Project design document form for CDM project activities

(Version 05.0)

Complete this form in accordance with the Attachment "Instructions for filling out the project design document form for CDM project activities" at the end of this form.

PROJECT DESIGN DOCUMENT (PDD)	
Title of the project activity	Chile: Quilleco Hydroelectric Project
Version number of the PDD	8
Completion date of the PDD	22/03/2016
Project participant(s)	Colbun S.A.; Netherlands' Ministry of Infrastructure and the Environment (IenM)[1]; International Bank for Reconstruction and Development (IBRD) as Trustee of the Netherlands CDM Facility (NCDMF)[2]; Electrabel NV/SA; Idemitsu Kosan Co., Ltd.; Japan Petroleum Exploration Co., Ltd; The Okinawa Electric Power Co., Inc.; Sumitomo Joint Electric Power Co., Ltd.; Suntory Holdings Limited; Tokyo Electric Power Company, Incorporated; Sumitomo Chemical; Italian Ministry for the Environment Land and Sea; International Bank for Reconstruction and Development (IBRD) as Trustee of the Bio Carbon Fund (BioCF); Ministry of Sustainable Development and Infrastructure; Kingdom of Spain-Ministry of the Agriculture, Food and Environment & Ministry of Economy and Competitiveness.
Host Party	Chile
Sectoral scope and selected methodology(ies), and where applicable, selected standardized baseline(s)	Sectoral Scope 1: Energy industries (renewable / non-renewable sources). AM0026 (version 3.0): Methodology for zero-emissions grid-connected electricity generation from renewable sources in Chile or in countries with merit order based dispatch grid.
Estimated amount of annual average GHG emission reductions	296,882 tCO_2e

[1] Withdrawn on 19/08/2014

[2] Withdrawn on 02/09/2014

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>> Quilleco Hydroelectric Project consists of a run-of-river power plant of 70 MW effective installed capacity[3] (turbines nameplate installed capacity is 71.76 MW) that utilizes the water discharged by the Rucúe hydropower plant (130 m^3/sec). The project generates approximately 422 GWh per year and injects 47 MW of firm power to the SIC electric grid (Central Interconnected System by its Spanish acronym). The estimates are based on long-term observations of water conditions of the Laja River. The estimate annual average GHG emissions reductions for this crediting period correspond to 296,882 tonCO_2e/year and 2,078,174 tonCO_2e for the total period.

The project's construction time was approximately 30 months. The project Feasibility Study can be found in the project file.

The project developer and operator is Colbún S.A., the second largest electric holding company in Chile, with a total installed capacity of 3,278 MW, from which 48% are hydraulic power units. In the third quarter of 2005 Colbún acquired Cenelca S.A. and Hidroelectrica Guardia Vieja S.A. (HGV). The latest company was one the first private companies worldwide to submit hydroelectric projects under the Kyoto Protocol CDM, this is the case of the Chacabuquito 26 MW power plant, operating since 01/07/2002.

HGV still operates as a subsidiary of Colbún and will be acting as the project sponsor, representing Colbún S.A. for all CDM activities.

Quilleco uses well-proven technologies for run-of-river power generation. The project design considers 4.4 km of concrete channels, a 3.2 km aqueduct tunnel, 105 m pressure penstock of 59.4 m height, a power house with two sets of 35.88 MW vertical Francis turbines/generators, 13.8/220 kV power transformer and 300 m of a 220 kV double circuit line connected to the existing 220 kV double circuit transmission line to the high voltage Charrúa substation in the Central Interconnected System (SIC).

This project contributes to the sustainable development in Chile through:

- Use of local renewable energy resources (small hydro) to displace coal and natural gas thermal power generation in the SIC.
- Increased commercial activity through clean and renewable source of power.
- Employment generation in the 8th Region where the project is located, improving economic benefits it the surrounding communities such as Tucapel, Antuco and Quilleco.

The Project's local environmental and socio-economic benefits are summarized in Table 1.

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[3] The effective installed capacity reflects the power which is actually delivered to the grid at the connection point by the project activity, while the turbines nameplate reflects the nominal capacity of the turbine before converting the mechanical power to electricity through the power generator and the high voltage transformer.

Table 1. Domestic and Local Benefits

Area	Description
Local environmental benefits	• The project contributes with clean energy to the Central Interconnected System of Chile, contributing to national development.
Socio-economic benefits	• The project allows the 8th Region of Chile to exploit its significant economic potential. • A total of 579 local jobs were created during the construction phase of Quilleco, positively impacting the surrounding communities of Antuco, Quilleco, Tucapel, Los Angeles and Huepil, which have a high level of rural population, poverty and unemployment compared to national average. • Economic activity impulse during the construction period and also during all of its lifetime
Capacity building	• Extensive pre-negotiations consultations were carried out and a Post-negotiation workshop communicating the lessons learned from the project design and implementation.
Technology transfer	• Introduction and demonstration of environmentally friendly power production techniques for the 8th Region is an explicit objective of the project. • The demonstration that emission reductions obtained from renewable energy can earn additional income and the introduction of CDM know-how raised environmental awareness
Environmental Impact Assessment (EIA)	• A full EIA was carried out in accordance with Chilean law 19.300 which was approved by CONAMA in 26/12/2000. • Colbún S.A. set up an Environmental Project Committee in charge of the management and coordination of the environmental aspects of Quilleco Hydroelectric Project in accordance with procedures of the ISO 14001 certified Environmental Management System of Colbún S.A. Environmental impacts of Quilleco Hydroelectric Project were well defined and were adequately assessed by environmental and sector authorities. • World Bank safeguard policies were applied as part of the detailed project design; the WB - Project Appraisal Document (PAD) was completed and approved on April 2006. Typically, small scale run-of river hydropower projects have very limited environmental impacts.

A.2. Location of project activity

A.2.1. Host Party

>>Chile

A.2.2. Region/State/Province etc.

>>8th Region of Bio-Bio

A.2.3. City/Town/Community etc.

>>Los Ángeles, Quilleco Comunne.

A.2.4. Physical/Geographical location

>> Quilleco Hydroelectric Project is located in the 8th region of Bio-Bio of Chile, at about 35 km east from Los Angeles city and 500 km south from Santiago. All project facilities are sited on the south bank of a branch of the Laja River, 8 km downstream of existing Rucúe power plant, receiving the waters from this plant in hydraulic series.
The road from Los Angeles to Antuco is the main road in the entire area. Secondary and rural roads connect the communes of Quilleco and Tucapel.

Table 2. Project coordinates

	Latitude	Longitude
Power house	37°20'10"S	71°56'59"W
Intake	37°21'26"S	71°52'39"W

The location of the project activity is illustrated in Figure 1.

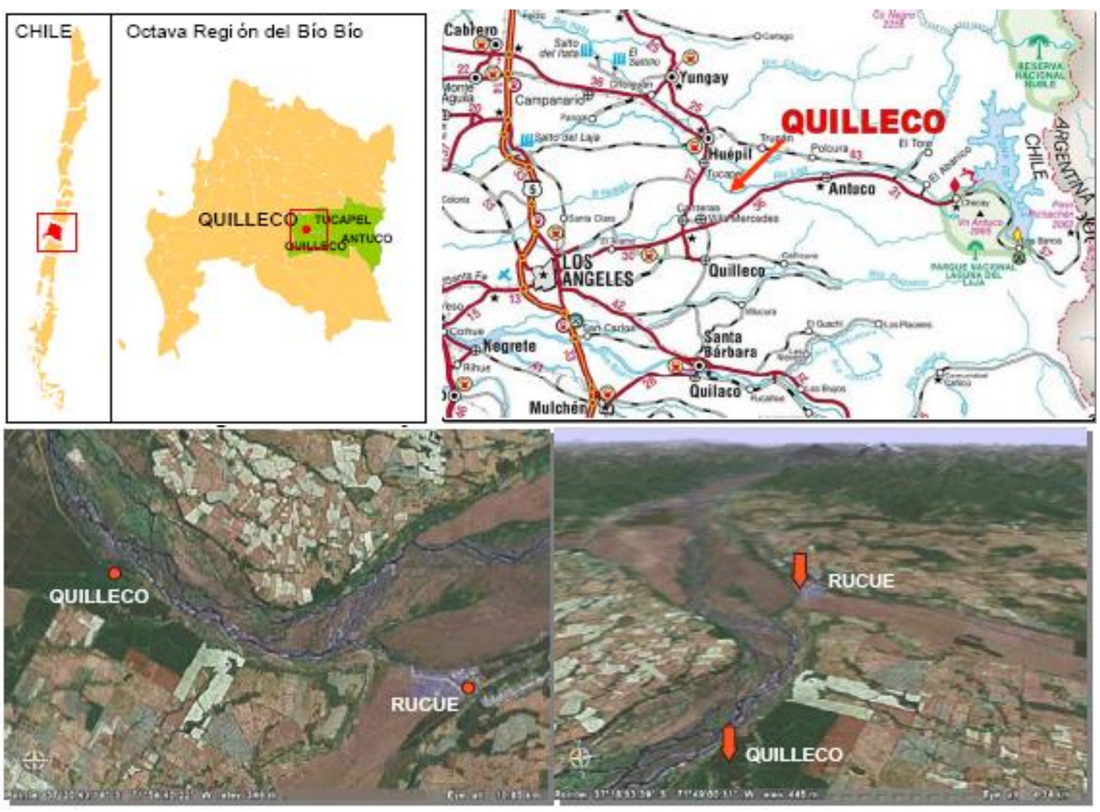

Figure 1. Project Location, Geographic Position

A.3. Technologies and/or measures

>>The technical design of the Quilleco Hydroelectric Project uses a simple layout and technologies well proven in Chile and worldwide and used in other Colbún operating power units. Table 3 below shows a brief description of the project technology.

Table 3. Project details

PHYSICAL INFRASTRUCTURE	POWER PLANT
• 4.4 km of open channel • 3.2 km aqueduct tunnel • 59.4 m pressure penstock • 2 sets of vertical Francis turbines and generators. The technical lifetime of the turbines and generators corresponds to 40 years[4]. • 0.5 km 220 KV transmission line • Design flow: 130 m^3/s	• Effective installed capacity: 70 MW • Turbines nameplate installed capacity: 71.76 MW • Average Net Generation: 422 GWh/year • Located 35 km east from Los Angeles city and 500 km south from Santiago • Construction time: 30 months • Estimated cost: US$ 79.6 million including 5% contingencies and VAT

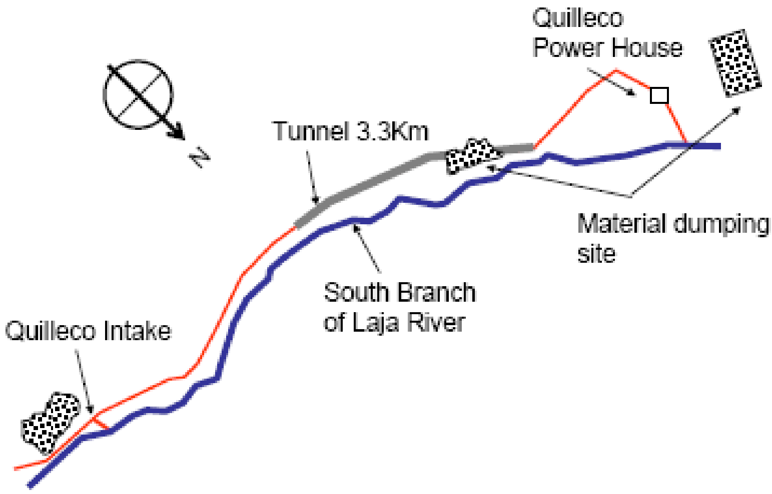

Figure 2. Project Design

[4] Information stated Hydroelectric Power. A Guide for Developers and Investors. International Finance Corporation (IFC), specifically in page 71, Table 11-1. This document has been provided to the DOE.

A.4. Parties and project participants

Party involved (host) indicates host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Chile (Host)	Colbun S.A. (Private entity)	No
Netherlands	Netherlands' Ministry of Infrastructure and the Environment (IenM) [5] (Public Entity); International Bank for Reconstruction and Development (IBRD) as Trustee of the Netherlands CDM Facility (NCDMF)[6] (Public Entity).	No
United Kingdom of Great Britain and Northern Ireland	Electrabel NV/SA (Private entity)	No
Japan	Idemitsu Kosan Co., Ltd. (Private Entity); Japan Petroleum Exploration Co., Ltd. (Private Entity); The Okinawa Electric Power Co., Inc. (Private Entity); Sumitomo Joint Electric Power Co., Ltd. (Private Entity); Suntory Holdings Limited (Private Entity); Tokyo Electric Power Company, Incorporated (Private Entity); Sumitomo Chemical (Private Entity).	No
Italy	Italian Ministry for the Environment Land and Sea (Public Entity); International Bank for Reconstruction and Development (IBRD) as Trustee of the Bio Carbon Fund (BioCF) (Public Entity).	Yes
Luxembourg	Ministry of Sustainable Development and Infrastructure (Public Entity).	Yes
Spain	Kingdom of Spain- Ministry of the Agriculture, Food and Environment & Ministry of Economy and Competitiveness (Public Entity).	Yes

[5] Withdrawn on 19/08/2014

[6] Withdrawn on 02/09/2014

A.5. Public funding of project activity

>>No public funding is involved in the project activity. The fund used to financing is not diversion of ODA.

SECTION B. Application of selected approved baseline and monitoring methodology and standardized baseline

B.1. Reference of methodology and standardized baseline

>>AM0026: Methodology for zero-emissions grid-connected electricity generation from renewable sources in Chile or in countries with merit order based dispatch grid (Version 3.0).
https://cdm.unfccc.int/methodologies/DB/OOI7OYUFZOXN07H7EDBA9GVHJ4GK20

The methodology also refers to the following methodological tools which have been applied:

Tool to calculate the emission factor for an electricity system (version 4.0)
https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v4.0.pdf

Tool for the demonstration and assessment of additionality (version 3.0)
https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v3.pdf

Since this PDD is submitted for the renewal of the project activity crediting period, the following tool was also applied:

“Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period” (version 3.0.1)
http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-11-v3.0.1.pdf

B.2. Applicability of methodology and standardized baseline

>>The project participant selected the approved baseline methodology AM0026 “Methodology for zero-emissions grid-connected electricity generation from renewable sources in Chile or in countries with merit order based dispatch grid” version 3.0 to develop the project activity design document

According to the methodology, the following conditions apply:

Applicability condition	Fulfilment of applicability condition
1) Projects that are renewable electricity generation projects of the following types: (a) Run-of-river hydro power plants and hydro electric power projects with existing reservoirs where the volume of the reservoir is not increased; (b) New hydro electric power projects with reservoirs having power densities (installed power generation capacity divided by the surface area at the full reservoir level) greater than 4 W/m^2. (c) Wind sources; (d) Solar sources; (e) Geothermal sources; (f) Wave and tidal sources.	The project is a run-off-river hydro power plant.
2) Projects that are connected to the interconnected grids of the Republic of Chile and Projects that fulfils all the legal obligations	The project activity is connected to the central

Applicability condition	Fulfilment of applicability condition
under the Chilean Electricity Regulation; or Proposed projects implemented in countries other than Chile provided the country has a regulatory framework for electricity generation and dispatch that meets the following conditions: (a) An identifiable independent identity is responsible for optimal operation of the system based on the principle of (b) The data for merit order based on marginal costs is publicly made available by the authority responsible for operation of the system. (c) The data on specific fuel consumption for each generation source in the system is publicly available. (d) It is possible with the information available, to ensure that power plants dispatched for other considerations (e.g. safety conditions, grid stability, transmission constraints, and other electrical reasons) are not identified as marginal plants.	grid of Chile (SIC grid) and fulfils all the legal obligations of the Chilean Electricity Regulation
The methodology is not applicable to: 1) The proposed CDM project activities that involve switching from fossil fuels to renewable energy at the site of the project activity, and 2) if the baseline is the continued use of fossil fuels at the site.	The project does not consider switching from fossil fuels to renewable energy nor its baseline is the continued use of fossil fuels at the site.

The project meets every condition stated in the approved methodology.

B.3. Project boundary

The methodology only claims emissions reductions from the substitution of power generation due to the implementation of a CDM activity in one of the grids. Only CO_2 derived from the combustion of the thermal plants is accounted.

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	SIC Thermal Dispatch	CO_2	Yes	Emission due to thermal power plant dispatch
		CH_4	No	
		N_2O	No	
Project scenario	SIC Thermal Dispatch	CO_2	Yes	
		CH_4	No	
		N_2O	No	

Below is presented a flow diagram of the project boundary.

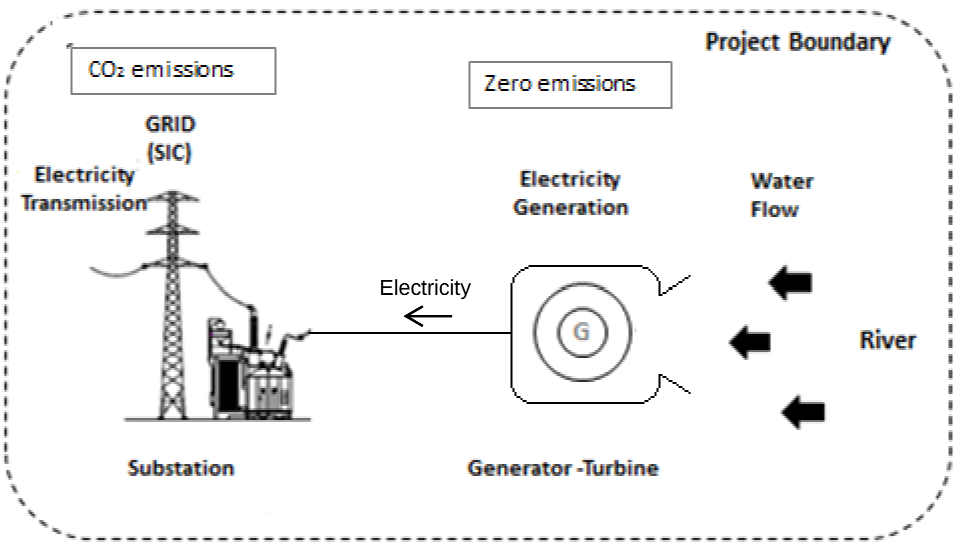

Figure 3. Flow Diagram of the project activity

B.4. Establishment and description of baseline scenario

>>**Identification of the Baseline Scenario**

According to the CDM methodology AM0026 v.3.0, for project activities that do not modify or retrofit an existing electricity generation facility, the baseline scenario is defined as the electricity delivered to the grid 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 reflected in the combined margin (CM) calculated as per the methodology.

In a centrally planned system, such as Chile, the baseline scenario can be determined on the basis of the least cost expansion and operation of the electric grid as defined by the planning authority. In Chile there is no central planning for expansion of power facilities. However, the National Energy Commission (CNE) prepares an indicative expansion plan, which is used to calculate system energy and power node prices. This calculation is based on the most plausible scenario for least cost capacity additions on the grid. However, sector investments come from private investors who are free to choose the projects they want to develop and base their decisions regarding investments and operation of plants on their own perception of the market, where the CNE node price determination is a key factor.

Consequently, the baseline for the purpose of estimating emission reductions prior to their actual generation, should be determined as the most likely scenario of capacity additions and generation private investors and plant operators would choose on the basis of demand projections, node and spot prices, investment costs, available technology for capacity expansions and expected price of fuels. Thus, the baseline scenario consists of the current power plants in the relevant system grid for Quilleco Hydroelectric Project boundary (which is the Central Interconnected System or SIC in Spanish) plus the projected capacity expansion and including the generation pattern in the SIC as it occurs in the absence of the generation of this CDM project.

Description of the identified Baseline Scenario

The baseline scenario for the Project is the continuing operation of the existing and future power plants, without Quilleco electricity generation, to meet the actual electricity demand. In the project scenario the same electricity demand is met with Quilleco generation dispatched in the base load displacing the generation from existing power plants and future power developments. Because the project uses renewable sources to produce electricity, there are no additional emissions from the project activity and the emissions reductions are generated by the displaced generation from the Central Interconnected System. Chile has four different grids and there are no interconnections between them. Therefore, each grid defines the geographical and system boundaries for proposed projects located within it (see map below).

The Northern Interconnected Grid (SING) compromises the regions 1 to 3 and accounts 34 percent of the total capacity. The Central Interconnected Grid (SIC), where Quilleco Hydroelectric Project is immersed, compromises the regions 3 to 10 and accounts 64 percent of the total capacity. The Aysen and Magallanes grids are located in the 11 and 12 regions, respectively, and accounts less than one percent of the total capacity.

The relevant system grid for Quilleco Hydroelectric Project boundary is the SIC, which its generation mix capacity comprises of 60% hydroelectric generation, 30% combine cycle gas turbines (fired with natural gas most of the time, but also diesel recently), and the remainder from coal, diesel, petcoke, and cogeneration. At present there are no electricity imports or exports of the SIC grid to other national or international grid, however future system expansion may include interconnection to the SING grid or Argentina grid (SADI).

Chile Electric Grids **Central Interconnected System – SIC**

Figure 4. Project boundary

Revalidation of the baseline of the project activity

According to the CDM project standard version 7.0, the validity of the original baseline or its update should be assessed as per the tool "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" (version 03.0.1).

The tool provides a stepwise procedure to assess the continued validity of the baseline and to update the baseline at the renewal of a crediting period. The tool consists of two steps:

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

The validity of the current baseline is assessed using the following Sub-steps:

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

According to the tool "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" (version 03.0.1)", "if the current baseline complies with all relevant mandatory national and/or sectoral policies which have come into effect after the submission of the project activity for validation or the submission of the previous request for renewal of the crediting period and are applicable at the time of requesting renewal of the crediting period, go to Step 1.2".

There are no new national and/or sectoral policies that have come into effect after the submission of the project for the first validation that are applicable to the project activity.

According to the registered PDD, the original baseline is "the continuing operation of the existing and future power plants, without Quilleco electricity generation, to meet the actual electricity demand".

The original baseline complies with all the current relevant mandatory national and sectoral policies.

Step 1.2: Assess the impact of circumstances

According to the tool, “in the situation where the baseline scenario identified at the validation of the project activity was the continuation of the current practice without any investment, an assessment of the changes in market characteristics is required for the renewal of the crediting period”.

Currently, the market characteristics for the electricity sector are still the same than described in the original baseline scenario. In fact, the planning authority (CNE) is still the same as originally described and the private sector is still the responsible actor in electricity generation, distribution and transmission market. There have not been relevant changes to the original circumstances in the market that could affect the applicability of the original baseline scenario.

The conditions used to determine the baseline emissions in the previous crediting period are still valid, as baseline emissions depend on the grid connected power plants operation.

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

According to the tool, “this sub-step should only be applied if the baseline scenario identified at the validation of the project activity was the continuation of use of the current equipment(s) without any investment and, the projects proponents or third party (or parties) would undertake an investment later due, for example, to the end of the technical lifetime of the equipment(s) before the end of the crediting period or the availability of a new technology”.

The tool also clarifies that it should be assessed “whether the remaining technical lifetime of the equipment that would have continued to be used in the absence of the project activity, as determined in the CDM-PDD, exceeds the crediting period for which renewal is requested”.

Since the baseline scenario identified at the validation of the project has not been modified and the baseline didn’t consider the use of any existing equipment by the project participant, because in the absence of the project activity the energy generated would have been generated by the operation of grid-connected power plants and by the addition of new generation sources to the SIC grid,, this sub-step does not apply.

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

According to the tool, in this step it should be assessed “whether data and parameters that were only determined at the start of the crediting period and not monitored during the crediting period are still valid or whether they should be updated”.
As the emission factor of the grid was estimated ex-post for the first monitoring period (in accordance with the methodology ACM0026 v.2), there were no fixed values over the past crediting period except for the weight for operating margin emission factor and build margin emission factor, which corresponded to 0.5 for each value.

During the second and third crediting period the weight for operating margin emission factor and build margin emission factor is fixed in 0.25 and 0.75 respectively, in accordance to the description provided in the “Tool to calculate the emission factor” v.4 (as required in the updated applicable methodology ACM0026 v.3.0).

Since some data and parameters were only determined at the beginning of the crediting period (and not monitored during it), they are not valid anymore, so the current baseline needs to be updated for the subsequent crediting period.

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

Step 2.1: Update the current baseline

According to the tool, in this step it should be updated "the current baseline emissions for the subsequent crediting period, without reassessing the baseline scenario, based on the latest approved version of the methodology applicable to the project activity. The procedure should be applied in the context of the sectoral policies and circumstances that are applicable at the time of request for renewal of the crediting period"

Since the original baseline is still in compliance with the current relevant mandatory national and/or sectoral policies of Chile and there are no new circumstances which may impact the validity of the project activity baseline, this step is not applied.

Step 2.2: Update the data and parameters

According to the tool "if the application of Step 1.4 showed that the data and/or parameters that were only determined at the start of the crediting period and not monitored during the crediting period are not valid anymore, project participants should update all applicable data and parameters, following the guidance in Step 1.4."

Specifically, as mentioned in Step 1.4, data of the weight for operating margin and build emission factor has been updated. This information can be reviewed in section B.6.2 of the PDD.

B.5. Demonstration of additionality

>> **How the anthropogenic GHG emissions are to be reduced**

The project activity is a grid connected run-of-river hydropower project. It does not involve switching from fossil fuels and the grid's geography and system boundaries are explicit and characteristics are readily available through CNE and CDEC-SIC.

The Project activity will reduce emissions by displacing electric energy generated from fuel-based power plants. The electric energy generated by the project is produced using renewable energy with zero emission to the atmosphere associated with its operations.

The following steps are used to demonstrate Quilleco's additionality. These are based on the latest Tool for the demonstration and assessment of additionality (version 3).

Step 1) Identification of alternatives to the project activity, based on the Chilean national authority indicative expansion plan; this step shows that Quilleco Hydroelectric Project is not the only alternative for the expansion of the system and nor the least cost alternative, which are combined cycle natural gas fired power plants and hydro dams (non run-of-river). Step 2) Investment analysis shows that the project is not the most financially attractive scenario. The analysis is based on the Chilean official optimization model (OSE2000), conducting a cost analysis in the system with and without the project activity, as indicated on AM0026 (v.2) sub-steps i), ii), and iii). Finally, Step 4) With a common practice analysis, other projects similar to Quilleco were searched for, showing that there are no similar

activities observed in the SIC, with the exception of those projects that have been submitted under, or are seeking, carbon finance under the CDM.

The step 3) Barrier analysis has been intentionally omitted to simplify the additionality assessment, even though Quilleco does face several identifiable barriers, as many hydro power projects in the Chilean system do.

Additionality Assessment

- ***Step 1. Identification of alternatives to the project activity consistent with current laws and regulation.***

  The CNE establishes for every node price report the optimal expansion plan of the SIC, and uses it to calculate the regulated prices (Node Prices). The expansion plan consists of successive iterations of comparing different options of system expansion that minimizes the net present cost of the energy supply, which includes the sum of the net present value of investments, operation and maintenance, and shortage cost for a period of ten years (see the Formula below). Therefore, the model picks the technologies and projects that minimize the objective formula, assuring the minimum economic cost for the expansion and operation of the system.

  $$Min\ \{\Sigma Investment + Op\ \&\ MantCosts + VariablesCosts - ResidualValue\ \}$$

  The effective CNE Node Price Report at the time the project was considered as an investment option is the April 2004 report, and thus, the one that impacted on the investment decision. It is then the relevant report to test the additionality of Quilleco Hydroelectric Project. The following table shows the expansion plan from that report (www.cne.cl).

Table 4. CNE Indicative Expansion Plan for the SIC – April 2004

Month	Year	Project	Capacity
April	2006	Exp. Coya and Pangal Hydro Power Plants (Run of River)	25
October	2007	V Region Hydro Power Plant (Run of River)	65
October	2007	Combined Cycle Natural Gas Plant # 1 (VIII Region)	385.1
January	2008	La Higuera Hydro Power Plant (Run of River)	155
April	2008	Combined Cycle Natural Gas Plant # 2 (VIII Region)	385.1
April	2009	Calabozo Geothermal Plant Stage 1	100
April	2009	Combined Cycle Natural Gas Plant # 3 (VIII Region)	381
January	2010	Confluencia Hydro Power Plant (Run of River)	155
April	2010	Calabozo Geothermal Plant Stage 2	100
January	2011	Combined Cycle Natural Gas Plant # 4 (VIII Region)	381
April	2011	Neltume Hydro Power Plant (Reservoir)	400
April	2011	Calabozo Geothermal Plant Stage 3	100
January	2013	Combined Cycle Natural Gas Plant # 5 (VIII Region)	379.4
October	2013	Combined Cycle Natural Gas Plant # 6 (VIII Region)	379.4

Source: Node Price Report April 2004 www.cne.cl

As shown above, the least cost alternative for the expansion of the SIC are combined cycle natural gas fired power plants and hydro dam called Neltume (400 MW, 2011). The rest of the projects are renewable energy CDM projects such as Hornitos in the fifth region, La Higuera and Calabozo geothermal Plant. The 25 MW indicated in Coya and Pangal hydro power plants

corresponds to a capacity expansion project based on the renewal of hydro turbines operating since 1911 and 1921 respectively.

- ***Step 2. Investment analysis / Substep 2b Option II. Investment comparison analysis***

<u>Macro analysis:</u>

The Official Expansion Plan elaborated by the CNE is the primary source to test the additionality.

The methodology requires an extra test to confirm additionality. This test consists of running the expansion model again with the same information from the CNE but adding the project official data (hydrological data, construction cost and operation and maintenance cost), and comparing both results. The outcome of this comparison is shown below, annually and in net present value:

Table 5. Projected Investment and costs

In million USD	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Baseline Scenario										
Generation	197.1	227.8	277.6	337.6	363.2	405.5	498.0	578.1	723.6	774.2
Unserved Energy	2.1	9.7	10.5	21.6	9.7	11.3	13.2	12.8	38.4	41.0
TOTAL	**199.3**	**237.6**	**288.0**	**359.2**	**372.9**	**416.8**	**511.2**	**590.9**	**762.1**	**815.2**
Including Project										
Generation	197.1	227.9	277.6	331.8	354.1	395.9	488.5	567.5	713.8	764.5
Unserved Energy	2.1	9.7	10.5	19.3	7.7	7.1	9.0	8.8	34.1	37.0
Project Investment	-	-	-	110.2	-	-	-	-	-	-76.8
Project O&M costs	-	-	-	0.5	1.5	1.5	1.5	1.5	1.5	1.5
TOTAL	**199.3**	**237.6**	**288.0**	**461.8**	**363.3**	**404.5**	**498.9**	**577.9**	**749.4**	**726.1**

Table 6. Investment Analysis

In million USD (*)	
Baseline Scenario	
Generation	2,630.8
Unserved Energy	98.8
TOTAL	2,729.6
Including Project	
Generation	2,594.8
Unserved Energy	85.0
Project Investment	50.2
Project O&M costs	5.3
TOTAL	**2,735.3**
Generation + Unserved	**-49.8**
Project Costs	**55.5**
Cost Difference	**5.7**
Investment Cost (apr-04)	**79.6**
Commissioning date	**Sep-07**
Annual Discount rate	**10%**
Annual O&M costs	**1.0**

(*) As of April 2004

The 10% discount rate is the official rate for the Chilean electric sector, used by the CNE to determine system prices with the expansion model.

The previous table shows the proposed CDM project has the following economic impact on the overall system:

- savings in the system operation cost of US$ 36.0 million (US$ 2,594.8 - US$ 2,630.8);
- savings in expected shortage of US$ 13.8 million (US$ 85.0 – US$ 98.8); and
- US$ 55.5 million of additional investment and maintenance and operation of the Project.

The overall outcome is US$ 5.7 million of additional cost for serving the same energy demand.

It should be noted that the model and all the information is publicly available and can be run by independent experts. The model cannot be manipulated and the information added by sponsor is official (construction cost and hydrological data). The project data used by the model can be confirmed during the validation process.

Therefore, according to the investment analysis, the Project would be additional.

<u>Micro analysis:</u>

At the project level, Quilleco Hydroelectric Project had all its legal procedures accomplished since year 2000, after the approval of the EIA by Conama (the National Environmental Agency). However the project did not reach the company's board approval for implementation until mid-2004, due to the low expected rate of return, and explained by the Argentinean natural gas effects on the local generation market.

Before its implementation the project developer submitted this project to the World Bank seeking for additional funding from the Emissions Reductions generated by the project. On 22/09/2004 Colbún S.A., through its subsidiary HGV, and the World Bank, acting as a trustee of the Netherlands Clean Development Mechanism Facility (NCDMF), signed a Letter of Intent for the purchase of Emissions Reductions; in 31/08/2005 the Government of Chile endorsed the project for the purpose of the Article 12 of the Kyoto Protocol; and in 27/04/2006, an Emission Reduction Purchase Agreement (ERPA) was signed, reflecting what was originally agreed in the Letter of Intent. Therefore, the CDM was seriously considered before the start of the construction of the project (2005) and the expected revenues from the CDM component of the project and the NCDMF as buyer were crucial for the investment decision.

- ***Step 4. Common practice analysis.***

    - **Sub-step 4a Analyze other activities similar to the proposed activity:**

    Since natural gas was introduced as a resource to Chile in 1996, which changed completely the business environment in both main grids, all other available technologies, such as renewable resources, became non-competitive, with the exception of big hydro dam power projects. Since 1996, only few hydro run-of-the-river power projects were built in the Chilean interconnected central grid (Loma Alta in 1997 and Peuchen - Mampil projects in 2000). The Chacabuquito hydro project was built in 2001. However this is a CDM project activity, thus additional to the baseline.

The Chilean Central Interconnected System (SIC), natural gas requirements are based on the installed capacity of combined cycle (CC) natural gas power plants, conformed by Electrica Santiago S.A. (Nueva Renca CC. power plant), Colbun S.A. (Nehuenco I and Nehuenco II CC power plants and Nehuenco III open cycle power plant) and San Isidro S.A. (San Isidro CC power plant).

The following figure shows SIC's historic energy price variations. It can be clearly identified an energy price reduction in the system after natural gas introduction.

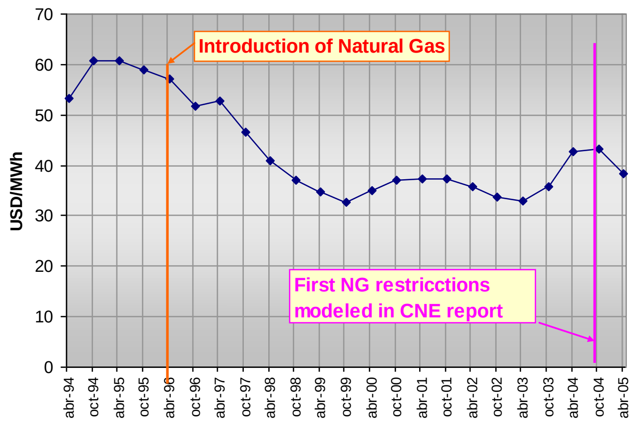

Figure 5. CNE Node Price Fixations (in real USD as of Oct-2006)
Source: CNE price reports (www.cne.cl) and US CPI index (www.bls.gov)

In 2004, Chilean natural gas supply from Argentina started to suffer restrictions imposed by Argentinean internal policies. However, the end of 2004, and even in 2005, previous historical restriction information from Argentina gas imports was not significant enough to foresee a deeper restriction scenario in the future that could affect the electric system.

As indicated previously, Quilleco Hydroelectric Project investment decision was taken only after seeking additional funding from carbon credits, as at that time the competition coming from natural gas-based projects, prevented the project developer from undertaking the investment. Quilleco investment decision was made before the natural gas restriction had important effects in the system.

- **Sub-step 4b. Discuss similar options that are occurring:**

There are no similar activities observed in the SIC being carried at the time the project initiated its construction, with the exception of those projects that have been submitted under, or are seeking, carbon finance under the CDM (ex Chacabuquito HPP and La Higuera).

Since all above steps are satisfied, it demonstrates the additionality of the proposed CDM project activity according to the Tool for the demonstration and assessment of additionality.

B.6. Emission reductions

B.6.1. Explanation of methodological choices

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Calculation of Emission Reductions

According to methodology AM0026 (v.3.0), the project activity mainly reduces CO_2 emissions through substitution of power generation supplied by the generation sources connected to the grid. The emission reduction (ER_y) by the project activity during year *y* is the difference between the baseline emissions (BE_y), project emissions (PE_y) and emissions due to leakage (L_y), and can be expressed as follows:

$$ER_y = BE_y - PE_y - L_y \qquad \textbf{(f1)}$$

Where,

ER_y	Emissions reductions of the project activity during the year *y*, in tons of CO_2;
BE_y	Baseline emissions due to displacement of electricity during the year *y*, in tons of CO_2;
PE_y	Project emissions during the year *y*, in tons of CO_2;
L_y	Leakage emissions during the year *y*, in tons of CO_2.

Calculation Project Emissions

For most renewable energy project activities, $PE_y = 0$. Since Quilleco Hydroelectric Project consists of a run of river hydro power plant, there are no Project Emissions ($PE_y = 0$).

Calculation of Baseline emissions

The baseline emissions for the project are calculated as follows using the emission factor estimated and the energy generated by the project activity:

$$BE_y = EF_y * Generation_y \qquad \textbf{(f2)}$$

Where,

EF_y	Baseline emission factor, in tCO_2/MWh;
$Generation_y$	Electricity generated by the proposed CDM Project in year *y*, in MWh.

The baseline to calculate the project emission reductions is based on a baseline emission factor (EF_y) calculated as a combined margin. For Quilleco project, according to AM0026 (v.3.0), this combined margin (CM) is calculated considering the weighted average for both the Operating Margin (OM) and the Build Margin (BM) emission factors, as follows:

$$EF_y = w_{OM} * EF_{OM,y} + w_{BM} * EF_{BM} \qquad \textbf{(f3)}$$

Where,

$EF_{OM,y}$	Emission factor for operating margin power generation sources, in tCO_2/MWh;
w_{OM}	0.25, Weight for operating margin emission factor;

EF_{BM} Emission factor for build margin power generation sources, in tCO_2/MWh;
w_{BM} 0.75, Weight for build margin emission factor.

The AM0026 (v.3.0) methodology determines the w_{BM} and w_{OM} by using the "Tool to calculate the emission factor for an electricity system" v.04.0 which states that for the second crediting period a value of 0.75 and 0.25 should be used for the build margin and operating margin emission factors weight respectively for estimating the combined emission factor.
The calculation of the project emissions reductions requires gathering and analysing a considerable quantity of data primarily for the estimation of the emission factor.

The amount of data to be analysed and processed and all the procedures to be followed do not allow the estimation of the Emission Factor to be simple and expedite. In order to make the emissions reduction estimation procedures accessible and efficient, the Project Participant has developed excel spreadsheet to process the information.

In general terms, the procedure executed to calculate the Emission Factor Estimation considers the following stages:

1. Data Acquisition
2. Operating Margin Emission Factor Estimation
3. Build Margin Emission Factor Estimation
4. Combined Margin Emission Factor Estimation

The first stage consists on gathering the required information for the emission factors estimation. The data to be gathered for every period is the energy generated and general data of all power plants of the system, the priority of the dispatch, data related to fuel consumption and information associated to the different fossil fuels being used. This information is trespassed to the excel spreadsheets and its sources verified prior to its use.

The second, third and fourth stage of the estimation use the information gathered, following the estimation procedures stated in the approved baseline and monitoring methodology AM0026 (v.3.0) and Tool to Calculate the Emission Factor for an Electricity System v.04.0.

Finally, and using the emission factor estimated, the emissions reductions associated to the operation of the project activity can be calculated.
The Baseline emission reductions calculation requires an overwhelming amount of data, considering all hourly dispatch and weekly merit order. All detailed system data can be obtained from CDEC-SIC's web page at www.cdec-sic.cl. Also, node price reports, used to calculate thermal plant fuel consumption for the OM emission factor, can be obtained from the National Energy Commission CNE at www.cne.cl.

The calculation of the Operating Margin emission factor will be provided ex-post with real data according the approved methodology; hence, the data used in the PDD for the calculation of the current baseline is only used for estimation purposes**.** The data required for the estimation of the EF_{BM}, which is fixed for the second crediting period, is provided in Table 8 in Section B.6.3.

Calculation of the Operating Margin Emission Factor

The OM emission factor from the project activity will depend on the actual generation data from the SIC. The dispatch data, to be provided *ex-post* by the Economic Dispatch Center (CDEC-SIC), will conclusively indicate the type of generation displaced by the addition of Quilleco in the generation mix

in the SIC. The monitoring and verification plan for the project utilizes the data provided by CDEC-SIC, CNE and IPCC.

The next diagram shows the complete process for calculating and assigning the operating emission factors for Quilleco Hydroelectric Power Project:

Net Hourly Generator output from other CDM Projects and Quilleco
(CDEC-SIC[7] and Project Participant hourly energy generation data)
(MWh)

↓

Analysis of hourly dispatch from all units of the SIC to determine the
Marginal Plant(s) that would be dispatched if the system is operated without all the CDM projects in the system
(CDEC-SIC[8])

↓

Calculation of emission factor of all operational thermal units of the system
(CDEC-SIC, CNE report[9] and 2006 IPCC manual)
(tonnes CO_2e/MWh)

↓

Determination of the marginal plants and energy being displaced due to the operation of Quilleco CDM project
(MWh and tonnes CO_2e/MWh)

↓

Determination of EF_{OM} of each CDM project as the weighted average emission factor of the Marginal Plant(s) not dispatched (or displaced) by the project
(tonnes CO_2e/MWh)

The Emission Factor of the operating margin is calculated in accordance with the following equations, as per AM0026 (v.3.0):

Where,

$$EF_{OM,y} = \frac{\sum_{h=1}^{8760} EF_{j,h} \times Generation_{j,h}}{\sum_{h=1}^{8760} Generation_{j,h}} \qquad \textbf{(f4)}$$

[7] www.cdec-sic.cl

[8] Energy generation data and Merit Order.

[9] www.cne.cl

$EF_{j,h}$	Operating margin emission factor for proposed CDM project activity '***j***' for hour '***h***', expressed in tCO_2/MWh;
$Generation_{j,h}$	Generation of proposed CDM project '***j***' during hour '***h***', expressed in MWh.

The emission factor for the proposed CDM project 'j', in a system with N CDM projects, for an hour 'h' is based on identification of the marginal plant(s) that would be operated to meet the electricity supplied by the proposed CDM project 'j'. The identification of marginal plant(s) displaced by proposed CDM project 'j' is based on the "first-built first served" principle. "Date of built" is defined as the date when the plant begins the dispatch of energy to the grid. In the case of Quilleco project, it was the first power plant in operation in the SIC to be commissioned as a CDM project activity.

The emission factor for any hour 'h' for a CDM project 'j' in system is estimated as weighted average of emission factor of the identified marginal plant(s) that would have supplied electricity to the grid in absence of the j^{th} CDM plant. The emission factor is estimated as follows:

$$EF_{j,h} = \sum_{i=1}^{M} D(j,i) * d_i \Big/ \sum D(j,i) \qquad \textbf{(f5)}$$

Where,

$D(j,i)$	Energy displacement of the marginal plant '***i***' due to the proposed CDM project '***j***', in MWh;
d_i	Emission factor of the marginal plant '***i***', expressed in tCO_2/MWh;
M	***M*** is the total number of marginal plants that would be dispatched if the system is operated without the ***N*** CDM projects.

M is such that:

$$\sum_{j=1}^{N} C_j \le \sum_{i=1}^{M} \left(A_i - B_i\right) \qquad \textbf{(f6)}$$

Where,

C_j	Energy generation of the CDM project '***j***' expressed in MWh/h= $Generation_{j,h}$;
N	Total number of CDM projects in the system, where N is the CDM project built first and 1 is the last CDM project build in the system;
A_i	Maximum energy generation of the marginal plant '***i***', expressed in MWh/h (equivalent to plant capacity in MW);
B_i	Actual Energy generation of the marginal plant '***i***', expressed in MWh/h.

The difference (*Ai* – *Bi*) represents the maximum possible additional electric energy that can be supplied by the i^{th} marginal plant.

Energy displacement of the marginal plant '***i***' due to the proposed CDM project '***j***', is calculated as follows:

$$D(j,i) = MIN\left\{C_j - \sum_{l=1}^{i-1} D(j,l); (A_i - B_i) - \sum_{k=j+1}^{N} D(k,i)\right\} \qquad \textbf{(f7)}$$

Where,

"*k*" represents group of CDM plants that were built before the "j" CDM plant.

$D(j,0)=0$ and $D(N+1,i)=0$

$D(j,i)=0$ for all i<m, s.t. $\sum_{i=1}^{m}(A_i - B_i) > \sum_{k=j+1}^{N} C_k$

$D(j,i)=0$ for all i>m*, s.t. $\sum_{i=1}^{m^*}(A_i - B_i) > \sum_{k=j+1}^{N} C_k + C_j$

And , "i" takes values between "m" and "m*"

d_i, the emission factor for displaced marginal plant, is estimated as follows:

$$d_i = SFC_i * CEF_{OM,i} * Oxid_i \qquad \textbf{(f8)}$$

Where,

SFC_i	Specific fuel consumption of i^{th} marginal power plant, expressed as (ton of fuel or TJ)/MWh;
$CEF_{OM,i}$	CO_2 emission factor of fuel used in i^{th} marginal power plant, expressed as tCO_2/(ton of fuel or TJ);
$Oxid_i$	Fraction of carbon in fuel, used in i^{th} marginal plant, oxidized during combustion.

The marginal plant(s) are those power plant listed in the top of the grid system dispatch order during hour 'h' needed to meet the electricity demand at the hour "h" without the generation of CDM project(s). If no thermal power plants are needed to meet the demand without the CDM projects, then the emission factor of the marginal plant is zero.

The generation of Quilleco is obtained from the metering system which follows a national standard of 0.2% error allowed[10] on a KWh base. Hourly energy data obtained from the metering system is periodically submitted to CDEC-SIC as for all other generating units of the system.

The Semi-annual Node Price Report[11] and the 2006 IPCC Good Practice Guidance[12] provide all the information to calculate the emission factors for all the power plants within the Chilean grids. Node Price Reports inform about the specific fuel consumption for every power plant, which are used together with the carbon content of the different fuels as reported by the IPCC.

Calculation of the Build Margin Emission Factor

The Build Margin emission factor is calculated with Option (i) of the approved baseline methodology AM0026 (v.3.0), i.e. build margin emission factor estimation process described in the "Tool to calculate the emission factor for an electricity system", which in this case corresponds to v 04.0.

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[10] Chilean Regulation NCh 2542.

[11] http://www.cne.cl/cnewww/opencms/07_Tarificacion/01_Electricidad/Otros/Precios_nudo/otros_precios_de_nudo/precios_de_nudo.html

[12] http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html

For the second crediting period, as stated in "Tool to calculate the emission factor for an electricity system" v.04.0, option 2 from the vintage of data options, the build margin (BM) emission factor is calculated ex-ante based on the most recent information available on units already built at the time of the submission of the request for renewal of the crediting period to the DOE.

The sample group of power units to be included in the build margin considers the set of capacity additions in the electricity system that comprise 20% of the system generation and that have been built most recently which represents Option (b) of *Step 5 Identify the group of power units to be included in the build margin* of the "Tool to calculate the emission factor for an electricity system". As shown in Table 8, the selection of plants, which comprise 20% of annual generation from plants that have been built most recently, has clearly more than five power plants, making option (a) inapplicable.

Power plants registered as CDM project activities are excluded from the sample group.

The next diagram shows the complete process for calculating and assigning the Build Margin emission factor:

SIC Dispatch of all power units of the system
(CDEC-SIC)
(MWh)

Determination of 20% of energy generated from most recent power units and the generation from the five most recently build plants. The set of power plants that comprises the larger annual generation, which is the set of power units that comprises the 20% of the system generation, is chosen.
(set of m plants following the "Tool to calculate the emission factor for an electricity system (v04)")
(MWh)

Calculation of emission factor for set of m plants
(CNE reports and IPCC manual)
(tonnes CO_2e/MWh)

Determination of EF_{BM} ("Tool to calculate the emission factor for an electricity system (v04)", step 4 (a)) as the weighted average emission factor of the dispatched plants and their individual emission factor
(tonnes CO_2e/MWh)

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

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} \qquad \textbf{(f9)}$$

Where,

$EF_{grid,BM,y}$	Build margin CO_2 emission factor in year *y,* in tCO_2/MWh;
$EG_{m,y}$	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y,* in MWh;
$EF_{EL,m,y}$	CO_2 emission factor of power unit *m* in year *y, in* tCO_2/MWh;
m	Power units included in the build margin;
y	Most recent historical year for which power generation data is available at the time of submission of the Project Design Document to the DOE for the renewal of the crediting period.

The CO_2 emission factor of the power units included for estimating the BM is determined using option A1, A2 or A3 presented in *Step 4 (a) Simple OM* of the "Tool to calculate the emission factor for an electricity system" v.04.0 during the most recent year y for which power generation data is available.

- **Option A1.** If for a power unit *m* data on fuel consumption and electricity generation is available, the emission factor ($EF_{EL,m,y}$) is determined as follows:

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \times NCV_{m,i,y} \times EF_{CO2,m,i,y}}{EG_{m,y}} \qquad \textbf{(f10)}$$

Where,

$EF_{EL,m,y}$	CO_2 emission factor of power unit m in year *y*, in tCO_2/MWh;
$FC_{i,m,y}$	Amount of fossil fuel type i consumed by power unit m in year *y*, in mass or volume unit;
$NCV_{m,i,y}$	Net calorific value (energy content) of fossil fuel type i used in the power unit m in year *y*, in GJ / mass or volume unit;
$EF_{CO2,m,i,y}$	CO_2 emission factor of fossil fuel type i used in power unit m in *year y*, in tCO_2/GJ;
$EG_{m,y}$	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y*, in MWh;
m	Power units included in the build margin;
i	All fossil fuel types combusted in power unit m in year *y*;
y	Most recent historical year for which power generation data is available at the time of submission of the Project Design Document to the DOE for the renewal of the crediting period.

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

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} \times 3.6}{\eta_{m,y}} \qquad \textbf{(f11)}$$

Where,

$EF_{EL,m,y}$ — CO_2 emission factor of power unit *m* in year *y*, in tCO_2/MWh;
$EF_{CO2,m,i,y}$ — Average CO_2 emission factor of fuel type i used in power unit *m* in year *y*, in tCO_2/GJ;
$\eta_{m,y}$ — Average net energy conversion efficiency of power unit *m* in year *y* (ratio);
y — Most recent historical year for which power generation data is available at the time of submission of the Project Design Document to the DOE for the renewal of the crediting period.

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

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

Leakage

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, fuel handling (extraction, processing, and transport) and land inundation. By applying methodology AM0026 v.3.0, these emission sources do not need to be considered.

B.6.2. Data and parameters fixed ex ante

Data / Parameter	EF_{BM}[13]
Unit	tCO_2/MWh
Description	Build margin emission factor
Source of data	Calculated as per equation (f9) as per methodology procedures described in section B.6.1
Value(s) applied	0.79074
Measurement methods and procedures	N/A (this parameter is not measured but calculated)
Monitoring frequency	Not applicable. This value is fixed ex-ante for the second and third crediting period.
QA/QC procedures	Calculation is made according to “Tool to calculate the emission factor for an electricity system” v.04.0
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

[13] This parameter corresponds to $EF_{grid,BM,y}$ of the “Tool to calculate the emission factor for an electricity system” v.04.0.

Data / Parameter	$EG_{m,y}$
Unit	MWh
Description	Net electricity generated and delivered to the grid by power plant / unit m included in the build margin calculation in year y.
Source of data	CDEC-SIC
Value(s) applied	Please refer to Table 8 of section 6.3 of this PDD.
Choice of data or Measurement methods and procedures	The data from the CDEC-SIC 2013 represents the most recent and reliable information available.
Purpose of data	Calculation of baseline emissions
Additional comment	There are no additional comments.

Data / Parameter	$EF_{CO2,m,i,y}$
Unit	tCO_2/GJ
Description	CO_2 emission factor of fuel type i used in power unit m in year y
Source of data	IPCC 2006 guidelines
Value(s) applied	Table 12 of Appendix 4.
Choice of data or Measurement methods and procedures	This is the best data publicly available (no data at a national level or from the fuel supplier is available).
Purpose of data	Calculation of baseline emissions
Additional comment	For the second crediting period, the EF_{BM} is calculated only once ex-ante..

Data / Parameter	$FC_{i,m,y}$
Unit	For Diesel: kg/year, for Natural Gas: m^3/year.
Description	Amount of fuel type i consumed by power plant/unit m included in the build margin calculation in year y
Source of data	CDEC-SIC Annual Report and CNE Definitive Technical Report (average value from April and October publication).
Value(s) applied	Please refer to Table 8 of section 6.3 of this PDD.
Choice of data or Measurement methods and procedures	Data from CDEC-SIC and CNE represents the most recent and reliable information available.
Purpose of data	Calculation of baseline emissions
Additional comment	For the second crediting period, the EF_{BM} is calculated only once ex-ante..

Data / Parameter	$NCV_{m,i,y}$
Unit	For Diesel: (GJ / mass or volume unit) and For Natural Gas: (GJ / mass or volume)

Description	Net calorific value of fossil fuel type i consumed by power plant / unit m included in the build margin calculation in year y
Source of data	Energy balance 2012, Ministry of Energy of Chile
Value(s) applied	Please refer to Table 12 from Appendix 4.
Choice of data or Measurement methods and procedures	The Ministry of Energy of Chile represent the most recent and reliable information available.
Purpose of data	Calculation of baseline emissions
Additional comment	For the second crediting period, the EF_{BM} is calculated only once ex-ante. The CNE Energy Balance Report includes Gross Calorific Values for the different fuels, these values were corrected to Net Calorific Values based on the IPCC 2006 assumption that for Diesel, Net Calorific Value is 5% lower than its Gross Calorific Value and for Natural Gas; Net Calorific Value is 10% lower than its Gross Calorific Value.

Data / Parameter	$\eta_{m,y}$
Unit	-
Description	Average net energy conversion efficiency of power unit m in year y
Source of data	Default values from Tool to calculate the emission factor for an electricity system (v 04.0)
Value(s) applied	Please refer to Table 8 of section 6.3 of this PDD.
Choice of data or Measurement methods and procedures	This is the best information available.
Purpose of data	Calculation of baseline emissions
Additional comment	For the second crediting period, the EF_{BM} is calculated only once ex-ante..

Data / Parameter	w_{BM}
Unit	Fraction
Description	Weight for Build Margin emission factor
Source of data	Tool to calculate the emission factor for an electricity system (v 04.0)
Value(s) applied	0.75
Choice of data or Measurement methods and procedures	Value for the second crediting period as per the applicable methodology AM0026 v.3.0 and the referred tool.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	w_{OM}
Unit	Fraction

Description	Weight for Operating Margin emission factor
Source of data	Tool to calculate the emission factor for an electricity system (v 04)
Value(s) applied	0.25
Choice of data or Measurement methods and procedures	Value for the second crediting period as per the applicable methodology AM0026 v.3.0and the referred tool.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

B.6.3. Ex ante calculation of emission reductions

>>
The emission factor of the grid was calculated in a transparent and conservative manner as a combined margin consisting in a combination of operating margin (OM) and a build margin (BM) according procedures prescribed in the methodology AM0026 v.3.0 and the "Tool to calculate the Emission Factor for an electricity system" v.04 as follows:

Operating Margin Emission Factor

AM0026 v.3.0 calculates ex-post the emission factor for the operating margin by observing actual dispatch data, the generation from the power plants and the merit order. The emission factor for the operating margin is determined by the generation that would be dispatched in the absence of this CDM Project based on the latest available data at time of submission of the PDD for the renewal of the crediting period, which is data from year 2013.

The value for the Operating Margin (OM) emission factor estimated with AM0026 v.3.0 is presented in the following table:

Table 7. Operating Margin Emission Factor

Operating Margin Emission Factor $EF_{grid,2013}$ [tCO_2/MWh]
0.44183

Build Margin Emission Factor

Build Margin emission factor was calculated according to Option (i) of the approved baseline methodology AM0026 v.3.0, as described in the "Tool to calculate the emission factor for an electricity system" v.04.0 and using data presented in Appendix 4.

The BM was estimated depending on annual fuel consumption or specific fuel consumption data availability, options A1 and A2 were applied, using Equation 10 and Equation 11, respectively. The BM emission factor is calculated for year 2013 using Equation 9 from section B.6.1.

For those plants that annual fuel consumption information was available Option A1 was used. For the rest of the power units, the default energy conversion efficiency was used in accordance with the “Tool to calculate the emission factor for an electricity system v.4”.

An example of the calculation with equation (f10) is provided using Calle-Calle, diesel based Power Unit:

$$EF_{EL,m,y} = \frac{2{,}000{,}000\ \frac{kg}{year} \cdot 0.043354\ \frac{GJ}{kg} \cdot 0.072600\ \frac{tCO_2}{GJ}}{8{,}969\ MWh/year} = 0.70184\ tCO_2/MWh$$

An example of the calculation with equation (f11) is provided using Punta Colorada, Diesel based Power Unit:

$$EF_{EL,m,y} = \frac{0.0726\frac{tCO_2}{GJ}x3.6}{0.395} = 0.66167tCO_2/MWh$$

The following table shows the set of Power Units included in the build margin and the associated CO_2 Emission Factor values, Energy Generated during 2013 and the energy conversion efficiency (if applicable, for equation f11).

Table 8. Build Margin Power Units data

Power Plant	Fuel type	Starting Date	$FC_{i,m,y}$ kg/year; m^3/year for gas	Energy conversion efficiency $\eta_{m,y}$	$EF_{EL,m,y}$ (tCO_2/MWh)	Yearly Generation $EG_{m,y}$ (MWh)
Los Corrales II@Run of the River	Run of the River	2013	0	-	0.000000	2,652.400
Ancali@Biomass	Biomass	2013	0	-	0.000000	2,421.900
Cardones@Diesel Oil	Diesel Oil	2013	0	0.395	0.661671	0.000
Don Walterio@Run of the River	Run of the River	2013	0	-	0.000000	14,434.90
El Llano@Run of the River	Run of the River	2013	0	-	0.000000	363.80
Ensenada@Run of the River	Run of the River	2013	0	-	0.000000	-
Estancilla@Run of the River	Run of the River	2013	0	-	0.000000	1,207.20
Laja 1@Run of the River	Run of the River	2013	0	-	0.000000	-
Lajacmpc@Biomass	Biomass	2013	0	-	0.000000	85,421.80
Las Pampas@Run of the River	Run of the River	2013	0	-	0.000000	0.00
Las Vertientes@Run of the River	Run of the River	2013	0	-	0.000000	301.00

Power Plant	Fuel type	Starting Date	$FC_{i,m,y}$ kg/year; m^3/year for gas	Energy conversion efficiency $\eta_{m,y}$	$EF_{EL,m,y}$ (tCO_2/MWh)	Yearly Generation $EG_{m,y}$ (MWh)
Los alamos@Diesel Oil	Diesel Oil	2013	0	0.395	0.661671	0.20
Los Hierros@Run of the River	Run of the River	2013	0	-	0.000000	-
Bonito@Run of the River	Run of the River	2013	0	-	0.000000	-
Negrete@Wind	Wind	2013	0	-	0.000000	-
Rio Huasco@Run of the River	Run of the River	2013	0	-	0.000000	1,943.90
Robleria@Run of the River	Run of the River	2013	0	-	0.000000	-
San Andres@Run of the River	Run of the River	2013	0	-	0.000000	-
Santa Irene@Biomass	Biomass	2013	0	-	0.000000	223.10
Santa Marta@Biomass	Biomass	2013	0	-	0.000000	-
SDGx02@Solar	Solar	2013	0	-	0.000000	558.00
Talinay@Wind	Wind	2013	0	-	0.000000	-
Tamm@Biomass	Biomass	2013	0	-	0.000000	1,121.96
Trebal Mapocho@Biomass	Biomass	2013	0	-	0.000000	31,915.60
Ucuquer@Wind	Wind	2013	0	-	0.000000	17,374.70
Allipen@Run of the River	Run of the River	2012	0	-	0.000000	-
Bocamina 2@Bituminous Coal	Bituminous Coal	2012	747,400,000	N/A Option A1 is selected	0.850598	2,189,553.00
Callao@Run of the River	Run of the River	2012	0	-	0.000000	-
Campiche@Petcoke	Petcoke	2012	712,800,000	N/A Option A1 is selected	0.838843	1,961,306.00
Contulmo@Run of the River	Run of the River	2012	0	-	0.000000	20.80
El Canelo@Run of the River	Run of the River	2012	0	-	0.000000	17,196.60
Nalcas@Run of the River	Run of the River	2012	0	-	0.000000	-
Providencia@Run of the River	Run of the River	2012	0	-	0.000000	-
Purisima@Run of the River	Run of the River	2012	0	-	0.000000	2,265.21
Renaico@Run of the River	Run of the River	2012	0	-	0.000000	30,032.20
Rucatayo@Dam	Dam	2012	0	-	0.000000	291,624.40
Santa Fe@Biomass	Biomass	2012	0	-	0.000000	484,125.60
Santa Fe 2@Biomass	Biomass	2012	0	-	0.000000	442.80
Tambo Real@Solar	Solar	2012	0	-	0.000000	2,017.00

Power Plant	Fuel type	Starting Date	$FC_{i,m,y}$ kg/year; m^3/year for gas	Energy conversion efficiency $\eta_{m,y}$	$EF_{EL,m,y}$ (tCO_2/MWh)	Yearly Generation $EG_{m,y}$ (MWh)
Calle-Calle@Diesel Oil	Diesel Oil	2011	2,000,000	N/A Option A1 is selected	0.701844	8,969.30
Chacayes@Run of the River	Run of the River	2011	0	-	0.000000	-
Danisco@Diesel Oil	Diesel Oil	2011	0	0.395	0.661671	0.90
Diuto@Run of the River	Run of the River	2011	0	-	0.000000	21,612.80
Energia Pacifico@Biomass	Biomass	2011	0	-	0.000000	76,755.60
HBS@Diesel Oil	Diesel Oil	2011	0	0.395	0.661671	0.00
JCE@Diesel Oil	Diesel Oil	2011	100,000	N/A Option A1 is selected	0.795030	395.90
La Arena@Run of the River	Run of the River	2011	0	-	0.000000	-
Lautaro@Biomass	Biomass	2011	0	-	0.000000	-
Lican@Run of the River	Run of the River	2011	0	-	0.000000	-
Lonquimay@Diesel Oil	Diesel Oil	2011	0	0.395	0.661671	19.00
Mallarauco@Run of the River	Run of the River	2011	0	-	0.000000	25,514.68
Muchi@Run of the River	Run of the River	2011	0	-	0.000000	2,156.00
Polincay@Diesel Oil	Diesel Oil	2011	0	0.395	0.661671	0.00
Reca@Run of the River	Run of the River	2011	0	-	0.000000	5,367.98
Santa Maria@Bituminous Coal	Bituminous Coal	2011	961,600,000	N/A Option A1 is selected	0.915850	2,616,358.00
Southern@Diesel Oil	Diesel Oil	2011	0	0.395	0.661671	1.00
Tirua@Diesel Oil	Diesel Oil	2011	0	0.395	0.661671	34.40
Tomaval@Diesel Oil	Diesel Oil	2011	0	0.395	0.661671	0.00
Punta Colorada@Wind	Wind	2011	0	-	0.000000	13,291.40
Dongo@Run of the River	Run of the River	17-12-2010	0	-	0.000000	-
Cem Bio Bio DIESEL@Diesel Oil	Diesel Oil	14-12-2010	0	0.395	0.661671	207.00
Cem Bio Bio IFO@Residual Fuel Oil	Residual Fuel Oil	14-12-2010	8,159,391	N/A Option A1 is selected	0.687383	37,428.40
Punta Colorada@Diesel Oil	Diesel Oil	03-12-2010	0	0.395	0.661671	1,758.40
Punta Colorada@Residual Fuel Oil	Residual Fuel Oil	03-12-2010	9,488,635	N/A Option A1 is selected	0.690536	43,327.10
Cabrero@Biomass	Biomass	01-12-2010	0	-	0.000000	-
Confluencia@Run of	Run of the	01-12-2010	0	-	0.000000	-

Power Plant	Fuel type	Starting Date	$FC_{i,m,y}$ kg/year; m^3/year for gas	Energy conversion efficiency $\eta_{m,y}$	$EF_{EL,m,y}$ (tCO_2/MWh)	Yearly Generation $EG_{m,y}$ (MWh)
the River	River					
Guayacán@Run of the River	Run of the River	01-12-2010	0	-	0.000000	-
La Higuera@Run of the River	Run of the River	01-12-2010	0	-	0.000000	-
Mariposas@Run of the River	Run of the River	01-12-2010	0	-	0.000000	29,640.00
La Paloma@Run of the River	Run of the River	10-05-2010	0	-	0.000000	-
Emelda 2@Diesel Oil	Diesel Oil	17-09-2010	85,704	N/A Option A1 is selected	1.110501	242.91
San Clemente@Run of the River	Run of the River	16-09-2010	0	-	0.000000	-
Los Corrales@Run of the River	Run of the River	15-09-2010	0	-	0.000000	6,405.70
Juncalito@Run of the River	Run of the River	01-09-2010	0	-	0.000000	2,824.10
Chuyaca@Diesel Oil	Diesel Oil	01-09-2010	600,000	N/A Option A1 is selected	0.754901	2,501.67
Colihues@Residual Fuel Oil	Residual Fuel Oil	16-08-2010	8,500,000	N/A Option A1 is selected	0.649815	41,244.99
El Salvador@Diesel Oil	Diesel Oil	06-08-2010	200,000	N/A Option A1 is selected	1.715271	367.00
Emelda 1@Diesel Oil	Diesel Oil	24-07-2010	214,296	N/A Option A1 is selected	1.110501	607.39
Colihues@Diesel Oil	Diesel Oil	01-07-2010	0	0.395	0.661671	0.00
Trueno@Run of the River	Run of the River	06-06-2010	0	-	0.000000	-
El Tartaro@Run of the River	Run of the River	10-05-2010	0	-	0.000000	407.20
Los colorados@Biomass	Biomass	01-04-2010	0	-	0.000000	-
Guacolda 4@Bituminous Coal	Bituminous Coal	30-03-2010	466,200,000	N/A Option A1 is selected	0.893082	1,300,791.21
Curanilahue@Diesel Oil	Diesel Oil	07-03-2010	0	0.395	0.661671	11.70
Nueva Ventanas@Bituminous Coal	Bituminous Coal	11-02-2010	790,700,000	N/A Option A1 is selected	0.908390	2,169,033.00

Using this data the Build Margin Emission Factor is calculated in accordance to equation (f9) exposed in section B.6.1.

$$EF_{BM} = \frac{9{,}129{,}756 \ tCO_2}{11{,}545{,}799 \ MWh} = 0.79074 \ tCO_2/MWh$$

Table 9: Build Margin Emission Factor

Build Margin Emission Factor $EF_{BM,2013}$ [tCO_2/MWh]
0.79074

Project Emissions Reductions

According to the methodology, the project does not consider any emissions during the project activity.

Combined Emission Factor

In accordance with equation (f3) as stated in section B.6.1, the combined margin estimation is calculated as follows:

$$EF_y = 0.25 \cdot 0.44183 \frac{tCO_2}{MWh} + 0.75 \cdot 0.79074 \frac{tCO_2}{MWh} = 0.70351 \frac{tCO_2}{MWh}$$

Baseline Emissions

In accordance with equation (f2) as stated in section B.6.1, the baseline emissions are calculated as follows:

$$BE_y = 0.70351 \frac{\mathrm{t}CO_2}{MWh} \cdot 422{,}000 \ Mwh/year = 296{,}882 \ \mathrm{tCO_2/year}$$

Project Activity Emissions

The project does not consider any emissions during the project activity.

Leakage

The project does not consider any leakage.

Project Emission Reductions

Finally and in accordance with equation (f1) as stated in section B.6.1:

$$ER_y = BE_y - PE_y - L_y = BE_y$$

Where,

ER_y	Emissions reductions of the project activity during the year *y*, in tCO_2/year;
BE_y	Baseline emissions due to displacement of electricity during the year *y*, in tCO_2/year;
PE_y	Project emissions during the year *y*, in tCO_2/year;
L_y	Leakage emissions during the year *y*, in tCO_2/year.

And using all the values estimated above:

$$ER_y = 296{,}882\ tCO_2/year - 0tCO_2/year - 0tCO_2/year = 296{,}882\ tCO_2/year$$

Summarizing, Quilleco Hydroelectric Power Project is expected to reduce approximately 296,882 tCO_2e per year. The actual combined emission factor shall be determined using a proper estimation of the OM emission factor in accordance with the AM0026 (v.3.0) approved methodology based in ex-post data. Table 10 summarizes the emission factor and emission reduction values estimated above.

Table 10. Emissions reductions data

Parameter	Value	Unit	Source
EF_{BM}	0.79074	tCO_2e/MWh	Estimated ex-ante in accordance with the AM0026 (v.3.0) approved methodology. Fixed value for the second crediting period.
$EF_{OM,y}$	0.44183	tCO_2e/MWh	Referential value only. The OM emission factor shall be estimated ex-post in accordance with the AM0026 (v.3.0) approved methodology.
EF_y	0.70351	tCO_2e/MWh	Referential value only since the OM emission factor shall be estimated ex-post in accordance with the AM0026 (v.3.0) approved methodology.
$Generation_y$	422,000	MWh	Estimated energy generation from the registered PDD. The estimates are based on long-term observations of water conditions of the Laja River.
ER_y	296,882	tCO_2e	Calculated

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

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
09/07/2015 - 31/12/2015	143,154	0	0	143,154
01/01/2016 - 31/12/2016	296,882	0	0	296,882
01/01/2017 - 31/12/2017	296,882	0	0	296,882
01/01/2018 - 31/12/2018	296,882	0	0	296,882
01/01/2019 - 31/12/2019	296,882	0	0	296,882
01/01/2020 - 31/12/2020	296,882	0	0	296,882
01/01/2021 - 31/12/2021	296,882	0	0	296,882
01/01/2022 - 08/07/2022	153,728	0	0	153,728
Total	2,078,174	0	0	2,078,174

Total number of crediting years	7			
Annual average over the crediting period	296,882	0	0	296,882

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data / Parameter	**EF_y**
Unit	tCO_2/MWh
Description	Combined Margin Emission factor for displaced grid electricity
Source of data	Calculation based on CDEC SIC, CNE and IPCC data, as weighted sum of build margin (EF_{BM}) and operating margin ($EF_{OM,y}$) emission factors and in accordance to the methodology procedures described in section B.6.1 (specifically as per equation f3 of this PDD).
Value(s) applied	0.70351
Measurement methods and procedures	N/A (this parameter is not measured but calculated)
Monitoring frequency	Annually (value is calculated ex post)
QA/QC procedures	Calculation based on data sources, following AM0026 v.3.0 procedures.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	**$EF_{OM,y}$**
Unit	tCO_2/MWh
Description	Operating margin emission factor
Source of data	Calculation based on CDEC SIC, CNE and IPCC data, as per equation (f4) as per methodology procedures described in section B.6.1
Value(s) applied	0.44183
Measurement methods and procedures	N/A (this parameter is not measured but calculated)
Monitoring frequency	Annually (value is calculated ex post)
QA/QC procedures	Calculation based on data sources, following AM0026 v.3.0 procedures.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	**$EF_{j,h}$**
Unit	tCO_2/MWh
Description	Operating margin emission factor for hour h
Source of data	Calculation based on CDEC SIC, CNE and IPCC data, as per formula (f5)

Value(s) applied	Values are provided in the attached spreadsheets.
Measurement methods and procedures	N/A (calculated)
Monitoring frequency	Hourly
QA/QC procedures	Calculation based on data sources, following AM0026 v.3.0 procedures.
Purpose of data	Calculation of baseline emissions
Additional comment	The amount of data is too big to be reported in this PDD but values are provided in the calculation spreadsheets to the DOE.

Data / Parameter	**$Generation_y$**
Unit	MWh
Description	Electricity exported to the grid by proposed CDM project, in year y
Source of data	Onsite metering system
Value(s) applied	422,000
Measurement methods and procedures	Electricity meters are located at the injection point to the grid, where auxiliary services are discounted.
Monitoring frequency	Hourly
QA/QC procedures	Meter should have a maximum error of 0.2% and be calibrated every one or two years according to local standards for electricity transactions in CDEC-SIC. Monitored data is cross checked against records for sold electricity which are publicly available at the CDEC-SIC web page (www.cdec-sic.cl).
Purpose of data	Calculation of baseline emissions
Additional comment	The estimates are based on long-term observations of water conditions of the Laja River.

Data / Parameter	**D(j,i)**
Unit	MWh
Description	Electricity displaced by j^{th} CDM project from i^{th} marginal plant in the system
Source of data	Calculated based on equation f7 using CDEC-SIC data
Value(s) applied	Data is provided in the emission factor calculation spreadsheet.
Measurement methods and procedures	N/A
Monitoring frequency	Hourly
QA/QC procedures	Calculation based on data sources, following AM0026 v.3.0 procedures.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	**d_i**
Unit	tCO_2/MWh
Description	Emission factor for electricity displaced D(j,i)
Source of data	Calculated based on equation f8 using CDEC-SIC, CNE and IPCC data

Value(s) applied	Data is provided in the emission factor calculation spreadsheet.
Measurement methods and procedures	N/A
Monitoring frequency	Hourly
QA/QC procedures	Calculation based on data sources, following AM0026 v.3.0 procedures.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	**SFC_i**
Unit	kg or m^3 (for natural gas) / MWh
Description	Specific fuel consumption per unit of electricity produced in i^{th} marginal plant
Source of data	CDEC SIC Annual Report and CNE node price report
Value(s) applied	Values in Table 13 of Appendix 4.
Measurement methods and procedures	N/A
Monitoring frequency	Yearly
QA/QC procedures	Calculation based on data sources, following AM0026 v.3.0 procedures.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	**M**
Unit	Number
Description	Number of electricity generation plants on the margin that would supply to the system in the absence of the CDM projects in the system.
Source of data	Calculated based on equation f6 using CDEC-SIC data
Value(s) applied	Data is provided in the emission factor calculation spreadsheet.
Measurement methods and procedures	N/A
Monitoring frequency	Hourly
QA/QC procedures	Data is obtained from CDEC-SIC databases
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	**N**
Unit	Number
Description	List of CDM registered plants in the system
Source of data	CDEC-SIC and UNFCCC registered projects for the country
Value(s) applied	43
Measurement methods and procedures	N/A
Monitoring frequency	As required

QA/QC procedures	Data is obtained from official sources.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	C_j
Unit	MWh
Description	Electricity generated by j^{th} CDM plant in hour h
Source of data	CDEC-SIC
Value(s) applied	Data is provided in the emission factor calculation spreadsheet.
Measurement methods and procedures	N/A
Monitoring frequency	Hourly
QA/QC procedures	Data is obtained from CDEC-SIC databases
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	A_i
Unit	MW
Description	Generation capacity of i^{th} plant on margin during hour h
Source of data	CDEC-SIC
Value(s) applied	Data is provided in the emission factor calculation spreadsheet.
Measurement methods and procedures	N/A
Monitoring frequency	Hourly
QA/QC procedures	Data is obtained from CDEC-SIC databases.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	B_i
Unit	MWh
Description	Electricity generated of the i^{th} plant on margin during hour h
Source of data	CDEC-SIC
Value(s) applied	Data is provided in the emission factor calculation spreadsheet.
Measurement methods and procedures	N/A
Monitoring frequency	Hourly
QA/QC procedures	Data is obtained from official CDEC-SIC databases.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	**CEF_i**
Unit	$tonCO_2/GJ$
Description	Carbon emission factor of fuel used in i^{th} plant
Source of data	IPCC Reports
Value(s) applied	Please refer to Table 12 in Appendix 4.
Measurement methods and procedures	N/A
Monitoring frequency	IPCC publications will be checked annually in order to confirm the values of the parameter
QA/QC procedures	N/A
Purpose of data	Calculation of baseline emissions
Additional comment	IPCC 2006 was used. Because parameter is monitored ex-post, another version of IPCC might be available in the future.

Data / Parameter	**$Oxid_i$**
Unit	fraction
Description	Fraction of fuel oxidized on combustion.
Source of data	IPCC Reports
Value(s) applied	1
Measurement methods and procedures	N/A
Monitoring frequency	IPCC publications will be checked annually in order to confirm the values of the parameter
QA/QC procedures	N/A
Purpose of data	Calculation of baseline emissions
Additional comment	IPCC 2006 was used. Because parameter is monitored ex-post, another version of IPCC might be available in the future.

B.7.2. Sampling plan

>> Not applicable.

B.7.3. Other elements of monitoring plan

>> During year 2005, Colbún S.A. merged with Hidroeléctrica Cenelca S.A., including the assets that belonged to this company, which considered the set of hydroelectric power plants owned by Hidroelectrica Guardia Vieja S.A.

Consequently, the administration, operation, maintenance, commercial aspects and environmental management of Quilleco Power Plant is currently conducted by Colbún S.A.

In order to fulfil the commitments established in Quilleco Project Design Document, and the ones associated to the related Emission Reduction Purchase Agreement, Colbún S.A. has the following CDM functional management structure:

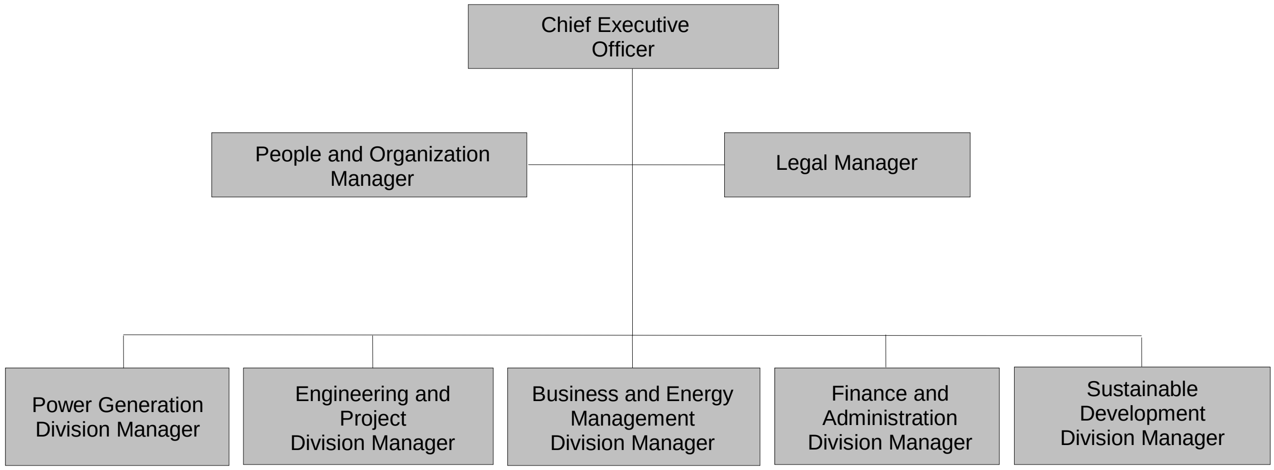

Figure 6. CDM Responsibilities structure

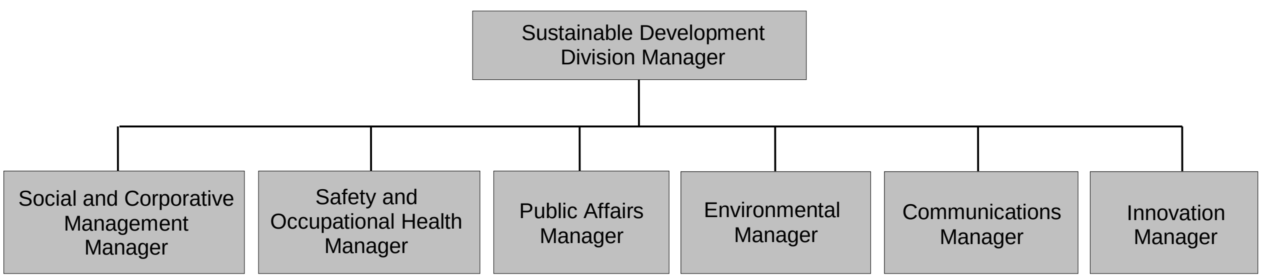

Figure 7. Sustainable Development Department structure

Under this structure CDM related responsibilities are accomplished as follows:

- Internal training:

I. Trainings related to specific operational procedures such as PO.17.Verification and replacement of energy meters and PO.18. Data collection from energy meters, established in the Management and Operation System Manual, and CDM topics are executed by the Innovation Department from the Sustainable Development Division.

II. Operator trainings are performed by a staff which is established by the Power Plant Manager (from the Hydroelectric Power Plants Department – Power Generation Division).

- Monitoring and record keeping of power generation data (data recording, measurements, etc.): The responsible for monitoring related data to the CER's calculation are the Power Plant Staff (Operations) (from the Power Generation Division), TI Management (from Finance and Administration Division).

- Generation and maintenance activities: Power plant staff as a part of the Power Generation Division.

- CER’s calculation: This is performed by the Innovation Department (as part of the Sustainable Development Division) and includes accounting for the generation of ERs including monitoring, record keeping, computation of ERs, on site trainings, audits and verifications.

Monitoring system

The monitoring methodology determines the baseline emissions by observing the actual power dispatch data from CDEC-SIC and the official expansion plan provided by CNE.

The monitoring methodology involves the monitoring of the following:

- Electricity generated and fed into the grid by the proposed CDM project, and other CDM registered projects (data available at CDEC-SIC).
- Public data on dispatch of electricity and other relevant information from the CDEC-SIC. This data is used to calculate the emission factor for the operating margin based on a dispatch increment analysis.
- Data needed to calculate the emission factor consistent with the Consolidated Baseline methodology for grid-connected electricity generation from renewable sources (AM0026 v.3.0).

The project participant has established all the procedures and responsibilities related to the fulfilment of CDM issues as part of the company’s Integrated Management System (IMS) Manual. In this system are included all the CERs related procedures, such as the monitoring, verification and others procedures, in order to assure the proper development of the monitoring plan activities.

Monitoring equipment

At Quilleco substation there are two primary energy meters, presented as M1 and M2. Electricity generation supplied to the grid shall be measured at Quilleco substation, owned and operated by Colbún S.A., where the project connects to the grid (primary measurement).

At Quilleco Power Plant (the project site) there are also two energy meters located at the generator units, which are defined as redundant energy meters and are presented in the following figure as M3 and M4. These meters are used as back-up meters, in case M1 and M2 fail (secondary measurement for CDM purposes).

Energy measurements from M1 and M2 meters are crosschecked with the records for sold electricity, which are publicly available in the CDEC-SIC web site.

In the event that M1 and M2 are found to be faulty, they will be repaired or replaced as soon as possible, and data from back-up meters will be used (M3 and M4).. In isolated cases where M3 and M4 measurements are lower than M1 and M2 measurements, M3 and M4 measured values are conservatively considered for the emission reduction calculation.

Also, the Project requires electricity for auxiliary services (own consumptions of the power plant), which is fed through a separate direct power line. This electricity is measured by a dedicated electricity meter (M5), located at Rucúe substation, so what is read by M1 to M4 excludes the auxiliary service consumptions.

The following simplified diagram illustrates the connection lines for Quilleco Hydroelectric Power Plant to the grid and the specific line for auxiliary services:

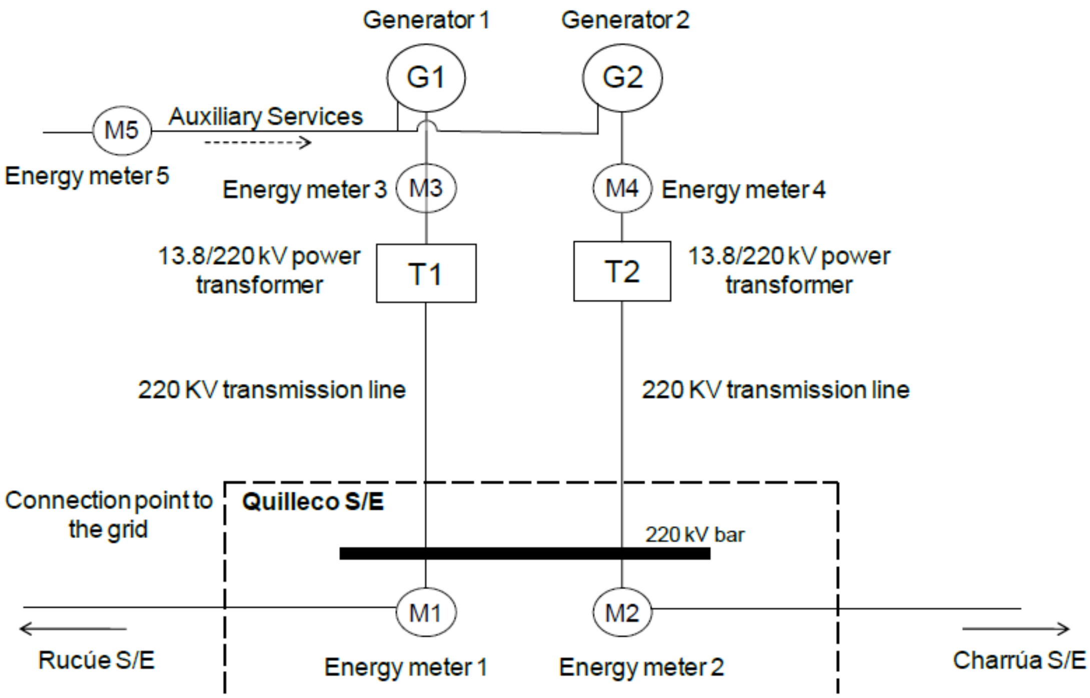

Figure 8. Measurement equipment diagram

The parameter "Generation$_y$" will be determined as the electricity generation supplied by the project activity at the interconnection point, and be measured with primary meters (M1 and M2), minus the electricity consumption for auxiliary services of the project activity (measured with meter M5).

$$Generation_y = (M1+M2-M5)$$

B.7.4. Date of completion of application of methodology and standardized baseline and contact information of responsible persons/ entities

>> The baseline and monitoring methodology application was completed on: 10/12/2014

Name of person/entity determining the baseline and monitoring methodology:

María Luz Farah (marialuz.farah@poch.cl)
Poch Ambiental S.A.
This entity is not a Project participant.

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

>> The project start date corresponds to 26/10/2004.

Quilleco hydroelectric project was implemented based on the Board of Directors decision on 26/10/2004 to invest in the Project. The decision to invest was an irrevocable decision, which took into consideration the expectation of carbon finance revenue from the project.

C.1.2. Expected operational lifetime of project activity

>> The operational lifetime of run-of-river hydropower plants is estimated over 30 years, 0 months.

C.2. Crediting period of project activity

C.2.1. Type of crediting period

>>7 years two times renewable.
This is the second crediting period.

C.2.2. Start date of crediting period

>>09/07/2015

C.2.3. Length of crediting period

7 years, 0 months.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>> The project complies with the specific applicable regulations of the host country in regard to Environment Impact Assessment (EIA). The EIA follows the regulations for EIA System set in Chile by the Supreme Decree N 30/97 of the Ministry General Secretariat of the Presidency, Regulation for the Environmental Impact Assessment System and its modifications set in Supreme Decree N 95/2001, and the Act N 19300 on the Environmental Framework. Review and clearance of EIA is a perquisite for an environmental license issued by the National Commission for the Environment (CONAMA). The EIA has also passed the World Bank's Safeguard Policies, included in the Project Appraisal Document (PAD) completed by the Bank on April 2006. PAD included an analysis of ten World Bank safeguard policies that the Project could be triggered by the Project. Safeguards like Environmental Assessment, Safety on Dams or Cultural Property were identified to have a Low Risk to be triggered and if so specific measures to be taken were included within PAD.

The EIA discusses a wide range of environmental impacts related to physical, biotic, human, cultural, patrimonial and landscapes impacts during the plant's construction and operation stages. It identifies the risk or contingency zones and the type of risk associated to them. It also discusses a number of corrective measures and establishes an environmental management plan to deal with the impacts identify. This plan addresses the significant and medium impacts providing measures for their mitigation, restoration or compensation.

In regard of environmental impacts of the project, the approval report recommends a number of measures to mitigate environmental impacts during the construction and implementation phases, which are the following:

- Minimum Ecological Flow: The Minimal Ecological Flow (MEF) is the most important environmental aspect for project operation phase. The MEF was defined by EULA in October 2002, approved by COREMA and added as part of the Environmental Qualification Resolution (26/12/2000). The conservative In-stream Flow Increase Methodology (IFIM) was used by EULA for the first time in Chile for MEF determination. Criteria of this methodology include landscape, habitat and biodiversity conservation. Special emphasis was given in this case to avoid the extinction of endangered and vulnerable fish species. Some of the detected species are man introduced fish species, but they have economic value associated to fishing activities.

  The MEF will be monitored at three points within the area if influence of the project, as recommended by EULA: (i) the South arm of the Laja River on a critical stretch of 2km will be monitored via remote signal in order to generate hourly data; (ii) the Laja River before Rucúe confluence will be monitored twice a year for 5 years; (iii) the Laja River after the Rucúe confluence in front of Quilleco aqueduct channel will be monitored twice a year for 5 years.

  Even though these monitoring measures are only recommendations from EULA, Colbún S.A. has ensured that they will be fully implemented as monitoring procedures for Quilleco's operation.

  The following table indicates MEF values established by EULA and accepted by COREMA. These values were included in the EIA Resolution.

Table 11. Minimum Ecological Flow for Quilleco Hydroelectric Project

River Section or Branch	MEF
Laja river before confluence of Laja river	>17 m^3/s
Laja river after Rucue confluence (south branch included) until Quilleco release	>17 m^3/s
South branch of Laja River, between Rucue confluence and 2 Km downstream	>6 m^3/s
South branch of Laja River, downstream of previous section	>13 m^3/s

Source: www.eula.cl

- Fauna: To mitigate impacts on aquatic fauna, water and terrestrial fauna, Colbún S.A. must maintain a Minimal Ecological Flow (MEF) of 6m^3/s in the south arm of Laja river along 2 km starting from Laja-Rucúe river union. The project area of influence involves 8 km of river system.

- Flora: For tree covered areas to be affected by works, project operator has to plant native trees (a minimum density of one tree per each 10 m^2). Colbún S.A will set out a 0.15 m layer of vegetal soil in every tree to be planted, a minimum of 0.5 m^2 of vegetal soil has to be put around the roots in order to facilitate root fixation. Species to be used are specified in the EIA resolution. – For pastures and bush areas to be affected by the project, Colbún S.A. will set out a 0.15 m layer of vegetal soil and plant with native species. - Local trees and bush species will be planted on slopes, embankments and working areas associated to the project according to an established plan.

- Water Quality: Run-of-river projects are considered benign to water quality. No major changes in water quality are expected from Quilleco plant operation. For the construction phase, every single potential water pollutant was identified during EIA and specific and suitable control measures to avoid underground and river water pollution were assessed and approved by the local environmental authority. The EIA established that water from the area of influence has in general a good quality considering requirements for irrigation, recreation, aquatic life and drinking purposes. No sewage emissions were observed. Variations in water parameters such as conductivity, dissolved solids and chlorine are caused by seasonal fluctuations of river flow only. Several river arms, mainly near the north shore, present low water level particularly in March due to low natural flow. Although water quality could be affected only during the construction phase of Quilleco, systematic monitoring of chemical and physical parameters of river water is contemplated for both the Rucúe and Quilleco projects.

- Waste and garbage management: - Arid deposits must be covered with 0.15 m of vegetal soil. – Project operator will maximize use of existing ways and routes and minimize construction of new ones – Project operator must fit out decantation pools for liquid waste from arid plants during construction phase - Garbage storage, transport and disposal are well defined in EIA. Supervision corresponds to Health Services. - Health Services will supervise treatment and disposal of sewage. Three treatment plants are considered for the construction phase. During operation, impacts will be significantly less than during construction. Sewage will be treated in a suitable treatment plant. Garbage will be stored adequately and disposed of systematically according to law.

- Land Value: In order to mitigate landscape impacts, the sponsor must implement re-vegetation and reforestation on exposed soils (soil cuts and embankments) - The EIA resolution specifies surface treatment (topography, upper layer) and tree species to be used for vegetation of arid deposits. - Colbún S.A. has to consider the following criteria for modeling arid deposits: a) Avoid topographic elements that denote artificiality, b) Respect natural topographic scales, c) Occult unavoidable visual impacts and d) Use vegetation in order to harmonize landscape.

- Natural Habitats: Through the MEF, Colbún S.A. ensures: a) Conservation of landscape structure of river system in the critical zone, b) Habitat conservation for all existing species, c) Conservation of Biodiversity of all species (micro algae, primary consumers and superior consumers), d) Increase of habitat usable surface for permanent and temporary species, e) Permanence of species under extinction risk as well as of vulnerable species e) Permanence of economically most important species (Onchorhynchus mykiss).

- Reforestation Plan: A reforestation plan was approved by CONAF. The plan includes recovery of land and planting of trees to compensate for trees cut during construction phase. Reforestation follow-up measures are considered as well. Plantation and transplantation measures are considered for some species. Rescue, relocation and habitat protection measures for flora and fauna are defined in the EIA for construction and for operating phase, with emphasis on species under protection.

D.2. Environmental impact assessment

>> Quilleco's EIA was approved in 26/12/2000 as COREMA was technically convinced that the established minimum ecological flow would not impact the ecosystem or the distribution of river branches. Irrigation channels are not affected by the project, since they operate downstream of the area of influence. The project will not produce large impacts on landscape value.

All objections were assessed and officially cleared up by COREMA in a meticulous way including those generated by lack of public information. Suitable mitigation, reparation and compensation measures are considered for minor impacts on life quality during construction and operation phases, particularly related to farming activities. Protection of livestock from stress generated by use of explosives during tunnel construction was not considered relevant, since operation will be executed away from permanent grazing zones. Furthermore, specific measures are considered for soil, natural water courses, transport, risk and emergency control, specially fire and spills.

Quilleco Hydroelectric Project does not entail any physical construction such as dams and dikes, or cause reservoir-like impoundments on the Laja River or any of its branches. Low height diversion weirs are placed on the river bed to ensure adequate diversion of water and hydraulic heads during the low-flow winter months.

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

>> **Local Authorities:**

In compliance with the Chilean environmental law, the EIA was distributed to 11 local authorities selected by COREMA in consideration to their legal relation to identified impacts of the project. These are:

- National Fishing Service (Servicio Nacional de Pesca)
- Municipality of Tucapel
- Municipality of Quilleco
- National Agriculture Service (Servicio Agrícola y Ganadero, SAG)
- Local Health Service (Servicio de Salud Bío Bío)
- National Energy Commission (Comisión Nacional de Energía, CNE)
- Fishing Undersecretary (Subsecretaría de Pesca)
- National Monument Council (Consejo de Monumentos Nacionales)
- General Water Directorate (Dirección General de Aguas, DGA)
- National Forestry Corporation (Corporación Nacional Forestal, CONAF)
- National Tourism Service (Servicio Nacional de Turismo, SERNATUR)

Local Community:

As established by the Chilean law, the EIA included a public consultation period of 60 days, which was conducted through announcements in local newspapers and workshops attended by representatives of the local community of Quilleco. All objections and questions posed by Quilleco community were assessed and officially cleared up by the local environmental authority (COREMA) in a meticulous way.

Even though the EIA was approved about 5 years ago (26/12/2000), COREMA will not make further requirements to Colbún S.A. or changes to the EIA resolution. Nevertheless, COREMA has monitored the environmental commitments since project construction begun.

E.2. Summary of comments received

>> Comments received by local authorities and the community relate to the following aspects: Increased erosion deterioration of the landscape, air emissions, noise generation during construction, loss of vegetation and biodiversity due to project operation, loss of agricultural area, lack of water for biological functions in the river, extinction of fish species in Laja river, employment generation and archaeological site founding. Details of each of the comments received can be obtained from the EIA process at CONAMA's web site www.seia.cl

E.3. Report on consideration of comments received

>> Comments, observations and questions received from above mentioned authorities and local communities were answered by Colbún S.A during the EIA process. The answers were compiled in four documents added to the EIA before the final approval by COREMA. Most legal permissions and authorizations required to carry out the project were obtained in 1998 and 1999.

Apart from the above comments, no major issues were raised that could be related to the environmental or CDM aspect of the project. All comments and questions were duly taken into account by the project developer for the construction and operation of the project.

Every single impact and risk was assessed by the local environmental and social authorities and discussed in detail with the project operator and third parties involved.

With respect to environmental monitoring, most sensitive aspects correspond to the conservation of two endangered fish species existing within the area of influence, and monitoring of Minimal Ecological Flow (MEF) within the area of influence.

Appropriate measures were met to ensure conservation of endangered species, which are included in the Environmental Monitoring Plan. On the other hand, even though MEF measurement frequency was not defined within EIA resolution, Colbún S.A. committed itself to implement MEF monitoring measures, including techniques and frequency according to recommendations made by EULA from the University of Concepción (see 7.5.2.c).

Colbún S.A. will implement a follow up plan in order to know and assess projects effects on water quality for aquatic species, biodiversity and hydro-biological resources under following considerations, conditions and requirements, and will complement this monitoring with independent environmental audits (with previous agreement of COREMA). Results of the follow up plan will be submitted to COREMA and relevant authorities in the form of reports of all activities committed. All data and resolving actions of a problem will be informed to COREMA within 24 hours after detection. Changes in the follow up plan will be informed to relevant authorities and no change will be implemented before approval by COREMA. Colbún S.A. will construct a monitoring station downstream of Rucúe discharge channel.

SECTION F. Approval and authorization

>> The letters of approval are available at the following link:
http://cdm.unfccc.int/Projects/DB/DNV-CUK1185438104.23/view

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Appendix 1. Contact information of project participants and responsible persons/ entities

Project participant and/or responsible person/ entity	☒ Project participant ☒ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
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Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
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Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
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Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
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Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
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Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
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Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
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Appendix 2. Affirmation regarding public funding

There is no public funding in the project. The fund used to financing is not diversion of ODA

Appendix 3. Applicability of methodology and standardized baseline

N/A. All the background information on the applicability of the selected methodology is presented in the PDD.

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

The following table shows the net calorific values (from national energy balance) and CO_2 emission factor (from IPCC 2006 guidelines) for each fuel considered for OM and BM calculation:

Table 12. Fuels data

Fuel type considered for each power plant operating in 2013	$EF_{CO2,i}$ (tCO_2/GJ)	NCV_i ($GJ/kg; GJ/m^3$)
Bituminous Coal	0.0895	0.027842
Petcoke	0.0829	0.027842
Diesel Oil	0.0726	0.043354
Natural Gas	0.0543	0.035198
LNG	0.0543	0.035198
Residual Fuel Oil	0.0755	0.041763
LPG	0.0616	0.048127
Butane gas	0.0616	0.048127
Propane gas	0.0616	0.048127
Butane/Propane	0.0616	0.048127

The following table shows the power units and parameters considered in the OM 2013 calculation:

Table 13. Power units data for OM 2013 calculation:

Common Name	Fuel	SFC_i (kg/MWh or m^3/MWh)	d_i (tCO_2/MWh)
Abanico	Run of the River	0.0	0.000000
Aconcagua Blanco	Run of the River	0.0	0.000000
Aconcagua Juncal	Run of the River	0.0	0.000000
Alfalfal	Run of the River	0.0	0.000000
Allipen	Run of the River	0.0	0.000000
Ancali	Biomass	0.0	0.000000
Ancud	Diesel Oil	0.0	0.000000
Antilhue TG	Diesel Oil	234.6	0.738291
Antuco	Dam	0.0	0.000000
Arauco	Biomass	0.0	0.000000
Biomar	Diesel Oil	0.0	0.000000
Bocamina 1	Bituminous Coal	385.0	0.959450
Bocamina 2	Bituminous Coal	341.3	0.850598
Cabrero	Biomass	0.0	0.000000

Common Name	Fuel	SFC_i (kg/MWh or m^3/MWh)	d_i (tCO_2/MWh)
Callao	Run of the River	0.0	0.000000
Calle-Calle	Diesel Oil	223.0	0.701844
Campiche	Petcoke	363.4	0.838843
Candelaria 1	Natural Gas	0.0	0.000000
Candelaria 1	Diesel Oil	283.6	0.892676
Candelaria 1	LNG	325.8	0.622747
Candelaria 2	Natural Gas	0.0	0.000000
Candelaria 2	Diesel Oil	283.6	0.892676
Candelaria 2	LNG	325.8	0.622747
Canela 1	Wind	0.0	0.000000
Canela 2	Wind	0.0	0.000000
Cañete	Diesel Oil	206.4	0.649523
Canutillar	Dam	0.0	0.000000
Capullo	Run of the River	0.0	0.000000
Carbomet	Run of the River	0.0	0.000000
Cardones	Diesel Oil	0.0	0.000000
Carena	Run of the River	0.0	0.000000
Casablanca 1	Diesel Oil	0.0	0.000000
Casablanca 2	Diesel Oil	0.0	0.000000
Cem Bio Bio DIESEL	Diesel Oil	0.0	0.000000
Cem Bio Bio IFO	Residual Fuel Oil	218.0	0.687383
Cenizas	Diesel Oil	255.8	0.805248
Chacabuquito	Run of the River	0.0	0.000000
Chacayes	Run of the River	0.0	0.000000
Chiburgo	Run of the River	0.0	0.000000
Chiloe	Diesel Oil	269.2	0.847171
Cholguan	Biomass	0.0	0.000000
Chuyaca	Diesel Oil	239.8	0.754901
Chuyaca 2	Diesel Oil	0.0	0.000000
Cipreses	Dam	0.0	0.000000
Colbun	Dam	0.0	0.000000
Colihues	Diesel Oil	0.0	0.000000
Colihues	Residual Fuel Oil	206.1	0.649815
Collipulli	Diesel Oil	0.0	0.000000
Colmito	Diesel Oil	248.0	0.780586
Concon	Diesel Oil	313.1	0.985356
Confluencia	Run of the River	0.0	0.000000
Constitucion	Diesel Oil	0.0	0.000000
Constitucion	Biomass	0.0	0.000000

Common Name	Fuel	SFC_i (kg/MWh or m^3/MWh)	d_i (tCO_2/MWh)
Celco	Biomass	0.0	0.000000
Contulmo	Run of the River	0.0	0.000000
Coya	Run of the River	0.0	0.000000
Curacautin	Diesel Oil	245.5	0.772635
Curanilahue	Diesel Oil	0.0	0.000000
Curauma	Diesel Oil	336.6	1.059380
Curico	Bituminous Coal	0.0	0.000000
Curillinque	Run of the River	0.0	0.000000
Diego de Almagro	Diesel Oil	489.4	1.540387
Danisco	Diesel Oil	0.0	0.000000
Degan	Diesel Oil	218.9	0.688904
Diuto	Run of the River	0.0	0.000000
Don Walterio	Run of the River	0.0	0.000000
Dongo	Run of the River	0.0	0.000000
Eagon	Diesel Oil	0.0	0.000000
El Canelo	Run of the River	0.0	0.000000
El Llano	Run of the River	0.0	0.000000
El Manzano	Run of the River	0.0	0.000000
El Peñon	Diesel Oil	215.9	0.679693
El Rincon	Run of the River	0.0	0.000000
El Salvador	Diesel Oil	545.0	1.715271
El Tartaro	Run of the River	0.0	0.000000
El toro	Dam	0.0	0.000000
Emelda 1	Diesel Oil	352.8	1.110501
Emelda 2	Diesel Oil	352.8	1.110501
Energia Pacifico	Biomass	0.0	0.000000
Ensenada	Run of the River	0.0	0.000000
Escuadron	Biomass	0.0	0.000000
Esperanza 1	Diesel Oil	380.3	1.197004
Esperanza 2	Diesel Oil	380.3	1.197004
Esperanza TG	Diesel Oil	0.0	0.000000
Estancilla	Run of the River	0.0	0.000000
Eyzaguirre	Run of the River	0.0	0.000000
Florida	Run of the River	0.0	0.000000
Guacolda 1	Bituminous Coal	369.7	0.921167
Guacolda 2	Bituminous Coal	367.5	0.915837
Guacolda 3	Bituminous Coal	352.9	0.879374
Guacolda 4	Bituminous Coal	358.4	0.893082
Guayacán	Run of the River	0.0	0.000000
HBS	Diesel Oil	0.0	0.000000
Horcones	Diesel Oil	351.1	1.105158

Common Name	Fuel	SFC_i (kg/MWh or m^3/MWh)	d_i (tCO_2/MWh)
Horcones	Natural Gas	0.0	0.000000
Hornitos	Run of the River	0.0	0.000000
Huasco TG	Residual Fuel Oil	0.0	0.000000
Huasco TV	Bituminous Coal	0.0	0.000000
Isla	Run of the River	0.0	0.000000
JCE	Diesel Oil	252.6	0.795030
Juncalito	Run of the River	0.0	0.000000
Laguna Verde	Bituminous Coal	0.0	0.000000
Laguna Verde	Diesel Oil	412.0	1.296780
La Arena	Run of the River	0.0	0.000000
La Higuera	Run of the River	0.0	0.000000
La Paloma	Run of the River	0.0	0.000000
Laja	Biomass	0.0	0.000000
Laja 1	Run of the River	0.0	0.000000
Lajacmpc	Biomass	0.0	0.000000
Las Pampas	Run of the River	0.0	0.000000
Las Vegas	Diesel Oil	213.0	0.670442
Las Vertientes	Run of the River	0.0	0.000000
Lautaro	Biomass	0.0	0.000000
Lebu	Diesel Oil	281.1	0.884881
Lebu	Wind	0.0	0.000000
Lican	Run of the River	0.0	0.000000
Licanten	Biomass	0.0	0.000000
Linares Norte	Diesel Oil	364.9	1.148563
Lircay	Run of the River	0.0	0.000000
Loma Alta	Run of the River	0.0	0.000000
Los Colorados	Biomass	0.0	0.000000
Lonquimay	Diesel Oil	0.0	0.000000
Los alamos	Diesel Oil	0.0	0.000000
Los Corrales	Run of the River	0.0	0.000000
Los Corrales II	Run of the River	0.0	0.000000
Los Espinos	Diesel Oil	211.8	0.666603
Los Hierros	Run of the River	0.0	0.000000
Los Molles	Run of the River	0.0	0.000000
Los Morros	Run of the River	0.0	0.000000
Los Pinos	Diesel Oil	179.8	0.566060
Los Quilos	Run of the River	0.0	0.000000
Angol 1	Diesel Oil	159.6	0.502478
Angol 2	Diesel Oil	184.5	0.580867
Los Vientos TG	Diesel Oil	270.6	0.851825
Louisiana Pacific	Diesel Oil	0.0	0.000000

Common Name	Fuel	SFC_i (kg/MWh or m^3/MWh)	d_i (tCO_2/MWh)
Machicura	Run of the River	0.0	0.000000
Maitenes	Run of the River	0.0	0.000000
Mallarauco	Run of the River	0.0	0.000000
Mampil	Run of the River	0.0	0.000000
Mariposas	Run of the River	0.0	0.000000
Maule	Diesel Oil	254.3	0.800286
Bonito	Run of the River	0.0	0.000000
Monte Patria	Diesel Oil	0.0	0.000000
Monte Redondo	Wind	0.0	0.000000
Muchi	Run of the River	0.0	0.000000
Multiexport 1	Diesel Oil	0.0	0.000000
Multiexport 2	Diesel Oil	0.0	0.000000
Nalcas	Run of the River	0.0	0.000000
Negrete	Wind	0.0	0.000000
Nehuenco 1	Natural Gas	0.0	0.000000
Nehuenco 1	Diesel Oil	341.0	1.073426
Nehuenco 1	LNG	192.8	0.368574
Nehuenco 2	Natural Gas	0.0	0.000000
Nehuenco 2	Diesel Oil	142.2	0.447485
Nehuenco 2	LNG	189.0	0.361176
Nehuenco 9B	Natural Gas	0.0	0.000000
Nehuenco 9B	Diesel Oil	266.3	0.838062
Nehuenco 9B	LNG	327.7	0.626255
Newen	Butane gas	0.0	0.000000
Newen	Diesel Oil	0.0	0.000000
Newen	Natural Gas	0.0	0.000000
Newen	Butane/propane	0.0	0.000000
Newen	Propane gas	0.0	0.000000
Nueva Aldea 1	Biomass	0.0	0.000000
Nueva Aldea 2	Diesel Oil	0.0	0.000000
Nueva Aldea 3	Biomass	0.0	0.000000
Nueva Renca	Natural Gas	0.0	0.000000
Nueva Renca	Diesel Oil	180.6	0.568389
Nueva Renca	LPG	108.4	0.321219
Nueva Renca	LNG	204.9	0.391703
Nueva Ventanas	Bituminous Coal	364.5	0.908390
Ojos de Agua	Run of the River	0.0	0.000000
Olivos	Diesel Oil	223.1	0.702151
Palmucho	Run of the River	0.0	0.000000
Pangue	Run of the River	0.0	0.000000
Pehuenche	Dam	0.0	0.000000

Common Name	Fuel	SFC_i (kg/MWh or m^3/MWh)	d_i (tCO_2/MWh)
Pehui	Run of the River	0.0	0.000000
Petropower	Petcoke	375.0	0.865574
Peuchen	Run of the River	0.0	0.000000
Pilmaiquen	Run of the River	0.0	0.000000
Placilla	Diesel Oil	229.1	0.721198
Polincay	Diesel Oil	0.0	0.000000
Providencia	Run of the River	0.0	0.000000
Puclaro	Run of the River	0.0	0.000000
Pullinque	Run of the River	0.0	0.000000
Punitaqui	Diesel Oil	0.0	0.000000
Punta Colorada	Diesel Oil	0.0	0.000000
Punta Colorada	Wind	0.0	0.000000
Punta Colorada	Residual Fuel Oil	219.0	0.690536
Puntilla	Run of the River	0.0	0.000000
Purisima	Run of the River	0.0	0.000000
Quellon 1	Diesel Oil	0.0	0.000000
Quellon 2	Diesel Oil	253.4	0.797618
Queltehues	Run of the River	0.0	0.000000
Quilleco	Run of the River	0.0	0.000000
Quintay	Diesel Oil	229.9	0.723757
Quintero 1	Diesel Oil	0.0	0.000000
Quintero 2	Diesel Oil	0.0	0.000000
Quintero 1	LNG	312.4	0.597107
Quintero 2	LNG	312.4	0.597107
Ralco	Dam	0.0	0.000000
Rapel	Dam	0.0	0.000000
Reca	Run of the River	0.0	0.000000
Renaico	Run of the River	0.0	0.000000
Renca	Diesel Oil	0.0	0.000000
Renca 2	Diesel Oil	0.0	0.000000
Rio Huasco	Run of the River	0.0	0.000000
Robleria	Run of the River	0.0	0.000000
Rucatayo	Dam	0.0	0.000000
Rucue	Run of the River	0.0	0.000000
Salmofood 1	Diesel Oil	0.0	0.000000
Salmofood 2	Diesel Oil	0.0	0.000000
San Andres	Run of the River	0.0	0.000000
San Clemente	Run of the River	0.0	0.000000
San Francisco de Mostazal	Diesel Oil	328.3	1.033245
San Gregorio	Diesel Oil	348.9	1.098267
San Ignacio	Run of the River	0.0	0.000000

Common Name	Fuel	SFC_i (kg/MWh or m^3/MWh)	d_i (tCO_2/MWh)
San Isidro 1	LNG	197.2	0.376854
San Isidro 1	Diesel Oil	174.1	0.547951
San Isidro 2	LNG	188.5	0.360324
San Isidro 2	Diesel Oil	171.0	0.538232
San Lorenzo	Diesel Oil	0.0	0.000000
Santa Irene	Biomass	0.0	0.000000
Santa Lidia	Diesel Oil	266.0	0.837346
Santa Maria	Bituminous Coal	367.5	0.915850
Santa Marta	Biomass	0.0	0.000000
Sauce Andes	Run of the River	0.0	0.000000
Sauzal 50Hz	Run of the River	0.0	0.000000
Sauzal 60Hz	Run of the River	0.0	0.000000
Sauzalito	Run of the River	0.0	0.000000
SDGx02	Solar	0.0	0.000000
Skretting	Diesel Oil	0.0	0.000000
Skretting Osorno	Diesel Oil	0.0	0.000000
Southern	Diesel Oil	0.0	0.000000
Santa Fe	Biomass	0.0	0.000000
Santa Fe 2	Biomass	0.0	0.000000
Talinay	Wind	0.0	0.000000
Tal Tal 1	LNG	348.4	0.665879
Tal Tal 1	Diesel Oil	318.2	1.001682
Tal Tal 2	LNG	348.5	0.666073
Tal Tal 2	Diesel Oil	0.0	0.000000
Tambo Real	Solar	0.0	0.000000
Tamm	Biomass	0.0	0.000000
Tapihue	Natural Gas	246.3	0.470783
Teno	Diesel Oil	216.8	0.682340
Termopacifico	Diesel Oil	218.7	0.688294
Coronel	Natural Gas	0.0	0.000000
Coronel	Diesel Oil	226.7	0.713524
Tirua	Diesel Oil	0.0	0.000000
Tomaval	Diesel Oil	0.0	0.000000
Totoral	Diesel Oil	219.0	0.689362
Totoral	Wind	0.0	0.000000
Traigen	Diesel Oil	209.3	0.658753
Trapen	Diesel Oil	214.0	0.673687
Trebal Mapocho	Biomass	0.0	0.000000
Trueno	Run of the River	0.0	0.000000
Truful Truful	Run of the River	0.0	0.000000
Ucuquer	Wind	0.0	0.000000

Common Name	Fuel	SFC_i (kg/MWh or m^3/MWh)	d_i (tCO_2/MWh)
Valdivia	Biomass	0.0	0.000000
Ventanas 1	Bituminous Coal	382.4	0.952914
Ventanas 2	Bituminous Coal	373.2	0.929880
Victoria	Diesel Oil	0.0	0.000000
Viñales	Biomass	0.0	0.000000
Volcan	Run of the River	0.0	0.000000
Watts	Diesel Oil	0.0	0.000000
Yungay 4	Diesel Oil	373.3	1.175077
Yungay 1	Diesel Oil	373.3	1.175077
Yungay 2	Diesel Oil	373.3	1.175077
Yungay 3	Diesel Oil	373.3	1.175077
Yungay 1	Natural Gas	297.0	0.567642
Yungay 2	Natural Gas	0.0	0.000000
Yungay 3	Natural Gas	0.0	0.000000

Appendix 5. Further background information on monitoring plan

All the information required is provided in section B.7.3.

Appendix 6. Summary of post registration changes

During the first crediting period the project activity has requested only a temporary deviation:
REF: I-DEV0405 “Use of redundant energy measurements instead of primary measurements for estimating baseline emissions”.
Current status: Deviation accepted on 28 Jun 2011.

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