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	Lautaro Generation Project
Scale of the project activity	☒ Large-scale ☐ Small-scale
Version number of the PDD	11
Completion date of the PDD	24/06/2021
Project participants	COMASA S.A
Host Party	Chile
Applied methodologies and standardized baselines	*"Consolidated methodology for electricity generation from biomass residues in power-only plants*" - ACM0018, Version 4.0
Sectoral scopes	1: Energy industries (renewable-/non-renewable)
Estimated amount of annual average GHG emission reductions	55,126

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

The project activity consists in the construction of a new power only plant that will produce electricity using biomass residues as a fuel in a boiler located in Lautaro community, in Chile. It is considered a Greenfield power plant because there is no energy generation at the project site prior the implementation of the CDM project activity.

COMASA S.A, developer of the project activity intends to produce grid connected electricity by using available biomass residues that otherwise would be left to decay or burnt on fields.

Residues consumed by the project activity are: cereal straw and husks and forestry residues. All the biomass residues will be obtained from different suppliers at the country's administrative region called "La Araucanía Region" in the South of Chile, where the project is located.

The total surface of the site is 29 ha, from which 9 ha will be used by the new power plant, including constructions and zones of fuel (biomass) management.

The power plant started delivering electricity to the SIC on the 30th of August 2011. In addition, on the 15/03/2012 the company started thinking about building another facility of 21.5 MW. This facility was designed to be fed using only biomass residues from the agricultural sector and has been delivering electricity to the grid since 26/04/2014. The new power plant, called Lautaro 2 delivers electricity to grid through the same substation, but has an independent meter so they are reported as different power plants by the Chilean coordinator, with different interconnection permits. Moreover, each power plant has its own transformer, storage center and machinery, so work independently. Thus, these facilities only share the administrative office.

Biomass residues will be fed without any previous treatment into the boiler (except for mechanical treatment in some cases like some wood residues). Then the overheated steam produced in the biomass boiler will be used to generate electricity in a turbo-generator equipment and the electricity produced was initially connected to the Central Interconnected System (SIC, by its Spanish acronym) and now will be connected to the National Electric System (SEN, by its Spanish acronym).

As a background, in the SIC, electricity generation from biomass residues was a technology that had a very small participation in the power generation and represented a 1.8% of the total installed capacity of the grid and a 1.3% of the capacity installed in the whole country[1].

The purpose of the project is to produce electrical energy from biomass resources to satisfy the growing electricity demand.

---

[1] http://www.minenergia.cl/minwww/opencms/14_portal_informacion/06_Estadisticas/Energias.html

File ERNC (% of Non Conventional Renewable Energy installed capacity per electricity system).

The project activity power only plant has a gross installed capacity of 24 MW and the expected amount of gross electricity generation is 153,265 MWh from which 18,087 MWh will be used on the auxiliary equipments[2] for the operation of the power plant. Then, the CDM project expects to deliver 135,178 MWh of net electricity per year initially to the Central Interconnected System of Chile and now to the National Electric System (SEN).

The activity Project contributes to local sustainable development by:

- Using biomass residues as a fuel which is a renewable source for electricity generation.
- Diversifying energy sources helping to decrease the import of fossil fuel from other countries.
- Promoting the development and implementation of biomass energy production technologies.

Lautaro Generation project will displace electricity generated by fossil fuel fired power plants, avoiding GHG emissions estimated in 55,126 tCO_2e per year and 385,882 tCO_2e in the second crediting period.

A.2. Location of project activity

The new power only plant will be located in a site owned by COMASA S.A located in Lautaro community, near Temuco City in La Araucanía Region.

The coordinates of the project site are shown in the following table. The following figures present the project location.

Table 1 Project site coordinates

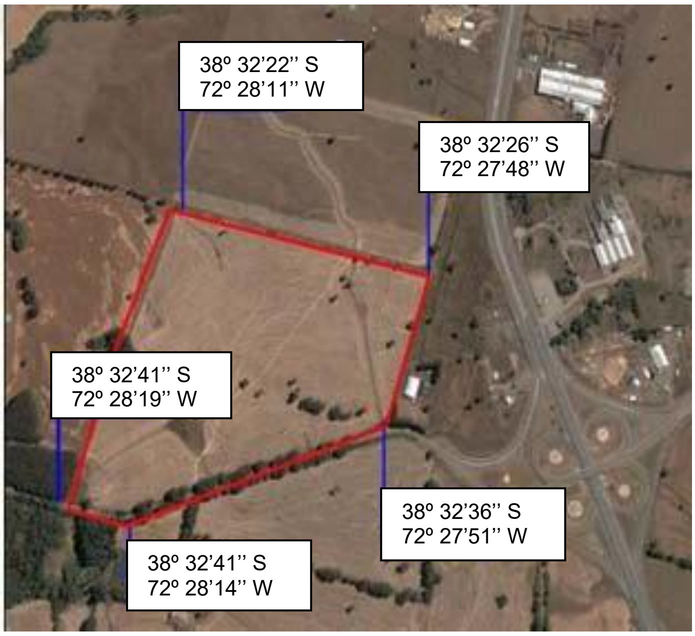
S	W
38º 32’ 22”	72º 28’ 11”
38º 32’ 26”	72º 27’ 48”
38º 32’ 36”	72º 27’ 51”
38º 32’ 41”	72º 28’ 14”
38º 32’ 41”	72º 28’ 19”

[2] Equipments Technical specifications: “Proposta Técnica nr. 220/2009 r9, page 24. Technical Data sheet of Weeg

Figure 1 La Araucanía, IX Region of Chile.

Figure 2 Project location.

Figure 3 Project Site.



A.3. Technologies/measures

The project activity involves the installation of a biomass boiler with an energy capacity of production of 90 t/h of steam at a pressure of 6,500 kPa and a steam temperature of 748.15 Kelvin degrees.

Biomass is obtained from different suppliers and it is transported from the supplier site to the project site by trucks. The biomass management inside the power plant is described as follows:
Biomass weight and/or volume measurement: The trucks that enter into the plant will pass by the scale sector where depending on the type of biomass, its content will be weighted in the scale and/or cubed (also in this place, samples are taken for the required laboratory analysis of the monitoring plan and other kind of data registration are performed).

The biomass trucks are then discharged and stock piled in different places according particular characteristics of the biomass: “Dry biomass” (biomass with less than 40% of moisture content) is stored at the storage room (closed ware house). The rest of the biomass is stockpiled on biomass patios at the project facilities. For the on-site transportation, arrangement and stock piling of biomass on the patio and inside the warehouse, the following equipments are used: Excavator, 2 Loaders and a Manitou.

Also a wood shipper could be used in order to reduce size of some bigger forestry residues (in example: wood side-cuts) to a size that can be accepted in the boiler system.

The Loader will be used according the operation leader for charging with biomass the main hopper that is used to feed the boiler with the different types of biomass (except for cereal straw).

This biomass mix is transported by conveyor belts to a sieve of discs and in the other hand, cereal straw is fed into a lateral hopper from which it is transported to be joined with the biomass already processed by the sieve of discs.

Finally, the complete mix of biomass is transported to a silo that is used to store the biomass mix that will be constantly feeding the boiler. The biomass is extracted from the silo by a screw at the floor that transports biomass into the conveyor belts that transport biomass from the silo into the boiler.

Water for the boiler operation is treated by osmosis before it enters into the boiler where it is transformed into steam. The overheated steam produced in the boiler is send into a turbine associated with a generator for electricity generation resulting in a total power capacity of 24 MW with a load plant factor of 0.729. Then the expected amount of electricity production is 153,265 MWh from which 18,087 MWh are used for power plant operations as autoconsumption and 135,178 MWh will be delivered to the SEN through Lautaro Sub Station. After the steam passes through the turbine for electricity generation it goes directly to a condenser where it comes out as liquid water. The heated water of the condenser is finally cooled in a cooling tower and subsequently used in the condenser.

Technical specifications of the main equipments are shown in the following tables[3]:

Table 2 Boiler technical specifications:

Type	**Aquatubular**
Capacity steam production	90 t/h
Pressure	6,500 kPa
Temperature	748.15 K
Supplier	Biochamm

Table 3 Generator Technical Specifications:

Type	**Synchronus Triphasic**
Model	WEG SPW 1120
speed	1500 rpm
Capacity	30,000 kvA
Tension	13.2 kv
Frequency	50 Hz
Power factor	0.8
Supplier	WEG

[3] Equipments Technical specifications: “Proposta Técnica nr. 220/2009 r9, page 24. Technical Data sheet of Weeg Generator, Technical Specifications of the Turbine page10-11 and 37, specifications from SINAX offer of the Cooling tower.

Table 4 Steam Turbine Technical Specifications:

Type	Condensing Axial Exhaust type
Model	C9-R16-ERX
Capacity	24 MW[4]
Speed	4900 rpm
Supplier	Shin Nippon

Table 5 Cooling tower specifications:

Type	Counter flow
Design Inlet temperature	306.15 K
Design Outlet temperature	298.15 K
Total Flow	4840 m3/hour
Number of cells	10
Supplier	SINAX

The lifetime of the project is at least of 30 years and depends on the procedures of maintenance and the regular inspections required for the main and auxiliary equipments of the plant[5].

Equipments are being acquired from international suppliers who are transferring its know-how to the host party.

As biomass combustion does not involve GHG emissions the project activity produces grid connected electricity to satisfy the country energy demand by using an environmentally safe and sound technology.

A.4. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Chile	COMASA S.A	No

A.5. Public funding of project activity

No public funding from Parties included in Annex 1 is involved.

[4] Even if the capacity of the steam turbine is 25 MW, the final output of the generator is 24 MW. That is why 24 MW is used as the output in the calculations.

[5] "Proterm Ambiente y Energía" and Wegg (Generator supplier) certificate that sates 30 years or more of lifetime.

A.6. History of project activity

>>

The project participants of this project confirm that:
(a) The proposed CDM project activity is neither registered as a CDM project activity nor included as a component project activity (CPA) in a registered CDM programme of activities (PoA);
(b) The proposed CDM project activity is not a project activity that has been deregistered.

On the other hand, the project participants declare:
(a) The proposed CDM project activity is not a CPA that has been excluded from a registered CDM PoA;
(b) A registered CDM project activity or a CPA under a registered CDM PoA whose crediting period has or has not expired (hereinafter referred to as former project) does not exists in the same geographical location as the proposed CDM project activity.
Lautaro Generation Project was registered on 31/01/2013 with a first crediting period from 31/01/2013 to 30/01/2020. This new PDD is edited to renew the crediting period.

A.7. Debundling

>>

Not applicable since a large scale methodology is used.

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

The methodology selected as applicable for this project activity is the "Consolidated methodology for electricity generation from biomass residues in power-only plants" - ACM0018, Version 4.0, EB 96.

This methodology also refers to:

- TOOL03: Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion v 03.0, EB96
  https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v3.pdf

- TOOL04: Emissions from solid waste disposal site v.8.0, EB94.
  https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v8.0.pdf

- TOOL05: Tool to calculate Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation v.3.0, EB96
  https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v3.0.pdf

- TOOL07: Tool to calculate the emission factor for an electricity system v.7.0, EB100.
  https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v7.0.pdf

- TOOL12: Project and leakage emissions from transportation of freight v.1.1.0, EB63.
  https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-12-v1.1.0.pdf

- TOOL11: Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period.
  http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-11-v3.0.1.pdf

- TOOL16: Project and leakage emissions from biomass v.04.0, EB96.
  https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-16-v4.pdf

B.2. Applicability of methodologies and standardized baselines

The project activity is a Greenfield power-only plant that generates electricity with residues from forestry and agriculture. The fuel fired in the project's power plant includes residues like wood chips collected from forestry management, bark, shaving, sawdust and other solid wood residues from sawmills, cereal straw and husk generated as residues from agriculture activity in the region. All this biomass residues are obtained off-site from specific suppliers.

The ACM0018 methodology is applicable to Lautaro project and detailed explanation of the applicability is listed as follows:

Id.	Applicability	Project activity vis-à-vis applicability Conditions
1	This methodology is applicable to project activities that generate electricity in biomass (co-) fired power-only plants, optionally combining with electricity generation using solar thermal technology. The project activity may include the following activities or, where applicable, combinations of these activities: (a) The installation of new biomass(co-)fired power-only plants at a site where currently no power generation occurs (Greenfield power projects); (b) The installation of new biomass (co-)fired power-only plants, which replace or are operated next to existing power-only plants fired with fossil fuels and/or biomass (power capacity expansion projects); (c) The improvement of energy efficiency of existing biomass (co-)fired power-only plants (energy efficiency improvement projects), which can also lead to a capacity expansion, for example by retrofitting the existing plant; (d) The total or partial replacement of fossil fuels by biomass in an existing power-only plant or in a new power-only plant that would have been built in the absence of the project (fuel switch projects), for example by increasing the share of biomass use as compared to the baseline, by retrofitting an existing plant to use biomass, etc.; (e) The installation of biomass (co-)fired power-only plants which include solar thermal power generation by sharing the power generation equipment between the biomass and solar components at a site where currently no power generation using solar thermal technology occurs (either as Greenfield or power capacity expansion project).	This project activity consists on the installation of new biomass(co-)fired power-only plants at a site where no power generation occurred before (Greenfield power projects).
2	Biomass used by the project facility is limited to biomass residues, biogas, RDF1 and/or biomass from dedicated plantations;	Biomass types used in Lautaro Project are (as explained above) residues from forestry and agriculture activity (cereal straw and husks). All of them are biodegradable

		organic residues from agriculture, forestry and a related industry as defined in the methodology ACM0018.
3	Fossil fuels may be co-fired in the project plant. However, the amount of fossil fuels co-fired shall not exceed 80% of the total fuel fired (i.e. fossil fuels and biomass) on an energy basis;	No other fuels than biomass will be fired in the boiler of the project plant. It is considered a small amount of Diesel consumption in the boiler only for the power plant start-ups, but this amount is negligible and doesn't exceed in any case the 80% of the total fuel fired on an energy basis.
4	For the projects that use biomass residues from a production process (e.g. production of sugar or wood panel boards), the implementation of the project shall not result in an increase of the processing capacity of raw input (e.g. sugar, rice, longs, etc.) or in other substantial changes (e.g. product change) in this process.	The amount of agriculture and forestry residues, available in the region are more than enough to satisfy the kind and amounts of biomass demanded by Lautaro Project (as demonstrated in section B.6.1 in Leakage determination) therefore the project activity should not make any difference in the processing capacity of those industries.
5	The biomass residues used by the project facility should not be stored for more than one year	According to biomass storage procedures at Lautaro power plant facilities the biomass storage period doesn't exceed a year. It's worth to mention that long storage periods are inconvenient because the biomass quality as a fuel decreases through time.
6	The biomass used by the project facility is not processed chemically or biologically (e.g. through esterification, fermentation, hydrolysis, pyrolysis, bio- or chemical-degradation, etc.) prior to combustion. Thermal degradation, drying and mechanical processing, such as shredding and pelletisation, are allowed;	The project activity does not consider any preparation of biomass residues prior to combustion and there are no significant energy quantities required except for transportation and mechanical treatment of the biomass.
7	No power and heat plant operates at the project site during the crediting period.	The only power plant that operates at the project site during crediting period is the power-only plant considered by the project activity.
8	If any heat is generated for purposes other than power generation (e.g. heat which is	All the heat generated in the boiler is used only for power generation purposes and

	produced in boilers or extracted from the header to feed thermal loads in the process) during the crediting period or was generated prior to the implementation of the project activity, by any on-site or off-site heat generation equipment connected to the project site, the following conditions should apply: a) The implementation of the project activity does not influence directly or indirectly the operation of the heat generation equipment, i.e. the heat generation equipment would operate in the same manner in the absence of the project activity. b) The heat generation equipment does not influence directly or indirectly the operation of the project plant (e.g. no fuels are diverted from the heat generation equipment to the project plant); and c) The amount of fuel used in the heat generation equipment can be monitoredand clearly differentiated from any fuel used in the project activity.	there is no heat generation equipment connected to the project site during crediting period or prior to the implementation of the project activity.
9	In the case of fuel switch project activities, the use of biomass residues or the increase in the use of biomass residues as compared to the baseline scenario is technically not possible at the project site without a capital investment in : 1. The retrofit or replacement of existing heat generators/boilers; or 2. The installation of new heat generators/boilers; or 3. A new dedicated biomass residues supply chain established for the purpose of the project (e.g. collecting and cleaning contaminated new sources of biomass that could otherwise not be used for energy purposes); 4. Equipment for preparation and feeing of biomass residues.	There is no fuel switch (i.e. replacement of fossil fuel by biomass) involved in this project activity which is a Greenfield power project.

10	If biogas is used for power generation, the biogas must be generated by anaerobic digestion of wastewater, and (a) If the wastewater generation source is registered as a CDM project activity, the details of the wastewater project shall be included in the PDD, and emission reductions from biogas energy generation are claimed using this methodology; (b) If the wastewater source is not a CDM project, the amount of biogas is lower than 50% of the total fuel fired on energy basis.	This condition does not apply to the project activity since no biogas is used for power generation.
11	In the case biomass from dedicated plantations are used, the applicability conditions of the methodological tool “Project and leakage emissions from biomass” shall apply	This condition does not apply to the project activity since biomass from dedicated plantations are used.
12	Finally, the methodology is only applicable if the baseline scenario, as identified per the “Procedure for the selection of the baseline scenario and demonstration of additionality” section hereunder, is: (a) For power generation: Scenarios P2 to P7, or a combination of any of those scenarios.	Is applicable since P5: The generation of power in the grid it is the realistic and feasible alternative which can provide outputs or services comparable with the proposed project.

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

Considering the applicable methodology ACM00018 v04.0, the spatial extent of the project boundary encompasses:

The project activity power-only plant;

- All other on-site power-only plants, whether fired with biomass residues, fossil fuels or a combination of both;
- All power plants connected physically to the electricity system (grid) that the project plant is connected to (plants connected to the SEN grid);
- The means of transportation of biomass residues to the project site;
- The site where the biomass residues would have been left for decay or dumped;

It is worth to notice that no processing power plants are included within the project boundary since biomass residues used by the project activity doesn’t require any processing prior its combustion in the boiler. Only mechanical treatment will be applied by using a wood shipper located at the project site, considered within the project boundary limits as shown in Figure 4.

The methodology also suggest to consider in the extent of the project boundary the wastewater treatment facilities used to treat the wastewater produced from the treatment of biomass residues but this project activity doesn't consider biomass treatment (and therefore no wastewater is produced) this is not applicable.

As a background there has not been other power plants installed at the project site prior to the project activity power plant.

The project activity is a Greenfield project that involves the installation of a Biomass based power plant with a gross installed capacity of 24 MW. Types and quantities of fuels that are planned to be used, are described in Table 6.

The following table shows the emissions sources included in the project boundary:

Source		GHG	Included?	Justification/Explanation
Baseline	Electricity Generation	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
	Uncontrolled burning or decay of surplus biomass residues	CO_2	No	It is assumed that CO_2 emissions from surplus biomass do not lead changes of carbon pools in the LULUCF sector.
		CH_4	Yes	CH_4 emissions from surplus biomass uncontrolled burnt or decay may be an important emission source.
		N_2O	No	Excluded for simplification. This is conservative. Note also that emissions from natural decay of biomass are not included in GHG inventories as anthropogenic sources.
Project activity	On site fossil fuel consumption	CO_2	Yes	May be an important emission source since a wood shipper to reduce size of larger forestry residues that consumes diesel fuel to operate.
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
	On-site and Off- site transportation and processing of biomass residues	CO_2	Yes	May be an important emission source since the equipments for transporting biomass on -site (i.e: Loaders, Manitou, etc) consumes diesel fuel to operate. There are also project emissions associated to the off-site transportation of biomass from its source to the project site by trucks. Other emissions source is the fossil fuel consumption in the wood shipper that could be used (as necessary) on-site or off-site for processing biomass.
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.

Source		GHG	Included?	Justification/Explanation
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
	Combustion of biomass for electricity	CO_2	No	It is assumed that CO_2 emissions from surplus biomass do not lead changes of carbon pools in the LULUCF sector.
		CH_4	Yes	As a conservative approach this emission source must be included because CH_4 emissions from uncontrolled burning or decay of biomass residues in the baseline scenario are included
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
	Cultivation of land to produce biomass feedstock	CO_2	No	No biomass from dedicated plantation is used
		CH_4	No	No biomass from dedicated plantation is used
		N_2O	No	No biomass from dedicated plantation is used
	Wastewater from the treatment of biomass residues	CO_2	No	The project activity does not involve a treatment of biomass residues.
		CH_4	No	The project activity does not involve a waste water is treatment under anaerobic conditions.
		N_2O	No	The project activity does not involve a treatment of biomass residues.

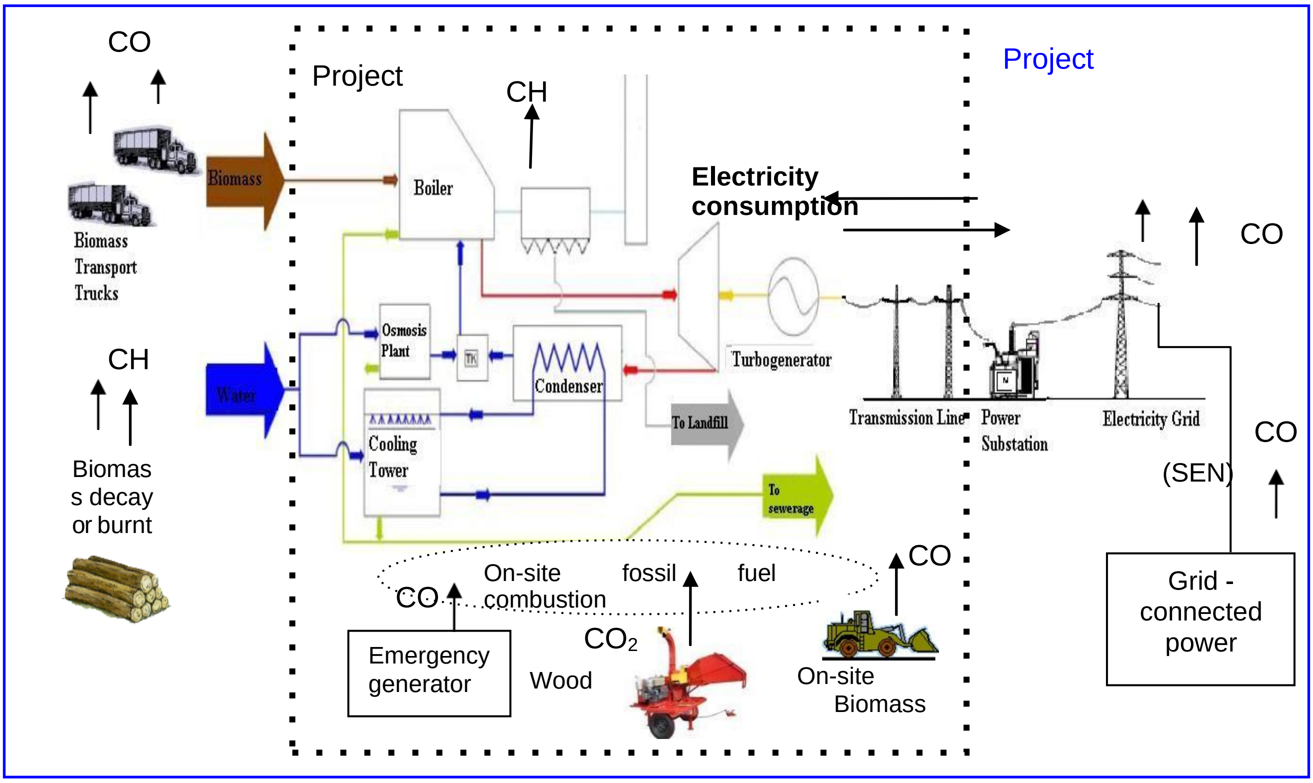


Figure 4. Emissions sources and gases included in the project boundary

It is worth to mention that the only emissions sources due to the on-site transport of biomass at the project site occurs due to the transport of biomass by equipments that consumes diesel as Manitou, Loaders, Excavator and the wood shipper that is sometimes needed. Conveyor belts, sieve and other auxiliary equipments for on-site biomass management uses electricity generated by the Lautaro project as autoconsumptions.

The following figure shows further details of on-site biomass management and its associated emission sources:

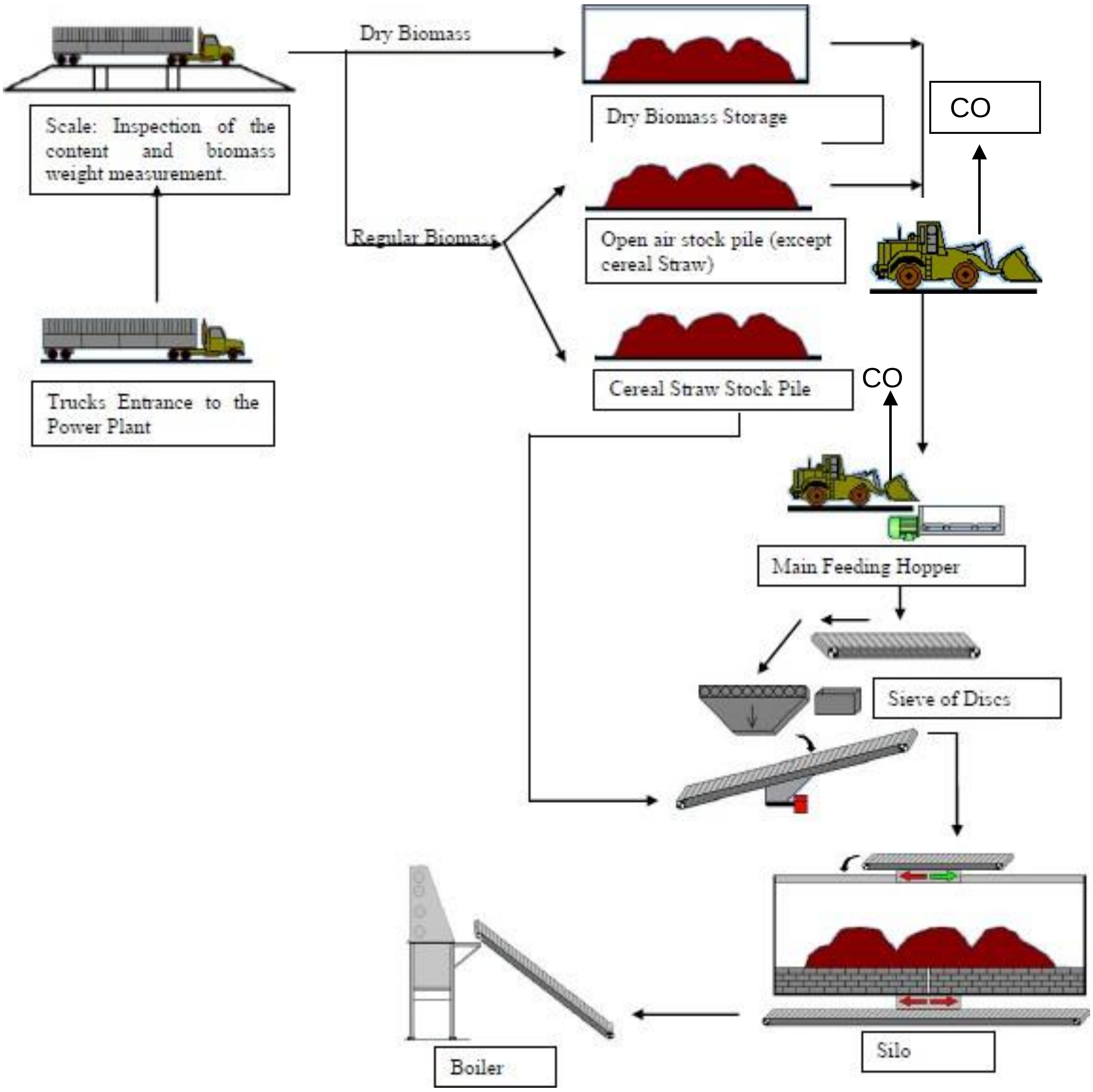


Figure 5. Detailed diagram for on-site biomass management and emissions sources.

B.4. Establishment and description of baseline scenario

The identification of the baseline scenario was performed by following Step 1of the "Procedure for the selection of the baseline scenario and demonstration of additionality" described in the methodology ACM0018 version 4.0:

Step 1: Identification of alternative scenarios:

This step serves to identify all alternative scenarios to the proposed CDM project activity(s) that can be the baseline scenario through the following sub-steps:

Sub-step 1a: Define alternative scenarios to the proposed CDM project activity

Identify all alternative scenarios that are available to the project participants and that provide outputs or services with comparable quality, properties and application areas as the proposed CDM project activity.

According the methodology, alternative scenarios should be separately determined regarding:

- How electric 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.

<u>Power Generation</u>

According to the methodology ACM0018 V04.0, if the project activity is the establishment of a Greenfield power plant and supplies electricity only to the grid, then the alternatives considered for power generation should include only the scenarios P1: The proposed project activity not undertaken as a CDM project activity and P5: The generation of power in the grid. The following table shows the analysis of alternative scenarios for electric power that concludes that the credible alternative scenarios are P1 and P5:

Alternatives scenarios	**Realistic and credible alternative scenario? Yes/No**
P1: The proposed project activity not undertaken as a CDM project activity	Yes. It seems to be a plausible alternative for greenfield projects according ACM0018 v04.0.

P2: If applicable, the continuation of power generation in existing power-only plants fired with biomass residues, or fossil fuels, or a combination of both, at the project site. The existing power-only 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. According to ACM0018 v04.0 it is not applicable for Greenfield power plant that only supplies energy to the grid.
P3: If applicable, the continuation of power generation in existing power-only plants fired with biomass residues, or fossil fuels, or a combination of both, at the project site. The existing power-only plants would operate with different conditions from those observed in the most recent three years prior to the project activity;	No. According to ACM018 v04.0 it is not applicable for Greenfield power plant that only supplies energy to the grid.
P4: If applicable, the retrofitting of existing power-only plants fired with biomass residues, or fossil fuels, or a combination of both, at the project site. The retrofitting may or may not include a change in fuel mix;	No. According to ACM018 v04.0 it is not applicable for Greenfield power plant that only supplies energy to the grid.
P5: The generation of power in the grid	Yes. It is the realistic and feasible alternative which can provide outputs or services comparable with the proposed project.
P6: The installation of new power-only plants fired with biomass residues, or fossil fuels, or a combination of both, at the project site, using the same amount or less biomass residues than under scenario P1	No. According to ACM018 v04.0 it is only applicable if the project activity includes the utilization of solar thermal energy.
P7: The installation of new power-only plants fired with biomass residues, or fossil fuels, or a combination of both, at the project site, using more biomass residues than under scenario P1.	No. According to ACM018 v04.0 it is e is only applicable if the project activity includes the utilization of solar thermal energy

P8: If applicable, the installation of new solar thermal power-only plant without biomass utilisation.	No. According to ACM018 v04.0 it is e is only applicable if the project activity includes the utilization of solar thermal energy.

<u>Biomass residues:</u>

Identified alternative scenarios for the use of biomass are listed in the following table for each residues category:

Table 6 Biomass residues categories consumed by the project activity

Biomass residues category (*k*)	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 (tonnes of dry matter/year)
1	Forestry residues	Off-site from several identified sellers (sawmills).	Dumped (B1)	Electricity generation on-site (biomass-only boiler)	86,855
2	Forestry residues	Off-site from the forest	Dumped (B1)	Electricity generation on-site (biomass-only boiler)	91,420
3	Agricultural residues (cereal straw)	Off-site from an identified seller.	Uncontrolled burnt (B3)	Electricity generation on-site (biomass-only boiler)	44,021
4	Agricultural residues (Cereal husks)	Off-site from an identified seller.	Uncontrolled burnt (B3)	Electricity generation on-site (biomass-only boiler)	24,576

The following table shows the analysis performed for the determination of alternative scenarios for biomass residues:

Alternatives scenarios	Realistic and credible alternative scenario? Yes/No
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	**Forestry residues k(1):** Yes, this is a common practice in the country because there is a bigger production (supply) compared to the consumption, therefore residues of this type that are not demanded or used are usually abandoned or stock-piled at the sawmills facilities[6]. **Forestry residues k(2):** Yes, this is a common practice in the country because after forestry management practices in the forest (in example thinning for waste activities) wood residues are usually abandoned or stock-piled in the forest[7]. **Cereal straw:** No, although a part of agriculture residues are usually accumulated and left to decay after the harvest, the main part (about a 90%)[8] is burnt without energy purposes which is a common practice in the country. **Cereal husk:** No, although a part of cereal husks are usually accumulated and left to decay on aerobic conditions the main part is burnt in an uncontrolled manner due to the abundance of it.

[6] The common practice in the area is to stock pile biomass in the sawmills yards as stated in an e-mail sent by a biomass supplier (Venturelli) File: RV Uso alternativo residuos aserradero.msg.

[7] Study: Forestry Biomass potential by CNE and GTZ institute, page 46 (thinning for waste definition).

[8] Source: Study “Straw availability in the wheat stubbles of three provinces of Chile”, page 400.

B2: 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	**<u>Forestry residues (k1):</u>** No, because costs associated to the collection, transport of the biomass from their source to the landfills makes this alternative scenario not the most suitable to the disposal of biomass used in the project which is usually left to decay aerobically in sawmills or given away. As in the case of residues from sawmills it is allowed to leave them to decay or stock piled this last option is more suitable than landfills alternative. **<u>Forestry residues (k2): No, after the harvest, as a product of forestry management practices there is an important amount of residues that remain in the forest in aerobic conditions.</u>** **<u>Cereal straw</u>**: No, because costs associated to the collection, transport of the biomass from their source to the landfills makes this alternative scenario not the most suitable to the disposal of biomass used in the project which is usually burnt on fields. **<u>Cereal husk:</u>** No, the same explanation for cereal straw residues applies to this category of biomass.
B3: The biomass residues are burnt in an uncontrolled manner without utilizing it for energy purposes	**<u>Forestry residues (k1):</u>** This is not a plausible scenario this kind of residues are usually stock pilled or accumulated at sawmills. **<u>Forestry residues (k2):</u>** This is not a plausible scenario this kind of residues are usually stock pilled or accumulated at the forests. **<u>Cereal straw:</u>** Yes, agriculture residues like Cereal straw used in the project power plant are usually burnt on fields without utilizing it for energy purposes in the absence of this project activity. Therefore this is a plausible scenario for this biomass type[9]. This scenario is demonstrated in the leakage Surplus Analysis of this PDD where it can be concluded that there is an excess of cereal straw in the region which and the common practice is the uncontrolled burn on fields due to the fact that it is not economically feasible to send them to landfills. **<u>Cereal husk:</u>** Agriculture residues like Cereal husks used in

[9] Source: Study “Straw availability in the wheat stubbles of three provinces of Chile”, page 400.

	the project power plant are usually burnt on fields without utilizing it for energy purposes in the absence of this project activity. Therefore this is a plausible scenario for this biomass type. This scenario is demonstrated in the leakage Surplus Analysis of this PDD where it can be concluded that there is an excess of cereal husks in the region and the common practice is the uncontrolled burn on fields due to the fact that it is not economically feasible to send them to landfills.
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.	**All biomass types:** No, there is no power-only or any kind of power plant in the project site prior to the implementation of the project activity, therefore this alternative does not apply. This scenario is not suitable for any of the categories of biomass residues (k1,k2,k3 and k4 from the Table 6) since it does not depend on the kind of biomass but it depends on the existence of other power only plants in the project site.
B5: The biomass residues are used for power-only plant configuration at the project site in new and/or existing power plants	**Forestry residues (k1)**: No. Biomass utilization for energy purposes is a marginal practice in the area. A very small part of electricity produced in the country is generated by biomass (aprox.1.3%) and this part is mainly composed by black liquor cogeneration units from large paper and cellulose industry that generates their own biomass residues. There is a surplus of biomass available for energy purposes as demonstrated in section B.6.1 (for leakage calculation), therefore the biomass in the absence of Lautaro Project would not be in any case consumed by other existing power plants at other sites. Also the probability of the development of new power plants at other sites is very small because as shown in the common practice analysis. Therefore, the use of biomass residues in new plants is not a plausible alternative. **Forestry residues (k2):** The same reason explained above for k1 applies for this category of biomass. Cereal straw: The same reason explained above for k1 applies for this category of biomass. There is a large excess of this kind of residues in the region and the common practice in Chile is to burn the straw on fields therefore it uses in power

	plants at other sites is not a suitable scenario for straw. **Cereal Husks;** The same reason explained above for k1 applies for this category of biomass, the technology of energy generation in power plants from biomass it is not very common in the country. A part of this kind of residues are sometimes used at the boilers of the industrial facilities (for their own processes) that produces those residues but the project activity only considers as available the biomass that is left after the amount autoconsumed at its source (by the providers). Finally, even if there is power plant called Lautaro 2, it is not included as a plausible alternative since it is a technically different project. Lautaro 2 is technically different as it uses a newer technology and it is only based on agricultural residues. Based on those differences, the operating costs of each plant are very different. The operating cost of both projects was compared[10] and it was concluded that Lautaro 1 power plant has an operating cost much bigger than Lautaro 2 and that they cannot be considered as alternative scenarios. In addition, according to Chilean official data[11] biomass projects are not being developed in Chile. There are only 10 project activities (not including CDM projects) that include biomass to produce electric energy and the last one was developed more than 6 years ago. In the meantime, a lot of solar and wind projects were developed in the country.

In conclusion, plausible alternative scenarios for power generation are P1 and P5. Plausible alternative scenario identified for forestry residues is B1, for agriculture residues (Cereal straw and husks) scenario B3 was identified.

Sub-step 1b: Consistency with mandatory applicable laws and regulations

The alternatives scenarios selected in sub-step 1a are in compliance with all mandatory applicable legal and regulatory requirements in Chile.

[10] Reporte de Mantención Global 2021 Global and Reporte de Mantención Global 2020 Global, COMASA S.A.

[11] CNE, Capacidad instalada de generación: https://www.cne.cl/estadisticas/electricidad/

In addition, To demonstrate the validity of the baseline scenario, the methodological tool: Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period Validity, Version 03.0.1, (EB 66 Annex 47) has been applied:

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

To define the validity of the current baseline for the second crediting period of the project following steps are followed:

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

For the second crediting period of the project, the baseline complies with existing rules and policies established from the Chilean government.

The applicable regulatory framework currently affecting SPII is as follows:

- Law 19,300, March 9, 1994, that "Approves Law about general environmental rules" (Ley 19.300, de 9 de Marzo de 1994, que "Aprueba Ley sobre bases generales del medioambiente").
- Decree No.327, September 10, 1998, that "Sets the Regulations of the General Law of Electrical Services" (Decreto nº 327, de 10 de Septiembre de 1998, que "Fija el Reglamento de la Ley General de Servicios Eléctricos").
- Law 19,940, March 13, 2004, that "Regulate Electric Power transport systems, establishes a new tariff system for medium power systems and introduces the adjustments that instructs the General Law of Electrical Services" (Ley 19.940, de 13 de Marzo de 2004, que "Regula Sistemas de transporte de Energía Eléctrica, establece un nuevo régimen de tarifas para sistemas eléctricos medianos e introduce las adecuaciones que indica a la Ley General de Servicios Eléctricos").
- Decree No.99, May 12, 2005, that "Sets distribution tolls applicable to transportation service that public distribution service dealerships provide, as it states" (Decreto nº 99, de 12 de Mayo de 2005, "Que fija peajes de distribución aplicables al servicio de transporte que presten los concesionarios de servicio público de distribución que señala").
- Law 20,018, May 19, 2005, that "Modifies Electrical Sector Regulatory Framework" (Ley 20.018, de 19 de Mayo de 2005, que "Modifica el Marco Normativo del Sector Eléctrico").
- Decree No.188, July 23, 2005, that "Modifies, as it states, Decree nº 99, 2005, which sets distribution tolls applicable to transportation service that public distribution service dealerships provide, as it states" (Decreto nº 188, de 23 de Julio de 2005, "Que modifica, en lo que indica, el Decreto nº 99, de 2005, que fija peajes de distribución aplicables al servicio de transporte que presten los concesionarios de servicio público de distribución que señala").
- Decree No.244, January 17, 2006, that "Approves regulation to unconventional generation means and small generation means, as established in the General Law of Electrical Services" (Decreto nº 244, de 17 de Enero de 2006, que "Aprueba el Reglamento para medios de generación no convencionales y pequeños medios de generación establecidos en la Ley General de Servicios Eléctricos").
- Supreme Decree No.62, June 16, 2006, "Approves regulation for power transfer between generation companies as established in the General Law of Electrical Services" (Decreto Supremo N°62, de 16 de Junio de 2006, "Aprueba reglamento de transferencias de potencia entre empresas generadoras establecidas en la Ley General de Servicios Eléctricos").

- Decree-Law No.4/20,018, February 5, 2007, that “Sets consolidated text, coordinated and systematized text of Decree-Law n º 1, about mining, 1982, General Law of Electrical Services, regarding Electric Power” (Decreto con Fuerza de Ley nº 4/20.018, de 5 de febrero de 2007, que “Fija texto refundido, coordinado y sistematizado del Decreto con Fuerza de Ley nº 1, de minería, de 1982, Ley General de Servicios Eléctricos, en materia de Energía Eléctrica”).
- Supreme Decree No.44, May 2, 2007, that “Modifies Decree nº 62, 2006, which approves regulation for power transfer between generation companies as established in the General Law of Electrical Services” (Decreto Supremo N° 44, de 2 de Marzo de 2007, que “Modifica Decreto Nº 62, de 2006, que Aprueba el Reglamento de Transferencias de Potencia entre Empresas Generadoras establecidas en la Ley General de Servicios Eléctricos”).
- Exempt Resolution No.24, May 25, 2007, that “Delivers Connection and Operation Technical Standard of small generation means distributed in medium voltage" (Resolución nº 24 Exenta, de 25 de Mayo de 2007, “Dicta Norma Técnica de Conexión y Operación de Pequeños Medios de Generación Distribuidos en Media Tensión”).
- Law 20,220, September 14, 2007, that “Refine the existing legal framework in order to protect the security of supply to regulated customers and sufficiency of electrical systems” Ley 20.220, de 14 de Septiembre de 2007, que “Perfecciona el marco legal vigente con el objeto de resguardar la seguridad del suministro a los clientes regulados y la suficiencia de los sistemas eléctricos”.
- Decree No.26, February 26, 2008, that “Enacts measures to avoid, reduce, and manage generation deficit in the Central Interconnected System, pursuant to the Article 163º of the General Law of Electrical Services” (Decreto nº 26, de 26 de Febrero de 2008, que “Decreta medidas para evitar, reducir, y administrar déficit de generación en el Sistema Interconectado Central, en ejecución del Artículo 163º de la Ley General de Servicios Eléctricos”).
- Law 20,257, April 1, 2008, that “Introduces modifications to the General Law of Electrical Services regarding to the electrical energy generation by non conventional renewable energy sources” (Ley 20.257, de 1 de Abril de 2008, que “Introduce modificaciones a la Ley General de Servicios Eléctricos respecto de la generación de energía eléctrica con fuentes de Energías Renovables No Convencionales”).
- Exempt Resolution No.329, June 14, 2013, that “Modifies and approves the consolidated text of the Connection and Operation Technical Standard of small generation means distributed in medium voltage “ (Resolución nº 329 Exenta, de 14 de Junio de 2013, que “Modifica y aprueba el texto refundido de Norma Técnica de Conexión y Operación de Pequeños Medios de Generación Distribuidos en Media Tensión”).
- Decree No.40, August 12, 2013, that “Approves Environmental Impact Assessment system regulation” (Decreto 40, de 12 de Agosto de 2013, que “Aprueba Reglamento del Sistema de Evaluación de Impacto Ambiental”).
- Law 20,698, October 22, 2013, that “Promotes the expansion of the electrical matrix, by non conventional renewable sources” (Ley 20.698, de 22 de Octubre de 2013, que “Propicia la ampliación de la matriz energética, mediante fuentes renovables no convencionales”).
- Technical Standard for Safety and Quality of Service (NTSCS, by its acronym in Spanish), May 2005, and its respective modifications (R.M. Exta. No.40, May 16, 2005; R.M. Exta. No.85, October 7, 2009; R.M. Exta. No.68, March 10, 2010) (Norma Técnica de Seguridad y Calidad de Servicio (NTSCS), de Mayo de 2005, y sus respectivas modificaciones: R.M.

Exta. nº 40 de 16 de Mayo de 2005; R.M. Exta. nº 85 de 7 de Octubre de 2009; R.M. Exta. nº 68 de 10 de Marzo de 2010).

- Decree 29, March 3, 2014, that "Approves bidding regulations for the provision of annual blocks of energy from non-conventional renewable energy generation means". (Decreto 29, de 3 de marzo de 2014, que "Aprueba reglamento de licitaciones para la provisión de bloques anuales de energía provenientes de medios de generación de energía renovable no convencional")
- Decree 31, March 16, 2017, that "Approves regulations for the determination and payment of compensation for unavailability of electricity supply". (Decreto 31, de 16 de marzo de 2017, que Aprueba reglamento para la determinación y pago de las compensaciones por indisponibilidad de suministro eléctrico).

Some minor changes in regulations have been newly introduced after the submission of the project activity for validation, but they only affect to the profitability of the project as explained in Step 1.2.

Step 1.2: Assess the impact of circumstances

There is no impact of circumstances existing at the time of requesting renewal of the crediting period on the current baseline emissions. The conditions, methodology and formulae used for the calculation of the emissions reduction of Power Plant have not changed. Nevertheless, the Chilean energy system has experienced some changes in the recent years. Before 2017 there were four interconnected systems that operated in isolation from the others, but that year, the two main ones - the Central Interconnected System (SIC) and the Great North Interconnected System (SING), were connected to form the National Electric System (SEN). But the project activity is connected at the same connection point, the only impact of the connection of the system is the grid is bigger than the previous one.

In addition, some new regulations have been newly introduced after the submission of the project activity for validation.

On the one hand, the Chilean government has published the Decree 296 and the Law 206987 , both promote the expansion of the energy matrix through non-conventional renewable sources. As they regulate the incorporation of new non-conventional renewable agents into the national grid, they do not impact the baseline, since they do not change connection conditions. Furthermore, they affect the profitability of the project because they facilitate the inclusion of renewable energies in the grid, which will lower the emission factor and, therefore, will penalize emission reduction of this facility.

On the other hand, the Decree 318 has been published, which regulates the determination and payment of compensations for unavailability of electrical supply. The impact of this new regulation comes from the payment of a new fee if there is any problem with the generation of energy that causes an interruption of the electricity availability. Nevertheless, the negative impact of this new rule can be minimized if the storage management of the biomass is improved. Thus, this power plant is not as affected as other plants that have sources (solar and wind) that depend on the meteorology.

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

This sub-step should only be applied if the baseline scenario identified at the validation of the project activity was the continuation of use of the current equipment without any investment and, the projects proponents would undertake an investment later. Since the project activity consisted in the construction of a new plant where there was no previous activity this sub-step is not applicable.

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

According to explained before in terms of the union of both systems, for the value of $EF_{grid,CM,y}$ is revised at the renewal of the crediting period.
The emission factor applied for renewal of the second crediting period is the result of recalculating the emission factor, according to the latest version of the “Tool to calculate the emission factor for an electricity system, Version 0.7, Tool 07”.

<u>**Step 2: Update the current baseline and the data and parameters**</u>

Step 2.1: Update the current baseline

As shown in step 1.1 above, the original baseline considering the relation between the energy delivered by the new plant and the emissions factor of the National Electric System (SEN), remains valid for the second crediting period, taking into account new relevant national and/or sectoral policies and circumstances applicable. Therefore, remains the same baseline of the project and is updated only the calculation of the reduction of CO_2 emissions with current emission factor, the generation that results of the addition of the new unit and methodology of monitoring.
This update was applied due to some changes that the Chilean energy system has experienced in the recent years.

Step 2.2 Update the data and parameters

The only parameter not monitored has been updated for the second crediting period:

- Grid emission factor ($EF_{grid,y}$). The “Tool to calculate the emission factor for an electricity system”, Version 07.0.0, TOOL07; has been used. In accordance with that tool, for the second crediting period of the project the weighting of the operating and build margin emission factors are: w^{OM} = 0.25 and w^{BM} = 0.75.
- CO^2 emission factor from fuel use due to transportation (Tonnes CO^2/km). The value comes from IPCC default values at the lower 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. These guidelines are the sources used for the last Chilean Biennial Update Report 9 , the Third one, published on 03/12/2018.

B.5. Demonstration of additionality

Prior Consideration of the CDM

According to the “Guidelines on the demonstration and assessment of prior consideration of the CDM”, version 04, EB 62, the CDM prior consideration *is a major element in assessing that CDM benefits were considered necessary in the decision to undertake the project as CDM project activity.*

The project developer (COMASA) sent the Prior Consideration of the CDM form fulfilled with the required project activity information on 04/03/2010 to the UNFCCC and to the DNA in Chile (CONAMA). The starting date of the project activity is defined by contract of the turbine purchase which was signed on 30/10/2009.

Additionality

According to methodology ACM0018 (version 2.0.0) additionality of the project activity shall be conducted by applying the following steps:

STEP1 Identification of alternative scenarios;
STEP2 Barrier analysis;
STEP3 Investment analysis;
STEP4 Common practice analysis**.**

Step1 Identification of alternative scenarios

Step 1a: Define alternative scenarios to the proposed CDM project activity:

As explained in section B.4, there are two identified realistic and credible alternative scenarios for Lautaro Generation Project:

Table 7 Identified alternatives baseline scenarios combinations

Identified alternative scenarios	Power Generation	Biomass use	
		Forestry biomass residues	Agriculture biomass residues
Scenario 1	P1	B1	B3
Scenario 2	P5	B1	B3

Step 1b: Consistency with mandatory applicable laws and regulations

The alternatives scenarios selected as baseline are in compliance with all mandatory applicable legal and regulatory requirements in Chile. Therefore, two plausible combined scenarios are left after Step 1:

a) The project not undertaken as a CDM project activity (Scenario 1 in Table 7).
b) The generation of power in the grid (Scenario 2 in Table 7)

Step 2: Barrier analysis

This Step serves to identify barriers and to assess which alternatives are prevented by these barriers. Apply the following steps:

Step 2a: Identify barriers that would prevent the implementation of alternative scenarios

There are no barriers identified that would prevent the implementation of either of the two alternative scenarios above.

Step 2b: List of alternative scenarios to the project activity that are not prevented by any barrier
Neither of the two combined scenarios is eliminated by the step 2. The two combined scenarios need to be further discussed in Step 3.

Step 3: Investment analysis

This Step serves to determine which of the alternative scenarios is the most economically or financially attractive. For this purpose, an investment comparison analysis is conducted for the remaining alternative scenarios after Step 2. If the investment analysis is conclusive, the economically or financially most attractive alternative scenario is considered as the baseline scenario.

For the investment analysis the financial indicator pre-tax IRR in real terms of the alternative scenario combination that involves implementation of the project without the CDM context (Scenario 1 in Table 7) was compared against a pre-tax benchmark (real).

As scenario 2 considers the generation of electricity in the grid which means no investment is required for the baseline of the project activity a benchmark was determined based on the Capital Asset Pricing Model (CAPM). The CAPM is widely used to determine a theoretically appropriate required rate of return of an asset, and its model takes into account the expected return of a theoretical risk-free asset (Rf), the asset's sensitivity to non-diversifiable risk (also known as systematic risk or market risk) represented by Beta (β), the expected risk premium of the market (Rm-Rf) and the country risk, according the following equation:

Equation B 1: CAPM equation

$$R=R_f + \beta^*(R_m-R_f) + R_{country}$$

Where:

R: Expected rate of return
R_f: Risk-free rate of return. This parameter considers a value equal to 4.42% which corresponds to an average of the last 10 years values prior to the investment decision, determined for USA treasury 10-year bond.
β: Beta factor is obtained from USA stock market information under Power Industry and resulted in a value of 0.81. It is estimated by regressing weekly returns on stock against NYSE composite, using 5 years of data or listed period (if less than 5 years). If data is available for less than 2 years, the Beta is not estimated.
(R_m – R_f): Risk premium estimate for the USA market based on the country valuation by international studies. An average value was calculated considering the last 9 years data prior to the investment decision (which is the oldest data available) concluding in a value of 4.97%.
$R_{country}$: Country risk shall be included since the analysis uses parameters obtained from the USA Power Industry. The average of the last 9 years data for Chile prior to the investment decision is equal to 1.27% when compared to the USA.

The national benchmark for this type of industries in Chile by October 2009, calculated in real terms, is therefore, equal to 9.7%.

The project evaluation considers the pure project, without financing or CER's incomes and involves a total investment of USD 34,218,798 with a 50% considered for the project execution in year 2009 and with the other 50% for the year 2010.
The yearly Operation and Maintenance cost value considered in the economical assessment of the project is 8,976,016 USD/year of Costs)[12].

The average expected amount of net energy produced for sale in Lautaro power plant (with a net installed capacity of 21.17MW) is 151,051 MWh/year, considering a plant load factor of 81.46% [13]and the price of energy considered in the economical evaluation of the project activity is presented in the following table:

Table 8 Electricity Price

Year	Energy Price (USD/MWh)[14]
2011	70.08
2012	75.15
2013	63.1
2014	60.2
2015	60.2
2016	60.2
2017	63.1
2018	62.1
2019	63.1
2020	64.0
2021	64.0
2022	64.0
2023	64.0

[12] This value has been estimated by the PP and is suitable according to the value (60 USD/MWh) reported International Energy Agency (IEA) - OECD. Deploying Renewables, Principles for Effective Policies. 2008. Page 80. Table 5 "Key Characteristics and costs of renewable technologies"

[13] Source: This value (81.46%) was considered at the moment of the investment decision although later a plant load factor of 72.9% was determined by a third party in a Report developed by Proterm (Engeenering company): "Estimación Factor de Planta Nueva Central de Energía Renovable Lautaro", page 5. The PLF of 81.46% that was considered at the moment of the investment decision will be applied only for the IRR calculation to be conservative.

[14] Spot Market prices according the Report published by the National Energy Comision "CNE": Fijación de Precios de Nudo Abril de 2009, Sistema Interconectado Central (SIC), Informe Técnico Definitivo. Page 40 and Projected prices of energy reported in a study by Synex company - Bernstein 2008 (Synex Ingenieros Consultores. Energía en Chile: Perspectivas para el 2020. Julio de 2008).

2024	64.0
2025	64.0
2026	64.0
2027	64.0
2028	64.0
2029	64.0
2030	64.0

It is worth to notice that the electricity prices reported in Table 8 is a projection of real prices and its yearly variation is not attributable to inflation.

The economical evaluation of the project considers 8.2 MW of firm power with a price of 8,829 USD/MW (at the reference spot: Quillota bar) per month[15], with a penalty factor at Temuco Bar of 0.9464.

The following table shows an extract from the project activity cash flows (in USD). For further details and references see the Economical Analysis spreadsheet of the project.

Table 9 Cash flows summary

Year	2009	2010	2011	(…)	2028	2029	2030
Investment	-17,109,399	-17,109,399					
		-	-		-	-	-
Incomes USD$		-	**11,404,696**		**10,493,142**	**10,493,142**	**10,493,142**
Electricity		-	10,585,813		9,674,259	9,674,259	9,674,259
Firm Capacity		-	818,883		818,883	818,883	818,883
Costs			**-9,114,065**		**- 9,114,065**	**- 9,114,065**	**- 9,114,065**
Production Costs			8,976,016		- 8,976,016	- 8,976,016	- 8,976,016
Transmission Fee			- 138,049		- 138,049	- 138,049	- 138,049
			-		-	-	-
EBITDA	**- 17,109,399**	**- 17,109,399**	**2,290,631**		**1,379,078**	**1,379,078**	**1,379,078**

[15] National Energy Comission: Fijación de Precios de Nudo Abril de 2009, Sistema Interconectado Central (SIC), Informe Técnico Definitivo. Page 41 (Document ITD SIC ABR09.pdf)

Finally, the result of the financial parameter IRR pre-tax in real terms compared against a pre-tax benchmark in real terms is:

Table 10: Project IRR.

	Project IRR	Benchmark
Financial Parameter	-1.9%	9.7%

As it can be seen in Table 10 above, the project IRR does not reach the benchmark and Lautaro Generation project in the absence of the CDM benefits have to face an investment barrier therefore the baseline scenario is scenario 2 which involves purchasing electricity from the grid.

Sensitivity analysis

According to the Guidance on the Assessment of Investment Analysis, *the objective of the sensitivity analysis is to determine in which scenarios the project activity would pass the benchmark*.

According to the economic evaluation the following parameters are included in the sensitivity analysis:

a) Investment Costs
b) Electricity generation
c) Electricity price
d) Operating Costs

According to the Guidance on the Assessment of Investment Analysis the sensitivity analysis should at least cover a range of +10% and -10%.
For this purpose, the project IRR is analyzed for a fluctuation of ± 10% of each of these four parameters independently, the results are shown in the following table:

Table 11: Sensibility analysis results

Parameter	Variation	IRR
Investment Costs	-10%	-0.98%
Electricity Generation	10%	3.17%
Electricity Price	10%	3.17%
Operation Costs	-10%	2.91%

*Costs (related to the investment and operation of the project) items were varied in a -10% and electricity generation and energy price items were incremented in a 10% in order to show the most conservative and favourable scenario for the Project activity.

The results presented above show that the project IRR does not exceed the benchmark (9.7%) in any case, confirming the fact that the project activity is unlikely to be financially attractive.

Step 4 Common practice analysis.

This test is a credibility check to demonstrate additionality and complements the investment analysis (Step 3). To perform common practice analysis, *the Stepwise approach for common practice* of the “Guidelines on Common Practice”, version 2.0, EB 69, was used.

Since the project activity is a renewable energy generation project, the following measure listed in the paragraph 2 of the Guidelines on Common Practice corresponds to the project activity:

(b) “Switch of technology with or without change of energy source (including energy efficiency improvement as well as use of renewable energies)”;

Therefore the project activity measure is covered in the guidelines framework. The following steps were followed:

Step 1: calculate applicable capacity or output range as +/-50% of the total design capacity or output of the proposed project activity.

As the proposed project activity installed gross capacity is 24 MW, then the calculated applicable output range is:

-50%: 12 MW
+50%: 36 MW

Step 2: Identify similar projects (both CDM and non-CDM) which fulfil all of the following conditions:

Table 12. Conditions to identify similar projects

Condition for similar projects	Similar project description
The projects are located in the applicable geographical area.	As per the paragraph 1 of the Guidelines in Common Practice, the applicable geographical area covers the entire host country as a default. Then similar projects should be located in Chile (host country).
The projects apply the same measure as the proposed project activity;	Similar projects measure should consider renewable energy generation.
The projects use the same energy source/fuel and feedstock as the proposed project activity, if a technology switch measure is implemented by the proposed project activity;	Similar projects consider renewable energy sources for energy generation.
The plants in which the projects are implemented produce goods or services with comparable quality, properties and applications areas (e.g. clinker) as the proposed project plant;	The output service provided by the project activity is grid connected electricity generation.
The capacity or output of the projects is within the applicable capacity or output range calculated in Step 1;	The installed capacity should be within the range 12 MW – 36 MW.

The projects started commercial operation before the project design document (CDM-PDD) is published for global stakeholder consultation or before the start date of proposed project activity, whichever is earlier for the proposed project activity.	Similar project should started commercial operation before the starting date of the project activity (30/10/2009).

According to Table 12 this analysis should consider as similar projects the renewable power plants connected to all the electricity grids in Chile: SIC, SING[16], Magallanes Electricity System and Aysén Electricity System, that started commissioning before 30/10/2009 and within the applicable capacity range (12 MW – 36 MW).

The following table shows all grid-connected power plants located in Chile, that deliver the same output within the applicable output range calculated in Step 1 (12 MW – 36 MW):

Table 13. Renewable Power plants that deliver the same output within 12 MW and 36 MW of capacity

Number#	Electricity System	Power Plant	Energy source / fuel	Capacity (MW)
1	SIC	Palmucho	Run off River (Hydro)	32.00
2	SIC	Maitenes	Run off River (Hydro)	31.00
3	SIC	Arauco	Biomass - Diesel nº 6	30.10
(CDM)	SIC	Nueva Aldea I **(CDM Ref #258)**	Biomass	29.30
(CDM)	SIC	Cholguán **(CDM Ref#0259)**	Biomass - Diesel nº 6	29.00
4	SIC	Florida	Run off River (Hydro)	28.50
5	SIC	Licanten	Biomass - Diesel nº 6	27.00
(CDM)	SIC	Chacabuquito **(CDM Ref#1052)**	Run off River (Hydro)	25.50
6	SIC	Puntilla	Run off River (Hydro)	22.00
7	SIC	Celco	Biomass	20.00
8	SIC	Chiburgo	Reservoir (Hydro)	19.40
(CDM)	SIC	Lircay **(CDM Ref#2417)**	Run off River (Hydro)	19.00

16 SIC: Central Interconnected Grid (Sistema Interconectado Central in Spanish); SING: Great North Interconnected Grid (Sistema Interconectado del Norte Grande in Spanish).

(CDM)	SIC	Canela **(CDM Ref#1958)**	Wind	18.20
(CDM)	SIC	Licán **(At CDM Validation)**	Run off River (Hydro)	18.00
9	SIC	Los Molles	Run off River (Hydro)	18.00
(CDM)	SIC	Escuadrón **(CDM Ref#2264)**	Biomass	15.50
10	SIC	Volcán	Run off River (Hydro)	13.00
(CDM)	SIC	Laja **(At CDM Validation)**	Biomass	12.70
11	SIC	Sauzalito	Run off River (Hydro)	12.00
(CDM)	SIC	Guayacán **(CDM Ref#3830)**	Run off River (Hydro)	12.00

Data Source: CNE statistics Installed capacity as per 2011.

Step 3: within the projects identified in Step 2, identify those that are neither registered CDM project activities, project activities submitted for registration, nor project activities undergoing validation. Note their number N_{all}.

According to table presented above, excluding CDM registered projects (7 power plants) and project activities undergoing validation (2 power plants), calculated number N_{all} is 11.
For further detail please refer to Common Practice Spreadsheet.

Step 4: within similar projects identified in Step 3, identify those that apply technologies that are different to the technology applied in the proposed project activity. Note their number N_{diff}.

According to the definition of different technologies stated in paragraph 4 of the Guidelines on Common Practice v. 2.0, in the context of Lautaro Generation project activity, power plants that doesn't operate with biomass as a fuel and that are different scale (i.e. small or micro scale), are considered as different technologies.

In Table 13 it can be seen that there are 8 power plants applying different technologies (excluding CDM projects).

Then, according to this criteria N_{diff} = 8.

Step 5: calculate factor $F=1-N_{diff/Nall}$ representing the share of similar projects (penetration rate of the measure/technology) using a measure/technology similar to the measure/technology used in the proposed project activity that deliver the same output or capacity as the proposed project activity.

According to the tool, the proposed project activity is regarded as "common practice" within a sector in the applicable geographical area if both the following conditions are fulfilled:

(a) The factor F is greater than 0.2; and
(b) N_{all}-N_{diff} is greater than 3.

The following table present the results for this project activity:

Table 14 Calculation of F indicator and N_{all}-N_{diff}

Parameter	Value
N_{all}	11
N_{diff}	8
N_{all}-N_{diff}	3
$F = 1-N_{diff}/N_{all}$	0.27

Condition (b) is not fulfilled and therefore the project activity is not regarded as common practice, then the proposed project activity is additional.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

According to the ACM0018/version 4.0 emission reductions are calculated as the difference between baseline emissions, project emissions and leakage emissions as per equation 1 of the methodology:

Equation 1 of ACM0018

$$ER_y = BE_y - PE_y - LE_y$$

Baseline emissions

Baseline emissions may, where applicable, include the following emission sources:

- CO_2 emissions from fossil fuel power plants at the project site;
- CO_2 emissions from grid-connected fossil fuel power plants in the electricity system;
- CH_4 emissions from anaerobic decay of biomass residues and/or CH_4 emissions from uncontrolled burning of biomass residues without utilizing them for energy purposes.

Equation 2 of the ACM0018

$$BE_y = BE_{EL,y} + BE_{BR,y}$$

Where:
BE_y = Baseline emissions in year y (tCO_{2e})
$BE_{EL,\ y}$ = Baseline emissions due to generation of electricity in year y (tCO_2)
$BE_{BR,\ y}$ = Baseline emissions due to uncontrolled burning or decay of biomass residues in year y (tCO_{2e})

Baseline emissions are determined through the following steps:

Step 1: Determination of $BE_{EL,y}$

Baseline emissions from electricity generation are calculated based on the net quantity of electricity generated at the project site under the project scenario ($EG_{PJ,y}$) and a baseline emission factor ($EF_{BL,EL,y}$) which expresses the weighted average CO2 intensity of electricity generation in the baseline, as follows:

Equation 3 of ACM0018

$$BE_{EL,y} = EG_{PJ,y} \times EF_{BL,EL,y}$$

$BE_{EL,y}$ = Baseline emissions due to generation of electricity in year y (tCO_2)
$EG_{PJ,y}$ = Net 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)
$EF_{BL,EL,y}$ = Emission factor for electricity generation in the baseline in year y (tCO_2/MWh)

Step 1.1: Determination of $EG_{PJ,y}$

The net quantity of electricity generated in all power plants which are located at the project site and included in the project boundary ($EG_{PJ,y}$) is determined as the difference between the gross electricity generation at the project site ($EG_{PJ,gross,y}$) and the auxiliary electricity consumption required for the operation of the power plants at the project site ($EG_{PJ,aux,y}$), as follows:

Equation 4 of ACM0018

$$EG_{PJ,y} = EG_{PJ,gross,y} - EG_{PJ,aux,y}$$

Where:
$EG_{PJ,y}$ = Net 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)
$EG_{PJ,gross,y}$ = 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)
$EG_{PJ,aux,y}$ = Total auxiliary electricity consumption required for the operation of the power plants at the project site (MWh).

$EG_{PJ,aux,y}$ includes all electricity required on-site for the operation of equipment related to the preparation, processing, storage and transport of biomass residues (e.g. for mechanical treatment of the biomass, conveyor belts, driers, pelletization, shredding, briquetting processes, etc.) and electricity required for the operation of all power plants which are located at the project site and included in the project boundary (e.g. for pumps, fans, cooling towers, instrumentation and control, etc.). In the case of Lautaro Project there is only one power plant at the project site.

Step 1.2: Determination of $EG_{PJ,y}$

The electricity generated under the project activity could be generated in the baseline in three different ways, depending on the baseline scenario and the particular situation of the project activity:

- **Use of biomass residues at the project site.** Electricity could be generated with biomass residues in power plants at the project site. This doesn't apply to Lautaro Generation project which is a Greenfield power plant.

AND/OR

- **Use of fossil fuels at the project site.** Electricity could be generated with fossil fuels in power plants at the project site. This doesn't apply to Lautaro Generation project which is a Greenfield power plant therefore there is no other power plants at the project site prior the implementation of the project activity. AND/OR

- **Power generation in the electricity grid.** Electricity could be generated by power plants in the electricity grid. This applies, because:

  a) The project activity exports all electricity to the grid and no electricity would be produced at the project site in the baseline.

For some project types, electricity would be generated in the baseline by a combination of these three ways. Therefore, $EF_{BL,EL,y}$ is a weighted average baseline emission factor: it is determined based on each of the three ways electricity could be generated (grid, biomass residues, fossil fuels), multiplied with its respective emission factor over the total amount of electricity produced in the baseline.

The methodology adopts a conservative approach and defines four different electricity quantities to be used for the calculation of the weighted average baseline emission factor $EF_{BL,EL,y}$. These four different electricity quantities are $EG_{BL,BR,y}$, $EG_{BL,grid,y}$, $EG_{BL,FF,y}$ and $EG_{BL,FF/grid,y}$:

- $EG_{BL,BR,y}$ corresponds to the amount of electricity that would be generated with biomass residues in power-only plants operated at the project site in the baseline;

- $EG_{BL,grid,y}$ corresponds to the amount of electricity for which it can be clearly identified that it would be generated in the electricity grid in the baseline. For example, the amount of electricity generated under the project activity that exceeds the amount that could be generated with the capacity of the baseline plants operated at the project site could only be generated in the grid in the baseline;

- $EG_{BL,FF,y}$ corresponds to the amount of electricity for which it can be clearly identified that it would be generated in the baseline with fossil fuels at the project site. For example, in the case of a co-fired boiler operated in the baseline, some fossil fuels may need to be fired for technical or operational reasons.

- $EG_{BL,FF/grid,y}$ corresponds to the amount of electricity that could be generated in the baseline

either by power plants in the electricity grid or with fossil fuels at the site of the project activity. As it can't be clearly identified which of these two options would be used in the baseline, the lower CO2 emission factor between the grid emission factor and the emission factor of fossil fuel power plants operated at the site of the project activity is used for this amount of electricity.

Based on this approach, $EF_{BL,EL,y}$ is calculated as follows:

Equation 5 of ACM0018

$$EF_{BL,EL,y} = \frac{EG_{BL,FF,y} \cdot EF_{BL,FF,y} + EG_{BL,grid,y} \cdot EF_{grid,CM,y} + EG_{BL,FF/grid,y} \cdot MIN\,(EF_{BL,FF,y}; EF_{grid,CM,y})}{EG_{BL,BR,y} + EG_{BL,FF,y} + EG_{BL,grid,y} + EG_{BL,FF/grid,y}}$$

Where:
$EF_{BL,EL,y}$ = Emission factor for electricity generation in the baseline in year y (tCO_2/MWh).
$EG_{BL,BR,y}$ = Amount of electricity that would be generated with biomass residues in power-only plants operated at the project site in the baseline in year y (MWh)
$EG_{BL,FF,y}$ = Minimum amount of electricity that would be generated with fossil fuels at the project site in the baseline in year y (MWh)
$EG_{BL,grid,y}$ = Minimum amount of electricity that would be generated by power plants in the electricity grid in the baseline in year y (MWh)
$EG_{BL,FF/grid,y}$ = Amount of electricity that could be generated in the baseline either by power plants in the electricity grid or by power plants at the project site using fossil fuels in year y
(MWh)
$EF_{grid,CM,y}$ = Combined margin CO_2 emission factor for grid-connected electricity generation in year y (tCO_2/MWh)
$EF_{BL,FF,y}$ = CO_2 emission factor for electricity generation with fossil fuels in power plant(s) at the project site in the baseline in year y (tCO_2/MWh)

In the following, first the amounts of electricity generated from the various sources in the baseline ($EG_{BL,BR,y}$, $EG_{BL,grid,y}$, $EG_{BL,FF,y}$ and $EG_{BL,FF/grid,y}$) are determined, taking into account the project configuration and the baseline scenario. Therefore, different cases have to be considered. Then the emission factors ($EF_{grid,CM,y}$ and $EF_{BL,FF,y}$) are determined.

Step 1.3: Determination of $EG_{BL,BR,y}$

The amount of electricity that would be generated with biomass residues in power-only plants operated at the project site in the baseline ($EG_{BL,BR,y}$) is in accordance with:

Case 1: No power generation with biomass residues in the baseline. Scenario B5 does not apply to any biomass residue category (because there is no power plants in the baseline at the project site), then: $EG_{BL,BR,y} = 0$.

Step 1.4: Determination of $EG_{BL,FF,y}$

The minimum amount of electricity that would be generated with fossil fuels at the project site in the baseline in year y ($EG_{BL,FF,y}$) is 0 in accordance with:

Case 1: No use of fossil fuels in the baseline. This case applies because no fossil fuels would be used for electricity generation in the baseline scenario at the project site (Greenfield project).
In this case, $EG_{BL,FF,y}$ = 0.

Step 1.5: Determination of $EG_{BL,grid,y}$

The minimum amount of electricity that would be generated by power plants in the electricity grid in the baseline ($EG_{BL,grid,y}$) should, in accordance with the baseline scenario, be determined as follows:

Case 2: No electricity generation at the project site in the baseline. If no power plants would be operated at the project site in the baseline, then all electricity generated by the project displaces grid electricity and $EG_{BL,grid,y}$ = $EG_{PJ,y}$.

Step 1.6: Determination of $EG_{BL,FF/grid,y}$

$EG_{BL,FF/grid,y}$ represents the amount of electricity that could be generated in the baseline in the grid or at the project site using fossil fuels. $EG_{BL,FF/grid,y}$ corresponds to the remainder of electricity generation, i.e. the amount that exceeds the minimum amount of electricity that would be generated by power plants in the electricity grid ($EG_{BL,grid,y}$), the minimum amount of electricity that could be generated with fossil fuels at the project site ($EG_{BL,FF,y}$), and the amount of electricity that would be generated with biomass residues at the project site ($EG_{BL,BR,y}$). Accordingly, $EG_{BL,FF/grid,y}$ is calculated as follows:

Equation 24 of ACM0018

$$EG_{BL,FF/grid,y} = EG_{PJ,y} - EG_{BL,BR,y} - EG_{BL,FF,y} - EG_{BL,grid,y}$$

Where:
$EG_{BL,FF/grid,y}$ = Amount of electricity that could be generated in the baseline either by power plants in the electricity grid or by power plants at the project site using fossil fuels in year *y* (MWh)
$EG_{PJ,y}$ = Electricity generated in power plants included in the project boundary in year *y* (MWh)
$EG_{BL,BR,y}$ = Amount of electricity that would be generated with biomass residues in power-only plants operated at the project site in the baseline in year *y* (MWh)
$EG_{BL,FF,y}$ = Minimum amount of electricity that would be generated with fossil fuels at the project site in the baseline in year *y* (MWh)
$EG_{BL,grid,y}$ = Minimum amount of electricity that would be generated by power plants in the electricity grid in the baseline in year *y* (MWh)

Since the project activity consist in the installation of a power plant in a site where no power generation with biomass or fossil fuel exists $EG_{BL,BR,y}$ and $EG_{BL,FF,y}$ are equal to 0 and $EG_{PJ,y}$ = $EG_{BL,grid,y}$.
Then: $EG_{BL,FF,grid,y}$ = 0.

Step 1.7: Determination of $EF_{BL,FF,}$

Since there is no power generation at the project site in the baseline, then emission factor for electricity generation with fossil fuels in power plant(s) at the project site in the baseline in year *y* ($EF_{BL,FF,y}$) is equal to 0.

Step 1.8: Determination of $EF_{grid,CM,y}$

The emission factor is calculated in a transparent and conservative manner as a Combined Margin (CM). CM consists in the combination of operating margin and build margin in accordance with the "Tool to calculate the emission factor of an electricity system", version 07.0, which includes six steps to be applied:

Step 1. Identify the relevant electricity systems.
Step 2. Choose whether to include off-grid power plants in the project electricity system (optional)
Step 3. Select a method to determine the operating margin (OM).
Step 4. Calculate the operating margin emission factor according to the selected method.
Step 5. Calculate the build margin (BM) emission factor.
Step 6. Calculate the combined margin (CM) emissions factor.

The steps and formulae used to estimate baseline emissions and project emissions of the proposed project activity are described below:

Step 1. Identify the relevant electric systems

The Chilean energy system has experienced some changes in the recent years. Before 2017 there were four interconnected systems that operated in isolation from the others, but that year, the two main ones - the Central Interconnected System (SIC) and the Norte Grande Interconnected System (SING), were connected to form the National Electric System (SEN). All of them operate independently and do not transfer electricity to each other, so neither imports nor exports are observed in any of the mentioned systems.

Due to the location of the project activity, it is connected to the SEN electricity system so it has been identified as the project electricity system and all the necessary information of the power plants within the SEN, will be considered to calculate the build margin and the operating margin emission factor.

The SEN system is the biggest grid in the country, which has total installed power of 24,736 MW of which 27.0% are hydroelectric. In the year 2019, the whole system generated 77,094.6 GWh[17].

The Project Developer chose to determine the CO_2 emission factor by calculating the Operating and Build Margin coefficients of the SEN of 2019 grid based on the combined margin method consisting of the combination of operating margin (OM) and build margin (BM).

Baseline emissions for this project activity are the amount of electricity (kWh) produced and injected to the grid multiplied with the emission factor of the SEN grid (2019) from which power will be displaced

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

[17] Source: https://www.cne.cl/estadisticas/electricidad/

To calculate the operating margin and build margin emission factors, the chosen method is Option I: Only grid power plants are included in the calculation.

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

For the selection of the OM Low-Cost/Must-Run share of the total year generation is analysed as stated in paragraph 40, Requirement A, Approach 1. In this case, less than 50% of the grid's electricity comes from low-cost must-run sources.

Chilean Energy System	**Low-Cost/Must-Run share of the total year generation**				
Year	2015	2016	2017	2018	2019
SEN	39.0%	34.1%	38.5%	45.5%	44.0%

The method selected from the "Tool to calculate the emission factor for an electricity system" V 07.0 is the Simple OM to the second crediting period.

The data vintage chosen for the calculation of the OM emission factor is the ex-ante option, where calculations are based on a 3-year generation-weighted average and the most recent data (2017, 2018 and 2019) available at the time of submission of the CDM-PDD to the DOE for validation. The emission factor is calculated ex-ante, without requirement to monitor and recalculate the emission factor during the crediting period.

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

For the calculation of the OM, official data from the CNE (National Commission of Energy) of energy generation per power plant and energy consumption was used to calculate the simple OM using the Option A of the paragraph 47.

Hence, the OM was calculated using the Simple OM method described in the applied methodological tool, using the following equation:

$$EF_{grid,OMsimple,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

The three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex-ante option).

The CO_2 emission factor of each power unit is determined using options A1, A2 or A3, as indicated in the "Tool to calculate the emission factor of an electricity system" using the most recent historical year (2017, 2018 and 2019) for which power generation data is available.

Option A1. If for a power unit *m* data on fuel consumption and electricity generation is available, the emission factor should be determined as follows:

Equation 4 of the Tool to calculate the emission factor for an electricity system

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \times NCV_{i,y} \times EF_{CO2,i,y}}{EG_{m,y}}$$

$EF_{EL,m,y}$:	CO_2 emission factor of power unit *m* in year *y* (tCO_2/GWh)
$FC_{i,m,y}$:	Amount of fossil fuel type *i* consumed by power unit *m* in year *y* (mass or volume unit)
$NCV_{i,y}$:	Net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ / mass or volume unit)
$EF_{CO2,i,y}$:	CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)
$EG_{m,y}$:	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
m:	All grid power units serving the grid in year *y*, except low-cost/must-run power units
i:	All fossil fuel types combusted in power unit *m* in year *y*
y:	The three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex-ante option).

When using option A1, data on fuel consumption of a particular power plant/unit ($FC_{i,m,y}$) can be obtained from two different sources that present the information in different ways:

1) Total amount of fuel in mass units (kg or m3), from CNE; or
2) Specific Fuel Consumption in mass units over energy units (kg/MWh or m3/MWh), from CNE. In this case fuel consumption is calculated multiplying the presented value and the total electricity generated by the power plant/unit.

When for a power plant/unit data from both sources is available, the first one is preferred over the second one.

<u>Step 5.</u> Calculate the build margin (BM) emission factor

The BM emission factor is determined in accordance to Option 1 of the "Tool to calculate the emission factor of an electricity system", where for the first crediting period the build margin emission factor is calculated ex-ante based on the most recent information available (2019) on units already built for sample group *m* at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the BM emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the BM emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

The sample group of power units *m* used to calculate the build margin is determined as per the following procedure provided in the "Tool to calculate the emission factor for an electricity system v.7.0":

- **(a)** Identify the set of five power units, excluding units registered as CDM project activities, that started to supply electricity to the grid most recently ($SET_{5\text{-units}}$) and determine their annual electricity generation ($AEG_{SET5\text{-units}}$ in MWh);
- **(b)** Determine the annual electricity generation of the project activity system, excluding power units registered as CDM project activities (AEG_{total}, in MWh). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of AEG_{total} (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) ($SET_{\geq 20\%}$) and determine their annual electricity generation, $AEG_{SET\geq 20\%}$ in MWh)
- **(c)** From SET $AEG_{SET5\text{-units}}$ and $SET_{\geq 20\%}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample});

Identify the date when the power units in SET_{sample} started to supply electricity to the grid.
If none of the power units in SETsample started to supply electricity to the grid more than 10 years ago, then use SETsample to calculate the build margin. Ignore steps (d), (e) and (f).

The $SET_{\geq 20\%}$ was selected as the SET_{sample} because it is the set of power units that comprises the larger annual generation (compared to $SET_{5\text{-units}}$).
The SET $_{\geq 20\%}$ consist in the power units (excluding CDM project activities) that started to supply electricity to the system most recently and that comprises the 20 % of the annual total electricity generation in the system excluding electricity generated by CDM project activities.
None of the power units in SET_{sample} started to supply electricity to the grid more than 10 years ago therefore steps (d), (e) and (f) are ignored.

The build margin emission factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units *m* during the most recent year *y* (2019) for which power generation data is available, calculated as follows:

Equation 15 of the Tool to calculate the emission factor for an electricity system

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:

$EF_{grid,BM,y}$:	Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EG_{m,y}$:	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
$EF_{EL,m,y}$:	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
m :	Power units included in the build margin
y :	Most recent historical year for which power generation data is available

The CO_2 emission factor of each power unit *m* ($EF_{EL,m,y}$) can be determined using options A1, A2 or A3 (represented by Equation 1, Equation 2 and Equation 3 of Tool to calculate the emission factor for an electricity system), using for *y* the most recent historical year (2019) for which power generation data is available, and using for *m* the power units included in the build margin as explained in Step 5. In this case, option A1 was used.

Step 6. Calculate the combined margin (CM) emissions factor.

The calculation of the combined margin (CM) emission factor ($EF_{grid,CM,y}$) is based on method (a) Weighted average CM as follows:

Equation 16 of the Tool to calculate the emission factor for an electricity system

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

Where:

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

The default values established in the “Tool to calculate the emission factor for an electricity system” for the weighting of the OM (w_{OM} = 25%) and for the weighting of the BM (w_{BM} = 75%), are used in the calculation of the baseline emission factor, as stated in the “Tool to calculate the emission factor of an electricity system”.

Step 2: Determination of baseline emissions due to uncontrolled burning or decay of biomass residues ($BE_{BR,y}$)

To include baseline emissions due to uncontrolled burning or decay of biomass residues is optional and project participants decided to include these emission sources in the calculations.
Baseline emissions due to uncontrolled burning or decay of biomass residues are determined for categories of biomass residues for which B1, B2 or B3 has been identified as the most plausible baseline scenario, as summarized in Table 6.
The emissions are 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:

Equation 26 of ACM0018

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

Where:

$BE_{BR,y}$ = Baseline emissions due to uncontrolled burning or decay of biomass residues in year y (tCO_2)

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

Step 2.1: Determination of $BE_{BR,B1/B3,y}$

For the biomass residues categories, as described in the biomass residues categories table, for which the most likely baseline scenario is either that the biomass 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), baseline emissions are calculated assuming, for both scenarios (aerobic decay and uncontrolled burning), that the biomass residues would be burnt in an uncontrolled manner.

Baseline emissions are calculated by multiplying the quantity of biomass residues with the net calorific value and an appropriate emission factor, as follows:

Equation 27 of ACM0018

$$BE_{Br,B1/B3,y} = GWP_{CH4} \times \sum_{n} BR_{n,B1/B3,y} \times NCV_{n,y} \times EF_{BR,n,y}$$

Where:

$BE_{BR,B1/B3,y}$ = Baseline emissions due to aerobic decay or uncontrolled burning of biomass residues in year y (tCO_2)

GWP_{CH4} = Global Warming Potential of methane valid for the commitment period (tCO_2/tCH_4)

$BR_{n,B1/B3,y}$ = Amount of biomass residues category n used in the project plant included in the project boundary in year y for which scenario B1 or B3 has been identified as the most plausible baseline scenario (tones on dry-basis)

$NCV_{n,y}$ = Net Calorific Value of the biomass residues category n in year y (GJ/tones 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	= Categories of biomass residues

Referenced default values for CH_4 emission factor will be used. According to ACM0018 it is recommended to use 0.0027 t CH_4 per ton of biomass as default value for the product of NCV_k and $EF_{burning,CH4,y}$.

According to the methodology, if the default CH_4 emission factor of 0.0027 t CH_4/t biomass is used, the uncertainty can be deemed to be greater than 100%, and a conservativeness factor of 0.73 must be applied resulting a CH_4 emission factor of 0.001971 tCH_4/ t biomass.

Step 2.2: Determination of $BE_{BR,B2,y}$

For the biomass residues categories, as described in the biomass residues categories table, for which the most likely baseline scenario is that the biomass residues would decay under clearly anaerobic conditions (case B2), project participants shall calculate baseline emissions using the latest approved version of the tool "Emissions from solid waste disposal site".

Since no biomass residues of case B2 are used by the project activity, baseline emissions due to decay under anaerobic conditions will not be claimed.

This is conservative. Finally $BE_{BR,B2,y}$ = 0.

Project Emissions

Project emissions are calculated as follows:

Equation 28 of ACM0018

$$PE_y = PE_{FF,y} + PE_{EL,y} + PE_{TR,y} + PE_{BR,y} + PE_{WW,y} + PE_{BG2,y} + PE_{BC,y}$$

Where:

PE_y	= Project emissions during year y (tCO_{2e})
$PE_{FF,y}$	= Emissions during the year *y* due to fossil fuel consumption (tCO_2)
$PE_{EL,y}$	= Emissions during the year *y* due to electricity use off-site for the processing of biomass residues (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 (t CO_2e)

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

Determination of PE_{FFy}

The following emission sources should be included in determining $PE_{FF,y}$:

- Emissions from on-site fossil fuel consumption for the generation of electric power. This includes all fossil fuels used at the project site in heat generators (e.g. boilers) for the generation of electric power;
- Emissions from on-site fossil fuel consumption of auxiliary equipment and systems related to the generation of electric power. This includes fossil fuels required for the operation of auxiliary equipment related to the power plants (e.g. for pumps, fans, cooling towers, instrumentation and control, etc.) which are not accounted in the first bullet;
- Fossil fuels required for the operation of equipment related to the on-site or off-site preparation, storage, processing and transportation of fuels and biomass residues (e.g. for mechanical treatment of the biomass, conveyor belts, driers, etc.);
- If any fossilized or non-biodegradable materials are used in the processing of biomass residues and incorporated in the processed biomass residues (e.g. binders) then emissions arising from those materials should be accounted for when the processed biomass residues are combusted. For that purpose, those materials should be deemed as fossil fuels. If net calorific values, carbon content and/or emission factors of those materials are available they could be used, otherwise the net calorific values, carbon content and/or emission factors of the most carbon intensive fossil fuel available in the country should be used.

$PE_{FF,y}$ emissions should be calculated following procedures described in the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”, version 03, for all the *j* processes mentioned above as follows:

Equation 1 of Tool to calculate project or leakage CO_2 emission from fossil fuel combustion

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

Where:

(In the tool $PE_{FF,y}$ parameter is named as $PE_{FC,i,y}$, therefore for now on $PE_{FC,I,y}$ will be used)

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

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

$COEF_{i,y}$ = Is the CO_2 emission coefficient of fuel type i in year y (tCO_2/mass or volume unit)
i = Are the fuel types combusted in process j during the year *y*

According to the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" $COEF_{i,y}$ the CO_2 emission coefficient $COEF_{i,y}$ can be calculated using one of the following two Options, depending on the availability of data on the fossil fuel type i, as follows:

Option A: The CO_2 emission coefficient $COEF_{i,y}$ is calculated based on the chemical composition of the fossil fuel type i, using the following approach:

If $FC_{i,j,y}$ is measured in a mass unit:

Equation 2 of Tool to calculate project or leakage CO2 emission from fossil fuel combustion

$$COEF_{i,y} = w_{C,i,y} \times 44/12$$

If $FC_{i,j,y}$ is measured in a volume unit:

Equation 3 of Tool to calculate project or leakage CO_2 emission from fossil fuel combustion

$$COEF_{i,y} = w_{C,i,y} \times \rho_{i,y} \times 44/12$$

Where:
$COEF_{i,y}$ = Is the CO_2 emission coefficient of fuel type i (tCO_2/mass or volume unit)
$W_{C,i,y}$ = Is the weighted average mass fraction of carbon in fuel type i in year y (tC/mass unit of the fuel)
ρ $p_{i,y}$ = Is the weighted average density of fuel type i in year y (mass unit/volume unit of the fuel)
i = Are the fuel types combusted in process j during the year y.

Option B: The CO_2 emission coefficient $COEF_{i,y}$ is calculated based on net calorific value and CO_2 emission factor of the fuel type i, as follows:

Equation 4 of Tool to calculate project or leakage CO_2 emission from fossil fuel combustion

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y}$$

Where:
$COEF_{i,y}$ = Is the CO_2 emission coefficient of fuel type i (tCO_2/mass or volume unit)
NCVi,y = Is the weighted average net calorific value of the fossil fuel type i in year y (GJ/mass or volume unit)
$EF_{CO2,i,y}$ = Is the weighted average CO_2 emission factor of fuel type i in year y (tCO_2/GJ) i = Are the fuel types combusted in process j during the year y.
i = Are the fuel types combusted in process j during the year y.

As data for the option A is not available option B is used.

Determination of PE_{ELy}

Emissions should be included that result from the generation of electric power required for the operation of equipment related to the off-site preparation, processing, storage and transportation of biomass residues (e.g. for mechanical treatment of the biomass, conveyor belts, driers, pelletization, shredding, briquetting processes, etc.). The latest approved version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" should be used to calculate $PE_{EL,y.}$ Note that the electric power used on-site for the purposes described above are already accounted as part of $EG_{PJ,aux,y}$. $PE_{EL,y}$ should account thus only for the off-site use of electricity.

According to the Methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" version 03, the following procedure should be applied in order to calculate $PE_{EL,y}$:

The following generic approach to calculate project emissions from consumption of electricity should be used:

Equation 1 of Tool to calculate Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y})$$

Where:

$PE_{EC,y}$:	Project emissions from electricity consumption in year y (tCO_2/yr)
$EC_{PJ,j,y}$:	Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr)
$EF_{EL,j,y}$:	Emission factor for electricity generation for source j in year y (tCO_2/MWh)
$TDL_{j,y}$:	Average technical transmission and distribution losses for providing electricity to source j in year y.
j:	Sources of electricity consumption in the project.

The emission factor ($EF_{EL,j,y}$) can' t be determined ex-ante because according to the applicable tool: "The determination of the emission factors for electricity generation ($EF_{EL,j/k/l,y}$) depends on which scenario (A, B or C) applies to the source of electricity consumption".

This generic approach is based on the quantity of electricity consumed, an emission factor for electricity generation.
Since currently all the biomass consumed by the project does not considers any pre-treatment, off-site electricity consumption is equal to zero.

The emission factor ($FE_{EL,j,y}$) can' t be determined ex-ante because according to the applicable tool: "The determination of the emission factors for electricity generation ($EF_{EL,j/k/l,y}$) depends on which scenario (A, B or C) applies to the source of electricity consumption".

For $TDL_{j,y}$, the same situation occurs, it is not possible to fix an ex-ante value because currently the project doesn’t consider any electricity consumptions for preparation or off-site pre-treatment of biomass residues.

Determination of PE_{TRy}

Since biomass residues are not generated directly at the project site, CO_2 emissions resulting from transportation of the biomass residues to the project plant are calculated using the latest version of the tool “Project and leakage emissions from transportation of freight” v.1.1.0.
According to this tool project participants may use two options to determine project or leakage emissions from road transportation of freight: monitoring fuel consumption (Option A) or using conservative default values (Option B).

The option selected to determine $PE_{TR,y}$ is option B as follows:

Option B. Using conservative default values

Under this option, the following data shall be monitored separately for each freight transportation activity *f* to estimate the 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 ($D_{f,m}$); and
- The vehicle class used.

This tool defines two vehicle classes based on their gross vehicle mass:
- **Light vehicles.** Vehicles with a GVM being less or equal to 26 tonnes;
- **Heavy vehicles.** Vehicles with a GVM being higher than 26 tonnes.

Project or leakage emissions are determined as follows:

Equation 1 of Tool to calculate project or leakage emissions from road transportation of freight

$$PE_{TR,y} = \sum_{f} D_{f,m} \times FR_{f,m} \times EF_{CO2,f} \times 10^{-6}$$

Where:

$PE_{TR,m}$	= Project emissions from road transportation of freight monitoring period *m* (t CO_2)
$LE_{TR,m}$	= Leakage emissions from road transportation of freight monitoring period *m* (t CO_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* in monitoring period *m* (t)
$EF_{CO2,f}$	= Default CO_2 emission factor for freight transportation activity *f* (g CO_2 / t km)
f	= Freight transportation activities conducted in the project activity in monitoring period *m*

Determination of $PE_{BR,y}$

According to the methodology, since CH_4 emissions due to uncontrolled burning or decay of biomass residues ($BE_{BR,y}$) are included in the calculations of the baseline emissions, then CH_4 emissions from the combustion of biomass residues must be considered in the project emissions calculations.

Corresponding emissions are calculated as follows:

Equation 29 of ACM0018

$$PE_{BR,y} = GWP_{CH4} \times EF_{CH4,BR} \times \sum_{n} BR_{PJ,n,y} \times NCV_{n,y}$$

Where:

$PE_{BR,y}$	= Emissions from the combustion of biomass residues during the year *y* (tCO_2)
GWP_{CH4}	= Global Warming Potential for methane valid for the relevant commitment period (tCO_2/tCH_4)
$EF_{CH4,BR}$	= 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 power plants which are located at the project site and included in the project boundary in year y (tonnes on dry-basis/yr)
$NCV_{n,y}$	= Net calorific value of the biomass residues category n in year y (GJ/tonnes on dry-basis)

In order to calculate those emissions, a 30 kg/TJ default value from IPCCC for the CH_4 emission factor. As the uncertainty of the CH_4 emission factor is in many cases relatively high, a conservativeness factor must be applied.

According to the methodology, where the default CH_4 emission factor of 30 kg/TJ from IPCC is used, the uncertainty is estimated to be 300%, resulting in a conservativeness factor of 1.37. Thus, in this case a CH_4 emission factor of 41.1 kg/TJ will be used.

Determination of $PE_{WW,CH4,y}$

Since there is not a treatment of biomass residues considered in the process, emissions from anaerobic treatment of wastewater originating from the treatment of the biomass residues prior to their combustion doesn't apply for the project activity, therefore $PE_{ww,y}$ = 0.

Leakage

The main potential source of leakage for this project activity is an increase in emissions from fossil fuel combustion or other sources due to diversion of biomass residues from other uses to the project plant as a result of the project activity. Changes in carbon stocks in the LULUCF sector are expected to be insignificant since this methodology is limited to biomass residues, as defined in the applicability conditions above. The baseline scenarios for biomass residues for which this potential leakage is relevant is B5.

Table 15 Baseline scenarios for biomass residues:

Biomass type	Identified baseline scenarios
Forestry residues	B1: Dumped or left to decay mainly under aerobic conditions.
Agriculture residues (cereal straw and husks)	B3: Uncontrolled burn.

As shown in the Table 15, neither of the baseline scenarios that consider leakage (B5) are involved, then leakage is 0.

In accordance with ACM0018 version 4.0, residues categories for which scenarios B1 and B3, is deemed a plausible baseline alternative, project participants should demonstrate that this is a realistic and credible alternative scenario. For each biomass residues category one of the following procedures should be applied:

a) Demonstrate that there is an abundant surplus of the type of biomass residue in the region of the project activity which is not utilized. For this purpose, demonstrate that the quantity of that type of biomass residues available in the region is at least 25% larger than the quantity of biomass residues of that type which is utilized in the region (e.g. for energy generation or as feedstock), including the project plant;

b) Demonstrate for the sites from where biomass residues are sourced that the biomass residues have not been collected or utilized (e.g. as fuel, fertilizer or feedstock) but have been dumped and left to decay, land-filled or burnt without energy generation (e.g. field burning) prior to their use under the project activity. This approach is only applicable to biomass residues categories for which project participants can clearly identify the site from where the biomass residues are sourced.

The following analysis intends to demonstrate alternative baseline scenarios for biomass types that fulfill approach (a) or (b) as mentioned above:

The following categories of biomass used in the project fulfill approach (a):

i. Forestry residues:

- From sawmills:

This type of biomass consist in residues like shavings, sawdust, bark and other woody residues generated at sawmills from the logging industry developed in La Araucanía region. Some part of this residues is autoconsumed at sawmills facilities to generate heat energy for their own wood drying process.

According to the most recent public information, the following table describes the quantity of residues generated at sawmills which is available for energy purposes and the amount of residues that are used in sawmills for power and/or heat generation:

Table 16. Availability of sawmill residues for energy purposes[18]:

Sawmill residues available in La Araucanía Region (m3ssc)	699,658
Autoconsumption in La Araucanía Region (m3ssc)	201,856
Consumption of Sawmill Residues by Lautaro Project (m3ssc)	279,852
Residues available in the region / Residues used > 1.25	**1.45**

The identified baseline scenario for this biomass type is B1 (left to decay in aerobic conditions) which can be demonstrated because the biomass residues produced at sawmills are 45% larger than the quantity of biomass residues of that type which is used including the project activity and this excess proves that there is not a diversion of biomass residues from other uses to the project plant as a result of the project activity.

- From forestry management:

The project also consumes residues produced from forestry management. Those residues remain on the forest ground after the forestry management activities and consist in woody material which can be collected and fired into the boiler.

In La Araucanía region, the forest is composed by Eucalyptus, Radiata pine and exotic species from the native forest. Some areas of the native forest are protected by SNASPE (System of National Wild Areas Protected by the State) and therefore not all the residues from the native forest are available for being utilized. As a conservative approach none of the total surface of the native forest will be considered as source of biomass in this analysis although in the practice some part (the not protected part) of it could be a source for the project activity.

[18] Residues from sawmills, data from INFOR. https://wef.infor.cl/publicaciones/subproductos_aserrio/2019/subproductos_aserrio2019.pdf f

Forestry management for the Radiata Pine and Eucalyptus plantations, involve the following activities from which forestry biomass residues can be obtained[19]:

Radiata Pine:

- Harvest
- Thinning for waste
- Thinning for market
- Prunning (In this case, this activity is excluded as a biomass source because the main residues involved are branches which are not used in the project activity).

Eucalyptus:

- Harvest
-

A large quantity of forestry biomass residues remains in the forest ground after each one of those activities Harvest considers a large generation of biomass residues but there are also other important activities that generates biomass residues like thinning and pruning. Since Pruning doesn't generate the kind of biomass residues used in the project activity (it produces mainly branches), those residues are not considered in this analysis.

Thinning for waste is a forestry intervention intended to remove some planted threes with the purpose of helping promises ones to grow better. It is carried out at a short age of the three and doesn't produce feedstock for the industry but instead it produces a large quantity of residues in the ground of the forest. "Thinning for market" produces feedstock for the wood panels, pulp and other related industries, but also generates biomass residues available for the project as shown in the following table:

Table 17 Residues produced from forestry management practices in La Araucanía Region:

Forestry management practice	m^3 ssc (solids without bark) (year 2011)
Radiata Pine Harvest	917,421
Eucalyptus Harvest	647,776
Radiata Pine Thining for waste	13,915
Radiata Pine Thinning for market	119,275
Total of Residues available for Lautaro Generation Project	1,698,386

The amount of residues presented in Table 17 consists in all the biomass residues (except branches from pruning which the project doesn't use) that are available for energy purposes for the year 2017

[19] Activities of Forestry management and quantities of residues obtained from them are described in a study called "Forestry Biomass Potential" made in Chile by the National Commission of Energy in conjunction with the German technical cooperation agency (gtz) in the year 2008.

(kast year of the project) according to a projection made using a study made by the government and other institutions.[20]

Table 18 Availability of forestry biomass residues for energy purposes

Residues from forestry management of Radiata Pine in La Araucanía Region (m3ssc[21])	1,698,386
Consumption of residues from forestry management by Lautaro Project (m3ssc)	146,955
Residues available in the region / Residues used > 1.25	**11.56**

Then, there is an abundant surplus of biomass residues available from the forestry management produced in the region and no leakage must be considered.

ii. Agricultural residues:

- Cereal Straw

In La Araucanía Region there was an annual surface of approximately 160,845 Ha of cereal crops in 2020 from which the wheat represents more than the 50% of the crops with 82,895 Ha, followed by oat with 51,037 Ha, other cereals including Tritricale with 15,387 Ha and barley with 11,417 Ha cultivated.[22]

The availability of straw that remain on fields and then it is burned depends on the yield of the crop, for the estimation effects, it is considered a straw density in the swath of 2,000 kg of wheat per hectare (as a conservative approach)[23].

The straw left in the wheat stubbles after harvest presents great difficulties to the following tillage or direct seeding operations. In Chile, the common practice is to burn on fields the straw that remains after the harvest (estimated to be 90%) and only during cold seasons a small fraction can be used for fodder.

As a conservative approach for the estimation of availability of straw, only wheat and “other cereals including Tritricale” are considered and the total availability of straw calculated is shown in the following table:

[20] Source: Projected annual volume of residues obtained after forestry management of Radiata Pine and Eucalyptus. Data extracted from the study “Potential of Forestry Biomass” by CNE and GTZ. CD-ROM page 81 and file “Estadísticas Forestales 2020

[21] SSC: solids without bark.

[22] Source: Agricultural Statistics 2020, Oficina de Estudios y Políticas Agrarias (Odepa) del Ministerio de Agricultura, Gobierno de Chile. Link: https://www.odepa.gob.cl/estadisticas-del-sector/estadisticas-productivas

[23] Source: Study ”Straw availability in the wheat stubbles of three provinces of Chile”, page 397.

Table 19 Availability of cereal straw in the region:

Cereal straw available in La Araucanía Region (tonnes/year)	196,564
Utilization of cereal straw for animal feeding (approx. 10%) (tonnes/year)	19,656
Consumption of cereal straw by Lautaro Project (tonnes/year)	50,264
Residues available in the region / Residues used > 1.25	**2.81**

There is a large excess of straw in the region therefore no leakage is considered for this type of biomass residues and baseline B3 (burn on fields) is demonstrated.

- Cereal Husks:

Project activity also uses cereal husks as a fuel and as there is no public data available, COMASA made its own research by making a field survey to oat (a kind of cereal) producers of the region.

The value was update using the surface of oat in the 2008-2009 campaign (when the "Report Availability of biomass in La Araucanía Region, by Rodrigo Izquierdo - from COMASA- was performed) against the surface of oat in the 2019-2020 campaign[24].

Results of oat husks availability are shown in the following table and it considers the remaining quantity of oat husk with no other uses than burning them:

Table 20 Availability of oat husk in the region:

Oat Husk available in La Araucanía Region (m3/year)	185,702
Consumption of cereal husks by Lautaro Project (m3/year)	122,290
Residues available in the region / Residues used > 1.25	**1.86**

There is an excess of 52% of oat husk in the region therefore scenario B3 (burning on fields) is demonstrated.

Finally, no leakage is considered for any type of biomass residues consumed by the project activity and $LE_y = 0$.

Emissions reductions

Emission reductions are calculated as follows:

Equation 1 of ACM0018

$$ER_y = BE_y - PE_y - LE_y$$

[24] Source: Agricultural Statistics 2020, Oficina de Estudios y Políticas Agrarias (Odepa) del Ministerio de Agricultura, Gobierno de Chile. Link: https://www.odepa.gob.cl/estadisticas-del-sector/estadisticas-productivas

Where:

ER_y = Emissions reductions during year *y* (tCO_2)
BE_y = Baseline emissions during year *y* (tCO_2)
PE_y = Project emissions during year *y* (tCO_2)
LE_y = Leakage emissions during year *y* (tCO_2)

B.6.2. Data and parameters fixed ex ante

Data/Parameter	**$EF_{grid,CM,y}$**
Data unit	tCO_{2e}/MWh
Description	CO_2 emission factor of the grid (SEN).
Source of data	Ex ante calculation according “Tool to calculate the emission factor for an electricity system” v.7.0
Value(s) applied	0.4117
Choice of data or measurement methods and procedures	This is the most reliable source of information.
Purpose of data	Baseline emissions calculation
Additional comment	N/A

Data/Parameter	**GWP_{CH4}**
Data unit	tCO_{2e}/tCH_4
Description	Global warming potential for methane valid for the relevant commitment period.
Source of data	IPCC
Value(s) applied	28 for the Fifth Assessment Report. Shall be updated according to any future COP/MOP decisions
Choice of data or measurement methods and procedures	This is the most reliable source of information.
Purpose of data	Baseline and project emissions calculation
Additional comment	N/A

Data/Parameter	**Biomass residues categories and quantities used for the selection of the baseline scenario selection and assessment of additionality**
Data unit	• Type (i.e. bagasse, rice husks, empty fruit bunches, etc.); • Source (e.g. 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); • Use in the project scenario (Scenarios P); • Quantity (tonnes on dry-basis) According to Table 6 Biomass residues categories consumed by the project activity
Description	Table with quantities of biomass residues categories used under the project activity and with their baseline scenario. The last column of Table 6 corresponds to the quantity of each category of biomass residues (tonnes). For the selection of the baseline scenario and demonstration of additionality, at the validation stage, an ex ante estimation of these quantities should be provided
Source of data	On-site assessment of biomass residues categories and quantities
Value(s) applied	Please refer to Table 6
Choice of data or measurement methods and procedures	Quantities of biomass residues were estimated by the project developer in order to generate the expected amount of energy. Baseline scenarios were selected based on the common practice in Chile.
Purpose of data	Baseline emissions calculation
Additional comment	Demonstration of the baseline scenarios for each biomass category is described in section B.6.1 for the leakage determination.

Data/Parameter	$EG_{m,y}$
Data unit	MWh
Description	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y.*
Source of data	CNE
Value(s) applied	Values in Table 37 of Appendix 4.
Choice of data or measurement methods and procedures	Data from CNE represents the most recent and reliable information available.
Purpose of data	Baseline emissions calculation
Additional comment	N/A

Data/Parameter	**$FC_{i,m,y}$**
Data unit	For Diesel and Coal: kg/year, for Natural Gas: m3/year. Residual Fuel Oil and IFO 180 consumption are not reported (no data available).
Description	Amount of fossil fuel type *i* consumed by power plant / unit *m* in year *y*
Source of data	CNE
Value(s) applied	Values in Table 37 of Appendix 4.
Choice of data or measurement methods and procedures	Data from CNE represents the most recent and reliable information available.
Purpose of data	Emission factor calculation
Additional comment	If information on annual fuel consumption for a specific power plant is not available from CEN, specific fuel consumption data reported by CNE in the CNE Definitive Technical Report (Half-Yearly). Data unit used is: For liquids and solids: kg/MWh, for gases: m3/MWh. Values are reported in Table 39 and Table 38 of Annex 3.

Data/Parameter	**$NCV_{i,y}$**
Data unit	For Diesel, IFO180, Residual Fuel Oil and Coal: [GJ/kg] and For Natural Gas: [GJ/m^3].
Description	Net calorific value (energy content) of fossil fuel type *i* in year *y*
Source of data	CNE Annual Energy Balance Report and IPCC revised guidelines (2006).
Value(s) applied	Values in Table A4-13. of Appendix 4.
Choice of data or measurement methods and procedures	Data from CNE represent the most reliable information available for national fuels, and IPCC represent the most reliable information available for default values and methodological requirements.
Purpose of data	Emission factor calculation
Additional comment	CNE Energy Balance Report includes Gross Calorific Values (GCV) for different types of fuel. These values were corrected to Net Calorific Values (NCV) based on IPCC assumption stating that for liquid and solid fuels NCV is 5% lower than GCV, and for gas fuels NCV is 10% lower than GCV.

Data/Parameter	**$EF_{CO2,i,y}$**
Data unit	tCO_2/GJ.
Description	CO_2 emission factor of fossil fuel type *i* in year *y*.
Source of data	IPCC revised guidelines (2006).
Value(s) applied	Values in Table 40 of Annex 3.
Choice of data or measurement methods and procedures	No other data is publicly available. For estimating emission factor for different
Purpose of data	Emission factor calculation
Additional comment	N/A

Data/Parameter	**Power plants Date of Build**
Data unit	Dimensionless
Description	Date of build/Operation start of each power plant
Source of data	CNE
Value(s) applied	Values in Table 39 of Annex 3.
Choice of data or measurement methods and procedures	Data from CNE represents the most recent and reliable information available.
Purpose of data	Emission factor calculation
Additional comment	N/A

Data/Parameter	**η_m**
Data unit	%
Description	Efficiency of power plant *m*
Source of data	Default values as per the Tool to calculate the emission factor for an electricity system
Value(s) applied	Values of Table 38 in Annex 3.
Choice of data or measurement methods and procedures	There are no other available data from local sources.
Purpose of data	Emission factor calculation
Additional comment	N/A

Data/Parameter	**$EF_{CO2,f}$**
Data unit	g CO_2 / t km
Description	Default CO_2 emission factor for freight transportation activity *f*
Source of data	As per the tool “Project and leakage emissions from road transportation of freight”
Value(s) applied	Light vehicles: 245 gCO_2/t km; Heavy vehicles: 129 gCO_2/t km.
Choice of data or measurement methods and procedures	As per the applicable tool.
Purpose of data	Project emissions calculation
Additional comment	N/A

B.6.3. Ex ante calculation of emission reductions

Baseline emissions

Baseline emissions calculation includes the following emissions sources:

- CO_2 emissions from fossil fuel power plants at the project site;
- CO_2 emissions from grid-connected fossil fuel power plants in the electricity system;
- CH_4 emissions from anaerobic decay of biomass residues and/or CH_4 emissions from uncontrolled burning of biomass residues without utilizing them for energy purposes.

Since the project activity is a Greenfield power plant then baseline emissions from fossil fuel power plants at the project site are equal to 0. Baseline emissions are then calculated through equation 2 of ACM0018, considering the following parameters and result:

Equation 2 of the ACM0018

$$BE_y = BE_{EL,y} + BE_{BR,y}$$

BE_y = 55,653 + 13,624

Table 21 Baseline emissions calculation

Baseline emissions sources	tCO2/year
Baseline emissions Due to electricity generation ($BE_{EL,y}$)	55,653
Baseline emissions from uncontrolled burning or decay of biomass residues ($BE_{BR,y}$)	13,624
Total Baseline emissions (BE_y)	69,277

As described in Section B.6, the following parameters must be determined in order to calculate baseline emissions:

1. **Determination of baseline emission due to generation of electricity ($BE_{EL,y}$)**

Baseline emissions due to generation of electricity are determined through equation 3 of ACM0018:

Equation 3 of ACM0018

$$BE_{EL,y} = EG_{PJ,y} \times EF_{BL,EL,y}$$

$BE_{EL,y}$ = 135,178 x 0.412

Table 22 Calculation of Baseline emission due to electricity generation

Parameter	Unit	Value
Net quantity of electricity generation by the project ($EG_{PJ,y}$)	MWh/year	135,178
Emission factor for electricity generation in the baseline ($EF_{BL,EL,y}$)	tCO_2e/MWh	0.412
Baseline emissions Due to electricity generation ($BE_{EL,y}$)	tCO_2e/year	55,653

2. Determination of $EG_{PJ,y}$

According to equation 4 of ACM0018:

$$EG_{PJ,y} = EG_{PJ,gross,y} - EG_{PJ,aux,y}$$

$EG_{PJ,y}$ = 153,265MWh – 18,087 MWh = 135,178 MWh

3. Determination of $EF_{BL,EL,y}$

As explained in Section B.6, parameters $EG_{BL,BR,y}$, $EG_{BL,FF,y}$, $EF_{BL,FF,y}$, $EG_{BL,ff,grid,y}$, of equation 5 of ACM0018 are equal to 0 since there is no electricity generation at the project site in the baseline. Then equation 5 of ACM0018 remains as follows:

Equation 5 of ACM0018

$$EF_{BL,EL,y} = \frac{EG_{BL,FF,y} \cdot EF_{BL,FF,y} + EG_{BL,grid,y} \cdot EF_{grid,CM,y} + EG_{BL,FF/grid,y} \cdot MIN\ (EF_{BL,FF,y}; EF_{grid,CM,y})}{EG_{BL,BR,y} + EG_{BL,FF,y} + EG_{BL,grid,y} + EG_{BL,FF/grid,y}}$$

Where:
$EF_{BL,EL,y}$ = Emission factor for electricity generation in the baseline in year y (tCO_2/MWh).
$EG_{BL,BR,y}$ = Amount of electricity that would be generated with biomass residues in power-only plants operated at the project site in the baseline in year y (MWh)
$EG_{BL,FF,y}$ = Minimum amount of electricity that would be generated with fossil fuels at the project site in the baseline in year y (MWh)
$EG_{BL,grid,y}$ = Minimum amount of electricity that would be generated by power plants in the electricity grid in the baseline in year y (MWh)

$EG_{BL,FF/grid,y}$ = Amount of electricity that could be generated in the baseline either by power plants in the electricity grid or by power plants at the project site using fossil fuels in year y (MWh)
$EF_{grid,CM,y}$ = Combined margin CO_2 emission factor for grid-connected electricity generation in year y (tCO_2/MWh)
$EF_{BL,FF,y}$ = CO_2 emission factor for electricity generation with fossil fuels in power plant(s) at the project site in the baseline in year y (tCO_2/MWh)

Then, $EF_{BL,EL,y}$ **=** $EF_{grid,CM,y}$ which is the Combined margin CO_2 emission factor is calculated in a transparent and conservative manner as a Combined Margin (CM). CM consists in the combination of operating margin and build margin which are calculated as follows:

3.1 Operating Margin Emission Factor

A transparent ex-ante calculation of the OM emission factor is presented below, applying all relevant equations presented in section B.6.1 above, provided in the “Tool to calculate the emission factor for an electricity system” and using the data presented in Appendix 4.

The values used for estimating the emission factor for each power unit included in the OM (except those considered as low-cost/must-run power sources since they represent an emission factor of 0 tCO_2/MWh) are exposed in the tables presented in Appendix 3 and depending on annual fuel consumption data availability options A1 is applied.An example of the calculation considering Option A1 is provided using 2019 data for Termoeléctrica Tarapacá power unit:

$$\mathbf{EF_{EL,m,y}} = (16{,}154{,}600 \text{ kg} \times 0.0278 \text{ GJ/kg} \times 0.0873 \text{ tCO}_2\text{/GJ}) / 36{,}842 \text{ MWh}$$

According to the data vintage chosen in Step 3 (ex-ante option), the Operating Margin emission factor is calculated as a 3-year generation-weighted average of the values for years 2017, 2018 and 2019.

Table 24: Operational Margin Emission Factors.

Year	Operational Margin Emission Factor $EF_{grid,OM-adj,y}$ [tCO2/MWh]	Energy Generated $\sum EG_{m,y}$ [MWh]
2017	0.6513	42,048,156
2018	0.7265	41,018,147
2019	0.7010	42,104,818

Table 25: Operating Margin Emission Factor.

Operating Margin Emission Factor
$EF_{grid,OM}$ [tCO2/MWh]

0.6926

3.2 Build Margin Emissions Factor

A transparent ex-ante calculation of the BM emission factor is presented below, applying all relevant equations presented in section B.6.1 above, provided in the "Tool to calculate the emission factor for an electricity system" and using the data presented in Annex 3.

The values used for estimating the emission factor for each power unit included in the BM are exposed in the tables presented in Annex 3 and depending on annual fuel consumption or specific fuel consumption data availability options A1 was applied.

$$EF_{BL,EL,y} = \frac{EG_{BL,FF,y} \cdot EF_{BL,FF,y} + EG_{BL,grid,y} \cdot EF_{grid,CM,y} + EG_{BL,FF/grid,y} \cdot MIN\ (EF_{BL,FF,y}; EF_{grid,CM,y})}{EG_{BL,BR,y} + EG_{BL,FF,y} + EG_{BL,grid,y} + EG_{BL,FF/grid,y}}$$

$EF_{EL,m,y}$ = (16,154,600 kg x 0.0278 GJ/kg x 0.0873 tCO_2/GJ)/ 36,842 MWh

Using the values presented in Appendix 3 the following value for the BM emission factor is calculated:

Table 26: Build Margin Emission Factor.

Build Margin Emission Factor $EF_{grid,BM}$ [tCO2/MWh]
0.3181

The detailed list of power units selected in the Build Margin and their data is presented in Table 39 of Annex 3.

3.3 Combined Margin Emission Factor

Using the $EF_{grid,OM}$ value, the $EF_{grid,BM}$ value and the weighting values of the OM (w_{OM} = 25%) and the BM (w_{BM} = 75%), the CM estimation is calculated as follows:

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

EF grid,CM = 0,25 x 0.6926 + 0,75 x 0.3181 = 0,4117 tCO2e/MWh

Table 27: Combined Margin Emission Factor.

Combined Margin Emission Factor $EF_{grid,2019}$ [tCO2/MWh]

0.4117

4. Determination of baseline emissions due to uncontrolled burning or decay of biomass residues ($BE_{BR,y}$)

Baseline Methane emissions are accounted for forestry and agricultural biomass residues which baseline scenario is B1 (aerobic decay) and B3 (uncontrolled burning) respectively.

According to equation 26 and 27 of ACM0018 baseline emissions $BE_{BR,y}$ are calculated as follows:

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

$$BE_{Br,B1/B3,y} = GWP_{CH4} \times \sum_{n} BR_{n,B1/B3,y} \times NCV_{n,y} \times EF_{BR,n,y}$$

$BE_{BR,B1/B3,y}$ = 28 tCO_2/tCH_4 x 246,872 Tonnes of dry biomass x 0.0027 x 0.73

Table 28 Calculation of Baseline emissions due to uncontrolled burning or aerobic decay of biomass residues ($BE_{BR,B1/B3,y}$)

Parameter	Unit	Value
NCV (dry basis) * $EF_{BR,n,y}$	tCH_4/tbiomass	0.0027
GWP of CH_4	tCO_2/tCH_4	28.00
Amount of biomass residues category n used in the project plant with scenario B1 and B3 ($BR_{n,B1/B3,y}$)	Tonnes of dry biomass	246,872
Conservativeness factor (uncertainty more than 100%)	-	0.73
Baseline emissions due to uncontrolled burning or aerobic decay of biomass ($BE_{BR,B1/B3,y}$)	tCO_2e/year	13,624

Since the no biomass residues under scenario B2 are identified, then $BE_{BR,B2,y} = 0$.

The total baseline emissions due to uncontrolled burning or decay (aerobic or anaerobic) of biomass residues are determined in the following table:

Table 29 Calculation of Baseline emissions due to uncontrolled burning or decay of biomass residues ($BE_{BR,y}$)

Parameter	tCO_2/year
Baseline emissions due to uncontrolled burning or aerobic decay of biomass residues ($BE_{BR,B1/B3,y}$)	13,624
Baseline emissions due to anaerobic decay of biomass residues ($BE_{BR,B2,y}$)	0
Baseline emissions due to uncontrolled burning or decay of biomass residues ($BE_{BR,y}$)	13,624

Project emissions

Project emissions are then calculated through equation 28 of ACM0018 considering the following parameters and result:

$$PE_y = PE_{FF,y} + PE_{EL,y} + PE_{TR,y} + PE_{BR,y} + PE_{WW,y} + PE_{BG2,y} + PE_{BC,y}$$

Table 30 Project emissions calculation

Project emissions sources	tCO_2/year
Project emissions Due to fossil fuel consumption at the project site ($PE_{FF,y}$)	1,461
Emissions due to electricity used off-site for the processing of biomass residues ($PE_{EL,y}$)	0
Emissions due to transport of the biomass residues to the project plant ($PE_{TR,y}$)	8,574
Emissions from the combustion of biomass residues ($PE_{BR,y}$)	4,116
Emissions from wastewater generated from the treatment of biomass residues ($PE_{ww,y}$)	0
Total Project emissions (PE_y)	**14,151**

As described in Section B.6, the following parameters must be determined in order to calculate Project emissions:

1 Determination of $PE_{FF,Y}$

The latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" was used to calculate $PE_{FF,y}$. The following combustion processes *j* were included in the calculation:

Table 31 Fossil fuel consumption at Lautaro power plant

Process *j*	Diesel consumption (l/year)
Generation of electricity for the operation of the water capture system c from the wells.	6,395
Generation of electricity with emergency generator equipment (as needed)	54,137
Loading of biomass (with a Front Loader 1)	120,884
Loading of biomass (with a Front Loader 2)	120,884
Manitou operation	57,631
Mechanical treatment of biomass with a Wood chipper (only as necessary for bigger wood residues)	125,257
Hydraulic excavator operation	45,449

The fossil fuel used to operate each equipment is Diesel. For further details about the fossil fuel consumption estimation of each item, please refer to the project spreadsheet.

Emissions due to fossil fuel consumption was calculated through equation of the Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion v.2 and $COEF_{i,y}$ according to the option B of the tool, through equation 4 of the tool:

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y}$$

$$COEF_{i,y} = 43\ TJ/Gg \times 74.1\ tCO_2/TJ$$

$$PE_{FF,y} = 530{,}636\ l/year \times 0.002753014\ tCO_2/l$$

Table 32 Calculation of Emissions due to fossil fuel (Diesel) consumption ($PE_{FF,y}$)

Parameter	Unit	Data
Total Diesel Consumption ($FC_{i,j,y}$)	l/year	530,636
$NCV_{i,y}$ (i=Diesel)	TJ/Gg	43.0
Density of Diesel	Kg/l	0.85
$EF_{CO2,i,y}$ (i=diesel)	tCO_2/TJ	74.1
$COEF_{i,y}$ (i=diesel)	tCO_2/l	0.00275
Project emissions due to fossil fuel consumption ($PE_{FF,y}$)	**tCO_2/year**	**1460.85**

2 Determination of $PE_{EL,Y}$

Currently the project does not consider any off-site electricity consumption therefore $PE_{EL,y} = 0$.
If in the future there is any off-site electricity consumption required for the operation of equipment related to the off-site preparation, processing, storage and transportation of biomass residues (e.g. for mechanical treatment of the biomass, conveyor belts, driers, pelletization, shredding, briquetting processes, etc.). Then the latest approved version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" should be used to calculate $PE_{EL,y}$.

According to equation 1 of the tool, $PE_{EL,y} = 0$, because the biomass residues consumed by the project activity does not consider any kind of processing for biomass residues before they enter to the project site.

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y})$$

Where:

$PE_{EC,y}$: Project emissions from electricity consumption in year y (tCO_2/yr)

$EC_{PJ,j,y}$: Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr)

$EF_{EL,j,y}$: Emission factor for electricity generation for source j in year y (tCO_2/MWh)

$TDL_{j,y}$: Average technical transmission and distribution losses for providing electricity to source j in year y.
j: Sources of electricity consumption in the project

The following table shows project emissions parameters considered in the calculation :

Parameter	Unit	Data
Quantity of electricity consumed by the off-site project electricity consumption source *j* ($EC_{PJ,j,y}$)	MWh/yr	0
Emission factor for electricity generation for source *j* ($EF_{EL,j,y}$)	tCO_2/MWh	Cannot be determined ex-ante
Average technical transmission and distribution losses for providing electricity to source *j*	%	Cannot be determined ex-ante
Project emissions due to off-site electricity consumption ($PE_{EL,j,,y}$)	tCO2/year	0

3 Determination of $PE_{TR,Y}$

All the biomass consumed by the project is produced off-site from different biomass suppliers in La Araucanía region (geographical region where the project is located).. In order to determine emissions due to transport of biomass, the tool “Project and leakage emissions from transportation of freight” v.1.1.0 was applied.

Please refer to section B.6.4 for further detail on the value applied for the quantity of freight transported ($FR_{f,m}$) and for the road distance between the origin and the destination ($D_{f,m}$).

An average on distance between origin (supplier site or source of biomass residues) and destination (which is Lautaro Plant) values available at the validation were used to calculate this project emissions. Equation 1 of the tool “Project and leakage emissions from transportation of freight” v.1.1.0 is used.

$$PE_{TR,y} = \sum_{f} D_{f,m} \times FR_{f,m} \times EF_{CO2,f} \times 10^{-6}$$

Where:
$PE_{TR,m}$ = Project emissions from road transportation of freight monitoring period *m* (t CO_2)
$LE_{TR,m}$ = Leakage emissions from road transportation of freight monitoring period *m* (t CO_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* in monitoring period *m* (t)
$EF_{CO2,f}$ = Default CO_2 emission factor for freight transportation activity *f* (g CO_2 / t km)
f = Freight transportation activities conducted in the project activity in monitoring period *m*

$\sum D_{f,m} * BR_{f,m}$ calculation is available in the ER calculation Spreadsheet.

$PE_{TR,y}$ = 35,788,681 Tonnes * km x 245 gCO_2/km*ton

For ex-ante calculations purpose, the default value emission factor for freight in light vehicles class was selected as it is the most conservative alternative but during the crediting period the class of the vehicle (truck) will be monitored for each transportation activity.

Parameters calculated are shown in the following table:

Table 33 Calculation of emissions due to transport of biomass

Parameter	Unit	Data
Sum of the product between roundtrip transportation distance and wet mass transported. ($\sum D_{f,m}$ * $BR_{f,m}$)	Tonnes × km	34,994,173
Default CO_2 emission factor for freight in light vehicles $EF_{f,CO2}$	gCO_2/km*ton	245
Project emissions due to biomass transportation ($PE_{FF,y}$)	**tCO_2/year**	**8,574**

For further detail on the estimation of emissions due to biomass transportation please refer to the "PDD calculations.xls" spreadsheet, "biomass suppliers" sheet.

4 Determination of $PE_{BR,Y}$

Project emissions due to the combustion of biomass at the project site are calculated according equation 29 of ACM0018.

$$PE_{BR,y} = GWP_{CH4} \times EF_{CH4,BR} \times \sum_{n} BR_{PJ,n,y} \times NCV_{n,y}$$

Where:

$PE_{BR,y}$	= Emissions from the combustion of biomass residues during the year *y* (tCO_2)
GWP_{CH4}	= Global Warming Potential for methane valid for the relevant commitment period (tCO_2/tCH_4)
$EF_{CH4,BR}$	= 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 power plants which are located at the project site and included in the project boundary in year y (tonnes on dry-basis/yr)
$NCV_{n,y}$	= Net calorific value of the biomass residues category n in year y (GJ/tonnes on dry-basis)

$\sum BR_{PJ,n,y} \times NCV_{n,y}$ calculation is available in the ER calculation Spreadsheet.

$PE_{BR,y}$ = 28 tCO_2/tCH_4 x 0.03 tCH_4/TJ x 3,585 TJ x 1.37

The following table shows data and parameters considered in the calculation:

Table 34 Project emissions due to combustion of biomass residues calculation

Parameter	Unit	Data
GWP_{CH4}	tCO_2/tCH_4	28
CH4 emission factor for the combustion of biomass residues in the project plant	tCH_4/TJ	0.03
Conservativeness factor	-	1.37
$\sum BR_{PJ,n,y} \times NCV_{n,y}$	TJ (dry basis)	3,576.8
Project emissions due to the combustion of biomass residues ($PE_{BR,y}$)	tCO2e/year	4,116

For further details about quantities of biomass residues and net calorific values considered for each type please refer to spreadsheet data of the project.

5 Determination of $PE_{WW,Y}$

As described in section B.6.1 the project activity does not involve any treatment to the biomass, therefore there is no wastewater generated.

Leakage emissions

As demonstrated in section B.6.1 there is an abundant surplus of biomass in La Araucanía region and there is diversion of biomass residues from other uses to the project plant as a result of the project activity. Forestry biomass used by the project activity would be left to decay and agricultural residues would be burnt on fields.

Therefore L_y = 0.

Emissions reductions

Emission reductions are calculated according to equation 1 of ACM0018 considering the following emissions from the Baseline, the project and Leakage:

$$ER_y = BE_y - PE_y - LE_y$$

ERy = 69,277 tCO_2e /year - 14,151 tCO_2e /year - 0

Table 35 Emission Reductions calculation:

Emissions	tCO_2e /year
Baseline emissions	69,277
Project emissions	14,151
Leakage	0
Emission reductions	**55,126**

Lautaro generation project will reduce 55,126 **tCO_2e per year.**

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

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
2020	63,504	12,972	0	50,532
2021	69,277	14,151	0	55,126
2022	69,277	14,151	0	55,126
2023	69,277	14,151	0	55,126
2024	69,277	14,151	0	55,126
2025	69,277	14,151	0	55,126
2026	69,277	14,151	0	55,126
2027	5,773	1,179	0	4,594
Total	484,939	99,057		385,882
Total number of crediting years	7			
Annual average over the crediting period	69,277	14,151	0	55,126

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data/Parameter	Biomass residues categories and quantities used in the project activity
Data unit	Type (i.e. bagasse, rice husks, empty fruit bunches, etc.); • Source (e.g. 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 (Scenario B); • Use in the project scenario (Scenario P); Quantity (tonnes on dry-basis)

Description	Explanation and documentation is provided transparently in the CDM-PDD, using Table 6, which quantities of which biomass residues categories are used in the project activity and what is their baseline scenario. The last column of Table 6 corresponds to the quantity of each category of biomass residues (tonnes on dry-basis). These quantities will be updated every year of the crediting period as part of the monitoring plan so as to reflect the actual use of biomass residues in the project scenario. These updated values should be used for emissions reductions calculations. Along the crediting period, new categories of biomass residues (i.e. new types, new sources, with different fate) can be used in the project activity. In this case, a new line should be added to the table. If those new categories are of the type B1:, B3:, the baseline scenario for those types of biomass residues should be assessed using the procedures outlined in the guidance provided in the procedure for the selection of the baseline scenario and demonstration of additionality.
Source of data	On-site measurements will be performed where the scale (for trucks) is located (at the entrance of the power plant). An Inspection will be made in order to register the type and source of biomass transported into the plant site by each truck.
Value(s) applied	Please refer to Table 6.
Measurement methods and procedures	The responsible person for this monitoring is the Scale Chief. Data is monitored continuously for each truck that transport biomass to the project site. The biomass inspection is made at the site where the scale (weight meter) is located where the biomass is weighted, the type of biomass is inspected and the source of the trucks are informed by the truck drivers in order to register data in a digital system called ERP Flexline. Fate in the absence of the project activity and use in the project scenario will be also monitored in order to built a table similar to Table 6 Biomass residues categories consumed by the project activity All data will be aggregated as appropriate, to calculate emissions reductions.. Moisture content is adjusted in order to determine the quantity of dry biomass.
Monitoring frequency	Data is monitored continuously for each truck that transport biomass to the project site
QA/QC procedures	Cross-check the measurements with an annual energy balance that is based on purchased quantities and stock changes
Purpose of data	Baseline emissions calculation
Additional comment	

Data/Parameter	**$BR_{PJ,n,y}$**
Data unit	Tonnes on dry basis
Description	Quantity of biomass residues of category n used in power plants which are located at the project site and included in the project boundary in year y
Source of data	On site measurements
Value(s) applied	Please refer to Table 6.

Measurement methods and procedures	A truck scale will be used and the moisture will be adjusted in order to determine the quantity of dry biomass. Data will be monitored continuously (for each truck that enters to the plant) and aggregated as appropriate to calculate emission reductions. The responsible person is the Scale Chief.
Monitoring frequency	Data will be monitored continuously (for each truck that enters to the plant) and aggregated as appropriate to calculate emission reductions.
QA/QC procedures	Measurements will be Cross-checked with an annual energy balance based on purchased quantities and stock changes
Purpose of data	Baseline emissions calculation
Additional comment	The biomass residue quantities used would be monitored separately for (a) each type of biomass residue (e.g. forestry biomass) and each source (e.g. produced on-site, obtained from biomass residues suppliers, obtained from a biomass residues market, obtained from an identified biomass residues producer, etc.)

Data/Parameter	**$BR_{n,B1/B3,y}$**
Data unit	Tonnes on dry basis
Description	Amount of biomass residues category n used in the project plant(s) included in the project boundary in year y for which B1 or B3 has been identified as the most plausible baseline scenario
Source of data	On site measurements
Value(s) applied	Please refer to Table 6.
Measurement methods and procedures	Weight meters will be used and the moisture will be adjusted in order to determine the quantity of dry biomass.
Monitoring frequency	Data will be monitored continuously and aggregated as appropriate to calculate emission reductions
QA/QC procedures	Measurements will be Cross-checked with an annual energy balance based on purchased quantities and stock changes
Purpose of data	Baseline emissions calculation
Additional comment	The biomass residue quantities used would be monitored separately for (a) each type of biomass residue (e.g. forestry biomass) and each source (e.g. produced on-site, obtained from biomass residues suppliers, obtained from a biomass residues market, obtained from an identified biomass residues producer, etc.)

Data/Parameter	**$BR,_{n,B2,y}$**
Data unit	Tonnes on dry basis
Description	Amount of biomass residues category n used in the project plant(s) included in the project boundary in year y for which B2 has been identified as the most plausible baseline scenario
Source of data	On site measurements

Value(s) applied	Since B2 scenario has been removed, the value of this parameter is zero as scenario B2 is not being considered
Measurement methods and procedures	Weight meters will be used and the moisture will be adjusted in order to determine the quantity of dry biomass.
Monitoring frequency	Data will be monitored continuously and aggregated as appropriate to calculate emission reductions.
QA/QC procedures	Measurements will be Cross-checked with an annual energy balance based on purchased quantities and stock changes
Purpose of data	Baseline emissions calculation
Additional comment	The biomass residue quantities used would be monitored separately for (a) each type of biomass residue (e.g. forestry biomass) and each source (e.g. produced on-site, obtained from biomass residues suppliers, obtained from a biomass residues market, obtained from an identified biomass residues producer, etc.)

Data/Parameter	**For biomass residues categories for which scenarios B1:, or B3: is deemed a plausible baseline alternative, project participants shall demonstrate that this is a realistic and credible alternative scenario**
Data unit	tonnes
Description	• Quantity of available biomass residues of 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 can not 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 from La Araucanía Region.
Value(s) applied	Please refer to section B.6.1, Determination of Leakage.
Measurement methods and procedures	The availability of a surplus of biomass residues type n will be demonstrated at the validation stage for biomass residues categories identified ex-ante, and always that new biomass residues categories are included during the crediting period
Monitoring frequency	N/A
QA/QC procedures	N/A
Purpose of data	Baseline emissions calculation
Additional comment	N/A

Data/Parameter	$EG_{PJ,gross,y}$
Data 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*
Source of data	On-site measurements.
Value(s) applied	153,265 MWh

Measurement methods and procedures	Data will be monitored continuously and aggregated as appropriate, to calculate emissions reductions. For this purpose a calibrated SEL 734 (or similar model) electricity meters will be installed at the Power plant substation as explained in section B.7.2. Accuracy class of the meters: 0.2 bidirectional In compliance with IEC 62053-22 and ANSI C12.20 0.2 international Standards. Calibration (Verification) frequency: At least once every 3 years. Responsible person for measurements: Electrical Supervisor.
Monitoring frequency	Data will be monitored continuously
QA/QC procedures	The consistency of metered electricity generation will be cross-checked with receipts from electricity sales (if available) and the quantity of fuels fired (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	Baseline emissions calculation
Additional comment	N/A

Data/Parameter	**$EG_{PJ,aux,y}$**
Data unit	MWh
Description	Total auxiliary electricity consumption required for the operation of the power plants at the project site
Source of data	On-site measurements.
Value(s) applied	18,087 MWh
Measurement methods and procedures	Data is monitored continuously with 2 calibrated electricity meters (as shown in Figure 8, section B.7.2 of the PDD) and aggregated as appropriate, to calculate emissions reductions. Electricity meter: SEL 734 (or similar model) Accuracy class: 0.2 bidirectional In compliance with IEC 62053-22 and ANSI C12.20 0.2 international Standards. Calibration (Verification) frequency: At least once every 3 years. Responsible person for measurements: Electrical Supervisor.
Monitoring frequency	Data is monitored continuously
QA/QC procedures	The consistency of metered electricity generation will be cross-checked with receipts from electricity sales (if available) and the quantity of fuels fired (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	Project emissions calculation
Additional comment	$EG_{PJ,aux,y}$ includes all electricity required for the operation of equipment related to the preparation,storage and transport of biomass residues (conveyor belts) and electricity required for the operation of the power plant at the project site and included in the project boundary (e.g. boiler auxiliary equipments, for pumps, fans, cooling towers, instrumentation and control, etc.)

Data/Parameter	**$NCV_{n,y}$**
Data unit	GJ/tonnes on dry-basis
Description	Net calorific value of biomass residues of category n in year *y*
Source of data	On-site measurements.
Value(s) applied	Please refer to Table 36 NCV and moisture content on biomass residues
Measurement methods and procedures	Measurements will be carried out at an external reputed laboratories (Concepción University lab if available) and according to relevant international standards. The NCV will be measured on dry-basis at least every six months, taking at least three samples for each measurement.
Monitoring frequency	It will be measured on dry-basis at least every six months
QA/QC procedures	The consistency of the measurements will be check 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) and default values by the IPCC. If the measurement results differ significantly from previous measurements or other relevant data sources, additional measurements will be conducted. NCV is determined on the basis of dry biomass
Purpose of data	Baseline emissions calculation
Additional comment	N/A

Data/Parameter	**Moisture content of the biomass residues**
Data unit	% Water content
Description	Moisture content of each biomass residues type *k*
Source of data	On-site measurements.
Value(s) applied	Table 36 NCV and moisture content on biomass residues
Measurement methods and procedures	The moisture content will be monitored for each batch of biomass of homogeneous quality in a laboratory that will be installed at the project site. The responsible for this monitoring activity will be the Laboratory Chief. The weighted average should be calculated for each monitoring period and used in the calculations.
Monitoring frequency	The moisture content will be monitored for each batch of biomass of homogeneous quality in a laboratory
QA/QC procedures	---
Purpose of data	Baseline emissions calculation
Additional comment	In case of dry biomass, monitoring of this parameter is not necessary.

Data/Parameter	**$EF_{BR,n,y}$**
Data unit	tCH_4/GJ
Description	CH_4 emission factor for uncontrolled burning of the biomass residues category n during the year y.

Source of data	Referenced default value will be used as per methodology: 0.0027 tCH_4 per ton of biomass as default value for the product $NCV_k \times EF_{burning,CH4,y}$
Value(s) applied	0.0027 tCH_4 per ton of biomass as default value for the product $NCV_k \times EF_{burning,CH_4,y}$.
Measurement methods and procedures	N/A
Monitoring frequency	N/A
QA/QC procedures	N/A
Purpose of data	Project emissions calculation
Additional comment	N/A

Data/Parameter	**$FC_{i,j,y}$**
Data unit	l/year
Description	Quantity of fuel type i combusted in process j during the year y
Source of data	Onsite measurements
Value(s) applied	Please refer to Table 31 Fossil fuel consumption at Lautaro power plant
Measurement methods and procedures	Data will be monitored continuously by the Supply Chief using volume meter from the tank system.
Monitoring frequency	Data will be monitored continuously
QA/QC procedures	The consistency of metered fuel consumption quantities will be cross- checked by an annual energy balance that is 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 calculation
Additional comment	---

Data/Parameter	**$NCV_{i,y}$**
Data unit	TJ/Gg
Description	Net calorific value of the fossil fuel type i in year y
Source of data	Default value of IPCC guidelines 2006 V2 Ch 1, table 1.4
Value(s) applied	Diesel: 43.0 TJ/Gg
Measurement methods and procedures	N/A
Monitoring frequency	N/A
QA/QC procedures	N/A
Purpose of data	Project emissions calculation
Additional comment	---

Data/Parameter	**$EF_{CO2,i,y}$**
Data unit	tCO_2/TJ
Description	Weighted average CO_2 emission factor of fuel type i in year y
Source of data	Default value IPCC 2006 V2 Ch 1, table 1.4
Value(s) applied	Diesel: 74.1
Measurement methods and procedures	N/A
Monitoring frequency	N/A
QA/QC procedures	N/A
Purpose of data	Project emissions calculation
Additional comment	This parameter is also identified as $EF_{ff,i,y}$ in ACM0018 v.2.0. $EF_{CO2,j,y}$ is the parameter abbreviation used in the “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion””.

Data/Parameter	**$EF_{CH4,BF}$**
Data unit	tCH4/TJ
Description	CH_4 emission factor for the combustion of biomass residues in the project plant
Source of data	IPCC guidelines 2006 (default value)
Value(s) applied	0.03×1.37 (conservativeness factor) =0.0411 tCH4/TJ
Measurement methods and procedures	N/A
Monitoring frequency	N/A
QA/QC procedures	N/A
Purpose of data	Project emissions calculation
Additional comment	---

Data/Parameter	**$EF_{Co2,LE}$**
Data unit	tCO2/GJ
Description	CO_2 emission factor for the most carbon intensive fuel used in the country (coal).
Source of data	IPCC revised guidelines (2006).
Value(s) applied	0.0946tCO_2/GJ

Measurement methods and procedures	This parameter will be monitored on an annually basis, consulting the most updated value of the most reliable literature source available, in this case IPCC guidelines.
Monitoring frequency	This parameter will be monitored on an annually basis
QA/QC procedures	N/A
Purpose of data	Leakage emissions
Additional comment	---

Data/Parameter	$\mathbf{EF_{EL,j,y}}$
Data unit	tCO2/Mwh
Description	Emission factor for electricity generation for source *j* in year *y*
Source of data	In case that off-site electricity consumption occurs in the future the emission factor will be determined as per “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” latest version.
Value(s) applied	N/A
Measurement methods and procedures	Measurements will be conducted according “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” latest version”
Monitoring frequency	N/A
QA/QC procedures	N/A
Purpose of data	Baseline emissions calculation
Additional comment	The project does not consider off-site electricity consumptions but in case that in the future this situation changes this parameter will be monitored

Data/Parameter	$\mathbf{EC_{PJ,j,,y}}$
Data unit	Mwh/year
Description	Quantity of electricity consumed by the project electricity consumption source *j* in year *y*
Source of data	In case that off-site electricity consumption occurs in the future it will be determined as per “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” latest version.
Value(s) applied	N/A
Measurement methods and procedures	Measurements will be conducted according “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” latest version
Monitoring frequency	N/A
QA/QC procedures	N/A
Purpose of data	Project emissions calculation

Additional comment	The project does not consider off-site electricity consumptions but in case that in the future this situation changes this parameter will be monitored.

Data/Parameter	**Df,m**
Data unit	Kilometre
Description	Return trip road distance between the origin and destination of freight transportation activity *f* in monitoring period *m*
Source of data	Records of vehicle operator or records by project participants.
Value(s) applied	**Freight type** / **Df,m**: Sawdust 83; Bark 83; Chips 83; Shavings 83; pine offcuts 83; side cuts 83; Oat husk 44; cereal straw 44
Measurement methods and procedures	Determined at the entrance of the project site for each freight transportation activity *f* for a reference trip using the vehicle odometer or any other appropriate sources (e.g. on-line sources).
Monitoring frequency	Determined for each freight transportation activity
QA/QC procedures	N/A
Purpose of data	Project emissions calculation
Additional comment	N/A

Freight type	**Df,m**
Sawdust	83
Bark	83
Chips	83
Shavings	83
pine offcuts	83
side cuts	83
Oat husk	44
cereal straw	44

Data/Parameter	**FRf,m**
Data unit	tonnes
Description	Total mass of freight transported in freight transportation activity *f* in monitoring period *m*
Source of data	Records by project participants or records by truck operators.

<table>
<tr><td>Value(s) applied</td><td>

Freight type	**FRf,m**
Sawdust	53,873
Bark	111,353
Chips	2,903
Shavings	24,499
pine offcuts	182,840
side cuts	4,553
Oat husk	28,200
cereal straw	50,264

</td></tr>
<tr><td>Measurement methods and procedures</td><td>Measured at the entrance of the project site. using a scale</td></tr>
<tr><td>Monitoring frequency</td><td>Continuously monitored</td></tr>
<tr><td>QA/QC procedures</td><td>N/A</td></tr>
<tr><td>Purpose of data</td><td>Project emissions calculation</td></tr>
<tr><td>Additional comment</td><td>N/A</td></tr>
</table>

B.7.2. Sampling plan

The monitoring plan to be applied is constituted by the following items:

- Electricity generation by the project activity (gross and auxiliary consumptions).
- Biomass residues categories and quantities used in the project activity and Amount of biomass residues of category k used in the project plan for each identified baseline scenario (B1,B3).
- Determination of Net Calorific Values on dry basis and Moisture content (%) of biomass residues of category k.
- Parameters involved in the calculations of project emissions due to the transport of the biomass from its source to the project site (i.e. type and weight of biomass at the entrance of the power plant and round trip distance, etc).
- Fossil fuel consumption required for the operation of equipment related to the on-site or off-site preparation (as a wood shipper) of biomass residues and for on-site transportation of biomass residues (i.e. Manitou, Loaders, Excavator, etc) necessary for the project power plant operation.

B.7.3. Monitoring organization

The following figure shows the organization structure of COMASA S.A:

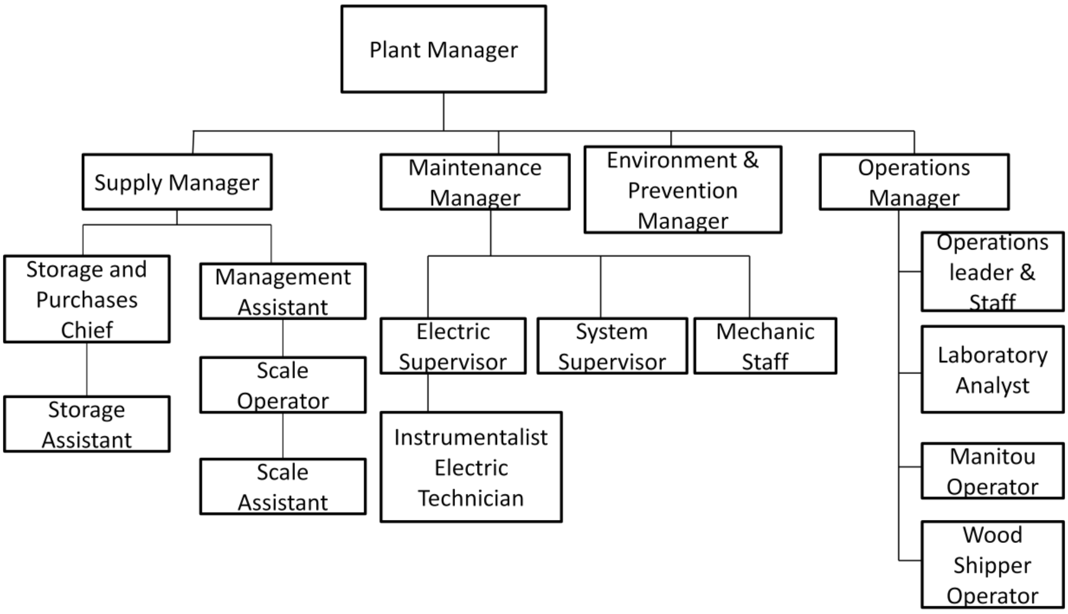


Figure 7. COMASA organizational structure.

1. **Measurements**

Measurements will be performed according the tables from the section B.7.1. All meters and instruments will be calibrated regularly as per industry practices.

Electricity generation by the project activity (gross and auxiliary consumptions):

The monitoring of gross electricity generation and auxiliary consumptions will be in charge of the Electric Supervisor. Electricity meters records and archived data measurements every 15 minutes. The monitoring of the gross electricity generation and auxiliary consumptions considered in Lautaro project consist in one electricity meter connected to the terminals of the generator (M1 in Figure 8) at the operations room and in addition an electricity meter installed at the on-site Substation that measures gross electricity at the 13.2 kV bar (M2 in Figure 8) .

Electricity meters for auxiliary consumptions are also installed at the on-site Substation and connected to the same 13.2 kV bar, from which one meter is used as back-up for auxiliary consumption measures (M3, M4 and M5). The Figure 8 shows the electricity meters considered in this monitoring plan (M3, M4 are used for $EG_{PJ,aux,y}$ measurements and M2 for $EG_{PJ,Gross,y}$).

For electricity meters considered as monitoring points (M1, M2, M3, M4 and M5) in the Figure 8, the model is SEL-734 with accuracy class 0.2 bidirectional.

They are connected to a server in order to keep monitored data archived for a 1 year period (after that period they will be archived electronically in order to keep data stored for at least 2 years after the crediting period).

The server mentioned above sends data reports on an automatically manner with a daily, weekly and monthly frequency in order to count with a triple back up of the data stored.

Net electricity provided to the grid will be measured at the Substation of Lautaro owned by Transnet (an electricity transmission company) with electricity meter M8.

In order to insure the quality of the monitored data, a cross check of the on-site measurements (auxiliary consumptions and gross electricity generation) against the net electricity measurements at the external Substation should be made. Other electricity meters also will be used in order to crosscheck electricity measurements and to recovered missing data in emergency situations (data losses, equipments failures, etc).

Maintenance of electricity meters will be done according equipments manual and calibration (verification) of equipments will be done at least every 3 years by a reputed external entity.

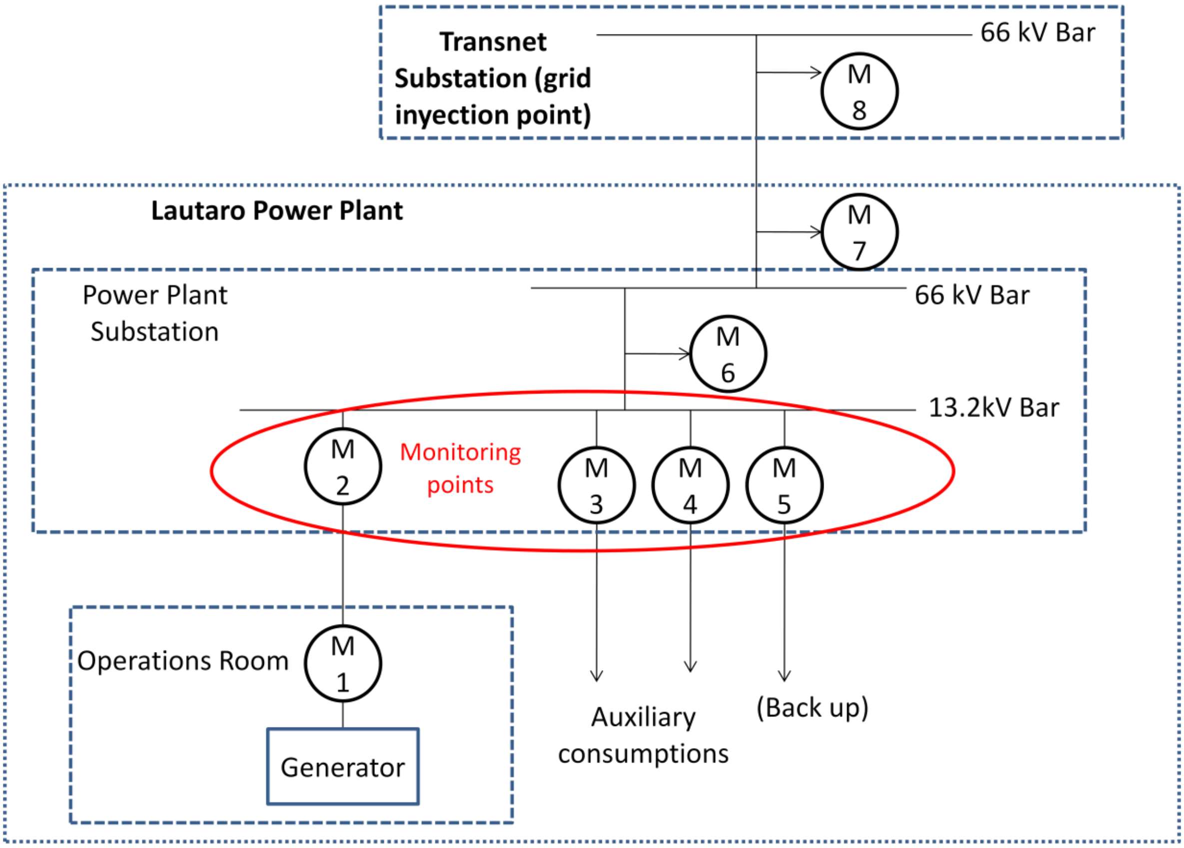


Figure 8. Electricity meters location and monitoring points

Biomass residues categories and quantities used in the project activity:

At the entrance of each truck with biomass to the project, trucks should stop at the scale where an inspection is performed by the Scale staff in order to register the following data:

- Type of biomass
- Source (according the shipping list)
- Quantity of biomass residues (tonnes) measured with the truck scale. (The moisture content of the biomass residues is considered in order to estimate tonnes on a dry basis).

With all the continuously monitored data, Table 6 should be up-dated for every monitoring period. All the monitored data in this monitoring point is registered and stored in an online system called ERP Flexline under the responsibility of the chief of the scale staff. Frequency of this monitored data is for each truck that transport biomass to the plant.

If along the crediting period, new categories (k) of biomass residues are used, a new line will be added to the Table 6, and an analysis for the selection of the baseline scenarios for those types of biomass residues should be assessed (each time that a new biomass category k is included). It is worth to mention that according to the ACM00018 methodology, the baseline scenario selected for each category of biomass residues identified ex-ante should be demonstrated at the validation stage only.

Determination of Net Calorific Values on dry basis and Moisture content (%) of biomass residues of category k:

For the Net Calorific Values on dry basis analysis, an external reputed laboratory will be hired by COMASA S.A. Net Calorific Analysis frequency will be at least every 6 months and 3 samples will be taken for each analysis.

The Moisture content analysis will be performed by the analyst in a laboratory installed at the project site for each truck of biomass that enters to the plant.

Parameters involved in the calculations of project emissions due to the transport of the biomass from its source to the project site:

Parameters monitored are:

- The quantity of freight transported: At the entrance of each truck with biomass to the project, trucks should stop at the scale where an inspection is performed by the Scale staff in order to register the weight and type of biomass transported to the plant.

- The origin and destination of the freight transported and the road distance between the origin and the destination ($D_{f,m}$): The source (origin) location and distance from the source of biomass to the project site is monitored continuously at the Scale location. This data is reported by each truck to the scale staff in order to complete the data in control sheets that will be stored in the ERP Flexline system. Data (km) will be cross checked with maps in order to calculate round trip average distance.

- The vehicle class used: For each truck that enters to the plant, the truck category will be

registered. If GVM (gross vehicle mass) is equal or less than 26 tonnes, the truck is classified as a “Light Vehicle”, otherwise the “Heavy Vehicle” category is registered.
GVM is determined as the maximum on-road mass of the fully-loaded vehicle, consisting of its tare mass (i.e. vehicle mass) and the mass of the load (i.e. the freight) the vehicle is allowed to carry according to its design specifications.

If for a specific transportation activity this information is missing, the truck should be considered as a “Light Vehicle”, as a conservative approach since the corresponding emission factor default value is higher.

All this monitored data will be in charge of the Scale Chief.

Fossil fuel consumption required for the operation of equipment related to the on-site or off-site preparation of biomass residues and for on-site transportation of biomass residues:

The project considers the operation of some equipments like loaders, Manitou, between other similar equipments in order to transport and manage biomass on-site the operation off and on site of a wood shipper. Equipments will use Diesel from a fuel tank installed at the project site and the fuel consumption will be measured continuously under the responsibility of the Supply Manager.
Data monitored will be digitally archived.

2. **Data recording procedure**

All data collected as part of monitoring will be archived electronically and be kept at least for two years after the end of the last crediting period.

B.7.4. Other elements of monitoring plan

Not applicable.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

The project started on 30/10/2009. This date correspond to the date on which contract for turbine purchase have been signed

C.2. Expected operational lifetime of project activity

The expected operational lifetime of the project activity will be at least 30 years and 0 months [25]

C.3. Crediting period of project activity

The project activity will use a renewable 7 years and 0 months crediting period.

C.3.1. Type of crediting period

Renewable

C.3.2. Start date of crediting period

31/01/2020

C.3.3. Duration of crediting period

7 years and 0 months.

[25] Lifetime certifícate for Lautaro power plant emmited by Proterm.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

The applicable Chilean law is the 19300[26] which stipulates in its article number 10, letter (c) that the generator centrals with capacity over 3 MW must be submitted to an environmental impact evaluation.

According to the law Lautaro Generation Project presented a Declaration of Environmental Impact (DIA for its Spanish acronym) to the environmental authority (CONAMA) on 11/11/2009.

The project activity had a positive Resolution of Environmental Qualifications (RCA for its Spanish acronym) on 11/03/2010.

D.2. Environmental impact assessment

Environmental impacts of the project activity are not considered significant by the host Party therefore the national environmental authority (CONAMA) approved the implementation by the submission of a favourable RCA.

Environmental Impact Declaration (DIA), project commitments and Resolution of Environmental Qualifications (RCA) can be downloaded from the web page of the National Environmental Impact Assessment System (SEIA for its spanish acronym) at Environmental impacts of the project activity are not considered significant by the host Party therefore the national environmental authority (CONAMA) approved the implementation by the submission of a favourable RCA.

Environmental Impact Declaration (DIA), project commitments and Resolution of Environmental Qualifications (RCA) can be downloaded from the web page of the National Environmental Impact Assessment System *(SEIA for its spanish acronym)at http://seia.sea.gob.cl/expediente/ficha/fichaPrincipal.php?id_expediente=4172357&idExpediente =417235 7&modo=ficha*

[26] General Environmental Law N° 19.300 "*Ley Sobre bases generales del medio ambiente*", http://www.bcn.cl/leyes/30667

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

On 18th October, COMASA S.A. invited to an online stakeholder's comments process through an open public announcement invitation published in Austral Newspaper from Temuco (a local newspaper). In addition to this public invitation, some entities were invited by mail: Environmental Evaluation Service (Servicio de Evaluación Ambiental), Production Development Corporation (CORFO), Climate Change Office from the Environmental Ministry, Lautaro Municipality, National Commission of Energy, Wood Corporation of Chile (CORMA), and others institutions related to the agricultural activity in the region.

The website was available to visits and comments from 15th October 2010 until 30th November 2010 in order to receive all local stakeholders comments related to the CDM project.

The website has information about the project developer (COMASA), and also there are documents available to download about relevant issues of the project (environmental impact statement, Gantt chart, project information) and about the CDM cycle calling for stakeholders comments in the website.

The website is available at the following link: http://comasageneracion.cl/. At the end of the process,

only two comments were received.
As a second phase of the local stakeholders process, the project developer has complemented the local newspaper invitation published with a letter posted an indigenous community called "Malpichahue- Pumalal" as it is located near the project site. The letter was sent to this community in order to insure if that this community is aware of the CDM project and to give them another instance to participate. Through this letter, COMASA invites the native community to contact COMASA or send all their questions comments and/or observations to them within a 30 days period (letter was sent on 04 th march 2011). No additional comments were received from Malpichahue-Pumalal Community or by the Environmental Authority.

E.2. Summary of comments received

Participating stakeholders made two comments:

1. ***Carlos Rosas* commented:**

"Good afternoon.
I would like to know if you need Biomass buyers agents.
Thanks"

2. ***Marcial González Aguirre says*:**

"I think this is a very interesting and appropriate project. My consultation is to understand the order of magnitude (ton / year) to buy forest residues and others.
You will have only one place, or reception yard and collection of waste? Greetings

E.3. Consideration of comments received

The questions were immediately answered at the website by the project developer:
Replay from COMASA to Carlos Rosas:

"Dear Carlos:
For business questions please contact the following email: csanchez@comasageneracion.cl."
COMASA S.A."

Replay from COMASA to Marcial Gonzales:

"Dear Marcial:
COMASA S.A. appreciates your interest in our project.
The project includes an annual consumption of 1.2 million cubic meters stereo (approximately). Facilities include a reception area and biomass management as well as 4 collection fields.
I hope to have answered your questions and I will be attentive for any other question. Greetings
COMASA S.A."

SECTION F. Approval and authorization

>>

The letter of approval (hereinafter LoA) from the Host Party for the project activity is available at the time of completion of the PDD.

Prior consideration (stamped by the Chilean DNA) has also been received at the time of submitting the PDD to the validation DOE

Appendix 1. Contact information of project participants

Organization name	COMASA S.A
Country	Lautaro, IX Región de La Araucanía (Region). Chile
Address	Route 5 Sur KM 645, road to Colonia KM 1 s/n / P.O.Box 88
Telephone	+ 56 9 92992872
Fax	
E-mail	rodrigoizquierdo@comasageneracion.cl
Website	
Contact person	Rodrigo Izquierdo (Plant Manager)

Appendix 2. Affirmation regarding public funding

N/A

Appendix 3. Applicability of methodologies and standardized baselines

N/A

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

NCV and moisture of Biomass residues:

Table 36 NCV and moisture content on biomass residues

Biomass residues	NCV (GJ/ton of dry matter)	% of moisture
Bark	15.6	66%
Sawdust	15.6	58%
Shavings	15.6	15%
Chips	15.6	45%
Wood Residues	15.6	24%
Forestry residues (woody material from the forest)	15.6	50%
Agricultural residues (Oat husks)	11.6	13%

Agricultural residues (Cereal Straw)	11.6	12%

The information collected in this appendix represents data used for the calculation of the operating margin and the build margin CO_2 emission factors, as well as the Emission factor of CO_2 from the combined margin of the electric system.

Table A4-1. Results of the Operating Margin Calculation for year 2019

	$NCV_{i,y}$ x $EF_{CO2,i,y}$		
Fuel Type	**EF** *(tCO_2/ton)*	**EF** *(tCO_2/MMBTU)*	**EF** *(tCO_2/m^3)*
Coal	2.43		
Natural Gas	-		0.00191
LPG	1.91		-
LNG	-	0.81098	
Petcoke	2.30		-
Diesel	3.14		-
Fuel-Oil	3.15-		-

$FC_{i,y}$ x $NCV_{i,y}$ x $EF_{CO2,i,y}$	
Fuel Type	**Emissions** *(tCO_2)*
Coal	23,856,742.06
Natural Gas	2,006,841.79
LPG	126.72
LNG	3,098,810.10
Petcoke	341.745,48
Diesel	208,817.05
Fuel-Oil	210,915.09
***TOTAL Emissions** (tCO2) =*	***29.515,181.25***

***EG_y*[27]**

[27] Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost/must-run power plants/units, in year 2019 (MWh).

Year	Total Generation *(MWh)*
2019	*42,104,818*

$EF_{grid,Omsimple,y}$	
Year	**Emission Factor** *(tCO2/MWh)*
2019	*0.701*

Table A4-2. Results of the Operating Margin Calculation for year 2018

	$NCV_{i,y}$ x $EF_{CO2,i,y}$		
Fuel Type	**EF** *(tCO_2/ton)*	**EF** *(tCO_2/MMBTU)*	**EF** *(tCO_2/m^3)*
Coal	2.43		
Natural Gas	-		0.00191
LPG	1.91		-
LNG	-	0.81098	
Petcoke	2.30		-
Diesel	3.14		-
Fuel-Oil	3.15-		-

$FC_{i,y}$ x $NCV_{i,y}$ x $EF_{CO2,i,y}$	
Fuel Type	**Emissions** *(tCO_2)*
Coal	24,934,596.19
Natural Gas	81,161.35
LPG	1,221.28
LNG	4,186,314.67
Petcoke	381,192.65
Diesel	203,747.42
Fuel-Oil	9,576.09
Biogas	0.00
***TOTAL Emissions** (tCO2) =*	***29,797,809.65***

EG_y[28]	
Year	**Total Generation** *(MWh)*
2018	***41,018,147***

$EF_{grid,Omsimple,y}$	
Year	**Emission Factor** *(tCO_2/MWh)*
2018	***0.726***

[28] Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost/must-run power plants/units, in year 2018 (MWh).

Table A4-3. Results of the Operating Margin Calculation for year 2017

	$NCV_{i,y}$ x $EF_{CO2,i,y}$		
Fuel Type	**EF** *(tCO_2/ton)*	**EF** *(tCO_2/MMBTU)*	**EF** *(tCO_2/m^3)*
Coal	2.43		
Natural Gas	-		0.00191
LPG	1.91		-
LNG	-	0.81098	
Petcoke	2.30		-
Diesel	3.14		-
Fuel-Oil	3.15-		-

$FC_{i,y}$ x $NCV_{i,y}$ x $EF_{CO2,i,y}$	
Fuel Type	**Emissions** *(tCO_2)*
Coal	25,513,614.65
Natural Gas	804,794.09
LPG	4,139.77
LNG	63,821.44
Petcoke	379.654,16
Diesel	572,477.50
Fuel-Oil	47,291.79
Biogas	0.00
***TOTAL Emissions** (tCO_2) =*	***27,385,788***

EG_y[29]	
Year	**Total Generation** *(MWh)*
2017	***42,048,156***

$EF_{grid,Omsimple,y}$	
Year	**Emission Factor** *(tCO_2/MWh)*

[29] Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost/must-run power plants/units, in year 2017 (MWh).

2017	*0.651*

Table A4-4. Results for the determination of $EF_{grid,OMsimple,y}$ [tCO_2/MWh]

Operating Margin Emission factor for the Chilean SEN		
Baseline	$EF_{grid,OMsimple,y}$ [tCO_2/MWh]	Net Generation[30] [MWh]
2017	0.6513	42,048,156
2018	0.7265	41,018,147
2019	0.7010	42,104,818
	$EF_{grid,OMsimple,2017-2019}$ **0.6926**	

Table A4-5. List of last power plants serving energy to the SEN system (Oct. 2019 - Dec. 2019)

Power Plants Oct-2019 / Dec-2019 (1)			
Power Plant	**Type**	**Start-up Date**	**CDM Status**
Ciruelillo	Thermoelectric	15/11/2019	-
Copiulemu	Natural gas	15/11/2019	-
Solar Luce	Solar	7/11/2019	-
Palacios	Hydropower: Run of the river	5/11/2019	-
TER Doña Javiera	Thermoelectric	28/10/2019	-
Solar Bellavista 1	Solar	24/10/2019	-
Solar San Isidro	Solar	12/10/2019	-
Solar Tricahue 2	Solar	1/10/2019	

Notes: *Note 1: to select power plants to include in this table, data are collected based on CNE (Chilean National Energy Commission) available information. They are, at first, selected by the year in which they start operating*

Table A4-6. Determination of $SET_{5\ units}$ and $AEG_{SET-5-units}$

Determination of $SET_{5\ units}$ and $AEG_{SET-5-units}$			
Power Plant	**Type**	**Start-up Date**	**Annual Electricity Generation** *(MWh)*
Ciruelillo	Thermoelectric	15/11/2019	0.0
Copiulemu	Natural gas	15/11/2019	0.0
Solar Luce	Solar	7/11/2019	1,441.5

30 Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost/must-run power plants/units, in year y (MWh).

Palacios	Hydropower: Run of the river	5/11/2019	6,771.8
TER Doña Javiera	Thermoelectric	28/10/2019	0.0
***Annual Electricity Generation ($AEG_{SET-5-units}$)** (MWh)*			***8,213***

Table A4-7. Determination of AEG_{TOTAL} and 20% of AEG_{TOTAL}

***AEG_{TOTAL}** (MWh)*	
***Annual Electricity Generation (AEG_{TOTAL})** (MWh)*	***69,243,201***[31]

***20 % of AEG_{TOTAL}** (MWh)*	
***20 % of AEG_{TOTAL}** (MWh)*	***13,935,190***

Table A4-8. List of power plants that shape the BM Emission Factor

Power Plant	Type	Electricity Supply Date	2019 Electricity Generation *(MWh)*	Gen 2019 *(Excluding CDM) (MWh)*	Percentage of AEG_{TOTAL}	Accumulated
Ciruelillo	Diesel	15/11/2019	0.0	0.0	0.0000%	0.00%
Copiulemu	Natural gas	15/11/2019	0.0	0.0	0.0000%	0.00%
Solar Luce	Solar	7/11/2019	1,441.5	1,441.5	0.0021%	0.00%
Palacios	Hydropower: Run of the river	5/11/2019	6,771.8	6,771.8	0.0098%	0.01%
TER Doña Javiera	Diesel	28/10/2019	0.0	0.0	0.0000%	0.01%
Solar Bellavista 1	Solar	24/10/2019	4,315.6	4,315.6	0.0062%	0.02%
Solar San Isidro	Solar	12/10/2019	503.1	503.1	0.0007%	0.02%
Solar Tricahue 2	Solar	1/10/2019	7,175.2	7,175.2	0.0104%	0.03%
Eólica San Gabriel	Wind	27/09/2019	147,785.3	147,785.3	0.2134%	0.24%
Solar La Ligua	Solar	18/09/2019	861.5	861.5	0.0012%	0.24%
Solar Villa Seca	Solar	17/09/2019	1,118.6	1,118.6	0.0016%	0.25%
Solar RLA	Solar	14/09/2019	1,927.2	1,927.2	0.0028%	0.25%
Dos Valles	Hydropower: Run of the river	14/09/2019	8,955.2	8,955.2	0.0129%	0.26%
Dos Valles	Hydropower: Run of the river	14/09/2019	8,955.2	8,955.2	0.0129%	0.27%
Solar Las Lechuzas	Solar	6/09/2019	2,997.3	2,997.3	0.0043%	0.28%
Solar Placilla	Solar	6/09/2019	684.8	684.8	0.0010%	0.28%
Solar Huatacondo	Solar	5/09/2019	135,165.3	135,165.3	0.1952%	0.47%

[31] Excluding power units registered as CDM project activities.

Power Plant	Type	Electricity Supply Date	2019 Electricity Generation *(MWh)*	Gen 2019 *(Excluding CDM) (MWh)*	Percentage of AEG_{TOTAL}	Accumulated
Calfuco	Diesel	4/09/2019	0.0	0.0	0.0000%	0.47%
Solar Poblacion	Solar	30/08/2019	3,372.8	3,372.8	0.0049%	0.48%
Río Azul	Diesel	30/08/2019	0.0	0.0	0.0000%	0.48%
Eólica La Flor	Wind	30/08/2019	6,905.0	6,905.0	0.0100%	0.49%
Solar Doñihue	Solar	27/08/2019	5,796.6	5,796.6	0.0084%	0.50%
Solar Jose Soler Mallafre	Solar	23/08/2019	983.3	983.3	0.0014%	0.50%
Tucúquere	Solar	23/08/2019	2,806.1	2,806.1	0.0041%	0.50%
Eólica El Nogal	Wind	23/08/2019	7,773.3	7,773.3	0.0112%	0.51%
Solar Las Perdices	Solar	21/08/2019	2,595.1	2,595.1	0.0037%	0.52%
Solar Ariztia	Solar	20/08/2019	2,320.7	2,320.7	0.0034%	0.52%
Solar Jaururo	Solar	15/08/2019	1,208.1	1,208.1	0.0017%	0.52%
Solar Marchihue VII	Solar	14/08/2019	2,289.9	2,289.9	0.0033%	0.53%
Solar Vituco 2B	Solar	14/08/2019	2,658.2	2,658.2	0.0038%	0.53%
Solar Canesa I	Solar	13/08/2019	3,032.2	3,032.2	0.0044%	0.53%
Solar Santa Adriana	Solar	6/08/2019	1,514.2	1,514.2	0.0022%	0.54%
Solar Crucero	Solar	1/08/2019	3,311.9	3,311.9	0.0048%	0.54%
Central Cumbres	Hydropower: Run of the river	1/08/2019	61,930.7	61,930.7	0.0894%	0.63%
Solar Talca	Solar	30/07/2019	7,947.3	7,947.3	0.0115%	0.64%
Solar Illapel 5X	Solar	20/07/2019	3,023.8	3,023.8	0.0044%	0.65%
Solar Chalinga	Solar	19/07/2019	3,007.3	3,007.3	0.0043%	0.65%
Solar Cruz	Solar	19/07/2019	3,634.9	3,634.9	0.0052%	0.66%
Solar Las Codornices	Solar	19/07/2019	3,287.7	3,287.7	0.0047%	0.66%
Solar Montt	Solar	19/07/2019	3,425.2	3,425.2	0.0049%	0.67%
Solar Ranguil	Solar	19/07/2019	2,126.9	2,126.9	0.0031%	0.67%
Solar Lo Sierra	Solar	12/07/2019	2,439.4	2,439.4	0.0035%	0.67%
Solar Casuto	Solar	29/06/2019	3,232.2	3,232.2	0.0047%	0.68%
Solar Norte Chico I	Solar	29/06/2019	1,976.1	1,976.1	0.0029%	0.68%
Diesel PRP Gami	Diesel	29/06/2019	0.0	0.0	0.0000%	0.68%
Diesel Los Sauces	Diesel	27/06/2019	0.0	0.0	0.0000%	0.68%
Diesel Picoltué	Diesel	27/06/2019	0.0	0.0	0.0000%	0.68%
Solar Lipangue	Solar	26/06/2019	2,706.5	2,706.5	0.0039%	0.68%
Solar La Lajuela	Solar	18/06/2019	9,764.7	9,764.7	0.0141%	0.70%
Solar Altos de Til Til	Solar	14/06/2019	2,146.3	2,146.3	0.0031%	0.70%
Solar Rovian	Solar	14/06/2019	9,001.6	9,001.6	0.0130%	0.71%
Diesel Almendrado	Diesel	11/06/2019	0.0	0.0	0.0000%	0.71%

Power Plant	Type	Electricity Supply Date	2019 Electricity Generation *(MWh)*	Gen 2019 *(Excluding CDM) (MWh)*	Percentage of AEG_{TOTAL}	Accumulated
Solar Santa Clara	Solar	5/06/2019	4,057.2	4,057.2	0.0059%	0.72%
Eólica Punta Sierra	Wind	5/06/2019	271,710.4	271,710.4	0.3924%	1.11%
CERRO PABELLON_Geotermica	Geothermal	31/05/2019	201,642.7	CDM Registered	0	1.11%
Solar El Laurel	Solar	29/05/2019	8,022.0	8,022.0	0.0116%	1.12%
Solar Pedreros	Solar	23/05/2019	3,887.2	3,887.2	0.0056%	1.13%
IEM	Coal	16/05/2019	737,056.9	737,056.9	1.0644%	2.19%
Solar Encon Solar	Solar	23/04/2019	10,501.3	10,501.3	0.0152%	2.21%
Solar Fotovolt Solar I	Solar	23/04/2019	940.2	940.2	0.0014%	2.21%
Solar GR Santa Rosa	Solar	12/04/2019	13,340.6	CDM registered	0	2.21%
Solar Pirque	Solar	11/04/2019	3,736.9	3,736.9	0.0054%	2.22%
Solar Marín	Solar	27/02/2019	6,146.0	6,146.0	0.0089%	2.23%
Minihidro Correntoso	Hydropower: Run of the river	22/02/2019	15,851.3	15,851.3	0.0229%	2.25%
Minihidro Palmar	Hydropower: Run of the river	22/02/2019	15,427.4	15,427.4	0.0223%	2.27%
Solar Cachiyuyo 2	Solar	15/02/2019	19,928.4	19,928.4	0.0288%	2.30%
Solar Calle Larga	Solar	15/02/2019	6,042.9	6,042.9	0.0087%	2.31%
Solar La Blanquina	Solar	15/02/2019	12,665.7	12,665.7	0.0183%	2.33%
Solar Malaquita 2	Solar	15/02/2019	20,271.3	20,271.3	0.0293%	2.36%
Zapallar	Diesel	15/02/2019	0.0	0.0	0.0000%	2.36%
Solar Valle Este 2	Solar	13/02/2019	18,754.6	18,754.6	0.0271%	2.38%
Solar Valle Oeste 2	Solar	13/02/2019	18,573.0	18,573.0	0.0268%	2.41%
Cogeneradora Aconcagua	Biomass	9/02/2019	1,163.6	1,163.6	0.0017%	2.41%
Eólica Aurora	Wind	1/02/2019	161,256.5	161,256.5	0.2329%	2.64%
Solar Alicahue	Solar	19/01/2019	5,233.7	5,233.7	0.0076%	2.65%
Solar El Queule	Solar	19/01/2019	1,638.8	1,638.8	0.0024%	2.65%
Punta Baja Solar	Solar	18/01/2019	3,950.2	3,950.2	0.0057%	2.66%
Solar Olivillo	Solar	27/12/2018	17,800.0	17,800.0	0.0257%	2.69%
Solar Piquero	Solar	6/12/2018	6,119.2	6,119.2	0.0088%	2.69%
Solar El Quemado	Solar	20/11/2018	6,219.2	6,219.2	0.0090%	2.70%
Solar Rodeo	Solar	17/11/2018	5,537.9	5,537.9	0.0080%	2.71%
Solar Las Palomas	Solar	31/10/2018	5,974.3	5,974.3	0.0086%	2.72%
Solar Catán	Solar	23/10/2018	5,456.3	5,456.3	0.0079%	2.73%
SOLAR EL ÁGUILA I	Solar	4/10/2018	3,928.8	3,928.8	0.0057%	2.73%
Solar El Pelícano	Solar	13/09/2018	290,274.3	290,274.3	0.4192%	3.15%
Solar El Chincol	Solar	7/09/2018	6,754.3	6,754.3	0.0098%	3.16%

Power Plant	Type	Electricity Supply Date	2019 Electricity Generation *(MWh)*	Gen 2019 *(Excluding CDM) (MWh)*	Percentage of AEG_{TOTAL}	Accumulated
Solar El Picurio	Solar	4/09/2018	6,361.2	6,361.2	0.0092%	3.17%
Solar Ocoa	Solar	1/09/2018	6,061.1	6,061.1	0.0088%	3.18%
Solar Villa Prat	Solar	22/08/2018	5,640.9	5,640.9	0.0081%	3.19%
Solar Santa Laura	Solar	17/08/2018	5,281.1	5,281.1	0.0076%	3.20%
Solar Los Patos	Solar	9/08/2018	5,482.6	5,482.6	0.0079%	3.20%
Solar Los Libertadores	Solar	8/08/2018	9,209.0	9,209.0	0.0133%	3.22%
Solar Talhuén	Solar	1/08/2018	8,192.5	8,192.5	0.0118%	3.23%
Solar La Acacia	Solar	28/07/2018	6,348.4	6,348.4	0.0092%	3.24%
CERRO DOMINADOR	Solar	4/07/2018	300,793.0	300,793.0	0.4344%	3.67%
Solar Peralillo	Solar	12/06/2018	6,549.0	6,549.0	0.0095%	3.68%
Eólica Cabo Leones	Wind	10/06/2018	353,877.1	CDM Registered	0	3.68%
Degañ	Diesel	5/06/2018	474.2	474.2	0.0007%	3.68%
HUAYCA1	Solar	4/06/2018	0.0	0.0	0.0000%	3.68%
HUAYCA2	Solar	4/06/2018	51,227.7	51,227.7	0.0740%	3.76%
Solar Amparo del Sol	Solar	1/06/2018	6,211.7	6,211.7	0.0090%	3.77%
Solar Mostazal	Solar	26/05/2018	20,660.3	20,660.3	0.0298%	3.80%
Solar Ovejería	Solar	25/05/2018	20,038.7	20,038.7	0.0289%	3.82%
Solar Luders	Solar	23/05/2018	6,968.9	6,968.9	0.0101%	3.83%
Eólica Sarco	Wind	1/05/2018	92,599.0	92,599.0	0.1337%	3.97%
FV BOLERO_Solar	Solar	6/04/2018	366,910.2	366,910.2	0.5299%	4.50%
Parque Sierra Gorda_Eólico	Wind	4/04/2018	356,459.2	356,459.2	0.5148%	5.01%
Solar El Sauce	Solar	27/03/2018	6,296.8	6,296.8	0.0091%	5.02%
Solar Chancon	Solar	21/03/2018	5,493.2	5,493.2	0.0079%	5.03%
Solar El Pitio	Solar	13/03/2018	6,300.5	6,300.5	0.0091%	5.04%
Hidro La Mina	Hydropower: Run of the river	21/02/2018	67,521.1	67,521.1	0.0975%	5.14%
Embalse Ancoa	Hydropower: Reservoir	16/02/2018	77,150.6	77,150.6	0.1114%	5.25%
Solar Santiago	Solar	31/01/2018	199,550.6	199,550.6	0.2882%	5.54%
El Campesino 1	Biomass	24/01/2018	1,172.1	1,172.1	0.0017%	5.54%
Solar Portezuelo	Solar	16/01/2018	5,657.2	5,657.2	0.0082%	5.55%
Solar Los Gorriones	Solar	5/01/2018	6,508.1	6,508.1	0.0094%	5.56%
Solar Cernicalo 1	Solar	21/12/2017	3,448.5	3,448.5	0.0050%	5.56%
Solar Cernicalo 2	Solar	21/12/2017	3,294.8	3,294.8	0.0048%	5.57%
Río Colorado	Hydropower: Run of the river	21/12/2017	49,267.1	49,267.1	0.0712%	5.64%
Solar La Manga I	Solar	13/12/2017	4,431.9	4,431.9	0.0064%	5.64%
Solar Doña Carmen Solar	Solar	29/11/2017	61,894.7	61,894.7	0.0894%	5.73%

Power Plant	Type	Electricity Supply Date	2019 Electricity Generation *(MWh)*	Gen 2019 *(Excluding CDM) (MWh)*	Percentage of AEG_{TOTAL}	Accumulated
Solar Chimbarongo	Solar	21/11/2017	5,070.7	5,070.7	0.0073%	5.74%
Santuario Solar	Solar	17/11/2017	7,410.0	7,410.0	0.0107%	5.75%
Solar Valle de la Luna II	Solar	9/11/2017	6,134.6	6,134.6	0.0089%	5.76%
Solar La Quinta	Solar	8/11/2017	7,196.8	CDM Registered	0	5.76%
Solar San Francisco	Solar	8/11/2017	7,111.8	7,111.8	0.0103%	5.77%
Solar Antay	Solar	3/11/2017	24,822.4	24,822.4	0.0358%	5.81%
Solar El Pilpen	Solar	2/11/2017	7,160.6	7,160.6	0.0103%	5.82%
Solar El Roble	Solar	19/10/2017	18,232.5	18,232.5	0.0263%	5.84%
Lepanto	Biomass	18/10/2017	0.0	0.0	0.0000%	5.84%
Solar Panquehue II	Solar	18/10/2017	12,110.1	12,110.1	0.0175%	5.86%
Solar Don Eugenio	Solar	26/09/2017	6,122.7	6,122.7	0.0088%	5.87%
La Bifurcada	Hydropower: Run of the river	9/09/2017	1,205.6	1,205.6	0.0017%	5.87%
PUERTO SECO SOLAR	Solar	1/09/2017	30,032.4	30,032.4	0.0434%	5.91%
La Viña - Alto La Viña	Hydropower: Run of the river	28/08/2017	3,437.1	3,437.1	0.0050%	5.92%
Riñinahue	Hydropower: Run of the river	23/08/2017	6,934.4	6,934.4	0.0100%	5.93%
Solar Cabilsol	Solar	28/07/2017	5,497.5	5,497.5	0.0079%	5.94%
Solar Las Turcas	Solar	1/06/2017	4,254.2	4,254.2	0.0061%	5.94%
Eólica San Pedro II	Wind	19/05/2017	112,835.5	112,835.5	0.1630%	6.11%
PMGD CALAMA_Solar	Solar	12/05/2017	18,349.1	18,349.1	0.0265%	6.13%
PARQUE SOLAR FINIS TERRAE_Solar	Solar	18/04/2017	387,475.3	387,475.3	0.5596%	6.69%
Solar Marchigue 2	Solar	31/03/2017	14,401.3	14,401.3	0.0208%	6.71%
Solar Cordillerilla	Solar	27/03/2017	1,440.2	1,440.2	0.0021%	6.71%
Eólica San Juan	Wind	16/03/2017	589,780.0	589,780.0	0.8518%	7.57%
Solar Quilapilún	Solar	9/03/2017	214,690.0	214,690.0	0.3101%	7.88%
Solar El Romero	Solar	3/03/2017	461,397.7	461,397.7	0.6663%	8.54%
Solar Cuz Cuz	Solar	2/03/2017	5,521.4	5,521.4	0.0080%	8.55%
Solar Cardones	Solar	21/02/2017	417.7	417.7	0.0006%	8.55%
Eólica La Esperanza	Wind	13/02/2017	17,658.1	17,658.1	0.0255%	8.58%
Solar El Boco	Solar	30/01/2017	5,975.2	5,975.2	0.0086%	8.59%
URIBE_Solar	Solar	8/01/2017	154,322.3	154,322.3	0.2229%	8.81%
Solar La Esperanza II	Solar	30/12/2016	18,867.1	18,867.1	0.0272%	8.84%
Eólica Las Peñas	Wind	28/12/2016	30,690.3	30,690.3	0.0443%	8.88%
Kelar	Diesel	27/12/2016	443.1	CDM registered	0	8.88%

Power Plant	Type	Electricity Supply Date	2019 Electricity Generation *(MWh)*	Gen 2019 *(Excluding CDM) (MWh)*	Percentage of AEG_{TOTAL}	Accumulated
Kelar	LNG	27/12/2016	1,636,052.9	CDM registered	0	8.88%
Parque Eólico Lebu III	Wind	14/12/2016	6,651.0	6,651.0	0.0096%	8.89%
Solar Ñilhue	Solar	1/12/2016	1,810.7	1,810.7	0.0026%	8.89%
Solar San Pedro	Solar	1/12/2016	5,553.7	5,553.7	0.0080%	8.90%
Newen	Propane	27/11/2016	0.0	0.0	0.0000%	8.90%
Newen	Diesel	27/11/2016	0.0	0.0	0.0000%	8.90%
Newen	Natural gas	27/11/2016	369.1	369.1	0.0005%	8.90%
Tránquil	Hydropower: Run of the river	23/11/2016	0.0	0.0	0.0000%	8.90%
La Montaña 1	Hydropower: Run of the river	16/11/2016	1,403.4	1,403.4	0.0020%	8.90%
Carilafquén	Hydropower: Run of the river	28/10/2016	59,660.6	59,660.6	0.0862%	8.99%
Solar Hormiga Solar	Solar	27/10/2016	4,584.6	4,584.6	0.0066%	9.00%
Cumpeo	Hydropower: Run of the river	26/10/2016	25,961.2	25,961.2	0.0375%	9.03%
Solar Pampa Solar Norte	Solar	19/10/2016	206,218.5	206,218.5	0.2978%	9.33%
Solar Alturas de Ovalle	Solar	4/10/2016	11,011.4	11,011.4	0.0159%	9.35%
Eólica Renaico	Wind	12/09/2016	280,540.1	280,540.1	0.4052%	9.75%
Itata Hidro	Hydropower: Run of the river	9/09/2016	53,700.7	53,700.7	0.0776%	9.83%
Solar Conejo	Solar	8/09/2016	305,716.0	305,716.0	0.4415%	10.27%
hbs gnl	Natural gas	1/09/2016	0.0	0.0	0.0000%	10.27%
Eólica Los Buenos Aires	Wind	30/08/2016	82,570.5	82,570.5	0.1192%	10.39%
El Colorado	Hydropower: Run of the river	29/08/2016	6,477.1	6,477.1	0.0094%	10.40%
Solar Los Loros	Solar	17/08/2016	100,147.3	100,147.3	0.1446%	10.54%
Solar La Silla	Solar	12/08/2016	4,583.4	4,583.4	0.0066%	10.55%
Solar El Divisadero	Solar	10/08/2016	8,828.4	8,828.4	0.0127%	10.56%
Cochrane	Coal	9/07/2016	1,679,646.4	1,679,646.4	2.4257%	12.99%
Cochrane	Coal	9/07/2016	1,696,310.2	1,696,310.2	2.4498%	15.44%
El Agrio	Hydropower: Run of the river	7/07/2016	9,871.4	9,871.4	0.0143%	15.45%
Pulelfu	Hydropower: Run of the river	7/07/2016	53,544.6	53,544.6	0.0773%	15.53%
El Galpón	Hydropower: Run of the river	28/06/2016	5,806.0	5,806.0	0.0084%	15.54%
CMPC Tissue	LNG	16/06/2016	10,510.2	10,510.2	0.0152%	15.55%
Solar Chuchiñi	Solar	9/06/2016	4,933.4	4,933.4	0.0071%	15.56%
Solar Til Til	Solar	19/05/2016	3,543.0	3,543.0	0.0051%	15.57%
Chanleufu	Hydropower: Run of the river	19/05/2016	1,784.6	1,784.6	0.0026%	15.57%
Andes Generación	Diesel	17/05/2016	123.8	123.8	0.0002%	15.57%
Andes Generación	Fuel N°6	17/05/2016	16.2	16.2	0.0000%	15.57%

Power Plant	Type	Electricity Supply Date	2019 Electricity Generation *(MWh)*	Gen 2019 *(Excluding CDM) (MWh)*	Percentage of AEG_{TOTAL}	Accumulated
Solar Las Araucarias	Solar	12/05/2016	0.0	0.0	0.0000%	15.57%
Alto Renaico	Hydropower: Run of the river	9/05/2016	8,246.7	8,246.7	0.0119%	15.58%
PARQUE SOLAR PAMPA CAMARONES	Solar	4/05/2016	13,001.0	13,001.0	0.0188%	15.60%
Solar Carrera Pinto	Solar	3/05/2016	238,325.5	238,325.5	0.3442%	15.94%
CMPC Cordillera	LNG	25/04/2016	1,324.3	1,324.3	0.0019%	15.95%
Río Mulchén	Hydropower: Run of the river	1/04/2016	2,336.5	2,336.5	0.0034%	15.95%
Ujina	Fuel N°6	29/03/2016	0.0	0.0	0.0000%	15.95%
Ujina	Fuel N°6	29/03/2016	289.3	289.3	0.0004%	15.95%
Ujina	Fuel N°6	29/03/2016	38.5	38.5	0.0001%	15.95%
Ujina	Fuel N°6	29/03/2016	270.6	270.6	0.0004%	15.95%
Ujina	Fuel N°6	29/03/2016	297.4	297.4	0.0004%	15.95%
Ujina	Fuel N°6	29/03/2016	301.2	301.2	0.0004%	15.95%
Solar Bellavista	Solar	23/03/2016	3,759.8	3,759.8	0.0054%	15.96%
Solar Santa Julia	Solar	17/03/2016	7,301.8	7,301.8	0.0105%	15.97%
Molinera Villarrica	Hydropower: Run of the river	3/03/2016	1,358.3	1,358.3	0.0020%	15.97%
El Paso	Hydropower: Run of the river	2/03/2016	88,664.5	88,664.5	0.1280%	16.10%
Solar La Chapeana	Solar	1/03/2016	4,887.3	4,887.3	0.0071%	16.10%
Solar Las Mollacas	Solar	1/03/2016	5,247.5	5,247.5	0.0076%	16.11%
Malalcahuello	Hydropower: Run of the river	1/03/2016	13,151.9	13,151.9	0.0190%	16.13%
Luz del Norte	Solar	24/02/2016	393,051.1	393,051.1	0.5676%	16.70%
Solar Lagunilla	Solar	5/02/2016	6,724.1	6,724.1	0.0097%	16.71%
SOLAR JAMA 2_Solar	Solar	21/01/2016	65,995.5	65,995.5	0.0953%	16.80%
El Molle	Biomass	18/12/2015	15,475.0	15,475.0	0.0223%	16.83%
Guacolda 5	Coal	15/12/2015	1,100,511.0	1,100,511.0	1.5893%	18.41%
PMGD PICA_Solar	Solar	10/12/2015	0.0	CDM registered	0	18.41%
Eólica Huajache	Wind	25/11/2015	14,210.1	14,210.1	0.0205%	18.44%
PAS1_Solar	Solar	4/11/2015	0.0	0.0	0.0000%	18.44%
El Mirador	Hydropower: Run of the river	2/11/2015	10,778.8	10,778.8	0.0156%	18.45%
Trailelfú	Hydropower: Run of the river	16/10/2015	7,841.5	7,841.5	0.0113%	18.46%
Solar El Pilar - Los Amarillos	Solar	15/10/2015	0.0	0.0	0.0000%	18.46%
Solar Sol	Solar	5/10/2015	6,409.0	6,409.0	0.0093%	18.47%
Los Hierros II	Hydropower: Run of the river	21/09/2015	19,203.2	19,203.2	0.0277%	18.50%
Solar Luna	Solar	16/09/2015	9,252.3	9,252.3	0.0134%	18.51%

Power Plant	Type	Electricity Supply Date	2019 Electricity Generation *(MWh)*	Gen 2019 *(Excluding CDM) (MWh)*	Percentage of AEG_{TOTAL}	Accumulated
Solar Lalackama 2	Solar	31/08/2015	46,758.9	46,758.9	0.0675%	18.58%
Munilque	Hydropower: Run of the river	13/08/2015	773.9	773.9	0.0011%	18.58%
Picoiquén	Hydropower: Run of the river	13/08/2015	83,501.7	CDM Registered	0	18.58%
LOS PUQUIOS	Solar	11/08/2015	1,159.3	1,159.3	0.0017%	18.58%
Lleuquereo	Hydropower: Run of the river	7/08/2015	7,518.1	7,518.1	0.0109%	18.59%
Los Guindos	Diesel	30/07/2015	0.0	0.0	0.0000%	18.59%
Raki	Wind	30/07/2015	18,372.4	18,372.4	0.0265%	18.62%
Bureo	Hydropower: Run of the river	13/07/2015	8,362.3	8,362.3	0.0121%	18.63%
Salvador RTS	Solar	7/07/2015	0.0	0.0	0.0000%	18.63%
Solar Lalackama	Solar	2/06/2015	154,951.6	154,951.6	0.2238%	18.86%
Solar Chañares	Solar	28/05/2015	92,814.7	92,814.7	0.1340%	18.99%
Laja 1	Hydropower: Run of the river	28/05/2015	79,123.4	CDM registered	0	18.99%
Talinay Poniente	Wind	26/05/2015	203,800.7	203,800.7	0.2943%	19.28%
Solar Javiera	Solar	19/05/2015	172,234.0	172,234.0	0.2487%	19.53%
SOLAR JAMA 1_Solar	Solar	14/04/2015	95,170.5	95,170.5	0.1374%	19.67%
Santa Fe	Biomass	10/04/2015	6,900.0	6,900.0	0.0100%	19.68%
Eólica Taltal	Wind	9/02/2015	307,674.0	307,674.0	0.4443%	20.12%

Table A4-9. Determination of $EF_{Grid,BM,y}$

Power Plant	Type	Start-up Date	Gen 2019 *(Excluding CDM) (MWh)*	GHG Emissions in 2019 (tCO2/y) *(excluding CDM)*
Ciruelillo	Diesel	15/11/2019	0.0	0.0
Copiulemu	Natural gas	15/11/2019	0.0	0.0
Solar Luce	Solar	7/11/2019	1,441.5	0.0
Palacios	Hydropower: Run of the river	5/11/2019	6,771.8	0.0
TER Doña Javiera	Diesel	28/10/2019	0.0	0.0
Solar Bellavista 1	Solar	24/10/2019	4,315.6	0.0
Solar San Isidro	Solar	12/10/2019	503.1	0.0
Solar Tricahue 2	Solar	1/10/2019	7,175.2	0.0
Eólica San Gabriel	Wind	27/09/2019	147,785.3	0.0
Solar La Ligua	Solar	18/09/2019	861.5	0.0
Solar Villa Seca	Solar	17/09/2019	1,118.6	0.0
Solar RLA	Solar	14/09/2019	1,927.2	0.0
Dos Valles	Hydropower: Run of the river	14/09/2019	8,955.2	0.0
Dos Valles	Hydropower: Run of the river	14/09/2019	8,955.2	0.0
Solar Las Lechuzas	Solar	6/09/2019	2,997.3	0.0
Solar Placilla	Solar	6/09/2019	684.8	0.0
Solar Huatacondo	Solar	5/09/2019	135,165.3	0.0
Calfuco	Diesel	4/09/2019	0.0	0.0
Solar Poblacion	Solar	30/08/2019	3,372.8	0.0
Río Azul	Diesel	30/08/2019	0.0	0.0
Eólica La Flor	Wind	30/08/2019	6,905.0	0.0
Solar Doñihue	Solar	27/08/2019	5,796.6	0.0
Solar Jose Soler Mallafre	Solar	23/08/2019	983.3	0.0
Tucúquere	Solar	23/08/2019	2,806.1	0.0
Eólica El Nogal	Wind	23/08/2019	7,773.3	0.0
Solar Las Perdices	Solar	21/08/2019	2,595.1	0.0
Solar Ariztia	Solar	20/08/2019	2,320.7	0.0
Solar Jaururo	Solar	15/08/2019	1,208.1	0.0
Solar Marchihue VII	Solar	14/08/2019	2,289.9	0.0
Solar Vituco 2B	Solar	14/08/2019	2,658.2	0.0
Solar Canesa I	Solar	13/08/2019	3,032.2	0.0
Solar Santa Adriana	Solar	6/08/2019	1,514.2	0.0
Solar Crucero	Solar	1/08/2019	3,311.9	0.0

Power Plant	Type	Start-up Date	Gen 2019 *(Excluding CDM) (MWh)*	GHG Emissions in 2019 (tCO2/y) *(excluding CDM)*
Central Cumbres	Hydropower: Run of the river	1/08/2019	61,930.7	0.0
Solar Talca	Solar	30/07/2019	7,947.3	0.0
Solar Illapel 5X	Solar	20/07/2019	3,023.8	0.0
Solar Chalinga	Solar	19/07/2019	3,007.3	0.0
Solar Cruz	Solar	19/07/2019	3,634.9	0.0
Solar Las Codornices	Solar	19/07/2019	3,287.7	0.0
Solar Montt	Solar	19/07/2019	3,425.2	0.0
Solar Ranguil	Solar	19/07/2019	2,126.9	0.0
Solar Lo Sierra	Solar	12/07/2019	2,439.4	0.0
Solar Casuto	Solar	29/06/2019	3,232.2	0.0
Solar Norte Chico I	Solar	29/06/2019	1,976.1	0.0
Diesel PRP Gami	Diesel	29/06/2019	0.0	0.0
Diesel Los Sauces	Diesel	27/06/2019	0.0	0.0
Diesel Picoltué	Diesel	27/06/2019	0.0	0.0
Solar Lipangue	Solar	26/06/2019	2,706.5	0.0
Solar La Lajuela	Solar	18/06/2019	9,764.7	0.0
Solar Altos de Til Til	Solar	14/06/2019	2,146.3	0.0
Solar Rovian	Solar	14/06/2019	9,001.6	0.0
Diesel Almendrado	Diesel	11/06/2019	0.0	0.0
Solar Santa Clara	Solar	5/06/2019	4,057.2	0.0
Eólica Punta Sierra	Wind	5/06/2019	271,710.4	0.0
CERRO PABELLON_Geotermica	Geothermal	31/05/2019	CDM Registered	CDM Registered
Solar El Laurel	Solar	29/05/2019	8,022.0	0.0
Solar Pedreros	Solar	23/05/2019	3,887.2	0.0
IEM	Coal	16/05/2019	737,056.9	625,221.3
Solar Encon Solar	Solar	23/04/2019	10,501.3	0.0
Solar Fotovolt Solar I	Solar	23/04/2019	940.2	0.0
Solar GR Santa Rosa	Solar	12/04/2019	CDM registered	CDM registered
Solar Pirque	Solar	11/04/2019	3,736.9	0.0
Solar Marín	Solar	27/02/2019	6,146.0	0.0
Minihidro Correntoso	Hydropower: Run of the river	22/02/2019	15,851.3	0.0
Minihidro Palmar	Hydropower: Run of the river	22/02/2019	15,427.4	0.0
Solar Cachiyuyo 2	Solar	15/02/2019	19,928.4	0.0
Solar Calle Larga	Solar	15/02/2019	6,042.9	0.0
Solar La Blanquina	Solar	15/02/2019	12,665.7	0.0

Power Plant	Type	Start-up Date	Gen 2019 *(Excluding CDM) (MWh)*	GHG Emissions in 2019 (tCO2/y) *(excluding CDM)*
Solar Malaquita 2	Solar	15/02/2019	20,271.3	0.0
Zapallar	Diesel	15/02/2019	0.0	0.0
Solar Valle Este 2	Solar	13/02/2019	18,754.6	0.0
Solar Valle Oeste 2	Solar	13/02/2019	18,573.0	0.0
Cogeneradora Aconcagua	Biomass	9/02/2019	1,163.6	0.0
Eólica Aurora	Wind	1/02/2019	161,256.5	0.0
Solar Alicahue	Solar	19/01/2019	5,233.7	0.0
Solar El Queule	Solar	19/01/2019	1,638.8	0.0
Punta Baja Solar	Solar	18/01/2019	3,950.2	0.0
Solar Olivillo	Solar	27/12/2018	17,800.0	0.0
Solar Piquero	Solar	6/12/2018	6,119.2	0.0
Solar El Quemado	Solar	20/11/2018	6,219.2	0.0
Solar Rodeo	Solar	17/11/2018	5,537.9	0.0
Solar Las Palomas	Solar	31/10/2018	5,974.3	0.0
Solar Catán	Solar	23/10/2018	5,456.3	0.0
SOLAR EL ÁGUILA I	Solar	4/10/2018	3,928.8	0.0
Solar El Pelícano	Solar	13/09/2018	290,274.3	0.0
Solar El Chincol	Solar	7/09/2018	6,754.3	0.0
Solar El Picurio	Solar	4/09/2018	6,361.2	0.0
Solar Ocoa	Solar	1/09/2018	6,061.1	0.0
Solar Villa Prat	Solar	22/08/2018	5,640.9	0.0
Solar Santa Laura	Solar	17/08/2018	5,281.1	0.0
Solar Los Patos	Solar	9/08/2018	5,482.6	0.0
Solar Los Libertadores	Solar	8/08/2018	9,209.0	0.0
Solar Talhuén	Solar	1/08/2018	8,192.5	0.0
Solar La Acacia	Solar	28/07/2018	6,348.4	0.0
CERRO DOMINADOR	Solar	4/07/2018	300,793.0	0.0
Solar Peralillo	Solar	12/06/2018	6,549.0	0.0
Eólica Cabo Leones	Wind	10/06/2018	CDM Registered	CDM Registered
Degañ	Diesel	5/06/2018	474.2	326.0
HUAYCA1	Solar	4/06/2018	0.0	0.0
HUAYCA2	Solar	4/06/2018	51,227.7	0.0
Solar Amparo del Sol	Solar	1/06/2018	6,211.7	0.0
Solar Mostazal	Solar	26/05/2018	20,660.3	0.0
Solar Ovejería	Solar	25/05/2018	20,038.7	0.0
Solar Luders	Solar	23/05/2018	6,968.9	0.0

Power Plant	Type	Start-up Date	Gen 2019 *(Excluding CDM) (MWh)*	GHG Emissions in 2019 (tCO2/y) *(excluding CDM)*
Eólica Sarco	Wind	1/05/2018	92,599.0	0.0
FV BOLERO_Solar	Solar	6/04/2018	366,910.2	0.0
Parque Sierra Gorda_Eólico	Wind	4/04/2018	356,459.2	0.0
Solar El Sauce	Solar	27/03/2018	6,296.8	0.0
Solar Chancon	Solar	21/03/2018	5,493.2	0.0
Solar El Pitio	Solar	13/03/2018	6,300.5	0.0
Hidro La Mina	Hydropower: Run of the river	21/02/2018	67,521.1	0.0
Embalse Ancoa	Hydropower: Reservoir	16/02/2018	77,150.6	0.0
Solar Santiago	Solar	31/01/2018	199,550.6	0.0
El Campesino 1	Biomass	24/01/2018	1,172.1	0.0
Solar Portezuelo	Solar	16/01/2018	5,657.2	0.0
Solar Los Gorriones	Solar	5/01/2018	6,508.1	0.0
Solar Cernicalo 1	Solar	21/12/2017	3,448.5	0.0
Solar Cernicalo 2	Solar	21/12/2017	3,294.8	0.0
Río Colorado	Hydropower: Run of the river	21/12/2017	49,267.1	0.0
Solar La Manga I	Solar	13/12/2017	4,431.9	0.0
Solar Doña Carmen Solar	Solar	29/11/2017	61,894.7	0.0
Solar Chimbarongo	Solar	21/11/2017	5,070.7	0.0
Santuario Solar	Solar	17/11/2017	7,410.0	0.0
Solar Valle de la Luna II	Solar	9/11/2017	6,134.6	0.0
Solar La Quinta	Solar	8/11/2017	CDM Registered	CDM Registered
Solar San Francisco	Solar	8/11/2017	7,111.8	0.0
Solar Antay	Solar	3/11/2017	24,822.4	0.0
Solar El Pilpen	Solar	2/11/2017	7,160.6	0.0
Solar El Roble	Solar	19/10/2017	18,232.5	0.0
Lepanto	Biomass	18/10/2017	0.0	0.0
Solar Panquehue II	Solar	18/10/2017	12,110.1	0.0
Solar Don Eugenio	Solar	26/09/2017	6,122.7	0.0
La Bifurcada	Hydropower: Run of the river	9/09/2017	1,205.6	0.0
PUERTO SECO SOLAR	Solar	1/09/2017	30,032.4	0.0
La Viña - Alto La Viña	Hydropower: Run of the river	28/08/2017	3,437.1	0.0
Riñinahue	Hydropower: Run of the river	23/08/2017	6,934.4	0.0
Solar Cabilsol	Solar	28/07/2017	5,497.5	0.0
Solar Las Turcas	Solar	1/06/2017	4,254.2	0.0
Eólica San Pedro II	Wind	19/05/2017	112,835.5	0.0

Power Plant	**Type**	**Start-up Date**	**Gen 2019** *(Excluding CDM) (MWh)*	**GHG Emissions in 2019 (tCO2/y)** *(excluding CDM)*
PMGD CALAMA_Solar	Solar	12/05/2017	18,349.1	0.0
PARQUE SOLAR FINIS TERRAE_Solar	Solar	18/04/2017	387,475.3	0.0
Solar Marchigue 2	Solar	31/03/2017	14,401.3	0.0
Solar Cordillerilla	Solar	27/03/2017	1,440.2	0.0
Eólica San Juan	Wind	16/03/2017	589,780.0	0.0
Solar Quilapilún	Solar	9/03/2017	214,690.0	0.0
Solar El Romero	Solar	3/03/2017	461,397.7	0.0
Solar Cuz Cuz	Solar	2/03/2017	5,521.4	0.0
Solar Cardones	Solar	21/02/2017	417.7	0.0
Eólica La Esperanza	Wind	13/02/2017	17,658.1	0.0
Solar El Boco	Solar	30/01/2017	5,975.2	0.0
URIBE_Solar	Solar	8/01/2017	154,322.3	0.0
Solar La Esperanza II	Solar	30/12/2016	18,867.1	0.0
Eólica Las Peñas	Wind	28/12/2016	30,690.3	0.0
Kelar	Diesel	27/12/2016	CDM registered	CDM registered
Kelar	LNG	27/12/2016	CDM registered	CDM registered
Parque Eólico Lebu III	Wind	14/12/2016	6,651.0	0.0
Solar Ñilhue	Solar	1/12/2016	1,810.7	0.0
Solar San Pedro	Solar	1/12/2016	5,553.7	0.0
Newen	Propane	27/11/2016	0.0	0.0
Newen	Diesel	27/11/2016	0.0	0.0
Newen	Natural gas	27/11/2016	369.1	203.4
Tránquil	Hydropower: Run of the river	23/11/2016	0.0	0.0
La Montaña 1	Hydropower: Run of the river	16/11/2016	1,403.4	0.0
Carilafquén	Hydropower: Run of the river	28/10/2016	59,660.6	0.0
Solar Hormiga Solar	Solar	27/10/2016	4,584.6	0.0
Cumpeo	Hydropower: Run of the river	26/10/2016	25,961.2	0.0
Solar Pampa Solar Norte	Solar	19/10/2016	206,218.5	0.0
Solar Alturas de Ovalle	Solar	4/10/2016	11,011.4	0.0
Eólica Renaico	Wind	12/09/2016	280,540.1	0.0
Itata Hidro	Hydropower: Run of the river	9/09/2016	53,700.7	0.0
Solar Conejo	Solar	8/09/2016	305,716.0	0.0
hbs gnl	Natural gas	1/09/2016	0.0	0.0
Eólica Los Buenos Aires	Wind	30/08/2016	82,570.5	0.0
El Colorado	Hydropower: Run of the river	29/08/2016	6,477.1	0.0

Power Plant	Type	Start-up Date	Gen 2019 *(Excluding CDM) (MWh)*	GHG Emissions in 2019 (tCO2/y) *(excluding CDM)*
Solar Los Loros	Solar	17/08/2016	100,147.3	0.0
Solar La Silla	Solar	12/08/2016	4,583.4	0.0
Solar El Divisadero	Solar	10/08/2016	8,828.4	0.0
Cochrane	Coal	9/07/2016	1,679,646.4	1,487,796.1
Cochrane	Coal	9/07/2016	1,696,310.2	1,431,523.5
El Agrio	Hydropower: Run of the river	7/07/2016	9,871.4	0.0
Pulelfu	Hydropower: Run of the river	7/07/2016	53,544.6	0.0
El Galpón	Hydropower: Run of the river	28/06/2016	5,806.0	0.0
CMPC Tissue	LNG	16/06/2016	10,510.2	2,246.2
Solar Chuchiñi	Solar	9/06/2016	4,933.4	0.0
Solar Til Til	Solar	19/05/2016	3,543.0	0.0
Chanleufu	Hydropower: Run of the river	19/05/2016	1,784.6	0.0
Andes Generación	Diesel	17/05/2016	123.8	95.2
Andes Generación	Fuel N°6	17/05/2016	16.2	12.5
Solar Las Araucarias	Solar	12/05/2016	0.0	0.0
Alto Renaico	Hydropower: Run of the river	9/05/2016	8,246.7	0.0
PARQUE SOLAR PAMPA CAMARONES	Solar	4/05/2016	13,001.0	0.0
Solar Carrera Pinto	Solar	3/05/2016	238,325.5	0.0
CMPC Cordillera	LNG	25/04/2016	1,324.3	283.0
Río Mulchén	Hydropower: Run of the river	1/04/2016	2,336.5	0.0
Ujina	Fuel N°6	29/03/2016	0.0	0.0
Ujina	Fuel N°6	29/03/2016	289.3	181.3
Ujina	Fuel N°6	29/03/2016	38.5	24.0
Ujina	Fuel N°6	29/03/2016	270.6	164.3
Ujina	Fuel N°6	29/03/2016	297.4	181.3
Ujina	Fuel N°6	29/03/2016	301.2	187.0
Solar Bellavista	Solar	23/03/2016	3,759.8	0.0
Solar Santa Julia	Solar	17/03/2016	7,301.8	0.0
Molinera Villarrica	Hydropower: Run of the river	3/03/2016	1,358.3	0.0
El Paso	Hydropower: Run of the river	2/03/2016	88,664.5	0.0
Solar La Chapeana	Solar	1/03/2016	4,887.3	0.0
Solar Las Mollacas	Solar	1/03/2016	5,247.5	0.0
Malalcahuello	Hydropower: Run of the river	1/03/2016	13,151.9	0.0
Luz del Norte	Solar	24/02/2016	393,051.1	0.0
Solar Lagunilla	Solar	5/02/2016	6,724.1	0.0

Power Plant	Type	Start-up Date	Gen 2019 *(Excluding CDM) (MWh)*	GHG Emissions in 2019 (tCO2/y) *(excluding CDM)*
SOLAR JAMA 2_Solar	Solar	21/01/2016	65,995.5	0.0
El Molle	Biomass	18/12/2015	15,475.0	0.0
Guacolda 5	Coal	15/12/2015	1,100,511.0	883,962.5
PMGD PICA_Solar	Solar	10/12/2015	CDM registered	CDM registered
Eólica Huajache	Wind	25/11/2015	14,210.1	0.0
PAS1_Solar	Solar	4/11/2015	0.0	0.0
El Mirador	Hydropower: Run of the river	2/11/2015	10,778.8	0.0
Trailelfú	Hydropower: Run of the river	16/10/2015	7,841.5	0.0
Solar El Pilar - Los Amarillos	Solar	15/10/2015	0.0	0.0
Solar Sol	Solar	5/10/2015	6,409.0	0.0
Los Hierros II	Hydropower: Run of the river	21/09/2015	19,203.2	0.0
Solar Luna	Solar	16/09/2015	9,252.3	0.0
Solar Lalackama 2	Solar	31/08/2015	46,758.9	0.0
Munilque	Hydropower: Run of the river	13/08/2015	773.9	0.0
Picoiquén	Hydropower: Run of the river	13/08/2015	CDM Registered	CDM Registered
LOS PUQUIOS	Solar	11/08/2015	1,159.3	0.0
Lleuquereo	Hydropower: Run of the river	7/08/2015	7,518.1	0.0
Los Guindos	Diesel	30/07/2015	0.0	0.0
Raki	Wind	30/07/2015	18,372.4	0.0
Bureo	Hydropower: Run of the river	13/07/2015	8,362.3	0.0
Salvador RTS	Solar	7/07/2015	0.0	0.0
Solar Lalackama	Solar	2/06/2015	154,951.6	0.0
Solar Chañares	Solar	28/05/2015	92,814.7	0.0
Laja 1	Hydropower: Run of the river	28/05/2015	CDM registered	CDM registered
Talinay Poniente	Wind	26/05/2015	203,800.7	0.0
Solar Javiera	Solar	19/05/2015	172,234.0	0.0
SOLAR JAMA 1_Solar	Solar	14/04/2015	95,170.5	0.0
Santa Fe	Biomass	10/04/2015	6,900.0	0.0
Eólica Taltal	Wind	9/02/2015	307,674.0	0.0

***Notes**:*

Note 1: Low-Cost/Must-Run power plant for which data on electricity generation and fuel consumption is available. Therefore, the Emission Factor has been calculated following Option A.1., taking into account that for Run-of-River, hydropower: Reservoir, Solar, Eolic or Biomass fired power plants, the fuel type emission factor is equal to zero.

Table A4-10. Results for $EF_{Grid,BM,y}$

Results for $EF_{grid,BM,y}$	
$EF_{grid,BM,y}$ (tCO2/MWh)	**0.3181**

Table A4-11. Results for $EF_{Grid,CM,y}$

Emission factors for the Chilean SEN interconnected grid

Baseline	$EF_{grid,OMsimple,y}$ [tCO_2/MWh]		Net Generation [MWh] [32]
2017	0.6513		42,048,156652
2018	0.7265		41,018,147
2019	0.7010		42,104,818
	$EF_{grid,OMsimple,2017\text{-}2019}$	$EF_{grid,BM,2019}$	$EF_{grid,\ CM,\ 2017,2018,2019}$ [tCO_2/MWh] other projects (no wind and solar)
	0.6926	**0.3181**	
	Weights_wind and solar projects	Weights_all other projects	
	w_{OM} = 0.75	w_{OM} = 0.25	
	w_{BM} = 0.25	w_{BM} = 0.75	**0.4117**

Table A4-12. Data for $EG_{m,y}$

Power Plant Name	Gen 2019 *(MWh)*
Ciruelillo	0.0
Copiulemu	0.0
Solar Luce	1,441.5
Palacios	6,771.8
TER Doña Javiera	0.0
Solar Bellavista 1	4,315.6
Solar San Isidro	503.1
Solar Tricahue 2	7,175.2
Eólica San Gabriel	147,785.3
Solar La Ligua	861.5
Solar Villa Seca	1,118.6
Solar RLA	1,927.2
Dos Valles	8,955.2
Dos Valles	8,955.2
Solar Las Lechuzas	2,997.3

[32] Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost/must-run power plants/units, in year y (MWh).

Power Plant Name	**Gen 2019** *(MWh)*
Solar Placilla	684.8
Solar Huatacondo	135,165.3
Calfuco	0.0
Solar Poblacion	3,372.8
Río Azul	0.0
Eólica La Flor	6,905.0
Solar Doñihue	5,796.6
Solar Jose Soler Mallafre	983.3
Tucúquere	2,806.1
Eólica El Nogal	7,773.3
Solar Las Perdices	2,595.1
Solar Ariztia	2,320.7
Solar Jaururo	1,208.1
Solar Marchihue VII	2,289.9
Solar Vituco 2B	2,658.2
Solar Canesa I	3,032.2
Solar Santa Adriana	1,514.2
Solar Crucero	3,311.9
Central Cumbres	61,930.7
Solar Talca	7,947.3
Solar Illapel 5X	3,023.8
Solar Chalinga	3,007.3
Solar Cruz	3,634.9
Solar Las Codornices	3,287.7
Solar Montt	3,425.2
Solar Ranguil	2,126.9
Solar Lo Sierra	2,439.4
Solar Casuto	3,232.2
Solar Norte Chico I	1,976.1
Diesel PRP Gami	0.0
Diesel Los Sauces	0.0
Diesel Picoltué	0.0
Solar Lipangue	2,706.5
Solar La Lajuela	9,764.7
Solar Altos de Til Til	2,146.3
Solar Rovian	9,001.6
Diesel Almendrado	0.0
Solar Santa Clara	4,057.2
Eólica Punta Sierra	271,710.4
CERRO PABELLON_Geotermica	CDM Registered
Solar El Laurel	8,022.0
Solar Pedreros	3,887.2
IEM	737,056.9
Solar Encon Solar	10,501.3
Solar Fotovolt Solar I	940.2
Solar GR Santa Rosa	CDM registered
Solar Pirque	3,736.9
Solar Marín	6,146.0

Power Plant Name	Gen 2019 *(MWh)*
Minihidro Correntoso	15,851.3
Minihidro Palmar	15,427.4
Solar Cachiyuyo 2	19,928.4
Solar Calle Larga	6,042.9
Solar La Blanquina	12,665.7
Solar Malaquita 2	20,271.3
Zapallar	0.0
Solar Valle Este 2	18,754.6
Solar Valle Oeste 2	18,573.0
Cogeneradora Aconcagua	1,163.6
Eólica Aurora	161,256.5
Solar Alicahue	5,233.7
Solar El Queule	1,638.8
Punta Baja Solar	3,950.2
Solar Olivillo	17,800.0
Solar Piquero	6,119.2
Solar El Quemado	6,219.2
Solar Rodeo	5,537.9
Solar Las Palomas	5,974.3
Solar Catán	5,456.3
SOLAR EL ÁGUILA I	3,928.8
Solar El Pelícano	290,274.3
Solar El Chincol	6,754.3
Solar El Picurio	6,361.2
Solar Ocoa	6,061.1
Solar Villa Prat	5,640.9
Solar Santa Laura	5,281.1
Solar Los Patos	5,482.6
Solar Los Libertadores	9,209.0
Solar Talhuén	8,192.5
Solar La Acacia	6,348.4
CERRO DOMINADOR	300,793.0
Solar Peralillo	6,549.0
Eólica Cabo Leones	CDM Registered
Degañ	474.2
HUAYCA1	0.0
HUAYCA2	51,227.7
Solar Amparo del Sol	6,211.7
Solar Mostazal	20,660.3
Solar Ovejería	20,038.7
Solar Luders	6,968.9
Eólica Sarco	92,599.0
FV BOLERO_Solar	366,910.2
Parque Sierra Gorda_Eólico	356,459.2
Solar El Sauce	6,296.8
Solar Chancon	5,493.2
Solar El Pitio	6,300.5
Hidro La Mina	67,521.1

Power Plant Name	Gen 2019 *(MWh)*
Embalse Ancoa	77,150.6
Solar Santiago	199,550.6
El Campesino 1	1,172.1
Solar Portezuelo	5,657.2
Solar Los Gorriones	6,508.1
Solar Cernicalo 1	3,448.5
Solar Cernicalo 2	3,294.8
Río Colorado	49,267.1
Solar La Manga I	4,431.9
Solar Doña Carmen Solar	61,894.7
Solar Chimbarongo	5,070.7
Santuario Solar	7,410.0
Solar Valle de la Luna II	6,134.6
Solar La Quinta	CDM Registered
Solar San Francisco	7,111.8
Solar Antay	24,822.4
Solar El Pilpen	7,160.6
Solar El Roble	18,232.5
Lepanto	0.0
Solar Panquehue II	12,110.1
Solar Don Eugenio	6,122.7
La Bifurcada	1,205.6
PUERTO SECO SOLAR	30,032.4
La Viña - Alto La Viña	3,437.1
Riñinahue	6,934.4
Solar Cabilsol	5,497.5
Solar Las Turcas	4,254.2
Eólica San Pedro II	112,835.5
PMGD CALAMA_Solar	18,349.1
PARQUE SOLAR FINIS TERRAE_Solar	387,475.3
Solar Marchigue 2	14,401.3
Solar Cordillerilla	1,440.2
Eólica San Juan	589,780.0
Solar Quilapilún	214,690.0
Solar El Romero	461,397.7
Solar Cuz Cuz	5,521.4
Solar Cardones	417.7
Eólica La Esperanza	17,658.1
Solar El Boco	5,975.2
URIBE_Solar	154,322.3
Solar La Esperanza II	18,867.1
Eólica Las Peñas	30,690.3
Kelar	CDM registered
Kelar	CDM registered
Parque Eólico Lebu III	6,651.0
Solar Ñilhue	1,810.7
Solar San Pedro	5,553.7
Newen	0.0

Power Plant Name	Gen 2019 *(MWh)*
Newen	0.0
Newen	369.1
Tránquil	0.0
La Montaña 1	1,403.4
Carilafquén	59,660.6
Solar Hormiga Solar	4,584.6
Cumpeo	25,961.2
Solar Pampa Solar Norte	206,218.5
Solar Alturas de Ovalle	11,011.4
Eólica Renaico	280,540.1
Itata Hidro	53,700.7
Solar Conejo	305,716.0
hbs gnl	0.0
Eólica Los Buenos Aires	82,570.5
El Colorado	6,477.1
Solar Los Loros	100,147.3
Solar La Silla	4,583.4
Solar El Divisadero	8,828.4
Cochrane	1,679,646.4
Cochrane	1,696,310.2
El Agrio	9,871.4
Pulelfu	53,544.6
El Galpón	5,806.0
CMPC Tissue	10,510.2
Solar Chuchiñi	4,933.4
Solar Til Til	3,543.0
Chanleufu	1,784.6
Andes Generación	123.8
Andes Generación	16.2
Solar Las Araucarias	0.0
Alto Renaico	8,246.7
PARQUE SOLAR PAMPA CAMARONES	13,001.0
Solar Carrera Pinto	238,325.5
CMPC Cordillera	1,324.3
Río Mulchén	2,336.5
Ujina	0.0
Ujina	289.3
Ujina	38.5
Ujina	270.6
Ujina	297.4
Ujina	301.2
Solar Bellavista	3,759.8
Solar Santa Julia	7,301.8
Molinera Villarrica	1,358.3
El Paso	88,664.5
Solar La Chapeana	4,887.3
Solar Las Mollacas	5,247.5
Malalcahuello	13,151.9

Power Plant Name	Gen 2019 *(MWh)*
Luz del Norte	393,051.1
Solar Lagunilla	6,724.1
SOLAR JAMA 2_Solar	65,995.5
El Molle	15,475.0
Guacolda 5	1,100,511.0
PMGD PICA_Solar	CDM registered
Eólica Huajache	14,210.1
PAS1_Solar	0.0
El Mirador	10,778.8
Trailelfú	7,841.5
Solar El Pilar - Los Amarillos	0.0
Solar Sol	6,409.0
Los Hierros II	19,203.2
Solar Luna	9,252.3
Solar Lalackama 2	46,758.9
Munilque	773.9
Picoiquén	CDM Registered
LOS PUQUIOS	1,159.3
Lleuquereo	7,518.1
Los Guindos	0.0
Raki	18,372.4
Bureo	8,362.3
Salvador RTS	0.0
Solar Lalackama	154,951.6
Solar Chañares	92,814.7
Laja 1	CDM registered
Talinay Poniente	203,800.7
Solar Javiera	172,234.0
SOLAR JAMA 1_Solar	95,170.5
Santa Fe	6,900.0
Eólica Taltal	307,674.0
MARIA ELENA FV_Solar	218,306.7
Las Flores	12,471.9
Solar Diego de Almagro	71,673.1
Punta Palmeras	CDM registered
María Elena	983.6
Collil	23,379.7
Las Pampas	0.0
Ucuquer 2	14,777.2
Las Terrazas	1,039.4
Pichilonco	5,427.0
Diesel La Portada	19.7
Solar PSF Pama	4,336.7
Eólica Los Cururos	248,387.7
San Pedro	CDM Registered
Solar San Andrés	116,830.8
San Andrés	CDM Registered
Solar PSF Lomas Coloradas	4,241.8

Power Plant Name	Gen 2019 *(MWh)*
PAS3_Solar	45,453.4
Eólica El Arrayán	CDM Registered
Los Padres	6,234.4
Boquiamargo	0.0
Quillaileo	1,443.6
Llano de Llampos	257,730.7
Los Hierros	CDM Registered
Santa Marta	CDM Registered
Energía Bio Bio	0.0
PAS2_Solar	21,286.6
Techos de Altamira	0.0
Eólica VALLE DE LOS VIENTOS_Eólico	CDM Registered
Coelemu	29,847.7
Los Bajos	22,076.1
CMPC Pacífico	118,043.9
El Llano	1,920.4
Las Vertientes	13,352.0
Solar La Frontera	9,335.6
Santa Cecilia	5,544.0
Negrete	94,058.8
Maisan	2,050.0
Diesel Zofri	0.0
Diesel Zofri	0.0
Diesel Zofri	0.0
Diesel Zofri	0.0
Diesel Zofri	0.0
Río Huasco	19,074.1
Santa Irene	0.0
Renaico	40,064.0
SDGx01	1,370.4
Los Álamos	2.3
Viñales	236,615.6
Solar Hornitos	151.4
Diesel Aguas Blancas	143.5
MC2	18,467.5
MC1	34,844.8
Ensenada	CDM registered
Ancali	0.0
CMPC Laja	153,897.4
Don Walterio	20,971.7
Robleria	CDM Registered
Talinay Oriente	CDM registered
Providencia	CDM Registered
Campiche	1,725,617.0
Tamm	0.0
Los Corrales II	4,538.1
Estancilla	42.0
Ucuquer	20,831.5

Power Plant Name	**Gen 2019** *(MWh)*
Rucatayo	248,828.8
Tambo Real	5,450.0
Trebal Mapocho	6,204.3
Bocamina II	2,333,196.0
PAM	128,995.3
Callao	CDM Registered
Nalcas	CDM Registered
Biocruz	2,251.3
Santa María	1,934,102.0
Curanilahue	9.3
El Canelo	21,443.3
Allipen	CDM Registered
Lautaro-Comasa	CDM Registered
Lautaro	CDM Registered
Planta Curicó	0.0
Purísima	2,299.0
CONSTITUCION	0.0
Cabrero	CDM Registered
Energía Pacífico	113,351.0
Lautaro-Comasa 2	CDM Registered
Chacayes	CDM Registered
Punta Colorada Eólica	7,543.5
La Arena	CDM Registered
Muchi	2,257.3
Loma Los Colorados II	CDM Registered
Danisco	0.0
Reca	7,459.7
Termoeléctrica Hornitos	877,686.9
Lonquimay	96.0
Tirúa	14.5
Termoeléctrica Andina	737,597.7
Mallarauco	25,035.9
HBS	408.2
Licán	75,071.8
Skretting Osorno	0.0
Donguil	741.1
La Higuera	CDM Registered
Confluencia	CDM Registered
Calle-Calle	610.2
Diuto	23,835.2
Termoeléctrica Angamos	2,068,339.3
Termoeléctrica Angamos	2,120,690.1
Tomaval 1	3,048.3
Guayacán	CDM Registered
Mariposas	23,137.2
Lousiana Pacific II	7.3
Cem Bio Bio	1,018.3
Dongo	CDM Registered

Power Plant Name	Gen 2019 *(MWh)*
Punta Colorada	0.0
Doña Hilda	2,847.8
CAVANCHA_PASADA	15,963.6
Los Corrales	238.3
SAN CLEMENTE	CDM Registered
El Tártaro	64.8
Chuyaca	271.5
Solar PV Salvador	186,335.2
El Salvador	116.1
Yungay 4 CA	50.7
Colihues U1	0.0
Emelda U2	629.7
Emelda U1	233.5
TRUENO	CDM Registered
Guacolda 4	967,253.0
LA PALOMA	CDM Registered
Nueva Ventanas	1,687,314.0
Loma Los Colorados	708.2
Monte Redondo	CDM Registered
Canela 2	CDM Registered
Termopacífico	958.1
San Lorenzo de D. de Almagro	0.0
Diego de Almagro	172.0
Diesel Inacal	44.3
Truful Truful	6,330.5
Quintero B	67,773.0
Quintero A	77,380.0
Tapihue	157.2
Guacolda 3	1,035,208.4
El Peñón	410.7
Cardones	31.9
Louisiana Pacific	202.5
Teno	720.1
Parque Eólico Lebu	CDM Registered
Santa Lidia	1,829.0
Los Pinos	13,437.0
Los Espinos	2,242.7
Lircay	CDM Registered
Multiexport II	2.7
Multiexport I	3.3
Watts I	0.0
Watts II	0.0
Biomar	814.7
Cenizas	0.0
Trapén	45,545.1
Quellón II	0.0
Colmito	5,219.5
Colmito	52,900.4

Power Plant Name	**Gen 2019** *(MWh)*
Olivos	0.0
Coya	0.0
Chiloé	333.9
Ojos de Agua	CDM Registered
Yungay 3	172.0
Nueva Aldea 3	235,346.4
Puclaro	CDM Registered
Eólica Totoral	CDM Registered
FPC	25,846.5
San Isidro II	34.0
San Isidro II	1,561,050.0
San Isidro II	758,167.0
El Manzano	CDM Registered
Hornitos	CDM Registered
Canela	CDM Registered
Palmucho	235,026.0
Chiburgo	66,875.0
Esperanza 1	13.5
Esperanza 2	12.8
Maule	269.3
Constitución 1	1,120.4
Curacautín	104.2
Cañete	26.9
Lebu	4.2
Quilleco	CDM Registered
El Rincón	2,073.5
Yungay 1	118.2
Yungay 2	121.1
Los Vientos	76,899.7
Curauma	6.2
Nueva Aldea II	CDM Registered
Candelaria 2	560.0
Candelaria 2	36,236.0
Candelaria 2	375.0
Candelaria 1	47,608.5
Candelaria 1	709.0
TG_Coronel	265.1
TG_Coronel	1,145.6
Nueva Aldea	CDM Registered
Antilhue TG	52,163.5
Horcones	CDM Registered
RALCO	2,309,853.0
Valdivia	CDM Registered
Valdivia LN	0.0
Valdivia	0.0
Nehuenco II	0.0
Nehuenco II	778,744.0
Nehuenco II	1,953,823.0

Power Plant Name	Gen 2019 *(MWh)*
Licantén	19,315.9
Licantén LN	0.0
Cholguán	36,980.5
Eyzaguirre	3,177.4
Nehuenco TG 9B	1,852.0
Nehuenco TG 9B	614.0
CHACABUQUITO	CDM Registered
Pehui	5,622.9
Taltal 2	1,508.0
Taltal 2	14,622.0
Taltal 1	420.0
Taltal 1	3,056.0
MAMPIL	141,646.7
PEUCHEN	190,669.5
Atacama	3,560.8
Atacama	78,709.0
Atacama	6,419.0
Atacama	215,546.1
Termoeléctrica Tarapacá	614,131.2
Termoeléctrica Tarapacá	112.3
San Isidro	326.0
Nehuenco	0.0
Petropower	392,476.5
RUCUE	715,126.0
San Isidro	971,946.0
San Isidro	334,138.0
Nehuenco	544,757.0
Nehuenco	1,142,704.0
Nueva Renca FA	19.0
Nueva Renca FA	193.0
Nueva Renca	0.0
LOMA ALTA	166,711.0
Nueva Renca	1,710,345.0
Nueva Renca	0.0
Celco	50,405.0
PANGUE	1,669,874.0
SAN IGNACIO	87,060.0
Guacolda 2	943,523.0
Diesel Mantos Blancos	1.1
LAJA	30,935.0
Termoeléctrica Mejillones	0.0
Termoeléctrica Norgener	966,723.4
Termoeléctrica Mejillones	4,401.1
Termoeléctrica Mejillones	844,399.2
CAPULLO	69,552.4
Termoeléctrica Mejillones	259,074.7
Termoeléctrica Mejillones	228,973.4
Termoeléctrica Norgener	925,755.9

Power Plant Name	**Gen 2019** *(MWh)*
Guacolda 1	1,049,378.0
Juncalito	2,232.9
ACONCAGUA	225,756.0
Florida 3	18,870.9
CURILLINQUE	417,520.4
PEHUENCHE	1,543,143.0
ALFALFAL	657,536.6
CANUTILLAR	647,068.0
MACHICURA	263,356.0
COLBUN	1,166,238.0
Arauco	45,087.9
ANTUCO	1,264,259.0
Huasco TG	0.0
Huasco TG	57.0
Ventanas 2	879,278.0
EL TORO	1,125,829.0
Bocamina	600,244.0
RAPEL	144,752.0
CHAPIQUIÑA _PASADA	38,970.3
Ventanas 1	190,496.0
ISLA	371,551.0
Auxiliar Maipo	19,939.3
PULLINQUE	188,019.0
Termoeléctrica Tocopilla	0.0
Termoeléctrica Tocopilla	1,072,176.3
Termoeléctrica Tocopilla	0.0
Termoeléctrica Tocopilla	9,043.7
Termoeléctrica Tocopilla	41,399.0
Termoeléctrica Tocopilla	112,337.8
Termoeléctrica Tocopilla	0.0
Termoeléctrica Tocopilla	22,650.4
Termoeléctrica Tocopilla	0.0
Termoeléctrica Tocopilla	0.0
SAUZALITO	54,061.0
CIPRESES	269,343.3
Diesel Arica	0.2
Diesel Arica	0.9
Diesel Arica	14.3
LOS MOLLES	30,829.8
SAUZAL 60 HZ	6,523.9
ABANICO	268,730.8
SAUZAL	287,968.0
VOLCAN	76,744.4
PILMAIQUEN	230,421.6
Carena	32,898.2
LOS QUILOS	141,222.4
LOS MORROS	6,386.8
QUELTEHUES	279,337.9

Power Plant Name	**Gen 2019** *(MWh)*
EPSA	77,009.9
MAITENES	98,177.9
SAUCE ANDES	3,165.2
Florida 2	42,321.0
ANDES SOLAR_Solar	CDM registered
Angostura	1,171,107.0
Solar Loma Los Colorados	1,041.8
Chufkén	6.6

Notes:

Note 1: source of thermoelectric generation information: "Consumos de Combustible de Centrales del Sistema Energético Nacional. Comisión Nacional de Energía, Gobierno de Chile. 2020"

Note 2: source of renewable generation information: "Generación Bruta del Sistema Energético Nacional. Comisión Nacional de Energía, Gobierno de Chile. 2020"

Note 3: some Power Plants names are repeated because they refer to different units and fuels. Depending on the year they use different fuels, so they are reported separately.

Note 4: this power plant was not connected in that year.

Table A4-13. Fuel consumption *[1]*

Fuel Properties					
Fuel Type	**Density** *(kg/m3)*	**GCV** [9] *(kcal/kg)*	*(kcal/m3)*	**NCV** [11] *(GJ/ton)*	*(GJ/m3)*
Coal	-	7,000		27.80	
Natural Gas	-		9,341		0.0351
LPG [2], [6]	552.40	12,100		45.50	
LNG [3]	-		9,341		0.0351
Petcoke	-	7,000		27.80	
Diesel [4]	840	10,900		43.28	
Fuel-Oil [5], [8]	945	10,500		41.70	

Conversion Factors			
Unit	**Natural Gas** *(m3)*[7]	**m3**	**GJ**
Mbtu	0.0302650		
Mmbtu	30.2650		
dam3		1,000	
Mm3 [10]		1,000	
kcal			0.000004180

Emission Factors *[12]*			
Fuel Type	**EF** *(tCO_2/GJ)*	**EF** *(tCO_2/ton)*	**EF** *(tCO_2/m^3)*
Coal	0.0873	2.43	
Natural Gas	0.0543		0.00191
LPG [2], [6]	0.0616	2.80	1.54895

LNG [3]	0.0543		0.00191
Petcoke	0.0829	2.30	
Diesel [4]	0.0726	3.14	
Fuel-Oil [5], [8]	0.0755	3.15	

Notes:

Note 1: source of fuel consumption information: "Consumos de Combustible de Centrales del Sistema Energético Nacional. Comisión Nacional de Energía, Gobierno de Chile. 2020"

Note 2: the "Butano" and "Propano" categories, as appear at the data source (Table 1), since they are all included into Liquified Petroleum Gases (LPG), as defined by the International Panel on Climate Change at "2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 2, CHAPTER 1", are going to be considered, at the time of calculating its emission factors, grouped into LPG category

Note 3: since Liquified Natural Gas consumption is measured in gaseous state, therefore its density is the same than the normal conditions natural gas and therefore the natural gas emission factor and calorific value is applied.

Note 4: the "Petróleo-Diésel - Petróleo IFO-180" category, as appear at the data source (Table 1), is going to be considered as "Diesel" to calculate the net quantity of fossil fuels consumptiom in the SEN System. As it represents about a 0,02% of the total Diesel consumption, this hypothesis is considered valid and without significative contribution or impact in the final results.

Note 5: the "Petróleo FO6", "Petróleo Nº6", "Petróleo IFO 180" and "Petróleo IFO 380" categories, as appear at the data source (Table 1), since they are all kinds of Fuel Oil, considering their Gross Calorific Value is the same (see GCV data source), they are going to be considered grouped into Fuel-Oil category (Table 2 and Table 3) when calculating their emission factor.

Note 6: source for density data: Chilean National Energy Balance 2018 ("Balance Nacional de Energía 2018. Comisión Nacional de Energía, División de Prospectiva y Política Energética del Ministerio de Energía. Ministerio de Energía de Chile, 2019").

Note 7: source for conversion factor: Chilean National Energy Balance 2018 ("Balance Nacional de Energía 2018. Comisión Nacional de Energía, División de Prospectiva y Política Energética del Ministerio de Energía. Ministerio de Energía de Chile, 2019").

Note 8: source for density data: Chilean National Energy Balance 2018 ("Balance Nacional de Energía 2018. Comisión Nacional de Energía, División de Prospectiva y Política Energética del Ministerio de Energía. Ministerio de Energía de Chile, 2093"). Since the density conversion factor has been only used for Petroleum No.6, its density has been established in Table 3

Note 9: source for GCV: Chilean National Energy Balance 2018 ("Balance Nacional de Energía 2018. Comisión Nacional de Energía, División de Prospectiva y Política Energética del Ministerio de Energía. Ministerio de Energía de Chile, 2019").

Note 10: source for conversion factor: National Statistics Institute of Chile (Instituto Nacional de Estadística, INE de Chile).

Note 11: The CNE Energy Balance Report includes Gross Calorific Values (GCV) for the different types of fuel. These values were corrected to Net Calorific Values (NCV) based on the IPCC 2006 assumptions. Net Calorific Value has been calculated as established by IPCC, following the next criteria: "The difference between NCV and GCV is the latent heat of vaporisation of the water produced during combustion of the fuel. As a consequence for coal and oil, the NCV is about 5 percent less than the GCV For most forms of natural and manufactured gas, the NCV is about 10 percent less". That means, from National or official values for GCV, NCV has been obtained applying a correction factor of 0,95 for solid or liquid fuels and a correction factor of 0,90 for gas type fuels. That approach have been proposed by the IPCC in "2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 2, CHAPTER 1"

Note 12: Unit-converted from values showed in: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 2, CHAPTER 1, Table 1.4 (lower limit of the 95% confidence intervals

Note 13: source for the emission factor value applicable to biogas power generation: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 2, CHAPTER 2, Table 2.2

Appendix 5. Further background information on monitoring plan

N/A

Appendix 6. Summary report of comments received from local stakeholders

N/A

Appendix 7. Summary of post-registration changes

1. Changes to project design

Change Observed:
Paper fibre wastes were not used to feed the boiler, so biomass residues categories used for the selection of the baseline scenario vary slightly.

Change Requested:
Consider only forestry and agriculture residues as biomass residues categories used for the selection of the baseline scenario.

Justifications of Change Requested:
The PDD was initially designed to use paper fiber wastes of a paper manufacturing facility owned by COMASA(Forestal y Papelera industrial papermill, in Concepción). Nevertheless, COMASA sold this industrial facility and stopped having access to this residue. That is why the use of paper fiber was no longer viable.
Moreover, regarding the quantity of this type of biomass, it can be neglected, since paper fibers only represented 501.07 tonnes of dry matter/year out of 247,373.07 tonnes/year, the 0.2%.

In addition, Baseline emissions will not be affected (69,277 t CO_2e), while Project emissions will be 14,151 t CO_2e. Thus, Emission reductions will be 55,126 t CO_2e. The PE are updated because there is a non-significant impact in $PE_{TR,y}$ (194 t CO_2e), since lower emissions due to transport of biomass are generated regarding the fact that the paper fiber residues were located 231 km from the project activity. Furthermore, there is a non-significant impact in $PE_{BR,y}$ (9 t CO_2e) since CH_4 from the combustion of paper fiber residues will no longer occur.

Table 30 Project emissions calculation

Project emissions sources	tCO_2/year
Project emissions Due to fossil fuel consumption at the project site ($PE_{FF,y}$)	1,461
Emissions due to electricity used off-site for the processing of biomass residues ($PE_{EL,y}$)	0
Emissions due to transport of the biomass residues to the project plant ($PE_{TR,y}$)	8,574
Emissions from the combustion of biomass residues ($PE_{BR,y}$)	4,116
Emissions from wastewater generated from the treatment of biomass residues ($PE_{WW,y}$)	0
Total Project emissions (PE_y)	**14,151**

Summary on Impact of the changes:

a. Applicability of the methodology:

As stated before, the project activity will continue using forestry and agriculture residues for electricity generation so it considered in the methodology as part of emissions reduction sources in the baseline scenario. This is further explained in Section B.6.1. Explanation of methodological choices.

b. Compliance of the Monitoring Plan

The monitoring plan will not be affected, since the same parameters will be monitored.

These parameters are further explained in Section B.7.1. Data and parameters to be monitored.

c. Level of accuracy and completeness compared with the requirement in the registered monitoring plan

The removal of the paper fiber residues will allow to have a more accurate vision of the implemented project activity, since no paper fiber residues are used.

d. Additionality of the project activity

The removal of the paper fiber residues does not affect the additionality of the project activity.

e. Scale of the project activity

Scale of the project will not be affected due to the removal of the paper fiber residues, as a large scale methodology will be also applicable.

2. Corrections

N/A

3. Permanent changes to the monitoring plan

N/A

4. Temporary deviations to the monitoring plan

N/A

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	Revision to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Make editorial improvement.

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

Decision Class: Regulatory
Document Type: Form
Business Function: Registration
Keywords: project activities, project design document