Monitoring report form

(Version 05.1)

Complete this form in accordance with the Attachment "Instructions for filling out the monitoring report form" at the end of this form.

MONITORING REPORT	
Title of the project activity	Chile: Quilleco Hydroelectric Project
UNFCCC reference number of the project activity	1265
Version number of the monitoring report	01
Completion date of the monitoring report	13/05/2016
Monitoring period number and duration of this monitoring period	Fifth monitoring period (01/01/2015-08/07/2015)
Project participant(s)	Colbun S.A.[1]; Netherlands' Ministry of Infrastructure and the Environment (IenM) [2] ; International Bank for Reconstruction and Development (IBRD) as Trustee of the Netherlands CDM Facility (NCDMF) [3] ; Electrabel NV/SA; Idemitsu Kosan Co. [4] , Ltd.; Japan Petroleum Exploration Co,,Ltd.[5]; The Okinawa Electric Power Co., Inc.[6]; Sumitomo Joint Electric Power Co.[7], Ltd.; Suntory Holdings Limited [8] ; Tokyo Electric Power Company [9] , Incorporated; Sumitomo Chemical[10]; Italian Ministry for the Environment Land and Sea[11]; International Bank for Reconstruction and Development (IBRD) as Trustee of the Bio Carbon Participants (BioCF) [12] ; Ministry of Sustainable Development and Infrastructure[13]; Kingdom of Spain- Ministry of the Agriculture, Food and

[1] Valid from 19/02/2016

[2] Withdrawn on 19/08/2014

[3] Withdrawn on 02/09/2014

[4] Added on 12/05/2015

[5] Added on 12/05/2015

[6] Added on 12/05/2015

[7] Added on 12/05/2015

[8] Added on 12/05/2015

[9] Added on 12/05/2015

[10] Added on 12/05/2015

[11] Added on 09/06/2015

[12] Added on 08/12/2015

[13] Added on 09/06/2015

	Environment & Ministry of Economy and Competitiveness[14].	
Host Party	Chile	
Sectoral scope(s)	Sectoral Scope 1: Energy industries (renewable - / non-renewable sources).	
Selected methodology(ies)	AM0026 "Methodology for zero-emissions grid-connected electricity generation from renewable sources in Chile or in countries with merit order based dispatch grid" (version 2). ACM0002 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (version 6).	
Selected standardized baseline(s)	Not applicable	
Estimated amount of GHG emission reductions or net GHG removals by sinks for this monitoring period in the registered PDD	89,154 tCO_2e	
Total amount of GHG emission reductions or net GHG removals by sinks achieved in this monitoring period	GHG emission reductions or net GHG removals by sinks reported up to 31 December 2012	GHG emission reductions or net GHG removals by sinks reported from 1 January 2013 onwards
	Not applicable	58,880

[14] Added on 09/06/2015

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>> The Quilleco Hydroelectric Project consists of a run-of-river power plant of 70 MW effective installed capacity (71.76 MW turbines nameplate installed capacity) run-of-the-river hydropower plant 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 (Sistema Interconectado Central). The estimates were based on long-term observations of water conditions of the Laja River.

The project developer and operator is Colbun S.A., the second largest electric holding company in Chile, with a total installed capacity of 2,962 MW, from which 43% are hydraulic power units. In the third quarter of 2005 Colbun acquired Cenelca S.A. and Hidroelectrica Guardia Vieja A.S (HGV). The latest company was one of the first private companies worldwide to submit hydroelectric projects under the Kyoto Protocol CDM, this is the case of Chacabuquito (26 MW) power plant, operating since 01/07/2002.

Quilleco uses well-proven technologies for run-of-river power generation. The project considers a 4.4 km concrete channel, 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 a 220 kV double circuit transmission line connected to the existing 220 kV double circuit transmission line to the high voltage Charrúa substation in the Central Interconnected System (SIC).

The total GHG emissions reductions achieved during this monitoring period is 58,880 tonnes of CO_2e.

In the following table there are presented the relevant dates for the project activity. It´s important to note that the project activity has operated continuously since the starting of the commissioning date.

Table 1. Relevant dates for the project activity

Date	Event
20/01/2005	The construction activities started
17/04/2007	Commissioning date
30/04/2007	Start of commercial operation
09/07/2008	Registration date and starting date of the crediting period

A.2. Location of project activity

>> Quilleco Hydroelectric Project is located in the 8th region of Bio-Bío of Chile (Host Party) in the commune of Quilleco, Bio-Bío province, 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.

In the following table are presented the GPS coordinates of the project in lat/long and decimal degrees.

Table 2. Project GPS Coordinates

	Latitude	Longitude
Power house	37°20'10"S / -37.33611111111111	71°56'59"W / -71.94972222222222
Intake	37°21'26"S / -37.35722222222223	71°52'39"W / -71.8775

The location of the project activity is illustrated in Figure 1 and Figure 2

Figure 1. Project activity geographical location

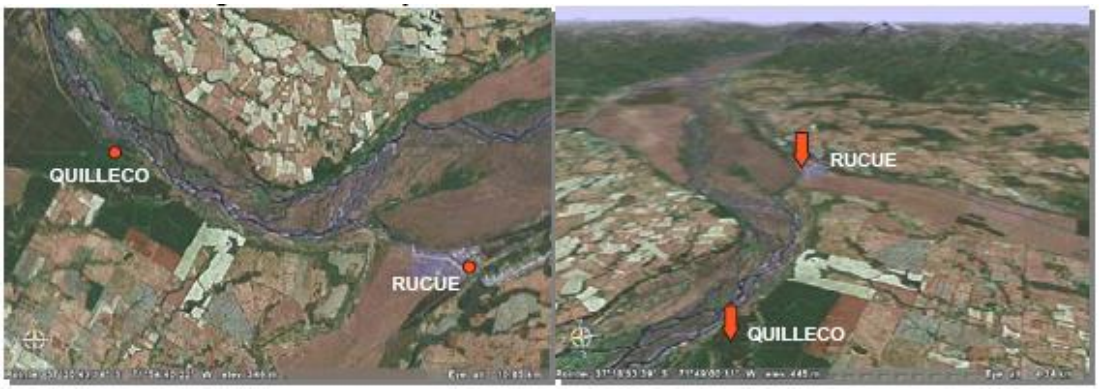

Figure 2. Project Location. Satellite and Panoramic View

A.3. Parties and project participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate whether the Party involved wishes to be considered as project participant (yes/no)
Chile (host)	Colbun S.A. [15] (Private Entity)	No
Netherlands	Netherlands' Ministry of Infrastructure and the Environment (IenM)[16] (Public Entity); International Bank for Reconstruction and Development (IBRD) as Trustee of the Netherlands CDM Facility (NCDMF)[17] (Public Entity).	No
United Kingdom of Great Britain and Northern Ireland	Electrabel NV/SA (Private Entity)	No

[15] Valid from 19/02/2016

[16] Withdrawn on 19/08/2014

[17] Withdrawn on 02/09/2014

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate whether the Party involved wishes to be considered as project participant (yes/no)
Japan	Idemitsu Kosan Co., Ltd. [18] (Private Entity); Japan Petroleum Exploration Co., Ltd.[19] (Private Entity); The Okinawa Electric Power Co., Inc.[20] (Private Entity); Sumitomo Joint Electric Power Co., Ltd.[21] (Private Entity); Suntory Holdings Limited [22] (Private Entity); Tokyo Electric Power Company, Incorporated [23] (Private Entity); Sumitomo Chemical[24] (Private Entity).	No
Italy	Italian Ministry for the Environment Land and Sea [25] (Public Entity); International Bank for Reconstruction and Development (IBRD) as Trustee of the Bio Carbon Participants (BioCF) [26] (Public Entity).	Yes
Luxembourg	Ministry of Sustainable Development and Infrastructure[27] (Public Entity).	Yes
Spain	Kingdom of Spain- Ministry of the Agriculture, Food and Environment & Ministry of Economy and Competitiveness[28] (Public Entity).	Yes

A.4. Reference of applied methodology and standardized baseline

>> The applied methodology is: AM0026: "Methodology for zero-emissions grid-connected electricity generation from renewable sources in Chile or in countries with merit order based dispatch grid" (Version 2.0).
http://cdm.unfccc.int/methodologies/DB/OOI7OYUFZOXN07H7EDBA9GVHJ4GK20

[18] Added on 12/05/2015

[19] Added on 12/05/2015

[20] Added on 12/05/2015

[21] Added on 12/05/2015

[22] Added on 12/05/2015

[23] Added on 12/05/2015

[24] Added on 12/05/2015

[25] Added on 09/06/2015

[26] Added on 08/12/2015

[27] Added on 09/06/2015

[28] Added on 09/06/2015

The applied methodology refers to the methodology ACM0002 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (Version 6.0). This methodology is used as per PDD version 2.2 date 05/10/2012 although is no longer the official version.
http://cdm.unfccc.int/methodologies/DB/UB3431UT9I5KN2MUL2FGZXZ6CV71LT

The methodology also refers to the following methodological tool:

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

A.5. Crediting period of project activity

>>1st crediting period: 09/07/2008 – 08/07/2015 (7 years, Renewable)

A.6. Contact information of responsible persons/entities

>> Colbun S.A
Avenida Apoquindo 4775, 11th Floor, Las Condes, Santiago, Chile / +56 2 24604229 - +56 2 2 4604311, Innovation Manager: Mr. Cristián Mosella (cmosella@colbun.cl)

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

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

Table 3. Project technology

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 - 0.5 km 220 KV transmission line - Design flow: 130 m^3/s	- Effective installed capacity: 70 MW - Turbines nameplate installed capacity: 71.76MW - Average Net Generation: 422 GWh/year - Located 35 km east from Los Angeles city and 500 km south from Santiago - Construction time: 30 months

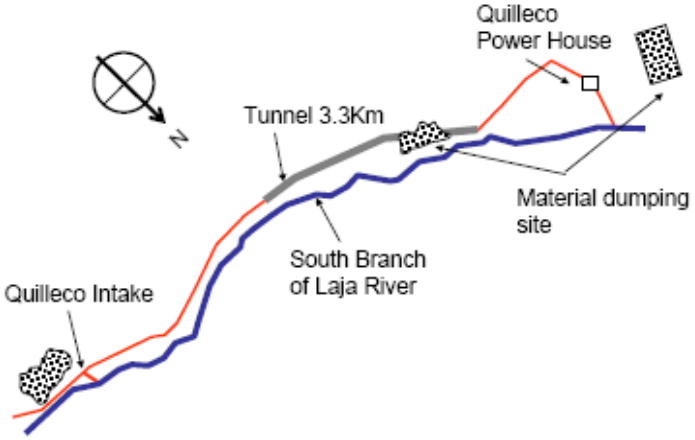

Figure 3. Project Design

Relevant dates and implementation status
The construction of the project activity started on 20/01/2005. The project started generating with Unit 1 on 17/04/2007, on 30/04/2007 Unit 1 was officially delivered to CDEC SIC, afterwards, on 28/05/2007 Unit 2 was also delivered.

During this monitoring period Quilleco power plant has continuously operated, with some exceptions due to the special events that are detailed in the table below. However, it is worth to mention that none of the following events are considered as a serious situation, and that they are part of the normal events faced by hydro power plants like Quilleco:

Table 4. Special events occurred during monitoring period

Unit	Start time	Start date	End time	End date	Details
U2	20:46	05-03-2015	23:25	05-03-2015	Failure
U1	8:48	12-03-2015	19:00	17-03-2015	Scheduled Maintenance
U2	8:36	13-03-2015	22:05	13-03-2015	Scheduled Maintenance
U2	10:26	26-03-2015	21:00	26-03-2015	Scheduled Maintenance
U1	8:09	05-06-2015	13:34	05-06-2015	Failure

Events reported in Table 4 don't have an impact on the applicability of the applied methodology.

No changes have been performed to the registered CDM project activity that required a prior approval by the Board.

B.2. Post-registration changes

B.2.1. Temporary deviations from registered monitoring plan, applied methodology or applied standardized baseline

>> Not applicable

B.2.2. Corrections

>> Not applicable

B.2.3. Changes to start date of crediting period

>> Not applicable

B.2.4. Inclusion of a monitoring plan to the registered PDD that was not included at registration

>> Not applicable

B.2.5. Permanent changes from registered monitoring plan, applied methodology or applied standardized baseline

>> Not applicable

B.2.6. Changes to project design of registered project activity

>> Not applicable

B.2.7. Types of changes specific to afforestation or reforestation project activity

>> Not applicable

SECTION C. Description of monitoring system

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Organization structure

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

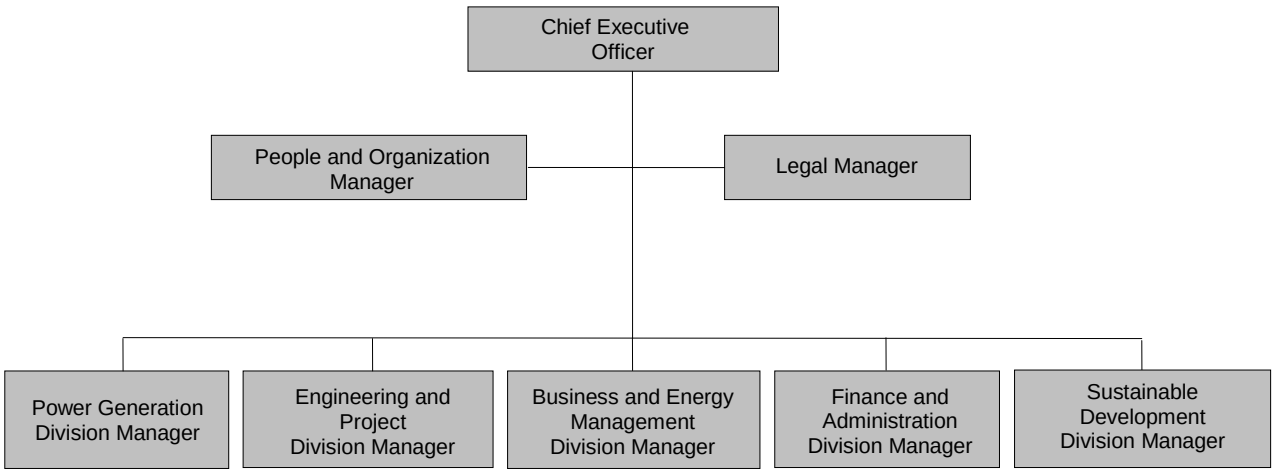

Figure 4. General Management structure

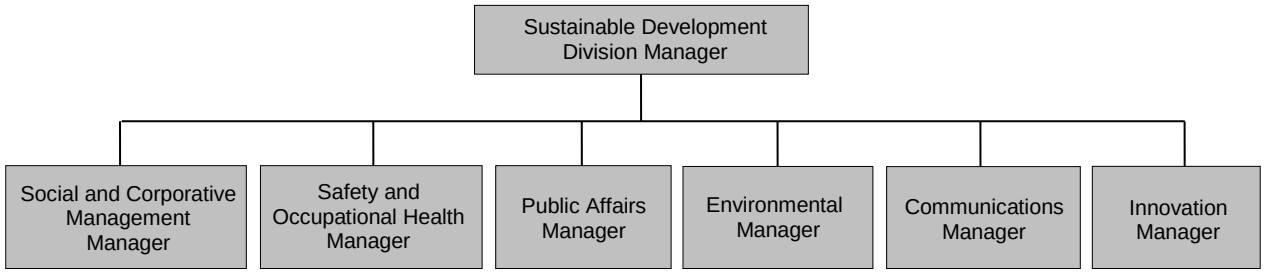

Figure 5. Sustainable Development Department structure

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 Manager.
  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 Manager).

- CER's trading: Innovation Department from the Sustainable Development Division Manager.

- Monitoring (data recording, measurements, etc.): The responsible for monitoring related data to the CER's calculation are the Power Plant Staff (Operations), TI Management (from Finance and Administration Division Manager), Innovation Manager (as part of the Sustainable Development Division Manager).

- CER's calculation: This is performed by the Innovation Department (as part of the Sustainable Development Division Manager).

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 the Economic Load Dispatch Centre, 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).

The project participant has developed a Management and Operation System Manual in order to establish all the procedures and responsibilities related to the fulfilment of CDM issues. This System includes all the procedures related to the monitoring plan, such as the monitoring and verification 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 Colbun 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 for cross-checking tasks (secondary measurement) for CDM purposes.

Measurements at M1 and M2 meters were crosschecked against 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), so what is read by M1 to M4 excludes the auxiliary service consumptions.

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

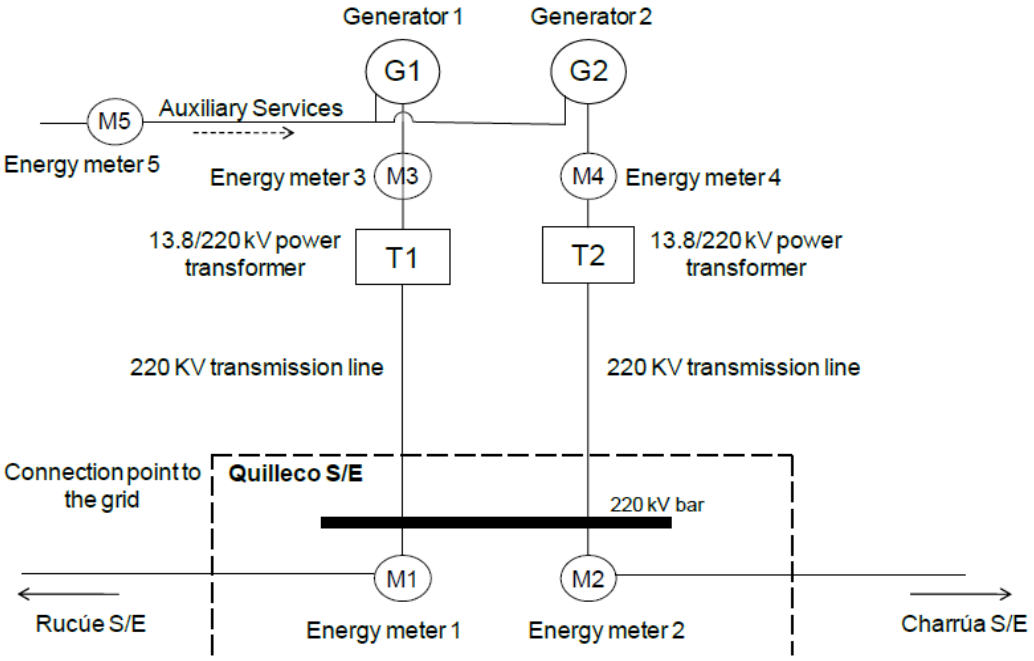

Figure 6. Measurement equipment diagram

For the current monitoring period, the generation is measured considering the two primary energy meters, presented as M1 and M2, and the auxiliary services through the accordingly calibrated meter, M5. Therefore, electricity generation supplied to the grid is measured at Quilleco substation, using the following equation:

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

Energy Measurement Equipment Periodic Calibration

During this monitoring period, the calibration of the meters was performed by CAM. Calibration dates of monitoring equipment are reported in the following table:

Table 5. Electricity meters information

M1 (Rucúe Line / Quilleco Substation)			
Calibration Dates	**Certifier**	**Equipment**	**Serial Number**
29/09/2014	CAM	ION 7650	PJ-0911A507-02
M2 (Charrúa Line / Quilleco Substation)			
Calibration Dates	**Certifier**	**Equipment**	**Serial Number**
29/09/2014	CAM	ION 7650	PJ-1009A683-02
M3 (Generator 1)			
Calibration Dates	**Certifier**	**Equipment**	**Serial Number**
30/09/2014	CAM	ION 7650	PJ-0911A868-02
M4 (Generator 2)			
Calibration Dates	**Certifier**	**Equipment**	**Serial Number**
30/09/2014	CAM	ION 7650	PJ-0911A860-02
M5 (Auxiliary Consumptions)			
Calibration Dates	**Certifier**	**Equipment**	**Serial Number**
02/10/2014	CAM	ION 7650	PJ-0911A866-02

Emergency procedures

The project participant has developed a Management and Operation System Manual based in the requirements of the ISO 14.001:2004 and OSHAS 18.001:2007 norms, which defines a structure that guarantees the adequate address of all matters related to the environment, security and emergency procedures, occupational health, as well as the fulfilment of CDM issues of the company.

This system includes the Contingency Plan, which states the procedures to address emergency situations that could occur during the operation of the company's power plants.

Monitoring of environmental, social and developmental impacts

The following two points are sustained beyond the construction phase of the project:

- Local community job creation (during the operation of the power plant):

The following table summarizes the amount of personnel and companies (local service suppliers) from the local communities currently working at Quilleco power plant:

Table 6. Personnel from local community currently working at Quilleco power plant

Company	Job performed at Quilleco Power Plant	Local Community	Amount of Workers
DINSA	Handyman	Villa Las Flores	1
G4S Seguridad	Security Guard	Canteras	1
		Antuco	1
		El Guindo	1
TRONGOL LTDA	Handymans, Day Laborers, Job Assistants	Villa Mercedes	3
		Cerro Yanqui	1
		Mirrihue	3
		Villa Las Flores	1
		El Guindo	1

- Increase in economic activity due to the Project Activity:

According to the implementation of Colbun's Sustainability Policy, an example of social and development positive impacts of the project activity in the local community corresponds to the FORCOM Programs, performed since 2008 with INACAP (a national technical educational institute), with who Colbun has implemented an educational program which provides competences and abilities to public school students.

During 2015, the FORCOM program performed the course "Development of employability skills" in the secondary schools Víctor Ríos Ruíz (community of Antuco), Isabel Riquelme (community of Canteras) and Francisco Bascuñan Guerrero (community of Quilleco). This course benefited more than 60 students, providing them with specialized knowledge and allowing them to achieve a certification provided by INACAP, improving their job access.

Monitoring of internal training during the monitoring period:

During the monitoring period, no training activities where performed.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante or at renewal of crediting period

Data/parameter:	Fuel Carbon Content
Unit	tC/TJ
Description	Determination of carbon content for different fuels
Source of data	IPCC Revised Guidelines
Value(s) applied)	**Fuel** / **Carbon content (tC/TJ)** Diesel / 20.2 Natural Gas / 15.30 Coal / 25.8 Petcoke / 27.13
Choice of data or measurement methods and procedures	Data from IPCC represents the most reliable information available
Purpose of data	Calculation of baseline emissions
Additional comments	There are no additional comments

Data/parameter:	Combustion efficiency
Unit	%
Description	Determination combustion efficiency of different fuel based generation technologies
Source of data	IPCC Revised Guidelines
Value(s) applied)	**Fuel** / **Combustion efficiency (%)** Diesel / 99.0 Natural Gas / 99.5 Coal / 98.0 Petcoke / 98.0
Choice of data or measurement methods and procedures	Data from IPCC represent the most reliable information available
Purpose of data	Calculation of baseline emissions
Additional comments	There are no additional comments

Data/parameter:	CO_2 conversion factor
Unit	%
Description	Molecular weight of carbon dioxide relative of that of carbon
Source of data	IPCC Revised Guidelines
Value(s) applied)	44/12=3.67
Choice of data or measurement methods and procedures	Data from IPCC represent the most reliable information available
Purpose of data	Calculation of baseline emissions
Additional comments	There are no additional comments

D.2. Data and parameters monitored

Data/parameter:	**$Generation_h$**
Unit	MWh
Description	Energy Generation of the Project for each hour "h"
Measured/calculated/default	Measured
Source of data	On-site metering system (same data submitted to CDEC-SIC)
Value(s) of monitored parameter	Please refer to emission reductions calculation spreadsheet
Monitoring equipment	During this monitoring period, energy was monitored using the following equipment: Meter M1: • Type: ION 7650 • Accuracy class: 0.2% • Serial number: PJ-0911A507-02 • Calibration frequency: Every two years • Last Calibration: 29/09/2014 Meter M2: • Type: ION 7650 • Accuracy class: 0.2% • Serial number: PJ-1009A683-02 • Calibration frequency: Every two years • Last Calibration: 29/09/2014 Meter M5: • Type: ION 7650 • Accuracy class: 0.2% • Serial number: PJ-0911A866-02 • Calibration frequency: Every two years • Last Calibration: 02/10/2014 The calibration for these meters during the monitoring period was carried out during September and October 2014, which for the local industry standard is valid for two years (for further details on the calibration dates of primary and redundant meters, please refer to Table 5 of this report).
Measuring/reading/recording frequency:	Hourly measurement
Calculation method (if applicable):	For the monitoring period the $Generation_h$ is obtained as follow: $Generation_h = (M1+ M2) - M5$ Electronic measurement system each 15 minutes. Verification procedures were based on redundant energy meters
QA/QC procedures:	Meters should have a maximum error of 0.2% and are calibrated periodically according to local standards for electricity transactions within the CDEC-SIC. Metering data is sent regularly to CDEC-SIC where a balance is made for energy transactions between power generators. Verification procedures were applied based on redundant energy meters
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**$COEF_{i, y}$**
Unit	tCO_2 per mass or volume

Description	CO_2 emission factor of each plant by fuel type used, taking into account the carbon content of the fuels used by relevant power sources i and percent of oxidation of fuel in year "y"
Measured/calculated/default	Calculated
Source of data	2006 IPCC Guidelines and CNE Node Price Reports
Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Yearly or twice a year
Calculation method (if applicable):	Calculation based on official data from CNE and 2006 IPCC Guidelines. Verification procedure was applied based on historical data per fuel type
QA/QC procedures:	Internal validation check was performed contrasting historical data for existing plants. For new plants, validation should be accomplished through fuel type normal emission factors form similar plants
Purpose of data:	Calculation of baseline emissions
Additional comments:	"i" refers to the power sources delivering electricity to the grid, not including low operating cost and must run power plants, and including imports to the grid

Data/parameter:	**EF_y**
Unit	tCO_2e/MWh
Description	CO_2e Emission factor of the displaced energy from the grid
Measured/calculated/default	Calculated
Source of data	Calculated based on formula f7 of this monitoring report
Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Annually
Calculation method (if applicable):	Calculated based on formula f7 of this monitoring report Calculation based on official data from CNEs Node Price Report and AM0026 procedures
QA/QC procedures:	Automatic calculation procedure through a revised worksheet
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**$EF_{OM,y}$**
Unit	tCO_2e/MWh
Description	Operating Margin Emission Factor
Measured/calculated/default	Calculated
Source of data	Calculated based on formula f1 of this monitoring report, using CDEC-SIC data
Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Annually

Calculation method (if applicable):	Calculated based on formula f1 of this monitoring report, using CDEC-SIC databases and AM0026 procedures
QA/QC procedures:	Automatic calculation procedure through a revised worksheet. Calculation was done after CDEC-SIC makes the data official (validation)
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**$EF_{j,h}$**
Unit	tCO_2e/MWh
Description	Operating Margin Emission Factor of hour "h"
Measured/calculated/default	Calculated
Source of data	Calculated based on formula f2 of this monitoring report, using CDEC-SIC data
Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Hourly
Calculation method (if applicable):	Calculated based on formula f2 of this monitoring report, using CDEC-SIC databases and AM0026 procedures.
QA/QC procedures:	Automatic calculation procedure through a revised worksheet. Calculation was done after CDEC-SIC energy balance to ensure data validity
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**D(j,i)**
Unit	MWh
Description	Energy displacement of the marginal plant "i" due to the proposed CDM project "j"
Measured/calculated/default	Calculated
Source of data	Calculated based on formula f3 of this monitoring report, using CDEC-SIC data
Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Hourly
Calculation method (if applicable):	Calculated based on formula f3 of this monitoring report, using CDEC-SIC databases and AM0026 procedures
QA/QC procedures:	Automatic calculated through a revised worksheet. Calculation was done after CDEC-SIC makes the data official (validation)
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**d_i**
Unit	tCO_2e/MWh
Description	Emission factor of the marginal plant "i"

Measured/calculated/default	Calculated
Source of data	2006 IPCC Guidelines and CNE node price report
Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Hourly
Calculation method (if applicable):	Calculated based on formula f4 of this monitoring report. Calculation based on official data from CNE. Verification procedures were applied based on historical data per fuel type
QA/QC procedures:	Calculation based on official data
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**SFC_i**
Unit	Ton/MWh or TJ/MWh
Description	Specific fuel consumption per unit of electricity produced in the "i^{th}" marginal plant
Measured/calculated/default	Estimated
Source of data	CNE node price report
Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Twice a year
Calculation method (if applicable):	Calculation based on official data from CNE. Verification procedure was applied based on historical data per fuel type.
QA/QC procedures:	Data is obtained from official reports. Historic comparison of each unit can provide data validation for existing and new units in the system. At the first priority, this parameter is obtained using the Yearly Fuel Consumption and the Annual Generation of each power source (information available in CDEC-SIC databases). If this information is not available, it is used the Specific Fuel Consumption, presented in CNE node price report.
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**M**
Unit	Number
Description	Number of electricity generation plants on margin, that would supply to the system in the absence of the CDM projects in the system
Measured/calculated/default	Estimated
Source of data	CDEC-SIC data
Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco.
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Hourly

Calculation method (if applicable):	Calculation based on f2 of this monitoring report, using CDEC-SIC databases and AM0026 procedures
QA/QC procedures:	Electronic worksheet was implemented to deliver automatic calculations through revised worksheet
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**N**
Unit	Number
Description	List of CDM plants in the system
Measured/calculated/default	Not applicable
Source of data	CDEC-SIC and UNFCCC registered projects for the country
Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	As required
Calculation method (if applicable):	Determined from CDEC-SIC databases
QA/QC procedures:	Data was obtained from official reports
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**C_j**
Unit	MWh
Description	Electric energy of the j^{th} CDM project of the system (j = 1,.. , N) in the hour "h"
Measured/calculated/default	Measured/Calculated
Source of data	CDEC-SIC
Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Hourly
Calculation method (if applicable):	Calculated based on CDEC-SIC databases and AM0026 procedures
QA/QC procedures:	Automatic calculation procedure through a revised worksheet. Calculation was done after CDEC-SIC makes the data official (validation)
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**A_i**
Unit	MW
Description	Generation capacity of i^{th} plant on margin during hour "h"
Measured/calculated/default	Measured
Source of data	CDEC-SIC databases

Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Hourly
Calculation method (if applicable):	Determined from CDEC-SIC databases
QA/QC procedures:	Data was obtained from official CDEC-SIC databases
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**B_i**
Unit	MWh
Description	Electric energy of the i^{th} plant on the margin during hour "h"
Measured/calculated/default	Measured
Source of data	CDEC-SIC databases
Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Hourly
Calculation method (if applicable):	Not applicable, the parameter is not calculated. Determined from CDEC-SIC databases
QA/QC procedures:	Data was obtained from official CDEC-SIC databases
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**$EF_{BM,y}$**
Unit	tCO_2e/MWh
Description	Build Margin Emission Factor of the grid for the year "y"
Measured/calculated/default	Calculated
Source of data	Calculated based on formula f5 of this monitoring report based on CNE Node Price Report and IPCC manual
Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco.
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Annually
Calculation method (if applicable):	Calculated based on formula f5 of this monitoring report using CDEC-SIC databases and AM0026 procedures
QA/QC procedures:	Automatic calculation using CDEC-SIC and official databases and CNE Node Price report values
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**$EF_{BM,i}$**
Unit	tCO_2e/MWh
Description	Emission Factor for the i^{th} plant in the Build Margin Cohort for the year "y"
Measured/calculated/default	Calculated
Source of data	Calculated based on formula f6 of this monitoring report, based on CNE Node Price Report, IPCC manual, CDEC-SIC databases.
Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Annually
Calculation method (if applicable):	Calculated from CDEC-SIC databases and AM0026 procedures
QA/QC procedures:	Official data was used
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**$Gen_{BM,i}$**
Unit	MWh
Description	Energy generation of the i^{th} plan on the Build Margin cohort
Measured/calculated/default	Estimated
Source of data	CDEC-SIC databases (for ex-post calculation)
Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Annually
Calculation method (if applicable):	Determined from CDEC-SIC databases
QA/QC procedures:	Automatic calculation through a revised worksheet using official CDEC-SIC databases
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**Plant name**
Unit	Text
Description	Plant name. Identification of power sources
Measured/calculated/default	Estimated
Source of data	CDEC-SIC databases
Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	As new power plants are available in the system

Calculation method (if applicable):	Determined from CDEC-SIC databases
QA/QC procedures:	Modify, if a new plant is available in the system
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**CEF_i**
Unit	TC per ton of fuel or TJ
Description	Carbon emission factor of fuel used in the i^{th} plant of the Build Margin cohort
Measured/calculated/default	Calculated
Source of data	Estimated based on official data form CNE node price reports and IPCC default values
Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Annually
Calculation method (if applicable):	Determined from IPCCC guidelines
QA/QC procedures:	Official data was used
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**$Oxid_i$**
Unit	%
Description	Fraction of fuel oxidized on combustion
Measured/calculated/default	Estimated
Source of data	2006 IPCC Guidelines
Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	As required
Calculation method (if applicable):	Determined from 2006 IPCC Guidelines
QA/QC procedures:	Official data was used
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**$SFC_{BM,i}$**
Unit	ton of fuel /MWh or TJ of fuel /MWh
Description	Specific fuel consumption of the i^{th} electricity generation plant
Measured/calculated/default	Estimated
Source of data	CNE Node Price Report and CDEC-SIC
Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco

Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Yearly or twice a year
Calculation method (if applicable):	Determined from 2006 IPCC Guidelines and official data form CNE Node Price Reports
QA/QC procedures:	Internal validation check was performed contrasting historical data for existing plants. For new plants, validation should be accomplished through fuel type normal emission factors for similar plants
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**w_{BM}**
Unit	%
Description	Weight for Build Margin emission factor
Measured/calculated/default	Default
Source of data	AM0026 default value = 50%
Value(s) of monitored parameter	50%
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Annually
Calculation method (if applicable):	Not applicable the parameter is not calculated
QA/QC procedures:	Official data was used
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**w_{OM}**
Unit	%
Description	Weight for Operating Margin emission factor
Measured/calculated/default	Default
Source of data	AM0026 default value = 50%
Value(s) of monitored parameter	50%
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Annually
Calculation method (if applicable):	Not applicable the parameter is not calculated
QA/QC procedures:	Official data was used
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**Changes in the regulatory framework that could affect the methodology**
Unit	Text
Description	Changes in the regulatory framework that could affect the methodology
Measured/calculated/default	Not applicable

Source of data	Official Gazette
Value(s) of monitored parameter	Not applicable. There has not been any change in the regulatory framework during the monitoring period
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	As required
Calculation method (if applicable):	Not applicable
QA/QC procedures:	Official data was used
Purpose of data:	Calculation of baseline emissions Calculation of project emissions Calculation of leakage
Additional comments:	There are no additional comments

D.3. Implementation of sampling plan

>> Not applicable

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

>> The Central Interconnected System (SIC) is coordinated by an independent entity called Economic Load Dispatch Centre (CDEC-SIC). The CDEC-SIC is responsible for optimal operation of the system based on the principle of lowest marginal costs.

The outcome is the hourly dispatch program and marginal cost for each power unit. The CDEC must coordinate in real time the dispatch at minimum cost of the power units according to the weekly programs. The weekly priority program Excel sheet contains a daily dispatch program which has three hour blocks: from hour 0 to 8, from 9 to 18, and from 19 to 24.

The CDEC-SIC publishes daily reports of the actual operation of the SIC, including the hourly generation for each power unit. This information is provided by CDEC-SIC and is available through its website.

In addition, CDEC-SIC publishes an Annual Report with fuel consumption of the mayor power units. On the other hand, the National Energy Commission (CNE) publishes every six months the Node Price Report, with the specific fuel consumption of most of the power units and the indicative expansion plan of the system. The information is publicly available at www.cne.cl.

Project emission reductions are calculated as a combined margin emission factor (CM), consisting of the weighted average of an operating margin (OM) and a build margin (BM), following AM0026 (v.2) approved methodology.

The OM emission factor from the project activity depends on the actual power generation data from the SIC. The dispatch data, obtained from the Economic Load Dispatch Centre (CDEC-SIC), conclusively indicates the type of generation displaced by the addition of Quilleco in the SIC generation mix. The monitoring and verification plan for the project uses the data provided by CDEC-SIC.

The BM emission factor is determined as option (i) in AM0026 v2.

The calculation of the project emissions reduction requires gathering and analyzing a considerable quantity of data for the estimation of the emission factor.

The amount of analyzed and processed data, and the complex procedures to be followed, do not allow a simple and expedite emission factor estimation. Then, in order to make the emissions reduction estimation accessible and efficient, the Project Participant has scheduled a Mathematical Tool for the Emissions Factor Calculation in Microsoft Office Excel. This Mathematical Tool permits qualified personnel to conduct ex-ante and ex-post emissions factor estimations based on available data.

In general terms, the procedure executed by the Emission Factor Calculation Mathematical Tool considers the following stages:

1. Data Acquisition
2. Operational Margin Emission Factor Calculation
3. Building Margin Emission Factor Calculation
4. Combined Margin Emission Factor Calculation

The first stage of the procedure consists on gathering the required information for the emissions factor estimation. The data to be gathered for the monitoring period is the energy generated and general data of all power plants of the system, the dispatch priority, fuel consumptions and information associated to the different fossil fuels used. This information is uploaded in the Mathematical Tool and its sources verified prior to its use.

The second, third and fourth stage of the estimation use the information previously uploaded, following the estimation procedures stated in the approved baseline and monitoring methodology AM0026 v2.

Finally, and using the Mathematical Tool, the emissions reductions associated to the operation of the project activity are calculated.

The following steps represent a description of the emissions reduction estimation associated to the project, which are applied in the Mathematical Tool with Microsoft Office Excel.

Operating Margin calculation

The operating margin emission factor is calculated as follows:

$$EF_{OM,y} = \frac{\sum_{h=1}^{H} EF_{j,h} \bullet Generation_{j,h}}{\sum_{h=1}^{H} Generation_{j,h}} \qquad \textbf{(f1)}$$

Where,

$EF_{j,h}$	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,
H	Total number of hours of the year "y".

The emission factor for any hour "h" for a CDM project "j" in the 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:

$$EF_{j,h} = \sum_{i=1}^{M} D(j,i) \bullet d_i \Big/ \sum D(j,i) \qquad \textbf{(f2)}$$

Where,

D(j,i)	Energy displacement of the marginal plant '***i***' due to the proposed CDM project '*j*', expressed 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.

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

$$D(j,i) = MIN\left\{ C_j - \sum_{l=1}^{i-1} D(j,l); (A_i - B_i) - \sum_{k=j+1}^{N} D(k,i) \right\} \qquad \textbf{(f3)}$$

Where,

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,
C_j	Energy generation of the CDM project *'j'* expressed in MWh/h,
N	Total number of CDM projects in the system,
M	Total number of additional marginal plants that should be dispatched if the system is operated without the N CDM projects.

Where,

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

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

$$d_i = SFC_i \bullet CEF_{OM,i} \bullet Oxid_i \qquad \textbf{(f4)}$$

Where,

SFC_i	is the specific fuel consumption of i^{th} marginal power plant, expressed as (TJ)/MWh,
$CEF_{OM,i}$	is the CO_2 emission factor of fuel used in i^{th} marginal power plant, expressed as tCO_2/(ton of fuel or TJ),
$Oxid_i$	is 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 power plant is obtained from the metering system which follows a national standard of 0.2% error allowed on a KWh base. Hourly energy data obtained from the metering system is submitted to CDEC-SIC every two hours as for all other generation units of the system.

All the information required for these calculations is obtained from the CDEC-SIC, CNE and IPCC as it is mentioned in section D of this monitoring report.

Finally, $EF_{OM,2015}$ = 0.41263 tCO_2/MWh

Build Margin calculation

$$EF_{BM,y} = \frac{\sum_{i=1}^{L} EF_{BM,i} \bullet Gen_{BM,i}}{\sum_{i=1}^{L} Gen_{BM,i}} \textbf{ (f5)}$$

Where,

L	Group of electricity generation plants that compromise 20% of the system generation (in MWh) and that have been built most recently. Power plant capacity additions registered as CDM project activities should be excluded from the sample group ***L***,
$EF_{BM,i}$	Emission factor of i^{th} electricity generation plant in the build margin, expressed in tCO_2/MWh,
$Gen_{BM,i}$	Projected generation for the i^{th} electricity generation plant included in the build margin, expressed in MWh.

$$EF_{BM,i} = SFC_{BM,i} \bullet CEF_{BM,i} \bullet Oxid_i \textbf{ (f6)}$$

Where,

$SFC_{BM,i}$	Specific fuel consumption of the i^{th} electricity generation plant, expressed in ton of fuel /MWh or TJ of fuel/MWh. The data shall be taken from published data of electricity regulatory authority,
$CEF_{BM,i}$	CO_2 content of fuel used in i^{th} electricity generation plant, expressed as tCO_2/(ton of fuel or TJ of fuel),
$Oxid_i$	Fuel oxidation factor, expressed as fraction.

Finally,

$EF_{BM,2015}$ = 0.49556 tCO_2/MWh

Combined Emission Factor calculation

The combined emission factor for the proposed project, according to AM0026 v2.0, is calculated with the weighted average for both the Operating Margin (OM) and the Build Margin (BM) as follows:

$$EF_y = w_{OM} \bullet EF_{OM,y} + w_{BM} \bullet EF_{BM,y} \textbf{ (f7)}$$

Where,

$EF_{OM,y}$ Emission factor for operating margin power generation sources, in tCO_2/MWh,
w_{OM} 0.5 Weight for operating margin emission factor,
$EF_{BM,y}$ Emission factor for build margin power generation sources, in tCO_2/MWh,
w_{OM} 0.5 Weight for building margin emission factor.

The values of the emission factors calculated are presented in the following table:

Table 7. Emission Factor

Parameter	2015
EF_{BM} (tCO_2/MWh)	0.49556
w_{BM}	0.5
EF_{OM} (tCO_2/MWh)	0.41263
w_{OM}	0.5
EF_{CM} (tCO_2/MWh)	0.45410

For further details on emission factor calculation please refer to the emission factor calculation spreadsheet for Quilleco.

Baseline emissions calculation

The baseline emissions for the project are calculated as follows:

$$BE_y = EF_y \bullet Generation_y \qquad \textbf{(f8)}$$

Where,

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

Following the formula $Generation_y = (M1 + M2) – M5$

$$Generation_{y,2015} = 131{,}403\ MWh - 1{,}738\ MWh = 129{,}665\ MWh$$

$$BE_{y,2015} = 0.45410\ tCO_2/MWh * 129{,}665\ MWh = 58{,}880\ tCO_2e$$

For further details on emission reductions calculation please refer to the emission reductions calculation spreadsheet.

E.2. Calculation of project emissions or actual net GHG removals by sinks

>> Quilleco Hydroelectric Project has no Project Emissions (PE_y) as explained in the registered PDD.

E.3. Calculation of leakage

>> According to the applied methodology AM0026 version 02 and the registered PDD, emissions due to leakage are not considered in this project.

E.4. Summary of calculation of emission reductions or net GHG removals by sinks

Item	Baseline emissions or baseline net GHG removals by sinks (t CO_2e)	Project emissions or actual net GHG removals by sinks (t CO_2e)	Leakage (t CO_2e)	GHG emission reductions or net GHG removals by sinks (t CO_2e) achieved in the monitoring period		
				Up to 31/12/2012	From 01/01/2013	Total amount
Total	58,880	0	0	Not applicable	58,880	58,880

E.5. Comparison of actual emission reductions or net GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO_2e)	89,154	58,880

E.6. Remarks on difference from estimated value in registered PDD

>> Hydroelectric projects are highly dependent to the annual hydrology level, so the annual electricity generation is subject to significant changes from year to year.

The ex-ante energy generation declared in the PDD was of 422,000 MWh/year. Considering that the current monitoring period has 189 days, the proportional ex-ante energy generated should be 218,515 MWh (for the period from 01/01/2015 to 08/07/2015). However, during this period the actual energy generated was 129,665 MWh, which is lower than the ex-ante PDD estimation, due to the poor hydrologic condition faced in the project region during the last years.

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

Project participant and/or responsible person/ entity	☒ Project participant ☒ Person/entity responsible for completing the CDM-MR-FORM
Organization name	Colbun S.A.
Street/P.O. Box	Avenida Apoquindo 4775, 11th Floor
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City	Santiago
State/region	Región Metropolitana
Postcode	7580097
Country	Chile
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Fax	-
E-mail	-
Website	-
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