Project design document form
(Version 12.0)

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

BASIC INFORMATION	
Title of the project activity	Cabo Leones Wind Farm
Scale of the project activity	☒ Large-scale ☐ Small-scale
Version number of the PDD	14.1
Completion date of the PDD	14/09/2021
Project participants	Ibereólica Cabo Leones I S.A.; Aprovechamientos Energéticos S.A.; ALLCOT COLOMBIA SAS
Host Party	Chile
Applied methodologies and standardized baselines	ACM0002 v.13.0.0 “Grid-connected electricity generation from renewable sources”
Sectoral scopes	I. Energy Industries (renewable / non-renewable sources)
Estimated amount of annual average GHG emission reductions	276,709 tCO_2/year

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>>

The purpose of the Cabo Leones Wind Farm is the generation of renewable electric energy with wind power technology in Chile.

The proposed project has a total installed capacity of 175.5 MW and a net total annual grid-connected power generation of 461,923 MWh. The electricity generated by the proposed project will be supplied to the National Electric System (SEN). It is expected that, when the Project becomes fully operational, will displace fossil fuel fired power stations avoiding the emission of 316,417 tCO_2 each year and 1,936,963 tCO_2 during the first crediting period.

As the project activity is a greenfield renewable energy power plant, the scenario existing prior its implementation is a semi-desert, sparse vegetated, coastal winded pasture and shrub land, where neither facilities nor crops existed previously.

According to the ACM0002, as the project activity is the installation of a new grid-connected renewable power plant, the baseline scenario is the "*electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin (CM) calculations described in the "Tool to calculate the emission factor for an electricity system*". Baseline scenario would be a continuation of the current practice.

The project activity will increase the percentage of renewable sourced power in the Chilean grids, promoting the growth of renewable capacity and diversifying the Chilean generation mix, significantly contributing to the sustainable development of the region. This represents a quite important solution, as the SIC (Central Interconnected System) electric generation mix was mainly weighted towards fossil fuels as it is shown in the following table:

System	Total Installed Power			Total
	Thermal (MW)	Hydraulic (MW)	Wind Power (MW)	System (MW)
SING	3,685.9	12.8	0.0	3698.7
SIC	6,625.7	5,355.6	165.8	12,147.1
AYSÉN	20.6	17.6	2.0	40.2
MAGALLANES *	98.8	0.0	0.0	98.8
Totals	**10,431.0**	**5386.0**	**167.8**	**15,984.8**

Table 1: Annual Statistical Table on energy production and peak demand, per system. Source: CDEC-SIC Yearbook 2001-2010 (https://www.cdec-sic.cl/datos/anuario2011_ing.pdf)

The project was designed to supply the electricity generated to the central Chilean grid: the Central Interconnected System (SIC), but in 2017 the SIC was connected to the SING to form the National Electric System (SEN[1]), so now supplies to this system.

The use of wind energy as a replacement for fossil fuel-based electricity generation has significant environmental benefits and contributes to sustainable development. The analysis of the electricity production technologies using coal, oil, natural gas, hydropower, solar photovoltaic, nuclear,

[1] SEN – Sistema Energético Nacional (National Energetic System)

biomass and wind energy (see Figure 3), show that wind farm energy is the less GHG emitting energy source compared to the rest of power sources:

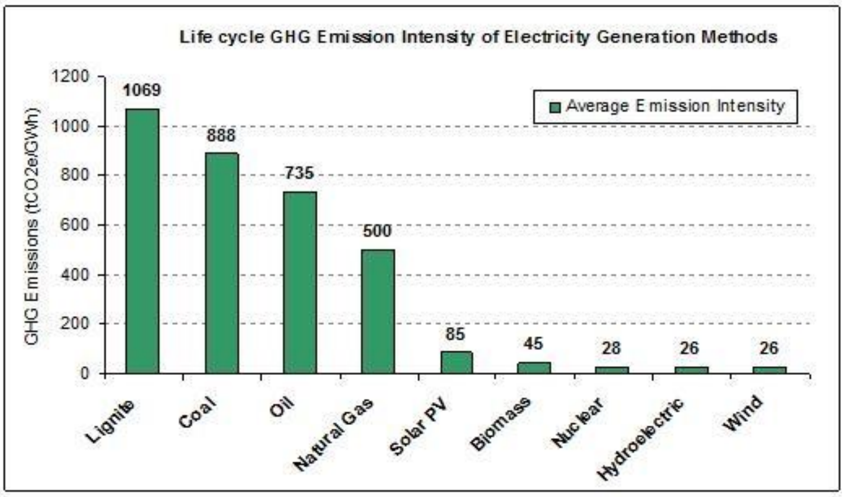


Figure 1. Lifecycle GHG emission intensity of electricity generation methods. Source: "Comparison of Lifecycle Greenhouse Gas Emissions of Various Electricity Generation Sources" Cameco Corporation, 2010[2].

Furthermore, the wind energy has less environmental impact than other power generation sources, as it can be seen in the following table:

Energy Technologies	Life Cycle Impacts (Pre- and Post-Generation)			Power Generation Impacts			CO_2 Emissions t/MWh
	Air	Water	Land	Air	Water	Land	
Coal - USC	Baseline Technology for Relative Assessments Below						0.777
Coal - Biomass	Positive	Positive	Variable / Uncertain	Variable / Uncertain	Minimal	Minimal	0.622
Coal - CCS	Negative	Negative	Negative	Variable / Uncertain	Negative	Minimal	0.142
Coal - IGCC	Minimal	Variable / Uncertain	Minimal	Positive	Positive	Minimal	0.708
NGCC	Positive	Positive	Positive	Positive	Positive	Positive	0.403
Nuclear	Positive	Variable / Uncertain	Variable / Uncertain	Positive	Negative	Positive	0.005
Solar - CSP	Positive	Positive	Positive	Positive	Negative	Minimal	0.017
Solar - PV	Positive	Positive	Positive	Positive	Positive	Minimal	0.009
Wind	Positive	Positive	Positive	Positive	Positive	Variable / Uncertain	0.002

Table 2. Environmental impacts of the different ways of power generation. International Energy Agency, Energy Technologies Perspectives, 2010[3].

So it can be concluded that wind power generation is a better performance technology than any other power generation technology currently used.

2 Available at http://www.google.ca/url?sa=t&rct=j&q=&source=web&cd=1&ved=0CE0QFjAA&url=http%3A%2F%2Fwww.ca meco.com%2Fcommon%2Fpdf%2Furanium_101%2FCameco_-_Corporation_Report_on_GHG_Emissions_nov_2010.pdf&ei=msYWUNTIEI_gtQaG4IGQDA&usg=AFQjCNFl Yc0PDXvhUhoy7nHDAksB1DY_Wg&cad=rja.

3 Available at http://www.iea.org/publications/freepublications/publication/etp2010.pdf.

The Project activity will create local employment during the project construction and operation period and will require training workers as soon as construction begins. In this sense, the turnkey contract tender indicates an employment of up to 100 qualified and non-qualified people during the construction phase and 10 for the operation and maintenance in the working phase. In addition to the direct jobs that will be created, the construction works will have a positive impact in the creation of more indirect jobs in companies that provide professional services as well as auxiliary and assistance services like transport, hotel management, food supply, etc.

Therefore, the Project will contribute to improving local income levels and living standards and reducing dependence of fossil fuels as energy sources. Furthermore, the Project will help to transfer acquired skills and promote administrative and rural property regulation.

The project faced some issues regarding the financing of the construction phase. The project developer had some difficulties to sign a PPA and even if they tried to get the required financing, they did not get it. Nevertheless, they get the PPA in October 2015, so they started the construction of the first phase of the power plant, that started selling energy to the grid on the 12th of June 2018. The first phase was carried out as it was initially designed. Thus, a capacity of 115.5 MW was installed and the rest of the capacity (54.5 MW) to reach the designed 170 MW was postponed to a second phase. Due to technological developments, the initial configuration had to be adjusted, so that in phase two, which is still in the process of coming into operation, the capacity was slightly increased to 60 MW.

A.2. Location of project activity

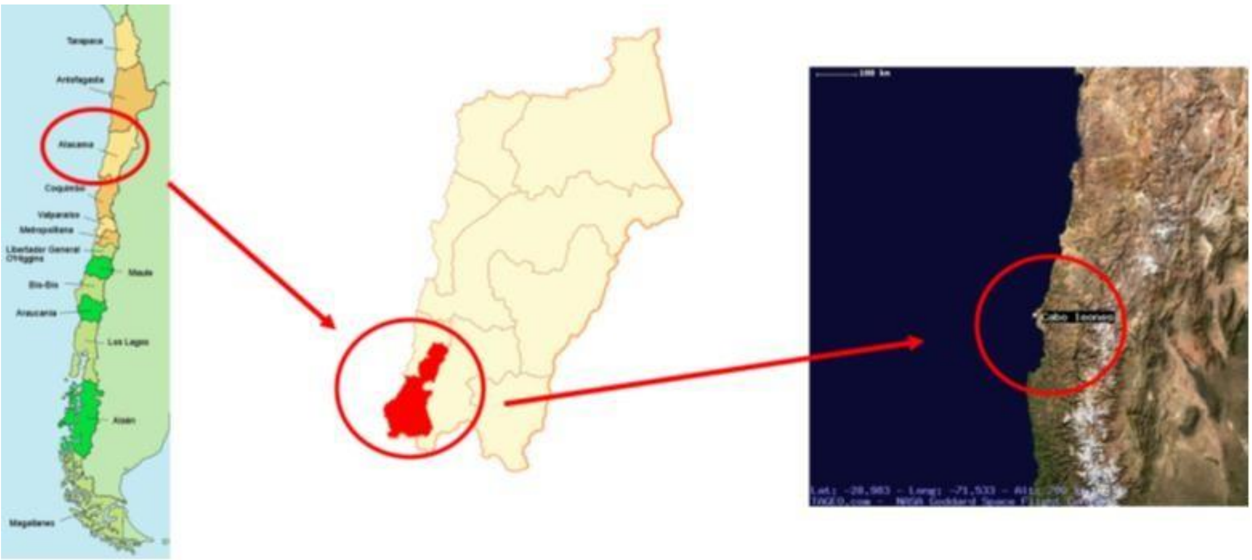
>>
The host party of the project is Chile. The project will be located in Huasco province, in 3rd Region of Atacama, in the North of Chile. The project will be located in Freirina Commune.

The Project lies in a perimeter defined by the following geographical coordinates in UNFCCC format, in decimal format with +/- sign and precision of almost 4 decimals:

Vertex	Longitud	Latitude
1	-71.4170	-28.9119
2	-71.4179	-28.9490
3	-71.4694	-28.9481
4	-71.4685	-28.9110
Geometrical middle/center point	-71.4432	-28.9300

Table 3. Coordinates defining the perimeter and the geometrical middle/center point where the wind farm will be installed.

The location of the project can be seen in the following map:



Specific coordinates of Wind Turbine Generators are included hereinunder:

ID Turbine	UTM	
	East	North
AE_1	259.508	6.795.712
AE_2	259.793	6.795.712
AE_3	260.093	6.795.712
AE_4	260.393	6.795.712
AE_5	260.693	6.795.712
AE_6	260.993	6.795.712
AE_7	261.293	6.795.712
AE_8	261.593	6.795.712
AE_9	261.893	6.795.712
AE_10	262.193	6.795.712
AE_11	262.493	6.795.712
AE_12	262.793	6.795.712
AE_13	263.093	6.795.712
AE_14	263.393	6.795.712
AE_15	263.693	6.795.712
AE_16	263.993	6.795.712
AE_17	264.318	6.795.692
AE_35	259.493	6.797.512
AE_36	259.793	6.797.512
AE_37	260.093	6.797.512
AE_38	260.393	6.797.512
AE_39	260.693	6.797.512
AE_40	260.993	6.797.512
AE_41	261.293	6.797.512
AE_42	261.593	6.797.512
AE_43	261.893	6.797.512
AE_44	262.193	6.797.512
AE_45	262.493	6.797.512
AE_46	262.793	6.797.512
AE_47	263.093	6.797.512
AE_48	263.393	6.797.512
AE_49	263.693	6.797.512
AE_50	263.993	6.797.512
AE_51	264.293	6.797.512
AE_52	259.493	6.798.412
AE_53	259.793	6.798.412

AE_54	260.093	6.798.412
AE_55	260.393	6.798.412
AE_56	260.693	6.798.412
AE_57	260.993	6.798.412
AE_58	261.293	6.798.412
AE_60	261.893	6.798.412
AE_61	262.193	6.798.412
AE_62	262.493	6.798.412
AE_63	262.793	6.798.412
AE_64	263.093	6.798.412
AE_65	263.393	6.798.412
AE_66	263.693	6.798.412
AE_67	263.993	6.798.412
AE_68	264.293	6.798.412
AE_69	259.493	6.799.312
AE_70	259.793	6.799.312
AE_71	260.093	6.799.312
AE_72	260.393	6.799.312
AE_73	260.693	6.799.312
AE_74	260.993	6.799.312
AE_75	261.293	6.799.312
AE_76	261.593	6.799.312
AE_77	261.893	6.799.312
AE_78	262.193	6.799.312
AE_79	262.493	6.799.312
AE_80	262.793	6.799.312
AE_81	263.093	6.799.312
AE_82	263.393	6.799.312
AE_83	263.693	6.799.312
AE_84	263.993	6.799.312
AE_85	264.293	6.799.312

Table 4. Wind turbines coordinates.

The coordinates of the measurements tower (Torre Norte) are presented next:

Longitud	Latitude
-71.4458	-28.9019

Table 5. Measurements tower coordinates.

The lay out of the surface occupied by the project can be seen in the following figure:

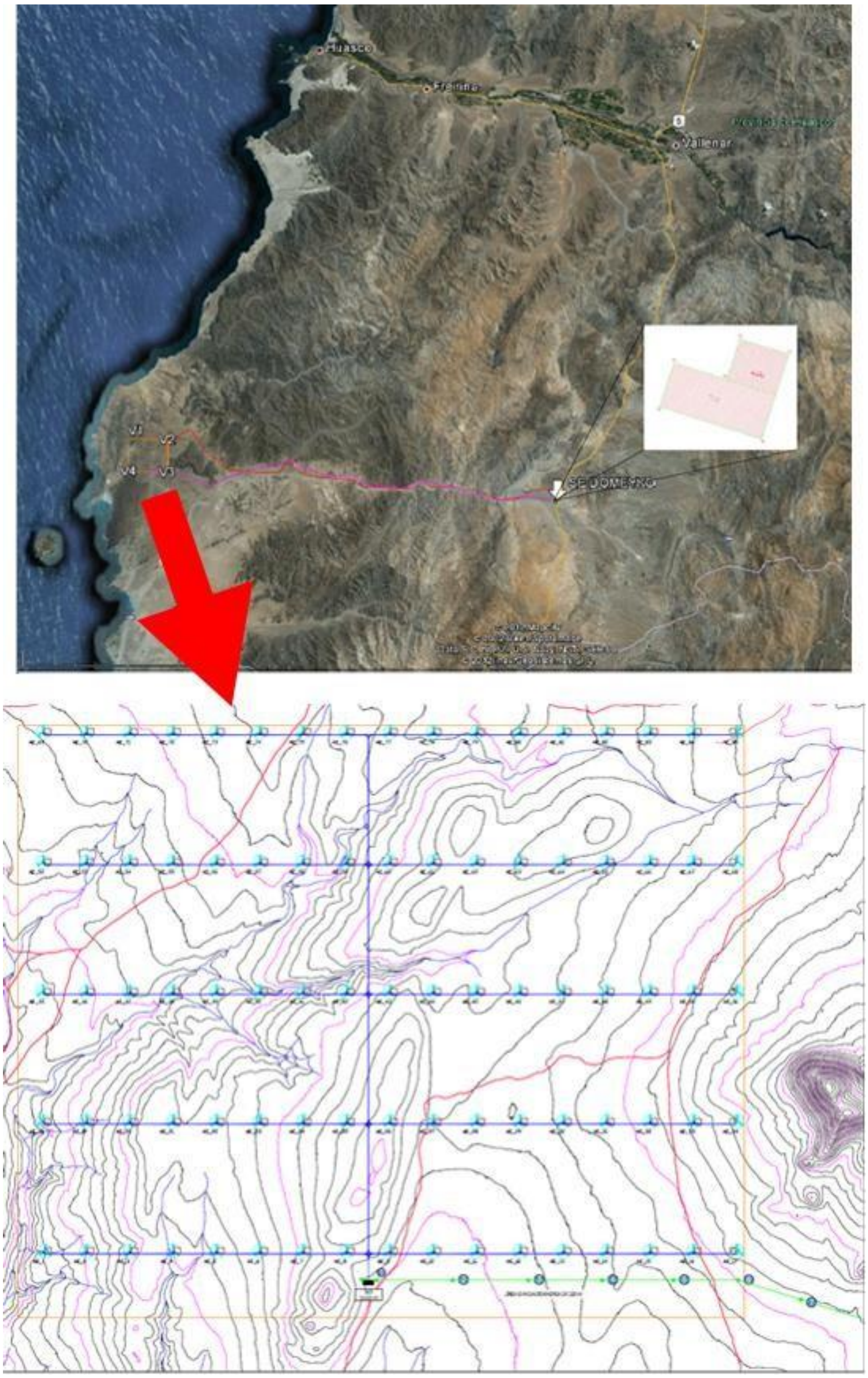


Figure 3. Lay out of the surface occupied by the project

Cabo Leones Wind Farm will be connected to a national power grid (National Electric System, SEN). CNE[4] provides information and data about the geographic area and infrastructure in SEN, energy exports and imports from/to the system, detailed characteristics of the SEN system, etc.

[4] CNE: https://www.coordinador.cl/

A.3. Technologies/measures

>>

The Project will have an installed capacity of 175.5 MW, with 55 wind turbines of SG 2.1-114 type (of 78 metres of hub height) and 12 wind turbines of SG 5.0-145 it is expected to supply to the grid 461,923 MWh per year taking into account transmission losses.

The minimum expected operational lifetime of these wind turbines is 20 years. The equivalent annual full load hours are 2,678.

According to the "Guidelines for the reporting and validation of Plant load factors" (version 01), the plant load factor is defined ex-ante according to option (b) "the plant load factor determined by a third party contracted by the project participants (e.g. an engineering company)". According to the estimation carried out by the project owner, and ratified by Altermia Asesores company engineering company in its feasibility study, the estimated load factor is 30.6%.

The following table shows the wind farm main characteristics:

1st phase:

Parameter	Value	Unit
Total Power Capacity	115.5	MW
Turbine model[5]	SG 2.1-114	
Rated Power per turbine[6]	2.1	MW
Generator specifications	690 V AC, double feeding; 50/60 Hz	
No. of turbines	55	-
Transmission line length	54	km
Transmission line voltage	220	kV

2nd phase:

Parameter	Value	Unit
Total Power Capacity	60	MW
Turbine model[7]	SG 5.0-145	
Rated Power per turbine[8]	5	MW
Generator specifications	690 V AC, double feeding; 50/60 Hz	
No. of turbines	12	-
Transmission line length	54	km
Transmission line voltage	220	kV

Table 6. Technical features.

The net electricity delivered to the grid will be monitored continuously on by electric meters on site. The design of monitoring system is presented detail in B.7.3.

The 175.5 MW will be evacuated by a new 54 km long 220 kV transmission line, from the Project to the SET Domeyko substation. Electricity exported to the grid will be monitored with electricity meters located at the wind farm electrical substation. Transmission losses in the evacuation line are estimated to be of a 1.81% of the generation of the wind farm. These transmission losses are subtracted to the electricity generation of the wind farm to determine the net electricity generation supplied to the grid.

[5] http://www.gamesacorp.com/es/productos-servicios/gamesa-g97-20-mw-iiia.html

[6] http://www.gamesacorp.com/es/productos-servicios/gamesa-g97-20-mw-iiia.html

[7] http://www.gamesacorp.com/es/productos-servicios/gamesa-g97-20-mw-iiia.html

[8] http://www.gamesacorp.com/es/productos-servicios/gamesa-g97-20-mw-iiia.html

In the baseline scenario, the amount of energy generated by the project would be provided by other plants already existing in the SEN grid, where the project is located. Since these plants are mainly fossil fuel thermal ones, 316,417 tCO_2e per year would be released to the atmosphere to supply the same power when the project becomes fully operational.

The development of the Project will help to stimulate the development of the wind power industry in Chile and will then contribute to transfer technology and knowledge to the country.

A.4. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Chile	Ibereólica Cabo Leones I S.A (private entity)	No
Chile	Aprovechamientos Energéticos S.A. (private entity)	No
Colombia	ALLCOT COLOMBIA SAS (private entity)	No

A.5. Public funding of project activity

>>
No public funding is received by this project activity.

A.6. History of project activity

>>
The project participants of this project confirm that:
(a) The proposed CDM project activity is neither registered as a CDM project activity nor included as a component project activity (CPA) in a registered CDM programme of activities (PoA);
(b) The proposed CDM project activity is not a project activity that has been deregistered.
On the other hand, the project participants declare:
(a) The proposed CDM project activity is not a CPA that has been excluded from a registered CDM PoA;
(b) A registered CDM project activity or a CPA under a registered CDM PoA whose crediting period has or has not expired (hereinafter referred to as former project) does not exists in the same geographical location as the proposed CDM project activity.

A.7. Debundling

>>
Not applicable since a large scale methodology is used.

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

>>

- Type Large Scale Consolidated Methodology (Reference ACM0002): “Grid-connected electricity generation from renewable sources” – for the power generation component using renewable energy and exports part of the same power to grid Version 13.0.0. Sectoral Scope: 01.

https://cdm.unfccc.int/methodologies/DB/XP2LKUSA61DKUQC0PIWPGWDN8ED5PG

- Methodological TOOL07 “Tool to calculate the emission factor for an electricity system” Version 03.0.0 - for the calculation of emissions factor.

  https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v3.0.0.pdf

- Methodological TOOL02 “Tool for the demonstration and assessment of additionality” Version 07.0.0 – for the baseline scenario and to demonstrate additionality.

  https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v7.0.pdf

Although next tools are listed as tools used for the ACM0002 methodology, they do not apply to the Project:

- “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” version 02
- “Combined tool to identify the baseline scenario and demonstrate additionality” version 05.0.0.

B.2. Applicability of methodologies and standardized baselines

>>

The **“Consolidated baseline methodology for grid-connected electricity generation from renewable sources”** (ACM0002, version 13.0.0) is applicable to the project as it is demonstrated next:

Applicability Conditions in the ACM0002/Version 13.0.0	Applicability to this project activity
This methodology is applicable to grid-connected renewable power generation project activities that a)) install a Greenfield power plant b) involve a capacity addition to (an) existing plant(s); c) involve a retrofit of (an) existing plant(s)/unit(s); or d) involve a replacement of (an) existing plant(s)/unit(s)”	The project activity consists on the installation of new wind farm at a site where no renewable power plant was operated prior to the implementation of the project activity. The project activity is hence a greenfield plant.
The project activity is the installation, capacity addition, retrofit or replacement of a power plant/unit of one of the following types: hydro power plant/unit (either with a run-of-river reservoir or an accumulation reservoir), wind power plant/unit, geothermal power plant/unit, solar power plant/unit, wave power plant/unit or tidal power plant/unit.	The project activity is the installation of a wind power plant.
○ In the case of capacity additions, retrofits or replacements (except for capacity addition projects for which the electricity generation of the existing power plant(s) or unit(s) is not affected): the existing plant started commercial operation prior to the start of a minimum historical reference period of five years, used for the calculation of baseline emissions and defined in the baseline emission section, and no capacity addition or retrofit of the plant has been undertaken	The project activity does not involve any capacity additions, retrofits or replacements, and hence this requirement is not applicable to the project activity.

between the start of this minimum historical reference period and the implementation of the project activity;	
In case of hydro power plants, at least one of the following conditions must apply: • The project activity is implemented in an existing single and multiple reservoirs, with no change in the volume of any of the reservoirs; or • The project activity is implemented in an existing single and multiple reservoirs, where the volume of any of reservoirs is increased and the power density of each reservoir, as per definitions given in the Project Emissions section, is greater than 4 W/m^2 after the implementation of the project activity; or • The project activity results in new single or multiple reservoirs and the power density of each reservoir, as per definitions given in the Project Emissions section, is greater than 4 W/m2 after the implementation of the project activity. In case of hydro power plants using multiple reservoirs where the power density of any of the reservoirs is lower than 4 W/m^2 after the implementation of the project activity all the following conditions must apply: • The power density calculated for the entire project activity using equation 5 is greater than 4 W/m^2; • All reservoirs and hydro power plants are located at the same river and where are designed together to function as an integrated project that collectively constitutes the generation capacity of the combined power plant; • The water flow between the multiple reservoirs is not used by any other hydropower unit which is not a part of the project activity; • The total installed capacity of the power units, which are driven using water from the reservoirs with a power density lower than 4 W/m^2, is lower than 15MW; The total installed capacity of the power units, which are driven using water from reservoirs with a power density lower than 4 W/m^2, is less than 10% of the total installed capacity of the project activity from multiple reservoirs.	The project activity is not a hydro power plant. Hence this condition is not applicable to the project activity.

The methodology is not applicable to the following: • Project activities that involve switching from fossil fuels to renewable energy sources at the site of the project activity, since in this case the baseline may be the continued use of fossil fuels at the site; • Biomass fired power plants; Hydro power plants that result in new reservoirs or in the increase in existing reservoirs where the power density of the reservoir is less than 4 W/m^2	Project activity does not involve switching from fossil fuels to renewable energy sources at the site of the project activity, biomass fired plants or construction of new reservoir or increase in an existing reservoir and hence, applicability is meat.
In the case of retrofits, replacements, or capacity additions, this methodology is only applicable if the most plausible baseline scenario, as a result of the identification of baseline scenario, is "the continuation of the current situation, i.e. to use the power generation equipment that was already in use prior to the implementation of the project activity and undertaking business as usual maintenance".	The project is not a retrofit, replacement, or capacity addition; hence, this condition is not applicable to the project activity.

Table 7. Applicability conditions of the methodology ACM0002, version 13.0.0.

Applicability of the tools:

The *"Tool to calculate the emission factor of an electricity system Version 03.0.0*" is applicable since the following applicability criteria are accomplished:

- "*This tool may be applied to estimate the OM, BM and/or CM when calculating baseline emissions for a project activity that substitutes grid electricity, that is where a project activity supplies electricity to a grid or a project activity that results in savings of electricity that would have been provided by the grid (e.g. demand-side energy efficiency projects)".*

  The tool may be applied because the project activity supplies electricity to a grid.

The "*Tool for the demonstration and assessment of additionality. Version 07.0.0*" is applicable since the following applicability criteria is accomplished:

- "*Once the additionally tool is included in an approved methodology, its application by project participants using this methodology is mandatory"*.

  The project activity does include an approved methodology, ACM0002, that includes the additionally tool.

"*Tool to Calculate Project or Leakage CO_2 Emissions from Fossil Fuel Combustion*" is not applicable as the project activity does not have project or leakage emissions as no fossil fuel is consumed.

"*Combined tool to identify the baseline scenario and demonstrate additionality*" is not applicable as the project activity is the installation of a Greenfield facility that provides a product to market where the output could be provided by other existing facilities or new facilities that could be implemented in parallel with the CDM project activity.

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

>>

Source		GHG	Included?	Justification/Explanation
Baseline	CO2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity	CO_2	Yes	Main emission source. CO_2 emissions are taken into account in emissions reductions estimations.
		CH_4	No	According to methodology it is a minor emission source and hence is not considered in estimations.
		N_2O	No	According to methodology it is a minor emission source and hence is not considered in estimations.
Project activity	For geothermal power plants, fugitive emissions of CH_4 and CO_2 from non-condensable gases contained in geothermal steam	CO_2	No	Excluded by the methodology as the Project Activity is not a geothermal power plant.
		CH_4	No	
		N_2O	No	
	CO_2 emissions from combustion of fossil fuels for electricity generation in solar thermal power plants and geothermal power plants	CO_2	No	Excluded by the methodology as the Project Activity is not a solar thermal power plant or a geothermal power plant.
		CH_4	No	
		N_2O	No	
	For hydro power plants, emissions of CH_4 from the reservoir For geothermal power plants, fugitive emissions of CH_4 and CO_2 from non-condensable gases contained in geothermal steam	CO_2	No	Excluded by the methodology as the Project Activity is not a hydro power plant.
		CO_2	No	
		CH_4	No	

According to ACM0002, "the spatial extent of the project boundary includes the project power plant and all power plants connected physically to the electricity system that the CDM project power plant is connected to".
A flow diagram of the project boundary is shown next:

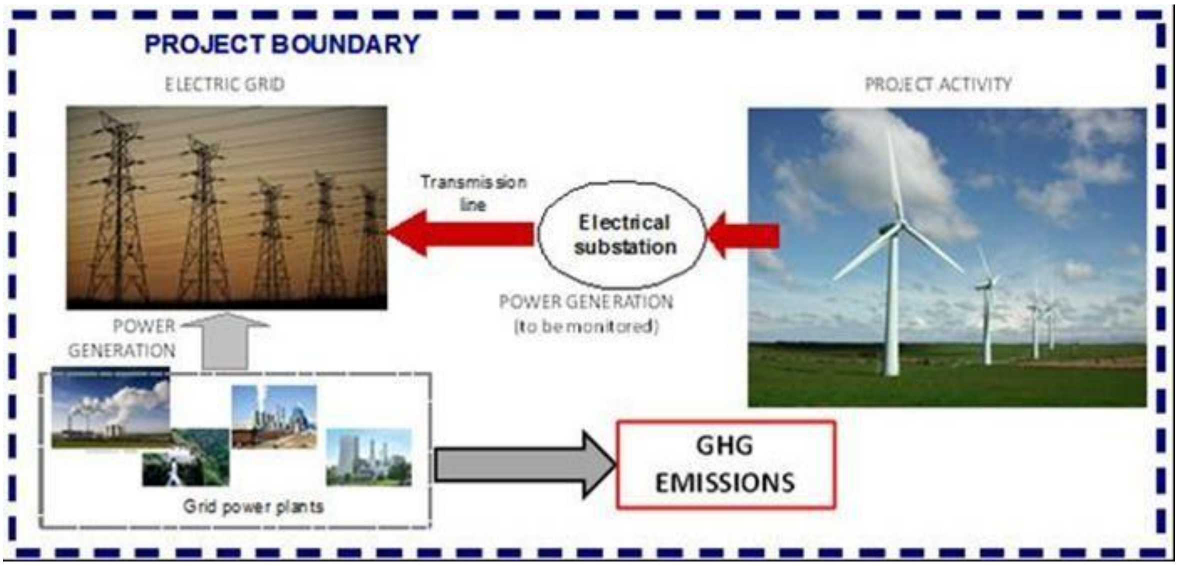


Figure 4. Flow diagram of the project boundary.

B.4. Establishment and description of baseline scenario

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The baseline continues being the same of the original validation since no changes has been identified. Thus, The baseline scenario is defined by the methodology ACM0002 as the "*electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin (CM) calculations described in the "Tool to calculate the emission factor for an electricity system*".

Once the wind farm is operational, it will produce renewable energy which will be consumed by the users of the SEN, displacing the use of fossil fuel fired electricity sources. The project activity does not modify or retrofit an existing electricity generation facility. Thus, the baseline scenario is that the electricity delivered to the Chilean SEN by the project would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources.

As mentioned before, "the grid", or the relevant electrical system to the SPII boundary corresponds to the SEN, being one of the three systems in the country, that are not interconnected between each other. The SEN comprises Chilean regions from Arica and Parinacota (XV) to Los Lagos (X) and there are no electricity imports or exports of the SEN grid to other national grid.

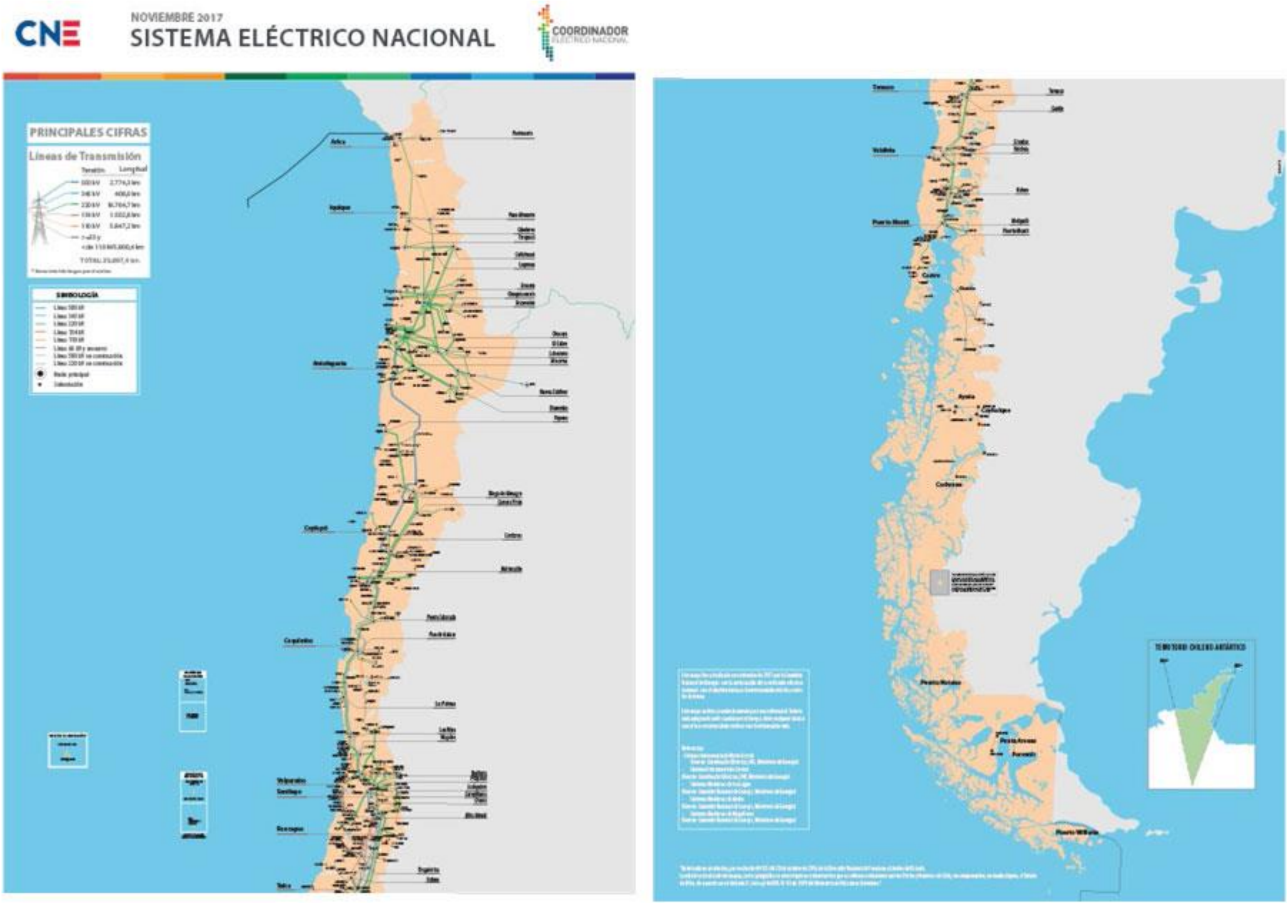

Figure B2. Project System Boundary SEN. Source: Electricas CEN (April 2020) https://www.electricas.cl/educacion-en-energia/mapas-de-energia/

Although there is legislation of non-conventional renewable energy (NCRE) in Chile, and specifically to promote use of renewable energy since 2008 (see *Section B.5*), it has not contributed enough and the causes are essentially attributable to:

1) Promotion is not an active liquid that can be used as part of the funding.
2) The promotion does not relieve the projects of the need to use their energy or have some other mechanism of prices stabilization to obtain funding.
3) The volatility of energy price is a significant barrier when financially developing an ERNC project.
4) Although the promotion of specific ERNC laws, the slowness in processing environmental permits, the fact of the existing regulatory deficiencies with negative implications for new entry companies and the very limited access to finance due to the third point above, are making it difficult for the real promotion of renewable energies in Chile.

The emission factor for the electricity grid is calculated, using the methodology applied to the project activity, as a Combined Margin (CM) defined as the combination of the Operating Margin (OM) and the Build Margin (BM), as described in Annex 3.

The Operating Margin is calculated using the Simple Adjusted Operating Margin Method, since low- cost/must-run resources constitute more than 50% of total grid generation in average of the first most recent years. The Build Margin is calculated ex-ante considering capacity additions that comprise 20% of the electricity generation that have been built most recently, in accordance with the “Tool to calculate the emission factor for an electricity system” (version 03.0.0).

Also, according to methodology ACM0002, “*no leakage emissions are considered. The main emissions potentially giving rise to leakage in the context of electric sector projects are emissions arising due to activities such as power plant construction and upstream emissions from fossil fuel use (e.g. extraction, processing, transport). These emissions sources are neglected*.”

B.5. Demonstration of additionality

>>

<u>CDM consideration:</u>

The project participants had undertaken the proposed project activity by considering the CDM benefits to overcome the financial barriers associated with it. The project participants, during their decision to invest in the project, had seriously considered CDM benefits.

In order to demonstrate the prior consideration of CDM, next is included a timetable indicating all the relevant information regarding the development of the project and the main events related to the CDM development (shown in bold font):

Milestone	Date
Wind resource study	May 2011
Request of the land	June 2011
Interconnection agreement with Transelec	September 2011
First contact with Garrigues Medio Ambiente consultant company for carrying out the project’s PDD	**September 2011**
Environment Impact Statement presented for approval	September 2011
Wind turbines offer reception	December 2011
Contract with Garrigues Medio Ambiente consultant company for carrying out the project’s PDD (Time of investment decision)	**December 2011**
Contract with the selected DOE	**23rd May 2012**
Publication of the PDD	**29 May 2012**
Start of stakeholders consultation process (consultation letters to stakeholders)	**January 2012**
Reception of stakeholders answers to the sent letters and modification of the project accordingly, and reception of definitive answers of agreement.	**January 2012**
Favourable Environmental Assessment Qualification Resolution	March 2012
Date when the final wind turbines supply contract was supposed to be signed **(Start date)**.	30th October 2013
Proposal for the Supply and Maintenance of Wind Turbine Generators Cabo Leones I Wind Farm – not accepted because the project did not have access to financing	24th December 2014
Cabo Leones Wind Farms wins a PPA in the Chilean public tender	October 2015
Signature of the PPA	2nd November 2015
Turbine supply, installation and guarantee agreement with Gamesa	11th August 2016
Signature of the EPC for the 1st phase of the project	23rd September

	2016
Starting date of commercial operation (**starting date of the crediting period**)	12th June 2018

Table 8. Milestones of Cabo LeonesWind Farm.

The chronology of events, as set out in the table, clearly shows that real and continuing action to secure CDM status for the project activity was taken right at the time of project start.

<u>Additionality</u>

Since wind farms are not a very common way for power generation it can be concluded that wind energy is not a particularly attractive proposition in the business-as-usual scenario.

To demonstrate the project's additionality, "Tool for the demonstration and assessment of additionality" (version 07.0.0) has been applied following the steps defined:

<u>Step 1. Identification of alternatives to the project activity consistent with current laws and regulations.</u>

<u>Sub-step 1a. Define alternatives to the project activity:</u>

ACM0002 (version 13.0.0) prescribes the baseline scenario as follows:

If the project activity is the installation of a new grid-connected renewable power plant/unit, the baseline scenario is the following:

> *Electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin (CM) calculations described in the Tool to calculate the emission factor for an electricity system.*

Therefore the alternative would be the continuation of the current situation according to the baseline.

<u>Sub-step 1b: Consistency with mandatory laws and regulations:</u>

According to the Tool:

- *The alternative(s) shall be in compliance with all mandatory applicable legal and regulatory requirements, even if these laws and regulations have objectives other than GHG reductions, e.g. to mitigate local air pollution. (This Sub-step does not consider national and local policies that do not have legally-binding status.)*
- *If an alternative does not comply with all mandatory applicable legislation and regulations, then show that, based on an examination of current practice in the country or region in which the law or regulation applies, those applicable legal or regulatory requirements are systematically not enforced and that noncompliance with those requirements is widespread in the country. If this cannot be shown, then eliminate the alternative from further consideration;*
- *If the proposed project activity is the only alternative amongst the ones considered by the project participants that is in compliance with mandatory regulations with which there is general compliance, then the proposed CDM project activity is not additional.*

Outcome of Step 1b: All the mentioned alternatives to the project are in compliance with existing laws and regulations in the host country, Chile.

As defined in the document "Tool for the demonstration and assessment of additionality" (version 07.0.0), after Step 1b: *Project participants may proceed to Step 2 (Investment analysis) or Step 3 (Barrier analysis). (Project participants may also select to complete both Steps 2 and 3).* Therefore, the project developer has selected to demonstrate the additionality of the project by completing the investment analysis steps.

Step 2. Investment analysis

Next will be demonstrated that the Project Activity is economically or financially less attractive than other alternatives without additional revenues from the sale of emission reductions. Accordingly, an investment analysis was performed.

Sub-step 2a. Determine appropriate analysis method

Since the proposed project will earn revenues from not only CER sales but also electricity sales, the simple cost analysis method is not appropriate. Instead, benchmark analysis (Option III) will be applied.

Sub-step 2b. Option III. Apply benchmark analysis

The financial indicator for this analysis is the post-tax equity IRR, which is one of the most commonly used parameters to demonstrate the additionality of the project activity.

According to the TOOL 27 "Investment analysis" (version 06), the benchmark is obtained from the Table 1. Considering that the project belongs to group 1 "Energy Industries", the default value for the expected return on equity in Chile provided by the Guidelines document is 8.7%. This is an after taxes default value. Based on this benchmark, calculation and comparison of financial indicator are carried out in sub-step 2c.

Sub-step 2c. Calculation and comparison of financial indicators

Calculation and comparison of financial indicator of the Project is implemented according to the TOOL 27 "Investment analysis" (version 06).

Estimations on basic parameters for calculation of Cabo Leones equity IRR are shown in the table below. More detailed data of the economic issues of the project can be found in the financial model. All evidences provided are considered applicable for the specific project at the time of the investment decision, which was August, 11st 2016 (11/08/2016).

Parameter	Unit	Value	Source
Lifetime	Years	20	GAMESA G97 2MW DNV Type Certificate
Installed capacity	MW	175.5	PP decision
Wind farm Load Factor	%	30.6%	Altermia Asesores Wind Resource Study
Transmission losses	%	1.81%	Internal calculations
Electricity generation	GWh	461.9	Altermia Asesores Wind Resource Study
Electricity price	USD/ MWh	85.2	1. Acta de Adjudicación Oferta Económica Licitación 2015-01 and 2016-06-10 RE 2016-459 Bases Licitacion 2015-0 and 1. Acta Adjudicación Oferta Económica Licitación 2015-02
Transmission costs	USD/ MWh	6.27	CDEC-SIC: Based on Average 2010 Data of Paposo 220 substation.
Total investment	kUSD	281,723.8	GAMESA Wind turbines and estimations

Wind farm civil and electric works	kUSD	234,452.8	GAMESA Wind turbines and estimations
Operation and maintenance costs	• 0 kUSD/MW for years 1-2 • 35 kUSD/MW for years 3-5 • 40 kUSD/MW for years 6-20		GAMESA O&M contract
Land lease	% of the gross income/ year	3.25%	Land lease contract (page 10)
Management technical operation	kUSD/ year	980	OFERTA ING. PROPIEDAD, D.I.OBRA Y GESTION TECNICA
Income taxes	% of net income	17%	Internal tax services web site[9]
Amortisation Period	Years	10	"Resolución Exenta N°43 del 26 de Diciembre del 2002" [10], concept "Equipos de generación y eléctricos utilizados en la generación."
Residual Value	kUSD	58,613	In order to be more conservative, a 25% of the wind farm civil and electric works is considered
Depretiation per year	kUSD	22,311	Calculation
Percentage of capital to be financed	%	70%	Based on internal experience, see "Santa Maria de Nieva Termsheet"
Interest Rate	%	3.25%	Bank BBVA- Madrid treasury, dated on 24/11/2011.
Swap	%	3.5%	BBVA Research: https://www.bbvaresearch.com/wp-content/uploads/2016/05/Situacion_Chile_2T16.pdf
Debt-Service Coverage Ratio (DSCR)	%	2	Calculated applying payback time to Base Case See "Santa Maria de Nieva Termsheet"

Table 9. Financial general parameters data of Cabo Leones Wind Farm project

The following table shows the after tax Equity IRR of the Cabo Leones Farm without the sales of CERs:

Equity IRR (without CER revenues)	Financial benchmark
5.3%	**8.70%**

Table 10. Financial parameters.

Without the sales of CERs the after tax Equity IRR is 5.3%, which is lower than the financial benchmark.

[9] http://www.sii.cl/aprenda_sobre_impuestos/impuestos/imp_directos.htm#o2p1

[10] http://www.sii.cl/documentos/resoluciones/2002/reso43.htm

More detailed data of the economic issues of the project can be found in the financial model of the project.

Sub-step 2d. Sensitivity Analysis

The sensitivity analysis shall show whether the conclusion regarding the financial attractiveness is robust to reasonable variations in the critical assumptions and is a frequently used method for assessing the perceived uncertainties by identifying the potential changing ranges of some key elements and potential impacts of such changes on the economic model of the Project.

According to the UNFCCC "Guidelines on the Assessment of Investment Analysis" (v. 05) variables that constitute more than 20% of either total project costs or total project revenues should be subjected to reasonable variation.

For this project, four parameters were selected as sensitive factors to check out the financial attractiveness: total investment, electricity price, operation and maintenance cost and electricity generation (these financial indicators are fluctuated within the range of -10% to +10%):

Equity IRR (%) variations according to key parameters	Fluctuations				
	-10%	**-5%**	**0%**	**5%**	**10%**
Total investment	7.48%	6.05%	5.31%	4.13%	3.21%
Electricity price	2.35%	3.78%	5.31%	6.28%	7.42%
O&M cost	5.49%	5.28%	5.31%	4.86%	4.64%
Electricity Generation (MWh)	2.57%	3.87%	5.31%	6.19%	7.25%

Table 11. Financial parameters.

Also, the variation of the parameters needed to reach benchmark has been calculated:

Financial Parameters	Variation to reach benchmark
Total investment	- 19.55%
Electricity price	+16.40%
O&M cost	- 100.00%
Electricity Generation (MWh)	10.66%

Table 12.Variation of main financial parameters to reach benchmark.

It is not expected for the above-mentioned parameters to experiment such variations to reach the benchmark:

- Total investment: investment costs are not expected to decrease in 19.55% as assumed values for the project are reasonably low in relation to other registered projects:

Project name	Total investment (kUSD/MW)
Canela Wind Farm Project	2,632
Totoral Wind Farm Project	2,870
Monte Redondo Wind Farm Project	2,895
Cabo Leones Wind Farm Project	**1,607**

Table 13.CDM registered wind farms in Chile. Source: UNFCCC

- Electricity price: assumed value for the project is reasonably high in relation to other registered projects, and hence it is not expected to increase in a 16.40%:

- O&M cost: O&M cost were provided by the supplier of the turbines to be installed. A 100.00% decrease in O&M cost is not expected.

- Electricity generation: according to the independent wind resource study, estimated production is 2,678 equivalent hours. Obtaining a generation increase of +10.66% is not reasonable since the probability of obtaining over 2,678 equivalent hours is 50%, and that such probability would substantially decrease with production increase assumptions.

Outcome of Step 2: According to the “Tool for the demonstration and assessment of additionality” (version 07.0.0), after the sensitivity analysis it is concluded that the proposed CDM project activity is unlikely to be the most financially/economically attractive, so the next step to be followed is Step 4 (Common practice analysis).

Step 3: Barrier analysis

N/A

Step 4. Common practice analysis

Sub-step 4a. Analyse other activities similar to the proposed project activity.

According to “Tool for demonstration and assessment of additionality” v. 07.0.0 (EB 70):

Sub-step 4a: The proposed CDM project activity(ies) applies measure(s) that are listed in the definitions section of the tool

The proposed CDM project activity corresponds to measure (ii) “switch of technology with or without change of energy source including energy efficiency improvement as well as use of renewable energies (example: energy efficiency improvements, power generation based on renewable energy)”, hence “Guidelines of Common practice” v. 02.0 (EB 69) are followed.

The next stepwise approach for common practice analysis is followed:

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

The capacity of our project is of 175.5 MW, so the applicable output range +/- 50% of the capacity of the project activity is the following: 87.75 MW – 263.25 MW.

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

(a) The projects are located in the applicable geographical area;
(b) The projects apply the same measure as the proposed project activity;
(c) The projects use the same energy source/fuel and feedstock as the proposed project activity, if a technology switch measure is implemented by the proposed project activity;
(d) The plants in which the projects are implemented produce goods or services with comparable quality, properties and applications areas (e.g. clinker) as the proposed project plant;
(e) The capacity or output of the projects is within the applicable capacity or output range calculated in Step 1;
(f) The projects started commercial operation before the project design document (CDM-PDD) is published for global stakeholder consultation or before the start date of proposed project activity

Table 14. Conditions to identify similar projects

Condition for similar projects	Similar project description
The projects are located in the applicable geographical area.	As per the paragraph 9 of the tool, the applicable geographical area covers the entire host country as a default. Then similar projects should be located in Chile (host country).
The projects apply the same measure as the proposed project activity;	Similar projects measure should consider wind energy generation
The projects use the same energy source/fuel and feedstock as the proposed project activity, if a technology switch measure is implemented by the proposed project activity;	The project does not involve a technology switch measure, therefore all plants are considered.
The plants in which the projects are implemented produce goods or services with comparable quality, properties and applications areas (e.g. clinker) as the proposed project plant;	The output service provided by the project activity is grid connected electricity generation.
The capacity or output of the projects is within the applicable capacity or output range calculated in Step 1;	The installed capacity should be within the range 87.75 MW – 263.5 MW.
The projects started commercial operation before the project design document (CDM-PDD) is published for global stakeholder consultation or before the start date of proposed project activity, whichever is earlier for the proposed project activity.	Similar project should started commercial operation before the publication for global stakeholder consultation of the project activity (29/05/2012).

According to the last table, this analysis should consider as similar projects the renewable power plants connected to all the electricity grids in Chile: SEN[11], Magallanes Electricity System and Aysén Electricity System, that started commissioning before 29/05/2012 and within the applicable capacity range (87.75 MW – 263.25 MW).

There are no power plants that fulfil the mentioned requirements.

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

According to the conclusion table presented above, calculated number N_{all} is 0.

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

According to the definition of different technologies stated in paragraph 16 of the TOOL 24 v.03.1, power plants that doesn't use wind resources fuel and that are different scale (i.e. small or micro scale), are considered as different technologies.

It can be seen that there are 0 power plants applying different technologies.

Then, according to this criteria N_{diff} = 0.

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[11] SEN: National Electric System (Sistema Eléctrico Nacional in Spanish)

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

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

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

The following table present the results for this project activity:

Table 15 Calculation of F indicator and N_{all}-N_{diff}

Parameter	Value
N_{all}	0
N_{diff}	0
N_{all}-N_{diff}	0

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

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

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Baseline emission (BEy)

The baseline scenario represents the electricity that would have otherwise been generated by the operation of the grid-connected power plants and by the addition of new generation sources.

The consolidated methodology ACM0002 (version 13.0.0) has been applied for the elaboration of this section. According to the methodology, the baseline emissions are to be calculated as follows:

$$BE_y = EG_{pj,y} \cdot EF_{grid,CM,y}$$

Where:

BE_y = Baseline emissions in year *y* (tCO_2)

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

$EF_{grid,CM,y}$ = Combined margin CO_2 emission factor for grid connected power generation in year *y* calculated using the latest version of the "Tool to calculate the emission factor for an electricity system" (tCO_2/MWh)

To calculate $EG_{PJ,y}$ it is necessary to distinguish between the type of project activity. As SPII is a Greenfield Plant (see *Section B2*) the following equation applies:

$$EG_{PJ,y} = EG_{facility,y}$$

Where:

$EG_{PJ,y}$	=	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year *y* (MWh/yr)
$EG_{facility,y}$	=	Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y* (MWh/yr)

Equation B4

All generation and fuel consumption data that have been used to calculate the emission factor come mainly from the CDEC-SIC, which is the organism responsible for the coordination of the SIC Electric System. Emission factors for fossil fuels consumed in the different power units were obtained from IPCC default values provided in the 2006 IPCC Guidelines on National GHG Inventories

The date of completion of the last baseline update was on December 2012. The entity responsible for the application of the baseline and monitoring methodology is Garrigues Medio Ambiente Consultoría Técnica y de Gestión Integrada del Medio Ambiente, which address is Hermosilla 3, 28001 Madrid, Spain, Tel: +34 91 514 52 00/ Fax: +34 91 399 24 08. This entity is not a project participant.

For detailed information of data sources, equations applied and intermediate results see Annex 3 of the present PDD.

To calculate de Emission Factor for the electricity system, which will yield the total equivalent CO_2 emission reduction for the whole crediting period, the "*Tool to calculate the emission factor of an electricity system*" Version 03.0.0 (EB 100) is going to be used.

At last, with the emission factor ($EF_{Grid,CM,y}$) it is going to be possible to calculate the Baseline Scenario Emissions (BE_y).

The steps for calculate the emission factor, are the following ones:

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

Step 1.Identify the relevant electricity systems

There are four separate electricity systems in Chile: the Central Interconnected System (SIC), which serves the central part of the country; the Great North Interconnected System (SING), and two local systems in the southern regions of Aysén and Magallanes. Each grid lays down the geographical and system boundaries for proposed projects located within them. Since Cabo Leones Wind Farm is located within the SIC, the SIC boundaries are the geographical and system boundaries for the project.

Considering the latest version of the Consolidated methodology ACM0002, the project boundary of the proposed project should be the spatial extent of the proposed project activity

and all power plants connected physically to the same grid that can be dispatched without significant constraints.

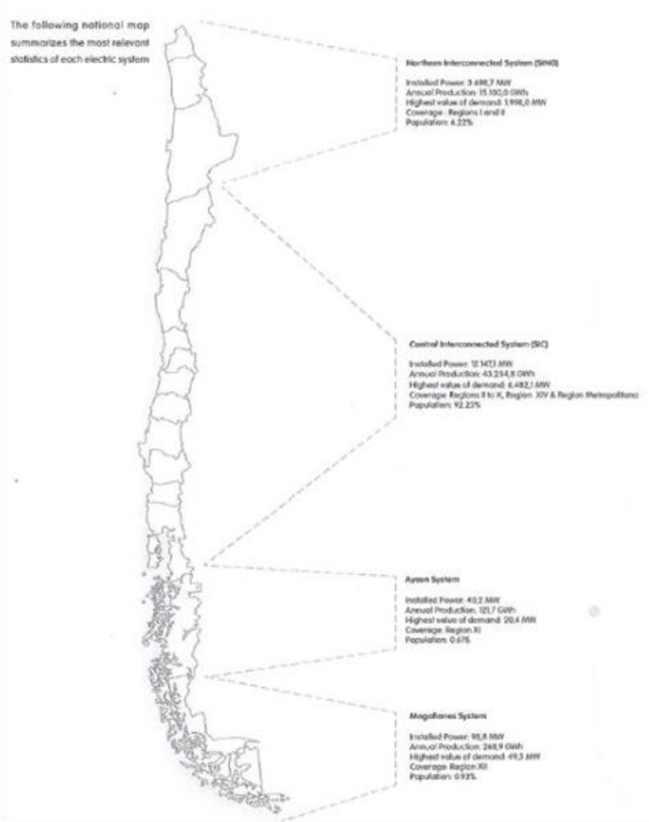

Figure 5. Chilean Power Generation structure. Source: CDEC-SIC Yearbook 2001-2010[12].

According to Step 1 of the methodological tool "Tool to calculate the emission factor for an electricity system" (version 03.0.0), for the purpose of determining the Operating Margin emission factor, the emission factor for imports from connected electricity systems located in the same host country is assumed to be 0 tCO2/MWh (option a). Nevertheless, the SIC grid does not have any imports from other electric grids.

On the other hand, and following the before mentioned tool, electricity exports should not be subtracted from electricity generation data used for calculating and monitoring the baseline emission factors. Nevertheless, according to the to the information provided by the dispatch centre (CEN), no electricity imports have been produced.

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

The option I is chosen, so only grid power plants are included in the calculation.

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

The methodological tool "Tool to calculate the emission factor for an electricity system" (version 03.0.0) provides four methods to calculate the Operating Margin. Option (b) "Simple adjusted OM" has been chosen in this case because low-cost/must-run resources in the Interconnected

Central System Grid account for more than 50% of total grid generation over the five most recent years (see the table below):

YEAR	Low-Cost/Must-Run gross generation (MWh)	Other sources gross generation (MWh)	Low-Cost/Must-Run Generation (%)	Other sources Generation (%)
2006	28,634,131	11,705,648	70.98%	29.02%
2007	22,922,862	19,116,940	54.53%	45.47%
2008	24,394,643	17,474,313	58.26%	41.74%
2009	25,578,048	16,212,189	61.21%	38.79%
2010	22,415,022	20,839,710	51.82%	48.18%
		AVERAGE L-C/ M-R (%)	**59.36%**	**40.64%**

Table 18. Annual electricity generation in the SIC by Low-cost/must run units and others during 2006, 2007, 2008, 2009 and 2010[13].

The Simple adjusted OM emission factor can be calculated using either of the two following data vintages for year(s):

- *Ex ante* option: A 3-year generation weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation, without requirement to monitor and recalculate the emissions factor during the crediting period, or
- *Ex post* option: The year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring.

The OM will be calculated *ex ante* and will be kept fixed for the first crediting period. *Ex ante* option has been chosen due to the simplicity of the project development and also for the emission reduction verification.

Step 4: Calculate the Operating Margin emission factor according to the selected method

The Simple Adjusted OM Emission Factor (EFgrid,OM-adj,y,) is a variation of the Simple OM, where the power plants / units (including imports) are separated in low-cost/must-run power sources (k) and other power sources (m). It is calculated based on the net electricity generation of each power unit and an emission factor for each power unit, as follows:

Where:

$$EF_{grid,OM-adj,y} = (1-\lambda_y)\cdot \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} + \lambda_y \cdot \frac{\sum_k EG_{k,y} \times EF_{EL,k,y}}{\sum_k EG_{k,y}} \ tCO_2e / MWh$$

EFgrid,OM-adj,y =Simple adjusted operating margin CO2 emission factor in year y (tCO2/MWh)

λy =Factor expressing the percentage of time when low-cost/must run units are on the margin in year y

EGm,y= Net quantity of electricity generated and delivered to the grid by power unit m in the year y (MWh)
EGk,y = Net quantity of electricity generated and delivered to the grid by power unit k in the year
y (MWh)
FEEL,m,y = CO2 emission factor of power unit m in year y (tCO2/MWh) FEEL,k,y = CO2 emission factor of power unit k in year y (tCO2/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 power units serving the grid in year y
y = The relevant year as per the data vintage chosen in Step 3 of the "Tool to calculate the emission factor for an electricity system"

For the calculation it is necessary to calculate the λy parameter which is defined as follows:

$$\lambda_y(\%) = \frac{Number\ hours\ low-cost/must-run\ on\ the\ margin\ \ year\ y}{8760 hours\ y\ year}$$

The total hours in the case of 2008 year were 8,784, as it was a leap year.

The emission factor of each power unit (EFEL,m,y and EFEL,k,y) have been calculated following the "Option A1" of simple OM method, mentioned in the Step 3 of the "Tool to calculate the emission factor for an electricity system". Option A1 has been chosen because data on fuel consumption and power generation of the power units m are available, so it is possible to apply the Option A1. According to "Option A1", the emission factor of each power unit m is determined as follows:

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{EG_{m,y}} \ (tCO_2e/MWh)$$

Where:

$EF_{EL,m,y}$ CO_2 emission factor of power unit m in year y (tCO_2/MWh)
$FC_{i,m,y}$ refers to the amount of fuel type i consumed by power unit m in year y (mass or volume unit)
$NCV_{i,y}$ refers to the net calorific value (energy content) of fuel type i in year y (TJ/Gg) $EF_{CO2,i,y}$ refers to the CO_2 emission factor of fuel type i in year y (tCO_2/GJ)
$EG_{m,y}$ refers to the net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
m refers to all power units serving the grid in the year y except low-cost/must-run power units
i refers to all fuel types combusted in power unit m in year y
y refers to the relevant year as per the data vintage chosen in step 3

The parameters that are used for calculating the Operating Margin are obtained as follows:

- The $FC_{i,m,y}$ was obtained from 2001-2010 CDEC-SIC Operation Statistics Yearbook[12].

[12] Source: 2001-2010 CDEC-SIC Operation Statistics Yearbook, pages 68-71 (https://www.cdecsic.cl/contenido_es.php?categoria_id=4&contenido_id=000034).

- The $EG_{m,y}$ has been obtained from 2001-2010 CDEC-SIC Operation Statistics Yearbook [13].
- The $NCV_{i,y}$ has been obtained from National Energy Balance 2009, National Energy Commission[14].
- The $EF_{CO2,i,y}$ factors can be found in the "Reviewed 2006 IPCC Guidelines for Greenhouse Gas Inventories: Workbook".

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

In terms of vintage data, one of the following two options must be chosen:

Option 1. Calculate, for the first crediting period, the BM emission factor ex-ante based on the most recent information available on units already built for sample group m at the time of CDM- PDD submission to the DOE for validation; and for the second crediting period, update the BM emission factor based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the BM emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

Option 2. Update the Build Margin emission factor annually, ex-post, for the first crediting period, including those units built up to the year of registration of the project activity or, if information up to the year of registration is no yet available, including those units built up to the latest year for which information is available. For the second crediting period, the BM 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.

Option 1 has been chosen. So the calculation of the Build Margin emission factor $EF_{grid,BM,y}$ ex-ante based on the most recent information available on plants already built for sample group m at the time of PDD submission has been carried out.

In accordance with the "Tool to calculate the emission factor for an electricity system", no capacity additions from retrofits are included in the calculation of the Build Margin emission factor.

The sample group of power units m used to calculate the Build Margin has been determined as per the procedure of the mentioned tool, which is shown next:

(a) Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently (SET5-units) and determine their annual electricity generation ($AEG_{SET5\text{-}units}$, in MWh);

(b) Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEG_{total}l, in MWh).

Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise

[13] Source: 2001-2010 CDEC-SIC Operation Statistics Yearbook, pages 50-59 (https://www.cdecsic.cl/contenido_es.php?categoria_id=4&contenido_id=000034).

[14] Source: National Energy Balance, 2009 (http://www.cne.cl/estadisticas/balances-energeticos)

20% of AEGtotal (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) (SET≥20%) and determine their annual electricity generation (AEGSET≥20%, in MWh);

(c) From SET5-units and SET≥20% select the set of power units that comprises the larger annual electricity generation (SETsample);

Identify the date when the power units in SETsample started to supply electricity to the grid.

If none of the power units in SETsample started to supply electricity to the grid more than 10 years ago, then use SETsample to calculate the Build Margin. Ignore steps (d), (e) and (f).

Otherwise:

(d) Exclude from SETsample the power units which started to supply electricity to the grid more than 10 years ago. Include in that set the power units registered as CDM project activity, starting with power units that started to supply electricity to the grid most recently, until the electricity generation of the new set comprises 20% of the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) to the extent is possible. Determine for the resulting set (SETsample-CDM) the annual electricity generation (AEGSETsample-CDM, in MWh);

If the annual electricity generation of that set is comprises at least 20% of the annual electricity generation of the project electricity system (i.e. AEGSETsample-CDM ≥ 0.2 × AEGtotal), then use the sample group SETsample-CDM to calculate the Build Margin. Ignore steps (e) and (f).

Otherwise:

(e) Include in the sample group SETsample-CDM the power units that started to supply electricity to the grid more than 10 years ago until the electricity generation of the new set comprises 20% of the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation);

(f) The sample group of power units m used to calculate the Build Margin is the resulting set (SETsample-CDM>10yrs).

Once followed paragraphs (a), (b) and (c), it was found that SET≥20% had a larger production than SET5- units, so SET≥20% is considered the sample set (SETsample).

The BM emission factor has been addressed following the equation below, as indicated by the "Tool to calculate the emission factor for an electricity system" (version 03.0.0).

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

Where:

$EF_{grid,BM,y}$ = Build Margin CO_2 emission factor in year y (tCO_2/MWh)
$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$= CO_2 emission factor of power unit m in year y (tCO_2/MWh)

m = Power units included in the Build Margin
y = Most recent historical year for which power generation data is available.

According to the "Tool to calculate the emission factor for an electricity system" (version 03.0.0), the CO_2 emission factor of each power unit m ($FE_{EL,m,y}$) should be determined as per the guidance in step 4
(a) for the simple OM, using options A1, A2 or A3, using for y the most recent historical year for which electricity generation data is available, and using for m the power units included in the build margin. Hence, since data on fuel consumption and power generation of each plant is available, option A1 (the same of the Operating Margin Emission Factor) has been used:

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{EG_{m,y}} \ (tCO_2e/MWh)$$

Where:

FEEL,m,y CO2 emission factor of power unit m in year y (tCO2/MWh)
FCi,m,y refers to the amount of fuel type i consumed by power unit m in year y (mass or volume unit)
NCVi,y refers to the net calorific value (energy content) of fuel type i in year y (TJ/Gg)
EFCO2,i,y refers to the CO2 emission factor of fuel type i in year y (tCO2/GJ)
EGm,yrefers to the net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
m refers to all power units serving the grid in the year y except low-cost/must-run power units
i refers to all fuel types combusted in power unit m in year y
y refers to the relevant year as per the data vintage chosen in step 3 The parameters that are used for calculating the Build Margin are obtained as follows:

- The $FC_{i,m,y}$ was obtained from 2001-2010 CDEC-SIC Operation Statistics Yearbook[15].
- The $EG_{m,y}$ has been obtained from 2001-2010 CDEC-SIC Operation Statistics Yearbook[16].
- The $NCV_{i,y}$ has been obtained from National Energy Balance 2009, National Enegy Commission[17].
- The $EFC_{O2,i,y}$ factors can be found in the "Reviewed 2006 IPCC Guidelines for Greenhouse Gas Inventories: Workbook".

Step 6: Calculate the Combined Margin (CM) emissions factor.

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[15] Source: 2001-2010 CDEC-SIC Operation Statistics Yearbook, pages 68-71 (https://www.cde-csic.cl/contenido_es.php?categoria_id=4&contenido_id=000034).

[16] Source: 2001-2010 CDEC-SIC Operation Statistics Yearbook, pages 50-59 (https://www.cdec-sic.cl/contenido_es.php?categoria_id=4&contenido_id=000034).

[17] Source: National Energy Balance, 2009 (http://www.cne.cl/estadisticas/balances-energeticos).

The calculation of the Combined Margin (CM) emission factor ($EF_{grid,CM,y}$) is based on one of the following methods:

(a) Weighted average CM; or
(b) Simplified CM.

The weighted average CM method (option a) should be used as the preferred option. The simplified CM method (option b) can only be used if:

- The project activity is located in a Least Developed Country (LDC) or in a country with less than 10 registered projects at the starting date of validation; and
- The data requirements for the application of step 5 above cannot be met.

As in Chile exist more than 10 CDM projects and data for step 5 are available, the option (a), Weighted average CM, has been chosen:

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

Where:

EFgrid ,BM,y= Build Margin CO2 emission factor in year y (tCO2/MWh)
EFgrid ,OM,y = Operating Margin CO2 emission factor in year y (tCO2/MWh)
wOM = Weighting of Operating Margin emissions factor (%)
wBM = Weighting of Build Margin emissions factor (%)

The following default values should be used for w_{OM} and w_{BM}:

- Wind and solar power generation project activities: w_{OM} = 0.75 and w_{BM} = 0.25 (owing to their intermittent and non-dispatchable nature) for the first crediting period and for subsequent crediting periods;

- All other projects: w_{OM} = 0.5 and w_{BM} = 0.5 for the first crediting period, and w_{OM} = 0.25 and w_{BM} = 0.75 for the second and third crediting period, unless otherwise specified in the approved methodology which refers to the “Tool to calculate the emission factor for an electricity system” (version 03.0.0).

As the project is a wind farm, during the first crediting period w_{OM} = 0.75 and w_{BM} = 0.25 will be used.

Project emissions (PEy)
The project activity is the installation of a wind farm. In accordance to ACM0002 (version 13.0.0), for most renewable power generation project activities, PE_y = 0, specifically, project emissions for wind farms are excluded from the project boundary and need not be accounted.

However, methodology also states that some project activities may involve project emissions that can be significant, in which case, they should be taken into account.

$$PE_y = PE_{FF,y} + PE_{GP,y} + PE_{HP,y}$$

Where,

PE_y = Project emissions in year y (tCO_2e)
$PE_{FF,y}$ = Project emissions from fossil fuel consumption in year y (tCO_2)
$PE_{GP,y}$ = Project emissions from the operation of geothermal power plants due to the release of non-condensable gases in year y (tCO_2e)
$PE_{HP,y}$ = Project emissions from water reservoirs of hydro power plants in year y

(tCO_2e)

The project activity is not a geothermal or a hydro power plant, so $PE_{GP,y}$ = $PE_{HP,y}$

= 0.

According to the methodology, as the project activity is not a geothermal or a solar thermal project, the use of fossil fuels for the back up or emergency purposes could not be neglected. Nevertheless, wind farm will not have fossil fuel consumption as the energy needed for the back up or emergency purposes will be electricity provided from the grid. Hence, PE FF,y = 0 and no project emissions will be considered.

Leakage (LEy)

According to ACM0002 (version 13.0.0), no leakage emissions are considered as potentially emissions sources are neglected.

Emission reductions (ERy)

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y$$

Where:

ER_y = Emission reductions in year y (tCO_2e).

BE_y = Baseline emissions in year y (tCO_2).

PE_y = Project emissions in year y (tCO_2e).

Since the project emissions are zero, the emission reductions (ER_y) are equal to the baseline emission (BE_y). Therefore, $ER_y = BE_y$.

B.6.2. Data and parameters fixed ex ante

Data/Parameter	**$FC_{i,m,y}$**
Data unit	Mass or volume unit
Description	Amount of fuel type i consumed the project electricity system in year y
Source of data	2001-2010 CDEC-SIC Operation Statistcs Yearbook, pages 68-71 (available at https://www.cdec-sic.cl/contenido_es.php?categoria_id=4&contenido_id=000034).
Value(s) applied	Please, see Appendix 4.
Choice of data or measurement methods and procedures	Specific data obtained from an official source has been chosen for the fuel consumption.
Purpose of data	Calculation of baseline emissions
Additional comment	Since the natural gas and natural gas liquids consumptions were given in units of volume and the Net Calorific Values (NCV) of the fuels are given per unit of mass, the densities of these fuels have been needed to obtain these consumptions in mass units. These two densities are: 0.55 t/m³ for natural gas liquids (provided by the National Energy Balance 2009, available at http://www.cne.cl/estadisticas/balances-energeticos), and 0.00071 t/m³ for the natural gas (provided by http://www.uniongas.com/aboutus/aboutng/composition.asp, considering the air density specified by ISO 2533:1975 for the sea level and 15ºC).

Data/Parameter	**NCV_i**
Data unit	GJ/t
Description	Net calorific value (energy content) of fuel type *i* in year *y.*
Source of data	National Energy Balance 2009 (made by the National Energy Commission, available at http://www.cne.cl/estadisticas/balances-energeticos)
Value(s) applied	see table below
Choice of data or measurement methods and procedures	According to the “Tool to calculate the emission factor for an electricity system” (version 03.0.0), if values are reliable and documented in regional or national energy statistics/energy balances, those country/region specific data must be used.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Fuel	kcal/kg	GJ/t
Diesel	10,900	45.64
Fuel oil	10,500	43.96
Coal	7,000	29.31
Natural gas	9,341	39.11
Natural gas liquids	12,100	50.66

<table>
<tr><td>Data/Parameter</td><td>$EF_{CO2,i,y}$ and $EF_{CO2,m,i,y}$</td></tr>
<tr><td>Data unit</td><td>tCO_2/TJ, tCO_2/m^3</td></tr>
<tr><td>Description</td><td>CO_2 emission factor of fuel type i used in power unit m in year y</td></tr>
<tr><td>Source of data</td><td>Default CO_2 emission factors for combustion (lower value at the 95% confidence interval as provided in Table 1.4. of the chapter 1, volume 2 of the 2006 IPCC Guidelines for National GHG Inventories.</td></tr>
<tr><td>Value(s) applied</td><td>
<table>
<tr><th colspan="2">Default CO_2 emission factors for combustion (lower value at the 95% confidence interval) (kg_{CO2}/TJ)</th></tr>
<tr><td>Diesel Oil</td><td>72,600</td></tr>
<tr><td>Residual Fuel Oil</td><td>75,500</td></tr>
<tr><td>Other Bituminous Coal</td><td>89,500</td></tr>
<tr><td>Natural Gas</td><td>54,300</td></tr>
<tr><td>Natural Gas Liquids</td><td>58,300</td></tr>
<tr><td>Biogas</td><td>46,200</td></tr>
</table>
</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>According to the “Tool to calculate the emission factor for an electricity system” (version 3.0.0), if values are reliable and documented in regional or national energy statistics/energy balances, those country/region specific data must be used. As no data were found at Chilean national sources, IPCC guidelines data were used.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

Data/Parameter	**$EF_{grid, CM, y}$**
Data unit	tCO_2/MWh
Description	Combined margin CO_2 emission factor for grid connected power generation in year y calculated using the latest version of the “Tool to calculate the emission factor for an electricity system” (version 3.0.0)
Source of data	As per the “Tool to calculate the emission factor for an electricity system” version 03.0.0.
Value(s) applied	0.685 tCO_2/MWh
Choice of data or measurement methods and procedures	As per the “Tool to calculate the emission factor for an electricity system” version 03.0.0. Ex-ante baseline emission factor.
Purpose of data	Calculation of baseline emissions
Additional comment	See Emission factor calculation spread sheet.

Data/Parameter	**$EG_{m,y}$ and $EG_{k,y}$**
Data unit	MWh
Description	In OM and BM calculation: net electricity generated and delivered to the grid by all power sources *m* serving the system in year *y*. *m* refers to non low-cost/must-run power plants
Source of data	- Name, capacity, commissioning date and fuel type of the plants were obtained from "2001-2010 CDEC-SIC Operation Statiscs Yearbook", pages 30-32 (https://www.cdec-sic.cl/contenido_es.php?categoria_id=4&contenido_id=000034). - Gross generation of grid plants was provided by "2001-2010 CDEC-SIC Operation Statiscs Yearbook", pages 50-59 (https://www.cdec-sic.cl/contenido_es.php?categoria_id=4&contenido_id=000034). - Self-consumption of the plants was provided by CDEC-SIC (webpage https://www.cdec-sic.cl/contenido_es.php?categoria_id=6&contenido_id=000044). In cases in which self-consumption was not provided by official documents, no self-consumption was assumed in a conservative approach.
Value(s) applied	Please, see Appendix 4.
Choice of data or measurement methods and procedures	Data are calculated in accordance with the "Tool to calculate the emission factor for an electricity system" (version 03.0.0), and are provided by official national sources.
Purpose of data	Calculation of baseline emissions
Additional comment	-

B.6.3. Ex ante calculation of emission reductions

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The calculation of the Simple Adjusted OM and the BM, in order to determine the emission reductions of the project activity, as indicated in the "Tool to calculate the emission factor for an electricity system" (version 03.0.0), is based on data provided by the CNE.

Calculate the Operating Margin Emission Factor (EF_{OM})

Ex-ante option to calculate the Simple Adjusted OM for grid power plants requires a 3-year generation weighted average based on the most recent data available.

$$EF_{grid,OM-adj,2008} = (1-\lambda_{2008}) \times \frac{\sum_m EG_{m,2008} \cdot EF_{EL,m,2008}}{\sum_m EG_{m,2008}} + \lambda_{2008} \times \frac{\sum_k EG_{k,2008} EF_{EL,k,2008}}{\sum_k EG_{k,2008}}$$

$$EF_{grid,OM-adj,2008} = 1 \cdot 0.798 + 0 \cdot 0.000 = 0.798 tCO_2e / MWh$$

$$EF_{grid,OM-adj,2009} = (1-\lambda_{2009}) \times \frac{\sum_m EG_{m,2009} \cdot EF_{EL,m,2009}}{\sum_m EG_{m,2009}} + \lambda_{2009} \times \frac{\sum_k EG_{k,2009} EF_{EL,k,2009}}{\sum_k EG_{k,2009}}$$

$$EF_{grid,OM-adj,2009} == 0.9999 \cdot 0.811 + 0.0001 \cdot 0 = 0.811\ tCO_2e / MWh$$

$$EF_{grid,OM-adj,2010} = (1-\lambda_{2010}) \times \frac{\sum_m EG_{m,2010} \cdot EF_{EL,m,2010}}{\sum_m EG_{m,2010}} + \lambda_{2010} \times \frac{\sum_k EG_{k,2010} \cdot EF_{EL,k,2010}}{\sum_k EG_{k,2010}}$$

$$EF_{grid,OM-adj,2010} = 0.9935 \cdot 0.647 + 0.0065 \cdot 0 = 0.644 tCO_2e / MWh$$

The 3-year weighted average Operating Margin is calculated below.

$$EF_{grid,OM-adj} = \frac{\sum_y EF_{grid,OM-adj,y} \cdot EG_y}{\sum_m EG_y} = 0.751 tCO_2e / MWh$$

Calculate the Build Margin Emission Factor (EFBM)

According to the definition and the formulae to calculate the Build Margin, the newer power plants installed within the Chilean SIC –excluding the CDM plants- that comprise the yearly last 20% system generation are those indicated in the following table20:

Name of power plant	Type of fuel	Commisioning date	$EG_{m,2010}$	Accumulated net generation	Accumulated net generation
			[MWh]	[MWh]	% over 2010 total Net Generation
Los Corrales	Renewable energy plant	2010	255	255	0 %
Doña Hilda	Renewable energy plant	2010	0	255	0

					%
Juncalito	Renewable energy plant	2010	9,749	10,004	0%
Dongo	Renewable energy plant	2010	0	10,004	0%
Guacolda-Unit 4	Coal [Petroleum]	2010	1,039,034	1,049,037	2%
Campanario-Unit 4	Natural Gas [Diesel Oil]	2010	8,580	1,057,618	3%
Emelda	Diesel Oil	2010	30,272	1,087,890	3%
CBB-Centro	Diesel Oil [Fuel Oil]	2010	5,987	1,093,877	3%
Punta Colorada	Diesel Oil	2010	6,086	1,099,963	3%
Chuyaca-Unit 6	Diesel Oil	2010	877	1,100,840	3%
Colihues-Unit 2	Diesel Oil [Fuel Oil]	2010	4,661	1,105,501	3%
Salvador	Diesel Oil	2010	10,420	1,115,921	3%
Colihues-Unit 1	Diesel Oil [Fuel Oil]	2010	4,661	1,120,581	3%
Nueva Ventanas	Coal	2010	1,829,208	2,949,790	7%
San Lorenzo-Unit 2	Diesel Oil	2010	620	2,950,410	7%
Escuadrón	Biomass	2008 U1 ; 2009 U2	73,223	3,023,633	7%
Pehui	Renewable energy plant	2009	351	3,023,984	7%
Trufultruful	Renewable energy plant	2009	3,316	3,027,300	7%
Santa Lidia	Diesel Oil	2009	49,269	3,076,569	7%
Quintero	Petroleum [NGL]	2009	242,737	3,319,306	8%
Los Pinos	Diesel Oil	2009	171,111	3,490,417	8%
Tierra Amarilla	Diesel Oil	2009	1,862	3,492,280	8%
Espinos	Diesel Oil	2009	12,896	3,505,176	8%
Trapén	Diesel Oil	2009	41,963	3,547,139	8%
Teno	Diesel Oil	2009	57,645	3,604,784	9%
El peñón	Diesel Oil	2009	57,049	3,661,833	9%
San Lorenzo-Unit 1	Diesel Oil	2009	620	3,662,453	9%
Termopacífico	Diesel Oil	2009	19,187	3,681,640	9%
Cenizas	Diesel Oil	2009	24,038	3,705,678	9%
Newen	Propane-Butane-Diesel Oil-Natural Gas	2009	40,295	3,745,973	9%
Linares Norte	Diesel Oil	2009	120	3,746,093	9%
San Gregorio	Diesel Oil	2009	120	3,746,213	9%
Tapihue	Natural Gas	2009	0	3,746,213	9%
Eagon	Diesel Oil	2009	765	3,746,979	9%
Biomar	Diesel Oil	2009	765	3,747,744	9%
Salmofood I	Diesel Oil	2009	510	3,748,254	9%
Salmofood II	Diesel Oil	2009	510	3,748,764	9%
Watt	Diesel Oil	2009	255	3,749,019	9%
Watt II	Diesel Oil	2009	510	3,749,52	9%

				9	
MultiExport I	Diesel Oil	2009	255	3,749,784	9%
MultiExport II	Diesel Oil	2009	510	3,750,295	9%
PMGD Planta Curicó	Coal	2009	0	3,750,295	9%
Orafti	Diesel Oil	2009	0	3,750,295	9%
Lousiana Pacific	Diesel Oil	2009	0	3,750,295	9%
San Isidro 2	Natural Gas [Diesel Oil - NGL]	2007-2008	2,880,144	6,630,439	16%
Coya	Renewable energy plant	2008	83,157	6,713,596	16%
Quellón 2	Diesel Oil	2008	13,285	6,726,880	16%
Skretting	Diesel Oil	2008	861	6,727,741	16%
Colmito	Diesel Oil	2008	1,110	6,728,851	16%
Olivos	Diesel Oil	2008	4,586	6,733,438	16%
El Totoral	Diesel Oil	2008	891	6,734,329	16%
Quintay	Diesel Oil	2008	900	6,735,229	16%
Placilla	Diesel Oil	2008	900	6,736,129	16%
Chiloé	Diesel Oil	2008	401	6,736,530	16%
Laja	Biomass	1995 - 2007	36,183	6,772,713	16%
Constitución	Biomass	1995 - 2007	46,064	6,818,777	16%
Chiburgo	Renewable energy plant	2007	74,899	6,893,676	16%
Palmucho	Renewable energy plant	2007	232,351	7,126,027	17%
El Rincón	Renewable energy plant	2007	2,437	7,128,464	17%
Eyzaguirre	Renewable energy plant	2007	6,673	7,135,137	17%
Degañ	Diesel Oil	2007	40,793	7,175,930	17%
Cañete	Diesel Oil	2007	957	7,176,886	17%
Los Sauces	Diesel Oil	2007	957	7,177,843	17%
Chufken (Traiguen)	Diesel Oil	2007	957	7,178,799	17%
Curacautín	Diesel Oil	2007	941	7,179,740	17%
Malleco (Collipulli)	Diesel Oil	2007	957	7,180,697	17%
Los Vientos TG	Diesel Oil	2007	48,934	7,229,630	17%
Esperanza	Diesel Oil	2007	1,854	7,231,484	17%
Las Vegas	Diesel Oil	2007	600	7,232,084	17%
Concón	Diesel Oil	2007	658	7,232,743	17%
Curauma	Diesel Oil	2007	600	7,233,343	17%
Casablanca	Diesel Oil	2007	360	7,233,703	17%
Constitución 1	Diesel Oil	2007	401	7,234,104	17%
Monte Patria	Diesel Oil	2007	401	7,234,505	17%
Punitaqui	Diesel Oil	2007	401	7,234,907	17%
Maule	Diesel Oil	2007	267	7,235,174	17%
Nueva Aldea II	Diesel Oil	2006	0	7,23	1

				5,174	7%
Quellón	Diesel Oil	2006	1591.09575	7,236,765	17%
Ancud	Diesel Oil	2006	834	7,237,599	17%
Nueva Aldea I	Biomass	2005	94,210	7,331,810	17%
Coronel	Natural Gas [Diesel Oil]	2005	92,610	7,424,419	18%
Candelaria	Natural Gas [Diesel Oil]	2005	182,310	7,606,730	18%
Antilhue TG	Diesel Oil	2005	71,382	7,678,112	18%
Ralco	Renewable energy plant	2004	2,198,391	9,876,503	23%

Table 19. Latest generation of the newest non-CDM power plants covering 20% of the 2010 SIC generation. Source: 2001-2010 CDEC-SIC Statistics Yearbook (pages 30-32, 50-59; https://www.cdec-sic.cl/contenido_es.php?categoria_id=4&contenido_id=000034) and CDEC-SIC webpage (https://www.cdec-sic.cl/contenido_es.php?categoria_id=6&contenido_id=000044).

No one of the additions in table above is due to a retrofit of a power plant. On the other hand, as it can be seen in the table above, the generation of the 5 newer plants is lower than the 20% of the generation in 2010. Therefore, in accordance with the “Tool to calculate the emission factor for an electricity system” (version 03.0.0), the set of plants of the above table is the proper one for the calculation of the Build Margin emission factor.

Thus, according to the tool, the Build Margin emission factor for the year 2010 is determined as follows.

$$EF_{grid,BM,2010} = \frac{\sum_m EG_{m,2010} \cdot EF_{EL,m,2010}}{\sum_m EG_{m,2010}} = 0.486\ tCO_2e / MWh$$

The baseline emission factor

As it was explained in the step 6 of the section B.6.1., the baseline emission factor is calculated as the weighted average of the Operating Margin and the Building Margin emission factors. In the case of wind projects, the default weights that should be used for both them are 0.75 in the case of w_{OM} and 0.25 for w_{BM} (owing to their intermittent and non-dispatchable nature).

Thus, the obtained ex-ante baseline emission factor which applies for the first year of the crediting period is:

$EF_{grid,CM}$ x $EF_{grid,OM}$ x w_{OM} x $EF_{grid,BM}$ x w_{BM} x 0.751x0.75x 0.486x0.25 x 0.685 tCO_2 / *MWh*

The baseline emissions

According to the baseline and monitoring methodology ACM0002 (version 13.0.0), baseline emissions include only CO2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity, and are to be calculated as follows:

$$BE_y = EG_{PJ,y} \cdot EF_{grid,CM,y}$$

Where:

BE_y	= Baseline emissions in year y (tCO_2)
$EG_{PJ,y}$	= Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year y (MWh)
$EF_{grid,CM,y}$	= Combined Margin CO_2 emission factor in year y (tCO_2/MWh)

According to the ACM0002 version 13.0.0 methodology, the Cabo Leones Wind Farm is considered as a Greenfield renewable energy power plant, then:

$$EG_{PJ,y} = EG_{facility,y} = 403{,}955 \text{ MWh}$$[18]

Where:

EGfacility,y = Quantity of net electricity generation supplied by the project plant/unit to the grid in year y (MWh).

Then, $BE_y = EG_{facility,y} \times EF_{grid,CM,y} = 403{,}955\ MWh \times 0.685\ tCO_2 / MWh = 276{,}709\ tCO_2$

Emissions reductions

The emissions avoided by the project activity should be calculated as the difference between the baseline emissions (BE_y), and project emissions (PE_y) and emissions due to leakage.

Since there are not project emissions in a wind farm project, it is not required to consider project emissions in calculations. Besides, no emissions due to leakage are caused either, the emission reductions are directly the baseline emissions.

Then, estimated yearly emission reductions calculated for the first year of the first crediting period are the baseline emission factor multiplied by the energy generation.

$$Estimated\_Emission\_\mathrm{Re}ductions_y = BE_y - PE_y = 276{,}709 - 0 = 276{,}709\ tCO_2e$$

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

Total emission reductions during the crediting period are 1,936,963 tCO_2 (See Annex 3).

Estimation of emission reductions:

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)

[18] A 1.81% of transmission losses is taken into account for determining the net energy provided to the grid.

2018	115,245	0	0	115,245
2019	208,240	0	0	208,240
2020	208,240	0	0	208,240
2021	316,417	0	0	316,417
2022	316,417	0	0	316,417
2023	316,417	0	0	316,417
2024	316,417	0	0	316,417
2025	139,570	0	0	139,570
Total	**1,936,963**	**0**	**0**	**1,936,963**
Total number of crediting years	7			
Annual average over the crediting period	276,709	0	0	276,709

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data/Parameter	**$EG_{facility,y}$**
Data unit	MWh
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in year y
Source of data	Electricity meters
Value(s) applied	403,955
Measurement methods and procedures	The following parameters shall be measured: (i)The quantity of electricity supplied by the project plant to the grid; and (ii)The quantity of electricity delivered to the project plant from the grid Both parameters will be measured by two bidirectional energy meters (main and back up) located at the electrical wind farm substation. Both meters will measure the energy produced by the plant ($EG_{export,y}$) and the energy delivered by the grid to the project plant ($EG_{import,y}$). Hence, net electricity generation supplied by the project plant to the grid will be obtained as follows: $EG_{facility,y} = (EG_{export,y} – L) – EG_{import,y}$ Transmission losses (L) of 1.81% of EG_{export} are taken into account. In a conservative way, for ex-ante estimations of emission reductions, the quantity of electricity consumed from the grid ($EG_{import,y}$) is considered to be not significant.
Monitoring frequency	Measures will be taken continuously by the main meter and the secondary meter.
QA/QC procedures	The main and backup meters will be of 0.2 S precision class, according to Chilean regulations[19]. Meters will be calibrated once every three years by the operative personnel. This is in line with national regulations related to electricity meters[20],. Net monthly generation will be approved by the CDM director and will be doubly checked with the electricity sales bills as QA/QC procedure.

[19] Procedure guidance for measurement and supervisión systems at CDEC-SIC (http://www.ecosoft.cl/clientes/Colbun/documents/Manual_CDEC_Medicion_Supervision.pdf)

Purpose of data	Calculation of baseline emissions
Additional comment	Archived data kept during the crediting period and two years after by means of electronic and paper backup.

B.7.2. Sampling plan

>>
N/A

B.7.3. Other elements of monitoring plan

>>

The proposed project meets the applicability criteria under the monitoring methodology, ACM0002 version 13.0.0 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources". This methodology is designed, among other things, for power plants using wind resources.

For this purpose and in accordance with monitoring methodology, the information that needs to be monitored shall include the electricity generation from the proposed project activity, measured from the control house on site.

General procedure

Data will be measured by two bidirectional energy meters (main and secondary) at the electrical substation of the wind farm. Measures of the net generation will be taken continuously by the main and secondary meters, which will register daily the outgoing energy from the project to the SEN grid. The net energy supplied to the grid by the project will be obtained as the difference between the outgoing and the transmission losses in the transmission line. Data will be registered monthly in the CDM project office and stored during the crediting period and two years after its end.

The net amount of energy exported to the grid will be obtained as follows:

$$EG_{facility,\,y} = (EG_{export,y} - L) - EG_{import,y}$$

Where:

$EG_{facility\,,\,y}$	= Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y*
$EG_{export,y}$	= Quantity of electricity supplied by the project plant to the grid, that will be measured at Cabo Leones wind farm substation (monitoring point).
L	= Total transmission losses until the monitoring point.
$EG_{import,y}$	== Quantity of electricity delivered to the project plant from the grid in year *y*, that will be measured at Cabo Leones wind farm substation (monitoring point).

Estimated losses according to the voltage and length of the transmission line from wind farm electrical substation until SET Domeyko electrical substation are considered to be approximately 1.81%.

[20] ANEXO TÉCNICO: SISTEMAS DE MEDIDAS PARA TRANSFERENCIAS ECONÓMICAS (https://www.cne.cl/wp-content/uploads/2015/06/Anexo-NT-Sistemas-de-Medidas-para-Transferencias-Econ%C3%B3micas.pdf)

For the emission reductions calculation the following formula is applied:

$$ER_y = EG_{facility,y} \times EF_{grid,CM,y}$$

Where:

ER_y	= Emission reduction in the year y (tCO_2)
$EG_{facility,y}$	= Quantity of net electricity generation supplied by the project plant/unit to the grid in year y (MWh)
$EF_{grid,CM,y}$	= Combined Margin CO_2 emission factor in year y (tCO_2/MWh)

Responsibilities organization

The project developer will assume the project monitoring general responsibility. A CDM director will be appointed, who will be in charge of the monitoring. Operative personnel will register, collect and file the data, will calibrate the meters, and will monitor and report the electricity generation of the project activity. All data in paper will be stored. At the same time, the CDM director will manage the training of the new personnel and will survey their work, guaranteeing always the integrity of the monitoring system.

Net monthly generation will be approved by the CDM director and will be doubly checked with the electricity sales bills.

Next a monitoring organization chart is showed:

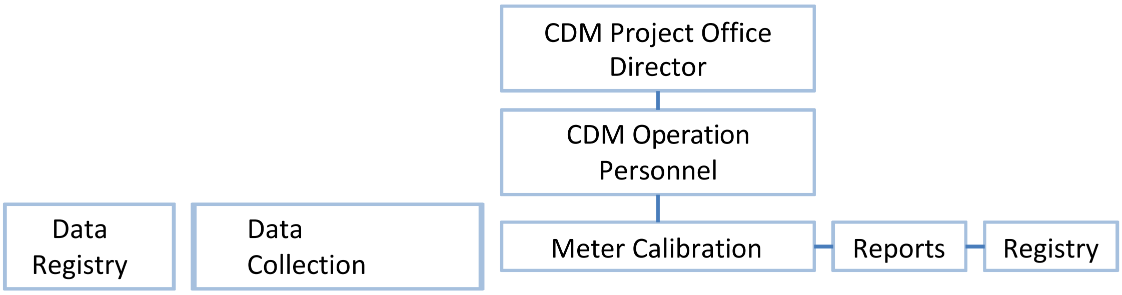

Figure 6. Monitoring organization chart.

Electricity meters

As it was pointed before, the two bidirectional meters will be located at the electrical substation of the wind farm and they will measure the energy supplied by the plant to the SEN grid ($EG_{export,y}$) and the energy delivered by the SEN grid to the plant ($EG_{import,y}$):

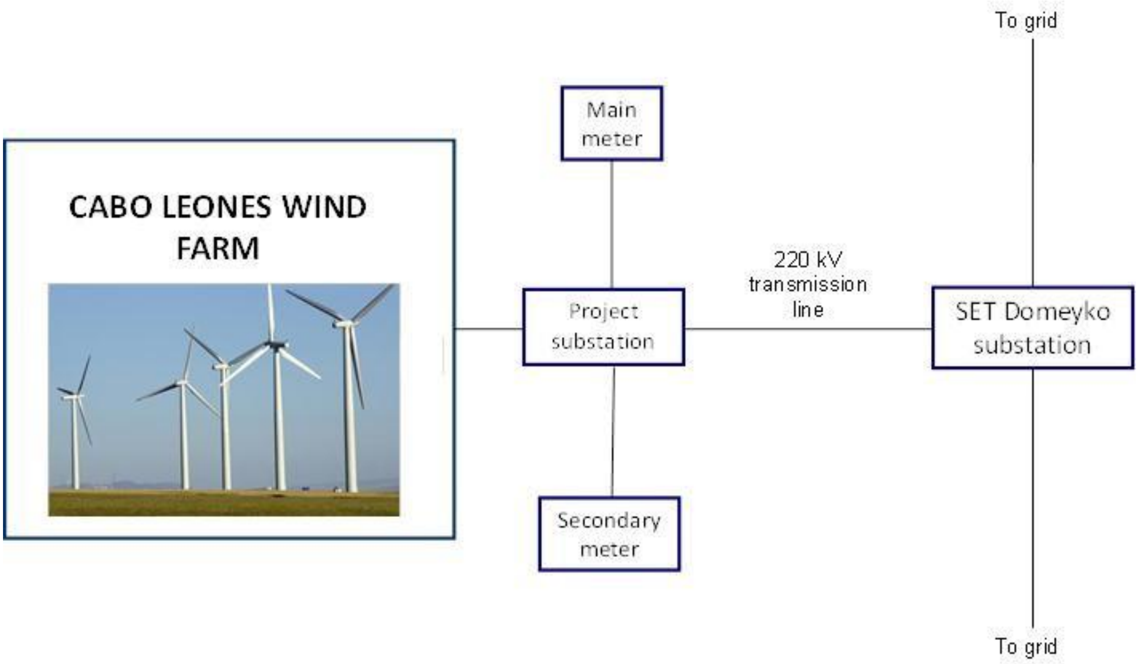

Figure 7. Energy meters location diagram.

The precision classes of the energy meters will be 0.2 S, according to Chilean regulations [21].

The readings of the main meter will be preferred for calculation of the emissions reductions. In case of failure of the main meter, a repair action will be quickly started. Nevertheless, while failure and repair of the main are achieved, backup meter will be used for monitoring parameters.

In eventual cases of damage of both meters or when erroneous readings will be detected in both meters thanks to the cross-check with bills, the CDM Project Office Director should formulate a reasonable and conservative estimation of the energy production and energy consumption, based on the historical or the nearest month of energy production or consumption data. A reliable source of information for these cases will be the project SCADA registered and stored data. In failure cases, the date and hour of the beginning and end of dysfunction of the metres will be carefully registered, and these data will be reported to the DOE for their verification.

Meters will be calibrated once every two years by the operative personnel. This is in line with national regulations related to electricity meters[22], which doesn't provide a specific calibration period but states that "meters could be verified in site every time that the Electrical Services Direction considers this action as convenient or when the electricity consumer or the electricity generators request this service".

Information about staff training and failure or emergency procedure can be seen in Appendix 5.

[21] Procedure guidance for measurement and supervisión systems at CDEC-SIC (http://www.ecosoft.cl/clientes/Colbun/documents/Manual_CDEC_Medicion_Supervision.pdf).

[22] Meters technical regulation (http://www.sec.cl/pls/portal/docs/PAGE/SECNORMATIVA/electricidad_normastecnicas/NSEG3_71.pdf).

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

>>
30/10/2013

C.2. Expected operational lifetime of project activity

>>
The project activity is expected to have a lifetime of 20 years and 0 months from its commissioning date.

C.3. Crediting period of project activity

C.3.1. Type of crediting period

>>
The crediting period will be renewable. This will be the first crediting period.

C.3.2. Start date of crediting period

>>
12/06/2018

C.3.3. Duration of crediting period

>>
The crediting period will be 7 years and 0 months, renewable.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>
The Cabo Leones Wind Farm will be located in a sparse vegetated coastal winded pasture and shrub land, being 12 kilometres northeast from the closest inhabited place (Caleta Chañaral de Aceituno). The next closest inhabited place is Domeykos, 60 kilometres east from the project.

The closest protected areas are located 14 kilometres southwest (*Pingüino de Humboldt* National Reserve) and 45 kilometres north (*Estuario de Huasco y Carrizal* Priority Site for the Biodiversity Conservation). None of these two areas is affected by the project.

The main impacts of the Cabo Leones Wind Farm can be summarized as follows:

- eventual collision of birds and bats with the blades of the turbines
- soil removal needed to assemble the turbines
- dust lifting due to the vehicles
- solid waste generation
- noise generation

All of the impacts are considered as slight. Moreover, it shall be pointed that the dust lifting is going to be naturally mitigated due to the usual coastal wind in the area, which blows away the dust. Furthermore, the noise generation will be always below the maximum limits allowed by Chilean laws.

The Environment Impact Statement was presented for approval on September 2011 and the Project obtained the Favourable Environmental Impact Assessment Qualification in March, 21th 2012[23]. The whole Environmental Impact Assessment procedure of the Project can be followed in the Chilean Service of Environmental Impact Assessment webpage[24].

D.2. Environmental impact assessment

>>

As it was indicated before, although all the impacts are considered not significant, in order to mitigate them, the following corrective, preventive and mitigation actions are planned to be carried out:

- Special structures to avoid the collision of birds and bats, and to decrease their habitats disposal within the wind farm area will be installed.
- A bird monitoring plan will be carried out.
- The soil will be restored in the places where it was removed after the turbines retirement
- The solid waste will be retired periodically and sent to authorized landfills.
- Dust lifted by the vehicles traffic will be blown by the strong coastal wind, therefore, no actions in this regard will be required.
- Respect to the noise, since it will be below the levels set by the Chilean laws, no measures are needed.

In addition, it shall be considered that the goats and horses can graze within the wind farm area once the construction of the wind farm will be finished. Furthermore, rescue of reptiles, rodents and other small mammals chasing and vegetation management are planned in detail for the construction phase of the project.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

>>

This chapter describes the stakeholders that were informed about the Cabo Leones Wind Farm Project and the process followed. Main agents selected by their concern in the Project have been informed and invited to take part in the process.

In order to guarantee the right to social participation two stakeholders meetings were organized. The first one took place in Freirina on January 30th, 2012, while the other was held the next day (January 31st, 2012) in Chañaral de Aceituno village. In both meetings, after a presentation of the project, questionnaires asking about the project and its influence in the environment and local sustainable development were filled out by the attendants.

In Freirina, an advertisement was posted at the town hall announcing the meeting. Furthermore, an invitation letter to Freirina's meeting was sent to the following stakeholders:

- Daniela Gallamalo, member of JJ.VV. Altiplano Sur
- Luis Arriagada, member of JJ.VV. Los Loros
- Andrea Callejas, member of JJ.VV. Vicuña Mackenna Nº 5
- Rebeca Ovalle, member of JJ.VV. Caleta Chañaral

[23] http://seia.sea.gob.cl/archivos/Parque_eolico_Cabo_Leones.pdf

[24] http://seia.sea.gob.cl/expediente/ficha/fichaPrincipal.php?modo=ficha&id_expediente=6079443

- Nibaldo Yáñez, member of JJ.VV. Los Bronces
- Nolfa Iribarren, member of JJ.VV. Carrizalillo
- Verónica Bustos, member of JJ.VV. Hda. Atacama
- Alba Cisternas, member of JJ.VV. Hda. Nicolasa
- Adonay Pizzarro, member of JJ.VV. Ignacio Carrera Pinto
- Rosa Yencke, member of JJ.VV. Juan XXIII
- Nilda Herrera, member of JJ.VV. Las Tablas
- Mercedes Pizarro, member of JJ.VV. Maitencillo
- Silvia Rojas, member of JJ.VV. Nueva Freirina
- Silvio Díaz, member of JJ.VV. Pedro Pérez
- Erika Espinoza, member of JJ.VV. Porvenir y Progreso
- Rosa Tapia, member of JJ.VV. Sauce Pérez
- Pedro Valenzuela, member of JJ.VV. Roberto Callejas
- Olga Pasten, member of JJ.VV. Santa Teresa Nicolasa
- Danton Godoy, member of JJ.VV. Agua Salada
- Maria Carmona, member JJ.VV. Santa Rosa Maitencillo
- Vilma Campusano, member of JJ.VV. Ramón Freire
- Consultorio de Freirina Sporting Club
- José Santos Ossa Sporting Club
- Vicuña Nackenna Sporting Club
- Ramón Freire Sporting Club
- Juventud América Sporting Club
- Araúco de Maitencillo Sporting Club
- Unión Rana Caleta Chañaral Sporting Club
- Unión Carrizalillo Sporting Club
- Football Association
- Independiente Sporting Club
- Altiplano Sur Sporting Club
- Peñarol de las Tablas Sporting Club
- Caleta los Bronces Sporting Club
- Transporte Unido de Maitencillo Sporting Club
- Escuela Alejandro Noemi Huerta Fathers Centre
- Emilia Schwabe Romohor Fathers Centre
- Jardín Infantil Los Grillitos Fathers Centre
- Escuela Virginia San Román Maitencillo Fathers Centre

For the meeting held in Chañaral de Aceituno the following stakeholders were invited:

- Amparo Martines, secretary
- Patricio Ortiz, worker in the tourism sector in Chañaral de Aceituno
- Pedro Flores, entrepreneur
- Jony Peña Lima, merchant
- Marinella Maldonado, tourist guide and skipper
- Luis González, diver and member of the Fishermen and Divers Union and of the Tourism Group
- Pedro Diet Pasini, entrepreneur
- Raimundo José Aedo Prokurica, student
- Juan Prokurica, merchant
- Gabriel Inzurra Besso, student
- Josefina Aguiluz Prokurica, student
- Freddy Catalán Francuyil, student
- Pablo Arróspide Alonso, geographer and ranger of the National Forestry Commission

(CONAF)
- Héctor Antonio Oyarzun Sazo, diver and fisherman

E.2. Summary of comments received

>>
Despite many stakeholders were invited to attend the meeting held in Freirina, only the following three stakeholders were present at the meeting:

- Germán Arriaza Torres, councillor of Freirina commune
- Mario Robles, mine worker and vice-president of Freirina Mine Workers Association
- Sergio Godoy Cuello, councillor of Freirina commune

The comments received from the stakeholders at the meeting of Freirina were of total agreement with the project. Councillors Germán Arriaza and Sergio Godoy pointed it should have been more broadcasted in order to make the local people know the environmental benefits of this kind of project. The assistants were concerned about if the energy generated in the wind farm was going to be available by the local inhabitants.

In general, comments received from Chañaral de Aceituno meeting assistants were of total agreement with the project, pointing its environmental benefits and its non-emission generating nature. Some questions and concerns were raised related the following issues:

- impacts on the environment, flora and fauna,
- possibility of building the transmission line underground,
- impacts on the quality of life of local inhabitants, and
- availability of the energy generated by local inhabitants.

E.3. Consideration of comments received

>>
As it can be checked, no negative comments have been received on the project so far at Freirina meeting. Regarding the concerns about the availability of the energy for local people, it was clarified that the CDEC-SEN will purchase energy generated at the wind farm, and therefore, it will be available for local people.

In the Chañaral de Aceituno meeting there were no negative comments from local stakeholders. The questions and concerns raised were addressed as follows:

- it was explained that an underground transmission line was technically more difficult to be built, being an underground transmission line less practical for maintenance and repair,
- it was clarified that the CDEC-SEN will purchase energy generated at the wind farm, and therefore, it will be available for local people,
- it was explained local people will be hired for the building and operation of the wind farm, and
- it was explained that the provisions of the Environmental Impact Assessment will be rigorously followed, so flora and fauna practically are practically not affected.

Furthermore, the Project developer will continue considering all suggestions that may come up.

SECTION F. Approval and authorization

>>

The LoA was issued on 03/12/2012 and it is available on “Project website of UNFCCC”.

Appendix 1. Contact information of project participants

Organization name	Ibereólica Cabo Leones I S.A.
Country	Chile
Address	Avenida Bosque Norte 0123, Oficina 502, Comuna de las Condes, Santiago
Telephone	(+56-02) 3333540
Fax	-
E-mail	vlt@grupoibereolica.com
Website	-
Contact person	Victor Manuel Lopez Tola

Organization name	Aprovechamientos Energéticos S.A.
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Fax	-
E-mail	vlt@grupoibereolica.com
Website	-
Contact person	Victor Manuel Lopez Tola

Organization name	ALLCOT COLOMBIA SAS
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Telephone	(+57) 322 209 8737
Fax	-
E-mail	all@allcot.com
Website	-
Contact person	Alexis Leroy

Appendix 2. Affirmation regarding public funding

No public funding is received by this project activity.

Appendix 3. Applicability of methodologies and standardized baselines

No further background information on the applicability of the selected methodology.

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

- **Generation by sources in SIC grid:**

YEAR	Low-Cost/Must- Run gross generation (MWh)	Other sources gross generation (MWh)	Low-Cost/Must-Run Generation (%)	Other sources Generation (%)
2006	28,634,131	11,705,648	70.98%	29.02%
2007	22,922,862	19,116,940	54.53%	45.47%
2008	24,394,643	17,474,313	58.26%	41.74%
2009	25,578,048	16,212,189	61.21%	38.79%
2010	22,415,022	20,839,710	51.82%	48.18%
		AVERAGE L-C/ M-R (%)	**59.36%**	**40.64%**

Table 21. Generation by Low-Cost/Must-Run and non Low-Cost/Must-Run sources in the Chilean SIC grid in the five last years for which generation data is available. Source: 2001-2010 CDEC SIC Operation Statistcs Yearbook, pages 50-59 (https://www.cdec-sic.cl/contenido_es.php?categoria_id=4&contenido_id=000034).

According to the Table 14, the total percentage of Low-Cost/Must-Run generation sources was 70.98%, 54.53%, 58.26%, 61.21% and 51.82% in 2006 to 2010 respectively, resulting an average of 59.36%.

- **Power plants of the Chilean SIC grid:**

The power plants of the Chilean SIC grid, as well as their characteristics, can be seen in the table below:

Power Plants	Commisioning date	Capacity (MW)	Technology	Self-consumption (%)
		Low-Cost/Must-Run		
Alfalfal	1991	178	Hydro	0.25%
Maitenes	1923 U1-U2-U3; 1989 U4-U5	31	Hydro	0.28%
Queltehues	1928	49	Hydro	0.12%
Volcán	1944	13	Hydro	0.02%
Colbún	1985	478	Hydro	0.25%
Machicura	1985	95	Hydro	0.25%
San Ignacio	1996	37	Hydro	0.23%
Rucúe	1998	178.4	Hydro	0.15%
Quilleco	2007	70.8	Hydro	0.00%
Chiburgo	2007	19.4	Hydro	1.25%
San Clemente	2010	6.1	Hydro	2.55%
Canutillar	1990	172	Hydro	0.25%
Los Molles	1952	18	Hydro	0.99%
Rapel	1968	377	Hydro	0.36%
Sauzal	1948	76.8	Hydro	0.55%
Sauzalito	1959	12	Hydro	1.00%
Cipreses	1955	106	Hydro	0.17%
Isla	1963-U1; 1964-U2	68	Hydro	0.17%
Ralco	2004	690	Hydro	1.00%
Palmucho	2007	32	Hydro	0.00%
Antuco	1981	320	Hydro	0.26%
El Toro	1973	450	Hydro	0.28%
Abanico	1948 U1-U2-U3-U4; 1959 U5-U6	136	Hydro	0.31%
Pangue	1996	467	Hydro	0.25%
Pehuenche	1991	570	Hydro	1.00%
Curillinque	1993	89	Hydro	0.25%
Loma Alta	1997	40	Hydro	0.17%
Mampil	2000	49	Hydro	0.35%
Peuchén	2000	85.6	Hydro	0.32%
Pilmaiquén	1944 U1-U2-U3; 1945-U4; 1959-U5	40.8	Hydro	0.30%
Pullinque	1962	51.4	Hydro	0.47%

Aconcagua	**1993-Ublanco; 1994-Ujuncal**	**74**	**Hydro**	**0.00%**
Los Quilos	**1943 U1-U2; 1989-U3**	**39.3**	**Hydro**	**0.00%**
Florida	**1909 U1-U2; 1993 U3-U4; 1999 U5-U6; 2003-U7**	**28.5**	**Hydro**	**0.00%**
Chacabuquito	**2002**	**25.5**	**Hydro**	**0.00%**
Capullo	**1995**	**11**	**Hydro**	**1.31%**
Puntilla	**1997**	**22**	**Hydro**	**0.05%**
Coya	**2008**	**10.8**	**Hydro**	**0.13%**
Hornitos	**2008**	**55**	**Hydro**	**0.00%**
Lircay	**2009**	**19**	**Hydro**	**0.25%**
El Rincón	**2007**	**0.28**	**Small hydro**	**0.25%**
El Manzano	**2008**	**4.85**	**Small hydro**	**0.00%**
Carena	**1943**	**8.5**	**Small hydro**	**16.00%**
Ojos de Agua	**2008**	**9**	**Small hydro**	**0.00%**
Eyzaguirre	**2007**	**2.1**	**Small hydro**	**0.00%**
Puclaro	**2008**	**6**	**Small hydro**	**0.00%**
Pehui	**2009**	**1.1**	**Small hydro**	**0.00%**
Trufultruful	**2009**	**0.5**	**Small hydro**	**0.00%**
Los Bajos	**1944**	**5.1**	**Small hydro**	**0.35%**
Caemsa	**1962 U1-U2; 1985-U3**	**3.4**	**Small hydro**	**1.02%**
Los Morros	**1930 U1-U2-U3; 1994 U4-U5**	**3.1**	**Small hydro**	**1.50%**
S. Andes	**1909**	**1.104**	**Small hydro**	**1.14%**
La Paloma	**2010**	**4.9**	**Small hydro**	**0.00%**
Trueno	**2010**	**5.6**	**Small hydro**	**0.00%**
Los Corrales	**2010**	**0.8**	**Small hydro**	**0.00%**
Doña Hilda	**2010**	**0.4**	**Small hydro**	**0.00%**
Juncalito	**2010**	**1.47**	**Small hydro**	**0.00%**
Dongo	**2010**	**6**	**Small hydro**	**0.00%**
Canela	**2007**	**18.2**	**Wind**	**1.00%**
Canela II	**2009**	**60**	**Wind**	**1.00%**
Monte Redondo	**2010**	**38**	**Wind**	**1.00%**
Totoral	**2010**	**46**	**Wind**	**1.00%**
Lebu	**2009**	**3.6**	**Wind**	**0.00%**
Confluencia	**2010**	**158**	**Small hydro**	**0.50%**
Guayacán	**2010**	**12**	**Small hydro**	**0.00%**
La Higuera	**2010**	**155**	**Small hydro**	**0.50%**

Table 22. Characteristics of the non thermal power plants in the Chilean SIC grid. Source: 2001-2010 CDEC SIC Operation Statistics Yearbook, pages 30-32 (https://www.cdec-sic.cl/contenido_es.php?categoria_id=4&contenido_id=000034) and CDEC SIC webpage -for self consumption and technologies https://www.cdec- sic.cl/contenido_es.php?categoria_id=6&contenido_id=000044).

Power Plants		**Commisioning date**	**Capacity (MW)**	**Technology**	**Self-consumption (%)**
Thermal	Fuel				
Arauco	Biomass-Fuel Oil	1996	9	Steam turbine	0.00%
Valdivia	Biomass-Fuel Oil	2004	61	Steam turbine	0.00%
Licantén	Biomass-Fuel Oil	2004	4	Steam turbine	0.00%
Horcones	Diesel Oil [Natural Gas]	2004	24.3	Gas turbine	0.00%
Celco	Biomass-Fuel Oil	1996	8	NA	0.00%
Cholguán	Biomass-Fuel Oil	2003	13	Steam turbine	0.00%
Nueva Aldea I	Biomass	2005	14	Steam turbine	0.00%
Nueva Aldea II	Diesel Oil	2006	10	Gas turbine	0.00%
Nueva Aldea III	Biomass	2008	37	Steam turbine	0.00%
Coronel	Natural Gas [Diesel Oil]	2005	46.7	Gas turbine	0.00%
Degañ	Diesel Oil	2007	39.	NA	0.0

			6		0%
Quellón 2	Diesel Oil	2008	10	NA	2.44%
Quellón	Diesel Oil	2006	4.99	NA	0.00%
Ancud	Diesel Oil	2006	3.3	NA	0.00%
Cañete	Diesel Oil	2007	3	NA	0.00%
Los Sauces	Diesel Oil	2007	3	NA	0.00%
Chufken (Traiguen)	Diesel Oil	2007	3	NA	0.00%
Curacautín	Diesel Oil	2007	2.95	NA	0.00%
Malleco (Collipulli)	Diesel Oil	2007	3	NA	0.00%
Chuyaca	Diesel Oil	2008-2009-2010	15	NA	2.44%
Skretting	Diesel Oil	2008	2.7	NA	0.00%
Lag. Verde	Coal	1939-U1; 1949-U2	54.7	Steam turbine	4.00%
Ventanas 1	Coal	1964	120	Steam turbine	5.50%
Ventanas 2	Coal	1977	220	Steam turbine	5.20%
Nueva Ventanas	Coal	2010	272	Steam turbine	9.36%
Lag. Verde TG	Diesel Oil	2004	18.8	Gas turbine	0.45%
Los Vientos TG	Diesel Oil	2007	132	Gas turbine	0.50%
Santa Lidia	Diesel Oil	2009	139	Gas turbine	0.50%
Bocamina	Coal	1970	128	Steam turbine	6.00%
Huasco TG	Diesel Oil [Fuel Oil]	1977 U1-U2; 1979-U3	64.23	Gas turbine	6.00%
D. de Almagro	Diesel Oil	1981	23.8	Gas turbine	0.55%
Taltal	Natural Gas [Diesel Oil]	2000	122.45	Gas turbine	0.20%
Taltal2	Natural Gas [Diesel Oil]	2000	122.45	Gas turbine	0.20%
San Isidro 2	Natural Gas [Diesel Oil – NGL]	2007-2008	353	NA	0.60%
Quintero	Petroleum [NGL]	2009	257	Gas turbine	0.00%
Guacolda	Coal [Petroleum]	1995-U1; 1996-U2; 2009-U3; 2010-U4	608	Steam turbine	7.53%
Laja	Biomass	1995 – 2007	12.7	Steam turbine	9.00%
Constitución	Biomass	1995 – 2007	11.1	Steam turbine	0.00%
S. Fco.de Mostazal	Diesel Oil	2002	24	Steam turbine	0.59%
Nueva Renca	Natural Gas [Diesel Oil]	1997	379	NA	2.40%
Renca	Diesel Oil	1962	100	Steam turbine	8.00%
Petropower	Petcoke	1998	75	Steam turbine	18.05%
Nehuenco	Natural Gas [Diesel Oil – NGL]	1998	368.4	NA	1.90%
Turbina 9B	Natural Gas [Diesel Oil – NGL]	2002	108	Gas turbine	1.00%
Nehuenco II	Natural Gas [NGL]	2003	398.3	NA	2.00%
Candelaria	Natural Gas [Diesel Oil]	2005	269.5	Gas turbine	0.50%
Los Pinos	Diesel Oil	2009	104.2	NA	2.60%
Antilhue TG	Diesel Oil	2005	101.3	Gas turbine	1.18%
San Isidro	Natural Gas [Diesel Oil – NGL]	1998	379	NA	3.00%
Campanario	Natural Gas [Diesel Oil]	2007 U1-U2; 2008-U3; 2010-*U4	219.2	Gas turbine	1.01%
Tierra Amarilla	Diesel Oil	2009	165	Gas turbine	1.65%
Esperanza	Diesel Oil	2007	22	Gas turbine	0.97%
Colmito	Diesel Oil	2008	58	NA	0.00%
Olivos	Diesel Oil	2008	99	Diesel engine	3.03%
Espinos	Diesel Oil	2009	128	Diesel engine	9.09%
Escuadrón	Biomass	2008 U1 ; 2009 U2	15.5	Steam turbine	12.50%
Trapén	Diesel Oil	2009	81	NA	0.00%
Teno	Diesel Oil	2009	58	NA	0.00%
El peñón	Diesel Oil	2009	81	NA	0.00%
San Lorenzo	Diesel Oil	2009-2010	56	NA	0.00%
Termopacífico	Diesel Oil	2009	96	NA	0.00%
Cenizas	Diesel Oil	2009	17.1	NA	6.00%
Newen	Propane-Butane-Diesel Oil-Natural Gas	2009	15	Gas turbine	0.80%

Emelda	Diesel Oil	2010	69.25	NA	0.70%
Colihues	Diesel Oil [Fuel Oil]	2010	22	NA	3.75%
Salvador	Diesel Oil	2010	23.8	Gas turbine	0.55%
Punta Colorada	Diesel Oil	2010	17	NA	2.30%
CBB-Centro	Diesel Oil [Fuel Oil]	2010	13.6	NA	0.00%
Las Vegas	Diesel Oil	2007	2	NA	0.00%
Concón	Diesel Oil	2007	2.2	NA	0.25%
Curauma	Diesel Oil	2007	2	NA	0.00%
Casablanca	Diesel Oil	2007	1.2	NA	0.00%
El Totoral	Diesel Oil	2008	3	NA	1.00%
Quintay	Diesel Oil	2008	3	NA	0.00%
Placilla	Diesel Oil	2008	3	NA	0.00%
Linares Norte	Diesel Oil	2009	0.4	NA	0.00%
San Gregorio	Diesel Oil	2009	0.4	NA	0.00%
Constitución 1	Diesel Oil	2007	9	NA	0.00%
Monte Patria	Diesel Oil	2007	9	NA	0.00%
Punitaqui	Diesel Oil	2007	9	NA	0.00%
Maule	Diesel Oil	2007	6	NA	0.00%
Chiloé	Diesel Oil	2008	9	NA	0.00%
Tapihue	Natural Gas	2009	6.4	NA	0.00%
Eagon	Diesel Oil	2009	2.4	NA	0.00%
Biomar	Diesel Oil	2009	2.4	NA	0.00%
Salmofood I	Diesel Oil	2009	1.6	NA	0.00%
Salmofood II	Diesel Oil	2009	1.6	NA	0.00%
Watt	Diesel Oil	2009	0.8	NA	0.00%
Watt II	Diesel Oil	2009	1.6	NA	0.00%
MultiExport I	Diesel Oil	2009	0.8	NA	0.00%
MultiExport II	Diesel Oil	2009	1.6	NA	0.00%
PMGD Planta Curicó	Coal	2009	2	NA	0.00%
Orafti	Diesel Oil	2009	0.5	NA	0.00%
Lousiana Pacific	Diesel Oil	2009	2.9	NA	0.00%
Loma Los Colorados (KDM)	BioGas	2010	2	Otto cycle	0.00%

Table 23. Characteristics of the thermal power plants in the Chilean SIC grid. Source: 2001-2010 CDEC SIC Operation Statistics Yearbook, pages 30-32 (https://www.cdec-sic.cl/contenido_es.php?categoria_id=4&contenido_id=000034) and CDEC SIC webpage -for self consumption and technologies, https://www.cdec- sic.cl/contenido_es.php?categoria_id=6&contenido_id=000044). NA means "Not Available".

The fuel consumption for power generation in the SIC plant is shown in the next tables:

	2008				
	FC$_{diesel,m,y}$	**Fc**$_{fuel\ oil,m,y}$	**Fc**$_{coal,m,y}$	**Fc**$_{natural\ gas,m,y}$	**Fc**$_{natural\ gas\ liquids,m,y}$
Power Plants	[t]	[t]	[t]	[t]	[t]
Thermal					
Arauco		0.00			
Valdivia	0.00				
Licantén		0.00			
Horcones	2,373.00			0.00	
Celco		0.00			
Cholguán		0.00			
Nueva Aldea II	0.00				
Coronel	16,800.00			0.14	
Degañ	14,400.00				
Quellón 2	734.96				
Quellón	2,275.31				
Ancud	1,354.46				
Cañete	1,191.49				
Los Sauces	1,026.73				
Chufken (Traiguen)	581.30				
Curacautín	1,447.72				

Malleco (Collipulli)	1,472.25				
Chuyaca	446.34				
Skretting	80.34				
Lag. Verde			171,396.00		
Ventanas 1			350,723.00		
Ventanas 2			607,142.00		
Nueva Ventanas			0.00		
Lag. Verde TG	9,799.00				
Los Vientos TG	102,022.00				
Santa Lidia	143.62				
Bocamina	1,370.00		399,252.60		
Huasco TG		59,540.00	0.00		
D. de Almagro	21,011.00				
Taltal	257,720.00			4.13	0.00
Taltal2				20.09	0.00
San Isidro 2	288,570.00			0.00	0.00
Quintero	0.00				0.00
Guacolda			1,187,037.00		
S. Fco.de Mostazal	10,897.00				
Nueva Renca	258,533.45			0.00	0.00
Renca	4,782.10				
Petropower			214,640.65		
Nehuenco	50,795.26			0.00	
Turbina 9B	39,611.64			23.22	
Nehuenco II	365,267.51			25.50	
Candelaria	147,160.00			8.33	
Los Pinos	1,488.26				
Antilhue TG	54,993.27				
San Isidro	102,580.00			117.58	0.00
Campanario	54,537.36			3.78	
Tierra Amarilla	0.00				
Esperanza	2,924.42				
Colmito	619.86				
Olivos	6,437.00				
Espinos	0.00				
Trapén	0.00				
Teno	0.00				
El peñón	0.00				
San Lorenzo	0.00				
Cenizas	0.00				
Newen	0.00				
Salvador	0.00				
Las Vegas	1,740.33				
Concón	2,169.50				
Curauma	2,243.59				
Casablanca	1,533.85				
El Totoral	0.00				
Quintay	0.00				

Placilla	0.00				
Linares Norte	0.00				
San Gregorio	0.00				

Thermal					
Constitución 1	2,123.00				
Monte Patria	3,810.00				
Punitaqui	3,890.00				
Maule	1,026.00				
Chiloé	22.43				

Table 24. Fuel consumption in power plants during the year 2008. Source: 2001-2010 CDEC-SIC Operation Statistics Yearbook, pages 68-71 (https://www.cdec-sic.cl/contenido_es.php?categoria_id=4&contenido_id=000034) [28].

	2009				
	$FC_{diesel,m,y}$	$Fc_{fuel\ oil,m,y}$	$Fc_{coal,m,y}$	$Fc_{natural\ gas,m,y}$	$Fc_{natural\ gas\ liquids,m,y}$
Power Plants	[t]	[t]	[t]	[t]	[t]
Thermal					
Arauco		0.00			
Valdivia	0.00				
Licantén		0.00			
Horcones	772.36			0.00	
Celco		0.00			
Cholguán		0.00			
Nueva Aldea II	0.00				
Coronel	6,130.00			0.24	
Degañ	8,963.00				
Quellón 2	3,440.00				
Quellón	310.00				
Ancud	5,785.00				
Cañete	650.00				
Los Sauces	870.00				
Chufken (Traiguen)	840.00				
Curacautín	660.00				
Malleco (Collipulli)	671.19				
Chuyaca	590.00				
Skretting	96.68				
Lag. Verde			14,422.00		
Ventanas 1			331,137.00		
Ventanas 2			635,736.00		
Nueva Ventanas			40,772.00		
Lag. Verde TG	4,969.00				
Los Vientos TG	41,501.00				
Santa Lidia	2,854.00				
Bocamina	1,583.00		370,076.80		
Huasco TG		10,167.00	0.00		
D. de Almagro	10,430.00				
Taltal	55,614.03			26.88	0.00
Taltal2				28.43	0.00
San Isidro 2	244,519.55			0.00	45,117.37
Quintero	774.78				2,721.68
Guacolda			1,738,999.00		
Laja					
Constitución					
S. Fco.de Mostazal	737.00				
Nueva Renca	211,938.00			0.00	0.00
Renca	0.00				
Petropower			209,528.00		
Nehuenco	152,900.00			16.05	
Turbina 9B	5,310.00			5.93	
Nehuenco II	246,420			1.66	

	.00				
Candelaria	27,800. 00			6.54	
Los Pinos	22,570. 00				
Antilhue TG	28,780. 00				

San Isidro	102,174.00			58.03	75,621.42
Campanario	30,546.00			0.00	
Tierra Amarilla	7,642.00				
Esperanza	548.00				
Colmito	1,113.66				
Olivos	11,826.00				
Espinos	5,810.94				
Trapén	10,280.00				
Teno	500.00				
El peñón	2,280.00				
San Lorenzo	360.00				
Termopacífico	305.50				
Cenizas	1,717.00				
Newen	24.48				
Salvador	0.00				
Las Vegas	366.88				
Concón	457.36				
Curauma	472.97				
Casablanca	323.35				
El Totoral	526.51				
Quintay	661.41				
Placilla	659.19				
Linares Norte	33.66				
San Gregorio	24.31				
Constitución 1	220.00				
Monte Patria	1,840.00				
Punitaqui	2,230.00				
Maule	90.00				
Chiloé	210.00				
Eagon	84.08				
Biomar	84.08				
Salmofood I	56.06				
Salmofood II	56.06				
Watt	28.03				
Watt II	56.06				
MultiExport I	28.03				
MultiExport II	56.06				

Table 25. Fuel consumption in power plants during the year 2009. Source: 2001-2010 CDEC-SIC Operation Statistics Yearbook, pages 68-71 (https://www.cdec-sic.cl/contenido_es.php?categoria_id=4&contenido_id=000034)[29].

	2010				
	$FC_{diesel,m,y}$	$Fc_{fuel\ oil,m,y}$	$Fc_{coal,m,y}$	$Fc_{natural\ gas,m,y}$	$Fc_{natural\ gas\ liquids,m,y}$
Power Plants	[t]	[t]	[t]	[t]	[t]
Thermal					
Arauco		0.00			
Valdivia	0.00				
Licantén		0.00			
Horcones	3,270.00			0.09	
Celco		0.00			
Cholguán		0.00			
Nueva Aldea II	0.00				
Coronel	16,600.00			2.28	
Degañ	8,740.00				
Quellón 2	3,229.26				
Quellón	0.70				
Ancud	7,400.00				
Cañete	190.00				
Los Sauces	240.00				
Chufken (Traiguen)	230.94				

Curacautín	361.86					
Malleco (Collipulli)	141.46					
Chuyaca	1,387.67					
Skretting	184.45					
Lag. Verde	1,034.00		0.00			
Ventanas 1			346,785.00			
Ventanas 2			450,447.00			
Nueva Ventanas			745,350.00			
Lag. Verde TG	1,034.00					
Los Vientos TG	14,009.00					
Santa Lidia	12,855.00					
Bocamina	0.00		81,992.60			
Huasco TG		622.40	0.00			
D. de Almagro	190.00					
Taltal					4.15	276.81
Taltal2					7.85	6.50
San Isidro 2	14,843.41				2.21	287,283.25
Quintero	4,050.00					37,312.00
Guacolda			1,738,999.00			
S. Fco.de Mostazal	281.00					
Nueva Renca	227,201.00				0.00	63,898.45
Renca	794.00					
Petropower			26,684.05			
Nehuenco	111,170.00				28.22	
Turbina 9B	180.00				1.12	
Nehuenco II	252,943.92				99.23	
Candelaria	26,813.34				20.58	
Los Pinos	36,780.00					
Antilhue TG	18,530.00					
San Isidro	7,865.46				4.51	240,496.22
Campanario	6,454.11				0.00	
Tierra Amarilla	741.52					
Esperanza	426.26					
Colmito	252.73					
Olivos	910.35					
Espinos	3,033.65					
Trapén	8,920.00					
Teno	12,430.00					
El peñón	12,250.00					
San Lorenzo	176.00					
Termopacífico	738.43					
Cenizas	984.15					
Newen	1,468.80					
Emelda	1,173.24					
Colihues	372.73					
Salvador	95.10					
Punta Colorada	239.72					
CBB-Centro	230.41					
Las Vegas	136.96					
Concón	180.29					
Curauma	160.45					
Casablanca	54.76					
El Totoral	88.08					
Quintay	206.86					
Placilla	226.93					
Linares Norte	34.28					
San Gregorio	59.51					
Constitución 1	430.58					
Monte Patria	36.12					
Punitaqui	86.30					
Maule	124.81					
Chiloé	0.30					

Eagon	29.45				
Biomar	29.45				
Salmofood I	19.63				
Salmofood II	19.63				
Watt	9.82				
Watt II	19.63				
MultiExport I	9.82				
MultiExport II	19.63				

- **Emission factor, net generations and emissions of each power plant in the SIC grid:**

The emission factor of each power plant was determined as per option A1 of the Simple OM method, as the “Tool to calculate the emission factor for an electricity system” (version 03.0.0) indicates Option A should be used and fuel consumption data is available for each plant:

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

Where:

$EF_{EL,m,y}$ = CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)

$FC_{i,m,y}$ = Amount of fuel type *i* consumped by power unit *m* in year *y* (mass or volume unit)

$NCV_{i,y}$ = Net calorific Value of fuel type *i* in year *y* (GJ/mass or volume unit)

$EF_{CO2,i,y}$ = CO_2 emission factor of fuel type *i* in year *y* (tCO_2/GJ)

$EG_{m,y}$ = Net quantity of of electricity genrated and delivered to the grid by power unit m in year y (MWh)

m = all power units serving the grid in year *y* except low-cost/must-run power units

i = All fuels types combusted in power unit *m* in year *y*

y = The relevant year as per the data vintage chosen

The net calorific values used were provided by the National Energy Commission (*Comisión Nacional de la Energía*) in its 2009 National Energy Balance[31], which are shown next:

Net calorific values		
Fuel	kcal/kg	GJ/t
Diesel	10,900	45.64
Fuel oil	10,500	43.96
Coal	7,000	29.31
Natural gas	9,341	39.11
Natural gas liquids	12,100	50.66
Biogas	5,600	23.45

Table 27. Net calorific values of fuels used in Chilean SIC grid for power generation.

The emission factors obtained for the thermal plants, the net generations and the emissions of each plant are shown in the next tables:

Arauco	12,307	0.00	0
Valdivia	218,900	0	0
Licantén	13,018	0.00	0
Horcones	6,806	1.16	7,863
Celco	43,450	0.00	0
Cholguán	89,964	0.00	0
Nueva Aldea I	107,546	0.00	0
Nueva Aldea II	0	0	0
Nueva Aldea III	209,769	0.00	0
Coronel	74,588	0.75	55,664
Degañ	68,288	0.70	47,712
Quellón 2	9,017	0.27	2,435
Quellón	4,612	1.63	7,539
Ancud	3,050	1.47	4,488
Cañete	2,773	1.42	3,948
Los Sauces	2,773	1.23	3,402
Chufken (Traiguen)	2,773	0.69	1,926
Curacautín	2,727	1.76	4,797
Malleco (Collipulli)	2,773	1.76	4,878
Chuyaca	13,526	0.11	1,479
Skretting	2,496	0.11	266
Lag. Verde	237,507	1.89	449,598
Ventanas 1	889,820	1.03	920,001
Ventanas 2	1,548,6	1.03	1,592,628

	37		
Nueva Ventanas	0	0	0
Lag. Verde TG	38,737	0.84	32,467
Los Vientos TG	378,890	0.89	338,034
Santa Lidia	524	0.91	476
Bocamina	900,640	1.17	1,051,841
Huasco TG	151,140	1.31	197,628
D. de Almagro	57,799	1.20	69,617
Taltal	518,853	1.65	853,923
Taltal2	518,853	0.00	43
San Isidro 2	1,638,0 37	0.58	956,131
Quintero	0	0	0
Guacolda	2,339,8 31	1.33	3,113,783
Laja	49,046	0.00	0
Constitución	58,061	0.00	0
S. Fco.de Mostazal	32,377	1.12	36,105
Nueva Renca	1,466,6 71	0.58	856,609
Renca	11,407	1.39	15,845
Petropower	404,784	1.39	563,036
Nehuenco	306,241	0.55	168,302
Turbina 9B	232,801	0.56	131,296
Nehuenco II	2,344,6 58	0.52	1,210,310
Candelaria	573,750	0.85	487,609
Los Pinos	6,943	0.71	4,931
Antilhue TG	238,304	0.76	182,211
San Isidro	1,344,1 17	0.25	340,132
Campanario	237,610	0.76	180,709
Tierra Amarilla	0	0	0
Esperanza	12,478	0.78	9,690
Colmito	2,671	0.77	2,054
Olivos	27,439	0.78	21,328
Espinos	0	0	0
Escuadrón	0	0	0
Trapén	0	0	0
Teno	0	0	0
El peñón	0	0	0
San Lorenzo	0	0	0
Termopacífico	0	0	0
Cenizas	676	0.00	0
Newen	0	0	0
Emelda	0	0	0
Colihues	0	0	0
Salvador	0	0	0
Punta Colorada	0	0	0
CBB-Centro	0	0	0
Las Vegas	8,807	0.65	5,766
Concón	9,663	0.74	7,188
Curauma	8,807	0.84	7,434
Casablanca	5,284	0.96	5,082
El Totoral	0	0	0
Quintay	0	0	0
Placilla	0	0	0
Linares Norte	0	0	0
San Gregorio	0	0	0
Constitución 1	13,774	0.51	7,034
Monte Patria	13,774	0.92	12,624
Punitaqui	13,774	0.94	12,889
Maule	9,183	0.37	3,399
Chiloé	370	0.20	74
Tapihue	0	0	0
Eagon	0	0	0
Biomar	0	0	0
Salmofood I	0	0	0
Salmofood II	0	0	0
Watt	0	0	0
Watt II	0	0	0
MultiExport I	0	0	0

MultiExport II	0	0	0
PMGD Planta Curicó	0	0	0
Orafti	0	0	0
Lousiana Pacific	0	0	0
Loma Los Colorados (KDM)	0	0	0
TOTAL THERMAL POWER PLANTS	**17,543, 893**		**13,994,223**

Table 28. Net generation, emission factor and total emissions in the year 2008 of each power plant in the SIC grid. Sources: 2001-2010 CDEC SIC Operation Statistics Yearbook (pages 30-32, 50-59, 68-71, https://www.cdec- sic.cl/contenido_es.php?categoria_id=4&contenido_id=000034), CDEC-SIC webpage (https://www.cdec- sic.cl/contenido_es.php?categoria_id=6&contenido_id=000044), 2009 National Energy Balance (http://www.cne.cl/estadisticas/balances-energeticos) and 2006 IPCC Guidelines on National GHG Inventories (Volume 2, Chapter 1, table 1.4).

	2009		
Thermal Power Plants	**EGm,2009 [MWh]**	**EFEL,m,2009 [tCO_2/MWh]**	**CO_2 emissions tCO_2**
Arauco	11,139	0.00	0
Valdivia	258,711	0.00	0
Licantén	20,270	0.00	0
Horcones	1,569	1.63	2,559
Celco	51,572	0.00	0
Cholguán	76,393	0.00	0
Nueva Aldea I	103,053	0.00	0
Nueva Aldea II	0	0	0
Nueva Aldea III	266,784	0.00	0
Coronel	26,504	0.77	20,311
Degañ	42,081	0.71	29,697
Quellón 2	15,069	0.76	11,398
Quellón	3,166	0.32	1,027
Ancud	2,094	9.15	19,168
Cañete	1,733	1.24	2,154
Los Sauces	1,733	1.66	2,883
Chufken (Traiguen)	1,733	1.61	2,783
Curacautín	1,704	1.28	2,187
Malleco (Collipulli)	1,733	1.28	2,224
Chuyaca	9,286	0.21	1,955
Skretting	1,560	0.21	320
Lag. Verde	19,373	1.95	37,831
Ventanas 1	834,786	1.04	868,624
Ventanas 2	1,580,705	1.05	1,667,634
Nueva Ventanas	109,092	0.98	106,951
Lag. Verde TG	19,075	0.86	16,464
Los Vientos TG	154,325	0.89	137,507
Santa Lidia	10,416	0.91	9,456
Bocamina	863,947	1.13	976,014
Huasco TG	22,679	1.49	33,747
D. de Almagro	24,599	1.40	34,558
Taltal	220,792	0.83	184,325
Taltal2	220,792	0.00	60
San Isidro 2	1,789,121	0.53	943,437
Quintero	22,355	0.47	10,606
Guacolda	2,971,018	1.54	4,561,665
Laja	42,132	0.00	0
Constitución	56,363	0.00	0
S. Fco.de Mostazal	2,159	1.13	2,442
Nueva Renca	1,245,770	0.56	702,223
Renca	311	0.00	0
Petropower	395,124	1.39	549,625
Nehuenco	1,028,996	0.49	506,644
Turbina 9B	41,818	0.42	17,606
Nehuenco II	1,508,784	0.54	816,477
Candelaria	127,581	0.72	92,125
Los Pinos	105,286	0.71	74,782
Antilhue TG	111,393	0.86	95,358
San Isidro	1,629,147	0.34	562,019

Campanario	102,403	0.99	101,209
Tierra Amarilla	23,382	1.08	25,321
Esperanza	2,338	0.78	1,816
Colmito	4,798	0.77	3,690
Olivos	51,272	0.76	39,184
Espinos	24,747	0.78	19,254
Escuadrón	67,592	0.00	0
Trapén	47,112	0.72	34,061
Teno	2,415	0.69	1,657
El peñón	11,404	0.66	7,554
San Lorenzo	635	1.88	1,193
Termopacífico	8,014	0.13	1,012
Cenizas	42,336	0.13	5,689
Newen	4,384	0.02	81
Emelda	0	0	0
Colihues	0	0	0
Salvador	0	0	0
Punta Colorada	0	0	0
CBB-Centro	0	0	0
Las Vegas	1,857	0.65	1,216
Concón	2,037	0.74	1,515
Curauma	1,857	0.84	1,567
Casablanca	1,114	0.96	1,071
El Totoral	2,757	0.63	1,744
Quintay	2,785	0.79	2,191
Placilla	2,785	0.78	2,184
Linares Norte	371	0.30	112
San Gregorio	371	0.22	81
Constitución 1	3,462	0.21	729
Monte Patria	3,462	1.76	6,097
Punitaqui	3,462	2.13	7,389
Maule	2,308	0.13	298
Chiloé	3,462	0.20	696
Tapihue	0	0	0
Eagon	1,386	0.20	279
Biomar	1,386	0.20	279
Salmofood I	924	0.20	186
Salmofood II	924	0.20	186
Watt	462	0.20	93
Watt II	924	0.20	186
MultiExport I	462	0.20	93
MultiExport II	924	0.20	186
PMGD Planta Curicó	0	0	0
Orafti	0	0	0
Lousiana Pacific	0	0	0
Loma Los Colorados (KDM)	0	0	0
TOTAL THERMAL PLANTS	16,488,139		13,376,942

Table 29. Net generation, emission factor and total emissions in the year 2009 of each power plant in the SIC grid. Sources: 2001-2010 CDEC SIC Operation Statistics Yearbook (pages 30-32, 50-59, 68-71, https://www.cdec- sic.cl/contenido_es.php?categoria_id=4&contenido_id=000034), CDEC-SIC webpage (https://www.cdec- sic.cl/contenido_es.php?categoria_id=6&contenido_id=000044), 2009 National Energy Balance (http://www.cne.cl/estadisticas/balances-energeticos) and 2006 IPCC Guidelines on National GHG Inventories (Volume 2, Chapter 1, table 1.4).

	2010		
	$EG_{m,2010}$	**$EF_{EL,m,2010}$**	**CO_2 emissions**
Thermal Power Plants	[MWh]	[tCO_2/MWh]	tCO_2
Arauco	15,261	0.00	0
Valdivia	226,740	0.00	0
Licantén	21,339	0.00	0
Horcones	3,617	3.00	10,835
Celco	30,486	0.00	0
Cholguán	82,671	0.00	0
Nueva Aldea I	94,210	0.00	0
Nueva Aldea II	0	0	0
Nueva Aldea III	188,214	0.00	0
Coronel	92,610	0.59	55,006
Degañ	40,793	0.71	28,959

Quellón 2	13,285	0.81	10,700
Quellón	1,591	0.00	2
Ancud	834	29.39	24,519
Cañete	957	0.66	630
Los Sauces	957	0.83	795
Chufken (Traiguen)	957	0.80	765
Curacautín	941	1.27	1,199
Malleco (Collipulli)	957	0.49	469
Chuyaca	5,264	0.87	4,598
Skretting	861	0.71	611
Lag. Verde	304	11.28	3,426
Ventanas 1	861,269	1.06	909,671
Ventanas 2	1,088,293	1.09	1,181,593
Nueva Ventanas	1,829,208	1.07	1,955,169
Lag. Verde TG	4,206	0.81	3,426
Los Vientos TG	48,934	0.95	46,417
Santa Lidia	49,269	0.86	42,593
Bocamina	201,991	1.06	215,079
Huasco TG	1,010	2.04	2,066
D. de Almagro	783	0.80	630
Taltal	71,582	0.01	826
Taltal2	71,582	0.00	36
San Isidro 2	2,880,144	0.31	897,716
Quintero	242,737	0.51	123,625
Guacolda	4,169,806	1.09	4,561,665
Laja	36,183	0.00	0
Constitución	46,064	0.00	0
S. Fco.de Mostazal	616	1.51	931
Nueva Renca	1,861,229	0.51	941,527
Renca	2,441	1.08	2,631
Petropower	50,313	1.39	69,996
Nehuenco	760,033	0.48	368,404
Turbina 9B	6,170	0.10	599
Nehuenco II	2,453,234	0.34	838,300
Candelaria	182,310	0.49	88,885
Los Pinos	171,111	0.71	121,865
Antilhue TG	71,382	0.86	61,396
San Isidro	2,391,749	0.31	736,409
Campanario	25,741	0.83	21,385
Tierra Amarilla	1,862	1.32	2,457
Esperanza	1,854	0.76	1,412
Colmito	1,110	0.75	837
Olivos	4,586	0.66	3,016
Espinos	12,896	0.78	10,052
Escuadrón	73,223	0.00	0
Trapén	41,963	0.70	29,555
Teno	57,645	0.71	41,185
El peñón	57,049	0.71	40,588
San Lorenzo	310	1.88	583
Termopacífico	19,187	0.13	2,447
Cenizas	24,038	0.14	3,261
Newen	40,295	0.12	4,867
Emelda	30,272	0.13	3,887
Colihues	9,322	0.13	1,235
Salvador	10,420	0.03	315
Punta Colorada	6,086	0.13	794
CBB-Centro	5,987	0.13	763
Las Vegas	600	0.76	454
Concón	658	0.91	597
Curauma	600	0.89	532
Casablanca	360	0.50	181
El Totoral	891	0.33	292
Quintay	900	0.76	685
Placilla	900	0.84	752
Linares Norte	120	0.95	114
San Gregorio	120	1.64	197
Constitución 1	401	3.56	1,427

Monte Patria	401	0.30	120
Punitaqui	401	0.71	286
Maule	267	1.55	414
Chiloé	401	0.00	1
Tapihue	0	0	0
Eagon	765	0.13	98
Biomar	765	0.13	98
Salmofood I	510	0.13	65
Salmofood II	510	0.13	65
Watt	255	0.13	33
Watt II	510	0.13	65
MultiExport I	255	0.13	33
MultiExport II	510	0.13	65
PMGD Planta Curicó	0	0	0
Orafti	0	0	0
Lousiana Pacific	0	0	0
Loma Los Colorados (KDM)	13,264	0.00	0
TOTAL THERMAL POWER PLANTS	**20,824,709**		**13,489, 178**

Table 30. Net generation, emission factor and total emissions in the year 2010 of each power plant in the SIC grid. Sources: 2001-2010 CDEC SIC Operation Statistics Yearbook (pages 30-32, 50-59, 68-71, https://www.cdec- sic.cl/contenido_es.php?categoria_id=4&contenido_id=000034), CDEC-SIC webpage (https://www.cdec- sic.cl/contenido_es.php?categoria_id=6&contenido_id=000044), 2009 National Energy Balance (http://www.cne.cl/estadisticas/balances-energeticos) and 2006 IPCC Guidelines on National GHG Inventories (Volume 2, Chapter 1, table 1.4).

Emission factor in wind farms, hydro and small-hydro power plants is 0 tCO_2/MWh, so they did not produced emissions due to power generation in years 2008, 2009 and 2010.

- **Lambda:**

Lambda (λ_y) expresses the percentage of time when low-cost/must-run power units are on the margin in year *y*. For each year *y* (2008[32], 2009, 2010) it has been determined as follows:

$$\lambda_y(\%) = \frac{Number\ hours\ low-\cos t\ /\ must-run\ on\ the\ m\arg\ in\ year\ y}{8760\ hours\ \ year}$$

The number of hours when low-cost/must-run sources are on the margin in year *y* is the number of hours to the right of the intersection between the load duration curve of that year and the horizontal line under which the area equals the total generation from this type of generating units. The calculation of λ_{2008}, λ_{2009}, and λ_{2010} is shown in the figures below.

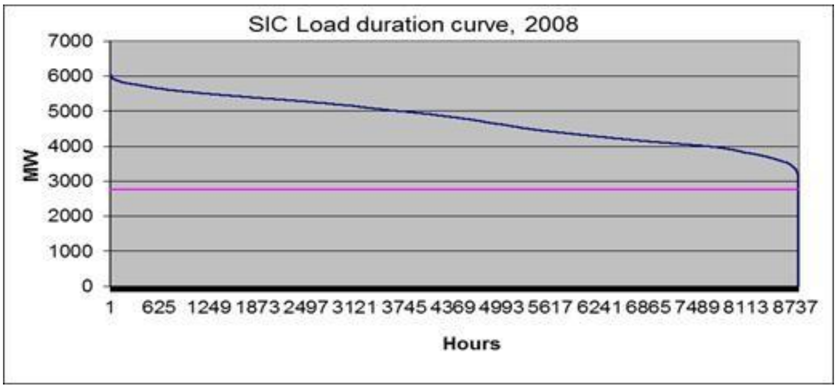

Figure 8. Calculation of λ_{2008} in the duration curve. Sources: CDEC-SIC for hourly generation data (https://www.cdec- sic.cl/est_opera_publica.php#C5) and 2001-2010 CDEC-SIC Operation Statistics Yearbook for Low-Cost/Must-Run generation data (pages 50-59, https://www.cdec- sic.cl/contenido_es.php?categoria_id=4&contenido_id=000034).

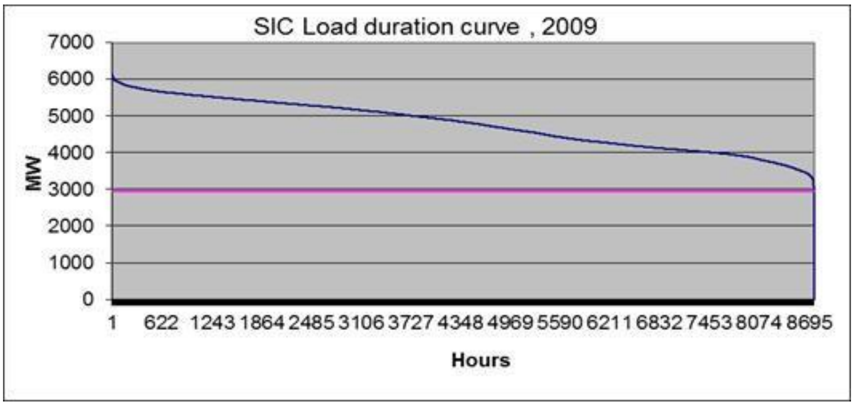

Figure 9. Calculation of λ_{2009} in the duration curve. Sources: CDEC-SIC for hourly generation data (https://www.cdec- sic.cl/est_opera_publica.php#C5) and 2001-2010 CDEC-SIC Operation Statistics Yearbook for Low-Cost/Must-Run generation data (pages 50-59, https://www.cdec-sic.cl/contenido_es.php?categoria_id=4&contenido_id=000034).

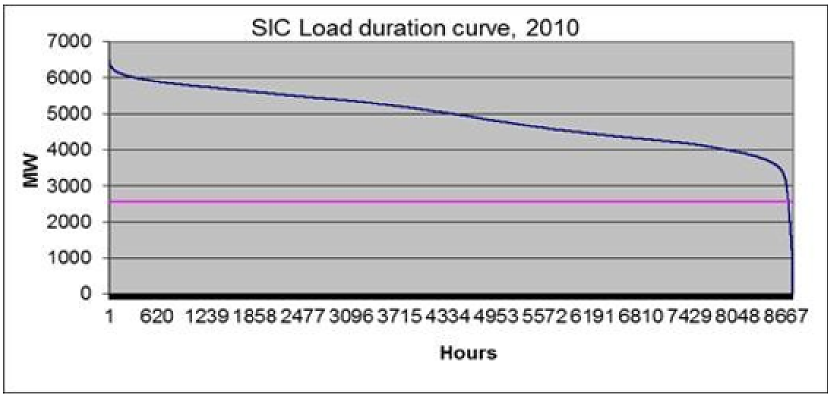

Figure 10. Calculation of λ_{2010} in the duration curve. Sources: CDEC-SIC for hourly generation data (https://www.cdec-sic.cl/est_opera_publica.php#C5) and 2001-2010 CDEC-SIC Operation Statistics Yearbook for Low-Cost/Must-Run generation data (pages 50-59, https://www.cdec-sic.cl/contenido_es.php?categoria_id=4&contenido_id=000034).

The electric power generated by low-cost/must-run units, the number of hours for which these units are marginal and the final value of lambda for each year 2008, 2009 and 2010 are listed in the following table:

Year	Low Cost / Must - Run Total Generation plus Imports (MWh)	MW LCMR	N° hours in margin	λ
2008	24,394,643	2,777	0	0.0000
2009	25,578,048	2,939	1	0.0001
2010	22,415,022	2,570	57	0.0065

Table 31. Values of λ_{2008}, λ_{2009} and λ_{2010}.

- ***Operating Margin:***

Once obtained the values of λ_{2008}, λ_{2009}, and λ_{2010}, it is possible to determine de Simple Adjusted OM Emission Factor for the years 2008, 2009 and 2010:

$$EF_{grid,OM-adj,2008} = (1-\lambda_{2008}) \times \frac{\sum_m EG_{m,2008} \cdot EF_{EL,m,2008}}{\sum_m EG_{m,2008}} + \lambda_{2008} \times \frac{\sum_k EG_{k,2008} EF_{EL,k,2008}}{\sum_k EG_{k,2008}} = 0.798 tCO_2e / MWh$$

$$EF_{grid,OM-adj,2009} = (1-\lambda_{2009}) \times \frac{\sum_m EG_{m,2009} \cdot EF_{EL,m,2009}}{\sum_m EG_{m,2009}} + \lambda_{2009} \times \frac{\sum_k EG_{k,2009} EF_{EL,k,2009}}{\sum_k EG_{k,2009}} = 0.811 tCO_2e / MWh$$

$$EF_{grid,OM-adj,2010} = (1-\lambda_{2010}) \times \frac{\sum_m EG_{m,2010} \cdot EF_{EL,m,2010}}{\sum_m EG_{m,2010}} + \lambda_{2010} \times \frac{\sum_k EG_{k,2010} EF_{EL,k,2010}}{\sum_k EG_{k,2010}} = 0.644\ tCO_2e / MWh$$

The 3-year weighted average Operating Margin is calculated below.

$$EF_{grid,OM-adj} = \frac{\sum_y EF_{grid,OM-adj,y} \cdot EG_y}{\sum_m EG_y} = 0.751\ tCO_2 e / MWh$$

- ***Build Margin:***

The factor $EF_{EL,m,y}$ for each power plant is obtained with the same formula it was obtained in the Operating Margin Emission Factor calculator:

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

As a consequence, the factor $EF_{EL,m,y}$ for each power plant included in the Build Margin is exactly the same it is in the calculation of the Operating Margin Emission Factor.

In the following table the emissions due to the plants included in the Build Margin and their generations in the year 2010 are shown:

Name of power plant	Type of fuel	Commisioning date	Technology	$EG_{m,2010}$ [MWh]	$EF_{EL,m,2010}$ [t_{CO2}/ MWh]	CO_2 emissions [tCO_2]
Los Corrales	Renewable energy plant	2010	Small hydro	255	0.00	0
Doña Hilda	Renewable energy plant	2010	Small hydro	0	0.00	0
Juncalito	Renewable energy plant	2010	Small hydro	9,749	0.00	0
Dongo	Renewable energy plant	2010	Small hydro	0	0.00	0
Guacolda-Unit 4	Coal [Petroleum]	2010	Steam turbine	1,039,034	1.09	1,136,677
Campanario-Unit 4	Natural Gas [Diesel Oil]	2010	Gas turbine	8,580	0.83	7,128
Emelda	Diesel Oil	2010	NA	30,272	0.13	3,887
CBB-Centro	Diesel Oil [Fuel Oil]	2010	NA	5,987	0.13	763
Punta Colorada	Diesel Oil	2010	NA	6,086	0.13	794
Chuyaca-Unit 6	Diesel Oil	2010	NA	877	0.87	766
Colihues-Unit 2	Diesel Oil [Fuel Oil]	2010	NA	4,661	0.13	617
Salvador	Diesel Oil	2010	Gas turbine	10,420	0.03	315
Colihues-Unit 1	Diesel Oil [Fuel Oil]	2010	NA	4,661	0.13	617
Nueva Ventanas	Coal	2010	Steam	1,829,	1.07	1,955,

			turbine	208		169
San Lorenzo-Unit 2	Diesel Oil	2010	NA	155	1.88	292
Escuadrón	Biomass	2008 U1 ; 2009 U2	Steam turbine	73,223	0.00	0
Pehui	Renewable energy plant	2009	Small hydro	351	0.00	0
Trufultruful	Renewable energy plant	2009	Small hydro	3,316	0.00	0
Santa Lidia	Diesel Oil	2009	Gas turbine	49,269	0.86	42,593
Quintero	Petroleum [NGL]	2009	Gas turbine	242,737	0.51	123,625
Los Pinos	Diesel Oil	2009	NA	171,111	0.71	121,865
Tierra Amarilla	Diesel Oil	2009	Gas turbine	1,862	1.32	2,457
Espinos	Diesel Oil	2009	Diesel engine	12,896	0.78	10,052
Trapén	Diesel Oil	2009	NA	41,963	0.70	29,555
Teno	Diesel Oil	2009	NA	57,645	0.71	41,185
El peñón	Diesel Oil	2009	NA	57,049	0.71	40,588
San Lorenzo-Unit 1	Diesel Oil	2009	NA	155	1.88	292
Termopacífico	Diesel Oil	2009	NA	19,187	0.13	2,447
Cenizas	Diesel Oil	2009	NA	24,038	0.14	3,261
Newen	Propane-Butane-Diesel Oil-Natural Gas	2009	Gas turbine	40,295	0.12	4,867
Linares Norte	Diesel Oil	2009	NA	120	0.95	114
San Gregorio	Diesel Oil	2009	NA	120	1.64	197
Tapihue	Natural Gas	2009	NA	0	0	0
Eagon	Diesel Oil	2009	NA	765	0.13	98
Biomar	Diesel Oil	2009	NA	765	0.13	98
Salmofood I	Diesel Oil	2009	NA	510	0.13	65
Salmofood II	Diesel Oil	2009	NA	510	0.13	65
Watt	Diesel Oil	2009	NA	255	0.13	33
Watt II	Diesel Oil	2009	NA	510	0.13	65
MultiExport I	Diesel Oil	2009	NA	255	0.13	33
MultiExport II	Diesel Oil	2009	NA	510	0.13	65
PMGD Planta Curicó	Coal	2009	NA	0	0	0
Orafti	Diesel Oil	2009	NA	0	0	0
Lousiana Pacific	Diesel Oil	2009	NA	0	0	0
San Isidro 2	Natural Gas [Diesel Oil - NGL]	2007-2008	NA	2,880,144	0.31	897,716
Coya	Renewable energy plant	2008	Hydro	83,157	0.00	0
Quellón 2	Diesel Oil	2008	NA	13,285	0.81	10,700
Skretting	Diesel Oil	2008	NA	861	0.71	611
Colmito	Diesel Oil	2008	NA	1,110	0.75	837
Olivos	Diesel Oil	2008	Diesel engine	4,586	0.66	3,016
El Totoral	Diesel Oil	2008	NA	891	0.33	292
Quintay	Diesel Oil	2008	NA	900	0.76	685
Placilla	Diesel Oil	2008	NA	900	0.84	752
Chiloé	Diesel Oil	2008	NA	401	0.00	1
Laja Unit 2	Biomass	2007	Steam turbine	4,274	0.00	0
Constitución Unit 2	Biomass	2007	Steam turbine	4,150	0.00	0
Chiburgo	Renewable energy plant	2007	Hydro	74,899	0.00	0
Palmucho	Renewable energy plant	2007	Hydro	232,351	0.00	0
El Rincón	Renewable energy plant	2007	Small hydro	2,437	0.00	0
Eyzaguirre	Renewable energy plant	2007	Small hydro	6,673	0.00	0
Degañ	Diesel Oil	2007	NA	40,793	0.71	28,959
Cañete	Diesel Oil	2007	NA	957	0.66	630
Los Sauces	Diesel Oil	2007	NA	957	0.83	795
Chufken (Traiguen)	Diesel Oil	2007	NA	957	0.80	765

Curacautín	Diesel Oil	2007	NA	941	1.27	1,199
Malleco (Collipulli)	Diesel Oil	2007	NA	957	0.49	469
Los Vientos TG	Diesel Oil	2007	Gas turbine	48,934	0.95	46,417
Esperanza	Diesel Oil	2007	Gas turbine	1,854	0.76	1,412
Las Vegas	Diesel Oil	2007	NA	600	0.76	454
Concón	Diesel Oil	2007	NA	658	0.91	597
Curauma	Diesel Oil	2007	NA	600	0.89	532
Casablanca	Diesel Oil	2007	NA	360	0.50	181
Constitución 1	Diesel Oil	2007	NA	401	3.56	1,427
Monte Patria	Diesel Oil	2007	NA	401	0.30	120
Punitaqui	Diesel Oil	2007	NA	401	0.71	286
Maule	Diesel Oil	2007	NA	267	1.55	414
Nueva Aldea II	Diesel Oil	2006	Gas turbine	0	0	0
Quellón	Diesel Oil	2006	NA	1591.09575	0.00	2
Ancud	Diesel Oil	2006	NA	834	29.39	24,519
Nueva Aldea I	Biomass	2005	Steam turbine	94,210	0.00	0
Coronel	Natural Gas [Diesel Oil]	2005	Gas turbine	92,610	0.59	55,006
Candelaria	Natural Gas [Diesel Oil]	2005	Gas turbine	182,310	0.49	88,885
Antilhue TG	Diesel Oil	2005	Gas turbine	71,382	0.86	61,396
Ralco	Renewable energy plant	2004	Hydro	2,198,391	0.00	0
TOTAL	[redacted]	[redacted]	[redacted]	**9,801,749**	[redacted]	**4,759,718**

Table 32. Net generation and emissions in 2010 of all the plants included in the Build Margin. Sources: 2001-2010 CDEC SIC Operation Statistics Yearbook (pages 30-32, 50-59, 68-71, https://www.cdec-sic.cl/contenido_es.php?categoria_id=4&contenido_id=000034), CDEC-SIC webpage (https://www.cdec-sic.cl/contenido_es.php?categoria_id=6&contenido_id=000044), 2009 National Energy Balance (http://www.cne.cl/estadisticas/balances-energeticos) and 2006 IPCC Guidelines on National GHG Inventories (Volume 2, Chapter 1, table 1.4).

Then, multiplying the factor $EF_{EL,m,y}$ by the corresponding electric generation, and dividing by the generation sum, the Build Margin is obtained:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \cdot EF_{EL,m,y}}{\sum_m EG_{m,y}} = 0.486 \text{ tCO}_2\text{/MWh}$$

- ***Emission Factor:***

Therefore, the emission factor is calculated as follows:

$$EF_{grid,CM} = EF_{grid,OM} \times w_{OM} + EF_{grid,BM} \times w_{BM} = 0.751 \times 0.75 + 0.486 \times 0.25 = 0.685 tCO_2 / MWh$$

The weights for the BM and OM emission factors are the indicated ones in the tool for wind farms.

The corresponding emissions reductions estimations would be:

	01/11/2014 - 31/12/2014	2015	2016	2017	2018	2019	2020	01/01/2021-31/10/2021
Net generation after transmission losses (M Wh)	74,496	446,975	446,975	446,975	446,975	446,975	446,975	372,479
Emission factor (tCO_2/M Wh)	0.685	0.685	0.685	0.685	0.685	0.685	0.685	0.685
Emission reductions (tCO_2)	50,993	305,956	305,956	305,956	305,956	305,956	305,956	254,963
Accumulative emission reductions (tCO_2)	50,993	356,949	662,905	968,861	1,274,816	1,580,772	1,886,728	2,141,692

Table 33. Emission reduction estimations.

Total cumulative reductions in the first crediting period will be: **2,141,692 tCO_2**.

Appendix 5. Further background information on monitoring plan

Staff training

Specific training will be provided for personnel directly involved in operation and maintenance and the monitoring of main parameters of the project activity. The content of the training will include daily operation and maintenance of power equipment, operation of monitoring system, emergency preparedness and management of data following operating manual. Also, a general knowledge of CDM, wind turbines technology and low voltage installations will be taught. Training is aimed to enable the employees to be fully aware of the importance of monitoring and personal responsibilities.

Failure or emergency procedure

The readings of the main meter will be preferred for calculation of the emissions reductions. In case of failure of the main meter, a repair action will be quickly started. Nevertheless, while failure and repair of the main are achieved, backup meter will be used for monitoring parameters.

In eventual cases of damage of both meters or when erroneous readings will be detected in both meters thanks to the cross-check with bills, the CDM Project Office Director should formulate a reasonable and conservative estimation of the energy production and energy consumption, based on the historical or the nearest month of energy production or consumption data. A reliable source of information for these cases will be the project SCADA registered and stored data. In failure cases, the date and hour of the beginning and end of dysfunction of the metres will be carefully registered, and these data will be reported to the DOE for their verification.

The project developer will be responsible of the repair, change or recalibration of the metres.

Appendix 6. Summary report of comments received from local stakeholders

No applicable

Appendix 7. Summary of post-registration changes

Change Observed:
The PP changed the configuration of the power plant so that the total nominal installed capacity regarding the aerogenerators is 175.5 MW instead of 170.

Project design change requested:
The approval of the new configuration with new installed capacity.

Justifications of Change Requested:
The real capacity of the power plant is limited to 170 MW since the transformer has a maximum capacity of 170 MW so that the project activity energy injection is limited to this value. The first phase was carried out as it was initially designed. Thus, a capacity of 115.5 MW was installed and the rest of the capacity (54.5 MW) to reach the designed 170 MW was postponed to a second phase. Due to technological developments, the initial configuration had to be adjusted, so that in phase two, which is still in the process of coming into operation, the capacity was slightly increased to 60 MW.

The requested design change is defined within the scope of the methodology applied.
In addition, the financial analysis was updated to include this new configuration and it is demonstrated that the project remains additional.
In addition, the scale of the project is not impacted by the change of the configuration.
Finally, the mentioned change in this plant do not significantly affect the estimated emissions reductions calculations.

Summary on Impact of the changes:

a. Applicability of the methodology:
As stated before, electricity generation is considered in the methodology as part of emissions reduction sources in the baseline scenario, when fossil fuel is displaced in the project activity by biogas produced from the biodigesters. This is further explained in Section B.6.1. Explanation of methodological choices.

b. Compliance of the Monitoring Plan
Slightly changing the configuration of the power plant will not affect the monitoring plan as direct measurements of electricity generation are already measured.

c. Level of accuracy and completeness compared with the requirement in the registered monitoring plan
The level of accuracy and completeness will remain unchanged since no additional parameter are required and there no changes in the monitoring plan.

d. Additionality of the project activity
The financial analysis and the common practice analysis were updated to include the new configuration. The project activity remains additional.

e. Scale of the project activity
Scale of the project will not be affected due to the addition of an extra aerogenerator, as a large scale methodology will be also applicable.

Changes to the start date of the crediting period
The start date of crediting period was changed from 01 November 2014 - 31 October 16 to 12 June 2018 - 11 June 2025.

(a) Demonstrate that the project activity remains additional;

A new additionally analysis was carried out in Section B.5 concluding that the project remains additional. According to the “Tool for the demonstration and assessment of additionality” (version 07.0.0), after the sensitivity analysis it was concluded that the proposed CDM project activity is unlikely to be the most financially/economically attractive, so the next step to be followed was the Common practice analysis. Conditions for being considered as common practice were not fulfilled and therefore the project activity was not regarded as common practice, then the proposed project activity is additional.

(b) Demonstrate that the original baseline scenario established in the registered PDD remains valid, or update the baseline scenario using the latest data, as appropriate;

In Section B.4 it was demonstrated that the original baseline is still valid. The baseline continues being the same of the original validation since no changes has been identified. Thus, The baseline scenario is defined by the methodology ACM0002 as the “electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin (CM) calculations described in the “Tool to calculate the emission factor for an electricity system”.

(c) demonstrate that substantive progress has been made by the project participants to start the project activity.

The project faced some issues regarding the financing of the construction phase. The project developer had some difficulties to sign a PPA and even if they tried to get the required financing, they did not get it. Nevertheless, they get the PPA in October 2015, so they could and started the construction of the first phase of the power plant, that started selling energy to the grid on the 12th of June 2018. Main milestones that demonstrate that substantive progress has been made by the project participants to start the project activity are shown in the following table:

Proposal for the Supply and Maintenance of Wind Turbine Generators Cabo Leones I Wind Farm – not accepted because the project did not have access to financing	24th December 2014
Cabo Leones Wind Farms wins a PPA in the Chilean public tender	October 2015
Signature of the PPA	2nd November 2015
Turbine supply, installation and guarantee agreement with Gamesa	11th August 2016
Signature of the EPC for the 1st phase of the project	23rd September 2016
Starting date of commercial operation (**starting date of the crediting period**)	12th June 2018

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Document information

Version	*Date*	*Description*
12.0	8 October 2021	Revision to: Improve consistency with version 03.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN).
11.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Make editorial improvements.
10.1	28 June 2017	Revision to make editorial improvement.
10.0	7 June 2017	Revision to: • Improve consistency with the “CDM project standard for project activities” and with the PoA-DD and CPA-DD forms; • Make editorial improvement.
09.0	24 May 2017	Revision to: • Ensure consistency with the “CDM project standard for project activities” (CDM-EB93-A04-STAN) (version 01.0); • Incorporate the “Project design document form for small-scale CDM project activities” (CDM-SSC-PDD-FORM); • Make editorial improvement.
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the “Standard: Applicability of sectoral scopes” (CDM-EB88-A04-STAN) (version 01.0).
06.0	9 March 2015	Revision to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Make editorial improvement.

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

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