CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

CONTENTS

SECTION A. General description of project activity

A.1. Title of the project activity:

- Title of the project activity: Viñales biomass power plant.
- Version number of the document: Version Nº 04.
- Date of the document: January 13th, 2011.

A.2. Description of the project activity:

The proposed project activity consists in the installation of a new biomass cogeneration power plant in the Viñales sawmill site. The new cogeneration plant is equipped with a new 210 ton/hr fluidized bed biomass power boiler and a 41 MW condensing/extracting turbo generator unit.

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

The project is presented by Celulosa Arauco y Constitución S.A. (from now on, Arauco), a leading forestry and pulp-producing company in Chile.

Before the implementation of the project activity, the Viñales sawmill relied on an external company, who supplied heat for wood drying, and on the grid for electric power. The proposed project activity is designed –then- to integrate the new cogeneration power plant to the Viñales sawmill, in order to cogenerate heat and power for this facility and to export the surplus power to the grid.

When the Arauco management evaluated the Viñales biomass power plant project, it considered the surplus of biomass available in the region and decided to install a big-scale new cogeneration unit that would allow cogenerating heat and power instead of installing a traditional low pressure boiler in the Viñales site. This solution implied going beyond the common practice of the Sawmill industry in Chile, which does not contemplate the use of the cogeneration technology in this type of facility. Given that this more sophisticated solution implied higher investment and operation costs than the conventional solution, the decision of installing electric power generating capacity in the Viñales sawmill relied on the possibility of not depending on the local grid for electric power consumption anymore, the possibility of selling surplus power to the grid and on the benefits from being a CDM project activity.

The proposed project activity assists Chile's sustainable growth by providing electricity to the Viñales sawmill and to the local grid through renewable biomass power generation. Without the Viñales project activity, not only there would be no new clean energy injection to the local grid, but the Viñales sawmill would continue sourcing its electric power requirements from the grid. In addition, this project accomplishes an additional greenhouse (GHG) reduction benefit derived from a reduced disposal or uncontrolled burning of biomass residues, which results in lower methane emissions to the atmosphere.

The Viñales biomass power plant project activity participants believe that biomass power generation constitute a sustainable source of power generation that brings clear advantages to mitigate global warming. Using the available natural resources in a rational way, the Viñales project activity helps to enhance the development of renewable energy sources in Chile, in particular the use of biomass generated as a by-product of the forestry industry, which has a significant potential in the country. The proposed project is a good example to demonstrate the viability of electricity generation as a source of revenue not only to the Sawmill industry, but also, to all forest-related industries. It is worthy to highlight that very few sawmills in Chile have on-site electric power generation capacity, making the Viñales biomass power plant project activity quite unique and particular in its type.

A.3. Project participants:

Name of Party involved(*) ((host) indicates a host Party)	Private and / or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes / No)
Chile	Celulosa Arauco y Constitución S.A..	No
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		
Note: *When the PDD is filled in support of a proposed new methodology (forms CDM-NBM and CDM-NMM)*, at least the host Party(ies) and any known project participant (e.g. those proposing a new methodology) shall be identified.		

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Chile, South America.

A.4.1.2. Region/State/Province etc.:

VII Region of Maule, commune of Constitución.

A.4.1.3. City/Town/Community etc.:

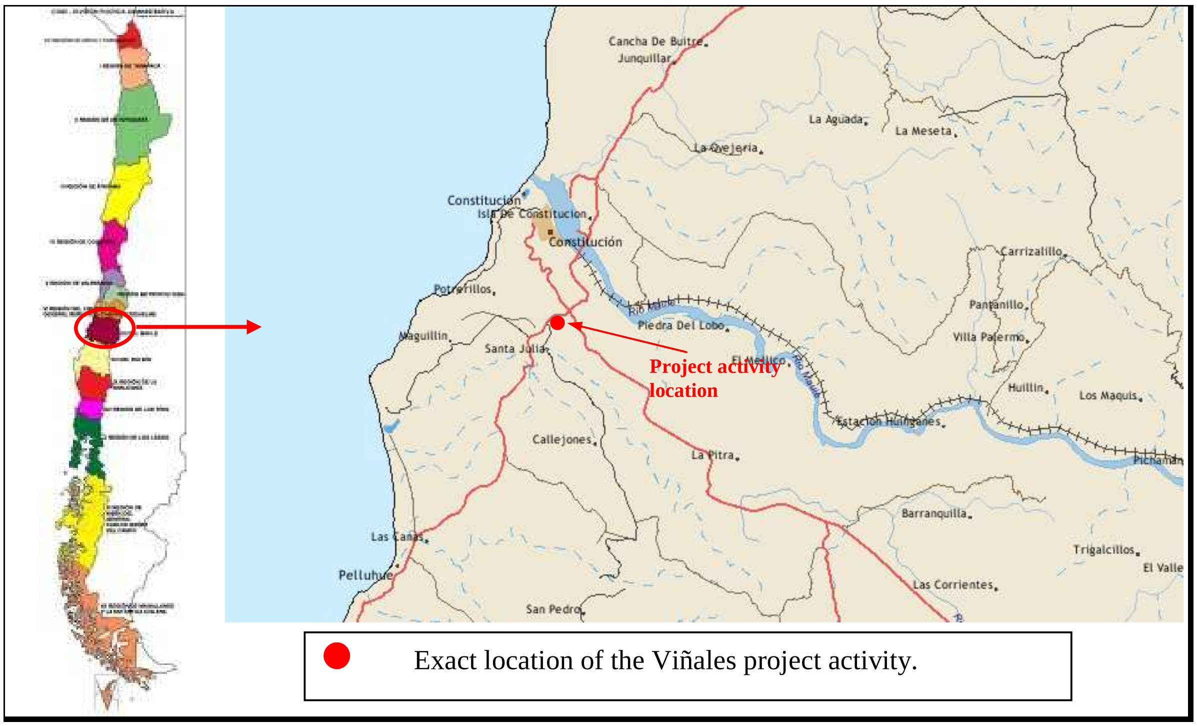
The nearest city is Constitución, which is located 3 km away from the Viñales sawmill.

A.4.1.4. Details of physical location, including information allowing the unique identification of this project activity (maximum one page):

The project activity is located in Km. 5 of the M-50 road to Chanco, commune of Constitución in the Maule Region. The nearest city is Constitución, located 3 Km away from the new power plant.

The project activity coordinates in decimals are provided in the table below:

Latitude	Longitude
-35.371°	-72.412°



A.4.2. Category(ies) of project activity:

The Viñales biomass power plant is a renewable energy supply side grid-connected project activity. It involves reduction of emission of greenhouse gases in the energy sector; more specifically, reduction of greenhouse gas emission sources from fuel combustion in energy industries, according to the list of sector/source categories indicated in Annex A of the Kyoto Protocol.

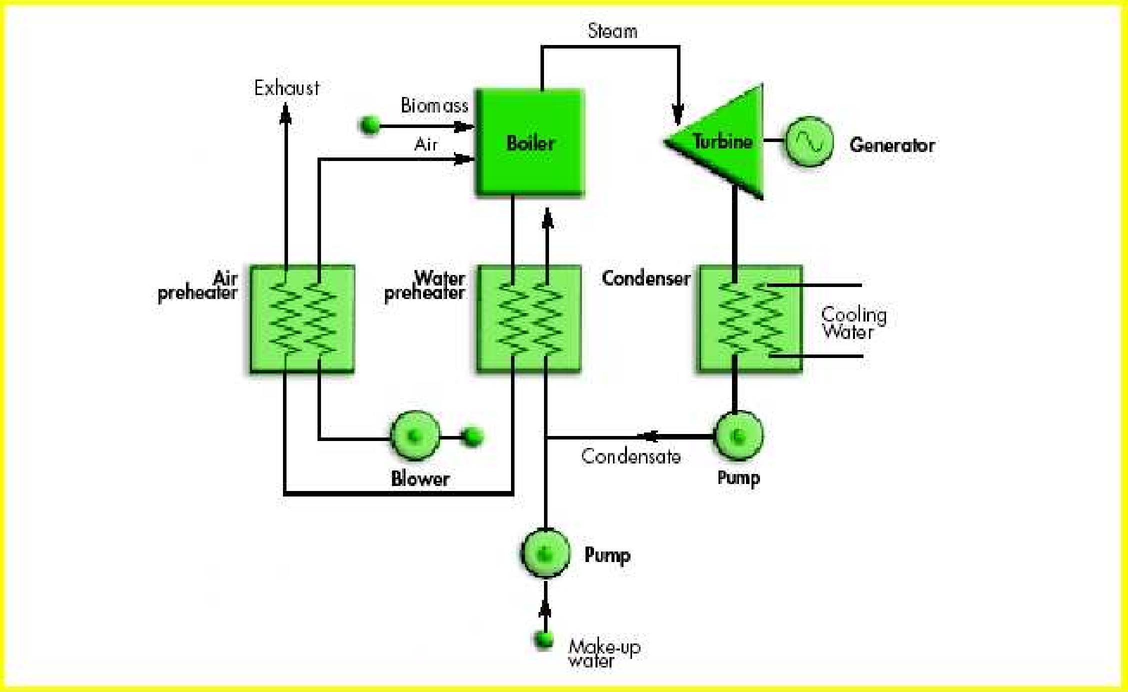
A.4.3. Technology to be employed by the project activity:

The predominant technology in all parts of the world today for generating megawatt (MW) levels of electricity from biomass is the steam-Rankine cycle, which consists of direct combustion of biomass in a boiler to generate steam, which is then expanded through a turbine. The steam-Rankine technology is a mature technology, having been introduced into commercial use about 100 years ago. Most steam cycle

plants are located at industrial sites, where the waste heat from the steam turbine is recovered and used for meeting industrial-process heat needs. Such combined heat and power (CHP), or cogeneration systems provide greater levels of energy services per unit of biomass consumed than systems that generate electric power only.

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

Steam turbines are designed as either "backpressure" or "condensing" turbines. CHP applications typically employ backpressure turbines, wherein steam expands to a pressure that is still substantially above ambient pressure. It leaves the turbine still as a vapor and is sent to satisfy industrial heating needs, where it condenses back to water. It is then partially or fully returned to the boiler. Alternatively, if process steam demands can be met using only a portion of the available steam, a condensing extraction steam turbine (CEST) might be used. This design includes the capability for some steam to be extracted at one or more points along the expansion path for meeting process needs (figure 3). Steam that is not extracted continues to expand to sub-atmospheric pressures, thereby increasing the amount of electricity generated per unit of steam compared to the backpressure turbine. The non-extracted steam is converted back to liquid water in a condenser that utilizes ambient air and/or a cold water source as the coolant.



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

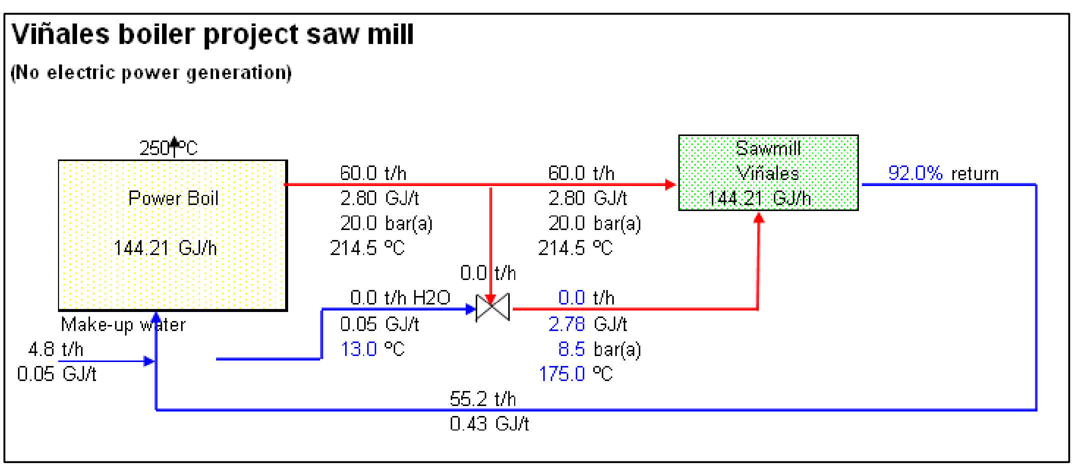
Schematic diagram of a biomass-fired steam-Rankine cycle for cogeneration using a condensing-extracting steam turbine.

Though the baseline or reference project alternative will be explained in detail in subsequent sections of this PDD, the most likely project alternative that would have been implemented instead of the proposed project activity would have been the installation of a new low-pressure biomass boiler that would have generated heat (no cogeneration) for the Viñales sawmill. The following table and energy/mass balances provide a general description of how the baseline project would have differed from the proposed project activity:

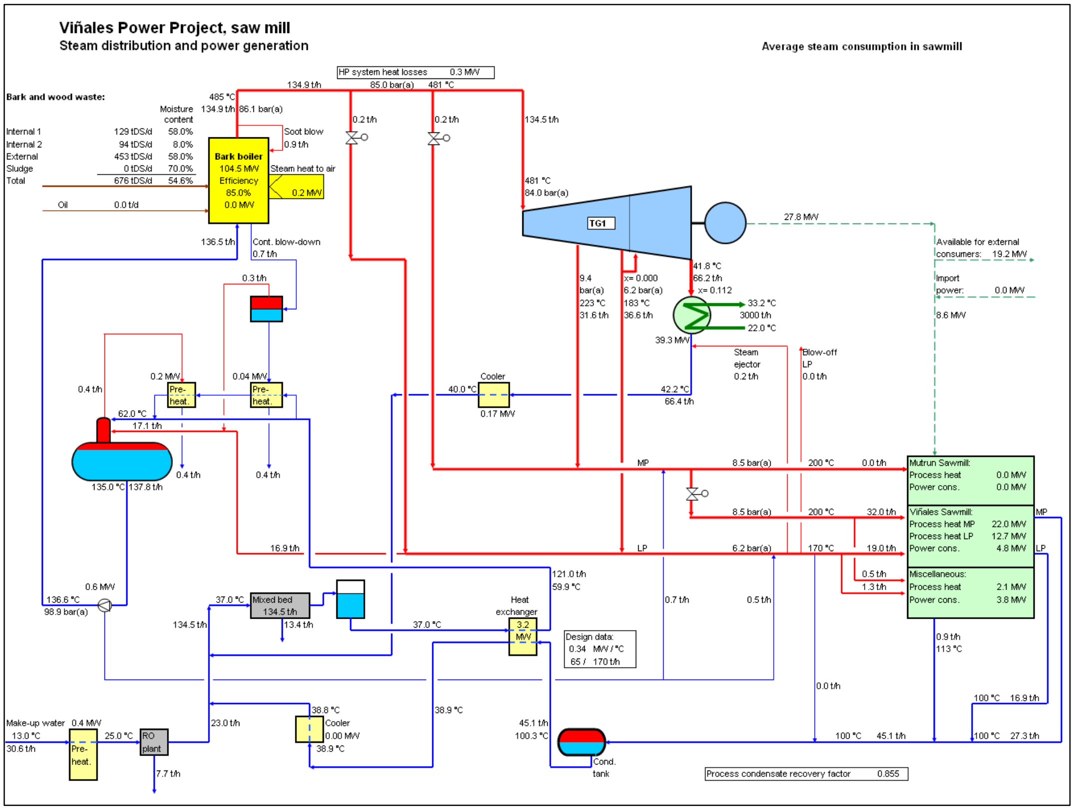
Department	Changes
Biomass Boiler	• Instead of the 210 ton/hr, 85 bar superheated steam biomass power boiler, there would have been a 60 (ton/hr), 20 bar, saturated steam biomass boiler.
Steam Distribution System	• Under a conventional scenario, the steam pressure of the new boiler unit would have been substantially lower, so the steam distribution system would have been simpler and less expensive compared to the one under the project scenario.
Process equipment	• There would have been fewer and less expensive equipment. For example, the biomass fuel processing/management equipment would have been designed for a smaller capacity.
Turbogenerator	• There would have been no extracting/condensing turbogenerator.
Electrical Equipment	• Without the new power generation capacity, there would have been no new electrical equipment needed; there would have been no generator and the corresponding power distribution equipment would have not been required.

The following diagrams show the power generation situation under a BAU (Business-As-Usual) situation, without investment in additional power generation capacity; and under the project situation, with additional investment in additional power generation capacity.

<u>The Viñales project without power cogeneration</u>



The Viñales project with power generation capacity (cogeneration)



A.4.4. Estimated amount of emission reductions over the chosen crediting period:

Chosen crediting period:	Three 7-year crediting periods (21 years)
Years	**Annual estimation of emission reductions in tonnes of CO_2 e**
2011	25,056
2012	150,335
2013	150,335
2014	150,335
2015	150,335
2016	150,335
2017	150,335
2018	150,335
2019	150,335
2020	150,335
2021	150,335
2022	150,335
2023	150,335
2024	150,335
2025	150,335
2026	150,335
2027	150,335
2028	150,335
2029	150,335
2030	150,335
2031	150,335
2032	125,279
Total estimated reductions (tonnes of CO_2 e)	**3,157,034**
Total number of crediting years	**21**
Annual average over the crediting period of estimated reductions (tonnes of CO_2 e)	**150,335**

Note: For the year 2011, only November and December are considered. For the year 2032, the months considered are from January to October inclusive.

A.4.5. Public funding of the project activity:

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

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

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

ACM0006 (Version 09), "Consolidated methodology electricity generation from biomass residues".

The project activity also relies on the following methodologies and tools:

- ACM0002 (Version 10), "Consolidated methodology for grid-connected electricity generation from renewable sources".
- "Combined tool to identify the baseline scenario and demonstrate additionality (Version 02.2)".
- "Tool to calculate the emission factor for an electricity system (Version 02)".
- "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion (Version 02)".

B.2. Justification of the choice of the methodology and why it is applicable to the project activity:

The Viñales biomass power plant project is a biomass cogeneration power plant that generates electricity and heat from renewable energy sources.

Paragraph 48 of the Marrakesh Accords stipulates that:

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

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

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

According to the baseline methodology ACM0006 (Version 09), the Viñales project activity fully complies with the applicability criteria:

The proposed project activity consists in the installation of a new biomass residue fired power plant, in a site where no power was generated. The proposed project activity is a **greenfield power generation project.**

The proposed project activity fully complies with all the applicability criteria of the ACM0006 (Version 09):

- **No other biomass types than biomass residues, as defined in the ACM0006 (Version 09), are used in the project plant and they constitute the predominant fuel used in the project plant.** The proposed project activity uses biomass residues generated in the forest industry (from nearby sawmills and from forestry operations). Some fossil fuels may be co-fired due to operational reasons (e.g. start-up operations) and to a limited extent, to enhance the economic performance of the plant.

- **The implementation of the project shall not increase the biomass production in the facility:** The implementation of the proposed project activity cannot affect or alter in any way the production capacity of the Viñales sawmill, since the capacity of the facility is fixed cannot change due to the implementation of the project activity. The sawmill production is determined by the sawn timber market conditions and not by the existence of the new power plant. In addition, the new power plant will use biomass residues which are already available from third parties. Therefore, it is not required for the Viñales sawmill to increase the local generation of biomass residues in order to generate additional power in the new power plant. The new power plant can achieve full capacity operation by relying on third party biomass fuel sources.

- **The biomass stored at the project facility should not be stored for more than one year:** The biomass used in the project activity power boiler (mix of sawdust and bark and biomass from forestry operations) is stored in a dedicated place near the new Viñales power plant. The residence time of the stored biomass (total biomass residues stored/biomass residues consumption rate of the power plant) is less than two weeks. The biomass stockpile is conveniently managed in order to avoid that part(s) of the pile stay stored for too long and suffer the consequent degradation of its potential as fuel.

- **No significant energy quantities, except from transportation or mechanical treatment of the biomass residues are required to prepare the biomass residues for fuel combustion.** The Viñales biomass power plant only contemplates biomass transportation to the power plant and some mechanical processing of biomass from forestry operations.

B.3. Description of the sources and gases included in the project boundary:

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

	Storage of biomass residues	CO_2	Excluded	It is assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Excluded	Excluded for simplification. Since biomass residues are stored for not longer than one year, the emission source is assumed to be small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Waste water from treatment of biomass residues	CO_2	Excluded	It is assumed that CO2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF
		CH_4	Excluded	This emission source shall be included in cases where the waste water is treated (partly) under anaerobic conditions. Since the proposed project activity does not originate wastewater from biomass treatment, this emission source is excluded in this case.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be small.

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

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

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

According to the ACM0006 (Version 09), project participants shall identify the most plausible baseline scenario and demonstrate additionality using the latest approved version of the "Combined tool to identify the baseline scenario and demonstrate additionality".

Baseline and additionality determination according to the Combined Tool

Step 1: List of plausible alternative scenarios to the project activity.

Considering that the ACM0006 (Version 09) includes several project scenarios that reasonably cover all possibilities for power generation, heat generation and biomass use that can be considered in this case, the baseline analysis will be carried out for all the project scenarios outlined in the methodology for power generation (PX), heat generation (HX) and biomass use (BX) (Step 1a).

Project scenarios for power generation

Scenario	Scenario description	Feasibility in the context of the proposed project activity
P1:	The proposed project activity not undertaken as a CDM project activity.	Yes.
P2:	The continuation of power generation in an existing biomass residue fired power plant at the project site, in the same configuration, without retrofitting and fired with the same type of biomass residues as (co-) fired in the project activity.	No. Currently power is obtained from the grid.
P3:	The generation of power in an existing captive power plant, using only fossil fuels.	No. There is no existing captive power plant running on fossil fuels in the Viñales sawmill site to date.
P4:	The generation of power in the grid.	Yes. This corresponds to the current situation.
P5:	The installation of a **new** biomass residue fired power plant, fired with the same type and with the same annual amount of biomass residues as the project activity, but with a lower efficiency of electricity generation (e.g. an efficiency that is common practice in the relevant industry sector) than the project plant and therefore with a lower power output than in the project case.	Yes.
P6:	The installation of a **new** biomass residue fired power plant that is fired with the same type but with a higher annual amount of biomass residues as the project activity and that has a lower efficiency of electricity generation (e.g. an efficiency that is common practice in the relevant industry sector) than the project activity. Therefore, the power output is the same as in the project case.	Yes.
P7:	The **retrofitting** of an existing biomass residue fired power plant, fired with the same type and with the same annual amount of biomass residues as the project activity, but with a lower efficiency of electricity generation (e.g. an efficiency that is common practice in the relevant industry sector) than the project plant and therefore with a lower power output than in the project case.	No. Currently power is obtained from the grid.
P8:	The **retrofitting** of an existing biomass residue fired power plant that is fired with the same type but with a higher annual amount of biomass residues as the project activity and that has a lower efficiency of electricity generation (e.g. an efficiency that is common practice in the relevant industry sector) than the project activity.	No. Currently power is obtained from the grid.
P9:	The installation of a **new** fossil fuel fired captive power plant at the project site.	Yes.
P10:	The installation of a new single- (using only biomass residues) or co-fired (using a mix of biomass residues and fossil fuels) cogeneration plant with the same rated power capacity as the project activity power plant, but that is fired with a different type and/or quantity of fuels (biomass residues and/or fossil fuels). The annual amount of biomass residue used in the baseline scenario is lower than that used in the project activity.	No. This project option is feasible but not realistic. There are no other biomass types (other than biomass from forest and/or industrial operations) available to generate power in the region. The efficiency of the cogeneration power plant would not be higher either (e.g. to consume a lower amount of biomass to that considered under the proposed project activity).
P11:	The generation of power in an existing fossil fuel fired cogeneration plant co-fired with biomass residues, at the project site.	No. There is no existing cogeneration power plant running primarily on fossil fuels in the Viñales sawmill to date.

According to the above, the feasible baseline scenarios for power generation would be: P1, P4, P5, P6 and P9.

Project scenarios for heat generation

Scenario	Scenario description	Feasibility in the context of the proposed project activity

H1:	The proposed project activity not undertaken as a CDM project activity.	Yes.
H2:	The proposed project activity (installation of a cogeneration power plant), fired with the same type of biomass residues but with a different efficiency of heat generation (e.g. an efficiency that is common practice in the relevant industry sector).	Yes.
H3:	The generation of heat in an existing captive, cogeneration plant, using only fossil fuels.	No. There is no existing captive cogeneration plant running on fossil fuels in the Viñales sawmill site.
H4:	The generation of heat in boilers using the same type of biomass residues.	Yes.
H5:	The continuation of heat generation in an existing biomass residue fired cogeneration plant at the project site, in the same configuration, without retrofitting and fired with the same type of biomass residues as in the project activity.	No. There is no biomass cogeneration power plant at the project site.
H6:	The generation of heat in boilers using fossil fuels.	Yes.
H7:	The use of heat from external sources, such as district heat.	Yes. Though district heating (as well as other heat generation sources) is not developed in Chile, in this particular case there is an external company that supplies heat to the Viñales sawmill. However, this is a particular situation.
H8:	Other heat generation technologies (e.g. heat pumps or solar energy).	No. There are no other heat-generation technologies readily available in the Viñales sawmill site. The development of such technologies in Chile is extremely low.
H9:	The installation of a **new** single- (using only biomass residues) or co-fired (using a mix of biomass residues and fossil fuels) cogeneration plant with the same rated power capacity as the project activity power plant, but that is fired with a different type and/or quantity of fuels (biomass residues and/or fossil fuels). The annual amount of biomass residue used in the baseline scenario is lower than that used in the project activity.	Yes.
H10:	The generation of power in an existing fossil fuel fired cogeneration plant co-fired with biomass residues, at the project site.	No. There is no existing cogeneration power plant running primarily on fossil fuels in the Viñales sawmill to date.

According to the above, the feasible baseline scenarios for heat generation would be: H1, H2, H4, H6, H7 and H9.

Project scenarios for biomass use

Scenario	Scenario description	Feasibility in the context of the proposed project activity
B1:	The biomass residues are dumped or left to decay under mainly aerobic conditions. This applies, for example, to dumping and decay of biomass residues on fields.	Yes.
B2:	The biomass residues are dumped or left to decay under clearly anaerobic conditions. This applies, for example, to deep landfills with more than 5 meters. This does not apply to biomass residues that are stock-piled or left to decay on fields.	Yes.
B3:	The biomass residues are burnt in an uncontrolled manner without utilizing them for energy purposes.	Yes.
B4:	The biomass residues are used for heat and/or electricity generation at the project site.	No. Currently there are no biomass boilers for heat and/or power generation at the project site.
B5:	The biomass residues are used for power generation, including cogeneration, in other existing or new grid-connected power plants.	No. Considering the surplus amount of biomass residues available in the region, the additional biomass consumed by the project plant would simply be left to decay or burned in an uncontrolled manner.
B6:	The biomass residues are used for heat generation in other existing or new boilers at other sites.	No. Considering the surplus amount of biomass residues available in the region, the additional biomass consumed by the project plant would simply be left to

		decay or burned in an uncontrolled manner.
B7:	The biomass residues are used for other energy purposes, such as the generation of biofuels.	No. The generation of biofuels using forestry biomass residues (sawdust and bark) is not developed at an industrial scale in Chile (and in the world) to date.
B8:	The biomass residues are used for non-energy purposes, e.g. as fertilizer or as feedstock in processes (e.g. in the pulp and paper industry).	No. The biomass residues used for energy generation purposes are not the same as the biomass residues used for feedstock or for pulp and paper production.

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

For each project scenario, it is established its compliance with the current mandatory and applicable laws and regulations in Chile (Step 1b).

<u>Consistency of project scenarios for power generation</u>

Scenario	Consistency with mandatory laws and regulation in Chile	Yes/No
P1	Once the corresponding permits are obtained from the national authorities, this project scenario is consistent with the mandatory laws and regulations in Chile. Currently, there are other similar projects that operate in Chile (as registered CDM projects), without restriction.	Yes.
P4	This project scenario is consistent with the mandatory laws and regulations in Chile.	Yes.
P5	Once the corresponding permits are obtained from the national authorities, this project scenario is consistent with the mandatory laws and regulations in Chile.	Yes.
P6	Once the corresponding permits are obtained from the national authorities, this project scenario is consistent with the mandatory laws and regulations in Chile.	Yes.
P9	Once the corresponding permits are obtained from the national authorities, this project scenario is consistent with the mandatory laws and regulations in Chile.	Yes.

According to the above, the project scenarios: P1, P4, P5, P6, and P9 would be consistent with the mandatory laws and regulations in Chile.

<u>Consistency of project scenarios for heat generation</u>

Scenario	Consistency with mandatory laws and regulation in Chile	Yes/No
H1	Once the corresponding permits are obtained from the national authorities, this project scenario is consistent with the mandatory laws and regulations in Chile. Currently, there are other similar projects that operate in Chile (as registered CDM projects), without restriction.	Yes.
H2	Once the corresponding permits are obtained from the national authorities, this project scenario is consistent with the mandatory laws and regulations in Chile.	Yes.
H4	Once the corresponding permits are obtained from the national authorities, this project scenario is consistent with the mandatory laws and regulations in Chile. Sawmills in Chile normally use biomass boilers to generate heat for wood drying.	Yes.
H6	Once the corresponding permits are obtained from the national authorities, this project scenario is consistent with the mandatory laws and regulations in Chile.	Yes.
H7	Once the corresponding permits are obtained from the national authorities, this project scenario is consistent with the mandatory laws and regulations in Chile.	Yes.
H9	Once the corresponding permits are obtained from the national authorities, this project scenario is consistent with the mandatory laws and regulations in Chile.	Yes.

According to the above, the project scenarios: H1, H2, H4, H6, H7 and H9 would be consistent with the mandatory laws and regulations in Chile.

Consistency of project scenarios for biomass use

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

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

Step 2: Barrier analysis.

Step 2a requires the identification of a set of barriers that would prevent the implementation of alternative scenarios. The Project Proponent identified the following set of barriers that prevent alternative scenarios to occur:

Investment barriers:

- With the current prevailing conditions in Chile, biomass power generation projects are normally not viable from a financial perspective. This is supported by the low share of this type of technology in the Chilean power matrix. In the case of the proposed project activity, this barrier will be further substantiated in a later section of this PDD.

- The proposed project activity contemplates the construction of a new grid-connected biomass power plant in the Viñales sawmill site. This implies additional risks and/or costs for Arauco. For example, any contingency in the power system (e.g. black-out), normally translates into an economic penalty that is applied to all power producers in the system, regardless of which company was responsible for the contingency[1]. To date, Arauco has paid around US$ 130,000 in fines to the corresponding national authority. The original amount, however, was approximately 7 times higher. In each case, Arauco had to appeal to the corresponding national authority.

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

Technological barriers:

Being biomass power cogeneration a technology not common in the context of the Sawmill industry in Chile, projects using cogeneration face several technological barriers:

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

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

  A cogeneration power plant is considerably more sophisticated and complex to operate than a conventional low pressure boiler. According to specialized literature[2], poor operational and maintenance skills generally translate into improper operation, which in the long-run result into early deterioration and failure of the power generation equipment. Skilful and fully involved personnel are crucial to achieve optimal plant operation and a low breakdown rate.

  The required skills to operate and maintain this kind of cogeneration plants is not readily available in Chile and particularly in the Sawmill industry, since power generation is not part of the common practice in this industry. There are not many big-scale biomass cogeneration facilities operating as power plants in Chile[3] and other than Arauco, there is no other company in Chile that operates a cogeneration facility as a self-power producer[4] in the grid.

  Furthermore, according to national statistics[5], people tend not to accept or stay long in job positions that are based in another country region. This restricts the universe of potential candidates and contributes to a high-job rotation, which tends to perpetuate the lack of experience problem for high-level technical positions. As a result, it is usual that the power plant owner ends up hiring people with lower competencies, who are not sufficiently qualified for the job.

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

  - The high steam demand fluctuations make the turbogenerator to operate in areas of low efficiencies. In some extreme cases, low stream flows through the turbogenerator may cause system trips. This can be clearly seen in the efficiency versus steam load chart of a turbogenerator machine[6] (provided by turbogenerator vendors).

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

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

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

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

[6] As supporting evidence, please see figure 6 in page 6 of the document “Steam Turbine Thermal Evaluation” by Paul Albert. This is a GE document and is available in the web at: <http://www.ge-energy.com/prod_serv/products/tech_docs/en/downloads/ger4190.pdf>

- The fluctuations also compromise the power generation capacity of the cogeneration plant, forcing the power plant to reduce its power generation to the grid. If this situation happens during a peak power demand period, the plant may be penalized on its future power revenues by the Dispatch Center for non-compliance with the dispatch program. This is not a minor issue, considering that currently approximately 25% of the annual revenue of a power plant of this type corresponds to firm power sales.

- The normal design of the drying chamber heating systems for sawmills in Chile do not contemplate separate pipes for each consumer. This would be far too expensive and difficult to do with the large number of heat consumers in a sawmill. As a result, condensates from different processes meet in the condensate pipes. Some condensates are so hot that they form flash steam while some others are colder than the saturation temperatures in the pipe. The mixing of these two types of condensates leads to implosions inside the pipes and a very noisy “hammering”. The hammering often leads to damage to the piping, valves, steam traps, etc. It could also lead to cracks in the system, so untreated water could enter the condensate system and contaminate the returned condensate to the boiler. This problem could seriously compromise the technical life of a high-pressure boiler, whereas it would be much less relevant in the case of a saturated steam boiler. This problem was described in a study carried out in December, 2007 by AF Celpap made for another cogeneration power plant owned by Arauco, currently registered as a CDM project. The study looked at operational problems of a cogeneration plant that provides heat to a sawmill and a panel board facilities.

It must be noted that since there are very few sawmills in Chile that operate with integrated cogeneration power plants (see official statistics below), it is not possible to reliably translate these barriers into additional cost. However, the low occurrence of this type of projects in Chile (even in the context of other big forest companies in Chile) clearly demonstrates that these barriers are real.

According to the “Guidelines for objective demonstration and assessment of barriers” approved in the EB 50, it is suggested that the Project Proponent complement the information provided above with information related to the nature of the company, the organization and its ownership, as well as with its previous experience with similar projects as the proposed project activity.

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

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

Arauco is fully owned by COPEC, a leading fuel distribution company in Chile. Arauco owns two biomass power generation projects in Chile that are similar (in context and technology) to the proposed project activity. Both projects are currently registered under the CDM. This past experience does contribute to mitigate some of the technological barriers outlined above. However, some of the barriers still persist, since they are structural to the industry contexts in which these type of projects are

implemented (e.g. Sawmill and Panel board industries) and tend to prevail regardless of the Project Proponent's past experience (e.g. sawmill drying chamber configuration, sawmill drying regime, turbogenerator efficiency range, etc.).

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

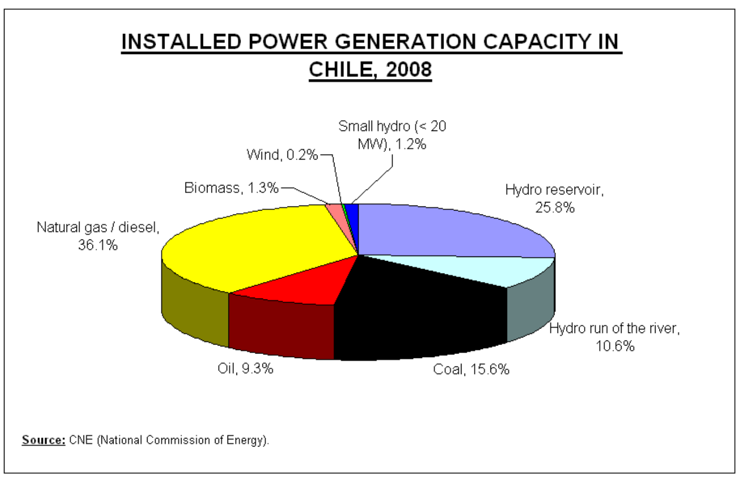
<u>Use of the biomass power generation technology in the Power industry in Chile:</u>

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

Power generation capacity per technology type in Chile, 2008[7]

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

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



<u>Use of the biomass power generation technology in the Sawmill and Panel board industries in Chile:</u>

[7] ERNC stands for "Energías Renovables No Convencionales" (Non conventional renewable energies).

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

- According to Infor (National Forestry Institute)[8], in 2007 there were 1,310 sawmills in Chile. Of these, only 2 have implemented power cogeneration at a comparable scale as the one considered by the proposed project activity. These two cogeneration power plants are registered CDM project activities. At a lower scale (not comparable to the proposed project activity), the number of sawmills that count with on-site cogeneration in Chile are no more than 2 or 3. In all, the number of sawmills that count with cogeneration technology do not surpass 0.4% of the total existing sawmills in Chile (including registered CDM projects).

- According to Infor[9], in 2007 there were 21 panel board mills in Chile. Of these, only 2 have integrated cogeneration technology. In both cases, the cogeneration power plants are registered CDM project activities.

Barriers due to the prevailing practice:

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

Cultural barriers:

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

- Commercial implications: Unlike forestry products, electric power cannot be stored in order to speculate on price. Power Purchase Agreements require different negotiation skills, which are not part of the competencies of companies that sell commodities such as metals, paper, wood, etc.

  In the case of Arauco, this is quite evident, since unlike other power companies in Chile, Arauco only has 30% of its available power capacity engaged in long-term contracts. The usual standard in the Power generation sector in Chile is higher than 60%. This makes Arauco more vulnerable to spot market fluctuations than other power companies.

- Operational implications: As mentioned above, cogeneration power plants are far more sophisticated than conventional saturated steam boilers and therefore, require trained and experienced personnel to operate them. This is not valid only for the cogeneration plant operators, but also for the operators of the facilities that use the steam for heating purposes such as sawmills and panel board mills.

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

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

[10] The only similar projects in Chile are the Trupan biomass power plant and the Nueva Aldea biomass power plant Phase 1. Both power plants (Ref: 0258 and Ref: 0259) are currently registered CDM project activities.

According to Arauco's experience, people-training is possible, however since there are two types of equipment operating at the same site (e.g. two operational standards coexist at the same site) the operational problems tend to prevail in time. This has been confirmed by external consultants hired be Arauco, who have detected these kinds of problems in other facilities (similar projects currently under the CDM) that have been in operation for some years.

The cultural barriers can be further substantiated by considering that in Chile, there are two big players in the forest industry (e.g. comparable to Arauco) and **none** of them have developed the biomass power cogeneration technology to the point of becoming a self-power producer in the grid, to date. All the initiatives currently under development by other players in the forest industry (both big and small) consider the use of the CDM. Evidence supporting this argument can be found in the corresponding Annual Reports of these companies and in the Environmental Impact Assessment studies of new cogeneration projects that are publicly available[11].

Regulatory barriers in the Power industry:

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

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

    - Article 3-8 of the Technical Norm (RM 40, May, 2005) establishes the frequency range in which all grid-connected power plants (including self-power producers) must operate grid-connected. Unfortunately, this range is set too wide and the norm does not allow self-power producers to disconnect their facilities from the grid until the frequency limits have been exceeded. As a result, self-power producers are not capable of re-establishing their internal power supply and go to island operation in case of extreme frequency fluctuations. This situation exposes the self-power producer production processes to instability and power outages, which translate into additional downtime and start-up operations. This problem has been addressed by external consultants the company has hired (see below).

    - As a result of the low flexibility allowed in the Technical Norm for self-power producers, the configuration of the protection system is crucial to efficiently deal with the fluctuations observed in the grid system. Since there are no other self-power producers than Arauco in Chile, there are no local companies capable of designing a suitable protection system for self-power producers in the country. Furthermore, the protection equipment that is available in the market is designed to react upon an external system failure and not to give the required time to the power producing facility to stabilize its electric system and go to island operation. In the case of Arauco, the company has to hire specialized consulting companies abroad and redesign the protection system of its power plants every time it modifies or install a new facility that functions as a self-power producer in the grid.

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

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

    - Unlike some developed countries in which biomass cogeneration receives favorable treatment and incentives (i.e. Finland, Germany, Sweden, etc.), in Chile, when a cogeneration system is not operational due to maintenance, the developer of cogenerated electricity needs to purchase electricity from the grid. A similar situation happens in case of a technical problem, even if it means stopping the cogeneration plant for just 15 minutes (the minimum period in which the electric distributors measure the peak power consumption). In that case, if the cogeneration facility registers peak power consumption during peak power time, the consuming plant not only has to pay for the electricity (MWh) consumed during this period, but also for the maximum power demand (MW) for the entire billing period. Moreover, while the billing period is monthly, the billing peak demand remains at the maximum demand for 12 months at a time. Thus, if the cogeneration facility is not operational even for a short period of time a year, the industrial customer must pay the demand charge all year long. This is described in CDEC-SIC Dispatch Center rules, Article 118, page 47.

    - Despite the regulatory authorities have recently incorporated some measures[12] to promote the use of non-conventional renewable energy sources, the RM17 of 2004 introduced a new algorithm for the firm power calculation for self-power producing companies. This new algorithm introduced a new penalization factor that lowered the firm power for these power producers, which is not present in the calculation of the firm power of conventional power producers. This measure negatively affects biomass cogeneration facilities such as the Viñales biomass power plant, given that the cogeneration facility falls under this power plant category.

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

    - The coordination with other generating/distribution/transmission companies also constitutes another barrier for cogeneration power plants such as the Viñales biomass power plant. To be able to sell electric power to the SIC grid and obtain the benefits of a power generating company, Arauco must be part of the CDEC-SIC, the Dispatch Center of the SIC grid. This constitute an operational barrier, since the cogeneration power plant needs to comply with both internal and external energy requirements, compared to pure power plants units in the system, which only need to coordinate with external CDEC instructions. This duality represents a higher operational complexity for the owner of the cogeneration facility, who cannot tune the power plant to exclusively maximize the return on electric power generation assets.

      An argument that ratifies and complements the above, refers to the fact that in the SIC system, the non-conventional renewable energy technologies represent less than 5% of the total energy generated in the system. In addition, the electric power industry is highly concentrated, with mainly four power companies concentrating over 60% of the total energy generated in the SIC grid. The low share of non-conventional renewable energy technologies, the high leverage of conventional power generators and the insufficient

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

incentives for renewable sources in the electric law make these barriers structural and relatively permanent for prospective non-conventional energy producers and current players such as Arauco.

The coordination with sub-distribution, distribution and transmission companies also becomes more complicated when an industrial facility not only consumes power from the grid but also injects power to the grid. Sometimes the system to which the cogeneration plant must connect is not capable of handling the additional power injected by the power plant. This implies additional investments (reinforcement of sub-transmission lines and new protection systems), which in some occasions can translate into additional (and costly) start-ups delays[13].

It must be noted that:

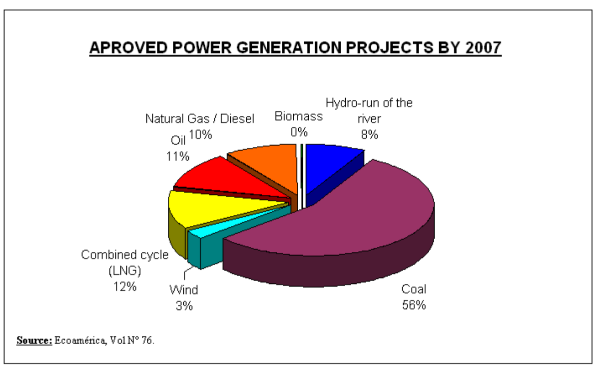
- The regulatory barriers outlined above are structural to the country as they equally apply to all kind of companies, regardless of their size and/or previous experience in the field.

- The regulatory barriers cannot be reliably translated into additional cost due to the limited amount of information publicly available. However, the best way to confirm the existence and significance of these barriers is by noting the low development of the cogeneration technology in the Power industry.

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

- There is a lack of awareness of the multiple benefits of decentralized energy and therefore, the considerable potential to develop micro power plants in the south of the country remains to be exploited. According to several studies, Chile has considerable electric power generation potential in small-hydraulic, wind and biomass renewable sources.

- Regulations for the electric sector are mostly oriented around centralized large-scale and conventional power generation. This can be substantiated by national statistics. The following graph below shows the new power generation projects that have been approved by the corresponding national authority in 2007:



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

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

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

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

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

1. The study: “Evaluaciones del Desempeño Ambiental Chile” (Environmental Performance Review study for Chile)[14], published by the OECD in 2005, addresses the difficulties faced by renewable power generation projects in Chile. In particular, the study identifies the following barriers:

    a. Current power prices and policies do not reflect the externality costs caused by more polluting power generation technologies (page 19).
    b. There is insufficient promotion of low-contaminating power generation technologies (page 33).
    c. Non-conventional renewable power generation projects must compete in the same terms and conditions as conventional power generation projects (page 63).

2. The study: “Aporte Potencial de Energías Renovables no Convencionales y Eficiencia Energética a la Matriz Eléctrica, 2008 – 2025” (Potential contribution of non-conventional renewable power sources and energy-efficiency to power generation, 2008 – 2025)[15], June 2008, developed by Universidad de Chile and Universidad Técnica Federico Santa María. Chapter 8 of the study addresses the barriers faced by non-conventional renewable power generation technologies in Chile. In particular, the study mentions the following barriers:

    a. Poor identification/insufficient information about the available energy resources.
    b. The geographical situation of Chile (extremely long and narrow country) makes it difficult for mini/micro power plant to interconnect to the SIC (main transmission system).
    c. Lack of skilled labor, experience and technological development.
    d. Insufficient incentives.

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[14] Available at: <http://desarrollosostenible.org/sitio/images/stories/documentos/nacionales/evaluaci%F3n%20del%20desempe%F1o%20ambiental%20en%20chile%20ocde.pdf>.

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

e. Current power prices do not truly reveal the cost of externalities.
f. Lack of negotiating capacity with equipment suppliers and long waiting times.
g. (For biomass power generation only) The dispersed availability of the biomass residues limits the size biomass power plants. This increases the biomass transportation costs (logistics) and compromises the financial viability of the power generation projects (e.g. the interconnection cost becomes more relevant for a smaller plant).

3. The report: "Chile Energy Policy Review 2009"[16], October 2009, developed by the International Energy Agency. Chapter 7 is dedicated to renewable energy sources and in page 165, box 7.1 the study explicitly mentions the barriers faced by non-conventional renewable energy sources:

   a. Lack of information on energy sources.
   b. Uncertainty in processing permits for new technologies.
   c. Regulatory barriers: Regulatory framework under development (first drafts started only in 2004).
   d. Technological barriers: Weak infrastructure (especially access to some resources).
   e. Investment barriers: Difficulty in accessing credit (capital-intensive with long pay-back periods)[17].
   f. Technological barriers: Uncertainty regarding technological options, their costs and performance.
   g. Operational barrier: Need to adapt systems (e.g. the grid) to operate with more intermittent (power) sources.

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

   a. Restrictions imposed by the current law to non-conventional renewable power generation technologies make them less competitive compared to other conventional power generation technologies.
   b. The current law does not provide enough incentives to develop non-conventional renewable power generation technologies in Chile.
   c. Current power prices and policies do not reflect the externality costs caused by more polluting power generation technologies.
   d. The presence of commercial restrictions for non-conventional renewable power generation technologies.
   e. Financing restrictions for non-conventional renewable power generation technologies (see note at the end of this page).

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

[17] This barrier is not really applicable to projects that are financed fully by the project owner and do not need additional credit. Such is the case with the proposed project activity.

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

1. The low share (3%) of non-conventional renewable power generation in Chile. In particular, for biomass power generation technology, this share is less than 2%.

2. The marginal implementation of the cogeneration technology (clearly less than 10% including CDM projects) in the Sawmill and Panel board industries in Chile.

3. The fact that other relevant players in the forest industry in Chile (comparable to Arauco) have not developed this technology without the aid of the CDM. All the initiatives currently underway by these companies (and smaller companies as well), consider the CDM to overcome the barriers outlined in this section of the PDD.

Step 2b of the Combined Tool requires the Project Proponent to eliminate the alternative scenarios that are prevented by the identified barriers. This is done in the table below for all the feasible heat generation and biomass use baseline scenarios.

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

Scenario	Barriers that prevent the implementation of the alternative scenarios	Likely baseline candidate?
P1	• Investment barriers. • Technological barriers. • Barriers due to the prevailing practice. • Cultural barriers. • Regulatory barriers.	No.
P4	This project option would not face barriers and is consistent with the common practice of the Sawmill industry in Chile.	Yes.
P5	• Investment barriers. • Technological barriers. • Barriers due to the prevailing practice. • Cultural barriers. • Regulatory barriers. Regardless of the efficiency of the new power plant, the integration of a cogeneration facility to a sawmill is not common practice in Chile.	No.
P6	• Investment barriers. • Technological barriers. • Barriers due to the prevailing practice. • Cultural barriers. • Regulatory barriers. Regardless of the efficiency of the new power plant, the integration of a cogeneration facility to Sawmills or a Panel board mill is not common practice in Chile.	No.
P9	• Financial barrier. The current oil prices would make this project option extremely expensive and therefore not viable. • Barriers due to the prevailing practice. The use of fossil fuels for heat generation is not the common practice in the Sawmill industry in Chile.	No.

Baseline assessment for Heat generation:

Scenario	Barriers that prevent the implementation of the alternative scenarios	Likely baseline candidate?
H1	• Investment barriers. • Technological barriers. • Barriers due to the prevailing practice. • Cultural barriers. • Regulatory barriers.	No.
H2	• Investment barriers. • Technological barriers. • Barriers due to the prevailing practice. • Cultural barriers. • Regulatory barriers. Regardless of the efficiency of the new power plant, the integration of a cogeneration facility to Sawmills or a Panel board mill is not common practice in Chile.	No.
H4	This project option would not face barriers and is consistent with the common practice of the Sawmill industry in Chile.	Yes.
H6	• Financial barrier. The current oil prices would make this project option extremely expensive and therefore not viable. • Barriers due to the prevailing practice. The use of fossil fuels for heat generation is not the common practice in the Sawmill and Panel board industries in Chile.	No.
H7	• Investment barriers. • Barriers due to the prevailing practice. • Regulatory barriers. Most sawmills in Chile have their own heat generation boilers. External heat generation sources are not part of the common practice in the Sawmill industry. Unlike other countries, current Chilean regulation does not favor the development of district heating and/or other sources of external heat generation in the country. In the case of the Viñales sawmill, this option is not available for the long-run, since the current heat supplier will shut down its operation by 2012. As a result, the Project Proponent has to find another way of generating the heat required by the Viñales sawmill.	No.
H9	• Investment barriers. • Technological barriers. • Barriers due to the prevailing practice. • Cultural barriers. • Regulatory barriers. Regardless of the biomass and/or fossil fuel mix used in a cogeneration plant, the integration of a cogeneration facility to a sawmill is not common practice in Chile and therefore this project would face all the barriers outlined above.	No.

Baseline assessment for Biomass use:

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

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

Baseline scenario options for power generation

Scenarios	Scenario description	Associated emissions (1 = lowest)
P4	The generation of power in the grid.	1

Baseline scenario options for heat generation

Scenarios	Scenario description	Associated emissions (1 = lowest, 2 = highest)
H4	The generation of heat in boilers using the same type of biomass residues.	1

Baseline scenario options for biomass use

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

According to the above, the project option that would be consistent with the baseline scenarios for power (P4), heat (H4) and biomass use (B1, B2 or B3) would be the installation of a new low-pressure boiler for heat generation in the Viñales sawmill.

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

The registration of the Viñales biomass power plant project activity in the CDM will report significant benefits to the Viñales sawmill. However, these benefits will not only circumscribe to the project activity itself, but also to Arauco for overcoming the associated barriers to carry out the proposed project to final completion, and to any other company in Chile who decides to follow Arauco's lead in biomass cogeneration in the future.

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

- The financial benefit derived from the sale of CERs to Annex I countries is a strong incentive to develop CDM project activities for Arauco. The additional investment related to a biomass electric power generation capacity is about 2 to 3 MMUS$ per installed MW (depending on the project context), which is significant. The barriers that must be overcome to implement such projects are not minor either. As previously mentioned, they cannot be easily/reliably quantified ex-ante, but they invariably end up translating into additional costs, deteriorating the financial performance of this type of projects ex-post. In this case, however, the expected revenue that would come from the sale of the CERs would significantly contribute to mitigate these extra risks and costs:

RELEVANCE OF THE CDM IN THE VIÑALES PROJECT ACTIVITY

		CER price scenarios	
		Low Price	High Price
Net emission savings	(tCO_2eq/yr)	154,198	154,198
CER price	(Euro$/CER)	8.0	13
CER price	(US$/CER)	11.8	19.1
Annual income from carbon sales	(KUS$/yr))	1,817	2,952
Relevant discount rate	(%)	12%	12%
Net present value of carbon sales	(KUS$)	13,736	22,322
Investment in the Viñales CDM project activity	(KUS$)	82,517	82,517
Relevance of CDM revenue	**(%)**	**17%**	**27%**

Note: The investment in the CDM project considers the additional investment with respect to the baseline scenario. The baseline scenario consists in the installation of a saturated biomass boiler in the Viñales sawmill.

As can be seen from the table above, the present value of the carbon sales represent a significant portion of the total investment related to the implementation of the proposed CDM project, even in the most conservative CER price scenario (e.g. 17% of the additional investment related to the CDM project activity). Though this analysis is not possible considering the additional costs associated to each of the identified barriers, it is reasonable to assume that the CDM revenues will most likely compensate the extra costs associated to the barriers, in this case.

Furthermore, in this case the carbon proceeds are not only significant compared to the overall investment, but they also make the proposed project activity financially viable. A detailed financial analysis will be shown in a subsequent section of this PDD to support this argument.

- The proposed project activity will unquestionably reduce anthropogenic greenhouse emissions by generating electric power via a clean energy source. This is consistent with Arauco's Corporate Policy of Sustainable Development and its current stand of combating Climate Change[18]. The CDM has allowed the company to leverage its energy-efficiency policy, by making the big-scale biomass cogeneration technology feasible. As a result, the company has developed this technology in a way no other company has done it in Chile to date.

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

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

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

- Every year, the Chilean Economic Development Agency (CORFO) organizes the International Conference on Renewable Energy Investments and CDM[19]. The event provides the opportunity for networking by bringing together private investors, carbon market intermediaries, national project developers, service suppliers, banks, public agents and experts in the renewable energy and CDM sectors. One of the main aims of this event is to provide the possibility of project proponents of renewable power generation projects to meet potential investors and financiers. The great success and continued growth in importance of this conference over the last years demonstrates that the CDM is in fact a mechanism that attracts potential investors and financiers who would normally not finance this kind of projects without the aid of this mechanism.

- In the case of the proposed project activity, from the moment Arauco started the validation of the Viñales biomass power plant expansion project, the company has received several communications from financial institutions who manifested interest in financing the project or provide low-interest financing possibilities to the company in exchange for credits.

• Finally, in the last 20 years, Chile has had a sound macroeconomic management and as a result, Chile is regarded today as one of the most attractive countries to do business with in Latin America. With the approval of free-trade agreements with USA and the European Union, Chile has a very open and world-integrated economy, which relies heavily on its exports (approximately 40% of its GNP). This makes the Chilean economy very sensitive to external shocks and currency fluctuations. The CDM provides a new/additional hard-currency cash flow stream for the proposed project activity that positively contributes to mitigate the effects of inflation and exchange rate fluctuation.

Step 3: Investment analysis

According to the Combined tool (Version 02.2), if there is only one alternative scenario that is not prevented by any barrier, this alternative is not the project activity and the CDM does alleviate the barriers identified for the proposed project activity, the Project Proponent must proceed to Step 4, the Common Practice Analysis.

In other words, Step 3 the investment analysis, cannot be performed in this case, if the Project Proponent is to follow the instructions exactly as in the Combined tool.

Nevertheless, the Project Proponent would like to present an investment analysis in this case, not as part of the Step 3 of the Combined tool, but as additional information/evidence in order to:

1. Substantiate the financial barrier faced by project options that involve cogeneration compared to the BAU project option that do not, in the context of the Viñales project activity (e.g. the Sawmill industry context).

2. Illustrate the relevance of the CDM in the financial performance of the Viñales project activity.

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[19] Please see the conference web page at: < http://www.investchile.com/energyconference/>.

This analysis is shown below and will follow the guidance of Step 3 of the Combined tool to develop the analysis.

Analysis method

Considering that the Viñales biomass power plant project generates financial benefits derived from heat and power purchase avoidance and power sales to the grid, the Project Proponent will carry out an investment comparison analysis in order to determine which option is the most economically/financially convenient.

The Project Proponent will compare different alternatives that involve on-site heat and power generation (a cogeneration plant) with the BAU project option, which only contemplates the generation of heat for the Viñales sawmill. This last project option will be the reference project option.

The Project Proponent will first determine the heat price that would be required to finance the implementation of the reference project option. This will be done by finding the heat price that would make the net present value of the reference project option equal to zero.

This heat price will –then- be used in the financial evaluations of the project alternatives that contemplate the generation of power (cogeneration) in the Viñales sawmill. The Project Proponent will consider two scales and efficiencies of cogeneration plants: the one contemplated by the proposed project activity and a smaller and less efficient cogeneration plant.

If the financial evaluations of the options involving cogeneration turn out to be positive, then it means that on-site heat and power generation (cogeneration) is preferable from a financial standpoint to the option that only implies heat generation. If the opposite happens, then it means that the options involving cogeneration are less convenient from a financial standpoint than the option that just implies heat generation in the Viñales sawmill.

Financial indicators

The Project Proponent will use the NPV to perform the financial evaluation of the different project options available.

Main assumptions

The main assumptions used to evaluate all the project options available are presented below:

- The prices for electric power are :
    - Energy: 85 (US$/MWh) (average for the evaluation horizon).
    - Power: 9 (US$/KW-month) (node price).

- The price for biomass fuels from industrial operations is 6 (US$/$m^3$st) and 11 (US$/m^3st, average) for biomass fuels from forestry operations. This price includes the transportation cost to the Viñales biomass power plant.

- The chosen evaluation horizon for the different project options is from 2008 to 2025.

- The project discount rate used to calculate the NPVs of each option was 12.0%. This is the normal rate used to evaluate the different project options for Arauco in Chile.

- The same assumptions presented above have been used to evaluate all the project options considered in this analysis.

Financial comparison results

The following summary table presents the financial indicators of each project option considered in the analysis:

Project options	NPV (In KUS$)	Comments
1.0 A low-pressure boiler on biomass fuels.	0	Reference scenario, no cogeneration
2.0 A new cogeneration power plant on biomass fuels, implemented with a lower efficiency/scale.	-14,891	With cogeneration
3.0 The proposed project activity.	-23,025	With cogeneration

From the table above, it can be seen that neither of the project options that contemplates generation of power (cogeneration) is more attractive than the reference project option, from a financial perspective. In particular, project option N° 3, which corresponds to the proposed project activity, is the most unattractive of all.

The excel spreadsheets with the corresponding financial evaluations are provided as an annexes to this PDD.

Sensitivity analysis

The tables below show the sensitivity analysis of project options N° 1, N° 2 and N° 3. In this case, the sensitivity analysis was performed considering possible/likely variations in the investment, heat, biomass fuel prices and power. The variations were determined according to the following rationale:

1. Investment: To determine the range in which the considered investment value would most likely fluctuate, the Project Proponent considered the investment behavior (e.g. investment estimation versus real and final investment figure) of similar projects carried out in the recent past by the Project Proponent. From all the projects analyzed, the Project Proponent considered fluctuation of the project that presented the widest investment fluctuation in order to be conservative.

2. Heat: The heat price variation range was determined from the minimum and maximum investment values drawn from the sensitivity analysis above. The rationale is the same as the one described before; a new (higher or lower) investment value for the project option N° 1 would automatically determine a new price for heat that would make the Net Present Value of project option N° 1 equal to zero. In other words, the heat price range is determined by the minimum and maximum investment values for project option N° 1.

3. Biomass: The biomass fuel price ranges were determined by analyzing the historic biomass price behavior during 2006, 2007 and 2008. The information was obtained from the Arauco's biomass procurement department, which supplies Arauco's existing biomass power plants with biomass fuels.

4. Power: Power price in Chile is significantly influenced by hydro power generation, which in turn is greatly determined by the annual hydrology. A dry hydrology means low hydro and high thermal power generation, which leads to high power prices in the system and vice versa. The Project Proponent considered a statistic of the last 49 annual hydrology scenarios to determine the possible power price scenarios. These scenarios contain the most extreme (i.e. driest and wettest) hydrologies that have happened in the last 49 years. The power price was determined by using the PLP simulation software, which is currently used in the CDEC-SIC dispatch center to determine the power price in the SIC interconnected system. The Project Proponent considered 49 different and possible power price scenarios in the sensitivity analysis for all the project alternatives considered.

The results of the sensitivity analysis are shown in the tables below:

Project option Nº 1: A low-pressure boiler on biomass fuels for heat generation

Variation in investment (% of variation)	**NPV (In US$ thousands)**
-10.0%	1,479
0.0%	**0**
25.0%	-3,697

Variation in power price (% of variation)	**NPV (In US$ thousands)**
-52%	1,070
0	**0**
65%	-1,360

Note: The boiler consumes a small amount of power.

Variation in heat price (% of variation)	**NPV (In US$ thousands)**
-7.3%	-1,479
0.0%	**0**
18.2%	3,697

Variation in biomass fuel price (% of variation)	**NPV (In US$ thousands)**
-25.0%	659
0.0%	**0**
25.0%	-659

Project option Nº 2: A new cogeneration power plant on biomass fuels with lower efficiency/scale

Variation in investment (% of variation)	NPV (In US$ thousands)
-10.0%	-11,164
0.0%	**-14,891**
25.0%	-24,210

Variation in power price (% of variation)	NPV (In US$ thousands)
-52%	-21,632
0	**-14,891**
65%	-7,169

Variation in heat price (% of variation)	NPV (In US$ thousands)
-7.3%	-15,878
0.0%	**-14,891**
18.2%	-12,423

Variation in biomass fuel price (% of variation)	NPV (In US$ thousands)
-25.0%	-11,779
0.0%	**-14,891**
25.0%	-18,013

Project option Nº 3: The proposed project activity

Variation in investment (% of variation)	NPV (In US$ thousands)
-10.0%	-15,449
0.0%	**-23,025**
25.0%	-41,963

Variation in power price (% of variation)	NPV (In US$ thousands)
-52%	-55,146
0	**-23,025**
65%	12,928

Variation in heat price (% of variation)	NPV (In US$ thousands)
-7.3%	-24,009
0.0%	**-23,025**
18.2%	-20,564

Variation in biomass fuel price (% of variation)	NPV (In US$ thousands)
-25.0%	-14,125
0.0%	**-23,025**
25.0%	-31,942

Considering the variation ranges given for investment, heat price, power price and biomass fuel prices, the Project Proponent assessed the probabilities of obtaining a positive Net Present Value for project options N° 1, N° 2 and N° 3. The results of this assessment are provided in the tables below:

Probability assessment of project option N° 1

Variables	Probability of NPV >=0	Comments
Investment	29%	Unlikely
Power price	88%	Likely
Heat price	71%	Likely
Biomass fuel price	49%	Neutral

Probability assessment of project option N° 2

Variables	Probability of NPV >=0	Comments
Investment	0%	The investment would have to be MUS$ 29,422, which is out of the range considered in this analysis. Unlikely.
Power price	0%	The power price would have to correspond to an extremely dry hydrology, which has not happened in the last 49 years. Unlikely.
Heat price	0%	The heat price would have to be 19.2 US$/ton, which is out of the range considered in this analysis. Unlikely.
Biomass fuel price	0%	The biomass fuel prices would have to be negative, which is not only out of the range considered in this analysis, but also impossible. Impossible.

Probability assessment of project option N° 3

Variables	Probability of NPV >=0	Comments
Investment	0%	The investment would have to be MUS$ 69,584, which is out of the range considered in this analysis. Unlikely.
Power price	6%	The power price would have to correspond to an extremely dry hydrology, which has only happened 3 times in the last 49 years. Unlikely.
Heat price	0%	The heat price would have to be 24.8 US$/ton, which is out of the range considered in this analysis.

		Unlikely.
Biomass fuel price	0%	The biomass fuel prices would be positive but extremely low. They would still be out of the range considered in the sensibility analysis. Unlikely.

According to the results above, at the expected heat price level (e.g. the one that makes the net present value of the reference project option equal to zero), project option N° 1 still has a fair chance of becoming financially attractive, considering the variation ranges chosen for the key variables.

For project options N° 2 and N° 3, the scenarios under which they become financially attractive (e.g. present a positive net present value) are extremely unlikely and in some cases, impossible.

In order to complement the analysis above, the Project Proponent performed a sensibility analysis, this time considering an extreme scenario in which project option N° 3 would present a very high[20] plant load factor (88%). The results for this case (only[21]) are presented below

Project option	**NPV (In US$ thousands)**	**Comments**
3.0 The proposed project activity	-9,916	With cogeneration

The sensitivity analysis is presented in the tables below:

Project option Nº 3: The proposed project activity

Variation in investment (% of variation)	**NPV (In US$ thousands)**
-10.0%	-2,341
0.0%	**-9,916**
25.0%	-28,854

Variation in power price (% of variation)	**NPV (In US$ thousands)**
-52%	-54,609
0	**-9,916**
65%	41,055

Variation in heat price (% of variation)	**NPV (In US$ thousands)**
-7.3%	-10,900
0.0%	**-9,916**
18.2%	-7,455

Variation in biomass fuel price	**NPV**

[20] Load factors for biomass power plants connected to the SIC grid normally vary from 60% to 80%.

[21] This analysis was not done for option N° 2, since the plant load factor considered in the previous analysis was already high enough (80%).

(% of variation)	(In US$ thousands)
-25.0%	3,256
0.0%	**-9,916**
25.0%	-23,103

Probability assessment of project option N° 3

Variables	Probability of NPV >=0	Comments
Investment	0%	The investment would have to be MUS$ 86,884, which is out of the range considered in this analysis. Unlikely.
Power price	6%	The power price would have to correspond to an extremely dry hydrology, which has only happened 3 times in the last 49 years. Unlikely.
Heat price	0%	The heat price would have to be 15.9 US$/ton, which is out of the range considered in this analysis. Unlikely.
Biomass fuel price	12%	The biomass fuel prices would be positive, but still very low. Unlikely.

Considering this new analysis for project option N° 3 (the proposed project activity), it can be reasonably concluded that even under a very favorable scenario (very high load factor), the circumstances under which this project option would present a positive NPV are extremely unlikely and therefore, the additional investment related to power generation (cogeneration) is not justified from a financial perspective.

From the sensibility analysis performed above, it is clear that both project options N° 2 and N° 3 are less attractive from a financial standpoint than project option N° 1, which is the reference scenario. In this context, it is much more convenient to invest in a conventional saturated steam boiler for the Viñales sawmill than in a cogeneration power plant.

The conclusions of this analysis are likely to hold considering the future perspectives of the variables considered relevant for the sensitivity analysis:

1. Investment costs are likely to increase slightly or maintain the current level, given the high demand of boilers and power-related equipment worldwide[22].

2. Power prices in Chile are likely to maintain their high current level for the next five years as a result of the low investment in power generation in the past 10 years. Prices will probably bounce back when the new power plants (mainly coal plants) enter in operation.

3. Since heat price is directly related to investment cost, it will most likely follow the investment cost behavior.

[22] This is mainly due to the high demand of steal and other raw materials from China and India, which have been growing approximately at 10% during the last years.

4. Since biomass fuel prices are greatly influenced by fuel prices (transport) and power prices (power demand), it will most likely follow the power price behavior.

Finally, it must also be noted that project option N° 3 could become financially attractive if carbon proceeds were included. The table below shows the NPV of project option N° 3:

Project option N° 3: The proposed project activity	**NPV In US$ thousands**
Net present value with carbon proceeds (normal load factor)	4,870
Net present value with carbon proceeds (high load factor)	17,979

Note: CERs prices were considered at the date of decision.

Without carbon proceeds, the proposed project activity is definitely not likely to become financially attractive. As a result, it can reasonably be concluded that:

1. The financial barrier is significant in this case, and clearly prevents the proposed project activity from happening.

2. The aid of the CDM clearly contributes to alleviate the financial barrier in this particular case.

According to the analysis above, the baseline project option would correspond to the installation of a new heat generation facility in the Viñales sawmill (no cogeneration). This option, however, still include three baseline scenarios for the additional biomass use: B1, B2 and B3. The Project Proponent will select the scenario with the least emissions, which is B1, in this case.

As a result, the baseline scenario for power, heat and biomass use would be:

Baseline scenarios for heat generation and biomass use, relevant for the proposed project activity	
P4	The generation of power in the grid.
H4	The generation of heat in boilers using the same type of biomass residues.
B1	The biomass residues are dumped or left to decay under mainly aerobic conditions. This applies for example, to dumping and decay of biomass residues on fields.

This baseline scenario would translate into an alternative (baseline) project option consisting in:

The installation of a new low pressure boiler on biomass fuels for heat generation (no cogeneration) in the Viñales sawmill site.

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

<u>Electric power generation baseline</u>

Industry	**Current practice in Chile**	**Documentation/reference**	**Description of the technology used in the**

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

According to ACM0006 (Version 09) and considering that the generation capacity of the proposed project activity is more than 15 MW, the baseline coefficient for the electricity displaced from the grid must be calculated as a Combined Margin (CM). This coefficient clearly and transparently indicates what

would have happened if the project activity had not taken place and the additional carbon neutral energy had not been injected to the grid.

Unused biomass baseline

The following table establishes the baseline of the additional biomass that will be burned in the new Viñales biomass power plant as a result of implementing the project activity. The baseline is established using a per-industry analysis.

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

	for heat generation (e.g. to aid start-up operations). These boilers usually run on biomass fuels (from the debarking section of the mill) or fossil fuels.	Control (IPPC), Reference Document on Best Available Techniques in the Pulp and Paper Industry, Seville, Spain, p 111.". The link: http://eippcb.jrc.ec.europa.eu/pages/FActivities.htm).	

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

Since page 51/77 of the ACM0006 (Version 09) considers that under this baseline scenario the corresponding baseline emissions must be those generated as if the biomass were burned in an uncontrolled manner, the calculated baseline emissions are much lower than those that actually take place due to biomass natural degradation. This happens because when biomass is dumped and left to decay, it releases more of the carbon it contains as methane than when it is burned in the open air. This results in a significantly greater baseline emission, considering the GWP of methane as GHG. This consideration results in a very conservative baseline for the use of the biomass residues.

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

CONSUMPTIONS AND BASELINES PER BIOMASS TYPES

Biomass types	Consumption before project activity		Consumption after project activity		Biomass situation	Baselines per biomass types
		(%)	(BDt/yr)	(%)		
3rd party biomass from industrial operations	0	0.0%	26,100	10.6%	Not generated in the Viñales sawmill	Dumped in piles / burned in the open-air
3rd party biomass from forestry operations	0	0.0%	130,640	52.9%	Not generated in the Viñales sawmill	Dumped in piles / burned in the open-air
Internal biomass from industrial operations	0	0.0%	90,000	36.5%	Generated in the Viñales sawmill	Fuel for heat generation / dump the surplus
Total	**0**	**0.0%**	**246,740**	**100.0%**		

Note: There are two types of biomass used in the proposed project activity: biomass from industrial operations and biomass from forestry operations.

According to the table above, it is clear that in this particular case the proposed project activity implies an additional consumption of biomass from industrial operations and from forestry operations for electric power generation.

It must be noted that normally, once sawmills have served their internal need for heat, they sell the surplus to local consumers (if possible) or simply discard the surplus in landfills. Since there is a considerable surplus of unused biomass from industrial operations in the region, the baseline for the surplus biomass generated by the Viñales sawmill as well as the baseline for the additional biomass that would be used for electric power generation is the disposal or the uncontrolled burning of the biomass residues.

The same baseline analysis as the one presented above is valid for the biomass from forestry operations. There is a considerable surplus of this type of biomass that is not used for energy purposes and therefore, is burned in uncontrolled manner in the open air or simply left in piles for natural decay.

Heat generation baseline

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

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

The remaining step of the Combined Tool (Step 4) is required to complete the demonstration of the additionality of the proposed project activity; therefore it will be presented in the following section of this PDD.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

As mentioned in section B.4, the Project Proponent will use version 02.2 of the Combined Tool to identify the baseline and demonstrate additionality. Considering that the previous section of the PDD addressed steps 1 to 3 (more related to the baseline), this section will go through Step 4, which is the final step of the Combined Tool required to establish the additionality of the proposed project activity.

Previously, and according to the last version of the PDD Guidelines for Completing the Project Design Document, point B.5 establishes that if the starting date of the project activity is before the date of validation, then evidence must be provided in order to show that the CDM was seriously considered in the decision to proceed with the proposed project activity and therefore demonstrate additionality of the project. Since the Viñales biomass power plant project started during the first half of 2008, the following evidence is provided to demonstrate that the incentive of the CDM was seriously considered in the decision to proceed with the project activity:

Evidence of serious consideration of Climate Change and the CDM at a corporate level:

- Arauco first considered the CDM principles in cogeneration initiatives in 1998. A study called "Estudio de Factibilidad de Cogenerar en Chile"[23] carried out by SERCOR S.A., a research company; subsidiary of Arauco explicitly considered the benefits related to power cogeneration: mainly higher efficiency and lower CO_2 emissions. It must be noted that unlike the environmental regulations in other countries, the Chilean environmental regulations do not consider CO_2 a pollutant and therefore, they do not contemplate any emission restriction at all. As a result of this study and other subsequent studies in the coming years, Arauco introduced the sustainability criteria in power generation and made it part of its Environmental Corporate Policy of Sustainable Development. As a highly integrated conglomerate in the forest industry, Arauco consistently and systematically applied this policy throughout all the business areas in which the company participates: forest management, wood processing (sawmills), Hardboard/MDF/Plywood panel manufacturing, pulp producing and power generation. Evidence that explicitly mentions Arauco's Environmental Corporate Policy and its compromise towards sustainable development in all of its business areas and subsidiaries can be found in Arauco's 1997 to 2008 Annual Reports and in the Environmental and Social Responsibility Reports.

- Arauco first considered the incentives of the CDM in 1999. In the study "Proyecto de fijación de carbono en plantaciones de Pinus Radiata en la VI y VII regiones, Chile"[24], carried out by the FIA (Foundation for Agriculture Innovation). This study was a result of a shared initiative of FIA, CONAF (National Forestry Corporation) and Forestal Celco (an Arauco subsidiary related to forest management) and was aimed at developing a participative mechanism that allowed small land owners located in the coastal dry lands of the south of Chile to reforest abandoned and/or eroded lands. The study evaluated the financial feasibility of the reforestation program and explicitly considered the carbon revenues derived from the reforestation program. As a result of this initiative, Forestal Celco

[23] "Feasibility Study of Cogeneration in Chile", the English translation.

[24] "Carbon capture project from Radiata Pine plantation in the VI and VIII regions, Chile", the English translation.

and later on, Licancel (an Arauco subsidiary related to pulp production) implemented the reforestation program. Since in those years the CDM was in its early beginnings, Arauco was unable to certify the emission savings from this reforestation project. As a result, the company maintained the reforestation program until 2002, the year in which it was no longer feasible to maintain the program without the economic incentives of the CDM.

- Arauco began the construction of its first CDM biomass cogeneration project in April 2001, the "Trupan Biomass Power Plant in Chile" (Ref. Nº 0259). The plant became operational in 2003 and the associated CDM project activity was successfully registered in June 06, 2006.

- Consistent with its policy of sustainable development and considering the potential of the CDM, Arauco implemented other cogeneration initiatives: The "Nueva Aldea Biomass Power Plant Phase 1" (Ref. Nº0258) which was started in September 2003 and the "Nueva Aldea Biomass Power Plant Phase 2" (Ref. Nº 0346), started in July 2004. Both were successfully registered as CDM project activities during 2006.

- During 2002, SERCOR S.A. developed the study "Bonos de Carbono"[25] about the Kyoto Protocol, the CDM and the Carbon Market possibilities available at that time. This study was presented to members of the Arauco board and contributed to foster the interest in the CDM and the Kyoto Protocol.

- During 2003, considering that still no baseline methodology suitable for Arauco's biomass projects had been developed, Arauco decided to develop its own internal CDM competencies and designed a CDM baseline methodology that suited its biomass cogeneration projects. The first methodology calculations are dated June/July 2003. As a result of these developments, Arauco finally presented the first CDM grid-connected baseline methodology for biomass projects in Chile (the NM0081) in October 28th 2004, and got the approval by the Executive Board by the end of February 2005[26]. The successful development of this methodology clearly proves Arauco's serious commitment with the CDM principles and its intention to continue developing biomass power cogeneration initiatives in the future.

- Unlike other companies, Arauco has developed its own competencies in the CDM. As a result, Arauco Bioenergía S.A., an Arauco subsidiary, has a full division dedicated to the development of new CDM project activities and the administration of Arauco's registered CDM projects.

In addition to the evidence presented above and according to EB 49, Annex 22, "Guidelines on the demonstration and assessment of prior consideration of the CDM" (Version 03) , paragraph 6, for project activities with a start date before August 2nd, 2008 and for which the start date is prior to the date of publication of the PDD for global stakeholder consultation (as it is the case of the Viñales project activity), the Project Proponent must demonstrate that the CDM was seriously considered in the decision to implement the project activity. Such demonstration requires the following elements to be satisfied:

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[25] "Carbon Bonds", the English translation.

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

1) Demonstrate awareness of the CDM prior to the project activity start date and that the benefits of the CDM were a decisive factor in the decision to proceed with the project. Evidence to support this would include, inter alia, minutes and/or notes related to the consideration of the decision by the Board of Directors, or equivalent, of the project participant, to undertake the project as a CDM project activity.

2) The project participant must indicate, by means of reliable evidence that continuing and real actions were taken to secure CDM status for the project in parallel with its implementation. Evidence to support this should include, inter alia, contracts with consultants for CDM/PDD/methodology services, Emission Reduction Purchase Agreements, etc.

1) <u>Awareness of the CDM and decisive role of the CDM in the decision to proceed with the Viñales project activity.</u>

According to the evidence presented above, it is clear that there was plenty of awareness of the CDM prior to the date if the publication of the PDD for global stakeholder consultation. Additional evidence showing awareness of the CDM related to the Viñales project activity includes the following:

- The first presentations of the Viñales project activity to the Arauco management are dated September 2005. Such presentation was made to the Board of Directors of Arauco Generación, Arauco's Power business unit.

- The first assessments of the Viñales project in the CDM, considering the applicable baseline methodology and the corresponding emission reduction calculation are dated January 2007. Documented evidence of this includes excel spreadsheets and internal emails between Arauco divisions. This assessment was later on incorporated in the financial evaluation of the proposed project (see below).

To demonstrate that the CDM was a decisive factor to proceed with the Viñales project, the Project Proponent would like to present several email communications involving the relevant key decision makers in Arauco for the Viñales project:

- The CEO of Arauco,
- The President of Arauco's Sawmill business unit,
- The CEO of Arauco's Power business unit,
- Board of Director Members of Arauco's Power and Sawmill business units,

In these communications it is clearly established that the Viñales biomass power plant is considered to be developed under the CDM and therefore, they <u>explicitly</u> mention and consider the CDM benefits associated to the Viñales project activity. Such communications are dated <u>before</u> the starting date of the Viñales project activity (23/04/2008, see section C of this PDD).

The table also presents official evidence that further confirms and ratifies the intention of the Arauco management to develop the Viñales power plant project as a CDM project activity.

N°	Communication	Description of the communication
1	Email date: 19/11/2008 (the email explicitly refers to a financial evaluation that considered the benefits of the CDM, dated January, 2008). From: Analyst in Arauco Generación, in charge of performing the financial evaluation of the Viñales project. To: Development Manager of Arauco Generación, in charge of CDM project development in Arauco.	The email contained the first financial evaluation of the Viñales project, performed in January, 2008, in which the benefits of the CDM were included.
2	Email date: 16/04/2008 From: Development Manager of Arauco Generación, in charge of CDM project development in Arauco. To: CEO of Arauco Generación.	Provided a new estimate (in US$/year) of the CDM income associated to the Viñales power plant. Also mentioned the underlying assumptions associated to estimated CDM income (e.g. quantity of electricity generated, biomass consumption, etc.).
3	Email date: 16/04/2008 From: CEO of Arauco Generación. To: President of Arauco's Sawmill business division and Board of Director member of Arauco Generación.	Email contained a brief presentation of the Viñales financial evaluation in which the CDM income is explicitly mentioned and considered as part of the project.
4	Email date: 17/04/2008 From: President of Arauco's Sawmill business division and Board of Director member of Arauco Generación. To: Arauco's CEO and Board of Director Member of Arauco Generación.	Idem as above.
5	Email date: 21/04/2008 From: CEO of Arauco Generación. To: President of Arauco's Sawmill business division and Board of Director member of Arauco Generación. Copy: Arauco's CEO and Board of Director Member of Arauco Generación among others.	Email contained a Power Point presentation of the Viñales biomass power plant project in which the CDM income is explicitly mentioned and used in the financial evaluation that was considered in the decision to proceed with the Viñales project (see the Board of Director meeting below).
6	Email date: 22/04/2008 From: CEO of Arauco Generación. To: Financial Analyst in Arauco's Financial Division. Copy: President of Arauco's Sawmill business division and Board of Director member of Arauco Generación and Arauco's CEO and Board of Director Member of Arauco Generación.	Email contained a Power Point presentation of the Viñales biomass power plant project in which the CDM income is explicitly mentioned and used in the financial evaluation that was considered in the decision to proceed with the Viñales project (see the Board of Director meeting below).
--	Sawmill division Board of Directors Meeting report. Date of the meeting: May, 23rd, 2008. Participants: Arauco's CEO, Directors of Arauco's Sawmill and Power business units.	The last page of the meeting report confirms the approval of the Viñales biomass power plant project. The meeting report explicitly mentions an IRR of the project that is the same as the IRR found in the Viñales power point presentation that considered the CDM income. This is the same power point presentation mentioned in the email communications presented above and such presentation explicitly considered the CDM income associated to the Viñales biomass power plant project.

Arauco publicly declared the consideration of the CDM in the development of the Viñales project activity in its 2008 Annual Report[27]:

Communication	Description of the communication
Arauco's 2008 Annual Report and Environmental and Social Responsibility Report.	Page 26 of the report states the following: "(…) During 2008, ARAUCO initiated two projects to further

[27] This report is publicly available at http://www.arauco.cl, under "Media", "Publications", "Annual Reports".

	increase its energy production from renewable resources for its own requirements and to increase its contribution to the Chile's energy grid (SIC) by an additional 32 MW. The first investment is (…). The second is the construction of a biomass-based cogeneration power plant in the Viñales area, near Constitución. Both projects are being carried out as Clean Development Mechanism projects according to the Kyoto Protocol. By generating CO2 neutral energy, they replace fossil-fuel generated electricity, which reduces greenhouse gas emissions. These investments also demonstrate how ARAUCO is working to address climate change. (…)"

The Declaration of Impact Assessment of the Viñales project was developed during the second half of 2008 by Arauco and was presented to the Environmental Authorities in July 2008. The document declares in pages 2 and 3 the following:

"It must be mentioned that the proposed project is developed within the framework of the Clean Development Mechanism of the Kyoto Protocol of 1997, which is aimed at stabilizing the Greenhouse Gas Emissions in the atmosphere. The project will generate lower green house gas emissions by means of generating renewable electric power which is neutral in CO_2. In this way, the project will comply with the main goal of the UNFCCC of 1992 and the Kyoto Protocol of 1997, both treaties ratified by Chile. It is estimated that the project will generate a reduction of greenhouse gases equal to 220,000 tons of CO_2 equivalents per year[28].

(…)

In addition, and just as it has been mentioned before, the proposed power generation type allows Celulosa Arauco y Constitución to consider this project as a CDM (Clean Development Mechanism) project, developed under the Kyoto Protocol, allowing (the company) to certify carbon credits."

2) Actions taken in parallel to the implementation of the Viñales project activity aimed at securing the CDM status of the Viñales project

The Project Proponent took the following actions:

- In July, 19th 2008 the Project Proponent sent an email to DNV asking for a validation proposal for the Viñales CDM project activity.
- In July, 29th 2008, the Project Proponent signed a contract with DNV for validation services for the Viñales CDM project activity.
- In July, 31st 2008, the Project Proponent sent the first version of the Viñales PDD to DNV to be published for public comments.

[28] This was a very preliminary estimation of the project activity´s credit generating capacity. This explains the difference between this estimation and the estimation done in this PDD.

- In July 31st 2008, the Project Proponent contacted the Chilean DNA in order to ask for the required documentation required to obtain the Letter of Approval for a CDM project activity. The Chilean DNA replied with a mail dated August, 1st 2008.

Considering the evidence presented above, the following can be concluded:

- There was plenty of awareness of the CDM, both on a general basis and in relation to the Viñales project activity before the starting date of the project activity,

- The CDM played a decisive role in the decision making process to go ahead with the Viñales project (also before the starting date of the project activity),

- The Project Proponent took continuing and real actions in parallel with the implementation of the Viñales project activity to secure its CDM status.

Step 4: Common practice analysis,

4.1 Other activities similar to the proposed project activity in Chile

4.1.1 Arauco initiatives:

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

Arauco has two biomass cogeneration power plants similar to the proposed project activity: The Trupan biomass power plant and the Nueva Aldea Phase 1 biomass power plant. Both projects were developed as part of Arauco's initiative in the CDM and are currently registered CDM project activities:

- "Trupan Biomass Power Plant in Chile", Ref: 0259
- "Nueva Aldea Biomass Power Plant Phase 1", Ref: 0258

4.1.2 Other company's initiatives:

A relevant competitor in the pulp industry in Chile installed a biomass (bark) power boiler (150 ton steam/hr at 60 bar) inside one of its pulp mills. This initiative was mainly oriented towards the generation of steam for a future wood products mill that will be installed near the pulp mill area. It will also provide additional steam to increase the electric power generation capacity inside the pulp mill to make it (and other company's interconnected pulp mills in the region) self-sufficient in electric power generation.

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

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

4.2. Analysis of similar options observed in Chile

Other biomass cogeneration initiatives have been presented and discussed in the preceding section. From the Project Proponent's point of view, these initiatives present clear differences that make the proposed project activity particular and unique in its type. However, even in the case these cogeneration initiatives were considered similar to the proposed project activity, biomass cogeneration for additional power generation would still not be the common practice in any of the industries in which the proposed project activity is related to:

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

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

Sources: CNE, <http://www.cne.cl/>, CDEC-SIC.
Note: Biomass power generation includes all types of biomass. 2008 includes 4 Arauco biomass power generation projects registered under the CDM.

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

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

Artificial drying is accomplished using two techniques. The first one uses traditional drying chambers in which the wood is dried at approximately 70ºC and ambient pressure. The energy required to heat the chamber is normally generated by a saturated steam boiler fuelled by the wood residues from the same saw-milling process. The second consists in vacuum drying, in which the wood is dried in a vacuum chamber at ambient temperature. This system is more efficient than the previous one, but implies the consumption of electric power, which is supplied from the grid. On-site electric power cogeneration from biomass sources is not considered (even hardly mentioned) as normal practice in this industry[29].

Other comparable industries: Plywood, MDF and other wood panel board industries: Like sawmills, plywood mills and other wood panel producing mills are not designed to operate with high pressure steam, so on-site power generation is not considered a normal practice either. In Chile there are

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

two cogeneration initiatives comparable (in scope and scale) to the proposed project activity: the Trupan and the Nueva Aldea Phase 1 cogeneration power plants, owned by Arauco. As mentioned before, both initiatives have been implemented under the CDM.

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

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

1. The Viñales biomass power plant project is one of the few of its type in Chile.

2. Biomass cogeneration projects in the Sawmill and Panel board industries are not observed as common initiatives.

3. Biomass cogeneration projects in the Power industry are equally unique and therefore not observed as common initiatives either.

4. The utilization of the biomass cogeneration technology in the Pulp industry context is normally used. However, this technology is used for making the pulp mill facility self-sufficient in heat and electric power generation and not for making the facility generate surplus power to the grid. In addition, there are sufficient differences in scale and context to make the proposed project activity not comparable to power generation initiatives in the Pulp industry.

For these reasons, the Viñales biomass power plant project activity is not considered to be part of the common practice in the relevant (and comparable) industry (ies) in Chile and therefore, considered additional from a common practice analysis perspective.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

Baseline case scenarios

According to the ACM0006 (Version 09), the Project Proponent must select a suitable combination of baseline scenarios for power, heat and biomass. Considering the analysis for the baseline done in section B.4 and Table Nº 2 of the ACM0006 (Version 09), the scenario that best fits with the chosen baseline scenario of the proposed project activity is Scenario Nº 3:

Combination of baseline scenarios chosen for the Viñales biomass power plant project

Scenario	Project type	Baseline scenario		
		Power generation	**Use of biomass**	**Heat generation**
3	Power projects	P4	B1	H4

Scenario Nº 3 fits exactly with the baseline scenario chosen for the proposed project activity. A detailed analysis of this scenario in the context of the project activity situation is provided below:

From scenario Nº 3 in Table Nº 2, page 10/77 of the ACM0006 (Version 09):

"The project activity involves the installation of a new biomass residue fired cogeneration plant at a site where no power was generated prior to the implementation of the project activity."

This is the case of the proposed project activity, since a new 210 (ton/hr), 85 bar power boiler and a 41 MW condensing/extracting turbogenerator will be installed in a site where no power was generated before. In fact, before the implementation of the project activity, the Viñales sawmill obtained the power from the grid.

"The power generated by the project plant is fed into the grid or would in the absence of the project activity be purchased from the grid."

This is precisely the case with the proposed project activity, since a fraction of the power that will be generated by the new cogeneration power plant will be consumed by the Viñales sawmill and the rest will be injected to the grid. As said before, in the absence of the proposed project activity, the sawmill would have continued sourcing its power from the grid.

"The biomass residues would in the absence of the project activity (a) be used for heat generation in boilers at the project site and (b) be dumped or left to decay or burnt in an uncontrolled manner without utilizing it for energy purposes. This may apply, for example, where the quantity of biomass residues that was not needed for heat generation was dumped, left to decay or burnt in an uncontrolled manner prior to the project implementation."

This is the case with the proposed project activity, since in the absence of the new power plant, a low pressure boiler would have used a fraction of the biomass residues used by the proposed project activity to generate heat and the rest of the biomass would have been dumped or left to decay or burnt in an uncontrolled manner without utilizing them for energy purposes.

"The heat generated by the new cogeneration plant would in the absence of the project activity be generated in boilers using the biomass residues that are fired in the cogeneration plant."

As was said before, in the absence of the proposed project activity, a low pressure boiler would have been installed, which would have generated the heat required by the Viñales sawmill.

To complement the analysis above, the ACM0006 (Version 09) requires in page 6/77 to provide the following information:

For each power plant that was operating at the project site during the most recent three years prior to the start of the project activity:

Type and capacity of the power plant:	There was no power plant operating at the project site before the implementation of the project activity.
Types and quantities of fuels that have been used in the power plant during the most recent three years prior to the start of the project activity:	Not applicable.
Does the plant continue to operate after the start of the project activity?:	Not applicable.

For each boiler or other heat generation equipment that was operating at the project site during the most recent three years prior to the start of the project activity:	
Type and capacity of the boiler:	There was no boiler or other heat generation equipment operating before the implementation of the project activity.
Types and quantities of fuels that have been used in the boiler during the most recent three years prior to the start of the project activity:	Not applicable.
Does the boiler continue to operate after the start of the project activity?:	Not applicable.

For each boiler or power plant installed under the project activity:	
Type and capacity of boilers and/or power plants:	• One 210 (t/hr), 85 bar power boiler. • One 41 MW condensing/extracting turbogenerator.
Types of fuels that are planned to be used:	• 130,640 (BDt/yr) of biomass from forestry operations (harvesting, pruning and thinning). • 26,100 (BDt/yr) of biomass from industrial operations (from nearby sawmills). • 90,000 (BDt/yr) of biomass from industrial operations (from the Viñales Sawmill). • 538 (ton/yr) of fuel oil N°6 due to operational reasons. • 61,320 (ton/yr) of fuel oil N°6. This consumption is occasional and subject to convenient power prices. This consumption was not considered for emission reduction calculation in this PDD. • 400 (lt/yr) of LPG. This consumption is related to start-up operations of the power boiler and is not related to the implementation of the project activity.

For each new boiler or power plant that would be installed in the absence of the project activity:	
Type and capacity of boilers and/or power plants:	• A 60 (t/hr), 20 bar biomass boiler. • No power generation capacity added.
Types of fuels that are planned to be used:	• 104,900 (BDt/yr) of biomass from industrial operations.

For more detailed information about the biomass types and quantities used before and after the implementation of the proposed project activity, please see table "Consumptions and baselines per biomass types" in section B.4 of this PDD.

<u>Equation used to calculate emission reductions</u>

The net emission reductions of the proposed project activity are calculated through equation 1 of the ACM0006 (Version 09):

$$ER_y = ER_{heat,y} + ER_{electricity,y} + BE_{biomass,y} - PE_y - L_y$$

Where:

ER_y =	Emission reductions of the project activity during the year y (tCO_2/yr).
$ER_{electricity,y}$ =	Emission reductions due to displacement of electricity during the year y (tCO_2/yr).
$ER_{heat,y}$ =	Emission reductions due to displacement of heat during the year y (tCO_2/yr).
$BE_{biomass,y}$ =	Baseline emissions due to anthropogenic sources of biomass residues during year y (tCO_2e/yr).
PE_y =	Project emissions during the year y (tCO_2/yr).
L_y =	Leakage emissions during the year y (tCO_2/yr).

Since the proposed project activity does not contemplate emission reductions on heat generation from biomass residues, equation 1 results in:

$$ER_y = ER_{electricity,y} + BE_{biomass,y} - PE_y - L_y$$

<u>Project emissions</u>

Project emissions for the proposed project activity are calculated through equation 2 of the ACM0006 (Version 09):

$$PE_y = PET_y + PEFF_y + PE_{EC,y} + GWP_{CH4} * (PE_{Biomass,CH4,y} + PE_{ww,CH4,y})$$

Where:

PET_y =	CO_2 emissions during the year y due to transport of the biomass residues to the project plant (tCO_2/yr).
$PEFF_y$ =	CO_2 emissions during the year y due to fossil fuels co-fired by the generation facility or other fossil fuel consumption at the project site that is attributable to the project activity (tCO_2/yr).
$PE_{EC,y}$ =	CO_2 emissions during the year y due to electricity consumption at the project site that is attributable to the project activity (tCO_2/yr).
GWP_{CH4} =	Global Warming Potential for methane valid for the relevant commitment period.
$PE_{Biomass,CH4,y}$ =	CH_4 emissions from the combustion of biomass residues during the year y (tCH_4/yr).
$PE_{WW,CH4,y}$ =	CH_4 emissions from waste water generated from the treatment of biomass residues in year y (tCH_4/yr).

Since the proposed project activity does not generate wastewater originating from the treatment of the biomass, equation 2 results in:

$$PE_y = PET_y + PEFF_y + PE_{EC,y} + GWP_{CH4} * PE_{Biomass,CH4,y}$$

<u>a) Carbon dioxide emissions from combustion of fossil fuels for transportation of biomass residues to the project plant (PET_y)</u>

The proposed project activity contemplates the use of additional biomass residues from industrial and forestry operations. Since the transportation of such residues is done by vehicles (trucks), the Project

Proponent will use Option 1 provided by the ACM0006 (Version 09) in page 27/77. This option contemplates the possibility to use two equations, alternatively:

$$PET_y = N_y * AVD_y * EF_{km,CO2,y}$$

or

$$PET_y = \frac{\sum_k BF_{T,k,y}}{TL_y} * AVD_y * EF_{km,CO2,y}$$

Where:

PET_y =	CO_2 emissions during year y due to transport of the biomass residues to the project plant (tCO_2/yr).
N_y =	Number of truck trips during the year y.
AVD_y =	Average round trip distance (from and to) between the biomass residue fuel supply sites and the site of the project plant during year y (km).
$EF_{km,CO2,y}$ =	Average CO_2 emission factor for the trucks measured during the year y (tCO_2/km).
$BF_{T,k,y}$ =	Quantity of biomass residue type k combusted in the project plant during the year y (tons of dry matter or liter).
TL_y =	Truck average biomass transportation capacity (ton).
k =	Types of biomass residues used in the project plant and that have been transported to the project plant in year y.

In this case, the Project Proponent will use the second equation to calculate $PET_{y.}$

It must be noted that project emissions related to this source will only be accounted for the additional consumption of biomass from industrial/forestry operations related to the additional power generation. The way in which the quantity of additional biomass is calculated will be presented in the section related to the baseline emissions calculation.

b) Carbon dioxide emissions from on-site consumption of fossil fuels ($PEFF_y$)

According to the ACM0006 (Version 09), the Project Proponent must use the last version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion". According to this tool and considering the availability of information in the country in which the proposed project activity is implemented, the project proponent will use the following approach for determining CO_2 emissions:

$$PE_{FC,j,y} = \sum_i (FC_{i,j,y} * COEF_{i,y})$$

Where:

$PE_{FC,j,y}$ =	CO_2 emissions from fossil fuel combustion in process j during the year y (tCO_2/yr).
$FC_{i,j,y}$ =	Quantity of fuel type i combusted in process j during the year y (mass or volume unit/yr);

$COEF_{i,y}$ = 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 $COEF_{i,y}$ will be calculated using approach B of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", which consists in calculating the coefficient based on the net calorific value and CO_2 emission factor of the fuel type i, as follows:

$$COEF_{i,y} = NCV_{i,y} * EF_{CO2,i,y}$$

Where:

$COEF_{i,y}$ = CO_2 emission coefficient of fuel type i in year y (tCO_2/mass or volume unit);
$NCV_{i,y}$ = Weighted average net calorific value of the fuel type i in year y (tCO_2/GJ);
$EF_{CO2,i,y}$ = Weighted average CO_2 emission factor of fuel type i in year y (tCO_2/GJ);
i = Fuel types combusted in process j during the year y.

For $NCV_{i,y}$ and $EF_{CO2,i}$ monitoring, the Project Proponent will use IPCC default values for the emission reduction calculation in this PDD. For subsequent monitoring, the project proponent may use other sources, in accordance with the guidance of the ACM0006 (Version 09) monitoring methodology and the corresponding tool.

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

Fossil fuels combusted in the project plant during the year y ($FF_{projectplant,i,y}$).

The proposed project activity includes the possibility of co-firing some fossil fuels due to operational reasons (i.e. start-up operations, biomass being too wet in winter, etc.) and to a limited extent, to enhance the economic performance of the power plant during high-power price market conditions. In the first case, fossil fuel used due to operational reasons will be measured and scaled down in proportion to the biomass associated to the project activity (i.e. biomass related to electric power generation). In the second case, fossil fuel is attributed completely to electric power generation, therefore it will be considered fully as a project emission source.

As a result, fossil fuel consumption attributable to the project activity may happen under the following circumstances:

1. Operational reasons: Consider additional fossil fuel consumption attributed to the project activity.
2. Power generation: Consider all fossil fuel amounts used to enhance electric power generation.

Fossil fuels combusted at the project site for other purposes that are attributable to the project activity during year y ($FF_{projectsite,i,y}$).

These include:

- Fossil fuels combusted due to the on-site transportation of the additional biomass to the power plant.

- Fossil fuels combusted due to the additional ashes disposal of the power boiler derived from a higher biomass consumption.

In this case, the fossil fuel consumption that will be considered as a project emission source is the one related to the additional biomass consumption (and the corresponding ash disposal) under the proposed project activity.

c) Carbon dioxide emissions from electricity consumption ($PE_{EC,y}$)

The proposed project activity does not imply electricity consumption at the project site, other than the power consumption of the new Viñales biomass power plant (i.e. new pumps, fans, etc.). According to page 29/77 of the ACM0006 (Version 09), all the additional electricity consumption related to the project activity is already accounted in the calculation of the net electric power generation (in addition to the baseline scenario) of the Viñales biomass power plant, therefore no project emissions are calculated due to this source.

Nevertheless, if in the future the project activity incorporated additional electric power consumption attributable to the project activity (e.g. for mechanical treatment of the biomass residues) this emission source will be calculated and considered as a project emission source. The calculation will be performed as indicated in the ACM0006 (Version 09), which indicates the use of the last approved version of the "Tool to calculate project emissions from electricity consumption".

d) Methane emissions from combustion of biomass residues ($PE_{Biomass,CH4,y}$)

Since this source is included in the project boundary, emissions are calculated using equation 6 of the ACM0006 (Version 09):

$$PE_{Biomass,CH4,y} = EF_{CH4,BF} * \sum_{k} BF_{k,y} * NCV_{k}$$

Where:

$BF_{k,y}$ =	Quantity of biomass residue type k combusted in the project plant during the year y (tons of dry matter or liter).
NCV_k =	Net calorific value of the biomass residue type k (GJ/ton of dry matter or GJ/liter).
$EF_{CH4,BF}$ =	CH_4 emission factor for the combustion of biomass residues in the project plant (tCH_4/GJ).

The methodology provides in Tables 4 and 5 default values for the methane emission factor. The selection and justification of the methane emission factor used is explained in the following subsection of this PDD.

e) Methane emissions from waste water treatment ($PE_{WW,CH4,y}$)

The proposed project activity does not imply the generation of wastewater from biomass treatment under anaerobic conditions. However, in the unlikely event that this situation changed in the future, this emission source will be determined according to the guidance of the ACM0006 (Version 09).

Baseline emissions

a) Emission reductions due to displacement of electricity

Emissions reductions due to the displacement of electricity are calculated using equation 8 of the ACM0006 (Version 09):

$$ER_{electricity,y} = EG_y * EF_{electricity,y}$$

Where:

$ER_{electricity,y}$ =	Emission reductions due to displacement of electricity during the year y (tCO_2/yr).
EG_y =	Net quantity of increased electricity generation as a result of the project activity (incremental to baseline generation) during the year y (MWh).
$EF_{electricity,y}$ =	CO_2 emission factor for the electricity displaced due to the project activity during the year y (tCO_2/MWh).

Determination of $EF_{electricity,y}$

According to the corresponding baseline scenario for electricity generation (P4), the proposed project activity displaces electricity from other grid-connected sources. In this case, the emission factor for the displacement of electricity should correspond to the grid emission factor ($EF_{electricity,y}$ = $EF_{grid,y}$) and $EF_{grid,y}$ shall be determined as follows:

- Since the proposed project activity involves a power capacity addition higher than 15 MW, $EF_{grid,y}$ is calculated as a combined margin (CM), following the guidance in the section “Baselines” in the “Consolidated baseline methodology for grid-connected electricity generation from renewable sources” (ACM0002). The ACM0002 (Version 10) refers to the “Tool to calculate the emission factor for an electricity system” for the proper calculation of the $EF_{electricty,y}$.

According to the “Tool to calculate the emission factor for an electricity system (Version 02)” the following steps must be followed:

Step 1: Identify the relevant electric power system.

The tool establishes that the Project Proponent should use the electricity system to which the proposed project activity is connected to, provided there are no significant transmission constraints.

The proposed project activity is connected to the Central Interconnected System of Chile (SIC). The SIC is composed by the transmission lines and the interconnected power plants that operate from Rada de Paposo in the north (II Region), to Isla Grande de Chiloé in the south (X Region). The SIC is the largest of the four transmission systems in Chile, accounting for about 75% of the power generation capacity of the country and supplying to approximately 93% of the total population. The SIC has no interconnection with any other transmission system in Chile or in the region.

According to the criteria indicated in the tool for establishing the presence of significant transmission constraints, the Project Proponent verified that none of the conditions are satisfied in the case of the SIC system. In particular, the Project Proponent verified that:

1. Prices in the SIC do not differ more than 5% during 60% or more of the year and

2. There is no transmission line in the SIC that is operated at 90% or more during 90% or more of the year.

The corresponding assessment for the SIC grid was done for the year 2008. The study will be provided as supporting evidence during the validation of the proposed project activity.

The absence of significant transmission constraints in the transmission systems can be further substantiated by the Short Law N° 1 (March, 2004). This law mandates transmission companies to assess their transmission systems every 4 years and make all the necessary investments in order to secure the quality and safety of the transmission service.

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

Not applicable in this case.

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

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

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

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

The Simple Adjusted OM method requires identifying low cost/must run resources (*k*) from other power sources (m):

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

Where:

$EF_{grid,OM-adj,y}$ = Simple adjusted operating margin CO_2 emission factor in year y (tCO_2/MWh).

λ = Factor expressing the percentage of time when low-cost/must-run power units are on the margin in year y.
$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh).
$EG_{k,y}$ = Net quantity of electricity generated and delivered to the grid by power unit k in year y (MWh).
$EF_{EL,m,y}$ = CO_2 emission factor of power unit m in year y (tCO_2/MWh).
$EF_{EL,k,y}$ = CO_2 emission factor of power unit k in year y (tCO_2/MWh).
m = All grid power units serving the grid in year y except low-cost/must run power units.
k = 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.

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

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

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

The Project Proponent will use the *Ex-post option* to calculate the OM; that is, the OM will be calculated the year in which the project generation occurs.

The Project Proponent will use:

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

- Option A1 for calculating the emission factor of each power unit m: Use information based on fuel consumption and electricity generation of each power unit m.

<u>Step 4:</u> Calculate the operating margin emission factor according to the selected method.

This is done in section B.6.3 of this PDD.

<u>Step 5:</u> Identify the group of power units to be included in the build margin.

This is done in section B.6.3 and in the Annex 3 of this PDD.

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

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

calculated *ex ante*, as described in Option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.

Step 6: Calculate the build margin emission factor.

This is done in section B.6.3 and in the Annex 3 of this PDD.

Step 7: Calculate the combined margin emission factor.

This is done in section B.6.3 and in the Annex 3 of this PDD.

It must be noted that according to the guidance provided by the "Tool to calculate the emission factor for an electricity system", page 16, there are no reasons to depart from the suggested weights, therefore the Project Proponent will choose the following option for selecting the weights:

- Weights: $w_{OM} = 0.5 = w_{BM} = 0.5$ for the first crediting period and
- Weights: $w_{OM} = 0.25 = w_{BM} = 0.75$ for the second and third crediting periods.

Determination of $EG_{,y}$

According to page 33/77 of the ACM0006 (Version 09), in this case, EG_y corresponds to the net quantity of electricity generation in the project plant:

$$EG_y = EG_{projectplant,y}$$

Where:

EG_y = Net quantity of electricity generation as a result of the project activity during the year y (MWh/yr).
$EG_{projectplant,y}$ = Net quantity of electricity generated in the project plant during the year y (MWh/yr).

b) Emission reductions due to biomass piling to natural decay

According to the ACM0006 (Version 09), in cases where the most likely scenario for the use of the biomass residues is that the residues would be dumped and left to decay under mainly aerobic conditions (B1), the corresponding baseline emissions must be calculated assuming that the biomass residues would be burnt in an uncontrolled manner. Therefore, the baseline emissions are calculated using equation 46 of the ACM0006 (Version 09):

$$BE_{biomass,y} = GWP_{CH4} * \sum_k BF_{PJ,k,y} * NCV_k * EF_{burning,CH4,k,y}$$

Where:

$BE_{biomass,y}$ = Baseline emissions due to natural decay or burning of anthropogenic sources of biomass residues during the year y (tCO_2e/yr).
GWP_{CH4} = Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4).
$BF_{PJ,k,y}$ = Incremental quantity of biomass residue type k used as a result of the project activity in the project plant during the year y (tons of dry matter or liter).
NCV_k = Net calorific value of the biomass residue type k (GJ/ton of dry matter or GJ/liter).
$EF_{burning,CH4,k,y}$ = CH_4 emission factor for uncontrolled burning of the biomass residue type k during the year y (tCH_4/GJ).
k = Types of biomass residues for which the identified baseline scenario is B1 or B3 and for which leakage effects could be ruled out with one of the approaches L_1, L_2 or L_3 described in the leakage section.

According to page 48/77 of the ACM0006 (Version 09), the biomass related to the project activity must be determined using equation 42 and 43 as follows:

$$BF_{PJ,k,y} = BF_{k,y} - \frac{Q_{projectplant,y}}{\varepsilon_{boiler} * NCV_k}$$

and

$$\sum_k BF_{PJ,k,y} * NCV_k = \sum_k BF_{k,y} * NCV_k - \frac{Q_{projectplant,y}}{\varepsilon_{boiler}}$$

Where:

$BF_{PJ,k,y}$ = Incremental quantity of biomass residues type k used as a result of the project activity in the project plant during the year y (tons of dry matter or liter).
$BF_{k,y}$ = Quantity of biomass residue type k combusted in the project plant during the year y (tons of dry matter or liter).
NCV_k = Net calorific value of the biomass residue type k (GJ/ton of dry matter or GJ/liter).
$Q_{Project\ plant,y}$ = Quantity of heat generated in the cogeneration project plant from firing biomass residues during the year y (GJ).
ε_{boiler} = Energy efficiency of the boiler that would be used in the absence of the project activity.

It must be noted that according to the ACM0006 (Version 09), the equations above will be applied based on the specific circumstances of the project activity, thereby ensuring that the total incremental quantity of all biomass residues types k used as a result of the project activity corresponds to the difference between the total quantity of biomass residues used in the project plant and the total quantity that would be required to generate heat in boilers in the absence of the project activity.

Leakage emissions

According to the ACM0006 (Version 09), page 52/77, where the most likely baseline scenario is that the biomass residues are dumped or left to decay or burnt in an uncontrolled manner without utilizing them

for energy purposes, project participants shall demonstrate that the use of the biomass residues does not result in increased fossil fuel consumption elsewhere.

To assess possible leakage effects of this biomass type, the Project Proponent will choose option L2, which requires establishing that the quantity of available biomass residues of this type in the region is at least 25% larger than the quantity of biomass residues of this type that are utilized.

Though the possibility of leakage in the proposed project activity is very low, in case it occurs, leakage emissions will be calculated according to equation 47 in page 53/77 of the ACM0006 (Version 09).

$$L_y = EF_{CO2,LE} * \sum_k BF_{PJ,k,y} * NCV_k$$

Where,

L_y =	Leakage emissions during the year y (tCO_2/yr).
$EF_{CO2,LE}$ =	CO_2 emission factor of the most carbon intensive fuel used in the country (tCO_2/GJ).
$BF_{PJ,k,y}$ =	Incremental quantity of biomass residue type k used as a result of the project activity in the project plant during the year y (ton of fry matter or liter).
k =	Types of biomass residues for which leakage effects could not be ruled out with one of the approaches L_1, L_2 or L_3 above.
NCV_k =	Net calorific value of the biomass residue type k (GJ/ton of dry matter or GJ/liter).

Default values

a) Methane emission factor for uncontrolled burning of biomass

According to the baseline methodology ACM0006 (Version 09), page 51/77, the Project Proponent may undertake measurements or use referenced default values to calculate the CH_4 baseline emissions from uncontrolled burning of biomass. In order to accomplish a higher accuracy in the baseline emission calculations, the Project Proponent conducted a local measurement of this factor at the start of the project activity instead of using the default value provided by the methodology.

During March 2009, the Project Proponent hired the U.S. Forest Service of Missoula, Montana, USA to conduct a measurement of the CH_4 emission factor for uncontrolled burning of the same biomass types that will be burned as a result of the Viñales CDM project activity. The results are the following:

- Biomass from third parties (mix of sawdust and bark): 930 (Kg CH_4/TJ) and a standard deviation of 168 (Kg CH_4/TJ).

- Biomass from forestry operations (from harvesting, thinning and pruning operations): 114 (Kg CH_4/TJ) and a standard deviation of 114 (Kg CH_4/TJ).

These results were obtained during the dry season in Chile (end of summer), when the biomass is dryer and the weather conditions favor a more efficient combustion of the biomass residues. As a result, these results reflect the lower boundary of methane emission factor that would be obtained if measurements were carried out during the full year. This approach was deemed appropriate by the Project Proponent,

since it leads to a more conservative emission reduction calculation for the project activity. For more details, please see Annex N° 3 of this PDD.

Considering the results above and Table 6 of the ACM0006 (Version 09) baseline methodology, the corresponding conservativeness factors for these measurements are[30]:

- Biomass from third parties (mix of sawdust and bark): 0.94.
- Biomass from forestry operations (from harvesting, thinning and pruning operations): 0.89.

These factors led to the following adjusted methane emission factors for the two types of biomass burned:

- Biomass from third parties (mix of sawdust and bark): 874.2 (Kg CH_4/TJ).
- Biomass from forestry operations (from harvesting, thinning and pruning operations): 101.46 (Kg CH_4/TJ).

b) Methane emission factor for controlled burning of biomass

According to the baseline methodology ACM0006 (Version 09), page 29/77, the Project Proponent may conduct measurements at the plant site or use IPCC default values. In this case, the Project Proponent decided to measure the methane emission factor from the power boiler flue gases, in accordance with the ACM0006 (Version 09) monitoring methodology. The conservativeness factor will be determined each time, in a similar way as it was determined for the uncontrolled burning of biomass residues, above.

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	**GWP_{CH4}**
Data unit:	(tCO_2e/tCH_4)
Description:	Global Warming Potential for CH_4.
Source of data used:	IPCC
Value applied:	21 for the first commitment period. Shall be updated according to any future COP/MOP decisions.
Justification of the choice of data or description of measurement methods and procedures actually applied:	Until the next COP/MOP decision, it is the accepted value for emission reduction calculations in CDM project activities.
Any comment:	--

Data / Parameter:	**$EG_{Baseline}$**

[30] A confidence interval for the sample mean was used to determine the assigned uncertainty band and the corresponding uncertainty range.

Data unit:	(MWh/yr)
Description:	Electricity consumption of the reference (baseline) plant.
Source of data used:	Energy/mass balance of a heat generating plant by Arauco.
Value applied:	0.7 MW
Justification of the choice of data or description of measurement methods and procedures actually applied:	The chosen value corresponds to a realistic (empiric) estimation of the electric power consumption of a heat generation plant in sawmills.
Any comment:	This power consumption must be considered in the determination of the net electricity generation of the project plant. For more details, please see EG_y in section B.7.1 of this PDD. The value used in this case is consistent with historic electricity consumption data of steam generating power plants in the Arauco sawmill division.

Data / Parameter:	**$EF_{burning,CH4,k,y}$**
Data unit:	(tCH_4/GJ)
Description:	CH_4 emission factor for uncontrolled burning of the biomass residue type k during year y.
Source of data used:	Direct measurements at the start of the project activity.
Value applied:	• Biomass residues from industrial operations (mainly sawdust and bark from sawmills): 0.0008742 (tCH_4/GJ) or 874.2 (Kg CH_4/TJ). This value includes the adjustment of a conservativeness factor of 0.94. • Biomass residues from forestry operations (mainly branches from harvesting, pruning and thinning operations): 0.00010146 (tCH_4/GJ) or 101.46 (Kg CH_4/TJ). This value includes the adjustment of a conservativeness factor of 0.89.
Justification of the choice of data or description of measurement methods and procedures actually applied:	The CH_4 measurement was performed for the biomass types that will be used as a result of the implementation of the Viñales project activity. For a detailed description on the methods used, please see Annex 3 of this PDD.
Any comment:	Differences between IPCC default values and the measured values are due to the compactness level of the biomass residues burned. In case of the biomass from industrial operations, the biomass is densely packed allowing for very little oxygen in the combustion process. This leads to high methane emission factors. In the case of the biomass from forestry operations, the biomass (mainly branches) allow for plenty of oxygen during the combustion, which leads to much lower methane emission factors. The measured values are consistent with values obtained in other parts of the word under similar conditions.

B.6.3. Ex-ante calculation of emission reductions:

Notes:

1. The emission reduction calculations below correspond to an expected year of operation of the project plant.

2. Baseline and project emissions calculations below may present some minor imprecision due to some decimal rounding.

Project emissions

a) Carbon dioxide emissions from combustion of fossil fuels for transportation of biomass residues to the project plant (PET_y)

The proposed project activity includes two types of biomass: a mix of sawdust and bark from sawmills in the nearby area and biomass residues from forestry operations, which are brought by trucks to the new power plant.

Under normal conditions, the new power plant will consume 246,740 (BDt/yr) from which 156,740 (BDt/yr) would have to be brought by truck to the Viñales sawmill. Since in this case all this biomass is attributed to the project activity (power generation), all the emissions associated to the transportation of these residues must be accounted as project emissions. According to Option 1, equation (4) of the ACM0006 (Version 09) and using some data estimates from the Viñales sawmill, the emissions related to this source can be calculated as follows:

(1) Biomass attributable to the project activity, bought from 3rd parties (dry)	156,740 (BDt/yr)
(2) Biomass average humidity (wet basis)	50%
(3) Approximate load for 1 trip	26 (ton/truck)
(4) Average trip distance between the biomass supply sites and the plant (one way)	120 (km)
(5) Emission factor for heavy truck transportation (*)	1.571 (kgCO_2/km)

(*) This parameter was calculated using the Diesel CO_2 emission factor and the performance index of the trucks (2.0 Km/lt), provided by the Viñales power plant, and the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".

Calculations:

(6) Biomass transported (wet)	(1)/[1 – (2)]	313,480 (wet ton/yr)
(7) Number of trips needed for the Plant per year	(6) / (3)	12,057 (trips/yr)
(8) Total distance travelled, considering round trip	(4)*(7)*2	2,893,662 (km/yr)
(9) Total emissions	**(5)*(8)*(1ton/1,000kg)**	**4,545 (tCO_2/yr)**

b) Carbon dioxide emissions from on-site consumption of fossil fuels ($PEFF_y$)

Fossil fuel consumption in the power boiler attributable to the project activity:
It is expected that 352 (ton/yr) of fuel oil attributed to the project activity will be consumed in the power boiler. According to this, the corresponding emissions can be calculated as follows:

Data/estimates:

(1) Fossil fuel used in the power boiler attributable to the project activity	352 (ton/yr)
(2) Fossil fuel net calorific value	41.7 (GJ/ton)
(3) Fossil fuel CO_2 emission factor	0.07880 (tCO_2/GJ)

Calculations:

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

(4) Total emissions	**(1)*(2)*(3)**	**1,158 (tCO_2/yr)**

Fossil fuel consumption due to on-site transportation of biomass residues: This emission source is generated by the front loaders and/or bulldozers used to transport the biomass residues attributed to the project activity to the power boiler area. To determine this fossil fuel amount, the Project Proponent will calculate the ratio of the biomass attributable to the project activity to the total biomass combusted in the power boiler, and will multiply this ratio by the total fossil fuel consumption related to on-site biomass transportation.

The Project Proponent calculates a total consumption of 246,740 (BDt/yr) of biomass residues in the Viñales new power plant and a total consumption of fossil fuel related to the on-site transportation of this biomass of 69.8 tons of diesel per year. The biomass related to the implementation of the project activity is 161,752 (BDt/yr)[31]. As a result, the project proponent estimates a fossil fuel consumption related to the on-site transportation of the biomass related to the project activity of 45.8 (ton/yr).

According to the above estimates, project emissions can be calculated as follows:

Data/estimates:

(1) Fossil fuel used for on-site biomass transportation due to the project activity	45.8 (ton/yr)
(2) Fossil fuel net calorific value	43.3 (GJ/ton)
(3) Fossil fuel CO_2 emission factor	0.07480 (tCO_2/GJ)

Calculations:

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

(4) Total emissions	**(1)*(2)*(3)**	**148 (tCO_2/yr)**

According to the calculations above, the carbon dioxide emissions from on-site consumption of fossil fuels attributable to the implementation of the project activity can be summarized in the table below:

Carbon dioxide emissions from on-site consumption of fossil fuels	**(tCO_2/yr)**

[31] This calculation is shown below, in the baseline emission calculation section.

Fossil fuel consumption in the power boiler	1,158
Fossil fuel consumption due to on-site biomass transportation	148
Total emissions	**1,306**

c) Carbon dioxide emissions from electricity consumption ($PE_{EC,y}$)

The proposed project activity does not imply any additional on-site electricity consumption. This variable, however, will be part of the monitoring plan and will be considered in the future if the current situation changes.

d) Methane emissions from combustion of biomass residues ($PE_{Biomass,CH4,y}$)

The proposed project activity implies additional biomass consumption due to electric power generation in the new power plant. As a result, the only source of methane emissions attributed to the project activity is the one related to this additional consumption under controlled burning conditions in the new power plant power boiler.

The Project Proponent estimates a total of 161,752 (BDt/yr) of biomass residues attributable to the project activity. From this amount, 31,112 (BDt/yr) corresponds to biomass from industrial operations and 130,640 (BDt/yr) corresponds to biomass from forestry operations. According to this, the project emissions related to this source can be calculated as follows:

Data/estimates:

(1) Biomass from industrial operations burned in the power boiler	31,112 (BDt/yr))
(2) Biomass from forestry operations burned in the power boiler	130,640 (BDt/yr)
(3) Biomass net calorific value (both biomass types)	18.5 (TJ/000dry ton)
(4) Methane emission factor for controlled burning conditions (both biomass types)	0 (KgCH_4/TJ)
(5) Conservativeness factor (both biomass types)	1.02
(6) Global Warming Potential of CH_4	21

Calculations:

(7) Emissions from biomass from industrial operations	(1)*(1/1000)*(BDt/thousands of BDt)*(3)*(4)*(1ton/1,000kg)*(5)*(6))	0 (tCO_2eq/yr)
(8) Emissions from biomass from forestry operations	(2)*(1/1000)*(BDt/thousands of BDt)*(3)*(4)*(1ton/1,000kg)*(5)*(6))	0 (tCO_2eq/yr)
(9) Total emissions	**(7) + (8)**	**0 (tCO_2eq/yr)**

e) Other project emissions related to the project activity

Emissions from biomass from forestry operations processing:

It is estimated that the proposed project will consume 130,640 (BDt/yr) of biomass residues from forestry operations. This implies an additional diesel consumption of 567.2 (ton/yr) of diesel. According to this, the project emissions related to this source can be calculated as follows:

Data/estimates:

(1) Fossil fuel used for biomass from forestry operations processing	567.2 (ton/yr)
(2) Fossil fuel net calorific value	43.3 (GJ/ton)
(3) Fossil fuel CO_2 emission factor	0.07480 (tCO_2/GJ)

Calculations:

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

(4) Total emissions	**(1)*(2)*(3)**	**1,837 (tCO_2/yr)**

Emissions from additional ash disposal to the dumpsite:
In the Viñales biomass power plant, the ashes derived from the biomass combustion in the power boilers are transported to a nearby dump site by trucks. The corresponding diesel consumption associated to the implementation of the project activity will be determined considering the total diesel consumption of the trucks that transport the ashes to the dumpsite and the biomass related to the project activity. With this rationale, it is estimated that the proposed project activity will imply the additional consumption of 48.7 (ton/yr) of additional diesel for the disposal of the ashes related to the implementation of the project activity. According to this, the project emissions related to this source can be calculated as follows:

Data/estimates:

(1) Fossil fuel used for additional ash transportation to the dumpsite	48.7 (ton/yr)
(2) Fossil fuel net calorific value	43.3 (GJ/ton)
(3) Fossil fuel CO_2 emission factor	0.07480 (tCO_2/GJ)

Calculations:

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

(4) Total emissions	**(1)*(2)*(3)**	**158 (tCO_2/yr)**

Other project emissions related to the project activity	(tCO_2/yr)
Emissions from biomass from forestry operations processing	1,837
Emissions from additional ash disposal to the dumpsite	158
Total emissions	**1,995**

Total project emissions

Emission sources	(tCO_2eq/yr)
Carbon dioxide emissions from biomass residues transportation to the power plant	4,545

Carbon dioxide emissions from on-site consumption of fossil fuels	1,306
Carbon dioxide emissions from electricity consumption	0
Methane emissions from combustion of biomass residues	0
Other project emissions related to the project activity	1,995
Total	**7,847**

Baseline emissions

a) Emissions reduction due to electricity displacement

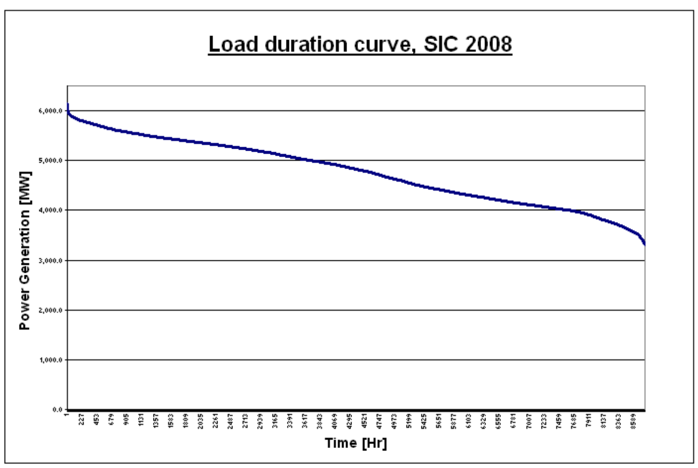
CO_2 emission factor ($EF_{electricity,y}$) calculation for the electricity displaced by the project activity

As previously indicated in section B.6.1 of this PDD, the $EF_{grid,y}$ is calculated as a combined margin (CM). This requires to calculate the Operating Margin ($EF_{OM,y}$) and the Build Margin ($EF_{BM,y}$) of the grid.

Operating Margin ($EF_{OM,y}$) calculation

According to the explanation given in section B.6.1 in this PDD, the Operating Margin ($EF_{OM,y}$) will be calculated according to option (b) ($EF_{grid,OM-adj,y}$) of the alternatives presented in the ACM0002 (Version 10). The Project Proponent will also use ex-post data to calculate the Operating Margin; that is, the coefficient will be calculated the year in which the project generation occurs.

For the Operating Margin calculation in this PDD, the Project Proponent will use information of the year 2008. This was the last information available at the date this PDD was reviewed and finished.



From the data that generates the curve above; it is possible to determine the fraction of the year in which low-cost/must-run sources are on the margin for the year 2008:

$$\lambda_y = \lambda_{2008} = 0$$

$$\lambda_{2008} = 0$$

The rest of the parameters used to calculate the $EF_{grid,OM-adj,y}$ for the year 2008, were obtained from the CDEC-SIC dispatch center (official and public information). In some cases the Project Proponent also used information from power company's web pages. The calculation is as follows:

- CO_2 emissions of non-low cost/must-run power sources for 2008.

$$\sum_m EG_{m,y} \cdot EF_{EL,m,y} = 14{,}064{,}160(tCO_2 / yr)$$

- Total power generation in the SIC by non low-cost/must-run power sources in 2008.

$$\sum_m EG_{m,y} = 16{,}400(GWh / yr)$$

- CO_2 emissions of low-cost/must run power sources in 2008. Since in Chile low-cost/must-run power sources include mostly hydro energy, the total emissions for this part of the equation are low.

$$\sum_k EG_{k,y} \cdot EF_{EL,k,y} = 447{,}042(tCO_2 / yr)$$

- Total power generation in the SIC by low-cost/must-run resources for 2008.

$$\sum_k EG_{k,y} = 24{,}686(GWh / yr)$$

Replacing the above values in the equation used to calculate the $EF_{grid,OM-adj,y}$ for the year 2008, the operating margin results:

$$EF_{grid,OM-adj,y} = (1-0) \cdot \frac{14{,}064{,}160}{16{,}400} + 0 \cdot \frac{447{,}042}{24{,}689} = 857.58(tCO_2 / GWh)$$

$$EF_{grid,OM-adj,y} = 857.58(tCO_2 / GWh)$$

<u>Build Margin ($EF_{BM,y}$) calculation</u>

According to 2008 SIC data, the group of plants that accounts for the largest generation in that year are the ones responsible for the 20% of the total generation in 2008. These plants are considered to calculate the Build Margin for 2008:

$$EF_{BM,y} = 459.3(tCO_2 / GWh)$$

As in the previous case, the Build Margin calculation also considered official CDEC-SIC data and/or other official data publicly available. For more details about the Build Margin calculation, please see Annex 3 of this PDD.

Having obtained both $EF_{OM,y}$ and $EF_{BM,y}$, and assuming the default values (0.5) for the weights w_{OM} and w_{BM}, it is possible to calculate $EF_{electricity,y}$ for the year 2008:

$$EF_{grid,CM,y} = 0.5 * 857.58 + 0.5 * 459.3 = 658.43 (tCO_2 / MWh)$$

$$EF_{grid,CM,y} = 0.658 (tCO_2 / MWh)$$

According to equation 8 of the ACM0006 (Version 09), the emission reductions due to electricity displacement can be calculated as follows:

<u>Data/estimates:</u>

(1) Net quantity of electricity generated in the project plant	216 (GWh/yr)
(2) Combined margin for the relevant grid	0.658 (tCO_2/MWh)

<u>Calculations:</u>

(3) Total grid emission savings	**(1)*(1000MWh/GWh)*(2)**	**142,466 (tCO_2/yr)**

<u>b) Baseline emissions due to burning of anthropogenic sources of biomass residues</u>

To calculate this emission source, it is necessary first to calculate the quantity of biomass residues used as a result of the project activity. According to equations 42 and 43 of the ACM0006 (Version 09), and considering that all the biomass residues associated to the project activity have the same net calorific value, the following calculation can be done:

<u>Data/estimates:</u>

(1) Total biomass mix consumption in the Viñales power plant.	246,740 (BDt/yr)
(2) Net calorific value of the biomass mix used in the Viñales sawmill.	18.5 (GJ/ton)
(3) Net quantity of heat generated by the new cogeneration power plant.	1,356,093 (GJ/yr)
(4) Energy efficiency of the boiler that would be used in the absence of the p. activity	86.3 (%)

<u>Calculations:</u>

(5) Additional biomass mix associated to the project activity.	**(1) – [(3)/((2)*(4))]**	**161,752 (BDt/yr)**

Since both types of biomass used by the proposed project activity (e.g. biomass from industrial operations and biomass from forestry operations) have the same net calorific value as the biomass mix used in the Viñales power boiler, the biomass types related to the project activity can be calculated as follows:

Data/estimates:

(1) Total biomass mix related to the project activity	161,752 (BDt/yr)
(2) Biomass from forestry operation considered for the project activity	130,640 (BDt/yr)

Calculations:

(3) Biomass from forestry ops. related to the project activity	**MIN [(1), (2)]**	**130,640 (BDt/yr)**
(4) Biomass from industrial ops. related to the project activity	**(1) – (2)**	**31,112 (BDt/yr)**

It must be noted that this is a particular case, since all net calorific values are assumed to be the same. If this turned not to be the case, the biomass type amounts will be determined as per equations 42 and 43 of the ACM0006 (Version 09).

With the biomass type amounts clearly identified, it is possible to calculate the avoided methane emissions:

Data/estimates:

(1) Biomass from forestry operations related to the project activity	130,640 (BDt/yr)
(2) Biomass from industrial operations related the project activity	31,112 (BDt/yr)
(3) Net calorific value of biomass (the same for both types)	18.5 (GJ/ton)
(4) Adjusted CH_4 emission factor, uncontrolled burning of biomass, forest ops.	101.5 (KgCH_4/TJ)
(5) Adjusted CH_4 emission factor, uncontrolled burning of biomass, industrial ops.	874.2 (KgCH_4/TJ)
(6) CH_4 global warming potential	21

Calculations:

(7) Emissions	(1)*(1ton/1,000kg)*(3)*(1ton/1,000kg)*(4)*(6)	5,149 (tCO_2eq/yr)
(8) Emissions	(2)*(1ton/1,000kg)*(3)*(1ton/1,000kg)*(5)*(6)	10,566 (tCO_2eq/yr)
(9) Emissions	**(7) + (8)**	**15,716 (tCO_2eq/yr)**

Total baseline emissions

Emission sources	(tCO_2eq/yr)
Carbon dioxide emissions due to electricity displacement	142,466
Methane emissions due to uncontrolled biomass burning avoidance	15,716
Total	**158,182**

Leakage emissions

As previously mentioned, the proposed project activity implies additional consumption of biomass from nearby sawmills (sawdust and bark) and forestry residues from harvesting, pruning and thinning operations. Though part of the biomass generated in some sawmills is used as fuel for energy purposes (i.e. to dry sawn timber), a significant surplus still remains. This surplus has no other use than to be left

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

Currently there are two sources of biomass in the south part of Chile (from VI to X Regions) that can that provide biomass fuels to a biomass power plant such as the Viñales biomass power plant:

1. Biomass from industrial operations, consisting basically in biomass generated by local sawmills. Currently, part of this biomass is normally used to generate thermal energy of sawmills that produce it and another fraction is sold to other facilities for other industrial uses. However a considerable surplus still remains, which is normally left in piles to natural decay.

Biomass from industrial operations

2. Biomass from forestry operations, consisting basically in operations of harvesting, pruning and thinning in managed forestlands. Currently this biomass has very little (if any) use in the local industry. A very small fraction is used as fuel for local homes warming, while the majority is left on the ground to natural decay. In some cases, these biomass residues are burned in order to prevent fires in new or existing forest plantations.

Biomass from forestry operations

It must be mentioned that all the biomass residues considered for the proposed project activity consist basically in a mix of sawdust (wood) and bark. The main difference between the biomass types identified for the project activity is related to the place where the residues are generated. Also, since all the biomass

residues come from managed forest plantations, all the biomass used as fuel comes from renewable sources. Further details on the sustainable origin of the biomass residues can be found in Annex 4 of this PDD.

Main uses for biomass residues from industrial operations:

1. Fuel for heat generation at sawmills for drying the sawn timber. Small demand compared to the supply generates a considerable surplus that is available to third parties.

2. Electric power generation at some power plants (few cases and small plants). Most have exclusivity biomass supply contracts with some nearby sawmills.

Uses for biomass from forestry operations

1. Fuel for home warming; however the demand for this biomass is almost negligible compared to the supply.

In both cases above, the supply is higher (and in some cases considerably higher) than the demand. This generates a surplus of biomass residues that is left on the ground or piled for natural decay.

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

1. In sawmills and other biomass producing mills that use the biomass as fuel; if they sell all their biomass to the new biomass power producer and change to fossil fuel instead;

2. In local factories that normally buy and use biomass as fuel, and now are forced to switch to fossil fuels given that the new biomass power plant has depleted the biomass resource in the area.

The possibility of leakage in biomass producing facilities that use part of the residues as fuel and sell the surplus to third parties is highly unlikely. Given the nature of the biomass suppliers (mostly small and local sawmills) and the cost of fossil fuels[32], these suppliers will use their biomass to serve their own energy needs in the very first place. Only then, they will sell the surplus biomass to nearby factories and power plants. Biomass fuels are much cheaper than any other fossil fuel source available; therefore it is highly unlikely that biomass suppliers would be willing to switch to a much expensive fuel source than biomass. Currently, what happens is that the biomass suppliers generate such an excess amount of biomass, that they do not have another alternative rather than to accumulate it in piles or sell it to a nearby factory or power plant (if there exist).

The possibility of leakage in local power plants and factories may occur in the event there is an insufficient supply of biomass from industrial operations. Today this is clearly not the case since all plants that use biomass in the VII Region operate without restriction. Despite the fact there is no official data available; the Project Proponent has performed a detailed research of the biomass supply/demand situation in the Viñales influence area, which is shown in the following table:

[32] By the time this PDD was written, the oil price was around US$ 130 per barrel.

Supply / Demand situation in the Viñales power plant influence area
(Estimation for year 2009)

Biomass residues supply

Biomass from industrial operations	(m^3st/yr)	4,818,310
Biomass from forestry operations	(m^3st/yr)	1,796,143
Total supply	**(m^3st/yr)**	**6,614,452**

Biomass residues demand

Demand from industrial operations	**(m^3st/yr)**	3,236,930
Demand from forestry operations	**(m^3st/yr)**	870,933
Total demand	**(m^3st/yr)**	**4,107,863**

Sources: Infor official bulletins, studies and Arauco forest databases.

Viñales power plant surplus index
(Estimation for year 2009)

This index was calculated using criteria "L2" of the ACM0006 (Version 09)

Biomass from industrial operations / Total biomass demand	(number)	1.4885
Biomass from forestry operations /Total biomass demand	(number)	2.0623
Total supply / Total demand	**(number)**	**1.6102**

According to the information above (approach L2, leakage section of the Baseline methodology), the Viñales biomass power plant project counts with sufficient biomass locally and has not caused other biomass plants in the area to switch from biomass to fossil fuels so far.

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

According to the information presented above, no leakage is anticipated for the Viñales biomass power plant project activity; therefore leakage emissions are assumed to be zero for the proposed project activity.

$$L_y = 0$$

The supply/demand status within Arauco power plant influence area will be periodically monitored as indicated in pages 52 to 54 of the ACM0006 (Version 09).

Net emission savings of the project activity (normal year)

Baseline / Project emissions	(tCO_2eq/yr)
Total baseline emissions	158,182
Total project emissions	7,847
Net emission reductions	**150,335**

B.6.4 Summary of the ex-ante estimation of emission reductions:

Year	Estimation of project activity emissions (tonnes of CO_2 e)	Estimation of baseline emissions (tonnes of CO_2 e)	Estimation of leakage (tonnes of CO_2 e)	Estimation of overall emission reductions (tonnes of CO_2 e)
2011	1,308	26,364	0	25,056
2012	7,847	158,182	0	150,335
2013	7,847	158,182	0	150,335
2014	7,847	158,182	0	150,335
2015	7,847	158,182	0	150,335
2016	7,847	158,182	0	150,335
2017	7,847	158,182	0	150,335
2018	7,847	158,182	0	150,335
2019	7,847	158,182	0	150,335
2020	7,847	158,182	0	150,335
2021	7,847	158,182	0	150,335
2022	7,847	158,182	0	150,335
2023	7,847	158,182	0	150,335
2024	7,847	158,182	0	150,335
2025	7,847	158,182	0	150,335
2026	7,847	158,182	0	150,335
2027	7,847	158,182	0	150,335
2028	7,847	158,182	0	150,335
2029	7,847	158,182	0	150,335
2030	7,847	158,182	0	150,335
2031	7,847	158,182	0	150,335
2032	6,539	131,818	0	125,279
Total (tonnes of CO_2 e)	**164,785**	**3,321,819**	**0**	**3,157,034**

Note: For the year 2011, only November and December are considered. For the year 2032, the months considered are from January to October inclusive.

B.7. Application of the monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	**$BF_{k,y}$**
Data unit:	Tons of dry matter (BDt) or liter.
Description:	Quantity of biomass residue type k combusted in the project plant during the year y.
Source of data to be used:	On-site measurements.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3rd party biomass from forestry operations: 130,640 (BDt/yr) 3rd party sawdust and bark from sawmills (industrial ops.): 26,100 (BDt/yr) Biomass from the Viñales sawmill (industrial ops.): 90,000 (BDt/yr) Total biomass used in the project plant: 246,740 (BDt/yr). Note that "BDt" stands for "Bone dry ton" which means dry ton.
Description of measurement methods and procedures to be applied:	Use weight or volume meters. Adjust for the moisture content in order to determine the quantity of dry biomass. This parameter will be monitored continuously.
QA/QC procedures to be applied:	Crosscheck the measurements with an annual (or monthly) energy balance, based on the internal biomass generation, purchased amounts, stock changes and the heat and power generation in the project plant. Additionally, measurements can

	be crosschecked using empiric production factors.
Any comment:	Monitoring of this parameter for project emissions is required, since in this case CH_4 emissions from biomass combustion are included in the project boundary. A conservative factor will be applied, as specified in the baseline methodology. Note that the amounts above are the best estimates at the date this PDD was written. Amounts per biomass fuel type may change in the future, subject to biomass fuel market conditions. Note as well that not all the biomass residues combusted in the power plant (estimated above) are residues associated to the project activity.

Data / Parameter:	**$BF_{T,k,y}$**
Data unit:	Tons of dry matter (BDt) or liter.
Description:	Quantity of biomass residues type k that have been transported to the project site during the year y where k are the types of biomass residues used in the project plant in year y.
Source of data to be used:	On-site measurements.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	156,740 (BDt/yr)
Description of measurement methods and procedures to be applied:	Incoming trucks with biomass from outside of the Viñales sawmill are weighed in dedicated weighbridges when they enter and leave the sawmill. The difference between these two weights is the weight of the wet biomass that comes from outside of the sawmill. The dry biomass is then calculated by adjusting the wet weight of the biomass by its moisture content, which is measured on-site by the Raw Material Analyst of Quality Department in the Viñales sawmill. Weighbridges, scales and all the equipment required for determining this parameter will receive periodic maintenance and calibration according to proper industry standards. This parameter will be monitored continuously.
QA/QC procedures to be applied:	Crosscheck the measurements with an annual (or monthly) energy balance, based on the internal biomass generation, purchased amounts, stock changes and the heat and power generation in the project plant. Additionally or alternatively, use biomass from third parties dispatch bills, if available.
Any comment:	Note that only biomass coming from outside the plant and attributable to the project activity will be considered in this case.

Data / Parameter:	**Moisture content of the biomass residues**
Data unit:	(%) Water content.
Description:	Moisture content of each biomass residue type k.
Source of data to be	On-site measurements.

used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	50% (wet basis) for all biomass types combusted in the new power generation unit in Viñales (see comment below).
Description of measurement methods and procedures to be applied:	Moisture content of each type of biomass will be monitored and registered periodically, by taking biomass samples from the corresponding sources. The moisture content (wet basis) of each type of biomass will be calculated by dividing the water amount contained in the wet biomass sample by its weight. The water content of the biomass sample will be determined by subtracting the dry weight of the dried biomass sample to the weight of the wet biomass sample. The dry weight of the biomass sample will be determined by evaporating 100% of the water of the wet sample in a dedicated oven and then weighing the dried sample in a scale. Ovens, scales and all the equipment required to determine this parameter will receive periodic maintenance and calibration according to proper industry standards. This parameter will be monitored continuously. Mean values will be calculated at least annually.
QA/QC procedures to be applied:	Repeated moisture content measurements for the same biomass types will ensure the quality and consistency of the monitored variable.
Any comment:	Almost all the biomass residues combusted in the Viñales new power boiler will have a moisture content of approximately 50% (wet basis). For this reason, this figure is a good estimate of the moisture content of the biomass types used in the Viñales power plant.

Data / Parameter:	**$EF_{CH4,BF}$**
Data unit:	(tCH_4/GJ)
Description:	CH_4 emission factor for the combustion of biomass residues in the project plant.
Source of data to be used:	On-site measurements.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0 (Kg CH_4/TJ) or 0.0 (tCH_4/GJ) (see comment below).
Description of measurement methods and procedures to be applied:	The CH_4 emission factor can be determined by taking samples from the power boiler flue gases and performing a gas analysis in a specialized laboratory. This parameter will be monitored at least quarterly, taking at least three samples per measurement.
QA/QC procedures to	Check the consistency of the measurements by comparing the measurement

be applied:	results with measurements from previous years, relevant data sources (e.g. values in the literature, values used in the national GHG inventory) and default values by the IPCC. If the measurement results differ significantly from previous measurements or other relevant data source, conduct additional measurements.
Any comment:	Monitoring of this parameter for project emissions is required, since in this case CH_4 emissions from biomass combustion are included in the project boundary. A conservative factor will be applied, as specified in the baseline methodology. During 2006, Arauco hired a consultant to conduct measurements of this factor in two similar power boilers (fluidized bed boiler) to the one that will be installed in the Viñales power plant. The results showed that combustion process of the biomass in a modern fluidized bed boiler was so efficient, that the methane concentration in the flue gases is **lower** than the concentration found in the clean air. In other words, the biomass combustion in this type of boilers reduces the methane concentration of the clean air. Since it is not possible to consider a negative methane emission factor, the Project Proponent believes that 0 (tCH_4/GJ) is a conservative and therefore an appropriate estimate in this case.

Data / Parameter:	**AVD_y**
Data unit:	(km)
Description:	Average round trip distance (from and to) between biomass fuel supply sites and the project site.
Source of data to be used:	Records for the biomass purchased from suppliers, which specify the amount of biomass purchased monthly, from known locations, with known distances to the Viñales sawmill.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	240 (km) on average (round trip).
Description of measurement methods and procedures to be applied:	Distances from each biomass supply centre (i.e. third party sawmill) to the Viñales power plant will be determined using a road map and recorded in the Viñales sawmill information system. The average distance in a period of time (i.e. month) will be determined by calculating a weighted average distance considering the amount of biomass and the distance from which each supply centre provided biomass to the power plant. The round trip average distance will be determined by multiplying the weighted average distance by two. This parameter will be monitored continuously.
QA/QC procedures to be applied:	Check consistency of distances with information from other sources.
Any comment:	Monitoring this variable is applicable, since the Project Proponent will use Option 1 to calculate the CO_2 emissions from transportation of biomass to the Viñales power plant.

Data / Parameter:	**TL_y**
Data unit:	(Tons)
Description:	Average truckload of the trucks used for transportation of biomass.
Source of data to be used:	On-site measurements.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	26 (Tons/truck).
Description of measurement methods and procedures to be applied:	The truck loads will be measured at the project plant in weighbridges. The loads will be determined by calculating a weighted average truck load in tons for the trucks that deliver biomass to the Viñales power plant. Weighbridges will receive periodic maintenance and calibration according to proper industry standards. This parameter will be monitored continuously and aggregated monthly or annually.
QA/QC procedures to be applied:	Weighbridges will receive periodic maintenance and calibration according to proper industry standards to ensure the accuracy of the weight measured.
Any comment:	Monitoring this variable is applicable, since the Project Proponent will use Option 1 to calculate the CO_2 emissions from transportation of biomass to the Viñales power plant.

Data / Parameter:	**$EF_{km,CO2,y}$**
Data unit:	(tCO_2/km)
Description:	Average CO_2 emission factor for the trucks during the year y.
Source of data to be used:	For the specific fuel consumption rate of the trucks (i.e. km/lt truck performance): Transportation subcontractor information and invoices from trucking companies. Alternatively, technical specification of the trucks from the manufacturer and/or local truck dealers. For net calorific values and CO_2 emission factors: reliable national default values or, if not available, (country-specific) IPCC default values. If the above sources are not available, use emission factors applicable for the truck types used from literature in a conservative manner (i.e. the higher end within a plausible range).
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1,571 (tCO_2/km).
Description of measurement methods	This parameter will be determined by adjusting the weighted average fuel performance index of the trucks that deliver biomass to the Viñales power plant

and procedures to be applied:	by the corresponding net calorific value and CO_2 emission factor of the fuel type used by the trucks. This parameter will be monitored at least annually.
QA/QC procedures to be applied:	Crosscheck results with emission factors referred to in the literature.
Any comment:	Monitoring this variable is applicable, since the Project Proponent will use Option 1 to calculate the CO_2 emissions from transportation of biomass to the Viñales biomass power plant.

<table>
<tr><td>Data / Parameter:</td><td>$EF_{CO2,FF,i}$</td></tr>
<tr><td>Data unit:</td><td>(tCO_2/GJ)</td></tr>
<tr><td>Description:</td><td>CO_2 emission factor for fossil fuel type i used in the project plant.</td></tr>
<tr><td>Source of data to be used:</td><td>
<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>a) Values provided by the fuel supplier in invoices.</td><td>This is the preferred source.</td></tr>
<tr><td>b) Measurements by the project participants.</td><td>If a) is not available.</td></tr>
<tr><td>c) Regional or national default values.</td><td>If a) is not available.

These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances).</td></tr>
<tr><td>d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.</td><td>If a) is not available.</td></tr>
</table>

Since in this case, options a), b) and c) are not available (e.g. information is not available and/or measurements are not possible), the Project Proponent will use option d) and select the emission factors from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Table 1.4. Default value at the upper limit of the uncertainty at a 95% confidence interval.</td></tr>
<tr><td>Value of data applied for the purpose of calculating expected emission reductions in section B.5</td><td>0.0748 (tCO_2/GJ) for Diesel.

0.0788 (tCO_2/GJ) for Fuel Oil.</td></tr>
<tr><td>Description of measurement methods and procedures to be applied:</td><td>Any future revision of the IPCC Guidelines will be taken into account.</td></tr>
</table>

QA/QC procedures to be applied:	Any future revision of the IPCC Guidelines will be taken into account.
Any comment:	The monitoring of this variable applies, since according to the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”, this PDD is using option B to determine the CO_2 emission coefficient of fuel type i.

Data / Parameter:	**$FF_{project\ plant,i,y}$**
Data unit:	Mass or volume per year.
Description:	Quantity of fossil fuel type i combusted in the project plant during the year y.
Source of data to be used:	On-site measurements.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	538 (ton/yr) of fuel oil due to operational reasons in the new power boiler. This is the full amount of fossil fuel consumed in the new power boiler.
Description of measurement methods and procedures to be applied:	This fuel amount is proportional to the amount of biomass combusted in the power boiler. Therefore, to determine the fossil fuel related to the project activity, this amount will be scaled down using the biomass fraction related to the implementation of the project activity. Dedicated flow meters will be used to monitor this parameter. This parameter will be monitored continuously.
QA/QC procedures to be applied:	Metered values will be crosschecked with an annual (or monthly) balance based on purchased quantities and stock changes.
Any comment:	This should include fossil fuels co-fired in the project plant but not any other fuel consumption at the project site that is attributable to the project activity (e.g. for mechanical preparation of the biomass residues).

Data / Parameter:	**$FF_{project\ site,i,y}$**
Data unit:	Mass or volume per year.
Description:	Quantity of fossil fuel type i combusted at the project site for other purposes that are attributable to the project activity during the year y.
Source of data to be used:	Fuel consumption records from front loaders and truck driver operators or from the corresponding transportation subcontractors.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	72,000 (lt/yr) of diesel used for on-site biomass transportation. This is the full amount of fossil fuel used for on-site biomass transportation to the new power plant.
Description of measurement methods and procedures to be applied:	Total fossil fuel amounts used on-site will be scaled down by the fraction of the biomass related to the project activity with respect to the total biomass combusted in the power plant.

	This parameter will be determined by monitoring the periodic fuel consumption of the trucks and/or front loaders. This parameter will be monitored continuously.
QA/QC procedures to be applied:	Crosscheck the measurements with an annual energy and/or mass balance that is based on purchased quantities and stock changes. Alternatively, perform consistency checks with vehicles specific fuel consumption rates: litres of fuel consumed per hour of operation, litres of fuel consumed per kilometre driven or other as appropriate.
Any comment:	This parameter does not include fossil fuels co-fired in the project plant, but any other fossil fuel consumption at the project site that is attributable to the project activity (e.g. for mechanical preparation of the biomass residues).

Data / Parameter:	$\mathbf{FF_{biomassprocessing,i,y}}$
Data unit:	Mass or volume per year.
Description:	Quantity of fossil fuel type i used for mechanical preparation of the biomass from forestry operations used in the project plant during the year y.
Source of data to be used:	Fuel consumption records from the subcontractors that process the biomass from forest operations.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	567.2 (ton/yr) of diesel. See comment below.
Description of measurement methods and procedures to be applied:	Total fossil fuel amounts used on-site will be scaled down by the fraction of the biomass related to the project activity. This parameter will be monitored continuously.
QA/QC procedures to be applied:	Crosscheck the measurements with an annual balance that is based on purchased quantities and stock changes. Alternatively, perform consistency checks with vehicles specific fuel consumption rates: litres of fuel consumed per hour of operation, litres of fuel consumed per kilometre driven or other as appropriate.
Any comment:	In this case, this amount is fully related to the implementation of the project activity and does not need to be scaled down. This could change in the future.

Data / Parameter:	$\mathbf{EG_{project\ plant,y}}$
Data unit:	(MWh/yr)
Description:	Net quantity of electricity generated in the project plant during the year y.
Source of data to be used:	On-site measurements.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	216,372 (MWh/yr) or 216 (GWh/yr).
Description of	Electric meters that measure the voltage and the current will continuously

measurement methods and procedures to be applied:	monitor the electric power generation at the Viñales project plant (the new power generation unit). Meters will receive calibration and maintenance according to proper industry standards. This parameter will be monitored continuously.
QA/QC procedures to be applied:	The consistency of metered net electricity generation will be crosschecked with receipts from electricity sales (if available), the internal power consumption in the Viñales sawmill and the total amount of biomass fuels consumed (e.g. check whether the electricity generation divided by the quantity of fuels fired results in a reasonable efficiency that is comparable to previous years).
Any comment:	Note that according to page 34/77 of the ACM0006 (Version 09), EG_y corresponds to the “Net quantity of increased electricity generation as a result of the project activity (incremental to baseline generation) during the year y”. That means that any generation and/or consumption of electricity that would occur in the baseline scenario must be considered in the determination of this variable.

Data / Parameter:	$\mathbf{Q_{Project\ plant,y}}$
Data unit:	(GJ)
Description:	Net quantity of heat generated from firing biomass in the project plant during year y.
Source of data to be used:	On-site measurements.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1,356,093 (GJ/yr).
Description of measurement methods and procedures to be applied:	The total heat consumed by the Viñales sawmill will be determined using data from the new cogeneration power plant. The flow meters, thermocouples and pressure gauges used for determining the thermodynamic conditions of the steam will be adequate for the operative conditions at the plant and will receive periodic maintenance and calibration, according to proper industry standards. This parameter will be monitored continuously and aggregated monthly.
QA/QC procedures to be applied:	Periodic (monthly and/or annual) consistency checks will be performed with the corresponding heat users in the Viñales sawmill.
Any comment:	**--**

Data / Parameter:	$\mathbf{NCV_i}$
Data unit:	(GJ/mass or volume unit).
Description:	Net calorific value of the fossil fuel type i.
Source of data to be used:	(see nested table below)

Data source	**Conditions for using the data source**
a) Values provided by the fuel supplier in invoices.	This is the preferred source if the carbon fraction if the fuel is not provided.

	<table><tr><td>b) Measurements by the project participants.</td><td>If a) is not available.</td></tr><tr><td>c) Regional or national default values.</td><td>If a) is not available. These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances).</td></tr><tr><td>d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.</td><td>If a) is not available.</td></tr></table> Since in this case, options a), b) and c) are not available (e.g. information is not available and/or measurement are not possible), the Project Proponent will use option d) and select the net calorific values from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Table 1.2. Default value at the upper limit of the uncertainty at a 95% confidence interval.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	43.3 (GJ/ton) for diesel. 41.7 (GJ/ton) for fuel oil.
Description of measurement methods and procedures to be applied:	Any future revision of the IPCC Guidelines should be taken into account.
QA/QC procedures to be applied:	Any future revision of the IPCC Guidelines should be taken into account.
Any comment:	The monitoring of this variable applies, since according to the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”, this PDD is using option B to determine the CO_2 emission coefficient of fuel type i.

Data / Parameter:	**NCV_k**
Data unit:	(GJ/ton of dry matter)
Description:	Net calorific value of biomass residue type k.
Source of data to be used:	Measurements.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	18.5 (GJ/BDt) for biomass from industrial and forestry operations (see comment below).
Description of	Net calorific value measurements of the biomass residue type k will be

measurement methods and procedures to be applied:	performed in reputed local laboratories and according to proper international standards. Measurements of this parameter will be based on dry biomass. This parameter will be monitored every six months, taking at least three samples for each measurement.
QA/QC procedures to be applied:	Check consistency of measurements by comparing the measurement results with measurements from previous years, relevant data sources (e.g. values in the literature, values used in the national GHG inventory if available) and default values by the IPCC. If measurement results differ significantly from previous measurements or other relevant data sources, conduct additional measurements. Ensure the NCV measurements are determined on the basis of dry biomass.
Any comment:	The types of biomass combusted in the Viñales project plant are relatively homogeneous and therefore have relatively the same net calorific value. For this reason, the value provided above is a good estimate for all types of biomass combusted in the Viñales project plant.

Data / Parameter:	**$EF_{burning,CH4,k,y}$**
Data unit:	(tCH_4/GJ)
Description:	CH_4 emission factor for uncontrolled burning of the biomass residue type k during the year y.
Source of data to be used:	Direct measurements at the start of the project activity.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	• Biomass residues from industrial operations (mainly sawdust and bark from sawmills): 0.0008742 (tCH_4/GJ) or 874.2 (Kg CH_4/TJ). This value includes the adjustment of a conservativeness factor of 0.94. • Biomass residues from forestry operations (mainly branches from harvesting, pruning and thinning operations): 0.00010146 (tCH_4/GJ) or 101.46 (Kg CH_4/TJ). This value includes the conservativeness factor adjustment. This value includes the adjustment of a conservativeness factor of 0.89.
Description of measurement methods and procedures to be applied:	The CH_4 emission factor for uncontrolled burning of the biomass types attributed to the proposed project activity were determined from measurements for each biomass type. Smoke samples (51 and 44 for each biomass type) were taken from several burning biomass piles. A detailed document with the method and results is enclosed in Annex 3 of this PDD. This parameter will be monitored once at the start of the project activity.
QA/QC procedures to be applied:	Comparisons with default values from the last version of the IPCC manuals will be carried out annually. If significant differences cannot be reasonably explained, new measurements will be carried out.
Any comment:	Monitoring of this parameter for project emissions is only required if CH_4 emissions from biomass combustion are included in the project boundary. Note that a conservative factor shall be applied, as specified in the baseline methodology.

	Differences between IPCC default values and the measured values are due to the compactness level of the biomass residues burned. In case of the biomass from industrial operations, the biomass is densely packed allowing for very little oxygen for the combustion process. This leads to high methane emission factors. In the case of the biomass from forestry operations, the biomass piles (mainly of branches) allow for plenty of oxygen during the combustion, which leads to much lower methane emission factors. The measured values are consistent with values obtained in other parts of the word under similar conditions. For further details, please see Annex 3 of this PDD. Also see section B.6.2 of the PDD, “Data and parameters available at the Validation”.

Data / Parameter:	ε_{boiler}
Data unit:	(% or number)
Description:	Average net energy efficiency of heat generation in the boiler that would generate heat in the absence of the project activity.
Source of data to be used:	Either use the higher value among (a) the measured efficiency and (b) manufacturer’s information on the efficiency OR assume an efficiency of 100% as a conservative default value.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The 86.3% efficiency of the manufacturer’s information will be used in this case.
Description of measurement methods and procedures to be applied:	No measurements will be carried out in this case.
QA/QC procedures to be applied:	--
Any comment:	The 100% default value was not used here, since it does not lead to a conservative emission reduction calculation in this case.

Data / Parameter:	**-**
Data unit:	Mass or volume units (tons/yr or m^3 st/yr).
Description:	Quantity of biomass residues of type k that are utilized (e.g. for energy generation or as feedstock) in the defined geographical region.
Source of data to be used:	Surveys or statistics, preferable from official sources: INFOR, CORMA, CONAF. Publications: Lignum, Ecoamérica, among others.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	--
Description of measurement methods and procedures to be	Arauco Bioenergía S.A. will be responsible for carrying out the necessary research and studies.

applied:	This parameter will be monitored annually.
QA/QC procedures to be applied:	--
Any comment:	Monitoring of this parameter is applicable since approach L2 will be used to rule out leakage.

Data / Parameter:	-
Data unit:	Mass or volume units (tons/yr or m^3 st/yr).
Description:	Quantity of available biomass residues of type k in the region.
Source of data to be used:	Surveys or statistics, preferable from official sources: INFOR, CORMA, CONAF. Publications: Lignum, Ecoamérica, among others.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	--
Description of measurement methods and procedures to be applied:	Arauco Bioenergía S.A. will be responsible for carrying out the necessary research and studies. This parameter will be monitored annually.
QA/QC procedures to be applied:	--
Any comment:	Monitoring of this parameter is applicable since approach L2 will be used to rule out leakage.

Data / Parameter:	$\mathbf{EC_{PJ,y}}$
Data unit:	(MWh)
Description:	On-site electricity consumption attributable to the project activity during the year y.
Source of data to be used:	On-site measurements.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0 (MWh). See comment below.
Description of measurement methods and procedures to be applied:	The Project Proponent will use electric meters to monitor this variable. This parameter will be monitored continuously and aggregated at least annually.
QA/QC procedures to be applied:	Crosscheck measurement results with invoices for purchased electricity if available.
Any comment:	The proposed project activity does not contemplate the consumption of additional power. However, this variable is considered in the monitoring plan in case this situation changes in the future.

Data / Parameter:	**$EF_{grid,y}$**
Data unit:	(tCO_2/MWh)
Description:	CO_2 emission factor for grid electricity during the year y.
Source of data to be used:	The Project Proponent will use the latest version of the ACM0002 to calculate the grid emission factor.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.65843 (tCO_2/MWh). This factor was calculated for the year 2008 and is used to estimate the future emission reductions of the proposed project activity. However, it is likely that this value will suffer changes in the subsequent years.
Description of measurement methods and procedures to be applied:	Arauco Bioenergía S.A. will be responsible for performing the calculations to determine the grid emission factor according to the last version of the ACM0002. Official and publicly available information will be used for that purpose. This variable will be monitored and updated annually, according to the guidance of the ACM0002.
QA/QC procedures to be applied:	Apply procedures in ACM0002.
Any comment:	All data and parameters to determine the grid electricity emission factor, as required by ACM0002 are included in the monitoring plan. See the corresponding parameters below.

Data / Parameter:	**$FC_{i,m,y}$, $FC_{i,k,y}$**
Data unit:	Mass or volume unit.
Description:	Amount of fossil fuel type i consumed by power plant/unit m and k in year y. In this case, “m” denotes all grid power units serving the grid in year y except low-cost/must-run power units and “k” denotes all low-cost/must run grid power units serving the grid in year y.
Source of data to be used:	Utility or government records or official publications.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See Annex 3 of this PDD.
Description of measurement methods and procedures to be applied:	• Monitoring frequency, simple adjusted OM: Annually during the crediting period for the relevant year. • Monitoring frequency, BM: For the first crediting period, annually ex-post. For the second and third crediting period, only once ex-ante at the start of the second crediting period.
QA/QC procedures to be applied:	--
Any comment:	Applicable in this case: • Calculation of power unit emission factors ($EF_{EL,m,y}$, $EF_{EL,k,y}$), as per

	equation (2) of the corresponding tool, in cases where fuel consumption and electricity generation data is available for each power unit m and k.

Data / Parameter:	**$NCV_{i,y}$**
Data unit:	(GJ / mass or volume unit)
Description:	Net calorific value (energy content) of fossil fuel type i in year y.
Source of data to be used:	The following data sources may be used in the relevant conditions apply: **Data source** / **Conditions for using the data source**: • Values provided by the fuel supplier of the power plants invoices. — If data is collected from power plant operators (e.g. utilities). • Regional or national average default values. — If values are reliable and documented in regional or national energy statistics/energy balances. • IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories. — -- In this case, there exist reliable and documented national energy statistics therefore; the source used for the emission reduction calculation was the CNE (National Energy Commission) Energy Balance for 2007.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Diesel: 45.6 (GJ/ton) IFO 180: 44.0 (GJ/ton) Natural Gas: 39.1 (GJ/ton) Coal: 29.3 (GJ/ton) Petcoke: 29.3 (GJ/ton)
Description of measurement methods and procedures to be applied:	• Monitoring frequency simple adjusted OM: Annually during the crediting period for the relevant year. • Monitoring frequency BM: For the first crediting period, annually ex-post. For the second and third crediting period, only once ex-ante at the start of the second crediting period.
QA/QC procedures to be applied:	--
Any comment:	The gross calorific value (GCV) of the fuel can be used, if gross calorific values are provided by the data sources used. In such cases, also a gross calorific value basis will be used for CO_2 emission factor.

Data / Parameter:	**$EF_{CO2,i,y}$, $EF_{CO2,m,i,y}$**
Data unit:	(tCO_2/GJ)
Description:	CO_2 emission factor of fossil fuel type i in year y.

<table>
<tr><td>Source of data to be used:</td><td>The following data sources may be used in the relevant conditions apply:
<table><tr><th>Data source</th><th>Conditions for using the data source</th></tr><tr><td>Values provided by the fuel supplier of the power plants invoices.</td><td>If data is collected from power plant operators (e.g. utilities).</td></tr><tr><td>Regional or national average default values.</td><td>If values are reliable and documented in regional or national energy statistics/energy balances.</td></tr><tr><td>IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.</td><td>--</td></tr></table></td></tr>
<tr><td>Value of data applied for the purpose of calculating expected emission reductions in section B.5</td><td>Since no actual, national or regional values are available, the Project Proponent used the IPCC default factors for the emission reduction calculation:

Diesel: 0.0726 (tCO_2/GJ)
IFO 180: 0.0722 (tCO_2/GJ)
Natural Gas: 0.0543 (tCO_2/GJ)
Coal: 0.0895 (tCO_2/GJ)
Petcoke: 0.0829 (tCO_2/GJ)

For subsequent emission reduction calculations, an alternative source –in accordance with the monitoring methodology- may be used instead.</td></tr>
<tr><td>Description of measurement methods and procedures to be applied:</td><td>• Monitoring frequency simple adjusted OM: Annually during the crediting period for the relevant year.

• Monitoring frequency BM: For the first crediting period, annually ex-post. For the second and third crediting period, only once ex-ante at the start of the second crediting period.</td></tr>
<tr><td>QA/QC procedures to be applied:</td><td>--</td></tr>
<tr><td>Any comment:</td><td>--</td></tr>
</table>

Data / Parameter:	$\mathbf{EG_{m,y}}$, $\mathbf{EG_{k,y}}$
Data unit:	(MWh)
Description:	Net electricity generated and delivered to the grid by power plant/unit m, k in year y.
Source of data to be used:	Utility or government records or official publications.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See Annex 3 of this PDD.

Description of measurement methods and procedures to be applied:	• Monitoring frequency simple adjusted OM: Annually during the crediting period for the relevant year. • Monitoring frequency BM: For the first crediting period, annually ex-post. For the second and third crediting period, only once ex-ante at the start of the second crediting period.
QA/QC procedures to be applied:	--
Any comment:	--

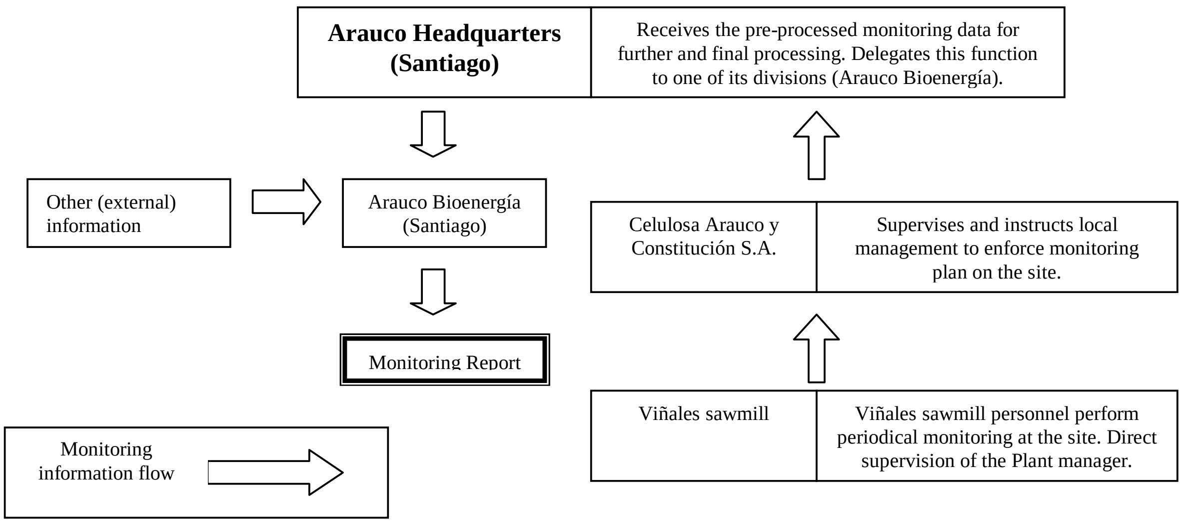
Data / Parameter:	$\mathbf{EF_{CO2,LE}}$
Data unit:	(tCO_2/GJ)
Description:	CO_2 emission factor of the most carbon intensive fuel used in the country.
Source of data to be used:	Identify the most carbon intensive fuel type from the national communication, other literature sources (e.g. IEA). Possibly consult with the national agency responsible for the national communication/GHG inventory. If available, use national default values for the CO_2 emission factor. Otherwise, IPCC default values may be used.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not used, since leakage is assumed to be 0.
Description of measurement methods and procedures to be applied:	This parameter will be monitored annually.
QA/QC procedures to be applied:	--
Any comment:	This variable is required for a period in which leakage for a biomass type i, could not be ruled out, otherwise, it is not needed.

B.7.2. Description of the monitoring plan:

The Project Proponent will implement monitoring procedures according to the monitoring methodology chosen for this project activity. This monitoring methodology will account for emission reductions and leakage effects in an accurate and conservative manner. According to the monitoring methodology (page 61/77 of the ACM0006 (Version 09)), all data collected as part of monitoring will be archived electronically and kept at least for 2 years after the end of the last crediting period.

The monitoring methodology will be supported by a dedicated management information system designed exclusively to guarantee the quality of the information related to the Viñales biomass power plant project activity. The system will use the same principles of the ISO 9001 version 2000 standard and will be incorporated to the plant's management information system. To ensure the quality and integrity of the management system, Arauco Bioenergía personnel will perform periodic internal audits.

Monitoring information flow of Viñales biomass power plant project activity



Arauco counts with on-site personnel (at the project activity site), who will be in charge of gathering and registering all the required information described in the monitoring plan. Such duties will be incorporated to the personnel's everyday activities to ensure continuity and high-quality standards. The information will be partially processed and stored there, and will be sent periodically (monthly) to Arauco Bioenergía in Santiago for further and final processing (table formats, reports, etc.). With the information at this level, Arauco will be in condition to certify the emission reduction of the Viñales project activity periodically (i.e. once every year).

Finally, since the Viñales sawmill is a modern facility and counts with very high quality, security and environmental standards, there are plenty of safety measures and security procedures implemented in the facility in case of emergencies or accidental events that might lead to unintended emissions. Particularly, for events related to accidental fires, the mill counts with on-line fire sensors that continuously monitor the entire production cycle and has a fire brigade especially trained to fight any fire contingency in the site.

B.8. Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies):

24/10/2005.

Arauco is the project participant responsible for the technical services related to GHG emission reductions, and is therefore, the entity that determined the baseline.

SECTION C. Duration of the project activity / crediting period

C.1. Duration of the project activity:

C.1.1. Starting date of the project activity:

23/04/2008.

The starting date of the proposed project activity corresponds to the date in which the purchase order of the power boiler was confirmed and assigned to the Viñales biomass power plant project. The evidence that supports this date is the signed purchase order for the power boiler, a letter to the vendor confirming this order and internal documents assigning this equipment to the Viñales project.

C.1.2. Expected operational lifetime of the project activity:

Minimum of 30 years, considered from the date in which the project started operating.

C.2. Choice of the crediting period and related information:

The proposed project activity will use a renewable crediting period; therefore section C.2.1 will be completed below.

C.2.1. Renewable crediting period:

C.2.1.1. Starting date of the first crediting period:

01/11/2011.

C.2.1.2. Length of the first crediting period:

Seven (7) years.

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

Not chosen.

C.2.2.2. Length:

Not chosen.

SECTION D. Environmental impacts

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

The impacts of the project that were identified in the Environmental Impact Declaration (DIA) are the following:

- **Solid and Liquid Wastes:** The operation of the plant will generate sewage water that will be treated in a sewage treatment plant in accordance with the Chilean regulations. The project will consume all the biomass residues that will be generated by the Viñales sawmill. Very low amounts of residues, like ashes, plastics and other industrial waste will be sent to a landfill, also according with the Chilean regulations.

- **Atmospheric emissions:** The emissions are related to noise and particulate material. Both of them are treated with state of art technology that put them below the emission limit factor required by the Chilean regulations.

All the impacts addressed above, were mentioned and resolved during the corresponding DIA procedure.

No transboundary impacts are considered for this project.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

According to the Chilean environmental regulations, since the proposed project activity does not generate a significant environmental impact, the project proponent must submit an Environmental Impact Declaration to the Environmental Authority. This document was presented to the Environmental National Authority, CONAMA in August, 2008 and the corresponding letter of approval was obtained in March, 25th, 2009.

SECTION E. Stakeholders' comments

E.1. Brief description how comments by local stakeholders have been invited and compiled:

The Project Proponent used the following media to present the proposed project activity to the local community:

- Television: Interviews in TV programs.
- Radio: Interviews.
- Press: Articles describing the proposed project, leaflets with information about Climate Change and the proposed project activity.
- Door-to-door presentation of the project to the local community.
- Meetings with local stake holders (see below).

The Project Proponent organized several meetings with the local community, the local authorities and other stakeholders in the VII Region. In these meeting, the project proponent described the technical aspects related to the project and the way in which the proposed project would contribute to reduce greenhouse gas emissions. Comments and impressions of the stakeholders were recorded and gathered via a Q&A session at the end of the meetings and via a brief questionnaire that was handed out by Arauco personnel and filled in by the attendants before they left the meeting. The meetings took place during July, 2008 and the following stakeholders were involved:

- Environmental authorities of the VII Region.
- Viñales personnel.
- Local business community.
- CORMA (the Wood Corporation).
- Fisherman federation of the VII Region.
- Environmental Committee of Constitución.
- Personnel of the Constitución pulp mill.
- Other professionals and members of the workforce of the VII Region.

E.2. Summary of the comments received:

From the 69 forms filled, 66 had positive comments about the project and 2 were neutral about the project. No negative comments were received about the proposed project activity.

E.3. Report on how due account was taken of any comments received:

The Project Proponent made several presentations to the local community about climate change and the proposed project activity. Questions from the attendees were answered during the meetings or via personal letters.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Represented by:	
Title:	Development Manager of Arauco Bioenergía S.A.
Salutation:	Mr.
Last Name:	Patrickson
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Department:	
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Direct FAX:	56-2-4623857
Direct tel:	56-2-4623795
Personal E-Mail:	cpatrickson@arauco.cl

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

The financial plans for the Project do not involve public funding.

Annex 3

BASELINE INFORMATION

SIC GRID DATA FOR COMBINED MARGIN CALCULATION

DATA PER POWER PLANT IN SIC GRID DURING 2008

(Source: Daily reports, CDEC-SIC)

POWER PLANT	DATE OF COMMISSIONING	POWER OUTPUT (MW)	PLANT TYPE	FUEL TYPE	LOW COST / MUST RUN	CDM PROJECT	NET POWER GENERATION IN 2008	SPECIFIC CONSUMPTION	UNITS OF SPECIFIC CONS.
Abanico	1948 - 1959	136.0	Run of the river	Hydro	Yes	No	**342**	0.00	N.C.
Aconcagua	1993 - 1994	72.9	Run of the river	Hydro	Yes	No	**439**	0.00	N.C.
Alfalfal	1991	178.0	Run of the river	Hydro	Yes	No	**907**	0.00	N.C.
Ancud	During last 90s	3.3	Diesel engines	Diesel	No	No	**6**	0.24	(Kg/KWh)
Antilhue new (I and II)	07-Ene-05	50.3	Open cycle	Diesel	No	No	**0**	0.24	(Kg/KWh)
Antilhue TG	07-Ene-05	101.3	Open cycle	Diesel	No	No	**241**	0.24	(Kg/KWh)
Antuco	1981	320.0	Reservoir	Hydro	Yes	No	**1,440**	0.00	N.C.
Arauco	1996	15.0	Biomass / Steam	Biomass	Yes	No	**12**	0.00	N.C.
Bocamina	30-Jun-70	125.0	Coal / Steam	Coal	No	No	**958**	0.39	(Kg/KWh)
Campanario	21-Mar-07	118.0	Open cycle	Natural Gas	No	No	**19**	0.39	(m^3-std/KWh)
Campanario Diesel	21-Mar-07	118.0	Open cycle	Diesel	No	No	**221**	0.25	(Kg/KWh)
Candelaria (Open cycle) 1	16-May-05	125.3	Open cycle	Natural Gas	No	No	**23**	0.30	(m^3-std/KWh)
Candelaria (Open cycle) 1 Diesel	16-May-05	125.3	Open cycle	Diesel	No	No	**264**	0.29	(Kg/KWh)
Candelaria (Open cycle) 2	01-May-05	128.6	Open cycle	Natural Gas	No	No	**12**	0.30	(m^3-std/KWh)
Candelaria (Open cycle) 2 Diesel	01-May-05	128.6	Open cycle	Diesel	No	No	**278**	0.29	(Kg/KWh)
Canutillar	1990	172.0	Reservoir	Hydro	Yes	No	**798**	0.00	N.C.
Cañete	During last 90s	1.7	Diesel engines	Diesel	No	No	**5**	0.24	(Kg/KWh)
Capullo	1995	12.0	Run of the river	Hydro	Yes	No	**69**	0.00	N.C.
Casablanca	20-Abr-07	1.8	Diesel engines	Diesel	No	No	**0**	0.23	(Kg/KWh)
Casablanca 1	20-Abr-07	1.3	Diesel engines	Diesel	No	No	**4**	0.23	(Kg/KWh)
Casablanca 2	20-Abr-07	0.5	Diesel engines	Diesel	No	No	**0**	0.28	(Kg/KWh)
Celco	1996	13.0	Biomass / Steam	Biomass	Yes	No	**43**	0.00	N.C.
Chacabuquito	22-Jul-02	25.0	Run of the river	Hydro	Yes	Yes	**177**	0.00	N.C.
Chiburgo	19-Jul-07	19.5	Run of the river	Hydro	Yes	No	**99**	0.00	N.C.
Cholguán	06-Jun-03	13.0	Biomass / Steam	Biomass	Yes	Yes	**90**	0.00	N.C.
Cipreses	1955	105.9	Reservoir	Hydro	Yes	No	**480**	0.00	N.C.
Colbún+Mach	1985	569.0	Reservoir	Hydro	Yes	No	**3,234**	0.00	N.C.
Collipulli	During last 90s	2.8	Diesel engines	Diesel	No	No	**8**	0.24	(Kg/KWh)
Concon	23-Abr-07	2.7	Diesel engines	Diesel	No	No	**7**	0.23	(Kg/KWh)
Constitución	1995-2007	9.7	Biomass / Steam	Biomass	Yes	No	**58**	0.00	N.C.
Constitución 1	06-Jul-07	9.0	Diesel engines	Diesel	No	No	**11**	0.30	(Kg/KWh)
Constitución 2	07-Jul-07	5.7	Diesel engines	Diesel	No	No	**0**	0.30	(Kg/KWh)
Coronel	01-May-05	45.7	Open cycle	Natural Gas	No	No	**1**	0.24	(m^3-std/KWh)
Coronel Diesel	01-May-05	45.7	Open cycle	Diesel	No	No	**74**	0.22	(Kg/KWh)
Curacautin	During last 90s	3.0	Diesel engines	Diesel	No	No	**6**	0.22	(Kg/KWh)
Curanilahue	27-Jun-07	2.1	Diesel engines	Diesel	No	No	**0**	0.00	(Kg/KWh)
Curauma	20-Abr-07	2.5	Diesel engines	Diesel	No	No	**6**	0.23	(Kg/KWh)
Curillinque	1993	89.0	Run of the river	Hydro	Yes	No	**605**	0.00	N.C.
D. de Almagro	1981	23.8	Open cycle	Diesel	No	No	**58**	0.35	(Kg/KWh)
Degan	04-Jul-07	36.0	Diesel engines	Diesel	No	No	**68**	0.22	(Kg/KWh)
El Rincón	23-Abr-07	0.3	Run of the river	Hydro	Yes	No	**3**	0.00	N.C.
El Toro	1973	450.0	Reservoir	Hydro	Yes	No	**1,206**	0.00	N.C.
Esperanza 1	29-Jun-07	1.7	Diesel engines	Diesel	No	No	**5**	0.22	(Kg/KWh)
Esperanza 2	27-Jun-07	1.5	Diesel engines	Diesel	No	No	**4**	0.23	(Kg/KWh)
Esperanza TG	22-Ago-07	17.9	Open cycle	Diesel	No	No	**4**	0.34	(Kg/KWh)
Eyzaguirre	12-Mar-07	1.5	Run of the river	Hydro	Yes	No	**9**	0.00	N.C.
Florida	1909 - 1993	28.0	Run of the river	Hydro	Yes	No	**155**	0.00	N.C.
FPC	27-Jun-07	11.6	Biomass / Steam	Biomass	Yes	No	**77**	0.00	N.C.
Guacolda I	1995 - 1996	152.0	Coal / Steam	Coal / Petcoke	No	No	**1,245**	0.37	(Kg/KWh)
Guacolda II	1995 - 1996	152.0	Coal / Steam	Coal / Petcoke	No	No	**1,285**	0.37	(Kg/KWh)
Horcones Diesel	20-Jun-07	24.3	Open cycle	Diesel	No	No	**7**	0.34	(Kg/KWh)
Horcones TG	01-Sep-04	24.3	Open cycle	Natural Gas	No	No	**0**	0.38	(m^3-std/KWh)
Huasco TG Diesel	1977 - 1979	64.2	Open cycle	Diesel	No	No	**0**	0.35	(Kg/KWh)
Huasco TG IFO	1977 - 1979	64.2	Open cycle	IFO 180	No	No	**160**	0.37	(Kg/KWh)
Huasco TV	1965	16.0	Coal / Steam	Coal	No	No	**0**	0.97	(Kg/KWh)
Isla	1963 - 1964	68.0	Run of the river	Hydro	Yes	No	**494**	0.00	N.C.
L. Verde TG	01-Feb-04	18.8	Open cycle	Diesel	No	No	**39**	0.26	(Kg/KWh)
L. Verde TV	1939 - 1949	54.7	Coal / Steam	Coal	No	No	**247**	0.72	(Kg/KWh)
Laja	1995-2007	10.2	Biomass / Steam	Biomass	Yes	No	**54**	0.00	N.C.
Las Vegas	20-Abr-07	2.3	Diesel engines	Diesel	No	No	**6**	0.23	(Kg/KWh)
Lebu	During last 90s	1.7	Diesel engines	Diesel	No	No	**4**	0.24	(Kg/KWh)
Licantén	30-Abr-04	5.5	Biomass / Steam	Biomass	Yes	No	**13**	0.00	N.C.
Loma Alta	23-Jul-97	40.0	Run of the river	Hydro	Yes	No	**256**	0.00	N.C.
Los Molles	1952	18.0	Run of the river	Hydro	Yes	No	**68**	0.00	N.C.
Los Morros	1930-1994	3.2	Run of the river	Hydro	Yes	No	**18**	0.00	N.C.
Los Quilos	1943 - 1989	39.3	Run of the river	Hydro	Yes	No	**282**	0.00	N.C.
Los Sauces	03-Ene-07	2.5	Diesel engines	Diesel	No	No	**5**	0.24	(Kg/KWh)
LosVientos_TG	03-Ene-07	125.0	Open cycle	Diesel	No	No	**381**	0.26	(Kg/KWh)
Maitenes	1923 - 1989	29.0	Run of the river	Hydro	Yes	No	**137**	0.00	N.C.
Mampil	01-Abr-00	49.0	Run of the river	Hydro	Yes	No	**163**	0.00	N.C.
Maule	23-Jul-07	6.0	Diesel engines	Diesel	No	No	**5**	0.30	(Kg/KWh)
Monte Patria	12-Jul-07	9.0	Diesel engines	Diesel	No	No	**17**	0.28	(Kg/KWh)
Nehuenco	01-Ene-99	368.4	Combined cycle	Natural Gas	No	No	**0**	0.20	(m^3-std/KWh)
Nehuenco (Open cycle)	01-Ene-99	250.0	Open cycle	Diesel	No	No	**0**	0.00	(Kg/KWh)
Nehuenco 9B	14-Jun-02	108.0	Open cycle	Natural Gas	No	No	**98**	0.34	(m^3-std/KWh)
Nehuenco 9B Diesel	14-Jun-02	108.0	Open cycle	Diesel	No	No	**137**	0.29	(Kg/KWh)
Nehuenco Diesel	01-Ene-99	368.4	Combined cycle	Diesel	No	No	**312**	0.16	(Kg/KWh)
Nehuenco II	30-Abr-04	390.4	Combined cycle	Natural Gas	No	No	**190**	0.20	(m^3-std/KWh)
Nehuenco II (Open cycle)	27-May-03	250.0	Open cycle	Natural Gas	No	No	**0**	0.00	(m^3-std/KWh)
Nehuenco II Diesel	15-May-07	376.1	Combined cycle	Diesel	No	No	**2,203**	0.17	(Kg/KWh)
Nueva Aldea 1	01-Abr-05	13.0	Biomass / Steam	Biomass	Yes	Yes	**107**	0.00	N.C.
Nueva Aldea 2	01-May-06	10.0	Open cycle	Diesel	No	No	**0**	0.29	(Kg/KWh)
Nueva Aldea 3	10-Sep-06	20.0	Biomass / Steam	Biomass	Yes	Yes	**210**	0.00	N.C.
Nueva Renca	24-Oct-97	379.0	Combined cycle	Natural Gas	No	No	**1**	0.22	(m^3-std/KWh)
Nueva Renca Diesel	24-Oct-97	379.0	Combined cycle	Diesel	No	No	**1,502**	0.18	(Kg/KWh)
Pangue	1996	467.0	Reservoir	Hydro	Yes	No	**1,789**	0.00	N.C.
Pehuenche	1991	566.0	Reservoir	Hydro	Yes	No	**2,754**	0.00	N.C.
Petropower	Ago-98	75.0	Petcoke / Steam	Petcoke	Yes	No	**494**	0.37	(Kg/KWh)
Peuchén	01-Ene-00	77.0	Run of the river	Hydro	Yes	No	**243**	0.00	N.C.
Pilmaiquén	1944 - 1959	39.0	Run of the river	Hydro	Yes	No	**244**	0.00	N.C.
Pullinque	1962	48.0	Run of the river	Hydro	Yes	No	**220**	0.00	N.C.
Punitaqui	06-Jul-07	9.0	Diesel engines	Diesel	No	No	**18**	0.28	(Kg/KWh)
Puntilla	01-May-98	14.0	Run of the river	Hydro	Yes	No	**149**	0.00	N.C.
Quellón	During last 90s	5.4	Diesel engines	Diesel	No	No	**10**	0.24	(Kg/KWh)
Quilleco	30-Abr-07	70.0	Run of the river	Hydro	Yes	Yes	**363**	0.00	N.C.
Ralco	01-Sep-04	690.0	Reservoir	Hydro	Yes	No	**2,573**	0.00	N.C.
Rapel	1968	378.0	Reservoir	Hydro	Yes	No	**1,034**	0.00	N.C.
Renca	1962	97.0	Diesel / Steam	Diesel	No	No	**12**	0.30	(Kg/KWh)
Rucúe	31-Oct-98	178.4	Run of the river	Hydro	Yes	No	**888**	0.00	N.C.
S. Fco. Mostazal	23-Jul-02	25.7	Open cycle	Diesel	No	No	**33**	0.31	(Kg/KWh)
San Ignacio	1996	37.0	Run of the river	Hydro	Yes	No	**213**	0.00	N.C.
San Isidro	10-Ago-98	379.0	Combined cycle	Natural Gas	No	No	**795**	0.28	(m^3-std/KWh)
San Isidro 2 Diesel	23-Abr-07	248.3	Combined cycle	Diesel	No	No	**1,647**	0.24	(Kg/KWh)
San Isidro 2	23-Abr-07	248.3	Combined cycle	Natural Gas	No	No	**1**	0.28	(m^3-std/KWh)
San Isidro Diesel	10-Ago-98	379.0	Combined cycle	Diesel	No	No	**590**	0.24	(Kg/KWh)
Sauce Andes	1930-1994	1.1	Run of the river	Hydro	Yes	No	**8**	0.26	(Kg/KWh)
Sauzal 50 Hz	1945 y 1959	76.8	Run of the river	Hydro	Yes	No	**490**	0.26	(Kg/KWh)
Sauzal 60 Hz	1946 y 1959	76.8	Run of the river	Hydro	Yes	No	**0**	0.26	(Kg/KWh)
Sauzalito	1948 y 1959	12.0	Run of the river	Hydro	Yes	No	**85**	0.26	(Kg/KWh)
Taltal (I and II)	02-Feb-00	244.9	Open cycle	Natural Gas	No	No	**104**	0.26	(Kg/KWh)
Taltal I Diesel	02-Feb-00	120.0	Open cycle	Diesel	No	No	**333**	0.26	(Kg/KWh)
Taltal II Diesel	02-Feb-00	120.0	Open cycle	Diesel	No	No	**603**	0.26	(Kg/KWh)
Traigen	During last 90s	1.7	Diesel engines	Diesel	No	No	**3**	0.26	(Kg/KWh)
Valdivia	14-May-04	61.0	Biomass / Steam	Biomass	Yes	No	**219**	0.26	(Kg/KWh)
Ventanas 1	1964	118.0	Coal / Steam	Coal	No	No	**942**	0.26	(Kg/KWh)
Ventanas 2	1977	220.0	Coal / Steam	Coal	No	No	**1,634**	0.26	(Kg/KWh)
Victoria	During last 90s		Diesel engines	Diesel	No	No	**0**	0.26	(Kg/KWh)
Volcán	1944	13.0	Run of the river	Hydro	Yes	No	**101**	0.26	(Kg/KWh)
Queltehues	1928	49.0	Run of the river	Hydro	Yes	No	**359**	0.24	(Kg/KWh)
Canela	31-Ago-07	18.2	Wind	Wind	Yes	No	**31**	0.29	(Kg/KWh)
Palmucho	29-Sep-07	32.0	Run of the river	Hydro	Yes	No	**225**	0.18	(Kg/KWh)
Hornitos	30-Sep-07	55.0	Run of the river	Hydro	Yes	Yes	**256**	0.38	(m^3-std/KWh)
Ojos de Agua	01-Jun-08	9.0	Run of the river	Hydro	Yes	Yes	**19**	0.18	(Kg/KWh)
Olivos	01-Feb-08	1.9	Open cycle	Diesel	No	No	**28**	0.18	(Kg/KWh)
Placilla	Abr-2008	3.0	Open cycle	Diesel	No	No	**3**	0.00	N.C.
Puclaro	01-May-08		Run of the river	Hydro	Yes	Yes	**33**	0.00	N.C.
Quintay	Abr-2008	3.0	Open cycle	Diesel	No	No	**3**	0.00	N.C.
Totoral	Abr-2008	3.0	Open cycle	Diesel	No	No	**3**	0.26	(Kg/KWh)
Chiloé	01-Jul-08		Diesel engines	Diesel	No	No	**0**	0.00	N.C.
Quellón II	01-Ago-08	10.0	Diesel engines	Diesel	No	No	**4**	0.24	(Kg/KWh)
Coya	01-Jul-08	34.8	Run of the river	Hydro	Yes	No	**43**	0.22	(Kg/KWh)
Colmito	01-Ago-08	55.0	Open cycle	Diesel	No	No	**3**	0.24	(Kg/KWh)
Los Pinos	23-Sep-08	97.0	Open cycle	Diesel	No	No	**7**	0.00	N.C.
Chuyaca	26-Nov-08	2.5	Diesel engines	Diesel	No	No	**0**	0.00	N.C.
Skretting	2008		Diesel engines	Diesel	No	No	**0**	0.26	(Kg/KWh)
Lircay	08-Oct-08	19.04	Run of the river	Hydro	Yes	No	**27**	0.00	N.C.
Cenizas	21-Oct-08	16.5	Diesel engines	IFO 180	No	No	**0**	0.00	N.C.
Santa Lidia	09-Dic-08	136	Open cycle	Diesel	No	No	**1**	0.26	(Kg/KWh)
TOTAL							**41,808**		

OPERATING MARGIN CALCULATION

(According to the Methdological tool, Annex 14, EB 50, Version 02 used by the ACM0002 (Version 10))

		2008
Total emissions from non-low cost / must run power plants	(tCO_2/yr)	14,064,160
Total emissions from low-cost / must-run power plants	(tCO_2/yr)	447,042
Total energy generated in the SIC	(GWh/yr)	41,089
Total energy by non-Low cost / must run power plants	(GWh/yr)	16,400
Total energy by low cost / must run power plants	(GWh/yr)	24,689
Factor λ	(number)	0.0000000
Operating Margin	**(tCO_2/GWh)**	**857.58**

Notes:

- Low cost / must run units present very low GHG emissions, since they are basically hydro plants and very few biomass plants.

BUILD MARGIN CALCULATION THE YEAR THE EMISSION ABATEMENT OCCUR

(According to the Methdological tool, Annex 14, EB 50, Version 02 used by the ACM0002 (Version 10))

(Calculation excludes CDM plants (if any), plants that have been moved and retired plants at the calculation date.)

POWER PLANT	POWER	PLANT TYPE	FUEL TYPE	DATE OF COMMISSIONING	CDM	TOTAL GEN 2008 (GWh)	(tCO_2/GWh)
Santa Lidia	136	Open cycle	Diesel	09-Dic-08	No	0.5	847.6
Chuyaca	2.5	Diesel engines	Diesel	26-Nov-08	No	0.1	691.0
Cenizas	16.5	Diesel engines	IFO 180	21-Oct-08	No	0.1	781.3
Lircay	19.04	Run of the river	Hydro	08-Oct-08	No	26.7	0.0
Skretting	0	Diesel engines	Diesel	30-Jun-05	No	0.0	718.8
Los Pinos	97	Open cycle	Diesel	23-Sep-08	No	7.1	675.4
Chiloé	0	Diesel engines	Diesel	01-Jul-08	No	0.1	890.0
Quellón II	10	Diesel engines	Diesel	01-Ago-08	No	3.6	734.7
Coya	34.8	Run of the river	Hydro	01-Jul-08	No	43.5	0.0
Colmito	55	Open cycle	Diesel	01-Ago-08	No	2.6	857.5
Ojos de Agua	9	Run of the river	Hydro	01-Jun-08	Yes	0.0	0.0
Puclaro	0	Run of the river	Hydro	01-May-08	Yes	0.0	0.0
Totoral	3	Open cycle	Diesel	Abr-2008	No	3.4	894.0
Quintay	3	Open cycle	Diesel	Abr-2008	No	3.2	894.0
Placilla	3	Open cycle	Diesel	Abr-2008	No	3.0	894.0
Olivos	1.94	Open cycle	Diesel	01-Feb-08	No	28.3	746.0
Hornitos	55	Run of the river	Hydro	30-Sep-07	Yes	0.0	0.0
Palmucho	32	Run of the river	Hydro	29-Sep-07	No	225.1	0.0
Canela	18.2	Wind	Wind	31-Ago-07	No	30.7	0.0
Esperanza TG	17.9	Open cycle	Diesel	22-Ago-07	No	3.6	1130.0
Maule	6	Diesel engines	Diesel	23-Jul-07	No	5.2	985.3
Chiburgo	19.5	Run of the river	Hydro	19-Jul-07	No	98.9	0.0
Monte Patria	9	Diesel engines	Diesel	12-Jul-07	No	17.1	932.7
Constitución 2	5.7	Diesel engines	Diesel	07-Jul-07	No	0.0	985.3
Punitaqui	9	Diesel engines	Diesel	06-Jul-07	No	18.1	932.7
Constitución 1	9	Diesel engines	Diesel	06-Jul-07	No	10.8	985.3
Degan	36	Diesel engines	Diesel	04-Jul-07	No	68.3	724.1
Esperanza 1	1.7	Diesel engines	Diesel	29-Jun-07	No	4.5	723.1
FPC	11.6	Biomass / Steam	Biomass	27-Jun-07	No	77.2	0.0
Esperanza 2	1.5	Diesel engines	Diesel	27-Jun-07	No	4.5	749.3
Curanilahue	2.1	Diesel engines	Diesel	27-Jun-07	No	0.0	0.0
Horcones Diesel	24.3	Open cycle	Diesel	20-Jun-07	No	6.8	1134.7
Nehuenco II Diesel	376.1	Combined cycle	Diesel	15-May-07	No	2158.9	550.5
Quilleco	70	Run of the river	Hydro	30-Abr-07	Yes	0.0	0.0
San Isidro 2 Diesel	248.3	Combined cycle	Diesel	23-Abr-07	No	1646.9	785.1
San Isidro 2	248.3	Combined cycle	Natural Gas	23-Abr-07	No	1.0	590.5
El Rincón	0.3	Run of the river	Hydro	23-Abr-07	No	2.5	0.0
Concon	2.72	Diesel engines	Diesel	23-Abr-07	No	7.2	747.6
Las Vegas	2.32	Diesel engines	Diesel	20-Abr-07	No	6.1	765.1
Curauma	2.502	Diesel engines	Diesel	20-Abr-07	No	5.9	760.9
Casablanca 2	0.475	Diesel engines	Diesel	20-Abr-07	No	0.1	920.6
Casablanca 1	1.3	Diesel engines	Diesel	20-Abr-07	No	4.0	765.7
Casablanca	1.775	Diesel engines	Diesel	20-Abr-07	No	0.0	765.7
Campanario Diesel	118	Open cycle	Diesel	21-Mar-07	No	221.3	829.1
Campanario	118	Open cycle	Natural Gas	21-Mar-07	No	18.9	831.3
Eyzaguirre	1.5	Run of the river	Hydro	12-Mar-07	No	8.7	0.0
LosVientos_TG	125	Open cycle	Diesel	03-Ene-07	No	380.8	844.3
Los Sauces	2.5	Diesel engines	Diesel	03-Ene-07	No	4.7	799.9
Nueva Aldea 3	20	Biomass / Steam	Biomass	10-Sep-06	Yes	0.0	0.0
Nueva Aldea 2	10	Open cycle	Diesel	01-May-06	No	0.0	959.5
Candelaria (Open cycle) 1 Diesel	125.3	Open cycle	Diesel	16-May-05	No	257.2	955.3
Candelaria (Open cycle) 1	125.3	Open cycle	Natural Gas	16-May-05	No	22.3	628.6
Coronel Diesel	45.7	Open cycle	Diesel	01-May-05	No	73.5	743.1
Coronel	45.7	Open cycle	Natural Gas	01-May-05	No	0.7	504.0
Candelaria (Open cycle) 2 Diesel	128.6	Open cycle	Diesel	01-May-05	No	271.3	955.3
Candelaria (Open cycle) 2	128.6	Open cycle	Natural Gas	01-May-05	No	12.1	628.6
Nueva Aldea 1	13	Biomass / Steam	Biomass	01-Abr-05	Yes	0.0	0.0
Antilhue TG	101.3	Open cycle	Diesel	07-Ene-05	No	239.8	793.4
Antilhue new (I and II)	50.3	Open cycle	Diesel	07-Ene-05	No	0.0	793.4
Ralco	690	Reservoir	Hydro	01-Sep-04	No	2568.8	0.0
Horcones TG	24.3	Open cycle	Natural Gas	01-Sep-04	No	0.0	799.4
Valdivia	61	Biomass / Steam	Biomass	14-May-04	No	218.9	0.0
Nehuenco II	390.4	Combined cycle	Natural Gas	30-Abr-04	No	185.8	415.6
Licantén	5.5	Biomass / Steam	Biomass	30-Abr-04	No	13.0	0.0
L. Verde TG	18.8	Open cycle	Diesel	01-Feb-04	No	38.7	861.4
Cholguán	13	Biomass / Steam	Biomass	06-Jun-03	Yes	0.0	0.0
Nehuenco II (Open cycle)	250	Open cycle	Natural Gas	27-May-03	No	0.0	0.0
S. Fco. Mostazal	25.7	Open cycle	Diesel	23-Jul-02	No	32.4	1025.0
Chacabuquito	25	Run of the river	Hydro	22-Jul-02	Yes	0.0	0.0
Nehuenco 9B Diesel	108	Open cycle	Diesel	14-Jun-02	No	135.7	967.1
Nehuenco 9B	108	Open cycle	Natural Gas	14-Jun-02	No	97.1	712.1
Mampil	49	Run of the river	Hydro	01-Abr-00	No	163.0	0.0
Taltal II Diesel	120	Open cycle	Diesel	02-Feb-00	No	600.8	895.6
Taltal I Diesel	120	Open cycle	Diesel	02-Feb-00	No	331.7	923.8
Taltal (I and II)	244.9	Open cycle	Natural Gas	02-Feb-00	No	104.2	702.4
Peuchén	77	Run of the river	Hydro	01-Ene-00	No	242.2	0.0
Nehuenco Diesel	368.4	Combined cycle	Diesel	01-Ene-99	No	306.2	529.3
Nehuenco (Open cycle)	250	Open cycle	Diesel	01-Ene-99	No	0.0	0.0
Nehuenco	368.4	Combined cycle	Natural Gas	01-Ene-99	No	0.0	420.7
Rucúe	178.4	Run of the river	Hydro	31-Oct-98	No	886.8	0.0
Petropower	75	Petcoke / Steam	Petcoke	20-Ago-98	No	403.0	905.1
San Isidro Diesel	379	Combined cycle	Diesel	10-Ago-98	No	572.5	593.4
San Isidro	379	Combined cycle	Natural Gas	10-Ago-98	No	771.6	590.5
Puntilla	14	Run of the river	Hydro	01-May-98	No	148.5	0.0
Nueva Renca Diesel	379	Combined cycle	Diesel	24-Oct-97	No	1466.0	583.4
Nueva Renca	379	Combined cycle	Natural Gas	24-Oct-97	No	0.7	464.1
Loma Alta	40	Run of the river	Hydro	23-Jul-97	No	255.6	0.0

TOTAL GEN. PER YEAR	**(GWh / yr)**	**41,089.0**
20% OF GEN. PER YEAR	**(GWh / yr)**	**8,217.8**
5 MOST RECENT PLANT GEN	**(GWh / yr)**	**34.5**

EMISSION FACTOR 5 PLANTS	**(tCO_2/GWh)**	**155.9**
EMISSION FACTOR 20% GEN	**(tCO_2/GWh)**	**459.3**

BUILD MARGIN	**(tCO_2/GWh)**	**459.3**

COMBINED MARGIN CALCULATION

(According to the Methdological tool, Annex 14, EB 50, Version 02 used by the ACM0002 (Version 10))

OM: Calculated ex-post (Option 2, the year in which the emissions occur).
BM: Calculated ex-post (Option 2, updated annually from the date the first emissions occur).

		2008
Operating Margin	(tCO_2/GWh)	857.58
Build Margin	(tCO_2/GWh)	459.28
Combined Margin	**(tCO_2/GWh)**	**658.43**

Methane emission factor of uncontrolled burning of biomass residues from forest operations

1. Introduction

The objective of this project is to quantify the emission factors (EF) of methane (CH_4) from burning forest residues in the open air, natural, uncontrolled conditions in the south central part of Chile. Two fuel types were burned:

a) A mixture of sawdust and bark, which are residues from industrial operations (mainly sawmill industry) and are used at Arauco biomass power plants.
b) A pile of different sizes of branches, which are residues from forestry operations (mainly harvesting, pruning, and thinning).

The mixture of sawdust and bark, collected by third parties, is planned to be used by the Celulosa Arauco y Constitución S.A. (as Arauco) at two new biomass power plants: one in the Horcones Complex, close to Concepcion in the VIII Region, and the other one in the Viñales sawmill, located near Consititución in the VII Region. The same biomass residues are being used by Arauco as fuels at the Nueva Aldea, Trupan, Valdivia, and other biomass power plants. Different sizes of branches (2.5–30 cm in diameter), collected from forestry operations, may also be used as supplemental fuel for the new plants.

We conducted field experiments in south central Chile on March 18–26, 2009, a transition period from late summer to early autumn, to quantify methane and other trace gas emissions from burning the two fuel types mentioned above. We will report the weather conditions, the fuel moisture and carbon content, and the average emission factor of methane (EF CH_4) with an associated standard deviation for each fuel type burned under natural conditions. We will also discuss the application of the methane emission factors derived from the experiments to calculate the annual amount of methane emissions from burning these fuels in open air.

Our team has a 20-year experience in studying emissions of trace gases from biomass fires in various ecosystems in the United States, Canada, Mexico, the Amazon in Brazil, Chile, Zambia, South Africa, and central Siberia in Russia. Dr. Hao was the co-author of one of the Intergovernmental Panel on Climate Change (IPCC) reports in 2001 [Hao, 2001]. He was recognized by the IPCC for the contribution to the 2007 Nobel Peace Prize to IPCC.

2. Field Site and Fuel Type

The experimental site (37°18'54.22"S, 71°59'39.50"W, elevation 310 m) was located at a gravel pit near Canteras in south central Chile. The choice of locating at a gravel pit was to prevent fires spreading to adjacent forests. Eight piles of biomass fuels used at the Arauco's power generating plants were arranged in two rows with four piles on each row and approximately 10 m apart between the piles. Each pile was about 2 m high and had a volume of about 30 m^3. The fuel types include a mixture of sawdust and bark and branches in different sizes. The description of each pile is summarized in Table 1.

Table 1. Fuel Types of the Experiments

Fuel Type	Identification	Piles

Mixture of sawdust and bark	MX4, MX11, MX5, X12	4, 5, 11, 12
Branches in different diameters	BR6, BR13, BR7, BR14	6, 7, 13, 14

3. Meteorological Conditions

These experiments were carried out during the transition period from late summer to early autumn. The daily weather conditions at the field site on March 18–26, 2009 are summarized in Table 2. We measured wind speed, temperature, and relative humidity. The weather conditions during the nine days were fairly constant: sunny, windy, warm, and low humidity almost everyday.

Table 2. Weather Conditions during the Experiments

Day	March	Condition	Wind Speed (km/hr)	Mean Temperature (^oC)	Mean Relative Humidity (%)
1	18	sunny	7 (2–15)	33	24
2	19	sunny	13 (6–23)	24	35
3	20	sunny	7 (3–22)	22	45
4	21	sunny	8 (5–12)	23	31
5	22	sunny			
6	23	sunny	6 (2–12)	23	36
7	24	sunny	7 (3–20)	23	34
8	25	sunny	8 (4–15)	23	42
9	26	sunny	5 (3–8)	21	47

4. Experimental Method

4.1 Combustion Processes

For uncontrolled, open air burning of piled forest residues, a propane torch was used to ignite the piles. The use of fossil fuels, such as diesel or kerosene, for ignition was avoided to prevent contamination of smoke samples. Small tunnels were dug to facilitate air flow in some of the piles. The piles of the sawdust and bark mixture burned for several hours until the combustion process was stabilized and the sampling was initiated. The duration of each pile burned varied considerably. It took several days to burn the piles of mixed sawdust and bark. Windy conditions increased the rate of fuel consumption. Combustion of a pile of sawdust and bark mixture, dominated by prolonged smoldering combustion, is shown in Figure 1. The piles of branches were completely burned within a few hours with predominantly flaming combustion. Combustion of a branch pile is shown in Figure 2.

Figure 1. Burning sawdust and bark mixture shortly after ignition, March 19, 2009

Figure 2. Burning branch pile shortly after ignition on March 20, 2009

4.2 Sampling System

Smoke samples were collected every 2–3 hours during daytime. A background sample of clean air was collected at the start of each day, about 100 m upwind from the burning piles. The sampling system was a portable unit mounted on a metal frame that can be carried as a backpack to collect a sample. The inlet of the sampling system was connected to a sample probe (3 m long, 6 mm O.D.) with a flexible 3/8" (O.D.) stainless steel tube. Smoke samples were collected by inserting the sample probe into the smoke about one meter from the pile.

The sampling system consists of a Rasmussen KNF canister pump with 6 mm (O.D.) stainless steel tubing connected through a T-fitting to a pressure relief valve and a pressure gauge, respectively. The

pressure relief valve was used to regulate the pressure of the system and set the final pressure in the canisters. The pressure gauge allowed the operator to monitor the pressure change in the canisters while filling the samples and to check that each canister was evacuated prior to sampling. The sampling system was initially purged with smoke, and then the samples were drawn into the canisters by pressuring the canisters to 25 psia. The flow rate into the canisters was 2 liters/minute and it took approximately 30 seconds to fill each canister. The canisters were 500 ml steel bottles with Nupro model SS-00121 stainless steel ball valves. At the end of each sampling, a purge valve opened to flush out the residual sample in the sampling line. The sampling pump was powered by a 12 volt gel cell rechargeable battery.

Based on our previous laboratory tests, the storage time for the low molecular weight trace gases in canisters is longer than six months. Thus, within the time frame of 4–6 weeks between sample collection and analysis, it is reasonable to assume that the concentrations of carbon dioxide (CO_2), carbon monoxide (CO), CH_4, and non-methane hydrocarbons (NMHC) in the canisters were stable and did not change during this period.

4.3 Fuel Analysis

Samples of about 250 g for each pile were collected prior to ignition for analysis of fuel moisture content. Samples were immediately weighed in the field with a portable balance. After the samples were transported back to the Fire Sciences Laboratory, they were dried for 48 hours at a 100^{o}C oven and weighed [Allen, 1989]. After fuel moisture analysis, a portion of each sample was milled (40 mesh) and sent to the University of Idaho Analytical Services Laboratory for analysis of the carbon content of the biomass by a CHN (carbon-hydrogen-nitrogen) analyzer.

4.4 Trace Gas Analysis

Trace gas concentrations in canisters were analyzed at the Fire Sciences Laboratory, using the methodology developed by Hao et al. [1996]. The samples were analyzed for CO_2, CO, CH_4, and C_2, C_3, and C_4 alkanes and alkenes with a Hewlett Packard model 5890 Series II gas chromatograph equipped with dual flame ionization detectors (FIDs). The CO_2 and CO analysis utilized a 1 ml sample loop to inject the sample onto a 3.2 mm I.D. x 2 m long Carbosphere (Alltech) column, with a helium carrier gas (flow rate - 16 ml/minute). After separation of CO_2 and CO in the column, the compounds were passed through a methanizer (375^{o}C) that converted CO_2 and CO to methane, enabling detection by the FID at 350^{o}C. The oven temperature program for this analysis was 40^{o}C for five minutes, an increase to 140^{o}C at 20^{o}C/minute, and 4 minutes at 140^{o}C. The CH_4 and C_2 –C_4 analyses were performed using a 0.25 ml sample loop, a 0.53 mm x 50 m HP-AL/S column (J&W Scientific), with helium carrier gas at a flow rate of 6 ml/min, and FID at 300^{o}C, with a makeup helium gas flow of 14 ml/min. The oven temperature program for hydrocarbon analysis was the same as the program for CO_2 and CO analysis, as both analyses were performed simultaneously.

Chromatogram data was processed and archived by Hewlett Packard ChemStation II software. A set of CO_2, CO, CH_4, and C_2 and C_3 calibration standards at concentrations close to the samples were analyzed each day to construct a standard curve for each compound. Based on the integrated peak areas, the sample concentrations were calculated from the standard curves and written into an Excel spreadsheet. Duplicate samples were analyzed for every sixth analysis. The National Institute of Science and Technology (NIST) primary CO_2 and CO standards were analyzed periodically to verify the response of the detectors. Both the accuracy and precision are 1% for CO_2, CO, and CH_4 analyses.

The emission factor of a compound is defined as the amount (g) of the compound emitted per kg of biomass burned. The emission factor was calculated by the carbon mass balance method [Ward and Radke, 1993]. The computation was based on the emitted, above-ambient background concentrations of carbon-containing compounds and the carbon content of the biomass. In these experiments, the carbon-containing compounds of CO_2, CO, CH_4, and C_2, C_3, and C_4 gases were analyzed in the sample, and C_2-C_4 gases were summed as the non-methane hydrocarbons. High molecular weight hydrocarbons were found in trace concentrations in smoke as compared to the major light carbon compounds (e.g., CO_2, CO, CH_4), and accounted for less than 0.01% of the total emitted carbon. Therefore, the omission of measuring the concentrations of high molecular weight hydrocarbons is insignificant in calculating emission factors of methane.

5. Results and Discussion

The piles were burned under weather conditions during the transition period from late summer to the beginning of autumn. We collected 51 smoke samples from burning four piles of mixed sawdust and bark, 44 smoke samples from burning four piles of branches in different sizes, and nine clean air samples during the nine-day period. The average moisture content of the mixed fuel of sawdust and bark was 45.5% with a standard deviation of 8.2% (n=4). The average moisture content of branches was extremely low (7.3%) with a standard deviation of 3.2% (n=4). The average carbon content of the mixed fuel and branches was 51.3% ± 0.5% (n=4) and 52.0±1.2% (n=4), respectively. These values are very similar to the default value of wood carbon content of 50%.

Clean air concentrations of 376–422 ppm for CO_2, 0.1–0.6 ppm for CO, and 1.6–1.8 ppm for CH_4 were comparable to the clean air concentrations measured in other parts of the world. The background concentrations were subtracted from the pile emission concentrations to obtain net emission concentrations.

The emission factor of methane of each sample from burning mixed fuel or branches is shown in Figure 3. The sample number is the order of the samples taken during the nine-day period. It is apparent that the EF CH_4 of mixed fuel (11.6–24.9 g/kg) were much higher than the EF CH_4 of branches (0.1–7.0 g/kg). The EF CH_4 in the first week were slightly higher than the ones in the second week.

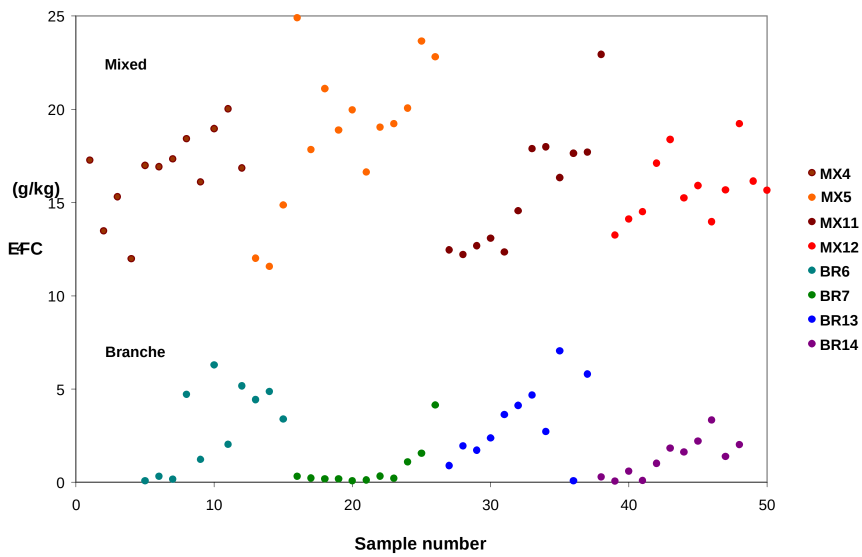

Figure 3. Emission Factor of Methane for Each Sample

The average methane emission factor for each fuel type is summarized in Table 3. The average emission factor of methane from burning mixed sawdust and bark (17.2 g/kg or 930 kg/TJ) is consistent with that for the same type of fuels burned in previous experiments in Chile. The standard deviation (±3.1 g/kg or 168 kg/TJ, n=51) is also similar with that of previous measurements carried out in Chile. The average emission factor of methane for burning branches (2.1 g/kg or 114 kg/TJ) is about eight times lower than the EF CH_4 for burning the mixture of sawdust and bark, because burning branches were dominated by high-temperature flaming combustion (Figure 2).

Table 3. Experimental Results

Fuel Type	EF CH_4 (g/kg)	Standard Deviation (g/kg)	Number of Samples (n)
Mixed sawdust and bark	17.2	3.1	51
Branches	2.1	2.1	44

or EF CH_4 are equivalent to 930 ± 168 kg CH_4 /TJ for mixed sawdust and bark, and 114 ± 114 kg CH_4/TJ for branches, based on the net heat content of fuel to be 18.5 MJ/kg measured and provided by Arauco.

<u>The values of the average methane emission factors of burning a mixture of sawdust and bark or branches in different sizes derived from these measurements are very conservative estimates, if the EF CH_4 are used to determine the amount of methane emitted annually from burning these fuels in the open field.</u> These experiments were carried out in warm, dry, windy conditions near the end of the dry season. The moisture content of the biomass is extremely low because of the weather conditions. The weather conditions favor flaming combustion, which result in low methane emissions. When the fuels are burned

in the rainy season, the conditions favor smoldering combustion and higher methane emission factors than the values in this report.

6. Conclusion

The average emission factor of methane was 17.2 g/kg (or 930 kg CH_4/TJ), with a standard deviation of 3.1 g/kg (or 167 kg/TJ), from open, uncontrolled burning of four sawdust/bark piles in central Chile in March 2009. This value was calculated by averaging the measurements of 51 samples collected in nine days. The piles were large enough to represent the combustion process of large piles. The proposition is based on visual observation of the piles burned and the narrow range of the CH_4 emission factors of the experiments. The average methane emission factor was 2.1 g/kg (or 114 kg CH_4/TJ), with a standard deviation of ±2.1 g/kg (or 114 kg/TJ), for burning four piles of branches in different sizes.

The average methane emission factors derived from these experiments are very conservative values if they are used to calculate the annual methane emissions from burning these fuels in open air. The experiments were conducted in warm, windy, and low humidity weather conditions in nine days. The emissions of methane are expected to be lower under these conditions than the methane emissions in cool, rainy, and high humidity conditions. In addition, digging tunnels, not a common practice, to speed up the experiments also tend to favor flaming combustion and low methane emissions.

The standard deviations of the reported emission factors of methane characterize the natural variability and changes of the combustion process during the duration of the experiments. The standard deviations do NOT represent the variation of the highly reproducible sampling and analytical methods used in this project.

7. References

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Annex 4

MONITORING INFORMATION

Sustainable origin of the biomass from forest operations used in the Viñales biomass power plant project

Implications of the DNA approval of the Viñales biomass power plant project activity

According to the Chilean DNA, the letter of approval is granted to a CDM project activity if such project fully complies with all the current and pertinent environmental Chilean regulation and positively contributes to the sustainable development of the country. As will be shown below, according to the Chilean law, the harvesting of forests (both native and exotic) that do not count with an authorized management plan is illegal and penalized by criminal and civil law. Furthermore, the purchase of illegal products is also illegal. Therefore, if the proposed project activity consumed or favored the consumption of illegal forest by-products (i.e. from forests not managed in a sustainable way), the Chilean DNA would not issue the Letter of National Approval to the project and the proposed project would not be viable under the CDM.

On the same lines, the Viñales power plant project was approved by the Chilean Environmental Authority, CONAMA (which also happens to be the DNA for CDM projects in Chile). Such approval cannot be obtained if the project does not comply with the outstanding Chilean regulations and in particular with the Chilean Forestry Law.

According to the two arguments above, by complying with the Chilean Law, the Viñales sawmill administration makes sure that all the forest products and by-products used in the plant come from legal and therefore sustainable sources.

Implications of the Chilean Forestry Law:

The Decree Nº 701 of 1974, in its Articles Nº 21 and 22 clearly and explicitly mandates forest and landowners to manage their forest plantations in a sustainable way. This implies to have a pre-approved management plan by CONAF,[33] which requires replanting the forest once it has been harvested. According to this, all forest plantations must be managed in a sustainable way according to the Chilean law.

The law is very stringent for those who do not follow it, specifying hefty fines for the non-compliant companies (Articles 17, 21 and 22 of the Decree Nº701). The fines can go from one to three times the value of the products generated from illegal forest cuts, plus the confiscation of the products. In some cases, forest owners and end buyers of illegally procured wood by-products may face criminal charges.

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[33] CONAF stands for National Corporation of Forestry, and is a governmental body in charge of administrating the national forestry policy and promoting the development of the forestry sector in Chile. Its main objective is to guarantee the sustainable management of forest ecosystems and of the natural endowment of the country.

The supervising body in Chile is CONAF, who does so via implementing sea, road and air control mechanisms programs throughout the entire national territory[34].

CONAF is the governmental body that authorizes the cut of artificial forest (i.e. exotic plantations serving productive purposes) and native forests. In both cases, there must be a management plan approved by CONAF, however in the second case, CONAF must issue a special authorization or dispatch bill (a "free transit dispatch document"), which must be kept by the owner to transport each and every product that results from the forest cut. This certificate is passed on to the end buyer of the products and kept for future internal controls and audits by the environmental authorities.

The Viñales sawmill management is aware of the law and the strict control and penalties there are for companies who do not observe the regulation regarding forest management and the consequences that might carry the possibility to purchase biomass fuels from doubtful or questionable origin. For that reason, the Viñales sawmill management will have the following controls in place:

1. The Viñales Procurement Department will make all its biomass fuel suppliers (and other suppliers as well) sign a supply contract agreement in which the sellers (for example the sawmills, in this case) declare to know and comply with the pertinent Chilean legislation, that the products they sell count with all permits and authorizations required by law, in particular those related to the origin of the wood that generated the biomass fuels, which are now sold and delivered to the Plant.

2. All biomass fuels that are planned to be used in the Viñales biomass power plant will come from plantations of exotic species, mainly Radiata pine and Eucalyptus. If biomass from native forests were used, the Viñales management will request the corresponding documentation, which will guarantee the renewable source of the biomass.

Since the Chilean law penalizes the purchase of illegal products, it is in the Viñales management's best interest to observe the forest regulation. In order to show the effectiveness of how the Chilean law is actually observed not only by Arauco but by other forest companies as well, the Project Proponent would like to present some evidence about the forest management situation in Chile.

The Viñales biomass power plant is located in the VII Region and will consume biomass from exotic species. These include mainly Radiata pine and a small fraction of other exotic tree species. The following tables show the situation of the exotic plantations and the way they are used by the different industries of the forest sector in Chile:

[34] See CONAF web page, www.confaf.cl, Legislation, Control of forest legislation.

EVOLUTION OF THE ANNUAL LAND PLANTED IN CHILE, MAIN SPECIES

(Hectares)

Year	Radiata Pine		Eucalyptus		Other species	
	Forestation	Reforestation	Forestation	Reforestation	Forestation	Reforestation
1994	39,424	23,638	31,591	6,200	6,487	2,546
1995	30,594	32,130	24,126	5,428	5,546	2,034
1996	26,565	26,880	12,033	6,105	3,863	3,148
1997	28,376	27,493	11,444	5,598	4,516	2,057
1998	18,147	40,605	14,044	8,754	3,409	1,621
1999	22,606	47,320	13,243	20,306	3,759	1,037
2000	16,453	42,958	23,173	13,607	4,708	1,451
2001	14,884	33,548	22,739	15,806	6,553	1,325
2002	15,183	23,890	19,689	16,785	11,348	1,194
2003	17,137	41,077	31,029	18,623	8,578	3,053
2004	18,724	42,837	32,657	19,374	16,856	193

Sources: INFOR (National Forestry Institute, www.infor.cl), CONAF, Companies.

Forestation: Plantation of new forests.
Reforestation: Plantation of forests that have been harvested.

ESTIMATION OF THE FUTURE WOOD AVAILABILITY IN CHILE, MAIN SPECIES

(Thousands of cubic meters per year)

Period	Radiata Pine
2003 - 2005	24,288
2006 - 2008	29,223
2009 - 2011	31,425
2012 - 2014	31,453
2015 - 2017	31,453
2018 - 2020	31,453
2021 - 2023	31,453
2024 - 2026	33,538
2027 - 2029	38,191
2030 - 2032	38,705

Period	Eucalyptus
2005 - 2006	4,763
2007 - 2008	6,791
2009 - 2010	7,343
2011 - 2012	10,930
2013 - 2014	13,978
2015 - 2016	14,077
2017 - 2018	14,099

Note: Results obtained according a mathematical programing model that maximizes the physical availability of wood, satisfying restrictions of age at the moment of harvesting and management schemes in order to guarantee the sustainability of wood over time.
Source: INFOR, "2004 Forestry Statistics of the VIII Region", Statistics Bulletin Nº102, Tables 2.15 and 2.16, page 41.

Main conclusion:
All forest plantations, including exotic species, are managed in a sustainable way in Chile.

WOOD CONSUMPTION IN THE NATIONAL FOREST INDUSTRY
(Year 2004, in cubic meters)

Industry	Radiata pine	Eucalyptus	Native	Other exotic	Total
Pulp	8,564,565	2,647,072			**11,211,637**
Sawn timber	14,910,943	11,318	418,528	168,983	**15,509,772**
Wood boards and laminate	1,584,692	6,884	197,016	24,900	**1,813,492**
Export sawn timber	68,025	26	7,019	11	**75,081**
Export pulp timber	116,946	81,290		184	**198,420**
Wood chips	108,166	2,589,997			**2,698,163**
Wood boxes	186,164		1,158	35,678	**223,000**
Wood posts	262,063	4,618		1,718	**268,399**
Total	**25,801,564**	**5,341,205**	**623,721**	**231,474**	**31,997,964**

Source: INFOR

According to the information in the table above, it is possible to estimate the sources of biomass fuels (sawdust and bark) generated by species at a national level:

	(%) per species	Accumulated (%)
Radiata pine	80.6%	80.6%
Eucalyptus	16.7%	97.3%
Other exotic	0.7%	**98.1%**
Native	1.9%	100.0%
Total	**100%**	

Main conclusions:
1. At a national level, the vast majority of the biomass residues (i.e. biomass fuels) come from exotic forests, mainly Radiata pine and Eucalyptus.
2. At a national level, the biomass residues (i.e biomass fuels) that come from native forests are very, very small (less than 2%).

WOOD CONSUMPTION FOR THE PRODUCTION OF SAWN TIMBER IN THE VII REGION
(Year 2004, in cubic meters)

Species	Total VII Region	(%)
Radiata pine	2,564,381	**99.61%**
Other exotic	610	0.02%
Native	9,489	0.37%
Annual consumption	**2,574,480**	**100.00%**

Source: INFOR, "2004 Forestry Statistics of the VII Region", Statistics Bulletin Nº104, Table 3.7, page 41.

Main conclusions:
1. Almost 100% of the wood consumption in the VII Region used to generate sawn timber comes from Radiata Pine plantations.
2. Almost 100% of the biomass residues (sawdust and bark) generated in sawmills of the VII Region, come from Radiata Pine plantations.

According to the conclusions drawn from the tables above, it is easy to see that all forests and particularly the exotic forest plantations are managed in a sustainable way in Chile. It is possible –then- to conclude that the biomass residues generated by harvesting these forests come from renewable sources. This shows that the Forestry Law (Decree Nº 701) is actually observed and enforced in Chile. The reason behind this is explained by the supervisory role of CONAF and due to the economic incentives provided by the Chilean Government to land and forest owners. These benefits can only be perceived if the forests are managed as prescribed by the Chilean law, which necessarily means that are supervised by CONAF[35].

In summary, by observing the Chilean Forestry Law, Arauco ensures that all the biomass used as fuel in the power boiler comes from sustainable sources. The reliability of this conclusion is based on the high level of compliance of this law in the country, which is confirmed by official information at a national and at a regional level.

[35]CONAF has a dedicated department for controlling the compliance of the Decree Nº 701.

INFLUENCE AREA OF THE VIÑALES POWER PLANT

Communes	Country region	Communes	Country region
Requinoa	VI	Teno	VII
Chépica	VI	Vichuquén	VII
Coltauco	VI	Talca	VII
La Estrella	VI	Constitución	VII
Las Cabras	VI	Curepto	VII
Litueche	VI	Empedrado	VII
Lolol	VI	Maule	VII
Malloa	VI	Pelarco	VII
Marchihue	VI	Pencahue	VII
Nancagua	VI	Río Claro	VII
Navidad	VI	San Clemente	VII
Palmilla	VI	San Rafael	VII
Paredones	VI	Linares	VII
Pichidegua	VI	Colbún	VII
Placilla	VI	Longaví	VII
Pumanque	VI	Parral	VII
Quinta de Tilcoco	VI	Retiro	VII
Rengo	VI	San Javier	VII
Santa Cruz	VI	Villa Alegre	VII
San Vicente	VI	Yerbas Buenas	VII
Peumo	VI	Cauquenes	VII
Peralillo	VI	Chanco	VII
Curicó	VII	Pelluhue	VII
Hualañé	VII	Cobquecura	VIII
Licantén	VII	Quirihue	VIII
Molina	VII	Ninhue	VIII
Rauco	VII	San Carlos	VIII
Romeral	VII	Ñiquen	VIII
Sagrada Familia	VII		

The communes presented above are all located at no more than 200 km. from the Viñales project power plant.

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