \cdot \frac{17{,}256{,}288}{23{,}869} + 0.000 \cdot \frac{379{,}865}{29{,}512} = 722.95(tCO_2/GWh)$$

$$EF_{grid,OM-adj,y} = 722.95\ (tCO_2/GWh)$$

For 2016

$$EF_{grid,OM-adj,y} = (1-0.000) \cdot \frac{19{,}309{,}717}{26{,}146} + 0.000 \cdot \frac{433{,}095}{26{,}286} = 738.52(tCO_2/GWh)$$

$$EF_{grid,OM-a\quad,y} = 738.52\ (tCO_2/GWh)$$

For 2015

$$EF_{grid,OM-a\quad,y} = (1-0.000) \cdot \frac{19{,}619{,}686}{23{,}405} + 0.000 \cdot \frac{545{,}449}{29{,}582} = 838.25(tCO_2/GWh)$$

$$EF_{grid,OM-a\quad,y} = 838.25\ (tCO_2/GWh)$$

The Project proponent uses the ex-ante option to calculate the OM; that is, the OM will be calculated once at the validation stage.

Selected option: Ex-ante option: considers the last 3-year data available.

		2015	2016	2017
Total emissions from non-low cost / must run power plants	(tCO_2/yr)	19,619,686	19,309,716	17,256,288
Total emissions from low-cost / must-run power plants	(tCO_2/yr)	545,449	433,095	379,865
Total net energy generated in the grid (incl. imports)	(GWh/yr)	52,987	52,432	53,382
Total net energy by non-Low cost / must run power plants	(GWh/yr)	23,405	26,146	23,869
Total net energy by low cost / must run power plants (incl. imports	(GWh/yr)	29,582	26,286	29,512
Factor λ	(number)	0.0000	0.0000	0.0000
Operating Margin	**(tCO_2/GWh)**	**838.25**	**738.52**	**722.95**

Generation weighted-average Operating Margin	**(tCO_2/GWh)**	**766.57**

Build Margin calculation:

According applicable tool 07 "Methodological tool: Tool to calculate the emission factor for an electricity system, Version 07", the project participant shall use the build margin emission calculated for the second crediting period, registered in 2009.

According to 2009 CEN data, the group of plant that accounts for the largest generation in that year are the ones responsible for the 20% of the total generation in 2009. $EF_{BM,2009}$ presented in the second crediting period is:

$$EF_{BM,2009} = 424.40\ (tCO_2/GWh)$$

As in the previous case, the Build Margin calculation also considered official CDEC-CEN data and/or other official data publicly available. For more details about the Build Margin calculation, please see Appendix 4 of this PDD.

Having obtained both $EF_{OM,y}$ and $EF_{BM,y}$, and assuming the default value of (0.25) for the weights W_{OM} and (0.75) for the W_{BM}, it is possible to calculate $EF_{grid\ CM,y}$:

Data

1) Operating Margin (OM)	$EF_{grid,OM,y}$	0.7666(tCO_2/MWh)
2) Build Margin (BM)	$EF_{grid,BM,y}$	0.4244(tCO_2/MWh)
3) Weighting of Operating Margin	W_{OM}	25%
4) Weighting of Build margin	W_{BM}	75%

Calculations:

5) Combined Margin calculation (CM)	**$EF_{grid,CM,y}$**	**(1)*(3) + (2)*(4)**	**0.509 (tCO_2/MWh)**

For more details regarding the calculation of the Operating Margin (OM) and Build Margin (BM) refer to Appendix 4 of this PDD.

Step 2 to determine the minimum baseline electricity generation in the grid.

According to equations 13 of the ACM0006 (Version 14.0), baseline minimum electricity generation in the grid can be calculated as follows:

Data:

(1) Baseline electricity generation in year y.	$EL_{BL,GR,y}$	**252,016 (MWh/y)**
(2) Baseline electricity generation capacity in year y.	$CAP_{EG,total,y}$	**0 (MWh/y)**

Calculations:

(3) Minimum baseline electricity generation in the grid in year y.	**$EL_{,BL,GR,y}$**	**Max [0,(1)-(2)]**	**252,016 (MWh/y)**

Step 3 to determine the baseline biomass-based heat and power generation.

Step 3.1 to determine the baseline biomass-based heat generation.

According to the procedures established by the ACM0006 (Version 14.0):

1. There would be only one heat generator (no cogeneration type heat engine) that would use biomass residues in the baseline scenario.
2. Such heat generator would consumed all the biomass residues for which the baseline scenario $BR_{B5,n,y}$ has been identified.
3. Since, such heat generator would have included the possibility of co-firing some fossil fuels due to operational reasons; the type and quantity required would be identified based on the estimated number of start-ups and for maintaining the heat generator temperature, especially in winter, when the biomass has a higher humidity. Such amounts of fossil fuels are shown below:

Fossil fuel consumption due to technical constraints:	Parameter	(l/y)	(ton/y)
Diesel consumption: Annual shut down due to maintenance (once a year): Fossil fuel consumed for shut-down and start-up activities. Operational constraints: Fossil fuel required to maintain operational temperature and reduce moisture content.	$FF_{BL,HG,y,i}$	62,870	53
LPG consumption : Due to operational constraints.	$FF_{BL,HG,y,i}$	1,039	0.571

The Project Participant informs that as an alternative fuel to Diesel the project activity might use Fuel Oil for technical requirements.

According to ACM0006 (Version 14.0), the Project Participant should clearly identify the type and quantity of fossil fuels required due to technical constraints and should be accounted in the total heat generation of the biomass power boiler, and also considered in the baseline emission calculation of the project.

In this case, the Project Participant will determine, according to equation 14 of the ACM0006 (Version 14.0), the amount of heat generated with biomass residues, and shall comply with the following restrictions:

- Restriction associated to equation 15: The biomass residues used in each generator should not exceed the total amount of biomass residues available.
- Restriction associated to equation 16: The heat generation in each heat generator should not exceed the total capacity of the heat generator.

Considering the above, the calculation of the baseline biomass-based heat generation is calculated as follow:

Determine the total heat generated in the power boiler considering all biomass residues types available in the baseline:

Data:

(1) Sludge from on-site industrial operations, heat generation.	$BR_{B5,1,y}$	14,569 (BDt/y)
(2) Net calorific value of sludge.	$NCV_{B5,1,y}$	22.7 (GJ/t)
(3) Mix of sawdust and bark from on-site industrial operation, heat generation.	$BR_{B5,2,y}$	96,217 (BDt/y)
(4) Net calorific value of mix of sawdust and bark.	$NCV_{B5,2,y}$	18.55 (GJ/t)
(5) Baseline biomass-based heat generation efficiency of the power boiler.	$\eta_{BL,HG,BR,power\ boiler}$	85%

Calculations:

Baseline biomass-based heat generation of the power boiler in year y (without FF)	$HG_{BL,BR,y}$	**[(1)*(2) + (3)*(4)]*(5)**	**1,798,198 (GJ/y)**

Determine the heat contribution due to fossil fuel consumption in the power boiler:
This is accomplished considering the total fossil fuel due to technical constraints for starts-ups and for maintaining the power boiler temperature, especially in winter, when biomass has a higher humidity.

Data:

1) Baseline Diesel consumption due to operational reasons.	$FF_{BL,HG,y,Diesel}$	43 (t/y)
2) Diesel net calorific value.	NCV_{Diesel}	43.3 (TJ/000t)
3) Baseline LPG consumption due to operational reasons.	$FF_{BL,HG,y,LPG}$	0.460 (t/y)
4) LPG net calorific value.	NCV_{LPG}	52.2 (TJ/000t)
5) Baseline biomass-based heat generation efficiency of the power boiler.	$\eta_{BL,HG,BR,PB}$	85%

Calculations:

6) Fossil fuel heat contribution in year y	$HG_{BL,FF,y}$	**(1)*(2)*(3)**	**1,587 (GJ/y)**

Determine the total biomass-based heat generation in the power boiler, including fossil fuel heat contribution:

Data:

1) Diesel heat contribution in year y	$HG_{BL,FF,y}$	1,587 (GJ/y)

2) Baseline biomass-based heat generation of the power boiler in year y (without FF)	$HG_{BL,BR,y}$	1,798,198 (GJ)

Calculations:

Baseline biomass-based heat generation of the power boiler in year y.	**$HG_{BL,BR,y}$**	**(1) + (2)**	**1,799,785 (GJ/y)**

Proceed to calculate the heat generation capacity of the power boiler:

The Project Participant would like to note that reference plant design parameters are used as source of data to determine the baseline capacity of the low pressure power boiler in the baseline scenario.

Data:

1) Length of the operational campaign in year y	LOC_y	8,496 (hr)
2) Baseline capacity of heat generator h [(a)]	$CAP_{HG,h}$	364 (GJ/hr)
3) Baseline load factor of heat generator h.	$LFC_{HG,h}$	0.87

Calculations:

4) Total capacity of heat generation of the power boiler	**(1) * (2) * (3)**	**2,687,605 (GJ/yr)**

Considering the above calculations both restriction 15 and 16 are met:

- Restriction 15: All biomass residues types available in the baseline would be used in the only heat generator i.e. low pressure power boiler available in the baseline.
- Restriction 16: Check whether this heat generation not exceed the total capacity of the heat generator.

In this case, the biomass-based heat generation of the only heat generator is less than the total capacity of the boiler.

$\sum BR_{B5,n,h,y} * NCV_{BR,n,y} * h_{BL,HG,BR,Power\ Boiler} \ = < LOC_y * CAP_{HG,h} * LFC_{HG,h}$	This restriction is met.

Step 3.2 to determine the baseline biomass-based cogeneration of process heat and electricity and heat extraction.

This step is not applicable since there would be no heat engines in the baseline, and therefore no co-generation occurred. Consequently, the biomass-based heat generated would be extracted from a low pressure boiler and used directly (without reductions) without co-generation of power.to meet process heat demand.

Step 3.3: Determine the baseline biomass-based electricity generated in power-only mode

Not applicable since there would be no heat engines in the baseline.

Step 4: Determine the baseline demand for fossil fuels to meet the balance of process heat and the corresponding electricity generation.

Not applicable in this case.

Step 5 to determine the baseline emissions due to uncontrolled burning or decay of biomass residues.

To calculate this emission source, it is necessary first to calculate the categories of biomass residues used as a result of the project activity. According to equation 36 the following calculation can be done:

Data:

Biomass residues attributable to project activity:

1) Mix of sawdust and bark from on-site industrial operations, electricity generation.	$BR_{PJ,3,y}$	4,332 (BDt/y)
2) Mix of sawdust and bark from off-site industrial operations, electricity generation.	$BR_{PJ,4,y}$	109,322 (BDt/y)
3) Mix of sawdust and bark from forest operations, electricity generation.	$BR_{PJ,5,y}$	106,400 (BDt/y)
4) Net calorific value of mix of sawdust and bark from on-site industrial operations.	$NCV_{BR,3,y}$	18.55 (GJ/t)
5) Net calorific value of mix of sawdust and bark from off-site industrial operations.	$NCV_{BR,4,y}$	18.55 (GJ/t)
6) Net calorific value of mix of sawdust and bark from forest operations.	$NCV_{BR,5,y}$	17.32 (GJ/t)
7) Adjusted CH_4 factor for uncontrolled burning of mix of sawdust and bark from on-site and off-site industrial operations.	$EF_{BR,3,y}$ $EF_{BR,4,y}$	874.2 (Kg/TJ)
8) Adjusted CH_4 factor for uncontrolled burning of mix of sawdust and bark from forest operations.	$EF_{BR,5,y}$	93.48 (Kg/TJ)
9) CH_4 Global Warming Potencial	GWP	25 (number)

Calculations:

10) Baseline emissions due to aerobic decay or uncontrolled burning of biomass residues ($BR_{B1/B3,3,y}$)	[(1) * (4) * (7) * (9)]/10^6	1,756 (tCO_2/y)
11) Baseline emissions due to aerobic decay or uncontrolled burning of biomass residues ($BR_{B1/B3,4,y}$)	[(2) * (5) * (7) * (9)]/10^6	44,320 (tCO_2/y)
12) Baseline emissions due to aerobic decay or uncontrolled burning of biomass residues ($BR_{B1/B3,5,y}$)	[(3) * (6) * (8) * (9)]/10^6	4,307(tCO_2/y)
13) Emissions		**50,383 (tCO_2/y)**

Step 6: Calculate baseline emissions

According to equation 2 of the ACM0006 (Version 14.0), the emission reductions due to electricity displacement can be calculated as follows:

Data:

1) Baseline minimum electricity generation in the grid in year y.	$EL_{BL,GR,y}$	252,016 (MWh/y)
2) Grid emission factor in year y.	$EF_{EG,GR,y}$	0.5099 (tCO_2/MWh)

3) Baseline fossil fuel demand for process heat in year y.	$FF_{BL,HG,y,f}$	1,587 (GJ)
4) CO_2 emission factor for fossil fuel type f in year y.	$EF_{FF,y,f}$	0,0748 (tCO_2/GJ)
5) Baseline uncertain electricity generation in the grid or on-site in year y.	$EL_{BL,FF/GR,y}$	0 (MWh/y)
6) CO_2 emission factor for electricity generation with fossil fuels at the project site in the baseline in year y.	$\min(EF_{EG;GR;Y}, EF_{EG;FF;Y})$	0.5099 (tCO_2/MWh)

Calculations:

7) Baseline emissions due to minimum grid electricity displacement.	(1) * (2)	128,511 (tCO_2/y)
8) Baseline emissions due to fossil fuel demand for process heat generation in year y.	(3) * (4)	1,698 (tCO_2/y)
9) Baseline emissions due to uncertain electricity generation in the grid in year y.	(5) * (6)	0 (tCO_2/y)
10) Baseline emissions.		**130,208 (tCO_2/y)**

Project emissions

Considering the simplifications of equation 33 of the ACM0006 (Version 14.0) presented in the preceding section of the PDD, the project emissions are calculated as follows:

$$PE_y = PE_{FF,y} + PE_{GRI,y} + PE_{TR,y} + PE_{BR,y}$$

Determination of $PE_{FF,y}$: Emissions due to fossil fuel consumption at the project site

– **Fossil fuel consumption in the power boiler**

A larger power boiler with a higher biomass combustion capacity and thereby higher steam generation capacity than baseline power boiler will lead to some additional consumption of fossil fuel required due to operational reasons, such as start-up and shut downs operations, fuel required to increase the combustion efficiency during winter operation, when biomass is extremely wet. As a result, this fossil fuel consumption may present a significant variation from year to year.

As a reasonable (average) estimate, the Project Participant contemplates 151,585 (l/y) equivalent to 127 tons per year of Diesel consumption based on measurements conducted in previous monitoring periods. Additionally, the Project Participant contemplates 2,500 (l/y) equivalent to 1.375(ton/y) of LPG consumption based on measurements conducted in previous monitoring period.

The Project Participant would like to inform the following:

- Alternatively, to Diesel consumption, the project activity might use Fuel Oil for operational requirements.
- Any other fuel consumed at the project site attributable to the project activity, such as consumption for mechanical treatment of the biomass, conveyor belts, driers, etc… will be not contemplated under this parameter.

The amount generates GHG emissions, which can be estimated as follows:

Data:

(1) Diesel consumption due to operational reasons.	$FC_{Diesel, y}$	127 (t)
(2) Diesel net calorific value.	$NCV_{,Diesel,y}$	43.3 (TJ/000t)
(3) Diesel CO_2 emission factor.	$EF_{,Diesel,}$	0.0748 (tCO_2/GJ)
(4) LPG consumption due to operational reasons.	$FC_{LPG, y}$	1.375 (t)
(5) LPG net calorific value.	$NCV_{,LPG,y}$	52.2 (TJ/000t)
(6) LPG CO_2 emission factor.	$EF_{,LPG,y}$	0.0656 (tCO_2/GJ)
(7) Fuel Oil consumption due to operational reasons.	$FC_{FO,y}$	0.0
(8) Fuel Oil net calorific value.	$NCV_{FO,y}$	41.7 (TJ/000t)
(9) Fuel Oil CO_2 emission factor.	$EF_{FO,y}$	0.0788 (tCO_2/GJ)

According to this, the total GHG emissions from this source are:

Calculations:

(10) Total emissions.	**[(1)*(2)*(3)+(4)*(5)*(6) +(7)*(8)*(9)]**	**416 (tCO_2/y)**

– **Fossil fuel consumption due to on-site transportation of biomass residues:**

This emission source is generated by the front loaders and/or bulldozers used to transport the biomass residues consumption attributed to the project activity to the power boiler area. The value applied contemplates a total amount of 265,345 (l/y) equivalent to 223(ton/y), in this case Diesel, based on measurements performed in previous monitoring periods, thus generating the following emissions:

Data:

(1) Diesel for on-site biomass transportation due to the project activity	$FC_{Diesel, y}$	222.89 (t)
(2) Diesel net calorific value.	$NCV_{FF,Diesel,y}$	43.3 (TJ/000t)
(3) Diesel CO_2 emission factor.	$EF_{FF,y,Diesel}$	0.0748 (tCO_2/GJ)

According to this, the total GHG emissions from this source are:

Calculations:

(4) Total emissions.	**(1) * (2) * (3)**	**721.9 (tCO_2/y)**

– **Fossil fuel consumption for processing biomass residues from forest operations:**

It is estimated that the project activity will imply a consumption of 120,826(BDt/y) of mix of saw dust and bark from forest operations. The mechanical processing of this biomass residue will contemplate a total of fossil fuel consumption of 472,000 (l/y) equivalent to 396.5 (ton/y), in this case Diesel, thus generating the following emissions:

Data:

(1) Diesel consumption for processing biomass from forest oper.	$FC_{Diesel,y}$	396.5 (t/y)
(2) Diesel net calorific value.	$NCV_{Diesel,y}$	43.3 (TJ/000t)

(3) Diesel CO_2 emission factor.	$EF_{Diesel,y}$	0.0748 (tCO_2/GJ)

According to this, the total GHG emissions from this source are:

Calculations:

(4) Total emissions.	**(1) * (2) * (3)**	**1,284 (tCO_2/y)**

$PE_{FF,y}$: Emissions due to fossil fuel consumption at the project site	
Emissions from fossil fuel consumption in the power boiler.	416 (tCO_2/y)
Emissions from fossil fuel consumption due to on-site transportation of biomass.	722 (tCO_2/y)
Emissions from fossil fuel consumption due to processing forestry biomass.	1,284(tCO_2/y)
Total emissions $PE_{FF,y}$	**2,422(tCO_2/y)**

The Project Participant would like to note that the latest approval version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" is used in this PDD for emission calculations.

Determination of $PE_{GR1,y}$: Emissions due to electricity imports from the grid to the project site.

According to equations 34 of the ACM0006 (Version 14.0), the following calculation can be done to calculate project emissions:

Data:

1) Project electricity imports from the grid.	$EL_{PJ,imp,y}$	70,501 (MWh/y)
2) Grid emission factor.	$EF_{EG,GR,y}$	0.5099(tCO_2/MWh)

According to this, the total GHG emissions from this source are:

Calculations:

3) Total emissions	**(1) * (2)**	**35,951 (tCO_2/y)**

Determination of $PE_{GR2,y}$: Emissions due to a reduction in electricity generation at the project site as compared to the baseline scenario.

Not applicable in this case.

Determination of $PE_{TR,y}$: Emissions due to transport of the biomass residues to the project plant.

The project activity includes the following categories of biomass residues:

- Third party biomass residues from industrial operations
- Third party biomass residues from forestry operations

Both biomass residues categories previously described are transported by heavy trucks to the power plant and therefore, contemplated as project emissions due to transportation.

According to Option B of the tool “Project and leakage emissions from transportation of freight” the emissions related to this source can be calculated as follows:

Data:

1) Total mass of freight transported in freight transportation activity f.	$FR_{f,m}$	523,595 (t/y)
2) Return trip road distance between the origin and destination of freight transportation activity f.[(b)]	$D_{f,m}$	67.4 (Km)
3) Weight average calculation.[(c)]	$\sum[D_{f,m} * FR_{f,m}]$	35,282,466 (t.km)
4) Default CO_2 emission factor for freight transportation activity f.	$EF_{CO2,f}$	129 (gCO_2/t-km)

Calculations:

(14) Total emissions.	**$[(5) * (6)]/10^6$**	**4,551 tCO_2/y**

Determination of $PE_{BR,y}$: Emissions from the combustion of biomass residues.

According to equation 36 of the ACM0006 (Version 14.0), the Project Participant should consider the total quantity of biomass residues of categories consumed in the project activity as source of methane emissions. As a result, the project emissions related to this source can be calculated as follows:

Data:

1) Sludge from on-site industrial operations, heat generation.	$BR_{PJ,1,y}$	14,569 (BDt/y)
2) Mix of sawdust and bark from on-site industrial operations, heat generation.	$BR_{PJ,2,y}$	96,217 (BDt/y)
3) Mix of sawdust and bark from on-site industrial operations, electricity generation.	$BR_{PJ,3,y}$	4,332 (BDt/y)
4) Mix of sawdust and bark from off-site industrial operations, electricity generation.	$BR_{PJ,4,y}$	109,322 (BDt/y)
5) Mix of sawdust and bark from forest operations, electricity generation.	$BR_{PJ,5,y}$	106,400 (BDt/y)
6) Net calorific value of sludge from on-site industrial operations.	$NCV_{BR,1,y}$	22.7 (GJ/ton)
7) Net calorific value of mix of sawdust and bark from on-site industrial operations.	$NCV_{BR,2,y}$	18.55 (GJ/ton)
8) Net calorific value of mix of sawdust and bark from on-site industrial operations.	$NCV_{BR,3,y}$	18.55 (GJ/ton)
9) Net calorific value of mix of sawdust and bark from off-site industrial operations.	$NCV_{BR,4,y}$	18.55 (GJ/ton)
10) Net calorific value of mix of sawdust and bark from forest operations.	$NCV_{BR,5,y}$	17.32 (GJ/ton)
11) Adjusted CH_4 emission factor for controlled burning, mix of sawdust and bark from forest operations.[(b)]	$EF_{CH4,BR}$	30 (kg CH_4/TJ)
12) Conservativeness factor [(a)]		1.37 (number)
13) CH_4 Global Warming Potential	GWP	25(tCO_{2e}/tCH_4)

The Project Participant would like to note the following:

(a) Conservativeness factors from Table 5 of the ACM0006 (Version 14.0).
(b) The Project Participant decided to use IPCC default value from Table 4: Default CH4 emission factor for combustion of biomass residues of this methodology.

Calculations:

(14) Emissions (2012)	[(1)*(6)+(2)*(7)+(3)*(8)+(4)*(9)+(5)*(10)]*(11)*(12)*(13)	6,233 (tCO_2eq/y)

Determination of $PE_{ww,y}$: Emissions from wastewater generated from the treatment of biomass residues
Not applicable in this case.

Determination of $PE_{BG2,y}$: Emissions from the production of biogas
Not applicable in this case.

Total project emissions

Project emission sources	Parameter	Value
Emissions due to fossil fuel consumption at the project site.	$PE_{FF,y}$	2,422 (tCO_2eq/y)
Emissions due to grid electricity imports to the project site.	$PE_{GR1,y}$	35,951 (tCO_2eq/y)
Emissions due to reduction in electricity generation at the project site as compared to the baseline.	$PE_{GR2,y}$	0.0 (tCO_2eq/y)
Emissions due to transport of the biomass residues to the project plant.	$PE_{TR,y}$	4,551 (tCO_2/y)
Emissions from the combustion of biomass residues.	$PE_{BR,y}$	6,233 (tCO_2eq/y)
Emissions from wastewater generated from the treatment of biomass residues.	$PE_{ww,y}$	0.0(tCO_2eq/y)
Emissions from the production of biogas.	PE_{BG2}	0.0(tCO_2eq/y)
Total emissions.		**49,158 (tCO_2eq/y)**

Leakage emissions

As it was previously stated in the PDD, the proposed project activity does not consider biomass residues for which leakage is potential. As a result, and according to equation 9 of the tool "Project and leakage emissions from biomass (Version 04.0) leakage emissions are assumed to be zero for the proposed project activity.

$$LE_{BR,y} = EF_{CO2,LE} * \sum_n BR_{PJ,n,y} * NCV_{n,y}$$

Where:

$LE_{BR,y}$ = Leakage emissions in year y (tCO_2).

$EF_{CO_2,LE}$ = CO_2 emission factor of the most carbon intensive fossil fuel in the country (tCO_2/GJ).

$BR_{PJ,n,y}$ = Quantity of biomass residues of category n used in the project site and included in the project boundary in year y (tonnes on dry-basis).

$NCV_{n,y}$ = Net calorific value of biomass residue of category n in year y (GJ/ton on dry matter).

n = Categories of biomass residues for which B4 has been identified as the alternative scenario.

For biomass residues categories for which scenarios B1, B2, or B3 is deemed a plausible baseline scenario, project participant should demonstrate that the quantity of available biomass residues of this type in the region is at least 25% larger than the quantity of biomass residues of this type that are utilized.

The biomass types for the Trupan project activity are presented below:

1. **Biomass from industrial operations**, consisting in biomass residues (a mix of sawdust and bark) generated mainly in sawmills. Currently, a fraction of this biomass is normally used to generate heat for wood-drying in sawmills. The remaining biomass is sold to other facilities for other industrial uses. However a considerable surplus still remains, which is not used for energy purposes and is left in piles to natural decay.

<u>Biomass from industrial operations</u>

<u>Biomass from forestry operations</u>

It must be mentioned that all the biomass residues considered for the Trupan project activity consist basically in a mix of sawdust (wood) and bark. The main difference between the biomass types identified for the project activity is related to the place where the residues are generated. Also, since all the biomass residues come from managed forest plantations, all the biomass used as fuel comes from renewable sources.

Uses for biomass residues (sawdust and bark) from industrial operations:

1. Fuel for heat generation at sawmills for drying the sawn timber. Small demand compared to the supply generates a considerable surplus that is available to third parties.
2. Electric power generation in some power plants (few cases and small plants). Most have exclusivity biomass supply contracts with nearby sawmills.

Uses for biomass from forestry operations:

1. Fuel for home warming; however the demand for this biomass is almost negligible compared to the supply. In both cases above, the supply is higher (and in some cases, considerably higher) than the demand. This generates a surplus of biomass residues that is left on the ground or piled for natural decay.

Leakage due to the proposed project activity might occur in two ways:

1. In sawmills and other biomass producing mills that use the biomass as fuel; if they sell all their biomass to the new biomass power producer and change to fossil fuel instead;
2. In local factories that normally buy and use biomass as fuel and now are forced to switch to fossil fuels given that the new biomass power plant has depleted the biomass resource in the area.

The possibility of leakage in biomass producing facilities that use part of the residues as fuel and sell the surplus to third parties is highly unlikely. Given the nature of the biomass suppliers (mostly small and local sawmills) and the cost of fossil fuels[28], these suppliers will use their biomass to serve their own energy needs in the very first place. Only then, they will sell the surplus biomass to nearby factories and power plants.

Biomass fuels are much cheaper than any other fossil fuel source available; therefore it is highly unlikely that biomass suppliers would be willing to switch to a much expensive fuel source than biomass. Currently, what happens is that the biomass suppliers generate such an excess amount of biomass, that they do not have another alternative rather than to accumulate it in piles or sell it to a nearby factory or power plant (if there exist).

The possibility of leakage in local power plants and factories may occur in the event there is an insufficient supply of biomass residues (mix of sawdust and bark) from industrial operations. Today this is clearly not the case since all plants that use biomass in the VIII Region operate without

[28] By the time this PDD was written, the oil price was around US$ 87 per barrel.

restriction. In this case, the project participant has performed a detailed research of the biomass supply/demand situation of the project activity, which is shown in the following table:

According to the tables presented in leakage section of this PDD, the supply/demand indexes for each of the biomass types consumed by the project activity are higher than the 1.25 threshold established by the criteria of the ACM0006 (Version 14.0). This clearly indicates that the proposed project activity counts with enough biomass locally, and therefore, is not causing other biomass plants in the area to switch to fossil fuels.

In addition to the above, it must be noted that Arauco owns a significant portion of the managed forestlands in VII, VIII and IX Regions. This makes Arauco an important supplier of bark and sawdust in the area (i.e. Arauco sawmills) and the main potential supplier of biomass from forest operations for the Trupan biomass power plant. This certainly contributes to guarantee the biomass availability to the power plant, without compromising the current biomass supply to other consumers in the area.

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

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
Year 2017	120,394	32,772	0	87,622
Year 2018	180,592	49,158	0	131,433
Year 2019	180,592	49,158	0	131,433
Year 2020	180,592	49,158	0	131,433
Year 2021	180,592	49,158	0	131,433
Year 2022	180,592	49,158	0	131,433
Year 2023	180,592	49,158	0	131,433
Year 2024	60,197	16,386	0	43,811
Total	1,264,141	344,107	0	920,034
Total number of crediting years	7 years			
Annual average over the crediting period	180,592	49,158	0	131,433

B.7 Monitoring plan

B.7.1 Data and parameters to be monitored

Data/Parameter table 20

Data / Parameter	Biomass categories and quantities used in the CDM project activity.
Unit	Type: sludge, mix of sawdust and bark from industrial and forest operations. Source: produced on-site, obtained from an identified biomass residues producer, obtained from a biomass residues market, etc. Fate (in the absence of the project activity): scenarios B. Quantity: 348,348 Tonnes on dry-basis.
Description	The applied values of biomass residues amounts presented in the table below were obtained from ex-post measurements performed in previous monitored periods. All biomass categories presented in this table as well as new (possible) categories that eventually might be incorporated later on will be continuously monitored in the project plant, according to the monitoring plan.
Source of data	On-site measurements.
Value(s) applied	(see table below)

Biomass residues category n	Biomass residues type	Biomass residues source	Biomass residues fate in the absence of the Project activity	Biomass residues use in project scenario	Biomass residues Quantity (BDt[29]/y.)
1	Sludge from industrial operations.	On-site production.	The biomass residues are used for heat generation at the project site in new and/or existing plants. (B5)	Biomass attributable to heat generation.	14,569
2	Mix of sawdust and bark from industrial operations.	On-site production.	The biomass residues are used for heat generation at the project site in new and/or existing plants. (B5)	Biomass attributable to heat generation.	96,217
3	Mix of sawdust and bark from industrial operations.	On-site production.	Dumped or left to decay under clearly aerobic conditions (B1),	Biomass attributable to power generation.	4,332
4	Mix of sawdust and bark from industrial operations.	Off-site production	Dumped or left to decay under clearly aerobic conditions (B1),	Biomass attributable to power generation.	109,322
5	Mix sawdust and bark from forest operations.	Off-site production.	Dumped or left to decay under clearly aerobic conditions (B1),	Biomass attributable to power generation.	106,400

[29] BDt stands for "Bone-dry ton" and means 100% dry biomass or tonnes on dry-basis.

Measurement methods and procedures	Biomass residues category n	Biomass residues type.	Biomass residues measurement system description
	1	Sludge from on-site industrial operations.	This variable will be monitored continuously using a dedicated weight meter(s) installed at the conveyor belt. The accuracy class of these type of flow meters are: (+/- 0.6 kg) The weight meter will receive periodic maintenance according to manufacturer's specifications. The sludge measurement will be done continuously, online and fully integrated with the Distributed Control System (DCS) of the pulp mill. Data of dry solids of sludge consumption are aggregated and reported monthly in the emission reductions calculation sheet. This parameter will be monitored continuously. At the time of the revalidation process the measurement method proposed to comply with monitoring requirements has not been installed yet. It is foreseen that after techno economic valuation the project participant will take a decision. The Project Participant would like to state that as a conservative approach, no sludge from on-site industrial operations will be claimed as attributable to the project activity until the weight meter is installed and properly measuring. Responsible to undertake the measurement: The Power Boiler Department will be responsible to undertake continuously measurement.
	2	Mix of sawdust and bark from on-site industrial operations.	The biomass residues amount will be measured using the weighbridge system and proper weight meters. – Biomass residues will be transported by trucks and measured by the weighbridge system. – Mix of sawdust and bark will be transported by trucks and measured by a proper and calibrated weighbridge system. – Biomass residues (sander dust from pine only) will be transported directly to the power boiler using a closed pipeline because of safety reasons, and will be measured by a proper and calibrated weight meter at the entrance at the entrance of the power boiler. Each of the weight meters described above has an accuracy class, according to manufacturing: Sander dust conveyor belt weight meter: +/- 1% Dust from pine only: +/- 1% The meters will receive periodic maintenance, in accordance with the specifications of the manufacturer and best practices of the Sawmill and Panel board industries. This parameter will be monitored continuously. Responsible to undertake the measurement: The Power Boiler Department will be responsible to undertake continuously measurement.
	3	Mix of sawdust and bark from	The mix of sawdust and bark corresponding to categories 2 and 3 are the same type of biomass originated from on-site industrial operations, and due to the same origin, they will be jointly monitored. The biomass corresponding to

		on-site industrial operations.	category 3 will be given by the total measurement of biomass residues (category 2 and category 3) minus the amount of biomass residues of category 2 which will be calculated from the heat demanded by the facility processes using equation 14 of the ACM0006 (Version 14.0). <u>Responsible to undertake the measurement:</u> The Power Boiler Department will be responsible to undertake continuously measurement.
	4	Mix of sawdust and bark from off-site industrial operations.	<u>Mix of sawdust and bark from industrial operations</u> The flow of the mix of sawdust and bark from off-site industrial sites transported by trucks towards the plant will be measured at the entrance of the plant by the weighbridge system of accuracy +/- 30 kg. This parameter will be monitored continuously. <u>Responsible to undertake the measurement:</u> The Power Boiler Department will be responsible to undertake continuously measurement.
	5	Mix of sawdust and bark from forest operations.	The mix of sawdust and bark from off-site transported by trucks to the plant will be measured at the entrance of the plant by the weighbridge system This parameter will be monitored continuously. <u>Responsible to undertake the measurement:</u> The Power Boiler Department will be responsible to undertake continuously measurement.
Monitoring frequency	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions.		
QA/QC procedures	Crosscheck the measurements with an energy balance based on purchased quantities and stock changes.		
Purpose of data	Baseline and project emissions calculations.		
Additional comment	Monitoring quantities of each category of biomass residue will be performed and be updated every year during the crediting period, as per required by the monitoring plan.		

Data / Parameter table 21

Data / Parameter	For biomass residues categories for which scenarios B1, B2 or B3 is deemed a plausible baseline alternative, project participants shall demonstrate that this is a realistic and credible alternative scenario**.**
Unit	Tonnes
Description	Quantity of available biomass residues type n in the region. Quantity of biomass residues of type n that are utilized (e.g. for energy generation or as feedstock) in the defined geographical region. - Availability of a surplus of biomass residues type n (which cannot be sold or utilized) at the ultimate supplier to the project and a representative sample of other suppliers in the defined geographical region.
Source of data	Surveys or statistics. In this case the Project Participant will use statistics.
Value(s) applied	According to the table informed in section **Leakage emissions** of this PDD, the supply/demand indexes for each of the biomass types consumed by the project activity are higher than the 1.25 threshold established by the criteria of the ACM0006 (Version 14.0). This clearly indicates that the proposed project activity counts with enough biomass locally, and therefore, is not causing other biomass plants in the area to switch to fossil fuels. A considerable surplus of this type of biomass residues remains unused in the region; the additional biomass consumed by the proposed project activity would most likely be left in piles for natural (aerobic) decomposition (B1) and in some particular cases, the biomass would be burned in the open-air in an uncontrolled manner (B3).
Measurement methods and procedures	--
Monitoring frequency	At the validation stage for biomass residues categories identified ex ante, and always that new biomass residues categories are included during the crediting period.
QA/QC procedures	--
Purpose of data	Baseline emission calculation.
Additional comment	--

Data / Parameter table 22

Data / Parameter	$BR_{PJ,n,y}$
Unit	Tonnes on dry basis.
Description	Quantity of biomass of category n used in the CDM project activity in year *y* (tonnes on dry-basis)
Source of data	On-site measurements.

<table>
<tr><td>Value(s) applied</td><td>
<table>
<tr><th>Biomass residues category n</th><th>Biomass residues type</th><th>Biomass residues source</th><th>Biomass residues fate in the absence of the Project activity</th><th>Biomass residues use in project scenario</th><th>Biomass residues Quantity (BDt[30]/y.)</th></tr>
<tr><td>1</td><td>Sludge from industrial operations.</td><td>Off-site production.</td><td>The biomass residues are used for heat generation at the project site in new and/or existing plants. (B5)</td><td>Biomass attributable to heat generation.</td><td>14,569</td></tr>
<tr><td>2</td><td>Mix of sawdust and bark from industrial operations.</td><td>On-site production.</td><td>The biomass residues are used for heat generation at the project site in new and/or existing plants. (B5)</td><td>Biomass attributable to heat generation.</td><td>96,217</td></tr>
<tr><td>3</td><td>Mix of sawdust and bark from industrial operations.</td><td>On-site production.</td><td>Dumped or left to decay under clearly aerobic conditions (B1),</td><td>Biomass attributable to power generation.</td><td>4,332</td></tr>
<tr><td>4</td><td>Mix of sawdust and bark from industrial operations.</td><td>Off-site production</td><td>Dumped or left to decay under clearly aerobic conditions (B1),</td><td>Biomass attributable to power generation.</td><td>109,322</td></tr>
<tr><td>5</td><td>Mix sawdust and bark from forest operations.</td><td>Off-site production.</td><td>Dumped or left to decay under clearly aerobic conditions (B1),</td><td>Biomass attributable to power generation.</td><td>106,400</td></tr>
</table>
</td></tr>
<tr><td>Measurement methods and procedures</td><td>See table describing measurement procedures under variable “Biomass residues categories and quantities used in the project activity”.</td></tr>
<tr><td>Monitoring frequency</td><td>Data monitored continuously and aggregated as appropriate, to calculate emissions reductions.</td></tr>
<tr><td>QA/QC procedures</td><td>Crosscheck the measurements with an energy balance that is based on purchased amounts and stock changes.</td></tr>
<tr><td>Purpose of data</td><td>Baseline and project emissions calculations.</td></tr>
<tr><td>Additional comment</td><td>- The biomass residues quantities used will be monitored separately for each type and source of production, as it is shown in table above.
- Monitoring of this parameter for Project emissions will be required, as in this case methane emissions from biomass combustion in the Power boiler contemplated in the project boundary.</td></tr>
</table>

Data / Parameter table 23

Data / Parameter	$BR_{B1/B3,n,y}$
Unit	Tonnes on dry basis.
Description	Quantity of biomass residues of category n used in the CDM project activity in year *y* for which the baseline scenario is B1or B3 (tonnes on dry-basis)

[30] BDt stands for “Bone-dry ton” and means 100% dry biomass or tonnes on dry-basis.

Source of data	On-site measurements.
Value(s) applied	<table><tr><td>Biomass residues category n</td><td>Biomass residues type</td><td>Biomass residues source</td><td>Biomass residues fate in the absence of the Project activity</td><td>Biomass residues use in project scenario</td><td>Biomass residues Quantity (BDt[31]/y.)</td></tr><tr><td>3</td><td>Mix of sawdust and bark from industrial operations.</td><td>On-site production.</td><td>Dumped or left to decay under clearly aerobic conditions (B1)</td><td>Biomass attributable to power generation.</td><td>4,332</td></tr><tr><td>4</td><td>Mix of sawdust and bark from industrial operations.</td><td>Off-site production.</td><td>Dumped or left to decay under clearly aerobic conditions (B1)</td><td>Biomass attributable to power generation.</td><td>109,322</td></tr><tr><td>5</td><td>Mix of sawdust and bark from forestry operations.</td><td>Off-site production.</td><td>Dumped or left to decay under clearly aerobic conditions (B1)</td><td>Biomass attributable to power generation.</td><td>106,400</td></tr></table>
Measurement methods and procedures	See table describing measurement procedures under variable "Biomass residues categories and quantities used in the project activity".
Monitoring frequency	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions.
QA/QC procedures	Crosscheck the measurements with an annual energy balance that is based on purchased amounts and stock changes.
Purpose of data	Baseline and project emissions calculations.
Additional comment	--

Data / Parameter table 24

Data / Parameter	$\mathbf{BR_{B4,n,y}}$
Unit	Tonnes on dry basis.
Description	Quantity of biomass residues of category n used in the CDM project activity in year *y,* for which the baseline scenario is B4 (tonnes on dry-basis)
Source of data	On-site measurements.
Value(s) applied	0 (tonnes) It is not foreseen that these biomass residues types will be used in the project activity in the future. However, the Project Participant will include this parameter in the monitoring plan, in case the situation changes in the future.

[31] BDt stands for "Bone-dry ton" and means 100% dry biomass or tonnes on dry-basis.

Measurement methods and procedures	The Project Participant will use proper weight meters and measurement obtained will be adjusted for the moisture content in order to determine the quantity of dry biomass.
Monitoring frequency	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions.
QA/QC procedures	Crosscheck the measurements with an annual energy balance that is based on purchased amounts and stock changes.
Purpose of data	Baseline and project emissions calculations.
Additional comment	--

Data / Parameter table 25

Data / Parameter	$BR_{B5,n,y}$
Unit	Tonnes on dry basis.
Description	Quantity of biomass residues of category n used in the CDM project activity in year *y* for which the baseline scenario is B5 (tonne on dry-basis)
Source of data	On-site measurements.
Value(s) applied	(see table below)
Measurement methods and procedures	See table describing measurement procedures under variable “Biomass residues categories and quantities used in the project activity”. Biomass residues will be determined from the heat demanded by the facility processes using equation 14 of the ACM0006.
Monitoring frequency	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions.
QA/QC procedures	Crosscheck the measurements with an annual energy balance that is based on purchased amounts and stock changes.
Purpose of data	Baseline and project emissions calculations.
Additional comment	See procedure described in Step 1.4 of this PDD to determine the baseline availability.

Value(s) applied:

Biomass residues category n	Biomass residues type	Biomass residues source	Biomass residues fate in the absence of the Project activity	Biomass residues use in project scenario	Biomass residues Quantity (BDt[32]/y.)
1	Sludge from industrial operations.	On-site production.	The biomass residues are used for heat generation at the project site in new and/or existing plants. (B5)	Biomass attributable to heat generation.	14,569
2	Mix of sawdust and bark from industrial operations.	On-site production.	The biomass residues are used for heat generation at the project site in new and/or existing plants. (B5)	Biomass attributable to heat generation.	96,217

[32] BDt stands for “Bone-dry ton” and means 100% dry biomass or tonnes on dry-basis.

Data / Parameter table 29.

Data / Parameter	$EF_{CO2, LE}$
Unit	tCO_2/GJ
Description	CO_2 emission factor of the most carbon intensive fossil fuel used in the country (t CO_2/GJ).
Source of data	Identify the most carbon intensive fuel type from the national communication, other literature sources (e.g. IEA). Possibly consult with the national agency responsible for the national communication/GHG inventory. If available, use national default values for the CO_2 emission factor. Otherwise, IPCC default values may be used.
Value(s) applied	Not used, since leakage is assumed to be 0.
Measurement methods and procedures	---
Monitoring frequency	The appropriateness of the data will be reviewed annually.
QA/QC procedures	---
Purpose of data	Leakage emissions calculations.
Additional comment	Note that this parameter will be required for a period in which leakage for a biomass type i, could not be ruled out, otherwise, this will be not used.

Data / Parameter table 30

Data / Parameter	$HC_{BL,y}$
Unit	GJ.
Description	Baseline process heat generation in year y
Source of data	On-site measurements.
Value(s) applied	1,798,198 (GJ/yr). The applied value is based on measurements in previous monitoring periods.
Measurement methods and procedures	Measurement of this parameter will be performed in accordance with the procedure established hereby: This parameter will be determined as the difference of the enthalpy of the process heat (steam or hot water) supplied to process heat loads in the project activity minus the enthalpy of the feed-water, the boiler blow-down and any condensate return to the heat generator. The respective enthalpies will be determined based on the mass (or volume) flows, the temperature and, in case of superheated steam, the pressure. Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature and pressure. For superheat steam, condensates and feed water, the level of accuracy of the pressure is +/- 0.075%, of calibrated span; of temperature measurement is +/- 0.10 °C of calibrated span, and of flow meters measurement is +/- 0.025% and 0.075% depending on flow meter type. <u>Responsible to undertake the measurement:</u> The Power Boiler Department will be responsible to undertake continuously measurement.

Monitoring frequency	This parameter will be monitored continuously and aggregated monthly.
QA/QC procedures	Periodic (monthly and/or annual) consistency checks will be performed with the corresponding heat users in the Trupan Complex. Alternatively, consistency checks can be carried out through a periodic (monthly and/or annual) energy/mass balance of the cogeneration plant.
Purpose of data	Calculation of project and baseline emissions.
Additional comment	--

Data / Parameter table 31

Data / Parameter	$EL_{PJ,gross,y}$
Unit	MWh
Description	Gross quantity of electricity generated in all power plants which are located at the project site and included in the project boundary in year y (MWh)
Source of data	On-site measurements.
Value(s) applied	217,147 (MWh/yr) or 217 (GWh/yr).
Measurement methods and procedures	Electric meters that measure the voltage and the current (accuracies of ±1% and ±3%) will continuously monitor the electric power generation at the Trupan power plant. Meters will receive calibration and maintenance in accordance with operational requirement and/or according to the supplier´s recommendations. <u>Responsible to undertake the measurement:</u> The Power Boiler Department will be responsible to undertake continuously measurement.
Monitoring frequency	This parameter will be monitored continuously.
QA/QC procedures	The consistency of metered net electricity generation will be crosschecked with receipts from electricity sales (if available), the internal power consumption in the Trupan Complex and the total amount of biomass fuels consumed (e.g. check whether the electricity generation divided by the quantity of fuels fired results in a reasonable efficiency that is comparable to previous years).
Purpose of data	Calculation of baseline emissions.
Additional comment	---

Data / Parameter table 32

Data / Parameter	$EL_{PJ,imp,y}$
Unit	MWh
Description	Project electricity imports from the grid in year y (MWh).
Source of data	On-site measurements.

Value(s) applied	70,501 (MWh/yr) or 70 (GWh/yr).
Measurement methods and procedures	Electric meters that measure the voltage and the current (accuracies of ±1% and ±3%) will continuously monitor the electric power import at the Trupan power plant. Meters will receive calibration and maintenance in accordance with operational requirement and/or according to the supplier´s recommendations. <u>Responsible to undertake the measurement:</u> The Power Boiler Department will be responsible to undertake continuously measurement.
Monitoring frequency	This parameter will be monitored continuously.
QA/QC procedures	The consistency of metered net electricity generation will be crosschecked with receipts from electricity sales (if available), the internal power consumption in the Trupan Complex and the total amount of biomass fuels consumed (e.g. check whether the electricity generation divided by the quantity of fuels fired results in a reasonable efficiency that is comparable to previous years).
Purpose of data	Calculation of baseline emissions.
Additional comment	--

Data / Parameter table 33

Data / Parameter	$EL_{PJ,aux,y}$
Unit	MWh
Description	Total auxiliary electricity consumption required for the operation of the power plants at the project site in year y (MWh).
Source of data	On-site measurements.
Value(s) applied	35,632 (MWh/y)
Measurement methods and procedures	Electric meters that measure the voltage and the current (accuracies of ±1% and ±3%) will continuously monitor the auxiliary electricity consumption at the Trupan power plant. Meters will receive calibration and maintenance in accordance with operational requirement and/or according to the supplier´s recommendations. <u>Responsible to undertake the measurement:</u> The Power Boiler Department will be responsible to undertake continuously measurement.
Monitoring frequency	This parameter will be monitored continuously.
QA/QC procedures	The consistency of metered net electricity generation will be crosschecked with receipts from electricity sales (if available), the internal power consumption in the Trupan Complex and the total amount of biomass fuels consumed (e.g. check whether the electricity generation divided by the quantity of fuels fired results in a reasonable efficiency that is comparable to previous years).
Purpose of data	Calculation of baseline emissions.

Additional comment	--

Data / Parameter table 34

Data / Parameter	$NCV_{BR,n,y}$
Unit	(GJ/ton of dry matter)
Description	Net calorific value of biomass residue of category n in year y.
Source of data	On-site measurements.
Value(s) applied	<table><tr><th>Biomass residues category n</th><th>Biomass residues type</th><th>Net calorific value (GJ/tonne of dry matter)</th></tr><tr><td>1</td><td>Sludge from industrial operations.</td><td>22.70</td></tr><tr><td>2</td><td>Mix of sawdust and bark from industrial operations.</td><td>18.55</td></tr><tr><td>3</td><td>Mix of sawdust and bark from industrial operations.</td><td>18.55</td></tr><tr><td>4</td><td>Mix of sawdust and bark from industrial operations.</td><td>18.55</td></tr><tr><td>5</td><td>Mix of sawdust and bark from forest operations.</td><td>17.3</td></tr></table>
Measurement methods and procedures	Net calorific value measurements of the biomass residue type n will be performed in reputed local laboratories and according to proper international standards. Measurements of this parameter will be based on dry biomass. Responsible to undertake the measurement: The Power Boiler Department will be responsible to undertake continuously measurement.
Monitoring frequency	This parameter will be monitored every six months, taking at least three samples for each measurement.
QA/QC procedures	Check consistency of measurements by comparing the measurement results with measurements from previous years, relevant data sources (e.g. values in the literature, values used in the national GHG inventory if available) and default values by the IPCC. If measurement results differ significantly from previous measurements or other relevant data sources, conduct additional measurements. Ensure the NCV measurements are determined on the basis of dry biomass.
Purpose of data	Calculation of project and baseline emissions.
Additional comment	The types of biomass combusted in the Trupan project plant are relatively homogeneous and therefore have relatively the same net calorific value. For this reason, the value provided above is a good estimate for all types of biomass combusted in the project plant.

Monitored parameters for the tool to calculate "Project or leakage emissions from transportation of freight" (Version 01.1.0).

Data / Parameter	$FR_{f,m}$
Unit	Tonnes.
Description	Total mass of freight transported in freight transportation activity *f* in monitoring period m.
Source of data	Records by Project Participant.
Value(s) applied	523,595 t The Project participant would like to note the following: Biomass amount from off-site will be brought by (heavy) trucks to the plant, hence the PP will contemplate this amount under $FR_{f,m}$. (See Diagram on Appendix 5 of this revised PDD).
Measurement methods and procedures	Mix of sawdust and bark from off-site production sources brought by trucks to the Power Plant will be duly measured (weight) by proper and calibrated weighbridges when they enter the Plant of accuracy +/-30 kg. The (wet) freight, measured directly by plant operators. Weighbridges, scales and all the equipment required for determining this parameter will receive periodic maintenance and calibration (if required), according to proper industry standards. This parameter will be monitored continuously. Responsible to undertake the measurement: The Power Boiler Department will be responsible to undertake continuously measurement.
Monitoring frequency	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions.
QA/QC procedures	Cross-check the measurements with an annual energy balance that is based on purchased quantities and stock changes.
Purpose of data	Project emissions calculations.
Additional comment	This parameter is applicable to Option B of the "Project and leakage emissions from transportation of freight". Only biomass coming from outside the Plant and attributable to the project will be considered in this case.

Data / Parameter	$D_{f,m}$
Unit	Kilometre.
Description	Return trip distance between the origin and destination of freight transportation activity *f* in monitoring period m.
Source of data	Records by Project Participants in which are specified the total biomass residues purchased (monthly), from known locations with known distances to the plant.
Value(s) applied	Weight average distance estimated according to monitored biomass supply from previous year. 67.4 km
Measurement methods and procedures	Distance will be determined once for each freight transportation activity *f* using road map, from each supply centre of biomass to the power plant and will be recorded in the Trupan Procurement Department IT system.

	This parameter will be updated whenever the road distance changes. Responsible to undertake the measurement: The procurement department IT system will be responsible to monitor and register data as required.
Monitoring frequency	The Project Participant will update whenever the road distance changes.
QA/QC procedures	--
Purpose of data	Project emissions calculations.
Additional comment	Applicable to Option B of the tool “Project and leakage emissions from transportation of freight” to calculate the CO_2 emissions from transportation of biomass to the Power Plant.

Monitored parameters for the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” (Version 03.0)

Data / Parameter	$FC_{i,project\ site,y}$
Unit	Mass or volume per year.
Description	Quantity of fuel type i combusted in process (project site) during the year y.
Source of data	Fuel consumption records from front loaders and truck driver operators or from the corresponding transportation subcontractors.
Value(s) applied	Total 737,345 (lt/yr) of diesel consumed at the project site. This amount embraces: a) 265,345 (lt/yr) of diesel used for on-site transportation of the biomass combusted in the Trupan power plant. b) 472,000 (lt/yr) of diesel used for processing biomass for forest operations.
Measurement methods and procedures	Total fossil fuel amounts used on-site will be scaled down by the fraction of the biomass related to the project activity with respect to the total biomass combusted in the power plant. This parameter will be determined by monitoring contractors fuel consumption of the trucks and/or front loaders. Since trucks and front drivers are property of subcontractors, all information related to the measurement of fossil fuel consumed will be managed externally to the plant. Responsible to undertake the data from third party will be the Power Boiler Department.
Monitoring frequency	This parameter will be monitored continuously.
QA/QC procedures	Crosscheck the measurements with an annual energy balance that is based on purchased quantities and stock changes. Alternatively, perform consistency checks with vehicles specific fuel consumption rates: litres of fuel consumed per hour of operation, litres of fuel consumed per kilometre driven or other as appropriate.
Purpose of data	Calculation of project emissions.
Additional comment	This parameter does not include fossil fuels co-fired in the project plant, but any other fossil fuel consumption at the project site that is attributable to the project activity (e.g. for mechanical preparation of the biomass residues).

Data / Parameter	$FC_{i,project\ plant,y}$
Unit	Mass or volume per year (e.g ton/yr or m^3/yr).
Description	Quantity of fuel type i combusted in process (project plant) during the year y.
Source of data	On-site measurements.

Value(s) applied	For diesel the applied value of 151,321 (l/y) equivalent to 127 (ton/y), in this case diesel, is based on average consumption from previous monitoring periods. For LPG the applied value of 2,500 (l/y) equivalents to 1.375 (ton/y), in the case LPG, based on monitored consumption due to start-up operations.in previous monitoring periods For Fuel oil the applied value of 0 (l/y), in this case FO, as an alternative to diesel consumption.
Measurement methods and procedures	Use either mass or volume meters. In cases where fuel is supplied from small daily tanks, rulers can be used to determine mass or volume of the fuel consumed, with the following conditions: The ruler gauge must be part of the daily tank and calibrated at least once a year and have a book of control for recording the measurements (on a daily basis or per shift). Accessories such as transducers, sonar, and piezo electronic devices are accepted if they are properly calibrated with the ruler gauge and receiving a reasonable maintenance. In case of daily tanks with pre-heaters for heavy oil, the calibration will be made with the system at typical operational conditions. The Project Participant would like to inform the following: Annual verification of calibrations will be conducted according to the manufacture recommendations. The instrument used to measure LPG consumption is property of the supplier and not belong to the Project Participant, calibrations must be done in order to comply with the Chilean law. Measurement of this parameter will be performed in accordance with the procedure established hereby: Fossil fuel consumption in the Power Boiler: Dedicated fuel tank level meter with accuracy of +/- 0.075% will be used to monitor Diesel and/or Fuel Oil consumption. For flow meter the accuracy of the equipment will be +/- 0.1% and +/- 0.5% for diesel. Since the instrument (s) used to measure the LPG consumption is property of the LPG´s supplier, all information related to the instrument (s) will be managed externally to the plant. Responsible to undertake the data will be the Power Boiler Department.
Monitoring frequency	This parameter will be monitored continuously.

QA/QC procedures	The consistency of fuel consumption measurement should be cross-checked by an annual energy and mass balance based on purchased quantities and stock changes. Where the purchased fuel invoices can be identified specifically for the CDM project, the metered fuel consumption quantities should also be cross-checked with available purchase invoices from the financial records.
Purpose of data	Project emissions calculations
Additional comment	No additional comments.

Data / Parameter	$p_{i,y}$
Unit	Mass unit/volume unit
Description	Weighted average of density of fuel type i in year y.
Source of data	(see table below) In this case, a) is not available. The selected source is the one provided in Option c) of table above and therefore, the Project Participant will select default values from the reliable and documented National Energy Statistic (National Energy Commission, energy balance 2012) is used to calculate emissions.
Value(s) applied	The values applied are: 0.84(kg/lt) for Diesel. 0.95(kg/lt) for Fuel Oil 550 (kg/m3) for Natural Gas. 0.65(kg/lt) for LPG
Measurement methods and procedures	Any future revision of the National Energy Statistics should be taken into account.
Monitoring frequency	The appropriateness of the data will be reviewed annually.
QA/QC procedures	Not applicable since a default factor will be used in this case.
Purpose of data	Project emissions calculations.
Additional comment	---

Data source	Conditions for using the data source
a) Values provided by the fuel supplier in invoices.	This is the preferred source if the carbon fraction if the fuel is not provided.
b) Measurements by the project participants.	If a) is not available.
c) Regional or national default values.	If a) is not available. These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances).

Data / Parameter	$NCV_{i,y}$
Unit	GJ per mass or volume unit (e.g. GJ/m^3, GJ/Ton)

<table>
<tr><td>Description</td><td>Weighted average net calorific value of fuel type i in year y.</td></tr>
<tr><td>Source of data</td><td>
<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>a) Values provided by the fuel supplier in invoices.</td><td>This is the preferred source if the carbon fraction if the fuel is not provided.</td></tr>
<tr><td>b) Measurements by the project participants.</td><td>If a) is not available.</td></tr>
<tr><td>c) Regional or national default values.</td><td>If a) is not available.
These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances).</td></tr>
<tr><td>d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.</td><td>If a) is not available.</td></tr>
</table>
Since in this case, options a), b) and c) are not available (e.g. information is not available and/or measurement are not possible), the Project Proponent will use option d) and select the net calorific values from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Table 1.2. Default value at the upper limit of the uncertainty at a 95% confidence interval.</td></tr>
<tr><td>Value(s) applied</td><td>43.3 (GJ/ton) for diesel.
41.7 (GJ/ton) for fuel oil.
52.2 (GJ/ton) for LPG.</td></tr>
<tr><td>Measurement methods and procedures</td><td>Any future revision of the IPCC Guidelines should be taken into account.</td></tr>
<tr><td>Monitoring frequency</td><td>The appropriateness of the data will be reviewed annually.</td></tr>
<tr><td>QA/QC procedures</td><td>Not applicable since a default factor will be used in this case.</td></tr>
<tr><td>Purpose of data</td><td>Project emissions calculations.</td></tr>
<tr><td>Additional comment</td><td>The monitoring of this variable applies, since according to the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”, this PDD is using option B to determine the CO_2 emission coefficient of fuel type i.</td></tr>
</table>

Data / Parameter	$EF_{CO2,i,y}$

Unit	tCO_2/GJ
Description	Weighted average CO_2 emission factor of fuel type i in year y.
Source of data	<table><tr><td>Data source</td><td>Conditions for using the data source</td></tr><tr><td>a) Values provided by the fuel supplier in invoices.</td><td>This is the preferred source.</td></tr><tr><td>b) Measurements by the project participants.</td><td>If a) is not available.</td></tr><tr><td>c) Regional or national default values.</td><td>If a) is not available. These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances).</td></tr><tr><td>d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.</td><td>If a) is not available.</td></tr></table>Since in this case, options a), b) and c) are not available (e.g. information is not available and/or measurements are not possible), the Project Proponent will use option d) and select the emission factors from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Table 1.4. Default value at the upper limit of the uncertainty at a 95% confidence interval.
Value(s) applied	0.0748 (tCO_2/GJ) for Diesel. 0.0788 (tCO_2/GJ) for Fuel Oil. 0.0656 (tCO_2/GJ) for LPG.
Measurement methods and procedures	In case of other data sources, such as IPCC the appropriateness of the data will be reviewed annually. This is the option selected by the Project participant. Any future revision of the IPCC guidelines will be taken into account.
Monitoring frequency	Annually.
QA/QC procedures	Not applicable since a default factor will be used in this case.
Purpose of data	Project emission calculations.
Additional comment	---

<u>Monitored parameters for the Tool16: “Project and leakage emissions from biomass (Version 04.0)”</u>

Data / Parameter	**Moisture content of the biomass residues**
Unit	% Water content in mass basis in wet biomass residues type n.

Description	Moisture content of each biomass residue type n.
Source of data	On-site measurements.
Value(s) applied	see table below
Measurement methods and procedures	Moisture content of each type of biomass will be monitored and registered periodically, by taking biomass samples from the corresponding sources. The moisture content (wet basis) of each type of biomass will be calculated by dividing the water amount contained in the wet biomass sample by its weight. The water content of the biomass sample will be determined by subtracting the dry weight of the dried biomass sample to the weight of the wet biomass sample. The dry weight of the biomass sample will be determined by evaporating 100% of the water of the wet sample in a dedicated oven (accuracy ±3°C, 1 year of calibration frequency) and then weighing the dried sample in a scale (accuracy class II, 2 years of calibration frequency). Ovens, scales and all the equipment required to determine this parameter will receive periodic maintenance and calibration according to proper industry standards.
Monitoring frequency	This parameter will be monitored batch by mean of moisture content measurement of biomass residues from industrial and forest operations. Mean values will be calculated at least annually. The plant will be responsible to undertake the measurements.
QA/QC procedures	Repeated moisture content measurements for the same biomass types will ensure the quality and consistency of the monitored variable.
Purpose of data	Calculation of project and baseline emissions.
Additional comment	---

Value(s) applied:

Biomass residues category n	Biomass residues type	Moisture content (% of water in wet biomass residues)
1	Sludge from on-site industrial operations.	(60-85) %
2	Mix of sawdust and bark from on-site industrial operations.	(42-65)%
3	Mix of sawdust and bark from on-site industrial operations.	(42-65)%
4	Mix of sawdust and bark from off-site industrial operations.	(44-65)%
5	Mix of sawdust and bark from forest operations.	(52-65)%

B.7.2 Sampling plan

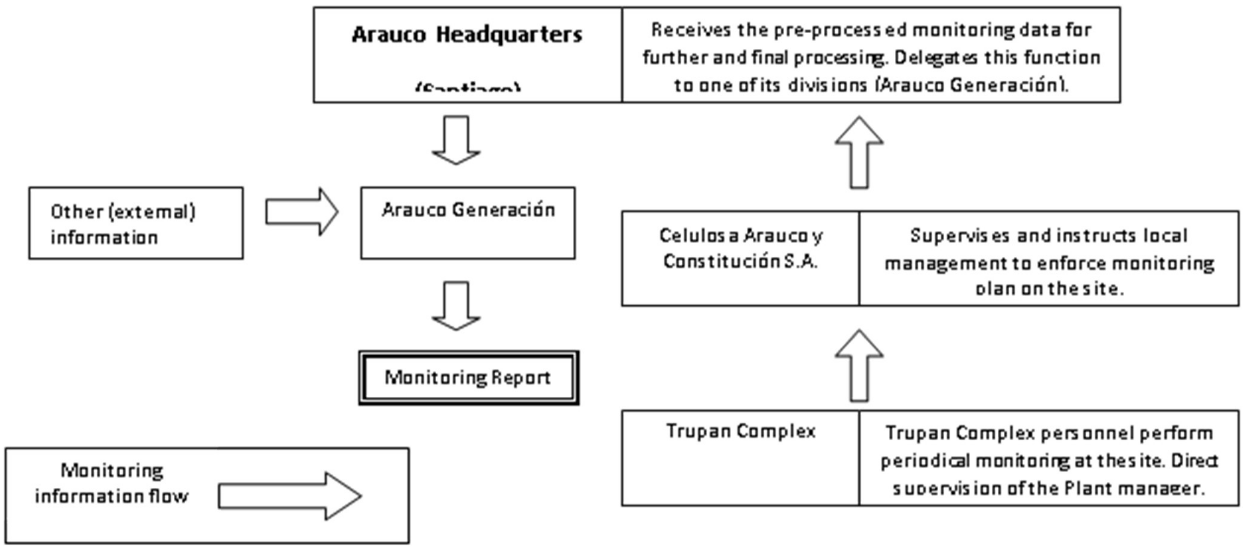
Not applicable in the case of this project activity

B.7.3 Other elements of monitoring plan

The Project Participant will implement monitoring procedures according to the monitoring methodology chosen for this project activity. This monitoring methodology will account for emission reductions and leakage effects (in case it corresponds) in an accurate and conservative manner. According to the monitoring methodology ACM0006 (Version 14.0) all data collected as part of

monitoring will be archived electronically and kept at least for 2 years after the end of the last crediting period.

The monitoring methodology will be supported by a dedicated management information system designed exclusively to guarantee the quality of the information related to the proposed project activity. The system will use the same principles of the ISO 9001 version 2000 standard and will be incorporated to the plant's management information system. In order to ensure the quality and integrity of the management system, Arauco Bioenergia S.A. personnel will perform periodic internal audits.



The Project Participant counts with on-site personnel (at the project activity site), who will be in charge of gathering and registering all the required information described in the monitoring plan. Such duties will be incorporated to the personnel's everyday activities to ensure continuity and high-quality standards. The information will be partially processed and stored there, and will be sent periodically (monthly) to Arauco Bioenergia S.A. in Santiago for further and final processing (table formats, reports, etc.). With the information at this level, Arauco will be in condition to certify the emission reduction of the Trupan project activity periodically (i.e. once every year).

Finally, since the Trupan Complex is a modern facility and counts with very high quality, security and environmental standards, there are plenty of safety measures and security procedures implemented in the facility in case of emergencies or accidental events that might lead to unintended emissions. Particularly, for events related to accidental fires, the mill counts with on-line fire sensors that continuously monitor the entire production cycle and has a fire brigade especially trained to fight any fire contingency in the site.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

04/04/2001

C.2. Expected operational lifetime of project activity

Minimum 25 years, considered from the date the project started operating.

C.3. Crediting period of project activity

C.3.1. Type of crediting period

Renewable. This is the third crediting period.

C.3.2. Start date of crediting period

01/05/2017.

C.3.3. Duration of crediting period

Seven (7) years.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

The Environmental Impact Assessment procedure in Chile establishes two different options to develop that assessment: Environmental Impact Study or Declaration, depending on the importance of the impact to the environment.

According to the low impacts to the environment of the project, in the case of Trupan the requirement was for an Environmental Impact Declaration (EID), which is the document that describes an activity or project intended to be carried out or of the modifications to be performed, issued under oath by the developer, and whose content enables the competent body to evaluate whether its environmental impact meets environmental regulations in force. The EID is presented in the form of an affidavit, stating that the project activity fully meets environmental legislation in force.

The impacts of the project that were identified in the EID are the following:

- Solid and Liquid Wastes: The operation of the Plant will generate sewage water that will be treated in a Sewage treatment Plant in accordance with the Chilean regulations. The Project will consume all the biomass that will be generated by the Plant. Very low amounts of residues, like ashes, plastics and other industrial waste will be sent to a landfill, also according with the Chilean regulations.
- Atmospheric emissions: The emissions are related to noise and particulate material. Both of them are treated with state of art technology that put them below the emission limit factor required by the Chilean regulations.

All those impacts were mentioned and resolved during the environmental impact assessment procedure.

D.2. Environmental impact assessment

Although no significant environmental impacts were identified by the project, according to national regulations, in October 30, 2000 Trupan S.A. submitted to the regional environmental authorities (COREMA VII Region) an EID regarding the Trupan Power Plant and Line Nº 2 construction.

On March 19, 2001 the project was approved by the COREMA VII Region, through the Resolution Nº087/2001, in which among other things states that "…the project complies with all the environmental requirements and with the environmental regulations including the sectorial permits applicable to the Project…"

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

As previously stated, the Trupan Power Plant project submitted an EID to the Regional Environmental authorities (COREMA).

As a publicity measure to maintain the community duly informed, the National or Regional Environmental Commission, as corresponds, shall publish every month on the first working day, in the Official Gazette and in a national or regional journal, as applicable, a list of the projects or activities subject to an EID that were submitted during the previous month. Additionally, the relevant Commission shall deliver a copy of the list to the municipalities of the places where the works or activities envisaged in the project under evaluation are to be carried out.

The correspondent EID from the Trupan projects was presented and published according to the law. No comments from the community were received, except technical comments from the authorities (those authorities include all public services related to the environment) that were resolved in due time, allowing the official approval of the project.

E.2. Summary of comments received

No comments were received with respect to the project.

E.3. Consideration of comments received

No comments were received with respect to the project.

SECTION F. Approval and authorization

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Appendix 1. Contact information of project participants.

Organization name	CELULOSA ARAUCO Y CONSTITUCIÓN S.A.
Country	Chile
Address	El Golf 150, floor 14.
Telephone	56-2-4623888
Fax	56-2-4623857
E-mail	Christian.rodriguez@arauco.ccom
Website	www.arauco.com
Contact person	Christian Rodríguez

Appendix 2. Affirmation regarding public funding

Public Funding:

The financial plans for the Project do not involve public funding.

Appendix 3. Applicability of methodology and standardized baseline

Not applicable in this case.

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

BASELINE INFORMATION

CEN GRID DATA FOR COMBINED MARGIN CALCULATION

BUILD MARGIN CALCULATION, EX - ANTE FOR THE SECOND AND THIRD CREDITING PERIODS

OPERATIONAL MARGIN CALCULATION, EX - ANTE FOR THE THIRD CREDITING PERIOD.

(The Project Proponent uses the Ex-ante option to calculate the OM; that is, the OM will be calculated once at the validation stage. As a result, no monitoring and recalculation of the emissions factor during the crediting period is required.)

(ACCORDING TO THE "TOOL TO CALCULATE THE EMISSION FACTOR FOR AN ELECTRICITY SYSTEM" VERSION 07.0)

BUILD MARGIN CALCULATION, EX - ANTE FOR THE SECOND AND THIRD CREDITING PERIODS

(ACCORDING TO THE ACM0002 (VERSION 10))

Calculation excludes CDM plants (if any), plants that have been moved and retired plants at the calculation date.

	POWER OUTPUT (MW)	PLANT TYPE	FUEL TYPE	START OPERATION	CDM PROYECT	TOTAL GEN IN 2009 (GWh)	(tCO_2/GWh)
Totoral (eólica)	46.00	Wind	Wind	2009	No	4.01	0.00
Monte Redondo	74.00	Wind	Wind	2009	No	6.07	0.00
Quintero GNL	N.A.	Open cycle	Natural Gas	2009	No	15.08	721.10
Canela 2	60.00	Wind	Wind	2009	No	19.40	0.00
Quintero	240.00	Open cycle	Natural Gas	2009	No	7.05	721.10
Tapihue	N.A.	Diesel engines	Natural Gas	2009	No	0.78	600.20
Termopacífico	96.00	Diesel engines	Diesel	2009	No	5.24	744.97
Nueva Ventanas	240.00	Coal / Steam	Coal	2009	No	111.17	1018.86
Truful Truful	N.A.	Run of the river	Hydro	2009	No	0.00	0.00
San Lorenzo de D. De Almagro	60.00	Diesel engines	Diesel	2009	No	0.63	1115.80
San Isidro GNL	350.00	Combined cycle	Natural Gas	2009	No	673.44	634.44
Louisiana Pacific	2.90	Diesel engines	Diesel	2009	No	0.00	732.39
El Peñón	80.00	Diesel engines	Diesel	2009	No	11.41	718.48
Pehui	1.00	Run of the river	Hydro	2009	No	3.63	0.00
San Gregorio + Linares Norte	0.80	Diesel engines	Diesel	2009	No	0.23	695.30
Newen Diesel	15.00	Open cycle	Diesel	2009	No	0.00	960.18
Newen Propano	15.00	Open cycle	Propane Gas	2009	No	0.75	1361.81
Newen Gas Natural	15.00	Open cycle	Natural Gas	2009	No	0.92	699.89
Newen Mezcla Butano/Propano	15.00	Open cycle	Butane/Propane	2009	No	0.00	1390.18
Watts	2.64	Diesel engines	Diesel	2009	Yes	0.00	732.39
Multiexport I	1.60	Diesel engines	Diesel	2009	No	0.00	732.39
Multiexport II	1.60	Diesel engines	Diesel	2009	No	0.00	732.39
Tierra Amarilla	142.00	Diesel engines	Diesel	2009	No	23.54	791.32
Teno	50.00	Diesel engines	Diesel	2009	No	2.07	718.48
Newen Butano	15.00	Open cycle	Butane Gas	2009	No	2.71	1418.56
Lebu (Cristoro)	2.76	Wind	Wind	2009	No	3.09	0.00
Guacolda 3	135.00	Coal / Steam	Coal	2009	No	650.97	950.93
Biomar	2.40	Diesel engines	Diesel	2009	No	0.00	734.70
Eagon	2.40	Diesel engines	Diesel	2009	No	0.00	732.72
Salmofood I	1.60	Diesel engines	Diesel	2009	No	0.00	761.52
Salmofood II	1.60	Diesel engines	Diesel	2009	No	0.02	728.41
Campanario Diesel 2	56.00	Open cycle	Diesel	2009	No	32.58	817.81
Campanario Diesel 3	56.00	Open cycle	Diesel	2009	No	66.71	811.19
Chuyaca 2	17.50	Diesel engines	Diesel	2009	No	0.08	695.30
Trapén	90.00	Diesel engines	Diesel	2009	No	47.71	718.48
Los Espinos	96.00	Diesel engines	Diesel	2009	No	28.51	731.72
EL Manzano	4.70	Run of the river	Hydro	2009	No	26.69	0.00
Santa Lidia	136.00	Open cycle	Diesel	2008	No	9.50	857.54
Chuyaca	2.50	Diesel engines	Diesel	2008	No	2.43	611.87
Cenizas	16.50	Diesel engines	Diesel	2008	No	44.99	761.52
Lircay	19.04	Run of the river	Hydro	2008	Yes	0.00	0.00
Los pinos	92.10	Open cycle	Diesel	2008	No	107.03	631.34
Quellon II	10.00	Diesel engines	Diesel	2008	No	15.48	735.03
Colmito	55.00	Open cycle	Diesel	2008	No	5.18	986.67
Coya	34.80	Run of the river	Hydro	2008	No	91.40	0.00
Chiloé	9.00	Diesel engines	Diesel	2008	No	0.69	890.65
Ojos de agua	9.00	Run of the river	Hydro	2008	Yes	0.00	0.00
Puclaro	5.20	Run of the river	Hydro	2008	Yes	0.00	0.00
Totoral	3.00	Open cycle	Diesel	2008	No	2.40	756.49
Quintay	3.00	Open cycle	Diesel	2008	No	3.03	756.49
Placilla	3.00	Open cycle	Diesel	2008	No	2.94	756.49
Olivos	1.90	Open cycle	Diesel	2008	No	51.66	757.67
Skretting	2.70	Diesel engines	Diesel	2008	No	0.00	728.41
Palmucho	32.00	Run of the river	Hydro	2007	No	243.73	0.00
Hornitos	55.00	Run of the river	Hydro	2007	Yes	0.00	0.00
Canela	18.20	Wind	Wind	2007	Yes	0.00	0.00
Esperanza TG	17.90	Open cycle	Diesel	2007	No	0.01	748.15
Maule	5.70	Diesel engines	Diesel	2007	No	0.32	933.69
Chiburgo	19.50	Run of the river	Hydro	2007	No	81.69	0.00
Monte Patria	8.60	Diesel engines	Diesel	2007	No	6.41	932.70
Constitución 1	8.60	Diesel engines	Diesel	2007	No	0.77	985.34
Punitaqui	8.60	Diesel engines	Diesel	2007	No	7.82	932.70
Degan	34.20	Diesel engines	Diesel	2007	No	42.42	707.10
Esperanza 1	1.70	Diesel engines	Diesel	2007	No	1.48	1129.17
Esperanza 2	1.50	Diesel engines	Diesel	2007	No	0.87	723.12
FPC + FPC 2	11.60	Biomass / Steam	Biomass	2007	No	68.11	0.00
Horcones Diesel	24.30	Open cycle	Diesel	2007	No	1.48	1124.70
Nehuenco II Diesel	376.10	Combined cycle	Diesel	2007	No	1495.24	560.92
Quilleco	70.00	Run of the river	Hydro	2007	Yes	0.00	0.00
El Rincón	0.30	Run of the river	Hydro	2007	No	2.11	0.00
San Isidro II	370.00	Combined cycle	Natural Gas	2007	No	115.26	430.54
San Isidro II Diesel	370.00	Combined cycle	Diesel	2007	No	1406.65	647.91
Concon	2.20	Diesel engines	Diesel	2007	No	1.92	759.27
San Isidro II GNL	370.00	Combined cycle	Natural Gas	2007	No	269.61	430.54
Casablanca 1	1.30	Diesel engines	Diesel	2007	No	1.04	765.67
Casablanca 2	0.48	Diesel engines	Diesel	2007	No	0.00	920.58
Las Vegas	2.20	Diesel engines	Diesel	2007	No	1.47	910.52
Curauma	2.40	Diesel engines	Diesel	2007	No	1.65	905.88
Campanario Gas 1	56.00	Open cycle	Natural Gas	2007	No	0.00	676.83
Campanario Diesel 1	56.00	Open cycle	Diesel	2007	No	4.95	864.16
Eyzaguirre	2.10	Run of the river	Hydro	2007	No	8.15	0.00
Los Vientos TG	120.80	Open cycle	Diesel	2007	No	153.92	881.46
Los Sauces	2.40	Diesel engines	Diesel	2007	No	4.05	799.93
Nueva Aldea 3	20.00	Biomass / Steam	Biomass	2006	Yes	0.00	0.00
Nueva Aldea 2	10.00	Open cycle	Diesel	2006	No	0.00	959.52
Candelaria 1	125.30	Open cycle	Natural Gas	2005	No	21.01	701.02
Candelaria 1 Diesel	125.30	Open cycle	Diesel	2005	No	68.08	920.37
TG_Coronel	45.70	Open cycle	Natural Gas	2005	No	3.03	549.90
TG_Coronel Diesel	45.70	Open cycle	Diesel	2005	No	23.45	745.04
Candelaria 2	128.60	Open cycle	Natural Gas	2005	No	7.28	701.02
Candelaria 2 Diesel	128.60	Open cycle	Diesel	2005	No	28.79	920.37
Nueva Aldea	13.00	Biomass / Steam	Biomass	2005	Yes	0.00	0.00
Antilhue TG	50.30	Open cycle	Diesel	2005	No	111.38	1972.10
Horcones TG	24.30	Open cycle	Natural Gas	2004	No	0.01	803.75
Ralco	690.00	Reservoir	Hydro	2004	No	3123.74	0.00
Valdivia	61.00	Biomass / Steam	Biomass	2004	Yes	0.00	0.00
Nehuenco II	390.40	Combined cycle	Natural Gas	2004	No	12.50	428.87
Licantén	5.50	Biomass / Steam	Biomass	2004	No	20.25	0.00
L.Verde TG	17.00	Open cycle	Diesel	2004	No	18.83	843.02
Cholguán	13.00	Biomass / Steam	Biomass	2003	Yes	0.00	0.00
Chacabuquito	25.00	Run of the river	Hydro	2002	Yes	0.00	0.00
San Fco. Mostazal	25.70	Open cycle	Diesel	2002	No	2.16	1073.34
Nehuenco TG 9B	108.00	Open cycle	Natural Gas	2002	No	24.75	723.86
Nehuenco TG 9B Diesel	108.00	Open cycle	Diesel	2002	No	17.07	962.26
Mampil	49.00	Run of the river	Hydro	2000	No	177.02	0.00
Taltal 2	244.90	Open cycle	Natural Gas	2000	No	123.03	680.94
Taltal 2 Diesel	120.00	Open cycle	Diesel	2000	No	83.69	911.17
Taltal 1	244.90	Open cycle	Natural Gas	2000	No	116.33	680.94
Taltal 1 Diesel	120.00	Open cycle	Diesel	2000	No	118.58	911.17
Peuchén	77.00	Run of the river	Hydro	2000	No	268.71	0.00
Nehuenco	368.40	Combined cycle	Natural Gas	1999	No	109.51	440.14
Nehuenco Diesel	368.40	Combined cycle	Diesel	1999	No	924.35	544.21

TOTAL GEN. PER YEAR	**(GWh / yr)**		**41,018.9**
20% OF GEN. PER YEAR	**(GWh / yr)**		**8,203.8**
5 MOST RECENT PLANT GEN	**(GWh / yr)**		**51.6**

EMISSION FACTOR 5 PLANTS	**(tCO_2/GWh)**		**309.26**
EMISSION FACTOR 20% GEN	**(tCO_2/GWh)**		**424.40**

BUILD MARGIN	**(tCO_2/GWh)**		**424.40**

OPERATIONAL MARGIN CALCULATION, EX - ANTE FOR THE THIRD CREDITING PERIOD.

(The Project Proponent uses the Ex-ante option to calculate the OM; that is, the OM will be calculated once at the validation stage.

Selected option: Ex-ante option: considers the last 3-year data available.

		2015	2016	2017
Total emissions from non-low cost / must run power plants	(tCO_2/yr)	19,619,686	19,309,716	17,256,288
Total emissions from low-cost / must-run power plants	(tCO_2/yr)	545,449	433,095	379,865
Total net energy generated in the grid (incl. imports)	(GWh/yr)	52,987	52,432	53,382
Total net energy by non-Low cost / must run power plants	(GWh/yr)	23,405	26,146	23,869
Total net energy by low cost / must run power plants (incl. imports	(GWh/yr)	29,582	26,286	29,512
Factor λ	(number)	0.0000	0.0000	0.0000
Operating Margin	**(tCO_2/GWh)**	**838.25**	**738.52**	**722.95**

Generation weighted-average Operating Margin	**(tCO_2/GWh)**	**766.57**

COMBINED MARGIN CALCULATION

ACCORDING TO THE TOOL TO CALCULATE THE EMISSION FACTOR FOR AN ELECTRICITY SYSTEM

OM: Calculated ex ante (Option 2, the year in which the emissions occur)
BM: Calculated exante (Option 1, updated annually from the date the first emissions occur)

		2017	
Operating Margin	(tCO_2/GWh)	766.57	note 1
Build Margin	(tCO_2/GWh)	424.39	note 2
Combined Margin other credit period	(tCO_2/GWh)	**509.93**	

Note 1:The Project Proponent uses the Ex-ante option to calculate the OM; that is, the OM will be calculated once at the validation stage. As a result, no monitoring and recalculation of the emissions factor during the crediting period is required.
Note:2 For the third crediting period, the Build Margin (BM) emission factor shall be calculated ex ante, as previously described in Option 1.

Appendix 5. Further background information on monitoring plan

METHANE EMISSION FACTOR OF UNCONTROLLED BURNING OF BIOMASS RESIDUES FROM FOREST OPERATIONS.

1. Introduction

The objective of this project is to quantify the emission factors (EF) of methane (CH_4) from burning forest residues in the open air, natural, uncontrolled conditions in the south central part of Chile. Two fuel types were burned:

a) A mixture of sawdust and bark, which are residues from industrial operations (mainly sawmill industry) and are used at Arauco biomass power plants.
b) A pile of different sizes of branches, which are residues from forestry operations (mainly harvesting, pruning, and thinning).

The mixture of sawdust and bark, collected by third parties, is planned to be used by the Celulosa Arauco y Constitución S.A. (as Arauco) at two new biomass power plants: one in the Horcones Complex, close to Concepcion in the VIII Region. The same biomass residues are being used by Arauco as fuels at the Nueva Aldea, Trupan, Valdivia, and other biomass power plants. Different sizes of branches (2.5–30 cm in diameter), collected from forestry operations, may also be used as supplemental fuel for the new plants.

We conducted field experiments in south central Chile on March 18–26, 2009, a transition period from late summer to early autumn, to quantify methane and other trace gas emissions from burning the two fuel types mentioned above. We will report the weather conditions, the fuel moisture and carbon content, and the average emission factor of methane (EF CH_4) with an associated standard deviation for each fuel type burned under natural conditions. We will also discuss the application of the methane emission factors derived from the experiments to calculate the annual amount of methane emissions from burning these fuels in open air.

Our team has a 20-year experience in studying emissions of trace gases from biomass fires in various ecosystems in the United States, Canada, Mexico, the Amazon in Brazil, Chile, Zambia, South Africa, and central Siberia in Russia. Dr. Hao was the co-author of one of the Intergovernmental Panel on Climate Change (IPCC) reports in 2001 [Hao, 2001]. He was recognized by the IPCC for the contribution to the 2007 Nobel Peace Prize to IPCC.

2. Field Site and Fuel Type

The experimental site (37°18'54.22"S, 71°59'39.50"W, elevation 310 m) was located at a gravel pit near Canteras in south central Chile. The choice of locating at a gravel pit was to prevent fires spreading to adjacent forests. Eight piles of biomass fuels used at the Arauco's power generating plants were arranged in two rows with four piles on each row and approximately 10 m apart between the piles. Each pile was about 2 m high and had a volume of about 30 m^3. The fuel types include a mixture of sawdust and bark and branches in different sizes. The description of each pile is summarized in Table 1.

Table 1. Fuel Types of the Experiments

Fuel Type	Identification	Piles
Mixture of sawdust and bark	MX4, MX11, MX5, X12	4, 5, 11, 12
j) Branches in different diameters	BR6, BR13, BR7, BR14	6, 7, 13, 14

3. Meteorological Conditions

These experiments were carried out during the transition period from late summer to early autumn. The daily weather conditions at the field site on March 18–26, 2009 are summarized in Table 2. We measured wind speed, temperature, and relative humidity. The weather conditions during the nine days were fairly constant: sunny, windy, warm, and low humidity almost every day.

Table 2. Weather Conditions during the Experiments

Day	March	Condition	Wind Speed (km/hr)	Mean Temperature (°C)	Mean Relative Humidity (%)
1	18	sunny	7 (2–15)	33	24
2	19	sunny	13 (6–23)	24	35
3	20	sunny	7 (3–22)	22	45
4	21	sunny	8 (5–12)	23	31
5	22	sunny			
6	23	sunny	6 (2–12)	23	36
7	24	sunny	7 (3–20)	23	34
8	25	sunny	8 (4–15)	23	42
9	26	sunny	5 (3–8)	21	47

4. Experimental Method

4.1 Combustion Processes

For uncontrolled, open air burning of piled forest residues, a propane torch was used to ignite the piles. The use of fossil fuels, such as diesel or kerosene, for ignition was avoided to prevent contamination of smoke samples. Small tunnels were dug to facilitate air flow in some of the piles. The piles of the sawdust and bark mixture burned for several hours until the combustion process was stabilized and the sampling was initiated. The duration of each pile burned varied considerably. It took several days to burn the piles of mixed sawdust and bark. Windy conditions increased the rate of fuel consumption. Combustion of a pile of sawdust and bark mixture, dominated by prolonged smoldering combustion, is shown in Figure 1. The piles of branches were completely burned within a few hours with predominantly flaming combustion. Combustion of a branch pile is shown in Figure 2.

Figure 1: Burning sawdust and bark mixture shortly after ignition, March 19, 2009

Figure 2: Burning branch pile shortly after ignition on March 20, 2009

4.2 Sampling System

Smoke samples were collected every 2–3 hours during daytime. A background sample of clean air was collected at the start of each day, about 100 m upwind from the burning piles. The sampling system was a portable unit mounted on a metal frame that can be carried as a backpack to collect a sample. The inlet of the sampling system was connected to a sample probe (3 m long, 6 mm O.D.) with a flexible 3/8" (O.D.) stainless steel tube. Smoke samples were collected by inserting the sample probe into the smoke about one meter from the pile.

The sampling system consists of a Rasmussen KNF canister pump with 6 mm (O.D.) stainless steel tubing connected through a T-fitting to a pressure relief valve and a pressure gauge, respectively. The pressure relief valve was used to regulate the pressure of the system and set the final pressure in the canisters. The pressure gauge allowed the operator to monitor the pressure change in the canisters while filling the samples and to check that each canister was evacuated prior to sampling. The sampling system was initially purged with smoke, and then the samples were drawn into the canisters by pressuring the canisters to 25 psia. The flow rate into the canisters was 2 liters/minute and it took approximately 30 seconds to fill each canister. The canisters were 500 ml steel bottles with Nupro model SS-00121 stainless steel ball valves. At the end of each sampling, a purge valve

opened to flush out the residual sample in the sampling line. The sampling pump was powered by a 12 volt gel cell rechargeable battery.

Based on our previous laboratory tests, the storage time for the low molecular weight trace gases in canisters is longer than six months. Thus, within the time frame of 4–6 weeks between sample collection and analysis, it is reasonable to assume that the concentrations of carbon dioxide (CO_2), carbon monoxide (CO), CH_4, and non-methane hydrocarbons (NMHC) in the canisters were stable and did not change during this period.

4.3 Fuel Analysis

Samples of about 250 g for each pile were collected prior to ignition for analysis of fuel moisture content. Samples were immediately weighed in the field with a portable balance. After the samples were transported back to the Fire Sciences Laboratory, they were dried for 48 hours at a 100°C oven and weighed [Allen, 1989]. After fuel moisture analysis, a portion of each sample was milled (40 mesh) and sent to the University of Idaho Analytical Services Laboratory for analysis of the carbon content of the biomass by a CHN (carbon-hydrogen-nitrogen) analyzer.

4.4 Trace Gas Analysis

Trace gas concentrations in canisters were analyzed at the Fire Sciences Laboratory, using the methodology developed by Hao et al. [1996]. The samples were analyzed for CO_2, CO, CH_4, and C_2, C_3, and C_4 alkanes and alkenes with a Hewlett Packard model 5890 Series II gas chromatograph equipped with dual flame ionization detectors (FIDs). The CO_2 and CO analysis utilized a 1 ml sample loop to inject the sample onto a 3.2 mm I.D. x 2 m long Carbosphere (Alltech) column, with a helium carrier gas (flow rate - 16 ml/minute). After separation of CO_2 and CO in the column, the compounds were passed through a methanizer (375°C) that converted CO_2 and CO to methane, enabling detection by the FID at 350°C. The oven temperature program for this analysis was 40°C for five minutes, an increase to 140°C at 20°C/minute, and 4 minutes at 140°C. The CH_4 and C_2 –C_4 analyses were performed using a 0.25 ml sample loop, a 0.53 mm x 50 m HP-AL/S column (J&W Scientific), with helium carrier gas at a flow rate of 6 ml/min, and FID at 300°C, with a makeup helium gas flow of 14 ml/min. The oven temperature program for hydrocarbon analysis was the same as the program for CO_2 and CO analysis, as both analyses were performed simultaneously.

Chromatogram data was processed and archived by Hewlett Packard ChemStation II software. A set of CO_2, CO, CH_4, and C_2 and C_3 calibration standards at concentrations close to the samples were analyzed each day to construct a standard curve for each compound. Based on the integrated peak areas, the sample concentrations were calculated from the standard curves and written into an Excel spreadsheet. Duplicate samples were analyzed for every sixth analysis. The National Institute of Science and Technology (NIST) primary CO_2 and CO standards were analyzed periodically to verify the response of the detectors. Both the accuracy and precision are 1% for CO_2, CO, and CH_4 analyses.

The emission factor of a compound is defined as the amount (g) of the compound emitted per kg of biomass burned. The emission factor was calculated by the carbon mass balance method [Ward and Radke, 1993]. The computation was based on the emitted, above-ambient background concentrations of carbon-containing compounds and the carbon content of the biomass. In these experiments, the carbon-containing compounds of CO_2, CO, CH_4, and C_2, C_3, and C_4 gases were analysed in the sample, and C_2-C_4 gases were summed as the non-methane hydrocarbons. High molecular weight hydrocarbons were found in trace concentrations in smoke as compared to the major light carbon compounds (e.g., CO_2, CO, CH_4), and accounted for less than 0.01% of the total emitted carbon. Therefore, the omission of measuring the concentrations of high molecular weight hydrocarbons is insignificant in calculating emission factors of methane.

5. Results and Discussion

The piles were burned under weather conditions during the transition period from late summer to the beginning of autumn. We collected 51 smoke samples from burning four piles of mixed sawdust and bark, 44 smoke samples from burning four piles of branches in different sizes, and nine clean air samples during the nine-day period. The average moisture content of the mixed fuel of sawdust and bark was 45.5% with a standard deviation of 8.2% (n=4). The average moisture content of branches was extremely low (7.3%) with a standard deviation of 3.2% (n=4). The average carbon content of the mixed fuel and branches was 51.3% ± 0.5% (n=4) and 52.0±1.2% (n=4), respectively. These values are very similar to the default value of wood carbon content of 50%.

Clean air concentrations of 376–422 ppm for CO_2, 0.1–0.6 ppm for CO, and 1.6–1.8 ppm for CH_4 were comparable to the clean air concentrations measured in other parts of the world. The background concentrations were subtracted from the pile emission concentrations to obtain net emission concentrations.

The emission factor of methane of each sample from burning mixed fuel or branches is shown in Figure 3. The sample number is the order of the samples taken during the nine-day period. It is apparent that the EF CH_4 of mixed fuel (11.6–24.9 g/kg) were much higher than the EF CH_4 of branches (0.1–7.0 g/kg). The EF CH_4 in the first week were slightly higher than the ones in the second week.

The average methane emission factor for each fuel type is summarized in Table 3. The average emission factor of methane from burning mixed sawdust and bark (17.2 g/kg or 930 kg/TJ) is consistent with that for the same type of fuels burned in previous experiments in Chile. The standard deviation (±3.1 g/kg or 168 kg/TJ, n=51) is also similar with that of previous measurements carried out in Chile.

The average emission factor of methane for burning branches (2.1 g/kg or 114 kg/TJ) is about eight times lower than the EF CH_4 for burning the mixture of sawdust and bark, because burning branches were dominated by high-temperature flaming combustion.

Table 3. Experimental Results

Fuel Type	EF CH_4 (g/kg)	Standard Deviation (g/kg)	Number of Samples (n)
Mixed sawdust and bark	17.2	3.1	51
Branches	2.1	2.1	44

The EF CH_4 are equivalent to 930 ± 168 kg CH_4 /TJ for mixed sawdust and bark, and 114 ± 114 kg CH_4/TJ for branches, based on the net heat content of fuel to be 18.5 MJ/kg measured and provided by Arauco.

The values of the average methane emission factors of burning a mixture of sawdust and bark or branches in different sizes derived from these measurements are very conservative estimates, if the EF CH_4 are used to determine the amount of methane emitted annually from burning these fuels in the open field. These experiments were carried out in warm, dry, windy conditions near the end of the dry season. The moisture content of the biomass is extremely low because of the weather conditions. The weather conditions favour flaming combustion, which result in low methane emissions. When the fuels are burned
in the rainy season, the conditions favour smouldering combustion and higher methane emission factors than the values in this report.

6. Conclusion

The average emission factor of methane was 17.2 g/kg (or 930 kg CH_4/TJ), with a standard deviation of 3.1 g/kg (or 167 kg/TJ), from open, uncontrolled burning of four sawdust/bark piles in central Chile in March 2009. This value was calculated by averaging the measurements of 51 samples collected in nine days. The piles were large enough to represent the combustion process of large piles. The proposition is based on visual observation of the piles burned and the narrow range of the CH_4 emission factors of the experiments. The average methane emission factor was 2.1 g/kg (or 114 kg CH_4/TJ), with a standard deviation of ±2.1 g/kg (or 114 kg/TJ), for burning four piles of branches in different sizes.

The average methane emission factors derived from these experiments are very conservative values if they are used to calculate the annual methane emissions from burning these fuels in open air. The experiments were conducted in warm, windy, and low humidity weather conditions in nine days. The emissions of methane are expected to be lower under these conditions than the methane emissions in cool, rainy, and high humidity conditions. In addition, digging tunnels, not a common practice, to speed up the experiments also tend to favour flaming combustion and low methane emissions.

The standard deviations of the reported emission factors of methane characterize the natural variability and changes of the combustion process during the duration of the experiments. The standard deviations do NOT represent the variation of the highly reproducible sampling and analytical methods used in this project.

7. References

Allen, S., editor, (1989), *Chemical Analysis of Ecological Materials*, Blackwell Scientific Publications, London.

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Ward, D.E., and L.F. Radke, (1993), Emissions Measurements Fires: A Comparative Evaluation of Methods and Results. In: *Fire in the environment: The Ecological, Atmospheric, and Climatic Importance of Vegetation Fires*, Wiley, New

Freight transportation activities for Trupán plant

The Project Participant documents which freight transportation activities f occurred under the project activity based on previous monitoring period and to the extent of available information at the Validation stage of the first renewal crediting period. Monitoring each freight transportation activity will be performed and be updated every year during the crediting period, as per required by the monitoring plan.

Activity	Origin	Destination	Freight type	wet metric t	Road distance	Vehicle class
1	Yungay	Trupan	Biomass residues (mix of sawdust and bark)	245.858	0	Heavy class
2	Los Angeles	Trupan	Biomass residues (mix of sawdust and bark)	145.556	71,7	Heavy class
3	Cabrero	Trupan	Biomass residues (mix of sawdust and bark)	48.236	43	Heavy class
4	Quilleco	Trupan	Biomass residues (mix of sawdust and bark)	23.461	48,6	Heavy class
5	Mulchen	Trupan	Biomass residues (mix of sawdust and bark)	15.303	100,1	Heavy class
6	Tucapel	Trupan	Biomass residues (mix of sawdust and bark)	11.245	23,2	Heavy class
7	Pemuco	Trupan	Biomass residues (mix of sawdust and bark)	10.423	22	Heavy class
8	Yumbel	Trupan	Biomass residues (mix of sawdust and bark)	8.787	66,5	Heavy class
9	Laja	Trupan	Biomass residues (mix of sawdust and bark)	4.393	89,3	Heavy class
10	Quillon	Trupan	Biomass residues (mix of sawdust and bark)	3.133	77	Heavy class
11	Coronel	Trupan	Biomass residues (mix of sawdust and bark)	2.516	148,2	Heavy class
12	Chillan	Trupan	Biomass residues (mix of sawdust and bark)	1.918	67,1	Heavy class
13	Bulnes	Trupan	Biomass residues (mix of sawdust and bark)	1.698	69	Heavy class
14	Talcahuano	Trupan	Biomass residues (mix of sawdust and bark)	450	126,8	Heavy class
15	Concepcion	Trupan	Biomass residues (mix of sawdust and bark)	426	113,4	Heavy class
16	Ranquil	Trupan	Biomass residues (mix of sawdust and bark)	133	118,7	Heavy class
17	Arauco	Trupan	Biomass residues (mix of sawdust and bark)	56	186,6	Heavy class
		tCO2	PETR,m	4.551		
		km	Df,m	67,4		
		t	∑Df,m * FR,f,m	35.282.466		
		gCO2/t*km	EFCO2,f	0,000129		

Summary report of comments received from local stakeholders

No comments received.

Appendix 6. Summary of post registration changes

There is no registration changes.

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Document information

Version	*Date*	*Description*
11.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); Make editorial improvements.
10.1	28 June 2017	Revision to make editorial improvement.
10.0	7 June 2017	Revision to: • Improve consistency with the “CDM project standard for project activities” and with the PoA-DD and CPA-DD forms; Make editorial improvement.
09.0	24 May 2017	Revision to: • Ensure consistency with the “CDM project standard for project activities” (CDM-EB93-A04-STAN) (version 01.0); • Incorporate the “Project design document form for small-scale CDM project activities” (CDM-SSC-PDD-FORM); Make editorial improvement.
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the “Standard: Applicability of sectoral scopes” (CDM-EB88-A04-STAN) (version 01.0).
06.0	9 March 2015	Revisions to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; Editorial improvement.

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

Decision Class: Regulatory
Document Type: Form
Business Function: Registration
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