Project design document form
(Version 10.1)

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

BASIC INFORMATION	
Title of the project activity	Puelche Project/Cancura Factory Biomass Boiler for Heat Generation
Scale of the project activity	☐ Large-scale ☒ Small-scale
Version number of the PDD	Version 11
Completion date of the PDD	27/12/2017
Project participants	Nestlé Chile S.A.
Host Party	Chile
Applied methodologies and standardized baselines	CDM Methodology AMS-I.C: “Thermal energy production with or without electricity” version 20.0
Sectoral scopes linked to the applied methodologies	Sectoral Scope 1, Energy Industries (renewable/non-renewable).
Estimated amount of annual average GHG emission reductions	16,333 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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Nestlé Chile S.A. is developing and executing a new project, which consists in the construction of a highly automated cow milk processing plant in the Osorno Province, Los Lagos Region in Chile. The project will have a maximum production of ~30,000 tons a year of powdered milk (final product) and considers the possibility of future production capacity expansions.

The thermal energy demand of this processing plant will be satisfied by using a 15 tons/h capacity Biomass Fired Boiler to produce steam. The CDM project activity involves the installation and operation of this biomass fired boiler, which is also considered as the main activity of the CDM project.

At concept design stage and credit approval, Nestlé Chile S.A. considered for this milk processing plant the installation of two 15 tons/hour capacity Coal Fired Boiler (one of them as a back-up boiler) to produce steam for the processes. Coal fired boilers represent the baseline scenario, because according to a preliminary assessment report of Nestlé, the coal was the cheapest fuel compared to other fuels available in the region, as described in section B.4 of the PDD and therefore the preliminary plan of Nestlé was to use Coal fired boilers for supply the thermal energy demand, and because the use of coal boilers for thermal energy production is the common and well known practice in the southern part of Chile.

Reflecting Nestlé's corporate commitment towards social and environmental responsibility as well as the company's strategy of promoting the concept of creating shared value, Nestlé Chile S.A. assigned an external local consultant to evaluate the potential of implementing and using biomass as a renewable fuel source. One of the key investigation points of the study (further on called the feasibility study) was the availability, sustainability and trading prices of biomass in the region of Osorno.

After the results of a biomass availability study conducted in the area, analyzing the feasibility of implementing such sort of boilers, and considering the CDM incentive, Nestlé Chile S.A. decided to implement one 15.4 tons/hour capacity Biomass fired Boiler[1] and one 15 tons/hour capacity Liquefied Petroleum Gas (LPG) fired back up Boiler, instead of the coal fired boilers.

The Biomass fired boiler will operate as the main thermal generation system and will cover the complete steam demand throughout the whole year. During the regular operation of the cow milk processing plant is not expected the operation of the LPG boiler. Maintenance activities of the biomass fired boiler will be executed during the annual scheduled shut down of the cow milk processing plant, so there is no steam demand during this period. For unforeseen shutdowns of the biomass fired boiler, the steam demand will be covered temporally by the LPG fired boiler.

The Greenhouse Gases (GHG) emissions reduction to be accounted for the Puelche Project/Cancura Factory are those achievable by the displacement of the coal that would have been consumed if no biomass boiler were to be implemented. The main GHG avoided is carbon dioxide CO_2. The implementation of the biomass fired boiler displaces the implementation of a coal fired boiler of the same thermal generation capacity.

The cow milk processing plant including the biomass fired boiler is not replacing any existing installations since it is currently under construction on a newly purchased land piece; therefore, this activity is considered as a **Greenfield Project**.

The biomass boiler design allows the use of wood chips, wood shavings, wood sawdust, among other biomass sources. In this project activity, the biomass boiler will only use **wood chips** (will not

[1] Biomass based electricity generation is not considered by the project.

use processed or manufactured solid biomass fuel), due to its stable handling and combustion properties. Wood chips are a well-known fuel source and (as concluded in the biomass availability study) they are highly available in the surrounding area of the project activity.

The implementation of the Puelche Project/Cancura Factory biomass boiler represents an initiative by Nestlé Chile S.A. that encourages the implementation of renewable energy generation technologies and resources in the country, particularly associated to industrial processes and facilities. This contributes to the sustainable development of country's energy sector through the energetic use of renewable biomass to satisfy thermal requirements. The expected annual emission reduction associated with the project activity corresponds to 16,333 tons of CO_2e/year and the total GHG emission reductions for the crediting period corresponds to 114,331 tons of CO_2e.

The project activity contributes to local sustainable development by:

- Using biomass (which is a renewable source) as a fuel for thermal energy generation.
- Diversifying energy sources helping to decrease the import and use of fossil fuel from other countries.
- Decreasing the greenhouse gas emissions related to the thermal energy generated with by fossil fuel and replacing the fossil fuel consumption by biomass generation which produces zero emissions.
- Promoting the development and implementation of biomass energy production knowledge- and technologies
- Creating shared value in the region of the project activity (Local employment, Agriculture- and rural development, etc.)

The project activity qualifies as Type I Renewable energy project activity with a maximum output capacity of 15 MW (or an appropriate equivalent), as per the CDM project standard for project activities Version 01.0. Specifically the project activity corresponds to a (iii) biomass project with a limit of 45 MWth of installed capacity of the thermal application equipment.

A.2. Location of project activity

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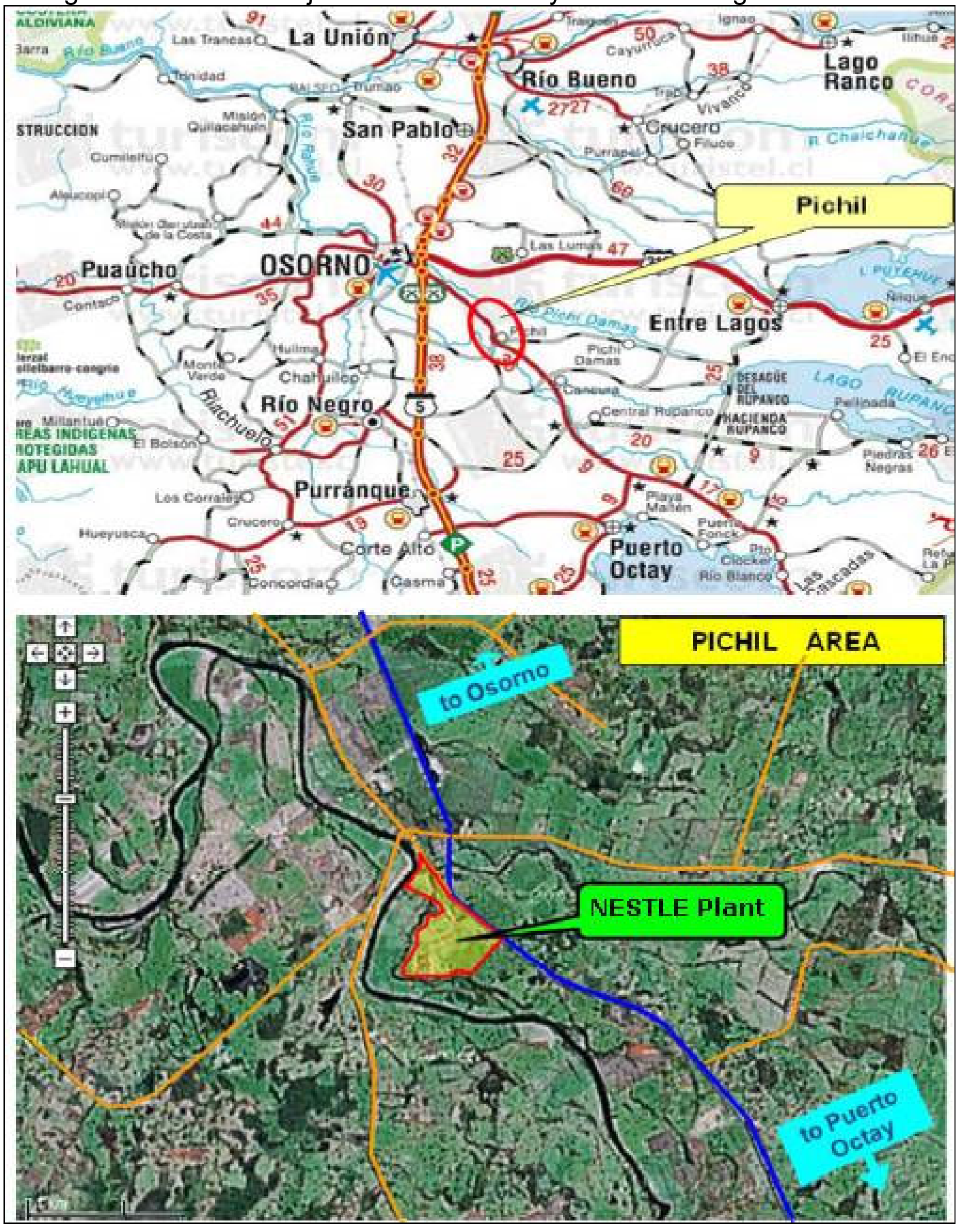
The Puelche Project/Cancura Factory will be implemented in a 62.33 ha property, located in the Pichil locality, Osorno Commune, Osorno Province, Region of Los Lagos. The property is located 16 kms from Osorno City.

The approximate coordinates that demarcate the project plant are:

Table 1: General Coordinates of the Project

General Coordinates	
Latitude	Longitude
-40.717773°	-73.011488°

Figure 1: Puelche Project/Cancura Factory Local and Regional Location



Source: Nestlé Chile S.A.

A.3. Technologies/measures

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The main technical characteristics of the Puelche Project/Cancura Factory Biomass Boiler are summarized in the following information:

In general terms, the project activity considers the implementation of two boilers (1x Biomass and 1x LPG) in order to satisfy the thermal requirements of the milk processing plant. A biomass fired boiler will be used for the regular operation, while a LPG fired boiler works as a back-up. LPG is technically the most reliable fuel for back-up boilers presenting a couple of significant technical- and operational advantages, such as a low start-up period resulting in a fast reaction time.

The main characteristics of each boiler are summarized below:

- Biomass fired boiler:
  - Type: Vibrating grate water tube Bi-drum boiler
  - Heating Surface (m^2): Furnace 105, Gen. Bank 245, Economiser 194 and Air Heater 428
  - Design temperature: 220 °C.

- o Boiler Nominal Capacity: 15.4 tons/h
- o Design Pressure: 22.5 barg
- o Guaranteed Boiler Efficiency: 89% ± 2
- o Plant Load Factor: 95%

- LPG fired boiler (back up boiler):
  - o Type: Fire tube
  - o Heating Surface (m^2): 450
  - o Design temperature: 224 °C @ 326 Psi
  - o Boiler Nominal Capacity: 15 tons/h
  - o Design Pressure: 22.5 barg
  - o Boiler Efficiency: 91%

At concept design stage and credit approval, Nestlé Chile S.A. considered for this milk processing plant the installation of two 15 tons/hour capacity Coal Fired Boiler (one of them as a back-up boiler) to produce steam for the processes. Coal fired boilers represent the baseline scenario, according to a preliminary assessment report of Nestlé as explained in section A.1. The cow milk processing plant including the biomass fired boiler is not replacing any existing installations since it is currently under construction on a newly purchased land piece; therefore, this activity is considered as a Greenfield Project.

The average lifetime of the biomass fired boiler is 25 years (as per manufacturer's specifications)[2].

This project activity will generate renewable energy, using a biomass boiler and LPG boiler, engineered and manufactured by RCR Energy Systems Ltd. RCR Energy Systems is a subsidiary of RCR Tomlinson Ltd, which is leading multi-disciplined engineering company specializing in the design, manufacture and maintenance of heavy equipment and industrial boiler systems, mechanical and electrical, site maintenance and construction, employing some 2300 staff and contractors across Australia. In Figure 2 of Section B.3 of this PDD is presented a diagram with the flow process of the project.

RCR is transferring an environmental safe/friendly technology, knowledge and experience to the Host Party (Chile) and to the project participant (Nestlé Chile S.A.) by implementing this project activity.

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 (host party)	Nestlé Chile S.A (Private entity)	No

A.5. Public funding of project activity

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The Puelche Project/Cancura Factory Biomass Boiler does not receive public funding.

A.6. History of project activity

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[2]This evidence has been provided to the DOE.

The project participant confirms that 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); and is not a project activity that has been deregistered.

A.7. Debundling

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The CDM project standard for project activities Version 01.0 stands that the project participants shall use the “Methodological tool: Assessment of debundling for SSC project activities” in order to demonstrate that the proposed small-scale CDM project activity is not a debundled component of a large-scale project activity.

According to the Methodological tool “Assessment of debundling for small-scale project activities” Version 04.0, Puelche Project/Cancura Factory Biomass Boiler is not a debundled component of a large project activity because there is not a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:

- With the same participants
- In the same project category and technology/measure; and
- Registered within the previous 2 years; and
- Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point.

The project proponent Nestlé Chile S.A. does not count with other registered CDM projects within 1 km of this project, which implicates that Puelche Project/Cancura Factory Biomass Boiler activity should not be considered a debundled component of a larger project activity.

SECTION B. Application of selected methodologies and standardized baselines

B.1. Reference to methodologies and standardized baselines

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The approved small scale methodology: AMS-I.C: “Thermal energy production with or without electricity” Version 20.0, Sectoral Scope 01, in effect as of EB 79.

http://cdm.unfccc.int/methodologies/DB/JSEM51TG3UVKADPA25IPUHXJ85HE8A

The AMS-I.C Version 20.0 methodology makes reference to the following tools:

- Methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (Version 03.0))

  https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v3.0.pdf

- Tool to calculate the emission factor from an electricity system (Version 06.0)

  https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v6.pdf

- Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion (Version 03.0)

  https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v3.pdf

- Methodological tool Leakage in biomass small-scale project activities Version 04.0, is applied (refered in the AMS-I.C Version 20.0 as “General guidance on leakage in biomass project activities”)

http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-22-v1.pdf

More information about the methodology can be obtained at:

http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html

B.2. Applicability of methodologies and standardized baselines

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Project participants choose Approved Small Scale Methodology AMS-I.C (version 20.0) to develop the projects activity design document due to the fact that this methodology is applicable to small scale renewable energy technologies that displace fossil fuel use in order to supply users i.e. residential, industrial or commercial facilities (in this case an industrial facility) with thermal energy, which is the case of the proposed project activity.

The project activity fulfils the following applicability conditions[3]:

Applicability conditions	Fulfilment
Biomass-based cogeneration and trigeneration systems are included in this category.	Not applicable as the project is a renewable biomass fired boiler; it uses renewable sources to generate thermal energy (steam).
Emission reductions from a biomass cogeneration or trigeneration system can accrue from one of the following activities: (a) Electricity supply to a grid; (b) Electricity and/or thermal energy production for on-site consumption or for consumption by other facilities; (c) Combination of (a) and (b).	Not applicable since the project is not a cogeneration nor trigeneration system.
Project activities that seek to retrofit or modify an existing facility for renewable energy generation are included in this category.	Not applicable, since the project is not a retrofit or modification of and existing facility.
In the case of new facilities (Greenfield projects) and project activities involving capacity additions the relevant requirements related to determination of baseline scenario provided in the “General guidelines for SSC CDM methodologies” for Type-II and Type-III Greenfield/capacity expansion project activities also apply.	The project activity, as a new facility (Greenfield project) complies with the related and relevant requirements related to determination of baseline scenario provided in the “General Guidelines to SSC CDM methodologies” version 22.1 for Type-II and Type-III Greenfield projects. Specifically the project complies with the four steps guide defined in the guideline: • Step 1: Identification of the various alternatives to the project proponent. In The preliminary assessment report considered all possible alternatives for the development of the project in order to preliminarily determine the most interesting alternatives. The price of the following fuels was studied in the preliminary assessment report; coal, fuel oil N°5, fuel oil N°6, natural gas, LPG, biomass and diesel. Among the alternatives included in the preliminary

[3] This information can be confirmed in the Feasibility study and in the technical documents of the project provided to the DOE (i.e the Biomass boiler performance document).

	assessment report, the three cheapest alternatives were coal, natural gas and biomass[1] and for these three alternatives, a more detailed financial analysis should be developed, but considering that the natural gas is not available in the region, the remaining alternatives were coal and biomass, for which a detailed investment comparison analysis was developed. • Step 2: List the alternatives from Step 1 that are in compliance with local regulations. All the alternatives analysed in Step 1 are in compliance with local regulations. • Step 3: Take into account barrier tests specified in the "Guidelines on the demonstration of additionality of small-scale project activities". This analysis is presented in section B.5 of the PDD. • Step 4: As demonstrated in section B.5 of the PDD, the project: (a) Is not the proposed project activity or PoA without being undertaken as registered CDM project activity or PoA; and (b) Corresponds to one of the baseline scenarios provided in the methodology. Also, the financially more viable alternative to the project activity would have led to higher emissions.
The total installed/rated thermal energy generation capacity of the project equipment is equal to or less than 45 MW thermal (see paragraph 9 for the applicable limits for cogeneration and trigeneration project activities).	It is a small scale project activity, Type I (according CDM project standard for project activities Version 01.0) due to its installed capacity, calculated from enthalpy, which reaches approximately of 10MW thermal, less than 45 MW thermal which is the limit value for small scale projects.
For co-fired systems, the total installed thermal energy generation capacity of the project equipment, when using both fossil and renewable fuel, shall not exceed 45 MW thermal (see paragraph 9 for the applicable limits for cogeneration project activities).	Not applicable since the project activity is not a co-fired system.
The following capacity limits apply for biomass cogeneration and trigeneration units: (a) If the emission reductions of the project activity are on account of thermal and electrical energy production, the total installed thermal and electrical energy generation capacity of the project equipment shall not exceed 45 MW thermal. For the purpose of calculating the capacity limit the conversion factor of 1:3 shall be used for converting electrical energy to thermal energy (i.e. for renewable energy project activities, the installed capacity of 15	Not applicable since the project activity is neither a Biomass-based cogeneration nor trigeneration system.

MW(e) is equivalent to 45 MW thermal output of the equipment or the plant); (b) If the emission reductions of the project activity are solely on account of thermal energy production (i.e. no emission reductions accrue from the electricity component), the total installed thermal energy production capacity of the project equipment shall not exceed 45 MW thermal; (c) If the emission reductions of the project activity are solely on account of electrical energy production (i.e. no emission reductions accrue from the thermal energy component), the total installed electrical energy generation capacity of the project equipment shall not exceed 15 MW.	
The capacity limits specified in paragraphs 7 to 9 above apply to both new facilities and retrofit projects. In the case of project activities that involve the addition of renewable energy units at an existing renewable energy facility, the total capacity of the units added by the project shall comply with capacity limits specified in the paragraphs 7 to 9, and shall be physically distinct from the existing units.	The project activity capacity meets the limits specified in paragraph 7 and paragraphs 8 and 9 are not applicable since the project is not a co-fired system, cogeneration nor a trigeneration.
If solid biomass fuel (e.g. briquette) is used, it shall be demonstrated that it has been produced using solely renewable biomass and all project or leakage emissions associated with its production shall be taken into account in the emissions reduction calculation.	Since the project activity does not use processed solid biomass fuel, the conditions stated in the methodology AMS-I.C v.20.0 related to the demonstration on how this is produced (if it's produced using solely renewable biomass, or not) are not applicable to this project.
Where the project participant is not the producer of the processed solid biomass fuel, the project participant and the producer are bound by a contract that shall enable the project participant to monitor the source of the renewable biomass to account for any emissions associated with solid biomass fuel production. Such a contract shall also ensure that there is no double-counting of emission reductions.	According paragraph 12 of methodology AMS-I.C v.20.0, if the project participant is not the producer of the processed solid biomass fuel, the project participant and the producer are bound by a contract that shall enable the project participant to monitor the source of the renewable biomass to account for any emissions associated with solid biomass fuel production. Such a contract shall also ensure that there is no double-counting of emission reductions. Considering that the project participant does not use processed solid biomass fuel, this paragraph is not applicable to this project.
If electricity and/or thermal energy produced by the project activity is delivered to a third party i.e. another facility or facilities within the project boundary, a contract between the supplier and consumer(s) of the energy will have to be entered into that ensures there is no double-counting of emission reductions.	The steam generated in the plant, will be used in its own facility, and will not be delivered to another facility.
If the project activity recovers and utilizes biogas for producing electricity and/or thermal energy and applies this methodology on a standalone basis i.e. without using a Type III	Not applicable since the project activity does not utilizes biogas for producing electricity or thermal energy.

component of a SSC methodology, any incremental emissions occurring due to the implementation of the project activity (e.g. physical leakage of the anaerobic digester, emissions due to inefficiency of the flaring), shall be taken into account either as project or leakage emissions as per relevant procedures in the tool "Emissions from solid waste disposal sites" and/or "Project emissions from flaring". In the event that the biomass fuel (solid/liquid/gas) is sourced from an existing CDM project, then the emissions associated with the production of the fuel shall be accounted with that project.	
If project equipment contains refrigerants, then the refrigerant used in the project case shall have no ozone depleting potential (ODP).	Not applicable since the project equipment does not contain refrigerants.
Charcoal based biomass energy generation project activities are eligible to apply the methodology only if the charcoal is produced from renewable biomass sources provided: (a) Charcoal is produced in kilns equipped with methane recovery and destruction facility; or (b) If charcoal is produced in kilns not equipped with a methane recovery and destruction facility, methane emissions from the production of charcoal shall be considered. These emissions shall be calculated as per the procedures defined in the approved methodology "AMS-III.K: Avoidance of methane release from charcoal production by shifting from traditional open-ended methods to mechanized charcoaling process". Alternatively, conservative emission factor values from peer reviewed literature or from a registered CDM project activity can be used, provided that it can be demonstrated that the parameters from these are comparable e.g. source of biomass, characteristics of biomass such as moisture, carbon content, type of kiln, operating conditions such as ambient temperature.	Not applicable since the project activity does not use charcoal.
In cases where the project activity utilizes biomass, sourced from dedicated plantations, applicability conditions prescribed in the tool "Project emissions from cultivation of biomass" shall apply.	The project does not use biomass sourced from dedicated plantations.

All methodological applicability conditions are met by the Puelche Project/Cancura Factory Biomass Boiler.

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

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In accordance with paragraph 23 of the approved small scale methodology AMS-I.C: "Thermal energy production with or without electricity" version 20.0, the spatial extent of the project boundary encompasses:

- One plant generating thermal energy located at the project site, fired with biomass and one back up LPG fired boiler.

- Industrial facility, consuming energy generated by the system and the processes or equipment affected by the project activity.

Section (b), (d), (e) and (f) of paragraph 15 of the methodology AMS-I.C version 20.0, are not applicable considering the characteristics of the project activity.

Consequently, the project boundary includes the biomass boiler, LPG boiler as back up boiler and the units from the milk processing plant, which consume thermal energy generated, according to the following diagram:

Figure 2: Puelche Project Boundary

Figure 2.a: Flow Process Diagram

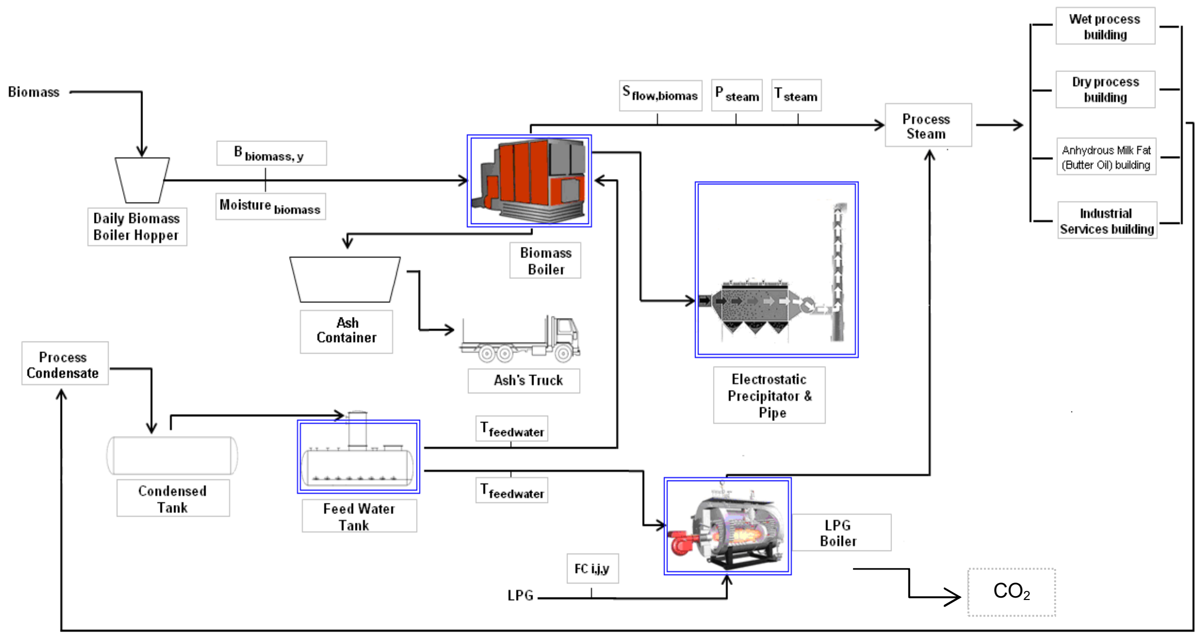
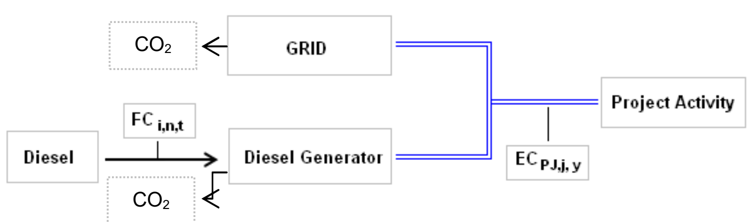


Figure 2.b: Electricity demand of the Project Activity



Source		GHG	Included?	Justification/Explanation
Baseline	CO_2 emissions from a coal fired boiler	CO_2	Yes	Main emission source
		CH_4	No	Not considered as an emission source
		N_2O	No	Not considered as an emission source
Project activity	CO_2 emissions from a LPG fired backup boiler	CO_2	Yes	Minor emission source.
		CH_4	No	Not considered as an emission source
		N_2O	No	Not considered as an emission source
	Emissions due to electricity consumption in the project activity	CO_2	Yes	Main emission source.
		CH_4	No	Not considered as an emission source
		N_2O	No	Not considered as an emission source

B.4. Establishment and description of baseline scenario

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The baseline scenario of the proposed project activity is defined as:

Thermal energy to be delivered to the user would have been generated with coal fired boilers in the absence of the project activity as it can be confirmed in the Environmental Impact Declaration and in the preliminary assessment report[4] since coal is a cheaper fuel compared to the available fuels in the region, such as a LPG, residual fuel oil (heavy fuel oil) and diesel oil[5]. For completeness reasons, it is worth to mention that natural gas is not available in the region of the project activity since there is no gas distribution grid[6] .

Baseline emissions of the project activity are determined considering quantity of generated heat that displaces heat generation in coal fired boilers (based on enthalpy and steam flow), CO_2 emission factor of coal (IPCC 2006, lower limit of the uncertainty at a 95% confidence interval) and efficiency of the coal boiler. The efficiency of the coal boiler, according to methodology AMS-I.C (v.20.0) shall be determined by adopting one of this three alternative, (1) the highest measured operational efficiency over the full range of operating conditions of a unit with similar specifications, using baseline fuel, (2) the highest of the efficiency values provided by two or more manufacturers for units with similar specifications, using the baseline fuel or (3) default efficiency of 100%. In this case, the second alternative was selected, hence the efficiency of the coal boiler is the highest of the efficiency values (most conservative case) provided by two manufacturers for units with similar specifications.

The identified baseline scenario is in line with all applicable laws and regulations. According to Chilean Law 19.300[7], the project or activities susceptible to cause environmental impacts must submit a DIA (Environmental Impact Declaration), which is evaluated by Chilean organisms with environmental competence, and if the project complies with all the applicable environmental requirements, the project is approved by means of an Environmental Qualification Resolution (RCA). If this resolution were unfavorable, the “cow milk processing plant” project would not be

[4] These documents were provided to the DOE during validation process.

[5] As it can be seen in the Market Study of Natural Gas between El Maule and Los Lagos Regions of Chile, performed by the consulting company Gamma Ingenieros S.A. for the National Energy Ministry (page 14, Table Nº3.1), the price of LPG nearly 3 times higher than coal.

[6] This information can be checked in the Market Study of Natural Gas between El Maule and Los Lagos Regions of Chile, performed by the consulting company Gamma Ingenieros S.A. for the National Energy Ministry (page 5).

[7] Law of General Environmental Bases.

executed. In the case of this project, the Chilean organisms who evaluated the project and participated in the execution of the RCA were SAG[8], SERNAGEOMIN[9], Sernapesca[10], SISS[11], Healthy Ministry, Agriculture Ministry, among others. They considered that the coal fired boiler is in line with the applicable laws, therefore they granted the RCA N°344.

B.5. Demonstration of additionality

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Prior Consideration of the CDM

In accordance to the CDM project standard for project activities Version 01.0, "*for a proposed CDM project activity with a start date on or after 2 August 2008, the project participants shall notify the designated national authority (DNA) of the host Party"* and the secretariat of their intention to seek CDM status in accordance with the Project cycle procedure.

The project developer sent the Prior Consideration of the CDM form fulfilled with the required project activity information on 04/02/2010 to the UNFCCC and on 02/02/2010 to the DNA in Chile (Environmental Ministry[12]). The starting date of the project activity is defined by the biomass fired boiler purchase order, which was issued on 24/11/2009.

Additionally, the following table represents the most important milestones of the timeline of the Puelche Project/Cancura Factory Biomass Boiler:

Table 2: Timeline of major milestones of the project activity

Milestone	Date
CDM and technical economic feasibility study consultancy services purchase order.	February 12th 2009
Decision to invest and proceed with the CDM project.	August 28th 2009
CDM consultancy services contract.	October 7th 2009
Puelche Project/Cancura Factory Biomass Boiler purchase order (starting date).	November 24th 2009
Prior consideration form received by Chilean DNA (Environmental Ministry[13])	February 2th 2010
Prior consideration published in CDM website	February 4th 2010
Local Stakeholders comments meeting	July 27th 2010
Purchase order for validation services	October 25th 2010
Global Stakeholders Process	January 18th 2011 - February 16th 2011
Hydraulic test of the biomass boiler	June 28th 2011
Biomass boiler certification	December 14th 2011
Commissioning of the milk processing plant (including the biomass boiler)	April 4th 2012
Submission of request for registration	July 10th 2013
Incompleteness from UNFCCC	April 10th 2014
Resubmission of request for registration	July 2nd 2014
Incompleteness from UNFCCC	September 3rd

8 Agricultural and Stockbreeding Service.

9 Geological and Mining National Service.

10 Fishing National Service.

11 Supervision of Health Services.

12 Formerly National Environmental Commission (CONAMA).

13 Formerly National Environmental Commission (CONAMA).

Milestone	Date
	2014
Resubmission of request for registration	April 08th 2015
Incompleteness from UNFCCC	May 4th 2015

Source: Project participant

In its Environmental Impacts Declaration, the Puelche Project/Cancura Factory mentions the possibility of assessing the implementation of a biomass fired boiler as part of the project. Subsequently, as part of the feasibility study, the alternative of the implementation of the biomass boiler was evaluated against the implementation of a coal fired boiler; the study also considered the possibility of submitting the project in the CDM context. Furthermore, and taking in consideration the results of the feasibility study, the project participant hired a CDM consultancy services to generate the documents associated with the project implementation as a CDM.

Therefore, the CDM was seriously considered beforehand the start of the project and the expected revenues from the CDM component of the project were crucial for the investment decision.

The CDM validation of the project started in January 2011 and the submission of the request for registration was completed in July 2013. Since then, the project has received some incompleteness from the UNFCCC, which have been addressed by the DOE and the project participant in order to resubmit the request for registration. As the AMS-I.C methodology has been updated since the initial submission, this PDD also updated the version of the applied methodology. Meantime, the project participant started the construction of the project and finally biomass boiler was commisioned in April 2012, as part of the commissioning of the milk processing plant. Since then, the biomass boiler has had a regular operation to satisfy the thermal energy requirements of the milk processing plant.

How the anthropogenic GHG emissions are to be reduced

The Puelche Project/Cancura Factory Biomass Boiler activity will reduce emissions by displacing thermal energy (steam) that would be generated with a coal fired boiler to satisfy the steam requirements of a milk processing plant in the absence of the project activity. The thermal energy generated by the project is to be produced using renewable biomass.

National Background

In accordance with similar activities, the implementation of biomass fired boilers for thermal energy generation and the biomass availability in the Los Lagos Region and in Chile will be analyzed. Moreover, the use of biomass as fuel in cogeneration plants will be mentioned as part of the analysis.

Biomass (firewood) has been widely used at a national level and its consumption for industrial purposes has been increasing in the last decades. In accordance with the 2008 Energy National Balance elaborated by the Energy National Commission, the total firewood consumption during 2008 reached 14.62 millions m^3, from which 32% was used in the industrial and mining sector.

In terms of energy generation installed capacity, the energy balance considers under the “Others” category the participation of biomass for electricity generation connected to the Central Interconnected System (SIC for its Spanish acronym). Its participation represents an installed capacity of 187 MW (1.4%).

There is no solid national data in order to determine the use of biomass for thermal generation. Nonetheless, the Supreme Decree Nº 138/05 of the Health Ministry, establishes the obligation to submit the necessary information in order to estimate the amount of atmospheric emissions from sources like steam and/or heat boilers, among others. Considering this data for the year 2005, 585 heat production sources were identified in the country using the generic term firewood as fuel.

In addition, the Environmental Impact Assessment System registry shows ten biomass steam/heat boilers related projects approved since 2001 until 2010.

Assessment and Demonstration of Additionality

Following the specifications of the methodology AMS-I.C (v.20.0), the project participant will apply the Methodological tool "Demonstration of additionality of small-scale project activities" Version 11.0. This methodological tool also refers to the document "Non-binding practice examples to demonstrate additionality for SSC project activities";

A barrier analysis is developed following the recommendation of the provisions and approach of the Methodological tool "TOOL21: Demonstration of additionality of small-scale project activities" Version 11.0. According to this methodological tool, "Project participants shall provide an explanation to show that the project activity would not have occurred anyway due to the following barrier":

Barrier Analysis

Investment Barrier: "*a financially more viable alternative to the project activity would have led to higher emissions*"

The preliminary assessment report considered all possible alternatives for the development of the project in order to preliminarily determine the most interesting alternatives. The price of the following fuels was studied in the preliminary assessment report; coal, fuel oil N°5, fuel oil N°6, natural gas, LPG, biomass and diesel. Among the alternatives included in the preliminary assessment report, the three cheapest alternatives were coal, natural gas and biomass[14] and for these three alternatives, a more detailed financial analysis should be developed, but considering that the natural gas is not available in the region, the remaining alternatives were coal and biomass, for which a detailed investment comparison analysis was developed.

Then, in order to demonstrate that the Puelche Project/Cancura Factory Biomass Boiler faces investment related barriers an investment analysis was performed comparing the implementation of the project activity with the alternative with which it has been compared during the entire development of the project, which is the coal fired boiler. The purpose of the analysis is to determine whether the proposed project activity is not the most economically attractive or not economically feasible, without the revenue from the sale of CERs.

According to the Document "Non-binding best practice examples to demonstrate additionality for SSC project activities" (EB 35, Annex 34), one of the best practice examples to demonstrate additionality for SSC project activities, is the application of investment comparison analysis using a relevant financial indicator. The investment comparison analysis is selected because the alternative requires investment anyhow and baseline emissions are based on that alternative, so the only means to conclude that the project activity is less financially attractive than at least one alternative is to conduct an investment comparison analysis.

The project activity applied an investment comparison analysis using the Net Present Value (NPV) as the financial indicator, therefore the NPV of two alternatives, coal fired boiler and biomass fired boiler, were compared to determine the most economically attractive course of action for Nestlé.

Relevant costs, such as investment costs, operation and maintenance costs, among others, are included in the analysis to calculate the financial indicator. The cash flow includes only negative flows (investment and operation cost), therefore, the NPV is considered to be an appropriate financial indicator for this investment analysis. In order to calculate the NPV is necessary to define

[14] As it is mentioned in footnote number 6 above, since LPG price is much higher than coal, this alternative was only considered as a backup measure for emergency provisions as it is explained in section B.6.1 of this document.

the projected cash flow and the discount rate; in this case the analysis considers a 25 year period and a discount rate of 12.29%. This discount rate was used to calculate the NPV and its detailed calculation is presented in Appendix 3 of the PDD.

The following tables present the investment analysis for the biomass fired boiler and the alternative coal fired boiler.

Table 3: Coal Based Fired Boiler Economical Evaluation

COAL BOILER (US$)	**0**	**1**	**…**	**25**	**Source**
Investment	-3,015,707				Feasibility study (Page 88, Table 6.3, based on ICP offer)
Fuel cost		-1,139,132	-1,139,132	-1,139,132	Feasibility study (Page 88, Table 6.3, based on ICP offer) and public values
Electricity cost		-126,422	-126,422	-126,422	Feasibility study (Page 88, Table 6.3, based on ICP offer)
Labour cost		-61,320	-61,320	-61,320	Feasibility study (Page 88, Table 6.3, based on ICP offer)
Maintenance cost		-150,785	-150,785	-150,785	Feasibility study (Page 88, Table 6.3, based on ICP offer)
Total cost		-1,477,660	-1,477,660	-1,477,660	-
Cash flow	-3,015,707	-1,477,660	-1,477,660	-1,477,660	-
NPV	**-$ 14,376,002**				

Table 4: Biomass Based Fired Boiler Economical Evaluation

BIOMASS BOILER (US$)	**0**	**1**	**…**	**25**	**Source**
Investment	-5,952,271				Feasibility study (Page 98 Table 7.3, based on RCR offer)
Fuel cost		-641,364	-641,364	-641,364	Feasibility study (Page 88 Table 6.3, based on ICP offer) and quotation
Electricity cost		-187,326	-187,326	-187,326	Feasibility study (Page 88 Table 6.3, based on ICP offer and Page 98 Table 7.1, based on RCR offer)
Labour cost		-61,320	-61,320	-61,320	Feasibility study (Page 88 Table 6.3, based on ICP offer)
Maintenance cost		-297,614	-297,614	-297,614	Feasibility study (Page 99 Table 7.4, based on RCR offer)
Total cost		-1,187,624	-1,187,624	- 1,187,624	-
Cash flow	-5.952.271	-1,187,624	-1,187,624	- 1,187,624	-
NPV	**-$ 15,082,764**				

The net present value (NPV) of the biomass fired boiler investment is much more negative than the NPV of the coal fired boiler investment. Then the most economically attractive course of action for Nestlé is the coal fired boiler.

A sensitivity analysis is included to assess whether the conclusion regarding the financial attractiveness is robust to reasonable variations in the critical assumptions. A 10% variation in investment cost and 10% in fuel cost is used in the sensitive analysis. The table and graphs below presents the NPV of each alternative considering these variations.

Table 5: Sensitivity analysis

Investment cost			
	-10%	0%	10%
Coal NPV (US$)	-$ 14,074,431	-$ 14,376,002	-$ 14,677,572
Biomass NPV (US$)	-$ 14,487,536	-$ 15,082,764	-$ 15,677,991

Fuel cost			
	-10%	0%	10%

Coal NPV (US$)	-$ 13,500,233	-$ 14,376,002	-$ 15,251,770
Biomass NPV (US$)	-$ 14,589,681	-$ 15,082,764	-$ 15,575,846

Maintenance cost			
	-10%	0%	10%
Coal NPV (US$)	-$ 14,260,077	-$ 14,376,002	-$ 14,491,926
Biomass NPV (US$)	-$ 14,853,957	-$ 15,082,764	-$ 15,311,570

Operational cost			
	-10%	0%	10%
Coal NPV (US$)	-$ 13,355,896	-$ 14,376,002	-$ 15,396,107
Biomass NPV (US$)	-$ 14,398,521	-$ 15,082,764	-$ 15,767,007

Figure 3: Investment cost sensitivity analysis

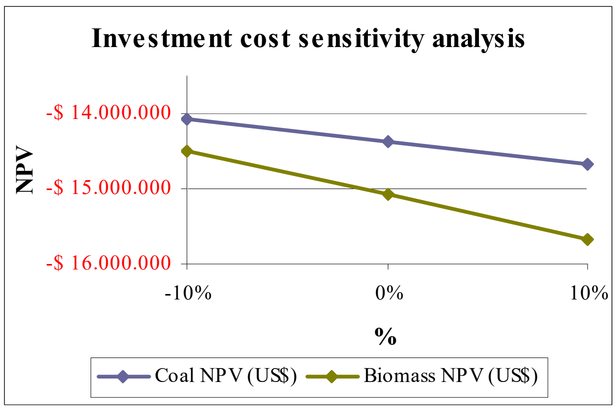


Figure 4: Fuel cost sensitivity analysis

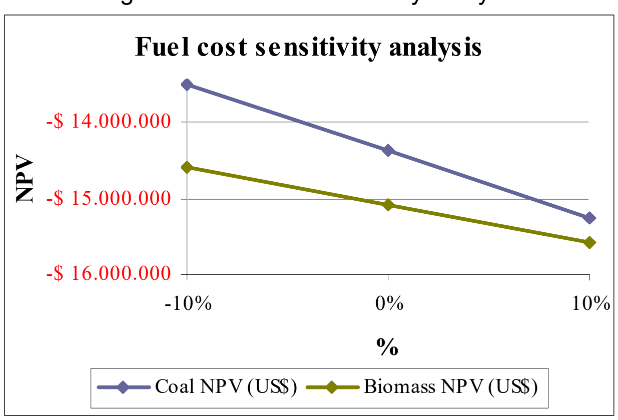


Figure 5: Maintenance cost sensitivity analysis

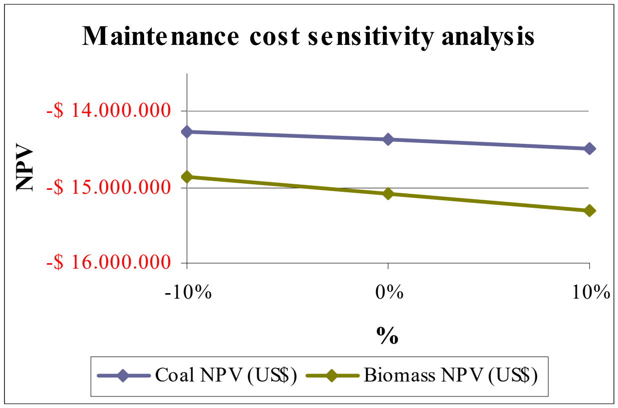
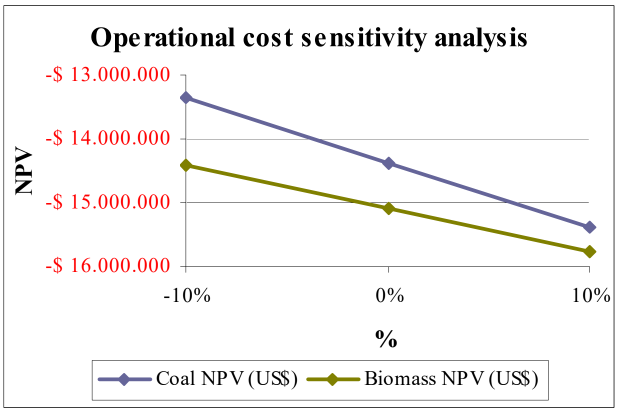


Figure 6: Operational cost sensitivity analysis



As per the table and graphs above, in all the sensitive analysis scenarios considered, the most financially attractive scenario is the coal fired boiler, and therefore it represents the baseline scenario. The project initiative has ranges of NPV far more negative than the other scenario presented, so it can be assured that the project scenario is additional compared to the chosen baseline. In this case, the financially more viable alternative to the project activity would have led to higher emissions.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

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The project activity's accountable emission reductions, associated with the implementation of the biomass boiler, will be determined in accordance with the approved small scale methodology: AMS-I.C: "Thermal energy production with or without electricity" Version 20.0.

Baseline Emissions

This is a project of thermal energy produced with biomass, therefore the baseline according paragraph 24 and 33 of methodology, is the fuel consumption of the technologies that would have been used in the absence of the project activity times an emission factor for the fossil fuel displaced; and is calculated as follows:

CO_2 emissions associated to the use of coal for thermal energy production at the project site

Eq. 1: Baseline emissions from fossil fuel use for thermal energy production

$$BE_y = BE_{thermal,CO_2,y} = \left(EG_{thermal,y} / \eta_{BL,thermal} \right) * EF_{FF,CO_2}$$

Where,

$BE_{thermal,CO_2,y}$	Baseline emissions from thermal energy displaced by the project activity during the year y; tCO_2.
$EG_{thermal,y}$	Net quantity of thermal energy supplied by the project activity during the year y; TJ.
EF_{FF,CO_2}	CO_2 emission factor of the fossil fuel that would have been used in the baseline plant obtained from reliable local or national data if available, alternatively, IPCC default emission factors can be used (tCO_2/TJ).
$\eta_{BL,thermal}$	Efficiency of the plant using fossil fuel that would have been used in the absence of the project activity. The most conservative efficiency value is used.

The efficiency used, according to the methodology for baseline units (excluding cogeneration or trigeneration plants), is the highest of the efficiency values provided by two or more manufacturers for units with similar specifications, using the baseline fuel.

Project Emissions (PEy)

As described in the applicable methodology AMS I-C Version 20.0, the project emissions shall be calculated using the following equation:

Eq. 2: Project emissions

$$PE_y = PE_{FF,y} + PE_{Ec,y} + PE_{Geo,y} + PE_{ref,y} + PE_{cultivation,y}$$

Where:

PE_y	= Project emissions from the project activity during the year *y* (t CO_2)
$PE_{FF,y}$	= Project emissions from fossil fuel consumption during the year *y* (t CO_2)
$PE_{Ec,y}$	= Project emissions from electricity consumption during the year *y* (t CO_2)
$PE_{Geo,y}$	= Project emissions from a geothermal project activity in year *y* (t CO_2)
$PE_{ref,y}$	= Project emissions from use of refrigerant in project activity in year *y* (t CO_2)
$PE_{cultivation,y}$	= Project emissions from cultivation of biomass in a dedicated plantation in year *y* (t CO_2e)

Since the project emissions of the project activity include only the CO_2 emissions from on-site consumption of fossil fuels (which in this project activity is only considered when an unplanned failure occurs and an LPG boiler is to be used) and from electricity consumption (which in this case comes from the grid and a fossil fuel fired captive power plant)[15], the project emissions are calculated as follows:

Eq. 3: Project emissions of the project activity

$$PE_y = PE_{FF,y} + PE_{Ec,y}$$

The description of the project emissions calculation considering the alternatives applicable to this project activity is presented below.

CO*$_2$ *emissions from on-site consumption of fossil fuels due to the project activity

[15] There aren't any other significant emissions associated with the project activity within the project boundary besides the described ones.

As stated in AMS-I.C version 20.0, the project CO_2 emissions from onsite combustion of fossil fuels $PE_{FF,y}$ shall be calculated using the latest version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (Version 03.0).

The project activity does not count with any on-site fossil fuel consumption rather than those associated to electricity generation.

The main thermal generation will be produced in the biomass fired boiler, and will cover the complete thermal demand throughout the whole year. The LPG boiler will not operate during the regular operation of the cow milk processing plant. The function of the LPG fired boiler is to cover the thermal demand when unforeseen shutdowns occur.

Only in case of unplanned failure, the LPG boiler will be used. In this case, project emission will be calculated as follows:

Eq. 4: Project emissions from fossil fuel

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

Where:

$PE_{FC,j,y}$	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

The CO_2 emission coefficient $COEF_{i,y}$ is calculated following Option B of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" Version 03.0, based on net calorific value and CO_2 emission factor of the fuel type i, as follows:

Eq. 5: CO_2 Emission Coefficient

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

Where:

$COEF_{i,y}$	Is the CO_2 emission coefficient of fuel type i in year y (tCO_2/mass or volume unit)
$NCV_{i,y}$	Is the weighted average net calorific value of the 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

<u>CO_2 emissions from electricity consumption by the project activity</u>

As stated in the methodology AMS-I.C v.20.0, the project emissions for on site electricity consumption $PE_{Ec,y}$ are calculated using the latest version of the Methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (Version 03.0).

For the particular situation of the project activity, Scenario C of the mentioned Tool applies due to the fact that the electricity consumption of the project activity comes from the grid and a fossil fuel fired captive power plant. The electricity consumption source can be provided with electricity from the captive power plant and from the grid. Scenario C of the Tool presents three applicability Cases. The Puelche Project/Cancura Factory Biomass Boiler falls into Case C.III because the electricity consumption of the project activity affects the electricity supplied from both the grid and captive power plant. The emission factor is determined in accordance with the Methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” Version 03.0. The more conservative value is chosen between a) the result of applying option A1 (Emission Factor of the Electricity Distribution Grid) and b) the result of applying option B1 (Emission Factor of the Captive Power Plant).

Emission Factor of the Electricity Distribution Grid

The emission factor of the electricity distribution grid will be determined in accordance with the “Tool to calculate the emission factor of an electricity system”, version 06 as permitted in the Methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (Version 03.0). , option A1.

The “Tool to calculate the emission factor of an electricity system” Version 06.0, includes six steps to be applied in order to determine de combined margin emission factor:

Step 1. Identify the relevant electricity power system.
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) emission factor.

The sub-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 power system

The relevant electric power transmission system is the SIC.

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

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)

The selected OM emission factor method from the “Tool to calculate the emission factor of an electricity system” is Option (b) named Simple Adjusted. In this method power plants / units are separated in low-cost/must-run power sources and other power sources.

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 available at the time of submission of the CDM-PDD to the DOE for validation, 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

The calculation of the Simple Adjusted OM emission factor is calculated as the generation-weighted average CO_2 emission per unit net electricity generation (tCO_2/MWh) of all generating

power plants serving the system, where the power plants / units are separated in low-cost / must-run power sources and other power sources. It is calculated choosing Option B, based on the electricity generation data of each power unit and the emission factor for each power unit, as follows:

Eq. 6: Operating margin emission factor for year *y* (Option B)

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

Where:

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

The indices *m* and *k* represent power sources supplying electricity to the grid in year *y*, where *k* refers to power plants/units which are either low-cost or must-run and *m* refers to the remaining power plants/units. The CO_2 emission factor of each power unit should be 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 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:

Eq. 7a: CO_2 emission factor based on fuel consumption

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} * NCV_{i,y} * EF_{CO_2,i,y}}{EG_{m,y}}$$

Where:

$EF_{EL,m,y}$:	CO_2 emission factor of power unit *m* in year *y* (tCO_2/GWh).
$FC_{i,m,y}$:	Amount of fuel type *i* consumed by power unit *m* in year *y* (mass or volume unit).
$NCV_{i,y}$:	Net calorific value (energy content) of fuel type *i* in year *y* (GJ / mass or volume unit).
$EF_{CO2,i,y}$:	CO_2 emission factor of 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 power units serving the grid in year *y* except low-cost/must-run power units
i:	All fuel types combusted in power unit *m* in year *y*
y:	The relevant year as per the data vintage chosen in Step 3

Eq. 7b: CO_2 emission factor based on fuel consumption

$$EF_{EL,k,y} = \frac{\sum_i FC_{i,k,y} * NCV_{i,y} * EF_{CO_2,i,y}}{EG_{k,y}}$$

Where:

$EF_{EL,k,y}$:	CO_2 emission factor of power unit *k* in year *y* (tCO_2/GWh).
$FC_{i,k,y}$:	Amount of fuel type *i* consumed by power unit *k* in year *y* (mass or volume unit).
$NCV_{i,y}$:	Net calorific value (energy content) of fuel type *i* in year *y* (GJ / mass or volume unit).
$EF_{CO2,i,y}$:	CO_2 emission factor of fuel type *i* in year *y* (tCO_2/GJ).
$EG_{k,y}$:	Net quantity of electricity generated and delivered to the grid by power unit *k* in year *y* (MWh)
k:	All low-cost/must run grid power units serving the grid in year y
i:	All fuel types combusted in power unit *m* in year *y*
y:	The relevant year as per the data vintage chosen in Step 3.

Option A2. If for a power unit *m* only data on electricity generation and the fuel types used is available, the emission factor should be determined based on the CO_2 emission factor of the fuel type used and the efficiency of the power unit, as follows:

Eq.8a: CO_2 emission factor based on efficiency of power units

$$EF_{EL,m,y} = \frac{EF_{CO_2,m,i,y} * 3.6}{\eta_{m,y}}$$

Where:

$EF_{EL,m,y}$:	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh).
$EF_{CO2,m,i,y}$:	Average CO_2 emission factor of fuel type *i* used in power unit *m* in year *y* (tCO_2/GJ).
$\eta_{m,y}$:	Average net energy conversion efficiency of power unit *m* in year *y* (ratio).
m:	All 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 relevant year as per the data vintage chosen in Step 3.

Eq.8b: CO_2 emission factor based on efficiency of power units

$$EF_{EL,k,y} = \frac{EF_{CO_2,k,i,y} * 3.6}{\eta_{k,y}}$$

Where:

$EF_{EL,k,y}$:	CO_2 emission factor of power unit *k* in year *y* (tCO_2/MWh).
$EF_{CO2,k,i,y}$:	Average CO_2 emission factor of fuel type *i* used in power unit *k* in year *y* (tCO_2/GJ).
$\eta_{k,y}$:	Average net energy conversion efficiency of power unit *k* in year *y* (ratio).
k:	All low-cost/must run grid power units serving the grid in year y
i:	All fossil fuel types combusted in power unit *k* in year *y.*
y:	The relevant year as per the data vintage chosen in Step 3.

Where several fuel types are used in the power unit, use the fuel type with the lowest CO_2 emission factor for $EF_{CO2,m,i,y}$.

Option A3. If for a power unit *m* only data on electricity generation is available, an emission factor of 0 tCO_2/MWh can be assumed as a simple and conservative approach.

λ_y is defined as follows:

Eq. 9: λ_y determination

$$\lambda_y(\%) = \frac{Number\ of\ hours\ low-cost/must-run\ sources\ are\ on\ the\ margin\ in\ year\ y}{8{,}760\ hours\ per\ year}$$

Lambda (λ_y) is calculated following Approach 2 as follows:

Step i) Plot a load duration curve. Collect chronological load data (typically in MW) for each hour of the year *y*, and sort and plot the load data from the highest to the lowest MW annual system load.

Step ii) Collect electricity generation data from each low-cost/must run power plant / unit. Calculate the total annual generation (in MWh) from low-cost/must-run power plants / units (i.e. $\sum_k EG_{k,y}$).

Step iii) Find out the intersection on the load duration curve in order to determine a period LCMR sources are on the margin. To find the intersection, fill the area under the load duration curve by the total generation (in MWh) from LCMR power plants/units. To fill the load duration curve, plot a horizontal line across the load duration curve such that the area under the horizontal line and the curve right from the intersection point (MW times hours) equals the total generation (in MWh) from low-cost/must-run power plants / units (i.e. $\sum_k EG_{k,y}$).

Step iv) Determine the "Number of hours for which low-cost/must-run sources are on the margin in year *y*".

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

The sample group of power units *m* used to calculate the build margin consists of the set of power capacity additions in the SIC that comprise 20% of the system generation (in MWh) and that have been built most recently. If 20% falls on part capacity of a unit, that unit is fully included in the calculation.

Power plants registered as CDM project activities should be excluded from the sample group *m*.

The BM emission factor will be determined in accordance to Option (1) of the "Tool to calculate the emission factor of an electricity system", where for the first crediting period BM emission factor is calculated ex-ante based on the most recent information available 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 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* for which electricity generation data is available, calculated as follows:

Eq. 10: Build margin emission factor for year *y*

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

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 electricity generation data is available.

The CO_2 emission factor of each power unit *m* ($EF_{EL,m,y}$) should be determined using options A1, A2 or A3 (represented by Eq. 7 and Eq. 8), using for *y* the most recent historical year for which electricity generation data is available, and using for *m* the power units included in the build margin as explained in Step 4.

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

The combined margin emission factor is calculated based on the weighted average CM method as shown as follows:

Eq. 11: Combined emission factor

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

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 (per cent)
w_{BM}:	Weighting of build margin emissions factor (per cent)

The default values for the weighting of the OM (w_{OM} = 50%) and for the weighting of the BM (w_{BM} = 50%) are used in the calculation of the combined emission factor, as stated in the "Tool to calculate the emission factor of an electricity system".

Emission Factor of the Captive Power Plant

The emission factor of the captive power plant will be determined in accordance with the Methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (Version 03.0), option B1.

Eq. 12: Emission Factor of Captive Power Plant

$$EF_{EL,j/k/l,y} = \frac{\sum_{n} \sum_{i} FC_{n,i,t} * NCV_{i,t} * EF_{CO2,i,t}}{\sum_{n} EG_{n,t}}$$

Where:

$EF_{EL,j/k/l,y}$: Emission factor for electricity generation for source *j*, *k* or *l* in year *y* (tCO_2/MWh).
$FC_{n,i,t}$: Quantity of fossil fuel type *i* fired in the captive power plant *n* in the time period *t* (mass or volume unit).
$NCV_{i,t}$: Average net calorific value of fossil fuel type *i* used in the period *t* (GJ / mass or volume unit).
$EF_{CO2,i,t}$: Average CO_2 emission factor of fossil fuel type *i* used in the period *t* (tCO_2 / GJ).
$EG_{n,t}$: Quantity of electricity generated in captive power plant *n* in the time period *t* (MWh).
i: are the fossil fuel types fired in captive power plant *n* in the time period *t.*
j: Sources of electricity consumption in the project.
k: Sources of electricity consumption in the baseline.
l: Leakage sources of electricity consumption.
n: Fossil fuel fired captive power plants installed at the site of the electricity consumption source *j*, *k* or *l.*
t: Time period for which the emission factor for electricity generation is determined.

The Methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (Version 03.0) mentions that under Case C.III, the most conservative value between the emission factor from the electricity distribution grid and the one from the captive power plant should be applied to estimate the emissions associated to the on-site electricity consumption.

Eq. 13: Emission factor for electricity consumption in the project activity

$$EF_{EL,j,y} = \max(EF_{EL,j/k/l,y}, EF_{Grid,CM,y})$$

Where:

$EF_{EL,j,y}$: Emission factor for electricity generation for source *j* (Sources of electricity consumption in the project) in year *y* (tCO_2/MWh).
$EF_{EL,j/k/l,y}$: Emission factor for electricity generation for source *j*, *k* or *l* in year *y* (tCO_2/MWh).
$EF_{grid,CM,y}$: Combined margin CO_2 emission factor in year *y* (tCO_2/MWh).

Therefore considering the above, the project emissions due to electricity consumption in the project activity are calculated in accordance to Methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (Version 03.0), as follows:

Eq. 14: Project Emissions due to electricity consumption in the project activity

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

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).
$TDL_{j,y}$: Average technical transmission and distribution losses for providing electricity to source *j* in year *y*.

Leakage (LE_y)

The project activity does not consider any sort of leakage emissions as indicated by the approved small scale methodology AMS-I.C: “Thermal energy production with or without electricity” version 20.0. According to paragraph 76, if the energy generating equipment currently being utilized is transferred from outside the boundary to the project activity, leakage is to be considered and in paragraph 77 it is explained that in case collection,processing and transportation of biomass residues is outside the project boundary and due to the implementation of the project activity

biomass residues are transported over a distance of 200 kilometers CO_2 emissions from collection, processing and transportation of biomass residues to the project site shall be taken into account as leakage.

In this project the energy generating equipment is not transferred from outside the boundary to the project activity and the biomass is transported from a distance of less than 200 kilometres, therefore, no leakage emissions from these sources are considered.

Also paragraph 78 from the methodology AMS-I.C v.20.0 does not apply since the project does not displace refrigerant greenhouse gases.

Paragraph 79 from the methodology AMS-I.C v.20.0 specifies that leakage emissions on account of the diversion of biomass residues from other uses (competing uses) shall be calculated as per the Methodological tool: Leakage in biomass small-scale project activities Version 04.0. According to this methodological tool project participants should evaluate ex ante if there is a surplus of biomass in the region of the project activity which is not utilized. At the beginning of the first crediting period the project participant has evaluated the surplus, demonstrating that the quantity of available biomass in the region is 35% larger than the quantity of biomass that is utilized including the project activity, and then this source of leakage is neglected.

Emission reductions

The emissions reduction is calculated in accordance to the CDM methodology AMS-I.C Version 20.0 and is composed by the baseline emissions, the project emissions and leakage emissions according to the following equation:

Eq. 15: Emission reductions

$$ER_y = BE_y - PE_y - LE_y$$

Where:

ER_y: Emission reductions for the year *y* (tCO_2e).
BE_y: Baseline emissions for the year *y* (tCO_2e).
PE_y: Project emissions for the year *y* (tCO_2).
LE_y: Leakage for the year *y* (tCO_2).

B.6.2. Data and parameters fixed ex ante

Data / Parameter	BF_{region}
Unit	%
Description	Quantity of available biomass in the region of the project activity
Source of data	INFOR Statistics 2015: Consumption of logs according the industry location, by region: http://wef.infor.cl/industria/industria.php
Value(s) applied	35% larger than the quantity of biomass that is utilized including the project activity.
Choice of data or Measurement methods and procedures	The project participant evaluated ex - ante the quantity of available biomass in the region. The calculation is presented in Appendix 4.
Purpose of data	N/A
Additional comment	N/A

Data / Parameter	$\eta_{BL,thermal}$
Unit	%
Description	Coal boiler efficiency
Source of data	Manufacturer specifications

Value(s) applied	85%
Choice of data or Measurement methods and procedures	The most conservative efficiency value from two coal fired boiler suppliers. In accordance to default baseline efficiency values for different technologies of the Appendix of the methodology AMS-I.C: “Thermal energy production with or without electricity” version 20.0
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	$\eta_{m,y}$ and $\eta_{k,y}$
Unit	-
Description	Average net energy conversion efficiency of power unit *m* or *k* in year *y*
Source of data	Default values provided in Annex 1 of “Tool to calculate the emission factor of an electricity system” (v.06.0).
Value(s) applied	Values in Table 13 of Appendix 4.
Choice of data or Measurement methods and procedures	The “Tool to calculate the emission factor of an electricity system” (v.06.0) indicates that the default values provided in Annex 1 shall be used.
Purpose of data	Calculation of baseline emissions
Additional comment	Fixed for the first monitoring period. This parameter is used to calculate the Emission Factor of the Electricity Distribution Grid.

Data / Parameter	$EF_{FF, CO2}$
Unit	tCO_2e / GJ
Description	CO_2 emission factor of coal
Source of data	As per the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” Version 03.0, specifically option d) IPCC 2006 Guidelines on National GHG Inventories table 1.4 of Chapter 1 of Vol. 2.
Value(s) applied	0.0895 tCO_2 /GJ
Choice of data or Measurement methods and procedures	No other data is publicly available. IPCC guidelines have been used in a conservative manner.
Purpose of data	Calculation of baseline emissions
Additional comment	Fixed. Any future revision of the IPCC Guidelines should be taken into account.

The following data was used to estimate the project emissions of the project activity:

Data / Parameter	$EF_{grid,CM,y}$
Unit	tCO_2/MWh
Description	Emission factor for electricity generation for source *j* in year *y*
Source of data	Calculated
Value(s) applied	0.545191 tCO_2/MWh
Choice of data or Measurement methods and procedures	Calculated based on the “Tool to calculate the emission factor of an electricity system”, version 06.0 Option (b), Simple Adjusted.
Purpose of data	Calculation of project emissions
Additional comment	This parameter is calculated using the ex-ante approach provided by the “Tool to calculate the emission factor of an electricity system” version 06.0 Therefore it will not be monitored during the crediting period.

Data / Parameter	$TDL_{j,y}$
Unit	-

Description	Average technical transmission and distribution losses for providing electricity to source *j* in year *y*
Source of data	Methodological tool to calculate baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation, Version 03.0.
Value(s) applied	0.2
Choice of data or Measurement methods and procedures	In accordance with the "Methodological tool to calculate baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (Version 03.0).
Purpose of data	Calculation of project emissions
Additional comment	Default value according to the "Methodological tool to calculate baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (Version 03.0).

Data / Parameter	$EF_{EL,j/k/l,y}$
Unit	tCO_2/MWh
Description	Emission factor for electricity generation from the generator *j* in year *y*
Source of data	Calculated
Value(s) applied	0.763 tCO_2/MWh
Choice of data or Measurement methods and procedures	Calculated based on the quantity of electricity consumed from the generator by the project activity, $EG_{n,t}$ (Project participant), the CO_2 emission factor of diesel oil (IPCC 2006 Guidelines on National GHG Inventories table 1.4 of Chapter 1 of Vol. 2) the net calorific value of diesel oil (Ministry of Energy[16]), and the fuel oil consumption of the electricity generator, $FC_{n,i,t}$ (Project Participant). The fuel consumption was calculated with NCV efficiency.
Purpose of data	Calculation of project emissions
Additional comment	N/A

Data / Parameter	$EG_{m,y}$ and $EG_{k,y}$
Unit	MWh
Description	Net electricity generated and delivered to the grid by power unit *m/k* in year *y.*
Source of data	CDEC-SIC
Value(s) applied	Values in Table 12 and Table 14 of Appendix 4.
Choice of data or Measurement methods and procedures	Data from CDEC-SIC represents the most recent and reliable information available.
Purpose of data	Calculation of project emissions
Additional comment	This parameter is used to calculate the Emission Factor of the Electricity Distribution Grid.

Data / Parameter	$FC_{i,m,y}$ and $FC_{i,k,y}$
Unit	Mass or volume unit
Description	Amount of fossil fuel type *i* consumed by power plant unit m/k *j* in year *y*
Source of data	CDEC-SIC Annual Report and CNE Definitive Technical Report (Half-Yearly).
Value(s) applied	Values in Table 13 of Appendix 4.
Choice of data or Measurement methods and procedures	The data from the CDEC-SIC and CNE represents the most recent and reliable information available.
Purpose of data	Calculation of project emissions

[16] Available at http://datos.energiaabierta.cl/datasets/172660-bne-2015-balance-energia-global.download/

Additional comment	This parameter is used to calculate the Emission Factor of the Electricity Distribution Grid. If information on annual fuel consumption for a specific power plant is not available from CDEC-SIC, specific fuel consumption data reported by CNE will be used.

Data / Parameter	$NCV_{i,y}$
Unit	GJ/mass or volume unit
Description	Net calorific value (energy content) of fuel type i in year y
Source of data	CNE Annual Energy Balance Report and IPCC 2006.
Value(s) applied	Values in Table 15 of Appendix 4.
Choice of data or Measurement methods and procedures	The data from the CNE and the IPCC 2006 represent the most recent and reliable information available.
Purpose of data	Calculation of project emissions
Additional comment	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 assumption that for Diesel NCV is 5% lower than GCV and for Natural gas and LPG NCV is 10% lower GCV. Is Fixed. Any future revision of the IPCC Guidelines should be taken into account.

Data / Parameter	$EF_{CO2,i,t}$
Unit	tCO_2/GJ
Description	CO_2 emission factor of diesel oil in the period t
Source of data	IPCC 2006 Guidelines on National GHG Inventories table 1.4 of Chapter 1 of Vol. 2
Value(s) applied	0.0748 tCO_2/GJ
Choice of data or Measurement methods and procedures	IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories. Any future revision of the IPCC Guidelines should be taken into account.
Purpose of data	Calculation of project emissions
Additional comment	Is fixed, however any future revision of the IPCC Guidelines should be taken into account. Parameter used for emissions from diesel electricity generation

Data / Parameter	$EF_{CO2,i,y}$ and $EF_{CO2,m,i,y}$ and $EF_{CO2,k,i,y}$
Unit	tCO_2/GJ.
Description	CO_2 emission factor of fossil fuel type *i* used in power unit *m* in year *y*
Source of data	IPCC 2006 Guidelines on National GHG Inventories table 1.4 of Chapter 1 of Vol. 2.
Value(s) applied	Values in table 15 of Appendix 4
Choice of data or Measurement methods and procedures	IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories. Any future revision of the IPCC Guidelines should be taken into account.
Purpose of data	Calculation of project emissions
Additional comment	This parameter is used to calculate the Emission Factor of the Electricity Distribution Grid.

Data / Parameter	$EF_{CO2,i,y,\ LPG}$
Unit	tCO_2/GJ.
Description	CO_2 emission factor of LPG in year y

Source of data	IPCC 2006 Guidelines on National GHG Inventories table 1.4 of Chapter 1 of Vol. 2.
Value(s) applied	0.0656 tCO_2/GJ
Choice of data or Measurement methods and procedures	IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories. Any future revision of the IPCC Guidelines should be taken into account.
Purpose of data	Calculation of project emissions
Additional comment	Is fixed, however any future revision of the IPCC Guidelines should be taken into account. Parameter used for calculate project emissions from LPG fired boiler, which will be use only in case of unplanned biomass boiler failure.

B.6.3. Ex ante calculation of emission reductions

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Baseline Emissions

CO_2 emissions associated to the use of fossil fuel for thermal production at the project site

Eq. 16: Baseline emissions from fossil fuel use for thermal production

$$BE_{thermal,CO2,y} = \left(EG_{thermal,y} / \eta_{BL,thermal}\right) * EF_{FF,CO2}$$

17,633 [tCO_2] = (167,470,000 [TJ/year] / 0.85) * 0.0000895 [tCO_2/TJ]

Project Emissions

CO_2 emissions from on-site consumption of fossil fuels due to the project activity

The project activity does not count with any on-site fossil fuel consumption rather than those associated to electricity generation.

CO_2 emissions from electricity consumption by the project activity

Emission Factor of the Electricity Distribution Grid

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” v.06.0 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 4 and depending on annual fuel consumption or specific fuel consumption data availability options B1 and B2 were applied, using Eq. 3 and Eq. 4, respectively. The OM emission factor is calculated using Eq. 2.

An example of the calculation considering Option (B1) is provided using 2016 data for Andes Diesel power unit:

$$EF_{EL,m,y} = \frac{1{,}507{,}622(kg) \bullet 0.043354(GJ/kg) \bullet 0.0726(tCO_2/GJ)}{6{,}236.543(MWh)} = 0.760882(tCO_2/MWh)$$

An example of the calculation considering Option (B2) is provided using 2016 data for CMPC Cordillera (Natural gas) power unit:

$$EF_{EL,m,y} = \frac{0.0543(tCO_2/GJ) \bullet 3.6}{0.375(MWh)} = 0.52128(tCO_2/MWh)$$

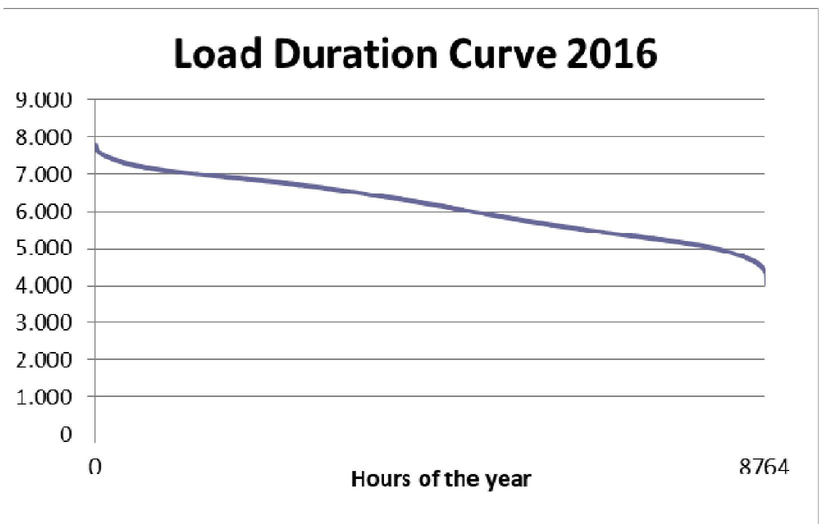
An example of the load duration curve is shown below for the year 2016. The resulting hours of low-cost/must run power sources operating not on the margin is 8784 hours (2016 was leap-year), thus the value of lambda is:

$$\lambda_y(\%) = \frac{(8,784 - 8,784)}{8,784} = 0$$

Table 6: Lambda Values

	Lambda λ_y
2014	0
2015	0
2016	0

Figure 7: Load Duration Curve for year 2016



Source: CDEC-SIC

Finally, as an example of the OM emission factor estimation, the OM emission factor for 2016 is presented below in accordance to the data provided in Appendix 4:

$$EF_{grid,OM-adj,y} = (1-0) \bullet \frac{17,225,358}{28,180,433} + 0 \bullet \frac{0}{25,719,983}$$

$$EF_{grid,OM-adj,y} = 0.611253$$

According to the data vintage chosen in Step 3 (ex-ante option), the Operating Margin Emission Factor is calculated as the generation weighed average of the values for years 2014, 2015 and 2016.

Table 7: Operational Margin Emission Factor

	Operational Margin Emission Factor	Energy Generated
	$EF_{grid,OM}$	EG_y
	[tCO_2/MWh]	[MWh]
2014	0.688169	52,224,354
2015	0.670866	52,898,828
2016	0.611253	53,900,416
OM Average	**0.656343**	-

Table 8: Operating Margin Emission Factor

Operating Margin Emission Factor $EF_{grid,OM}$ [tCO_2/MWh]
0.656343

Build Margin Emission 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 Appendix 4.

The values used for estimating the emission factor for each power unit included in the BM are exposed in the tables presented in Appendix 4 and depending on annual fuel consumption or specific fuel consumption data availability options B1 and B2 were applied, using Eq. 3 and Eq. 4, respectively. The BM emission factor is calculated using Eq. 6.

Using the values presented in Appendix 4 the following is calculated:

$$EF_{grid,BM,y} = \frac{4{,}508{,}724(tCO_2)}{10{,}387{,}749(MWh)} = 0.434043(tCO_2/MWh)$$

Table 9: Build Margin Emission Factor

Build Margin Emission Factor $EF_{grid,BM}$ [tCO_2/MWh]
0.434043

The detailed list of power units selected in the Build Margin and their data is presented in Table 14 of Appendix 4.

Combined Emission Factor

Using the $EF_{grid,OM,y}$ value, $EF_{grid,BM,y}$ value and the weighting values of the OM (w_{OM} = 50%) and the BM (w_{BM} = 50%), the CM estimation is calculated as follow:

$$EF_{grid,CM,y} = 0.5 \times 0.656343 + 0.5 \times 0.434043 = 0.545191(tCO_2/MWh)$$

Table 10: Combined Margin Emission Factor

Combined Margin Emission Factor

$EF_{grid,2009}$ [tCO_2/MWh]
0.545193

<u>Emission Factor of the Captive Power Plant</u>

The emission factor of the captive power plant will be determined in accordance with the Methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (Version 03.0), option B1.

Eq. 17: Emission Factor of Captive Power Plant

$$EF_{EL,j/k/l,y} = \frac{\sum_n \sum_i FC_{n,i,t} * NCV_{i,t} * EF_{CO2,i,t}}{\sum_n EG_{n,t}}$$

0.763 [tCO_2/MWh] = (33.42 [t] * 43.3 [GJ/t] * 0.0748 [tCO_2/GJ]) / 141.9 [MWh]

The tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (Version 03.0) mentions that under Case C.III, the most conservative value between the emission factor from the electricity distribution grid and the one from the captive power plant should be applied to estimate the emissions associated to the on-site electricity consumption.

Eq. 18: Emission factor for electricity consumption in the project activity

$$EF_{EL,j,y} = \max(EF_{EL,j/k/l,y}, EF_{Grid,CM,y})$$

$$EF_{EL,j,y} = \max(0.763;0.545) = 0.763\, tCO2 / MWh$$

Eq. 19: Project Emissions due to electricity consumption in the project activity

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

1,300 [tCO_2/yr] = 1,419.1 [MWh/yr] * 0.763 [tCO_2/MWh] * (1+20%)

Emission reductions

The emissions reduction is composed by the baseline emissions, the project emissions and leakage emissions. The project activity does not consider any sort of leakage emissions as indicated by the approved small scale methodology AMS-I.C: “Thermal energy production with or without electricity” version 20.0.

Eq. 20: Emission reductions

$$ER_y = BE_y - PE_y - LE_y$$

16,333 [tCO_2e] = 17,633 [tCO_2e] - 1,300 [tCO_2] - 0 [tCO_2]

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

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
Year 1 (07 Feb 2018 – 06 Feb 2019)	17,633	1,300	0	16,333
Year 2 (07 Feb 2019 – 06 Feb 2020)	17,633	1,300	0	16,333
Year 3 (07 Feb 2020 – 06 Feb 2021)	17,633	1,300	0	16,333
Year 4 (07 Feb 2021 – 06 Feb 2022)	17,633	1,300	0	16,333
Year 5 (07 Feb 2022 – 06 Feb 2023)	17,633	1,300	0	16,333
Year 6 (07 Feb 2023 – 06 Feb 2024)	17,633	1,300	0	16,333
Year 7 (07 Feb 2024 – 06 Feb 2025)	17,633	1,300	0	16,333
Total	123,431	9,100	0	114,331
Total number of crediting years	7			
Annual average over the crediting period	17,633	1,300	0	16,333

During the trial phase, the volume of biomass and the consequent steam generation and emission reduction would be lower that the presented values for the first crediting year.

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data / Parameter	-
Unit	Nm^3/y
Description	Quantity of steam
Source of data	Monitored by project participant
Value(s) applied	8,805,817 m^3/y (71,151 ton/yr)
Measurement methods and procedures	The flow of steam will be monitored continuously, integrated hourly and at least monthly recording.
Monitoring frequency	Monitored continuously, integrated hourly and at least monthly recording.
QA/QC procedures	Measurement equipment will be maintained and calibrated regularly. The calibration frequency will be three years maximum.
Purpose of data	Calculation of baseline emissions

Additional comment	The volumetric flow could convert into mass flow or vice versa. Considering the steam pressure is 15 barg and the steam temperature is 205 ºC, the density is 0.00808 t/m^3. Therefore multiplicand the steam density with the steam volume, is obtained the mass flow (0.00808*8,805,817=71,151 t/y).

Data / Parameter	$EG_{thermal,y}$
Unit	TJ
Description	The net quantity of thermal energy supplied by the project activity during the year *y*
Source of data	Calculated
Value(s) applied	167.470 TJ
Measurement methods and procedures	Heat generation is determined as the difference of the enthalpy of the steam generated by the boiler and the enthalpy of the feed water. The respective enthalpies should be determined based on the mass (or volume) flows and the temperatures. Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature.
Monitoring frequency	Continuous monitoring; aggregated annually.
QA/QC procedures	-
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	$PE_{FF,y}$
Unit	t CO_2/yr
Description	Project emissions from fossil fuel combustion in year y
Source of data	Calculated
Value(s) applied	0 t CO_2/yr
Measurement methods and procedures	Calculated according to the latest version of the “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”.
Monitoring frequency	Annually
QA/QC procedures	-
Purpose of data	Calculation of project emissions
Additional comment	Parameter measured for the calculation of project emissions from LPG fired boiler, which will be use only in case of unplanned biomass boiler failure.

Data / Parameter	$PE_{EC,y}$
Unit	t CO_2/yr
Description	Project emissions from electicity consumption in year y
Source of data	Calculated
Value(s) applied	1,300 t CO_2/yr
Measurement methods and procedures	Calculated according to the latest version of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”.
Monitoring frequency	Annually
QA/QC procedures	-
Purpose of data	Calculation of project emissions
Additional comment	Parameter measured for the calculation of project emissions from electricity consumption.

Data / Parameter	$EC_{PJ,j,y}$
Unit	MWh/yr
Description	Quantity of electricity consumed by the project activity in year *y*
Source of data	Monitored by project participant
Value(s) applied	1,419.1 MWh/yr
Measurement methods and procedures	Electronically monitoring and recording.

Monitoring frequency	Continuous monitoring and recording, added annually.
QA/QC procedures	Electricity meters will be maintained and calibrated regularly. The calibration frequency will be every three years maximum.
Purpose of data	Calculation of project emissions
Additional comment	For ex ante emission reduction this parameter is calculated based in the installed electrical capacity of the boiler and the total operating hours.

Data / Parameter	$FC_{n,i,t}$
Unit	Mass or volume unit per year (in m^3, ton or l)
Description	Diesel oil consumption of the electricity generator in year *y*
Source of data	Monitored by project participant
Value(s) applied	33.42 ton/y
Measurement methods and procedures	Continuously use of mass or volume meters.
Monitoring frequency	Continuously
QA/QC procedures	The consistency of metered fuel consumption quantities should be cross-checked with an annual energy balance that is based on purchased quantities and stock changes.
Purpose of data	Calculation of project emissions
Additional comment	If the fuel consumption is measured in volume unit per year, it should be multiplied by diesel density, provided by Ministry of Energy[17].

Data / Parameter	$B_{biomass,y}$
Unit	Mass
Description	Net quantity of biomass consumed in the year *y*
Source of data	Plant records
Value(s) applied	18,590 ton[18]
Measurement methods and procedures	Continuously measured electronically with an EMC Weighfeeder which measures and controls the mass flow of biomass. The biomass is weighed by passing over a platform which consists of 3 precision engineered idler rollers or fixed bars.
Monitoring frequency	Continuously and estimate using annual mass/energy balance
QA/QC procedures	Measurement equipment will be maintained and calibrated every two years, in line with manufacturer's recommendation. The measurement cross-check will be performed with an annual energy balance based in purchased quantities (e.g with sales receipt) and stock changes.
Purpose of data	N/A
Additional comment	The value shall be adjusted for the moisture content in order to determine the quantity of dry biomass.

Data / Parameter	-
Unit	%
Description	Moisture content of the biomass (wet basis)
Source of data	Plant records
Value(s) applied	50%
Measurement methods and procedures	The moisture content of biomass of homogeneous quality shall be monitored for each batch of biomass. On-site measurements.

[17] Available at http://datos.energiaabierta.cl/datasets/172660-bne-2015-balance-energia-global.download/

[18] This value is used only for the cross check procedure, because the baseline emissions are calculated with the net quantity of steam/heat supplied by the project activity during the year *y* ($EG_{thermal,y}$)

Monitoring frequency	The weighted average should be calculated for each monitoring period and used in the calculations.
QA/QC procedures	The moisture content of biomass of homogeneous quality shall be monitored for each batch of biomass.
Purpose of data	N/A
Additional comment	N/A

Data / Parameter	T (steam)
Unit	ºC
Description	Steam temperature
Source of data	Measurement by the project participant.
Value(s) applied	205 ºC
Measurement methods and procedures	Measured using calibrated meters.
Monitoring frequency	Continuous monitoring, integrated hourly and at least monthly recording.
QA/QC procedures	Measurement equipment will be maintained and calibrated regularly in line with manufacturer's recommendation, and calibration frequency will not be less than once in three years.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	P
Unit	Bar
Description	Pressure
Source of data	Measurement by the project participant.
Value(s) applied	15 bar
Measurement methods and procedures	Measured using calibrated meters.
Monitoring frequency	Continuous monitoring, integrated hourly and at least monthly recording.
QA/QC procedures	Measurement equipment will be maintained and calibrated regularly in line with manufacturer's recommendation, and calibration frequency will not be less than once in three years.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	T (feedwater)
Unit	ºC
Description	Feed water temperature
Source of data	Measurement by the project participant.
Value(s) applied	105 ºC
Measurement methods and procedures	Continuous monitoring, integrated hourly and at least monthly recording.
Monitoring frequency	Continuous monitoring, integrated hourly and at least monthly recording.
QA/QC procedures	Measurement equipment will be maintained and calibrated regularly in line with manufacturer's recommendation, and calibration frequency will not be less than once in three years.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	$NCV_{i,t}$
Unit	GJ/ton
Description	Net calorific value of diesel oil
Source of data	National Energy Comission
Value(s) applied	43.3 GJ/ton

Measurement methods and procedures	Review appropriateness of the values annually.
Monitoring frequency	Review annually.
QA/QC procedures	Verify if the values are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements.
Purpose of data	Calculation of project emissions
Additional comment	Local value from the national energy balance.

Data / Parameter	NCV_k
Unit	GJ/kg
Description	Net calorific value of biomass type *k*
Source of data	Plant records
Value(s) applied	19,188 GJ/kg
Measurement methods and procedures	Measured in authorized laboratories according to relevant national / international standards. Measure the NCV based on dry biomass. Check the consistency of the measurement by comparing the measurement result with 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 relevant data sources, conduct additional measurements.
Monitoring frequency	Determine once in the first year of the crediting period.
QA/QC procedures	The measurement is done in authorized laboratories where is checked the consistency.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	$EG_{n,t}$
Unit	MWh
Description	Quantity of electricity generated in captive power plant *n* in the time period *t*
Source of data	Monitored by project participant
Value(s) applied	141.9 MWh
Measurement methods and procedures	Continuously using electricity meter, added at least annually.
Monitoring frequency	Continuously, added at least annually.
QA/QC procedures	Measured using calibrated meter.
Purpose of data	Calculation of project emissions
Additional comment	For ex ante emission reductions this parameter is calculated based in the installed electrical capacity of the boiler, the total operating hours and the percentage of total electricity to be supplied from the generator.

Data / Parameter	$FC_{i,j,y}$
Unit	Mass or volume unit per year (e.g. ton/yr or m^3/yr)
Description	Quantity of LPG i combusted in process j during the year y
Source of data	Onsite measurements
Value(s) applied	0 ton/yr
Measurement methods and procedures	Continuously use mass or volume meters
Monitoring frequency	Continuously
QA/QC procedures	The consistency of metered fuel consumption quantities should be cross-checked by an annual energy balance that is based on purchased quantities and stock changes.
Purpose of data	Calculation of project emissions

Additional comment	Parameter measured for calculate project emissions from LPG fired boiler, which will be use only in case of unplanned biomass boiler failure.

B.7.2. Sampling plan

>>
N/A

B.7.3. Other elements of monitoring plan

>>
Project Monitoring Plan

The monitoring plan of the Puelche Project/Cancura Factory Biomass Boiler performance will be the responsibility of the project participant.

The operation, maintenance and revision of the plant will be in accordance to the Chilean Decree Supreme Nº48 “Regulation for Boilers and Steam Generators”.

In order to monitor and record the different variables the appropriate monitoring and recording equipments will be implemented. These instruments will be calibrated in accordance with the manufacturer’s specifications and the applicable national standards if any.

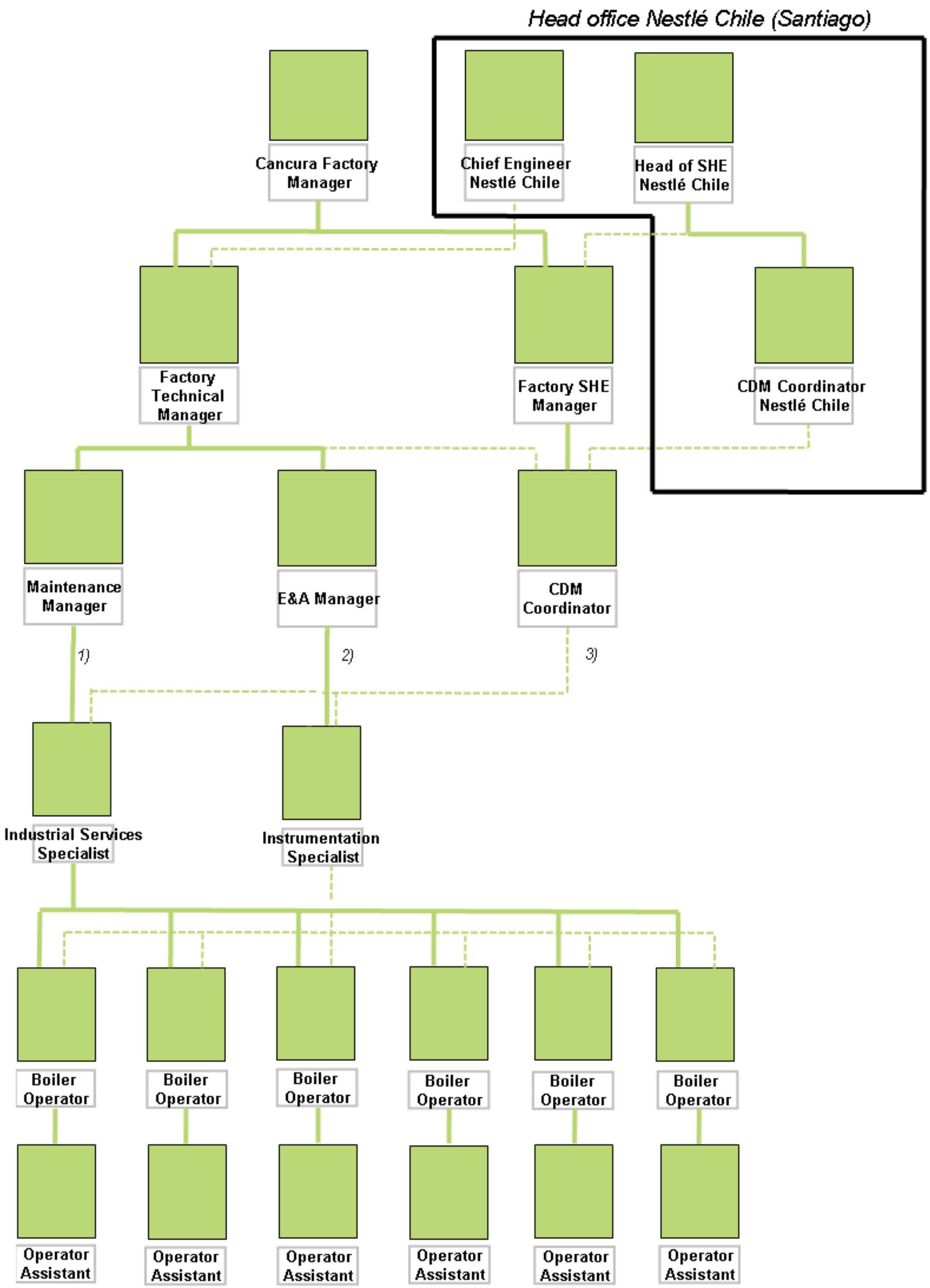
The project participant will establish a data collection and monitoring management who will be responsible of the following tasks:

- Monitoring, recording and safe storage of the following data:
  - Quantity of biomass used in the project activity.
  - Steam flow, temperature and pressure in order to estimate the steam’s enthalpy.
  - Electricity generated in the captive plant and electricity supplied by the grid.
  - Amount of fuel consumed by the captive power plant.
- Calculation of the emissions reduction in the most transparent and conservative manner, following the procedures established by the applicable CDM methodology.
- Kept under safe custody the monitoring data until two years after the end of the crediting period or the last issuance of CERs for this project activity.

Project data collection and record organization

The following figure shows the structure of the data collection and monitoring management, including the responsibility structure related to the CDM project:

Figure 8. Data collection, Monitoring management and CDM responsibility structure



Data monitoring and recording procedures

The monitored parameters will be measured and collected as specified in section B.7.1. The collected data required for emissions reduction estimation will be stored for a period of two years after the crediting period or after the last issuance of CERs for the project activity whichever occurs later.

Maintenance and Calibration of monitoring equipment

All the measurement and recording equipment implemented as part of the monitoring plan of the project activity will be maintained and calibrated in accordance with manufacturer's recommendations and the applicable national standards if any. The measuring equipment will be recalibrated at appropriate intervals according to manufacturer specifications, but at least once in three years. This will assure the appropriate and accurate performance of the equipment.

Staff training

The project activity operators and staff will be trained in order to continuously check the metering equipment operation, to collect data on the specified basis and to keep record of the data collected.

Quality Assurance (QA) and Quality control (QC)

Data and records will be checked prior to being archived and stored. Data from the project will be checked to identify possible errors or omissions. In addition, with the objective of guaranteeing the quality and accuracy of the data collected and recorded, historical operation registers of the project participant has to be checked and compared with the metered data.

Data and records management

At the end of each month the monitoring data will be filed electronically. The electronic files need to have digital and hard copy back-up.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

>>

24/11/2009, date of the purchase order of the biomass boiler (RCR).

C.2. Expected operational lifetime of project activity

>>

25 years, 0 months

C.3. Crediting period of project activity

C.3.1. Type of crediting period

>>

Renewable crediting period (First crediting period)

C.3.2. Start date of crediting period

>>

07/02/2018 or registration date (whichever is later)

C.3.3. Duration of crediting period

>>

7 years, 0 months.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>

The Environment National Commission (CONAMA[19]) has developed the Environmental Impact Assessment System (SEIA) as the established instrument to analyze the environmental impact of different project initiatives and prevent the national environment decay. The SEIA relies on defined and specific criteria, as stated on the *SEIA Regulations*[20] to determine whether a project requires to be subject matter to the system or not. If the project activity requires to be submitted to the SEIA and it results to be authorized, the proper authorities will make public their response through an authorization document (RCA) published on the SEIA web page[21], and if the project activity does not require to be subject matter to the SEIA, CONAMA elaborates and presents to the project activity developers a written letter expressing this matter.

Nestlé Chile S.A. submitted to the national authorities all required evidence related to the Puelche Project/Cancura Factory in an Environmental Impact Declaration (DIA[22]) in September 2008 and received its approval in July 2009.

The following represent the project activity milestones regarding its environmental evaluation:

Table 11: Project activity environmental assessments

Milestones	Date
Puelche Project/Cancura Factory documents submitted for environmental assessment.	September 29th 2008
Puelche Project/Cancura Factory Environmental authority's approval.	July 14th 2009

The original project considered the implementation of coal fired boilers as the primary alternative to satisfy the thermal energy requirements of the milk processing facilities. Nevertheless, the project participant mentions in the Environmental Impact Declaration the possibility of analyzing the use of other sorts of technology to satisfy those energy requirements. As mentioned above the Environmental Impact Declaration of the Puelche Project/Cancura Factory was approved by the national authorities considering the implementation of the coal fired boilers.

According to CONAMA, the implementation of the biomass fired boiler as part of the "cow milk processing plant" project activity did not required the submission of an additional Environmental Impact Declaration. The project activity does not generate any additional environmental impacts than those associated to the implementation of the original project.

The Environmental Impact produced by the construction and operation of cow milk processing plant is:

- Generation of liquid waste.

[19] The Environmental National Commission ("Comisión Nacional del Medio Ambiente – CONAMA" in Spanish) was the environmental authority at the time of submission of the project's DIA. From 26th January 2010 the environmental authority is the Environmental Ministry with the release of the Law 20.417 creating the Ministry, the Environmental Assessment Service ("Servicio de Evaluación Ambiental – SEA" in Spanish) and the Environment Superintendence.

[20] http://www.sinia.cl/1292/articles-37936_pdf_reglamento_seia.pdf

[21] http://www.e-seia.cl

[22] DIA stands in spanish for "Declaración de Impacto Ambiental" (Environmental Impact Assessment)

- Generation of noise and vibration produced during the construction phase.
- Diversification of energy sources helping to decrease the import of fossil fuel from other countries.
- Reduction of greenhouse gas emissions related to the thermal energy generated with biomass instead of fossil fuel.
- Promotion of the development and implementation of biomass energy production technologies (technology and experience transfer to the Host country)
- Generation of local employment opportunities.

D.2. Environmental impact assessment

>>

Not applicable since the project did not required an additional environmental impact assessment.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

>>

Nestlé Chile S.A. invited the community to the public stakeholder consultation meeting through an announcement in the municipality's bulletin board. Invitations were also sent individually to the local community members requesting their attendance to the consultation meeting. The meeting was held in the Ordinary Session N° 28/2010 of the city council, at the Sessions Room of Osorno municipality on July 27th 2010.

The main purpose of the meeting was to inform the local community in aspects related to the project's description and environmental benefits associated to the implementation of the project activity in terms of sustainable development and GHG emissions reduction to the atmosphere. The community was also informed and instructed in the Clean Development Mechanism and the beneficial implications associated to the Puelche Project/Cancura Factory Biomass Boiler implementation in the CDM context.

The meeting agenda considered the following topics:

- Opening
- Technical characteristics of the project
- Climate change, CDM project and emission reductions
- Questions session

Some of the pictures from the stakeholders meeting are presented in the following figure.

Figure 9: Stakeholder meeting pictures

E.2. Summary of comments received

>>

Questions raised during the session were mainly related to the following matters:

1. Amount of biomass consumed by the project activity: The project developer said that the amount of biomass would be sent by email. An email with this information was sent on 02/08/2010.
2. Local employment: For the construction of the plant the project developer said that they considered local labour as main option. For the operation phase, the project developer explained that the project activity considers the transfer qualified personnel form other facilities of Nestlé Chile S.A. for the direct operation of the plant and the use of local labour for indirect activities such as internal transport and storage of the biomass, maintenance, services, safety issues and administrative staff.
3. Road works: The project developer explained that the works were mainly related to the access road, according to the requirements of the Department of Municipal Works and the Ministry of Public Works (MOP).

In addition, there were also encouraging comments, mainly congratulations for the implementation of the project.

The list of questions and answered is presented in section E.3. More details regarding the received comments and answers can be found in the Act of the Ordinary Session N° 28/2010 of the city council.

E.3. Consideration of comments received

>>

None of the comments expressed by the participants during the meeting required an action to be taken by Nestlé Chile S.A. During the event, there were only questions mainly related to topics like: amount of biomass, local employment and road works, which were immediately answered at the meeting event or answered by email by the project developer. These questions and answers are listed below.

1st Question (Done by Counsellor Sr. Casanova): Has the amount of biomass to be used at the plant been quantified already? Likewise, have they quantified the total amount of kilocalories that will be consumed as a result of the methane gas emissions? Can you disclose any figures?

Answer (Answered by Mr. Costa)**:** Yes, all such have been quantified. All the documentation will be sent to you. The decision to use biomass as fuel input was not a casual one. Indeed it was linked to an overall availability survey focused on the biomass stock to be had within the project's area of influence. Such survey validated and ensured the existence of the biomass in sufficient quantities to justify this project. A second argument endorsing this project is that the Clean Development Mechanism projects do meet a rigorous and exacting calculation methodology; clearly aimed at assisting with accurate estimates of the emission reduction prospects. The latter estimates are also based on a baseline analysis which encompasses all the calculations that you are asking me about.

2nd Question (Done by Counsellor Mrs. Ubilla): My questions are referred to the potential new job opportunities for the people in Osorno as a result of this project's implementation. And, I understand that about 80% of the plant's output will be exported so it is likely that the end-consumers abroad will get to know about the powder milk as processed in Osorno. Are there any possibilities of mentioning Osorno in the text of the statement of origin and thus boosting its international exposure?

Answer (Anserwed by Mr. Chavalos): The work we can do as Nestlé and the investment we are about to implement here must be regarded as a joint effort aimed at supplementing the initiatives adopted by the milk and dairy producers. Had it no been for the high milk quality available here in Osorno, I could not be adamantly stating now that Chile was been considered as a venue for investment options. Certainly this speaks well for the work carried out in the region by the various organisations concerned. As I have already stated, doubtless the key factor is a high-quality standard of fresh milk.

The work opportunities and associated demand to be generated by the new plant (supplemented by the internal plant work needs), will bring to bear a significant influence on activities such as transportation and storage. The same effect on labour opportunities should show up in the normal operations at the plant and referred to security, garden and green areas' maintenance plus a whole host of indirect services. All the foregoing entails a significant number of job opportunities that are customarily generated as a result of the plant's specific operations. What we are stressing now to the companies that will be undertaking the construction work for such new plant is the compelling requirement of hiring labour with the necessary qualifications from the adjacent areas.

Question 3rd (Done by Counsellor Mr. Carrillo): My question is concerned with the availability of any specific survey focused on the likely impact on the road and transportation structure in the Pichil area, now that there will be two manufacturing establishments, namely you and Mafrisur. Is there any survey of this kind? And what about the road impact?

Answer (Anserwed by Mr. Chavalos):_We have worked in close consultation with CONAMA, with the Chilean Ministry of Public Works and other authorities. In other words, everything had been done along the guidelines specified in the existing regulations.

The road works whose implementation we had to arrange was merely confined to the plant's own access points to the main road. Although the lorry flows going along the main road was already allowed, we went a step ahead and produced a more ambitious project aimed at generating the dual carriage motorway onto Puerto Octay. In doing so, and bearing in mind the tourist potential prevalence in the area, we took the appropriate safeguards ensuring that the normal and tourist traffic would continue unaffected. In short, our industrial output would be moved in and out of our plants albeit in full harmony with the nearby environment. All the road works that required both traffic flow detours and main avenue expansions were undertaken as per the guidelines specified by the Municipality's Works Directorate and the Ministry of Public Works alike.

SECTION F. Approval and authorization

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The Letter of approval is available at the present and has been provided to the DOE.

Appendix 1. Contact information of project participants

Organization name	Nestlé Chile S.A.
Country	Chile
Address	Avenida Las Condes 11287, Las Condes, Santiago, Region Metropolitana.
Telephone	+56 2 2338 4000
Fax	-
E-mail	Luis.Santibanez-Ortiz@CL.nestle.com
Website	-
Contact person	Luis Santibañez

Appendix 2. Affirmation regarding public funding

Puelche Project/Cancura Factory Biomass Boiler for Heat Generation project does not receive public funding.

Appendix 3. Applicability of methodologies and standardized baselines

Discount Rate Calculation

The discount rate was determined considering an analysis 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:

Eq. 1: CAPM equation

$$R=Rf + \beta*(Rm-Rf) + Rcountry$$

Where:

R	Expected rate of return
Rf	Risk-free rate of return. This parameter considers a value equal to 5.57% which corresponds to the 10-year bond of the Central Bank of Chile (BCP) for 28/08/2009 (date of investment decision).
β	Beta factor is obtained from USA stock market information under Food Processing Industry and resulted in a value of 0.65. 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.
(Rm – Rf):	Risk premium estimate for the Chilean market based upon the country ratings among various international and national studies concluding in a value of 7.1%.
Rcountry	Country risk shall be included since the analysis uses a value of Beta obtained from the USA Food Processing Industries. For Chile this value is equal to 2.1% when compared to the USA.

The discount rate this project by August 2009, is therefore, equal to 12.29%.

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

BASELINE INFORMATION

(i) Emissions Reduction

The following information is used to estimate the emissions reduction of the associated to the implementation of the project activity:

Table 12: Power Plants Energy Generation Data

Power Unit	Fuel Type	Starting Date	Total Generation by power unit *m* or *k* in year *y*		
			2014	2015	2016
Abanico@Run of the River	run off river (hydro)	1948	259.385,0	280.302,0	255.197,0
Aconcagua Ublanco@Run of the River	run off river (hydro)	1993	13.995,8	145.304,7	228.195,4
Aconcagua Ujuncal@Run of the River	run off river (hydro)	1994	107.310,7	103.174,6	117.375,1
Alfalfal@Run of the River	run off river (hydro)	1991	695.984,3	694.311,7	869.818,9
Allipen@Run of the River	run off river (hydro)	2012	18.208,1	18.131,0	17.905,0
Alto Renaico@Run of the River	run off river (hydro)	2013	0,0	3	6.571,7
Ancali@Biomass	biomass	2013	6.447,2	0,0	0,0
Andes@Diesel Oil	Diesel	2016	0,0	0	6.236,5
Angostura@Dam	Reservoir (hydro)	2014	1.300.172,0	1.220.693,0	657.430,0
Antilhue TG@Diesel Oil	Diesel	2005	59.875,0	8.095,0	9.693,0
Antuco@Dam	Reservoir (hydro)	1981	1.285.267,0	1.378.341,0	1.079.426,0
Arauco@Biomass	biomass	1996	86.655,0	85.346,3	94.530,7
Auxiliar del Maipo@Run of the River	run off river (hydro)	1962	21.937,9	25.173,4	34.936,4
Biocruz@Natural Gas	Natural Gas	2012	0,0	3.197	2.146,4
Biomar@Diesel Oil	Diesel	2009	5,6	11,6	0,4
Bocamina 1@Bituminous Coal	Coal	1970	507.909,0	207.030,0	730.349,0
Bocamina 2@Bituminous Coal	Coal	2012	0,0	749.409	2.211.533,0
Bonito@Run of the River	run off river (hydro)	2013	56.116,9	44.912,9	34.509,8
Bureo@Run of the River	run off river (hydro)	2015	36.226,6	0,0	6.107,8
Callao@Run of the River	run off river (hydro)	2012	11.429,6	9.464,1	6.335,0
Calle-Calle@Diesel Oil	Diesel	2011	3.183,0	12.498,2	10.933,2
Campiche@Petcoke	Coke	2013	2.156.023,0	2.119.265	2.268.649,0
Candelaria 1@Diesel Oil	Diesel	2005	6.807,0	1.897,0	35.452,0
Candelaria 1@LNG	LNG	2005	2.126,0	2.692,0	74.923,0
Candelaria 2@Diesel Oil	Diesel	2005	5.966,0	1.816,0	35.640,0
Candelaria 2@LNG	LNG	2005	800,0	4.858	73.736,0
Canela 1@Wind	wind	2007	26.594,7	23.066,4	20.134,5
Canela 2@Wind	wind	2009	129.891,4	111.076,3	89.412,1
Canutillar@Dam	Reservoir (hydro)	1990	963.961,0	839.863,0	590.163,0
Cañete@Diesel Oil	Diesel	2007	186,8	405,0	10,2
Capullo@Run of the River	run off river (hydro)	1995	67.909,3	57.249,6	46.236,1
Cardones@Diesel Oil	Diesel	2009	40,8	4.181,2	0,0
Carena@Run of the River	run off river (hydro)	1943	76.219,6	71.158,9	68.026,9
Carilafquen@Run of the River	run off river (hydro)	2016	0,0	0	67.742,1

Power Unit	Fuel Type	Starting Date	Total Generation by power unit *m* or *k* in year *y*		
			2014	2015	2016
Carrera Pinto@Solar	Solar	2015	0,0	249,2	120.124,8
Casablanca 1@Diesel Oil	Diesel	2007	38,7	50,7	23,3
Celco@Biomass	biomass	1996	29.585,1	35.294	39.053,3
Celco@Residual Fuel Oil	IFO 180	1995	0,0	55,1	0,0
Cem Bio Bio@Diesel Oil	Diesel	2010	480,9	175,1	510,8
Cem Bio Bio@Residual Fuel Oil	IFO 180	2010	26.039,7	29.890,7	15.952,8
Chacabuquito@Run of the River	run off river (hydro)	2002	112.486,9	72.437	98.285,9
Chacayes@Run of the River	run off river (hydro)	2011	447.793,0	477.811,6	328.003,6
Chañares@Solar	Solar	2015	2.342,0	66.236	67.790,6
Chiburgo@Run of the River	run off river (hydro)	2007	59.904,0	69.518,0	63.074,0
Chiloe@Diesel Oil	Diesel	2008	0,0	13,6	17,8
Cholguan@Biomass	biomass	2003	75.105,5	61.902	89.615,2
Chuchiñi@Solar	Solar	2016	0,0	0,0	2.684,1
Chufken@Diesel Oil	Diesel	2007	157,5	932,5	314,4
Chuyaca@Diesel Oil	Diesel	2008	1.504,5	2.687	3.728,9
Cipreses@Dam	Reservoir (hydro)	1955	270.667,0	312.488,0	435.824,0
CMPC Cordillera@Natural Gas	Natural Gas	2015	0,0	13.428	115.646,0
CMPC Laja@Biomass	biomass	2015	84.297,1	7.562,7	105.764,5
CMPC Pacifico@Biomass	biomass	2014	175.966,5	209.023,5	199.428,0
CMPC Santa Fe@Biomass	biomass	1991	0,0	67.744,9	28.559,3
CMPC Tissue@Natural Gas	Natural Gas	2015	0,0	79,7	10.961,4
Coelemu@Biomass	biomass	2014	21.251,2	32.099	33.221,2
Colbun@Dam	Reservoir (hydro)	1985	1.962.275,0	1.881.436,0	1.263.591,0
Colihues@Diesel Oil	Diesel	2010	0,0	0,0	16.793,5
Colihues@Residual Fuel Oil	IFO 180	2010	32.094,4	41.614,5	20.744,4
Collil@Run of the River	run off river (hydro)	2014	1.482,9	22.850,9	0,0
Collipulli@Diesel Oil	Diesel	2007	0,2	0	0,0
Colmito@Diesel Oil	Diesel	2008	5.890,2	11.905,3	455,3
Colmito@LNG	LNG	2008	0,0	14.665,9	7.947,5
Concon@Diesel Oil	Diesel	2007	111,2	65,6	30,0
Conejo@Solar	Solar	2016	0,0	0,0	110.313,9
Confluencia@Run of the River	run off river (hydro)	2011	375.812,0	402.275,0	462.656,1
Constitucion@Diesel Oil	Diesel	2007	1.569,0	800	1.442,1
Contulmo@Diesel Oil	Diesel	2012	186,3	2,8	0,0
Cordillerilla@Solar	Solar	2016	0,0	0,0	322,7
Coronel@Diesel Oil	Diesel	2005	23.087,7	32.719,0	16.519,2
Coronel@Natural Gas	Natural Gas	2005	0,0	20.952,9	6.555,1
Coya@Run of the River	run off river (hydro)	2008	87.874,4	80.531,3	84.755,3
Cuel@Wind	wind	2014	57.586,0	93.809,6	76.191,9
Cumpeo@Run of the River	run off river (hydro)	2016	0,0	0,0	9.315,0
Curacautin@Diesel Oil	Diesel	2007	703,8	1.432,1	339,4
Curanilahue@Diesel Oil	Diesel	2012	94,8	170,5	18,6
Curauma@Diesel Oil	Diesel	2007	81,0	66,0	53,9

Power Unit	Fuel Type	Starting Date	Total Generation by power unit *m* or *k* in year *y*		
			2014	2015	2016
Curillinque@Run of the River	run off river (hydro)	1993	506.240,0	482.889,0	484.558,0
Danisco@Diesel Oil	Diesel	2011	0,2	0,6	0,2
Degan@Diesel Oil	Diesel	2007	339,9	549,0	10.864,6
Diego de Almagro@Diesel Oil	Diesel	1981	205,0	1.022	279,0
Diego de Almagro@Solar	Solar	1981	25.589,0	46.161,9	50.800,6
Diuto@Run of the River	run off river (hydro)	2011	14.077,8	9.895,6	24.477,7
Don Walterio@Run of the River	run off river (hydro)	2013	22.935,5	14.883,2	3.557,7
Dongo@Run of the River	run off river (hydro)	2010	21.817,3	15.857	9.491,6
Donguil@Run of the River	run off river (hydro)	2011	366,4	1.110,2	1.246,2
Eagon@Diesel Oil	Diesel	2009	456,2	3,8	10,4
El Agrio@Run of the River	run off river (hydro)	2016	0,0	0,0	5.007,8
El Arrayan@Wind	wind	2014	183.947,9	277.068,1	253.296,1
El Canelo@Run of the River	run off river (hydro)	2012	17.397,9	13.640,3	15.931,7
El Divisadero@Solar	Solar	2016	0,0	0,0	3.559,9
El Galpon@Run of the River	run off river (hydro)	2016	0,0	0,0	4.030,0
El Llano@Run of the River	run off river (hydro)	2013	4.543,9	4.916,9	5.832,8
El Manzano@Run of the River	run off river (hydro)	2008	26.290,6	25.835,8	21.363,8
El Mirador@Run of the River	run off river (hydro)	2015	0,0	0,0	229,0
El Paso@Run of the River	run off river (hydro)	2015	0,0	38.487,4	134.417,0
El Peñon@Diesel Oil	Diesel	2009	63.995,5	80.428,6	14.298,7
El Pilar-Los Amarillos@Solar	Solar	2015	0,0	1.312,5	2.346,4
El Rincon@Run of the River	run off river (hydro)	2007	1.730,8	2.355,8	1.962,9
El Romero@Solar	Solar	2016	0,0	0,0	39.065,2
El Salvador@Diesel Oil	Diesel	2010	77,0	664	105,3
El Toro@Dam	Reservoir (hydro)	1973	946.808,0	1.114.268,0	1.118.623,0
Emelda 1@Diesel Oil	Diesel	2010	98,0	174,5	290,1
Emelda 2@Diesel Oil	Diesel	2010	48,8	61	128,8
Energia Bio Bio@Biomass	biomass	2014	40.881,7	43.139,3	0,0
Energia Pacifico@Biomass	biomass	2014	104.627,7	87.792,3	82.742,3
Ensenada@Run of the River	run off river (hydro)	2013	5.127,3	1.933,7	0,0
Escuadron@Biomass	biomass	2008	88.739,1	75.180,6	76.322,2
Esperanza 1@Diesel Oil	Diesel	2007	23,1	3,2	56,1
Esperanza 2@Diesel Oil	Diesel	2007	38,0	4,7	142,0
Esperanza TG@Diesel Oil	Diesel	2007	0,0	0,0	161,1
Esperanza@Solar	Solar	2013	2.824,1	5.637	2.027,3
Estancilla@Diesel Oil	Diesel	2013	87,0	173,6	650,2
Eyzaguirre@Run of the River	run off river (hydro)	2007	5.053,4	4.953,4	6.278,4
Florida@Run of the River	run off river (hydro)	1909	90.575,0	90.755,8	124.904,9
Guacolda 1@Bituminous Coal	Coal	1995	1.182.617,0	858.755,3	973.896,2
Guacolda 2@Bituminous Coal	Coal	1996	1.245.215,7	994.402,5	960.651,0
Guacolda 3@Bituminous Coal	Coal	2009	1.216.427,0	1.223.784,4	1.052.710,6
Guacolda 4@Bituminous Coal	Coal	2010	1.245.172,3	1.175.591,3	890.203,1
Guacolda 5@Bituminous Coal	Coal	2015	0,0	295.077	897.041,4

Power Unit	Fuel Type	Starting Date	Total Generation by power unit *m* or *k* in year *y*		
			2014	2015	2016
Guayacan@Run of the River	run off river (hydro)	2010	77.260,1	75.522,0	91.472,8
Horcones@Diesel Oil	Diesel	2004	8,5	381	1.170,4
Hormiga Solar@Solar	Solar	2016	0,0	0,0	8,9
Hornitos@Run of the River	run off river (hydro)	2008	165.061,0	160.956	264.571,8
Huasco TG@Diesel Oil	Diesel	1977	395,0	163,0	161,0
Huasco TG@Residual Fuel Oil	IFO 180	1979	91,0	189,0	3,0
Isla@Run of the River	run off river (hydro)	1963	402.499,0	400.146,0	407.910,0
Itata@Run of the River	run off river (hydro)	2015	0,0	16	25.719,1
Javiera@Solar	Solar	2015	0,0	110.363,0	145.571,9
JCE@Diesel Oil	Diesel	2011	28,5	4	0,0
Juncalito@Run of the River	run off river (hydro)	2010	2.951,6	2.371,6	2.493,0
La Arena@Run of the River	run off river (hydro)	2011	18.003,9	20.673,4	12.871,8
La Chapeana@Solar	Solar	2016	0,0	0	3.832,2
La Esperanza@Wind	wind	2016	0,0	0	16.220,0
La Higuera@Run of the River	run off river (hydro)	2011	460.503,1	536.951,4	693.696,4
La Paloma@Run of the River	run off river (hydro)	2010	0,0	0,0	2.987,1
La Silla@Solar	Solar	2016	0,0	0	2.701,1
Lagunilla@Solar	Solar	2015	0,0	1.059,4	4.181,3
Laja 1@Run of the River	run off river (hydro)	2013	59.348,9	95.697,0	44.689,0
Laja@Biomass	biomass	1995	39.830,0	34.065,0	29.932,0
Lalackama 2@Solar	Solar	2015	0,0	10.028	39.268,7
Lalackama@Solar	Solar	2015	0,0	128.042	128.524,7
Las Araucarias@Solar	Solar	2016	0,0	0,0	93,1
Las Flores@Run of the River	run off river (hydro)	2015	0,0	8.715,7	10.072,7
Las Mollacas@Solar	Solar	2016	0,0	0,0	3.356,1
Las Pampas@Biomass	biomass	2013	1.421,6	2.655,6	2.162,9
Las Terrazas@Solar	Solar	2014	1.129,8	6.475,3	3.366,5
Las Vegas@Diesel Oil	Diesel	2007	95,5	98,6	60,1
Las Vertientes@Run of the River	run off river (hydro)	2013	10.581,1	11.909,0	7.676,9
Lautaro Comasa 1@Biomass	biomass	2012	191.876,5	165.429,6	158.012,0
Lautaro Comasa 2@Biomass	biomass	2015	51.161,4	137.907,1	126.759,7
Lautaro@Biomass	biomass	2012	30,9	9,5	6,9
Lebu@Diesel Oil	Diesel	2007	145,0	857	11,4
Lebu@Wind	wind	2009	7.351,1	8.673,9	18.215,9
Lican@Run of the River	run off river (hydro)	2011	85.598,8	77.760,9	58.334,3
Licanten@Biomass	biomass	2004	44.959,9	38.997,1	31.642,2
Linares Norte@Diesel Oil	Diesel	2009	33,4	60,0	17,5
Lircay@Run of the River	run off river (hydro)	2009	122.887,2	123.442,3	121.342,9
Llano de Llampos@Solar	Solar	2014	218.681,4	247.379,5	235.747,6
Lleuquereo@Run of the River	run off river (hydro)	2015	0,0	6.277,0	5.754,4
Loma Alta@Run of the River	run off river (hydro)	1997	224.214,0	217.418,0	201.522,0
Loma Los Colorados 1@Biomass	biomass	2010	3.516,7	367,0	2.085,3
Loma Los Colorados 2@Biomass	biomass	2011	131.352,2	119.933	127.614,7

Power Unit	Fuel Type	Starting Date	Total Generation by power unit *m* or *k* in year *y*		
			2014	2015	2016
Loma Los Colorados@Solar	Solar	2015	0,0	722,2	1.391,1
Lonquimay@Diesel Oil	Diesel	2011	164,1	47	27,2
Los Alamos@Diesel Oil	Diesel	2013	6,8	231,6	26,7
Los Bajos@Run of the River	run off river (hydro)	1944	33.497,0	34.804,0	44.775,8
Los Bueno Aires@Wind	wind	2016	0,0	0,0	41.991,7
Los Corrales 1@Run of the River	run off river (hydro)	2010	6.025,6	5.595,1	4.760,5
Los Corrales 2@Run of the River	run off river (hydro)	2013	5.578,6	4.572,8	3.356,4
Los Cururos@Wind	wind	2014	149.243,8	258.140,7	206.679,5
Los Espinos@Diesel Oil	Diesel	2009	45.011,9	35.774,9	4.192,9
Los Guindos@Diesel Oil	Diesel	2015	0,0	6.996,4	37.583,7
Los Hierros 1@Run of the River	run off river (hydro)	2014	104.905,6	129.089,3	111.177,3
Los Hierros 2@Run of the River	run off river (hydro)	2015	0,0	23.404,8	20.249,3
Los Loros@Solar	Solar	2016	0,0	0,0	23.550,4
Los Molles@Run of the River	run off river (hydro)	1952	23.475,0	33.642,9	77.023,0
Los Morros@Run of the River	run off river (hydro)	1930	11.688,7	12.814,2	20.561,6
Los Padres@Run of the River	run off river (hydro)	2014	4.340,3	5.702,7	3.968,0
Los Pinos@Diesel Oil	Diesel	2009	129.566,0	180.309,0	86.673,0
Los Quilos@Run of the River	run off river (hydro)	1943	187.116,4	175.207,7	260.150,0
Los Sauces 1@Diesel Oil	Diesel	2007	554,0	0,0	0,0
Los Sauces 2@Diesel Oil	Diesel	2011	253,7	0,0	0,0
Los Vientos TG@Diesel Oil	Diesel	2007	10.114,3	76.754,3	31.763,5
Louisiana Pacific@Diesel Oil	Diesel	2009	22,6	76,7	2,4
Luna@Solar	Solar	2015	0,0	1.901,2	5.716,0
Luz del Norte@Solar	Solar	2015	0,0	84.188	273.089,6
Machicura@Dam	Reservoir (hydro)	1985	430.712,0	406.922,0	279.012,0
Maisan@Run of the River	run off river (hydro)	2013	1.932,3	2.145	1.182,2
Maitenes@Run of the River	run off river (hydro)	1923	108.844,5	101.302,4	104.032,2
Malalcahuello@Run of the River	run off river (hydro)	2016	0,0	0,0	18.151,3
Mallarauco@Run of the River	run off river (hydro)	2011	25.405,0	25.547	25.660,7
Mampil@Run of the River	run off river (hydro)	2000	143.534,5	144.885,0	90.532,1
Maria Elena@Run of the River	run off river (hydro)	2014	128,4	758,3	171,3
Mariposas@Run of the River	run off river (hydro)	2011	23.203,7	25.526	19.563,0
Masisa@Biomass	biomass	2011	55.027,0	46.809,2	48.378,5
Maule@Diesel Oil	Diesel	2007	588,3	217,0	527,2
Molinera Villarica@Run of the River	run off river (hydro)	2016	0,0	0,0	90,7
Monte Patria@Diesel Oil	Diesel	2007	0,5	0	0,0
Monte Redondo@Wind	wind	2010	109.693,7	99.870,4	72.724,7
Muchi@Run of the River	run off river (hydro)	2011	2.909,9	3.071	999,8
Multiexport 1@Diesel Oil	Diesel	2009	0,8	1,0	0,2
Multiexport 2@Diesel Oil	Diesel	2009	0,0	2,1	0,6
Munilque 1@Run of the River	run off river (hydro)	2015	0,0	0	1.856,1
Munilque 2@Run of the River	run off river (hydro)	2015	0,0	0,0	1.947,9
Nalcas@Run of the River	run off river (hydro)	2012	28.595,5	18.460,8	14.044,5

Power Unit	Fuel Type	Starting Date	Total Generation by power unit *m* or *k* in year *y*		
			2014	2015	2016
Nehuenco 1@Diesel Oil	Diesel	1998	232.668,0	50.401,0	121.026,0
Nehuenco 1@LNG	LNG	1998	1.076.190,0	1.296.732	2.158.323,0
Nehuenco 2@Diesel Oil	Diesel	2003	106.608,0	1.312,0	21.151,0
Nehuenco 2@LNG	LNG	2004	1.929.758,0	2.115.680,0	1.283.397,0
Nehuenco 9B@Diesel Oil	Diesel	2002	4.769,0	308,0	5.559,0
Nehuenco 9B@LNG	LNG	2002	1.999,0	1.675,0	3.461,0
Newen@Butane gas	Butane Gas	2009	23.879,3	0,0	0,0
Newen@Diesel Oil	Diesel	2009	0,0	0,0	58,0
Newen@Natural Gas	Natural Gas	2009	20,7	4.421,8	464,0
Newen@Propane gas	Propane	2009	868,8	1.960,3	7,1
Nueva Aldea 1@Biomass	biomass	2005	82.941,3	72.591,2	72.730,6
Nueva Aldea 2@Diesel Oil	Diesel	2006	0,0	50,5	31,6
Nueva Aldea 3@Biomass	biomass	2008	274.809,9	243.060,7	267.237,4
Nueva Renca@Diesel Oil	Diesel	1997	725.384,0	78.644	94.671,6
Nueva Renca@LNG	LNG	1997	429.044,0	1.743.544,0	2.001.076,4
Nueva Renca@LPG	LPG	1997	23.019,0	14.826,0	21.574,0
Nueva Renca@Natural Gas	Natural Gas	1997	0,0	3.127	0,0
Nueva Ventanas@Bituminous Coal	Coal	2010	2.183.243,0	2.254.565,0	2.165.583,0
Ojos de Agua@Run of the River	run off river (hydro)	2008	48.258,4	50.036,9	44.711,1
Olivos@Diesel Oil	Diesel	2008	6.556,4	4.007	1.068,4
Palmucho@Run of the River	run off river (hydro)	2007	241.538,0	236.661,0	218.821,0
Pampa Solar Norte@Solar	Solar	2016	0,0	0,0	129.377,2
Pangue@Dam	Reservoir (hydro)	1996	1.839.707,0	1.709.402,0	832.179,0
Pehuenche@Dam	Reservoir (hydro)	1991	2.275.887,0	2.279.918,0	1.678.791,0
Pehui@Run of the River	run off river (hydro)	2009	7.400,4	5.704,6	1.537,8
Petropower@Petcoke	Coke	1998	529.764,0	505.050,0	497.111,0
Peuchen@Run of the River	run off river (hydro)	2000	90.594,8	195.983	118.340,6
Pichilonco@Run of the River	run off river (hydro)	2014	1.615,8	4.475,6	3.085,5
Picoiquén@Run of the River	run off river (hydro)	2015	0,0	59.621,4	56.326,3
Pilmaiquen@Run of the River	run off river (hydro)	1944	250.749,4	220.593,9	163.510,6
Placilla@Diesel Oil	Diesel	2008	137,9	749,3	61,0
Providencia@Run of the River	run off river (hydro)	2013	26.481,3	36.128,1	24.772,9
PSF Lomas Coloradas@Solar	Solar	2014	2.011,6	4.335	4.360,4
PSF Pama@Solar	Solar	2014	2.040,0	4.384	4.278,1
Puclaro@Run of the River	run off river (hydro)	2008	1.589,7	3.335,2	19.339,2
Pulelfu@Run of the River	run off river (hydro)	2015	0,0	46.087,8	39.444,0
Pullinque@Run of the River	run off river (hydro)	1962	219.733,6	219.206,3	139.204,5
Punitaqui@Diesel Oil	Diesel	2007	35,8	0,0	0,0
Punta Colorada@Diesel Oil	Diesel	2010	634,3	600,5	78,5
Punta Colorada@Residual Fuel Oil	IFO 180	2010	22.612,9	20.122,4	900,0
Punta Colorada@Wind	wind	2011	21.471,5	22.932	20.917,8
Punta Palmeras@Wind	wind	2014	27.581,1	110.897,2	95.233,0
Puntilla@Run of the River	run off river (hydro)	1997	95.960,9	97.095,8	136.845,2

Power Unit	Fuel Type	Starting Date	Total Generation by power unit *m* or *k* in year *y*		
			2014	2015	2016
Purisima@Run of the River	run off river (hydro)	2012	2.441,2	3.309,4	2.683,1
PV Salvador@Solar	Solar	2015	8.634,6	162.921,2	159.309,9
Quellon 2@Diesel Oil	Diesel	2008	1.623,7	3.938	1.101,9
Queltehues@Run of the River	run off river (hydro)	1928	307.545,0	303.275	346.794,0
Quilapilún@Solar	Solar	2016	0,0	0,0	49.430,1
Quillaileo@Run of the River	run off river (hydro)	2014	241,5	958,9	1.923,9
Quilleco@Run of the River	run off river (hydro)	2007	315.679,0	325.449,0	224.440,0
Quintay@Diesel Oil	Diesel	2008	201,6	888,1	91,5
Quintero 1@LNG	LNG	2009	97.144,0	256.321,0	103.469,0
Quintero 2@LNG	LNG	2009	149.943,0	287.228	152.091,0
Raki@Wind	wind	2015	0,0	7.034,0	9.001,8
Ralco@Dam	Reservoir (hydro)	2004	2.620.976,0	2.489.856,0	1.029.575,0
Rapel@Dam	Reservoir (hydro)	1968	480.566,0	581.377,0	715.801,0
Reca@Run of the River	run off river (hydro)	2011	8.556,3	7.132,9	5.326,7
Renaico@Run of the River	run off river (hydro)	2013	47.130,2	52.136,8	48.106,9
Renaico@Wind	wind	2013	0,0	0,0	129.805,7
Rio Huasco@Run of the River	run off river (hydro)	2013	4.339,1	3.816,2	21.551,4
Rio Mulchen@Run of the River	run off river (hydro)	2015	0,0	0,0	2.883,5
Robleria@Run of the River	run off river (hydro)	2013	15.964,6	16.626,1	10.979,0
Rucatayo@Dam	Reservoir (hydro)	2012	270.001,9	245.134,6	164.870,2
Rucue@Run of the River	run off river (hydro)	1998	766.630,0	802.457,0	542.579,0
San Andres@Run of the River	run off river (hydro)	2014	104.627,6	113.414,7	129.481,0
San Andres@Solar	Solar	2014	98.989,7	94.624,5	65.950,6
San Clemente@Run of the River	run off river (hydro)	2010	16.036,6	16.307,2	16.543,5
San Francisco de Mostazal@Diesel Oil	Diesel	2002	91,2	156,8	0,0
San Gregorio@Diesel Oil	Diesel	2009	75,0	129	15,3
San Ignacio@Run of the River	run off river (hydro)	1962	174.499,0	171.326,0	90.394,0
San Isidro 1@Diesel Oil	Diesel	1998	20.545,0	1.127,0	342,0
San Isidro 1@LNG	LNG	1998	1.750.618,0	877.809,0	1.412.262,0
San Isidro 2@Diesel Oil	Diesel	2008	38.916,0	20.732,0	12.955,0
San Isidro 2@LNG	LNG	2008	2.357.715,2	1.671.958	2.713.061,0
San Juan@Wind	wind	2016	0,0	0,0	124.831,5
San Lorenzo 1@Diesel Oil	Diesel	2009	110,6	0,0	104,8
San Lorenzo 2@Diesel Oil	Diesel	2010	39,4	0	0,0
San Lorenzo 3@Diesel Oil	Diesel	2014	172,8	74,0	2,0
San Pedro II@Wind	wind	2016	0,0	0	2.097,6
San Pedro@Wind	wind	2014	78.289,9	105.532	84.472,7
Santa Cecilia@Solar	Solar	2013	4.054,9	5.919	5.752,3
Santa Fe@Biomass	biomass	2012	480.537,3	196.586	387.680,0
Santa Irene@Biomass	biomass	2013	3.130,2	2.718,0	2.688,1
Santa Julia@Solar	Solar	2016	0,0	0,0	3.567,1
Santa Lidia@Diesel Oil	Diesel	2009	296,1	18.548	17.312,1
Santa Maria@Bituminous Coal	Coal	2012	2.623.094,0	2.404.882	2.504.908,0

Power Unit	Fuel Type	Starting Date	Total Generation by power unit *m* or *k* in year *y*		
			2014	2015	2016
Santa Marta@Biomass	biomass	2014	99.502,3	93.592	73.335,9
Sauce Andes@Run of the River	run off river (hydro)	1909	4.717,3	4.627,0	4.133,5
Sauzal 50Hz@Run of the River	run off river (hydro)	1948	387.838,0	384.428,9	464.472,0
Sauzal 60Hz@Run of the River	run off river (hydro)	1948	0,0	2.322,5	5.485,8
Sauzalito@Run of the River	run off river (hydro)	1959	68.696,0	66.436,0	83.316,0
SDGx01@Solar	Solar	2013	1.316,1	2.082	867,4
Skretting Osorno@Diesel Oil	Diesel	2011	29,5	3,4	0,0
Skretting@Diesel Oil	Diesel	2008	2,0	2,5	0,2
Sol@Solar	Solar	2015	0,0	1.457,9	5.771,1
Southern@Diesel Oil	Diesel	2000	0,5	0,0	0,4
Tal Tal 1@Diesel Oil	Diesel	2000	7.371,0	7.278	2.451,0
Tal Tal 1@LNG	LNG	2000	76.902,0	106.219,0	53.470,0
Tal Tal 1@Natural Gas	Natural Gas	2000	0,0	0,0	279,0
Tal Tal 2@Diesel Oil	Diesel	2000	1.257,0	5.131	1.226,0
Tal Tal 2@LNG	LNG	2000	114.245,0	105.325,0	19.190,0
Talinay Poniente@Wind	wind	2015	0,0	170.893,5	172.026,2
Talinay@Wind	wind	2013	228.631,0	169.105,3	177.247,1
Taltal@Wind	wind	2015	29.561,0	267.305,3	286.341,4
Tambo Real@Solar	Solar	2012	3.782,7	4.112,6	1.464,1
Tamm@Biomass	biomass	2013	320,5	154,4	0,3
Tapihue@Natural Gas	Natural Gas	2009	1.590,9	2.007	6,9
Techos de Altamira@Solar	Solar	2014	21,8	145,5	138,5
Teno@Diesel Oil	Diesel	2009	11.991,6	25.380,6	13.566,0
Termopacifico@Diesel Oil	Diesel	2009	3.262,1	1.748	1.494,9
Til Til@Solar	Solar	2016	0,0	0,0	3.044,3
Tirua@Diesel Oil	Diesel	2011	52,3	146,6	44,6
Tomaval@Diesel Oil	Diesel	2011	0,0	3.869	894,7
Totoral@Diesel Oil	Diesel	2008	104,9	93,3	53,7
Totoral@Wind	wind	2010	89.384,6	80.611,9	66.042,5
Trailelfu@Run of the River	run off river (hydro)	2015	0,0	587,8	4.894,0
Tranquil@Run of the River	run off river (hydro)	2016	0,0	0,0	291,8
Trapen@Diesel Oil	Diesel	2009	25.472,9	112.124,2	125.136,3
Trebal Mapocho@Biomass	biomass	2012	41.221,4	40.471,9	47.204,8
Trueno@Run of the River	run off river (hydro)	2010	24.990,7	22.870,0	17.569,5
Truful Truful@Run of the River	run off river (hydro)	2009	5.747,0	5.887,2	5.896,4
Ucuquer 2@Wind	wind	2014	8.250,0	26.762	24.228,5
Ucuquer@Wind	wind	2013	19.452,2	18.170,1	17.308,5
Valdivia@Biomass	biomass	2004	324.489,9	270.458,5	271.837,9
Valdivia@Residual Fuel Oil	IFO 180	2004	1.130,8	6.101,5	6.458,3
Ventanas 1@Bituminous Coal	Coal	1905	748.705,0	619.715,0	681.908,0
Ventanas 2@Bituminous Coal	Coal	1977	1.178.109,0	1.032.537	1.338.707,0
Viñales@Biomass	biomass	2013	178.457,9	212.762,5	244.814,4
Volcan@Run of the River	run off river (hydro)	1944	89.879,0	80.816,0	104.784,0

Power Unit	Fuel Type	Starting Date	Total Generation by power unit *m* or *k* in year *y*		
			2014	2015	2016
Watts I@Diesel Oil	Diesel	2009	5,1	1,2	0,0
Watts II@Diesel Oil	Diesel	2009	10,9	1	0,0
Yungay 1@Diesel Oil	Diesel	2007	87,3	0	301,1
Yungay 2@Diesel Oil	Diesel	2007	57,1	0	321,0
Yungay 3@Diesel Oil	Diesel	2008	0,0	0	309,3
Yungay 4@Diesel Oil	Diesel	2010	53,0	0	231,4

Table 13: Power Plants Fuel type, Fuel Consumption by Year, Specific Fuel Consumption and Efficiency

Power Unit	Fuel Type	Fuel Consumption (kg or m^3 for natural gas)			Specific Fuel Consumption (2016) kg/MWh or m^3/MWh	Efficiency (%)
		2014	2015	2016		
Andes@Diesel Oil	Diesel	0	0	1.507.622	214,0	
Antilhue TG@Diesel Oil	Diesel	13.764.695	1.860.750	2.175.017	230,2	
Biocruz@Natural Gas	Natural Gas	0	447.506	566.636	337,0	
Biomar@Diesel Oil	Diesel		288	87	220,9	46,0%
Bocamina 1@Bituminous Coal	Coal	181.425.095	73.951.116	260.880.663	380,0	
Bocamina 2@Bituminous Coal	Coal	0	241.669.414	713.175.162	378,0	
Calle-Calle@Diesel Oil	Diesel	704.234	2.771.912	2.418.677	191,5	
Campiche@Petcoke	Coke	770.131.416	757.001.458	810.361	380,0	
Candelaria 1@Diesel Oil	Diesel	1.839.519	510.081	9.305.657	270,5	
Candelaria 1@LNG	LNG	665.072	842.133	2.348.012		
Candelaria 2@Diesel Oil	Diesel	1.612.248	488.301	9.355.004	270,5	
Candelaria 2@LNG	LNG	250.262	1.519.718	23.066.685		
Cañete@Diesel Oil	Diesel	45.503	95.335	2.455	220,9	
Cardones@Diesel Oil	Diesel	9.751	999.297	0	240,0	
Casablanca 1@Diesel Oil	Diesel	10.115	13.232	5.945	233,5	
Celco@Residual Fuel Oil	IFO 180	0	17.632	0		
Cem Bio Bio@Diesel Oil	Diesel	92.333	33.619	98.069	218,0	
Cem Bio Bio@Residual Fuel Oil	IFO 180	5.676.764	6.515.894	3.477.531		
Chiloe@Diesel Oil	Diesel	0	3.832	5.015	282,0	
Chufken@Diesel Oil	Diesel	38.053	223.263	75.966	220,9	
Chuyaca@Diesel Oil	Diesel	358.071	640.149	827.329	254,0	
CMPC Cordillera@Natural Gas	Natural Gas	0	2.819.964			37,5%
CMPC Tissue@Natural Gas	Natural Gas	0		3.329.049	303,7	37,5%
Colihues@Diesel Oil	Diesel	0	0	3.593.802	214,0	
Colihues@Residual Fuel Oil	IFO 180	6.868.214	8.902.711	4.437.626		
Collipulli@Diesel Oil	Diesel		0	0		
Colmito@Diesel Oil	Diesel	1.460.770	761.431	135.673	248,0	

Power Unit	Fuel Type	Fuel Consumption (kg or m^3 for natural gas)			Specific Fuel Consumption (2016) kg/MWh or m^3/MWh	Efficiency (%)
		2014	2015	2016		
Colmito@LNG	LNG	0	6.464.183	2.183.263		
Concon@Diesel Oil	Diesel	26.523	15.647	6.996	238,6	
Constitucion@Diesel Oil	Diesel	442.060	225.481	406.299	282,0	
Contulmo@Diesel Oil	Diesel		608	0	220,9	46,0%
Coronel@Diesel Oil	Diesel	5.161.209	7.289.136	3.665.513	228,0	
Coronel@Natural Gas	Natural Gas	0	5.689.360	1.793.320		
Curacautin@Diesel Oil	Diesel	155.127	313.406	74.818	220,9	
Curanilahue@Diesel Oil	Diesel	21.694	38.889	4.264		
Curauma@Diesel Oil	Diesel	21.140	17.250	13.738	233,5	
Danisco@Diesel Oil	Diesel		87	43	220,9	46,0%
Degan@Diesel Oil	Diesel	74.351	120.090	2.376.555	219,0	
Diego de Almagro@Diesel Oil	Diesel	111.210	344.397	94.018	337,0	
Eagon@Diesel Oil	Diesel	101.585	841	2.299	220,9	
El Peñon@Diesel Oil	Diesel	14.143.006	17.774.373	3.136.588	219,0	
El Salvador@Diesel Oil	Diesel	25.949	258.128	35.484	337,0	
Emelda 1@Diesel Oil	Diesel	27.824	50.961	84.712	292,0	
Emelda 2@Diesel Oil	Diesel	15.337	19.294	40.447	314,0	
Esperanza 1@Diesel Oil	Diesel	5.752	797	13.625	360,4	
Esperanza 2@Diesel Oil	Diesel	9.077	1.123	33.101	248,6	
Esperanza TG@Diesel Oil	Diesel	0	0	56.608	238,6	
Estancilla@Diesel Oil	Diesel		39.581	148.246	365,0	39,5%
Guacolda 1@Bituminous Coal	Coal	400.197.593	290.602.800	359.950.459	396,0	
Guacolda 2@Bituminous Coal	Coal	421.381.006	336.505.809	355.449.678	397,0	
Guacolda 3@Bituminous Coal	Coal	384.026.004	386.348.738	359.893.366	382,0	
Guacolda 4@Bituminous Coal	Coal	398.766.503	376.483.114	312.018.703	384,0	
Guacolda 5@Bituminous Coal	Coal	0	103.277.122	312.162.733	384,0	
Horcones@Diesel Oil	Diesel	2.985	133.742	401.166	351,1	
Huasco TG@Diesel Oil	Diesel	137.460	56.721	56.025	348,0	
Huasco TG@Residual Fuel Oil	IFO 180	33.773	70.140	1.086		
JCE@Diesel Oil	Diesel	5.970	63	0	220,9	
Las Vegas@Diesel Oil	Diesel	22.792	23.667	10.312	238,6	
Lebu@Diesel Oil	Diesel	35.343	162.766	2.747	220,9	
Linares Norte@Diesel Oil	Diesel	7.801	13.246	3.778	220,9	
Lonquimay@Diesel Oil	Diesel	43.794	11.543	7.277	220,9	
Los Alamos@Diesel Oil	Diesel	1.643	55.955	6.446	220,9	
Los Espinos@Diesel Oil	Diesel	9.958.815	7.925.968	927.673	221,0	
Los Guindos@Diesel Oil	Diesel	0	1.548.741	9.169.962	205,0	
Los Pinos@Diesel Oil	Diesel	24.683.878	34.346.697	16.117.002	190,7	
Los Sauces 1@Diesel Oil	Diesel	133.895	0	0	220,9	
Los Sauces 2@Diesel Oil	Diesel	61.270	0	0	220,9	

Power Unit	Fuel Type	Fuel Consumption (kg or m^3 for natural gas)			Specific Fuel Consumption (2016) kg/MWh or m^3/MWh	Efficiency (%)
		2014	2015	2016		
Los Vientos TG@Diesel Oil	Diesel	2.700.515	20.492.440	8.480.424	267,0	
Louisiana Pacific@Diesel Oil	Diesel	4.823	25.665	541	220,9	
Maule@Diesel Oil	Diesel	165.751	61.139	148.547		
Monte Patria@Diesel Oil	Diesel	141	0	0	231,0	
Multiexport 1@Diesel Oil	Diesel	465	243	44	263,0	
Multiexport 2@Diesel Oil	Diesel	0	66	143	263,0	
Nehuenco 1@Diesel Oil	Diesel	37.055.636	8.026.302	18.458.647	159,6	
Nehuenco 1@LNG	LNG	208.297.974	250.984.164	417.746.223		
Nehuenco 2@Diesel Oil	Diesel	16.955.860	204.498	3.218.263	158,8	
Nehuenco 2@LNG	LNG	342.678.707	375.693.992	227.900.506		
Nehuenco 9B@Diesel Oil	Diesel	1.311.151	83.832	1.471.458	274,7	
Nehuenco 9B@LNG	LNG	624.971	532.675	1.082.054		
Newen@Butane gas	Butane Gas		0	0		39,5%
Newen@Diesel Oil	Diesel	0	0	16.457		
Newen@Natural Gas	Natural Gas	6.759	1.272.833	151.506		
Newen@Propane gas	Propane		472.166	1.705		39,5%
Nueva Aldea 2@Diesel Oil	Diesel	0	14.635	8.940		
Nueva Renca@Diesel Oil	Diesel	124.040.664	13.656.572	15.800.311	171,0	
Nueva Renca@LNG	LNG	83.929.000	335.251.845	394.758.222	202,0	
Nueva Renca@LPG	LPG	4.425.909	3.451.859	4.148.076	197,0	
Nueva Renca@Natural Gas	Natural Gas	0	11.028.683	0		
Nueva Ventanas@Bituminous Coal	Coal	759.445.444	784.254.944	753.302.378	380,0	
Olivos@Diesel Oil	Diesel	1.476.869	902.060	246.800	231,0	
Petropower@Petcoke	Coke	200.179.274	190.840.718	187.840.848		
Placilla@Diesel Oil	Diesel	34.489	174.974	13.910	233,5	
Punitaqui@Diesel Oil	Diesel	10.085	0	0	231,0	
Punta Colorada@Diesel Oil	Diesel	121.151	114.671	14.991	219,0	
Punta Colorada@Residual Fuel Oil	IFO 180	4.952.225	4.406.806	197.056		
Quellon 2@Diesel Oil	Diesel	386.441	937.839	262.247	254,0	
Quintay@Diesel Oil	Diesel	47.349	207.380	20.863	233,5	
Quintero 1@LNG	LNG	30.623.536	80.802.267	32.617.420		
Quintero 2@LNG	LNG	47.267.818	90.545.346	47.944.950		
San Francisco de Mostazal@Diesel Oil	Diesel	28.181	48.449	0		
San Gregorio@Diesel Oil	Diesel	17.075	28.388	3.289	220,9	
San Isidro 1@Diesel Oil	Diesel	3.796.716	202.022	61.306	185,0	
San Isidro 1@LNG	LNG	344.714.190	172.849.370	278.088.510	203,0	
San Isidro 2@Diesel Oil	Diesel	6.623.091	3.450.418	2.138.660	183,0	
San Isidro 2@LNG	LNG	419.888.607	297.762.344	483.174.460	195,0	

Power Unit	Fuel Type	Fuel Consumption (kg or m^3 for natural gas)			Specific Fuel Consumption (2016) kg/MWh or m^3/MWh	Efficiency (%)
		2014	2015	2016		
San Lorenzo 1@Diesel Oil	Diesel	96.151	0	35.841	342,0	
San Lorenzo 2@Diesel Oil	Diesel	14.988	0	0	380,0	
San Lorenzo 3@Diesel Oil	Diesel	43.338	18.559	579	289,0	46,0%
Santa Lidia@Diesel Oil	Diesel	78.173	4.896.217	4.569.929	264,0	46,0%
Santa Maria@Bituminous Coal	Coal	853.433.076	782.437.016	814.980.836	352,0	
Skretting Osorno@Diesel Oil	Diesel	6.621	738	0	220,9	
Skretting@Diesel Oil	Diesel	442	553	48	220,9	
Southern@Diesel Oil	Diesel	239	0	91		
Tal Tal 1@Diesel Oil	Diesel	1.872.234	1.844.915	621.309	254,0	
Tal Tal 1@LNG	LNG	23.254.703	32.119.988	16.169.007	303,0	
Tal Tal 1@Natural Gas	Natural Gas	0	0	84.368		
Tal Tal 2@Diesel Oil	Diesel	319.278	1.300.667	310.781	254,0	
Tal Tal 2@LNG	LNG	34.547.003	31.849.648	5.802.941		
Tapihue@Natural Gas	Natural Gas	505.666	595.836	2.031	337,0	
Teno@Diesel Oil	Diesel	2.629.758	5.565.855	2.974.960	219,0	
Termopacifico@Diesel Oil	Diesel	733.973	393.170	336.334	265,8	
Tirua@Diesel Oil	Diesel	12.959	41.817	11.915	220,9	
Tomaval@Diesel Oil	Diesel	0	400.344	234.411	233,5	
Totoral@Diesel Oil	Diesel	24.422	21.776	12.542	233,5	
Trapen@Diesel Oil	Diesel	5.586.207	24.595.257	27.441.831	219,0	
Valdivia@Residual Fuel Oil	IFO 180	504.530	1.952.480	2.066.656		
Ventanas 1@Bituminous Coal	Coal	293.623.383	243.036.730	269.091.661	415,0	
Ventanas 2@Bituminous Coal	Coal	443.388.391	388.601.495	503.830.412	397,0	
Watts I@Diesel Oil	Diesel	1.150	265	0	220,9	
Watts II@Diesel Oil	Diesel	2.412	288	0	220,9	
Yungay 1@Diesel Oil	Diesel	24.455	0	84.308	280,0	
Yungay 2@Diesel Oil	Diesel	14.379	0	80.884	252,0	
Yungay 3@Diesel Oil	Diesel	0	0	84.756	274,0	
Yungay 4@Diesel Oil	Diesel	15.635	0	68.723	297,0	

Table 14: Build Margin Calculation Data

Power Unit serving the grid	Start Year	Fuel type	Total Generation by power unit	Power plant emission factor	Power Plant CO_2 emissions	% of the Total	% Acumulated
-	*y*	-	$EG_{m,2016}$	$EF_{EL,m,2016}$	$EG_{m,2015}$ * $EF_{EL,m,2016}$	-	-
-	-	-	MWh	tCO_2/MWh	tCO_2	%	%
Andes@Diesel Oil	2016	Diesel	6.237	0,000	0	0,0%	0,0%
Carilafquen@Run of the River	2016	run off river (hydro)	67.742	0,000	0	0,1%	0,2%

Power Unit serving the grid	Start Year	Fuel type	Total Generation by power unit	Power plant emission factor	Power Plant CO_2 emissions	% of the Total	% Acumulated
-	y	-	$EG_{m,2016}$	$EF_{EL,m,2016}$	$EG_{m,2015} * EF_{EL,m,2016}$	-	-
-	-	-	MWh	tCO_2/MWh	tCO_2	%	%
Chuchiñi@Solar	2016	Solar	2.684	0,000	0	0,0%	0,2%
Conejo@Solar	2016	Solar	110.314	0,000	0	0,2%	0,4%
Cordillerilla@Solar	2016	Solar	323	0,000	0	0,0%	0,4%
Cumpeo@Run of the River	2016	run off river (hydro)	9.315	0,000	0	0,0%	0,4%
El Agrio@Run of the River	2016	run off river (hydro)	5.008	0,000	0	0,0%	0,4%
El Divisadero@Solar	2016	Solar	3.560	0,000	0	0,0%	0,4%
El Galpon@Run of the River	2016	run off river (hydro)	4.030	0,000	0	0,0%	0,4%
El Romero@Solar	2016	Solar	39.065	0,000	0	0,1%	0,5%
Hormiga Solar@Solar	2016	Solar	9	0,000	0	0,0%	0,5%
La Chapeana@Solar	2016	Solar	3.832	0,000	0	0,0%	0,5%
La Esperanza@Wind	2016	wind	16.220	0,000	0	0,0%	0,5%
La Silla@Solar	2016	Solar	2.701	0,000	0	0,0%	0,6%
Las Araucarias@Solar	2016	Solar	93	0,000	0	0,0%	0,6%
Las Mollacas@Solar	2016	Solar	3.356	0,000	0	0,0%	0,6%
Los Bueno Aires@Wind	2016	wind	41.992	0,000	0	0,1%	0,6%
Los Loros@Solar	2016	Solar	23.550	0,000	0	0,0%	0,7%
Malalcahuello@Run of the River	2016	run off river (hydro)	18.151	0,000	0	0,0%	0,7%
Molinera Villarica@Run of the River	2016	run off river (hydro)	91	0,000	0	0,0%	0,7%
Pampa Solar Norte@Solar	2016	Solar	129.377	0,000	0	0,3%	1,0%
Quilapilún@Solar	2016	Solar	49.430	0,000	0	0,1%	1,1%
San Juan@Wind	2016	wind	124.831	0,000	0	0,3%	1,4%
San Pedro II@Wind	2016	wind	2.098	0,000	0	0,0%	1,4%
Santa Julia@Solar	2016	Solar	3.567	0,000	0	0,0%	1,4%
Til Til@Solar	2016	Solar	3.044	0,000	0	0,0%	1,4%
Tranquil@Run of the River	2016	run off river (hydro)	292	0,000	0	0,0%	1,4%
Bureo@Run of the River	2015	run off river (hydro)	6.108	0,000	0	0,0%	1,4%
Carrera Pinto@Solar	2015	Solar	120.125	0,000	0	0,2%	1,6%
Chañares@Solar	2015	Solar	67.791	0,000	0	0,1%	1,8%
CMPC Cordillera@Natural Gas	2015	Natural Gas	115.646	0,401	46.416	0,2%	2,0%
CMPC Laja@Biomass	2015	biomass	105.765	0,000	0	0,2%	2,2%
CMPC Tissue@Natural Gas	2015	Natural Gas	10.961	0,521	5.714	0,0%	2,2%
El Mirador@Run of the River	2015	run off river (hydro)	229	0,000	0	0,0%	2,2%
El Paso@Run of the River	2015	run off river (hydro)	134.417	0,000	0	0,3%	2,5%
El Pilar-Los Amarillos@Solar	2015	Solar	2.346	0,000	0	0,0%	2,5%
Guacolda 5@Bituminous Coal	2015	Coal	897.041	0,872	782.361	1,8%	4,3%
Itata@Run of the River	2015	run off river (hydro)	25.719	0,000	0	0,1%	4,4%
Javiera@Solar	2015	Solar	145.572	0,000	0	0,3%	4,7%
Lagunilla@Solar	2015	Solar	4.181	0,000	0	0,0%	4,7%
Lalackama 2@Solar	2015	Solar	39.269	0,000	0	0,1%	4,8%

Power Unit serving the grid	Start Year	Fuel type	Total Generation by power unit	Power plant emission factor	Power Plant CO_2 emissions	% of the Total	% Acumulated
-	y	-	$EG_{m,2016}$	$EF_{EL,m,2016}$	$EG_{m,2015}$ * $EF_{EL,m,2016}$	-	-
-	-	-	MWh	tCO_2/MWh	tCO_2	%	%
Lalackama@Solar	2015	Solar	128.525	0,000	0	0,3%	5,0%
Las Flores@Run of the River	2015	run off river (hydro)	10.073	0,000	0	0,0%	5,1%
Lautaro Comasa 2@Biomass	2015	biomass	126.760	0,000	0	0,3%	5,3%
Lleuquereo@Run of the River	2015	run off river (hydro)	5.754	0,000	0	0,0%	5,3%
Loma Los Colorados@Solar	2015	Solar	1.391	0,000	0	0,0%	5,3%
Los Guindos@Diesel Oil	2015	Diesel	37.584	0,697	26.186	0,1%	5,4%
Los Hierros 2@Run of the River	2015	run off river (hydro)	20.249	0,000	0	0,0%	5,5%
Luna@Solar	2015	Solar	5.716	0,000	0	0,0%	5,5%
Luz del Norte@Solar	2015	Solar	273.090	0,000	0	0,6%	6,0%
Munilque 1@Run of the River	2015	run off river (hydro)	1.856	0,000	0	0,0%	6,0%
Munilque 2@Run of the River	2015	run off river (hydro)	1.948	0,000	0	0,0%	6,0%
Pulelfu@Run of the River	2015	run off river (hydro)	39.444	0,000	0	0,1%	6,1%
PV Salvador@Solar	2015	Solar	159.310	0,000	0	0,3%	6,4%
Raki@Wind	2015	wind	9.002	0,000	0	0,0%	6,5%
Rio Mulchen@Run of the River	2015	run off river (hydro)	2.884	0,000	0	0,0%	6,5%
Sol@Solar	2015	Solar	5.771	0,000	0	0,0%	6,5%
Talinay Poniente@Wind	2015	wind	172.026	0,000	0	0,4%	6,8%
Taltal@Wind	2015	wind	286.341	0,000	0	0,6%	7,4%
Trailelfu@Run of the River	2015	run off river (hydro)	4.894	0,000	0	0,0%	7,4%
Angostura@Dam	2014	Reservoir (hydro)	657.430	0,000	0	1,3%	8,8%
CMPC Pacifico@Biomass	2014	biomass	199.428	0,000	0	0,4%	9,2%
Coelemu@Biomass	2014	biomass	33.221	0,000	0	0,1%	9,2%
Collil@Run of the River	2014	run off river (hydro)	0	0,000	0	0,0%	9,2%
Energia Bio Bio@Biomass	2014	biomass	0	0,000	0	0,0%	9,2%
Energia Pacifico@Biomass	2014	biomass	82.742	0,000	0	0,2%	9,4%
Las Terrazas@Solar	2014	Solar	3.367	0,000	0	0,0%	9,4%
Llano de Llampos@Solar	2014	Solar	235.748	0,000	0	0,5%	9,9%
Los Cururos@Wind	2014	wind	206.680	0,000	0	0,4%	10,3%
Los Padres@Run of the River	2014	run off river (hydro)	3.968	0,000	0	0,0%	10,3%
Maria Elena@Run of the River	2014	run off river (hydro)	171	0,000	0	0,0%	10,3%
Pichilonco@Run of the River	2014	run off river (hydro)	3.086	0,000	0	0,0%	10,3%
PSF Lomas Coloradas@Solar	2014	Solar	4.360	0,000	0	0,0%	10,3%
PSF Pama@Solar	2014	Solar	4.278	0,000	0	0,0%	10,3%
Quillaileo@Run of the River	2014	run off river (hydro)	1.924	0,000	0	0,0%	10,4%
San Andres@Solar	2014	Solar	65.951	0,000	0	0,1%	10,5%
San Lorenzo 3@Diesel Oil	2014	Diesel	2	0,789	2	0,0%	10,5%
Santa Marta@Biomass	2014	biomass	73.336	0,000	0	0,1%	10,6%
Techos de Altamira@Solar	2014	Solar	138	0,000	0	0,0%	10,6%
Ucuquer 2@Wind	2014	wind	24.229	0,000	0	0,0%	10,7%

Power Unit serving the grid	Start Year	Fuel type	Total Generation by power unit	Power plant emission factor	Power Plant CO_2 emissions	% of the Total	% Acumulated
-	y	-	$EG_{m,2016}$	$EF_{EL,m,2016}$	$EG_{m,2015}$ * $EF_{EL,m,2016}$	-	-
-	-	-	MWh	tCO_2/MWh	tCO_2	%	%
Alto Renaico@Run of the River	2013	run off river (hydro)	6.572	0,000	0	0,0%	10,7%
Ancali@Biomass	2013	biomass	0	0,000	0	0,0%	10,7%
Campiche@Petcoke	2013	Coke	2.268.649	0,824	1.870.411	4,6%	15,3%
Don Walterio@Run of the River	2013	run off river (hydro)	3.558	0,000	0	0,0%	15,3%
El Llano@Run of the River	2013	run off river (hydro)	5.833	0,000	0	0,0%	15,3%
Esperanza@Solar	2013	Solar	2.027	0,000	0	0,0%	15,4%
Estancilla@Diesel Oil	2013	Diesel	650	0,718	467	0,0%	15,4%
Las Pampas@Biomass	2013	biomass	2.163	0,000	0	0,0%	15,4%
Las Vertientes@Run of the River	2013	run off river (hydro)	7.677	0,000	0	0,0%	15,4%
Los Alamos@Diesel Oil	2013	Diesel	27	0,760	20	0,0%	15,4%
Los Corrales 2@Run of the River	2013	run off river (hydro)	3.356	0,000	0	0,0%	15,4%
Maisan@Run of the River	2013	run off river (hydro)	1.182	0,000	0	0,0%	15,4%
Renaico@Run of the River	2013	run off river (hydro)	48.107	0,000	0	0,1%	15,5%
Renaico@Wind	2013	wind	129.806	0,000	0	0,3%	15,7%
Rio Huasco@Run of the River	2013	run off river (hydro)	21.551	0,000	0	0,0%	15,8%
Santa Cecilia@Solar	2013	Solar	5.752	0,000	0	0,0%	15,8%
Santa Irene@Biomass	2013	biomass	2.688	0,000	0	0,0%	15,8%
SDGx01@Solar	2013	Solar	867	0,000	0	0,0%	15,8%
Tamm@Biomass	2013	biomass	0	0,000	0	0,0%	15,8%
Ucuquer@Wind	2013	wind	17.308	0,000	0	0,0%	15,8%
Viñales@Biomass	2013	biomass	244.814	0,000	0	0,5%	16,3%
Rucatayo@Dam	13/12/2012	Reservoir (hydro)	164.870	0,000	0	0,3%	16,7%
Contulmo@Diesel Oil	05/12/2012	Diesel	0	0,683	0	0,0%	16,7%
Bocamina 2@Bituminous Coal	28/10/2012	Coal	2.211.533	0,804	1.777.146	4,5%	21,2%
Santa Fe@Biomass	05/09/2012	biomass	387.680	0,000	0	0,8%	22,0%
Biocruz@Natural Gas	19/08/2012	Natural Gas	2.146	0,268	574	0,0%	22,0%
Santa Maria@Bituminous Coal	15/08/2012	Coal	2.504.908	0,811	2.030.833	5,1%	27,1%
El Canelo@Run of the River	05/07/2012	run off river (hydro)	15.932	0,000	0	0,0%	27,1%
Tambo Real@Solar	12/06/2012	Solar	1.464	0,000	0	0,0%	27,1%
Lautaro@Biomass	26/03/2012	biomass	7	0,000	0	0,0%	27,1%
Purisima@Run of the River	31/01/2012	run off river (hydro)	2.683	0,000	0	0,0%	27,1%
Trebal Mapocho@Biomass	12/01/2012	biomass	47.205	0,000	0	0,1%	27,2%
Curanilahue@Diesel Oil	08/01/2012	Diesel	19	0,718	13	0,0%	27,2%
Calle-Calle@Diesel Oil	2011	Diesel	10.933	0,698	7.632	0,0%	27,3%
Danisco@Diesel Oil	2011	Diesel	0	0,455	0	0,0%	27,3%
Diuto@Run of the River	2011	run off river (hydro)	24.478	0,000	0	0,0%	27,3%
Donguil@Run of the River	2011	run off river (hydro)	1.246	0,000	0	0,0%	27,3%
JCE@Diesel Oil	2011	Diesel	0	0,051	0	0,0%	27,3%

Power Unit serving the grid	Start Year	Fuel type	Total Generation by power unit	Power plant emission factor	Power Plant CO_2 emissions	% of the Total	% Acumulated
-	y	-	$EG_{m,2016}$	$EF_{EL,m,2016}$	$EG_{m,2015}$ * $EF_{EL,m,2016}$	-	-
-	-	-	MWh	tCO_2/MWh	tCO_2	%	%
Loma Los Colorados 2@Biomass	2011	biomass	127.615	0,000	0	0,3%	27,6%
Lonquimay@Diesel Oil	2011	Diesel	27	0,766	21	0,0%	27,6%
Los Sauces 2@Diesel Oil	2011	Diesel	0	0,000	0	0,0%	27,6%
Mallarauco@Run of the River	2011	run off river (hydro)	25.661	0,000	0	0,1%	27,6%
Mariposas@Run of the River	2011	run off river (hydro)	19.563	0,000	0	0,0%	27,7%
Muchi@Run of the River	2011	run off river (hydro)	1.000	0,000	0	0,0%	27,7%
Punta Colorada@Wind	2011	wind	20.918	0,000	0	0,0%	27,7%
Reca@Run of the River	2011	run off river (hydro)	5.327	0,000	0	0,0%	27,7%
Skretting Osorno@Diesel Oil	2011	Diesel	0	0,683	0	0,0%	27,7%
Tirua@Diesel Oil	2011	Diesel	45	0,898	40	0,0%	27,7%
Tomaval@Diesel Oil	2011	Diesel	895	0,326	291	0,0%	27,7%
Cem Bio Bio@Diesel Oil	2010	Diesel	511	0,604	309	0,0%	27,7%
Cem Bio Bio@Residual Fuel Oil	2010	IFO 180	15.953	0,687	10.965	0,0%	27,7%
Colihues@Diesel Oil	2010	Diesel	16.793	0,000	0	0,0%	27,8%
Colihues@Residual Fuel Oil	2010	IFO 180	20.744	0,675	13.993	0,0%	27,8%
El Salvador@Diesel Oil	2010	Diesel	105	1,224	129	0,0%	27,8%
Emelda 1@Diesel Oil	2010	Diesel	290	0,919	267	0,0%	27,8%
Emelda 2@Diesel Oil	2010	Diesel	129	0,988	127	0,0%	27,8%
Guacolda 4@Bituminous Coal	2010	Coal	890.203	0,798	710.404	1,8%	29,6%
Juncalito@Run of the River	2010	run off river (hydro)	2.493	0,000	0	0,0%	29,6%
Los Corrales 1@Run of the River	2010	run off river (hydro)	4.761	0,000	0	0,0%	29,7%
Nueva Ventanas@Bituminous Coal	2010	Coal	2.165.583	0,867	1.877.138	4,4%	34,1%
Punta Colorada@Diesel Oil	2010	Diesel	79	0,601	47	0,0%	34,1%
Punta Colorada@Residual Fuel Oil	2010	IFO 180	900	0,691	621	0,0%	34,1%
San Lorenzo 2@Diesel Oil	2010	Diesel	0	0,000	0	0,0%	34,1%
Yungay 4@Diesel Oil	2010	Diesel	231	0,000	0	0,0%	34,1%
Biomar@Diesel Oil	2009	Diesel	0	0,078	0	0,0%	34,1%
Cardones@Diesel Oil	2009	Diesel	0	0,752	0	0,0%	34,1%
Eagon@Diesel Oil	2009	Diesel	10	0,696	7	0,0%	34,1%
El Peñon@Diesel Oil	2009	Diesel	14.299	0,696	9.946	0,0%	34,1%
Guacolda 3@Bituminous Coal	2009	Coal	1.052.711	0,787	828.153	2,1%	36,3%
Linares Norte@Diesel Oil	2009	Diesel	18	0,695	12	0,0%	36,3%
Los Espinos@Diesel Oil	2009	Diesel	4.193	0,697	2.924	0,0%	36,3%
Los Pinos@Diesel Oil	2009	Diesel	86.673	0,600	51.966	0,2%	36,4%
Louisiana Pacific@Diesel Oil	2009	Diesel	2	1,053	3	0,0%	36,4%
Multiexport 1@Diesel Oil	2009	Diesel	0	0,766	0	0,0%	36,4%
Multiexport 2@Diesel Oil	2009	Diesel	1	0,099	0	0,0%	36,4%
Newen@Butane gas	2009	Butane Gas	0	0,000	0	0,0%	36,4%

Power Unit serving the grid	Start Year	Fuel type	Total Generation by power unit	Power plant emission factor	Power Plant CO_2 emissions	% of the Total	% Acumulated
-	y	-	$EG_{m,2016}$	$EF_{EL,m,2016}$	$EG_{m,2015}$ * $EF_{EL,m,2016}$	-	-
-	-	-	MWh	tCO_2/MWh	tCO_2	%	%
Newen@Diesel Oil	2009	Diesel	58	0,000	0	0,0%	36,4%
Newen@Natural Gas	2009	Natural Gas	464	0,550	255	0,0%	36,4%
Newen@Propane gas	2009	Propane	7	0,714	5	0,0%	36,4%
Pehui@Run of the River	2009	run off river (hydro)	1.538	0,000	0	0,0%	36,4%
Quintero 1@LNG	2009	LNG	103.469	0,603	62.340	0,2%	36,7%
Quintero 2@LNG	2009	LNG	152.091	0,603	91.635	0,3%	37,0%
San Gregorio@Diesel Oil	2009	Diesel	15	0,695	11	0,0%	37,0%
San Lorenzo 1@Diesel Oil	2009	Diesel	105	0,000	0	0,0%	37,0%
Santa Lidia@Diesel Oil	2009	Diesel	17.312	0,831	14.384	0,0%	37,0%
Tapihue@Natural Gas	2009	Natural Gas	7	0,567	4	0,0%	37,0%
Teno@Diesel Oil	2009	Diesel	13.566	0,690	9.364	0,0%	37,0%
Termopacifico@Diesel Oil	2009	Diesel	1.495	0,708	1.059	0,0%	37,0%
Trapen@Diesel Oil	2009	Diesel	125.136	0,690	86.398	0,3%	37,3%
Truful Truful@Run of the River	2009	run off river (hydro)	5.896	0,000	0	0,0%	37,3%
Watts I@Diesel Oil	2009	Diesel	0	0,696	0	0,0%	37,3%
Watts II@Diesel Oil	2009	Diesel	0	0,696	0	0,0%	37,3%
Chiloe@Diesel Oil	2008	Diesel	18	0,887	16	0,0%	37,3%
Chuyaca@Diesel Oil	2008	Diesel	3.729	0,750	2.796	0,0%	37,3%
Colmito@Diesel Oil	2008	Diesel	455	0,201	92	0,0%	37,3%
Colmito@LNG	2008	LNG	7.948	0,842	6.695	0,0%	37,3%
Coya@Run of the River	2008	run off river (hydro)	84.755	0,000	0	0,2%	37,5%
Olivos@Diesel Oil	2008	Diesel	1.068	0,709	757	0,0%	37,5%
Placilla@Diesel Oil	2008	Diesel	61	0,735	45	0,0%	37,5%
Quellon 2@Diesel Oil	2008	Diesel	1.102	0,750	826	0,0%	37,5%
Quintay@Diesel Oil	2008	Diesel	92	0,735	67	0,0%	37,5%
San Isidro 2@Diesel Oil	2008	Diesel	12.955	0,524	6.786	0,0%	37,5%
San Isidro 2@LNG	2008	LNG	2.713.061	0,340	923.468	5,5%	43,1%
Skretting@Diesel Oil	2008	Diesel	0	0,696	0	0,0%	43,1%
Totoral@Diesel Oil	2008	Diesel	54	0,735	39	0,0%	43,1%
Yungay 3@Diesel Oil	2008	Diesel	309	0,000	0	0,0%	43,1%
Cañete@Diesel Oil	2007	Diesel	10	0,741	8	0,0%	43,1%
Casablanca 1@Diesel Oil	2007	Diesel	23	0,822	19	0,0%	43,1%
Chiburgo@Run of the River	2007	run off river (hydro)	63.074	0,000	0	0,1%	43,2%
Chufken@Diesel Oil	2007	Diesel	314	0,754	237	0,0%	43,2%
Collipulli@Diesel Oil	2007	Diesel	0	0,000	0	0,0%	43,2%
Concon@Diesel Oil	2007	Diesel	30	0,751	23	0,0%	43,2%
Constitucion@Diesel Oil	2007	Diesel	1.442	0,887	1.279	0,0%	43,2%
Curacautin@Diesel Oil	2007	Diesel	339	0,689	234	0,0%	43,2%
Curauma@Diesel Oil	2007	Diesel	54	0,822	44	0,0%	43,2%

Power Unit serving the grid	Start Year	Fuel type	Total Generation by power unit	Power plant emission factor	Power Plant CO_2 emissions	% of the Total	% Acumulated
-	y	-	$EG_{m,2016}$	$EF_{EL,m,2016}$	$EG_{m,2015}$ * $EF_{EL,m,2016}$	-	-
-	-	-	MWh	tCO_2/MWh	tCO_2	%	%
Degan@Diesel Oil	2007	Diesel	10.865	0,689	7.480	0,0%	43,2%
El Rincon@Run of the River	2007	run off river (hydro)	1.963	0,000	0	0,0%	43,2%
Esperanza 1@Diesel Oil	2007	Diesel	56	0,784	44	0,0%	43,2%
Esperanza 2@Diesel Oil	2007	Diesel	142	0,752	107	0,0%	43,2%
Esperanza TG@Diesel Oil	2007	Diesel	161	0,000	0	0,0%	43,2%
Eyzaguirre@Run of the River	2007	run off river (hydro)	6.278	0,000	0	0,0%	43,2%
Las Vegas@Diesel Oil	2007	Diesel	60	0,756	45	0,0%	43,2%
Lebu@Diesel Oil	2007	Diesel	11	0,598	7	0,0%	43,2%
Los Sauces 1@Diesel Oil	2007	Diesel	0	0,000	0	0,0%	43,2%
Los Vientos TG@Diesel Oil	2007	Diesel	31.763	0,840	26.692	0,1%	43,3%
Maule@Diesel Oil	2007	Diesel	527	0,887	468	0,0%	43,3%
Monte Patria@Diesel Oil	2007	Diesel	0	0,000	0	0,0%	43,3%
Palmucho@Run of the River	2007	run off river (hydro)	218.821	0,000	0	0,4%	43,7%
Punitaqui@Diesel Oil	2007	Diesel	0	0,000	0	0,0%	43,7%
Yungay 1@Diesel Oil	2007	Diesel	301	0,000	0	0,0%	43,7%
Yungay 2@Diesel Oil	2007	Diesel	321	0,000	0	0,0%	43,7%
Nueva Aldea 2@Diesel Oil	2006	Diesel	32	0,912	29	0,0%	43,7%
Antilhue TG@Diesel Oil	2005	Diesel	9.693	0,724	7.013	0,0%	43,8%
Candelaria 1@Diesel Oil	2005	Diesel	35.452	0,846	30.004	0,1%	43,8%
Candelaria 1@LNG	2005	LNG	74.923	0,598	44.796	0,2%	44,0%
Candelaria 2@Diesel Oil	2005	Diesel	35.640	0,846	30.163	0,1%	44,1%
Candelaria 2@LNG	2005	LNG	73.736	0,598	44.086	0,2%	44,2%
Coronel@Diesel Oil	2005	Diesel	16.519	0,701	11.583	0,0%	44,3%
Coronel@Natural Gas	2005	Natural Gas	6.555	0,519	3.402	0,0%	44,3%
Horcones@Diesel Oil	2004	Diesel	1.170	1,105	1.293	0,0%	44,3%
Licanten@Biomass	2004	biomass	31.642	0,000	0	0,1%	44,3%
Nehuenco 2@LNG	2004	LNG	1.283.397	0,339	435.575	2,6%	46,9%
Ralco@Dam	2004	Reservoir (hydro)	1.029.575	0,000	0	2,1%	49,0%
Valdivia@Residual Fuel Oil	2004	IFO 180	6.458	1,009	6.516	0,0%	49,1%
Nehuenco 2@Diesel Oil	2003	Diesel	21.151	0,491	10.377	0,0%	49,1%
Nehuenco 9B@Diesel Oil	2002	Diesel	5.559	0,857	4.762	0,0%	49,1%
Nehuenco 9B@LNG	2002	LNG	3.461	0,608	2.104	0,0%	49,1%
San Francisco de Mostazal@Diesel Oil	2002	Diesel	0	0,973	0	0,0%	49,1%
Mampil@Run of the River	2000	run off river (hydro)	90.532	0,000	0	0,2%	49,3%
Peuchen@Run of the River	2000	run off river (hydro)	118.341	0,000	0	0,2%	49,6%
Southern@Diesel Oil	2000	Diesel	0	0,000	0	0,0%	49,6%
Tal Tal 1@Diesel Oil	2000	Diesel	2.451	0,798	1.956	0,0%	49,6%
Tal Tal 1@LNG	2000	LNG	53.470	0,578	30.903	0,1%	49,7%
Tal Tal 1@Natural Gas	2000	Natural Gas	279	0,000	0	0,0%	49,7%

Power Unit serving the grid	Start Year	Fuel type	Total Generation by power unit	Power plant emission factor	Power Plant CO_2 emissions	% of the Total	% Acumulated
-	*y*	-	$EG_{m,2016}$	$EF_{EL,m,2016}$	$EG_{m,2015}$ * $EF_{EL,m,2016}$	-	-
-	-	-	MWh	tCO_2/MWh	tCO_2	%	%
Tal Tal 2@Diesel Oil	2000	Diesel	1.226	0,798	978	0,0%	49,7%
Tal Tal 2@LNG	2000	LNG	19.190	0,578	11.091	0,0%	49,7%
Nehuenco 1@Diesel Oil	1998	Diesel	121.026	0,501	60.663	0,2%	50,0%
Nehuenco 1@LNG	1998	LNG	2.158.323	0,370	798.418	4,4%	54,4%
Petropower@Petcoke	1998	Coke	497.111	0,872	433.559	1,0%	55,4%
Rucue@Run of the River	1998	run off river (hydro)	542.579	0,000	0	1,1%	56,5%
San Isidro 1@Diesel Oil	1998	Diesel	342	0,564	193	0,0%	56,5%
San Isidro 1@LNG	1998	LNG	1.412.262	0,376	531.497	2,9%	59,4%
Loma Alta@Run of the River	1997	run off river (hydro)	201.522	0,000	0	0,4%	59,8%
Nueva Renca@Diesel Oil	1997	Diesel	94.672	0,547	51.745	0,2%	60,0%
Nueva Renca@LNG	1997	LNG	2.001.076	0,367	735.394	4,1%	64,0%
Nueva Renca@LPG	1997	LPG	21.574	0,690	14.891	0,0%	64,1%
Nueva Renca@Natural Gas	1997	Natural Gas	0	6,741	0	0,0%	64,1%
Puntilla@Run of the River	1997	run off river (hydro)	136.845	0,000	0	0,3%	64,4%
Arauco@Biomass	1996	biomass	94.531	0,000	0	0,2%	64,6%
Celco@Biomass	1996	biomass	39.053	0,000	0	0,1%	64,6%
Guacolda 2@Bituminous Coal	1996	Coal	960.651	0,843	810.071	2,0%	66,6%
Pangue@Dam	1996	Reservoir (hydro)	832.179	0,000	0	1,7%	68,3%
Capullo@Run of the River	1995	run off river (hydro)	46.236	0,000	0	0,1%	68,4%
Celco@Residual Fuel Oil	1995	IFO 180	0	1,009	0	0,0%	68,4%
Guacolda 1@Bituminous Coal	1995	Coal	973.896	0,843	821.240	2,0%	70,4%
Laja@Biomass	1995	biomass	29.932	0,000	0	0,1%	70,4%
Aconcagua Ujuncal@Run of the River	1994	run off river (hydro)	117.375	0,000	0	0,2%	70,7%
Aconcagua Ublanco@Run of the River	1993	run off river (hydro)	228.195	0,000	0	0,5%	71,1%
Curillinque@Run of the River	1993	run off river (hydro)	484.558	0,000	0	1,0%	72,1%
Alfalfal@Run of the River	1991	run off river (hydro)	869.819	0,000	0	1,8%	73,9%
CMPC Santa Fe@Biomass	1991	biomass	28.559	0,000	0	0,1%	74,0%
Pehuenche@Dam	1991	Reservoir (hydro)	1.678.791	0,000	0	3,4%	77,4%
Canutillar@Dam	1990	Reservoir (hydro)	590.163	0,000	0	1,2%	78,6%
Colbun@Dam	1985	Reservoir (hydro)	1.263.591	0,000	0	2,6%	81,2%
Machicura@Dam	1985	Reservoir (hydro)	279.012	0,000	0	0,6%	81,7%
Antuco@Dam	1981	Reservoir (hydro)	1.079.426	0,000	0	2,2%	83,9%
Diego de Almagro@Diesel Oil	1981	Diesel	279	1,061	296	0,0%	83,9%
Diego de Almagro@Solar	1981	Solar	50.801	0,000	0	0,1%	84,0%
Huasco TG@Residual Fuel Oil	1979	IFO 180	3	1,170	4	0,0%	84,0%
Huasco TG@Diesel Oil	1977	Diesel	161	1,095	176	0,0%	84,0%
Ventanas 2@Bituminous Coal	1977	Coal	1.338.707	0,938	1.255.484	2,7%	86,8%
El Toro@Dam	1973	Reservoir (hydro)	1.118.623	0,000	0	2,3%	89,1%

Power Unit serving the grid	Start Year	Fuel type	Total Generation by power unit	Power plant emission factor	Power Plant CO_2 emissions	% of the Total	% Acumulated
-	y	-	$EG_{m,2016}$	$EF_{EL,m,2016}$	$EG_{m,2015}$ * $EF_{EL,m,2016}$	-	-
-	-	-	MWh	tCO_2/MWh	tCO_2	%	%
Bocamina 1@Bituminous Coal	1970	Coal	730.349	0,890	650.083	1,5%	90,5%
Rapel@Dam	1968	Reservoir (hydro)	715.801	0,000	0	1,5%	92,0%
Isla@Run of the River	1963	run off river (hydro)	407.910	0,000	0	0,8%	92,8%
Auxiliar del Maipo@Run of the River	1962	run off river (hydro)	34.936	0,000	0	0,1%	92,9%
Pullinque@Run of the River	1962	run off river (hydro)	139.205	0,000	0	0,3%	93,2%
San Ignacio@Run of the River	1962	run off river (hydro)	90.394	0,000	0	0,2%	93,4%
Sauzalito@Run of the River	1959	run off river (hydro)	83.316	0,000	0	0,2%	93,6%
Cipreses@Dam	1955	Reservoir (hydro)	435.824	0,000	0	0,9%	94,4%
Los Molles@Run of the River	1952	run off river (hydro)	77.023	0,000	0	0,2%	94,6%
Abanico@Run of the River	1948	run off river (hydro)	255.197	0,000	0	0,5%	95,1%
Sauzal 50Hz@Run of the River	1948	run off river (hydro)	464.472	0,000	0	0,9%	96,1%
Sauzal 60Hz@Run of the River	1948	run off river (hydro)	5.486	0,000	0	0,0%	96,1%
Los Bajos@Run of the River	1944	run off river (hydro)	44.776	0,000	0	0,1%	96,2%
Pilmaiquen@Run of the River	1944	run off river (hydro)	163.511	0,000	0	0,3%	96,5%
Volcan@Run of the River	1944	run off river (hydro)	104.784	0,000	0	0,2%	96,7%
Carena@Run of the River	1943	run off river (hydro)	68.027	0,000	0	0,1%	96,9%
Los Quilos@Run of the River	1943	run off river (hydro)	260.150	0,000	0	0,5%	97,4%
Los Morros@Run of the River	1930	run off river (hydro)	20.562	0,000	0	0,0%	97,4%
Queltehues@Run of the River	1928	run off river (hydro)	346.794	0,000	0	0,7%	98,1%
Maitenes@Run of the River	1923	run off river (hydro)	104.032	0,000	0	0,2%	98,3%
Florida@Run of the River	1909	run off river (hydro)	124.905	0,000	0	0,3%	98,6%
Sauce Andes@Run of the River	1909	run off river (hydro)	4.133	0,000	0	0,0%	98,6%
Ventanas 1@Bituminous Coal	1905	Coal	681.908	0,977	666.396	1,4%	100,0%

Table 15: Fossil Fuel Data

Fuel type i	CO_2 Emission Factor $EF_{CO2,i,y}$; $EF_{CO2,m,i,y}$; $EF_{CO2,k,i,y}$ [tCO_2/GJ]	Gross calorific Value $GCV_{i,y}$ [Kcal/Kg; Kcal/m^3 (gas)]	GCV to NCV conversion factor according to IPCC guidelines	Net Calorific Value $NCV_{i,y}$ [GJ/kg; GJ/m^3 (gas)]
Coal	0.0895	7,000	0.95	0.027842
Diesel	0.0726	10,900	0.95	0.043354
Natural Gas	0.0543	9,341	0.90	0.035198
IFO 180	0.0755	10,500	0.95	0.041763
Residual Fuel Oil	0.0755	10,500	0.95	0.041763
LPG	0.0616	12,100	0.90	0.045594

(ii) Leakage

According to the "Methodological tool Leakage in biomass small-scale project activities v.04.0", project participants should evaluate ex ante if there is a surplus of biomass in the region of the project activity which is not utilized otherwise they should consider the competing uses for the biomass as a potentially significant source of leakage. It is demonstrated, using statistics published by the Chilean Forestry Institute, that there is an abundant quantity of available forestry biomass (quantified as logs harvested and then consumed for different uses) in the region of the project.

Since the site of the project is located in *Los Lagos* administrative region near the limit with *Los Ríos* administrative Region of Chile, both areas are considered as the relevant geographical area to be considered in this analysis, from now on "the region of the project". It must be considered that the project site is located in Los Lagos region but also, the farthest limit of Los Ríos Region is approximately 140 km away from the project site, therefore biomass can be sourced from Los Ríos Region as well. As a background, before the year 2007, when Los Ríos administrative Region was created, Los Lagos and Los Ríos regions used to be one only administrative region, therefore it is valid to consider both regions as a single one from which biomass can be sourced.

The region of the project has a total biomass availability of 5,847,145 m^3 of logs/year, but it is considered than a 73% of the logs are consumed for other uses (different uses than wood chips which is the biomass fuel used in the project) like production of pulp, wood panels, etc. (as shown in Table 16). The remaining 27% of the logs can be consumed by the project as wood chip. In the following table, the different amounts of logs used in the region of the Project (Los Lagos and Los Ríos areas) are shown:

Table 16: Log consumption in the region of the project:[23]

Log (forestry biomass) consumption in the region	Los Lagos m^3 of log/year	Los Ríos m^3 of log/year	Region of the Project m^3 of log/year
Pulp Industry	-	2,163,177	2,163,177
Sawmills	294,929	1,162,867	1,457,796
Boardmills (wood panels)	32,000	340,345	372,345
Log for exporting	131	144	275
Wood chips	815,709	676,568	1,492,277
TOTAL	**1,142,769**	**4,344,376**	**5,487,145**

The project considers a biomass consumption of 61,968 m^3/year of wood chips which is equivalent to a logs consumption of 64,874 m^3/year (in order to produce wood chips it is considered a factor of 1.0469 of m^3 of log consumed per m^3 of wood chip produced[24]).

Using this information, the surplus of biomass can be calculated as following:

Table 17: Surplus of biomass in the region.

Biomass	m^3 of log/year
Total biomass in the region	5,487,145
Wood chips production	1,492,277
Biomass used (pulp industry, sawmills, boardmills,	3,994,868

[23] INFOR Statistics 2015: Consumption of logs according the industry location, by region: http://wef.infor.cl/estadisticas_regionales/estadisticasregionales.php

[24] This relation was estimated from volumes of Logs Consumption and Production of woodchips. Values extracted from: Forestry Statistics of Los Lagos Region, INFOR, Chile 2008. Page 77, Frame 3.23, "Wood-chip Industry".

Biomass	m^3 of log/year
exporting)	
Wood chips consumed by the project activity	64,874

$$Biomass\,surplus = \frac{5{,}487{,}145}{3{,}994{,}868 + 64{,}874} - 1 = 35\%$$

Finally, the available volume of biomass is 35% larger than the quantity of biomass that is utilized in the region of the project, including the project activity; therefore competing uses of biomass can be neglected as a source of leakage.

Appendix 5. Further background information on monitoring plan

All the information related to the monitoring plan is presented in the PDD.

Appendix 6. Summary report of comments received from local stakeholders

Local stakeholders' consultation report

A consultation meeting with the community was held during the Ordinary Session Nº 28/2010 of the city council, at the Sessions Room of Osorno municipality on July 27th 2010.

The meeting was attended by:

- City mayor, Mr. Jaime Bertín
- Secretary, Mrs. María Isabel Gallardo
- Counsellor, Mr. Orlando Mella
- Counsellor, Mr. Emeterio Carrillo
- Counsellor, Mr. José Luis Muñoz
- Counsellor, Ms. Cecilia Ubilla
- Counsellor, Mr. Alexis Casanova
- Counsellor, Mr. Carlos Vargas
- Counsellor, Mr. Alejandro Baeza
- Nestlé Manager, Mr. Lorenzo Chavalos
- Nestlé adviser, Mr. Luis Costa
- Nestlé adviser, Ms. María Luz Farah
- Community representatives

The meeting agenda considered the following topics:

- Opening
- Technical characteristics of the project
- Climate change, CDM project and emission reductions
- Questions session

During the event, there were only questions mainly related to topics like: amount of biomass, local employment and road works, which were immediately answered at the meeting event or answered by email by the project developer. The summary of the questions raised during the meeting is presented below.

1. Amount of biomass consumed by the project activity: The project developer said that the amount of biomass would be sent by email. An email with this information was sent on 02/08/2010.
2. Local employment: For the construction of the plant the project developer said that they considered local labour as main option. For the operation phase, the project developer explained that the project activity considers the transfer qualified personnel form other facilities of Nestlé Chile S.A. for the direct operation of the plant and the use of local labour for indirect activities such as internal transport and storage of the biomass, maintenance, services, safety issues and administrative staff.
3. Road works: The project developer explained that the works were mainly related to the access road, according to the requirements of the Department of Municipal Works and the Ministry of Public Works (MOP).
4. In addition, several counsellors appreciated the project and expressed their gratitude for the implantation of the project, considering the environmental responsibilities and the development of the milk industry in the area, as an improvement for the local economy.

The questions and answers raised during the meeting are listed below.

1st Question (Done by Counsellor Sr. Casanova): Has the amount of biomass to be used at the plant been quantified already? Likewise, have they quantified the total amount of kilocalories that will be consumed as a result of the methane gas emissions? Can you disclose any figures?

Answer (Answered by Mr. Costa)**:** Yes, all such have been quantified. All the documentation will be sent to you. The decision to use biomass as fuel input was not a casual one. Indeed it was linked to an overall availability survey focused on the biomass stock to be had within the project's area of influence. Such survey validated and ensured the existence of the biomass in sufficient quantities to justify this project. A second argument endorsing this project is that the Clean Development Mechanism projects do meet a rigorous and exacting calculation methodology; clearly aimed at assisting with accurate estimates of the emission reduction prospects. The latter estimates are also based on a baseline analysis which encompasses all the calculations that you are asking me about.The email was sent on 2nd August 2010.

2nd Question (Done by Counsellor Mrs. Ubilla): My questions are referred to the potential new job opportunities for the people in Osorno as a result of this project's implementation. And, I understand that about 80% of the plant's output will be exported so it is likely that the end-consumers abroad will get to know about the powder milk as processed in Osorno. Are there any possibilities of mentioning Osorno in the text of the statement of origin and thus boosting its international exposure?

Answer (Anserwed by Mr. Chavalos): The work we can do as Nestlé and the investment we are about to implement here must be regarded as a joint effort aimed at supplementing the initiatives adopted by the milk and dairy producers. Had it no been for the high milk quality available here in Osorno, I could not be adamantly stating now that Chile was been considered as a venue for investment options. Certainly this speaks well for the work carried out in the region by the various organisations concerned. As I have already stated, doubtless the key factor is a high-quality standard of fresh milk.

The work opportunities and associated demand to be generated by the new plant (supplemented by the internal plant work needs), will bring to bear a significant influence on activities such as transportation and storage. The same effect on labour opportunities should show up in the normal operations at the plant and referred to security, garden and green areas' maintenance plus a whole host of indirect services. All the foregoing entails a significant number of job opportunities that are customarily generated as a result of the plant's specific operations. What we are stressing now to the companies that will be undertaking the

construction work for such new plant is the compelling requirement of hiring labour with the necessary qualifications from the adjacent areas.

<u>Question 3rd</u> (Done by Counsellor Mr. Carrillo): My question is concerned with the availability of any specific survey focused on the likely impact on the road and transportation structure in the Pichil area, now that there will be two manufacturing establishments, namely you and Mafrisur. Is there any survey of this kind? And what about the road impact?

<u>Answer</u> (Anserwed by Mr. Chavalos): We have worked in close consultation with CONAMA, with the Chilean Ministry of Public Works and other authorities. In other words, everything had been done along the guidelines specified in the existing regulations.
The road works whose implementation we had to arrange was merely confined to the plant's own access points to the main road. Although the lorry flows going along the main road was already allowed, we went a step ahead and produced a more ambitious project aimed at generating the dual carriage motorway onto Puerto Octay. In doing so, and bearing in mind the tourist potential prevalence in the area, we took the appropriate safeguards ensuring that the normal and tourist traffic would continue unaffected. In short, our industrial output would be moved in and out of our plants albeit in full harmony with the nearby environment. All the road works that required both traffic flow detours and main avenue expansions were undertaken as per the guidelines specified by the Municipality's Works Directorate and the Ministry of Public Works alike.

Stakeholders meeting pictures

The following pictures show the attendance to the meeting.

Figure 10: Stakeholder meeting pictures

Appendix 7. Summary of post-registration changes