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	First monitoring period (09/07/2015-31/12/2015)
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 Participants (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(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 3.0).
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	143,154 tCO_2e

[1] Withdrawn on 19/08/2014

[2] Withdrawn on 02/09/2014

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	132,657

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>> The project participant of Quilleco Hydroelectric Project is Colbun S.A. The 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.

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).

The total GHG emissions reductions achieved during this monitoring period is 132,657 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 first crediting period
09/07/2015	Starting date of the second 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 water 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.

In the following table are presented the geographic coordinates of the project.

Table 2. Project geographic 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.

[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.

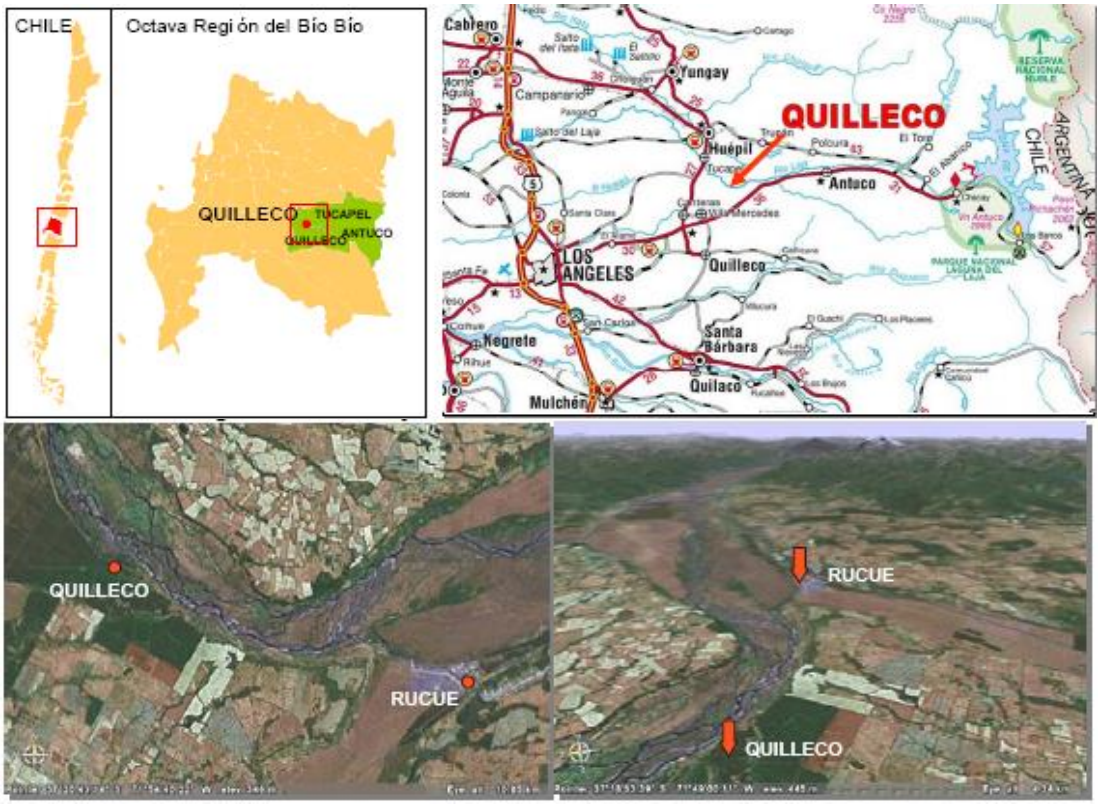

Figure 1. Project Location

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. (Private Entity)	No
Netherlands	Netherlands' Ministry of Infrastructure and the Environment (IenM)[4] (Public Entity); International Bank for Reconstruction and Development (IBRD) as Trustee of the Netherlands CDM Facility (NCDMF)[5] (Public Entity).	No
United Kingdom of Great Britain and Northern Ireland	Electrabel NV/SA (Private Entity)	No

[4] Withdrawn on 19/08/2014

[5] 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. (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 Participants (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

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 3.0).
https://cdm.unfccc.int/methodologies/DB/OOI7OYUFZOXN07H7EDBA9GVHJ4GK20

The methodology also refers to the following methodological tools:

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

A.5. Crediting period of project activity

>> 2nd crediting period: 09/07/2015 – 08/07/2022 (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. Table 3 below shows a brief description of the project technology and Figure 2 shows a diagram of the project design.

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. - 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

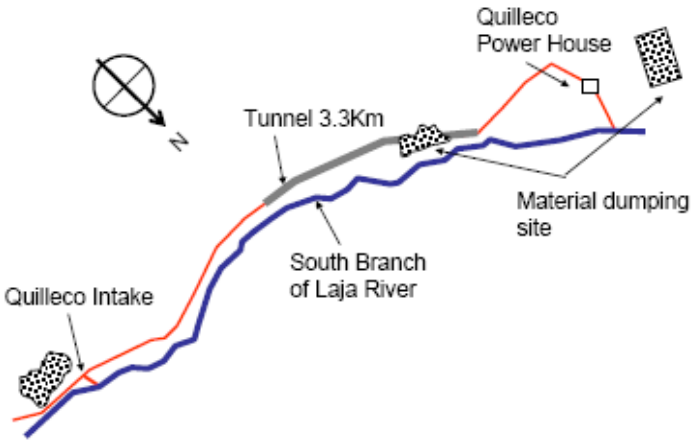

Figure 2. Project Design

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
U1	4:15	29-08-2015	6:20	29-08-2015	Scheduled Maintenance
U2	12:02	03-09-2015	12:26	03-09-2015	Failure
U2	9:48	04-09-2015	14:00	04-09-2015	Scheduled Maintenance
U1	9:31	24-09-2015	18:23	24-09-2015	Scheduled Maintenance
U1	7:48	02-11-2015	10:07	07-11-2015	Scheduled Maintenance
U2	9:50	03-11-2015	16:20	03-11-2015	Scheduled Maintenance
U2	15:19	04-11-2015	19:17	04-11-2015	Scheduled Maintenance
U2	8:00	09-11-2015	18:08	14-11-2015	Scheduled Maintenance

Unit	Start time	Start date	End time	End date	Details
U1	11:39	19-11-2015	15:45	19-11-2015	Scheduled Maintenance
U2	8:16	19-11-2015	11:38	19-11-2015	Scheduled Maintenance
U2	15:36	17-12-2015	22:15	17-12-2015	Scheduled Maintenance

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 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:

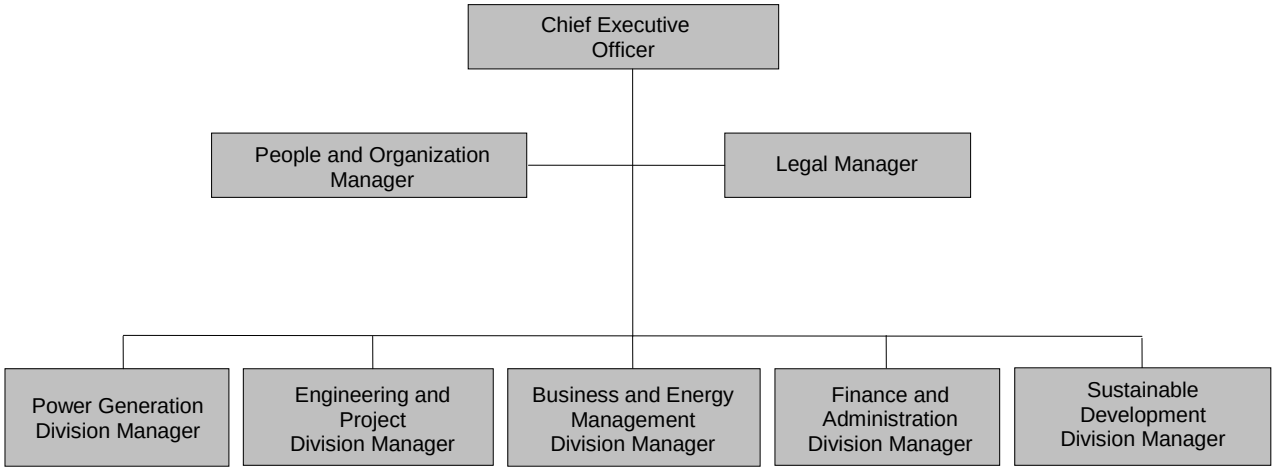

Figure 3. General Management structure

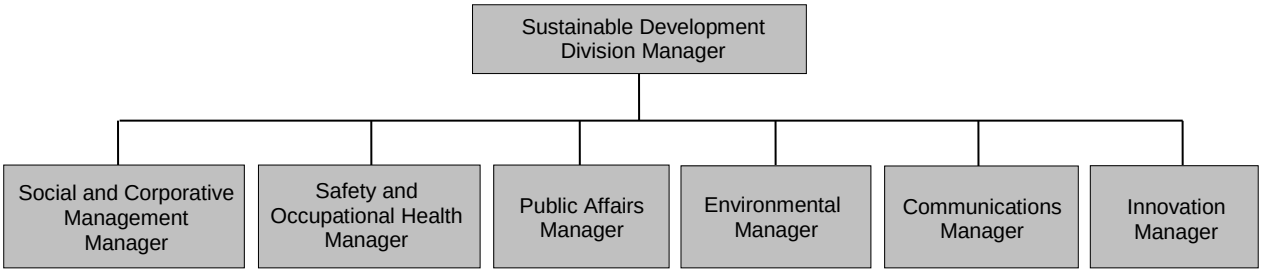

Figure 4. Sustainable Development Department structure

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 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 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). During this monitoring period, information from the back-up meters M3 and M4 was not used.

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:

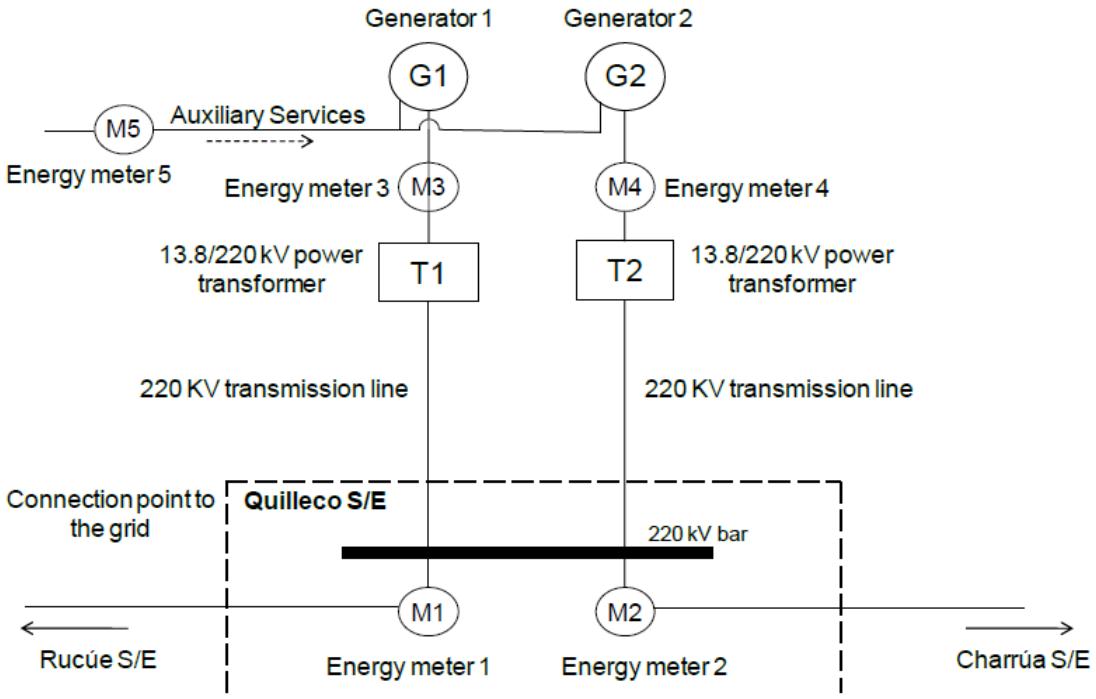

Figure 5. Measurement equipment diagram

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).

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

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
23/09/2015	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
24/09/2015	CAM	ION 7650	PJ-1009A683-02
M5 (Auxiliary Consumptions)			
Calibration Dates	**Certifier**	**Equipment**	**Serial Number**
02/10/2014	CAM	ION 7650	PJ-0911A866-02
23/09/2015	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 internal training during the monitoring period:

The following table summarizes the training activities performed during the monitoring period:

Table 6. Training activities

Subject	Date	Attendance	Exhibitor
Clean Development Mechanism-Climate Change	29/12/2015	11	Paula Reyes

SECTION D. Data and parameters

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

Data/parameter:	EF_{BM}[6]
Unit	tCO_2/MWh
Description	Build margin emission factor
Source of data	Registered PDD
Value(s) applied)	0.79074
Choice of data or measurement methods and procedures	The calculation was made according to "Tool to calculate the emission factor for an electricity system" v.04.0. using the most reliable information available
Purpose of data	Calculation of baseline emissions
Additional comments	This value is calculated ex ante in the registered PDD and fixed for the second monitoring period.

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 defined for the second crediting period as per the applicable methodology AM0026 v.3.0 and the referred tool

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

Purpose of data	Calculation of baseline emissions
Additional comments	There are no additional comments

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 04.0)
Value(s) applied)	0.25
Choice of data or measurement methods and procedures	Value defined 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 comments	There are no additional comments

D.2. Data and parameters monitored

Data/parameter:	**EF_y**
Unit	tCO_2/MWh
Description	Combined Margin Emission factor for displaced grid electricity
Measured/calculated/default	Calculated
Source of data	CDEC SIC, CNE and IPCC data
Value(s) of monitored parameter	0.69621
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Annually
Calculation method (if applicable):	The calculation is the 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 E of this MR (specifically as per equation f2).
QA/QC procedures:	Calculation based on data sources, following AM0026 v.3.0 procedures
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**$EF_{OM,y}$**
Unit	tCO_2/MWh
Description	Operating margin emission factor
Measured/calculated/default	Calculated
Source of data	CDEC SIC, CNE and IPCC data
Value(s) of monitored parameter	0.41263
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Annually

Calculation method (if applicable):	Calculated based on equation f4 of this monitoring report
QA/QC procedures:	Calculation based on data sources, following AM0026 v.3.0 procedures
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**$EF_{j,h}$**
Unit	tCO_2/MWh
Description	Operating margin emission factor for hour h
Measured/calculated/default	Calculated
Source of data	CDEC SIC, CNE and IPCC 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 equation f5 of this monitoring report
QA/QC procedures:	Calculation based on data sources, following AM0026 v.3.0 procedures
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**$Generation_y$**
Unit	MWh
Description	Electricity exported to the grid by proposed CDM project, in year y
Measured/calculated/default	Measured
Source of data	Onsite metering system
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 Calibrations: 29/09/2014 and 23/09/2015 Meter M2: • Type: ION 7650 • Accuracy class: 0.2% • Serial number: PJ-1009A683-02 • Calibration frequency: Every two years • Last Calibration: 29/09/2014 and 24/09/2015 Meter M5: • Type: ION 7650 • Accuracy class: 0.2% • Serial number: PJ-0911A866-02 • Calibration frequency: Every two years • Last Calibration: 02/10/2014 and 23/09/2015 The last calibration for the electricity meters during this monitoring period was carried out during September 2015, 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
Calculation method (if applicable):	Calculated based on equation f3 of this monitoring report. Electronic measurement system is performed every 15 minutes.
QA/QC procedures:	Meters 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 comments:	There are no additional comments

Data/parameter:	**D(j,i)**
Unit	MWh
Description	Electricity displaced by j^{th} CDM project from i^{th} marginal plant in the system
Measured/calculated/default	Calculated
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):	Calculated based on equation f7 of this monitoring report
QA/QC procedures:	Calculation based on data sources, following AM0026 v.3.0 procedures
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	d_i
Unit	tCO_2/MWh
Description	Emission factor for electricity displaced D(j,i)
Measured/calculated/default	Calculated
Source of data	CDEC-SIC, CNE and IPCC 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 equation f8 of this monitoring report.
QA/QC procedures:	Calculation based on data sources, following AM0026 v.3.0 procedures
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

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
Measured/calculated/default	Default
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:	Yearly
Calculation method (if applicable):	Not applicable
QA/QC procedures:	Data is obtained from official sources.
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	Calculated
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 equation f6 of this monitoring report
QA/QC procedures:	Data is obtained from official sources.
Purpose of data:	Calculation of baseline emissions

Additional comments:	There are no additional comments

Data/parameter:	**N**
Unit	Number
Description	List of CDM registered plants in the system
Measured/calculated/default	Not applicable
Source of data	CDEC-SIC and UNFCCC data
Value(s) of monitored parameter	47
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	As required
Calculation method (if applicable):	Not applicable
QA/QC procedures:	Data is obtained from official sources
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**C_j**
Unit	MWh
Description	Electricity generated by j^{th} CDM plant in hour h
Measured/calculated/default	Not applicable
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):	Not applicable
QA/QC procedures:	Data is obtained from official sources.
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	Not applicable
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):	Not applicable
QA/QC procedures:	Data is obtained from official sources.

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	Not applicable
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):	Not applicable
QA/QC procedures:	Data is obtained from official sources.
Purpose of data:	Calculation of baseline emissions
Additional comments:	There are no additional comments

Data/parameter:	**CEF_i**
Unit	tonCO_2/GJ
Description	Carbon emission factor of fuel used in the i^{th} plant
Measured/calculated/default	Not applicable
Source of data	IPCC Reports
Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	IPCC publications will be checked annually in order to confirm the values of the parameter
Calculation method (if applicable):	Not applicable
QA/QC procedures:	Data is obtained from official sources.
Purpose of data:	Calculation of baseline emissions
Additional comments:	IPCC 2006 was used

Data/parameter:	**$Oxid_i$**
Unit	fraction
Description	Fraction of fuel oxidized on combustion
Measured/calculated/default	Not applicable
Source of data	IPCC Reports
Value(s) of monitored parameter	Please refer to emission factor calculation spreadsheet for Quilleco
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	IPCC publications are checked annually in order to confirm the values of the parameter
Calculation method (if applicable):	Not applicable

QA/QC procedures:	Data is obtained from official sources
Purpose of data:	Calculation of baseline emissions
Additional comments:	IPCC 2006 was used

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

$$BE_y = EF_y * Generation_y \qquad \textbf{(f1)}$$

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 emission factor (EF_y) is 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:

$$EF_y = w_{OM} * EF_{OM,y} + w_{BM} * EF_{BM} \qquad \textbf{(f2)}$$

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. For the second crediting period is fixed.
4. Combined Margin Emission Factor Estimation

The first stage consists on gathering the required information for the estimation of the Operating Margin Emission Factor. The data to be gathered 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 during the monitoring period. This information is trespassed to the excel spreadsheets and the information sources are verified prior to its use.

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

The electricity generation of the project, as explained in section C of this Monitoring Report, is calculated as follows:

$Generation_y = (M1 + M2 – M5)$ **(f3)**

Finally, using the emission factor estimated and the electricity generation of the project, 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.

Operating Margin Emission Factor calculation

The operating margin emission factor is calculated as follows:

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

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.

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:

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

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:

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

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 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 and the 2006 IPCC Good Practice Guidance 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.

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

Build Margin Emission Factor calculation

The build margin emission factor was calculated in the registered PDD and is fixed for the second crediting period.

Therefore $EF_{BM} = 0.79074\ tCO_2/MWh$

Combined Emission Factor calculation

The combined emission factor for the proposed project, according to AM0026 v3.0, is calculated as the weighted average for both the Operating Margin (OM) and the Build Margin (BM) as follows:

$$EF_y = w_{OM} * EF_{OM,y} + w_{BM} * EF_{BM} \quad \textbf{(f9)}$$

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.

In accordance with equation (f9), the combined margin corresponds to:

$$EF_{2015} = 0.25 * 0.41263 \frac{tCO_2}{MWh} + 0.75 * 0.79074 \frac{tCO_2}{MWh} = 0.69621 \frac{tCO_2}{MWh}$$

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

Electricity Generation calculation

Following the equation f3, the electricity generation of the project for the monitoring period corresponds to:

$$Generation_{2015} = 192{,}172\ MWh - 1{,}631\ MWh = 190{,}541\ MWh$$

For further details on electricity generation calculation please refer to the emission reductions calculation spreadsheet for Quilleco.

Baseline emissions calculation

Following the equation f1, the baseline emissions correspond to:

$$BE_{2015} = 0.69621 \frac{tCO_2}{MWh} * 190{,}541 MWh = 132{,}657 tCO_2$$

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 does not consider any Project Emissions (PE_y).

E.3. Calculation of leakage

>> Quilleco Hydroelectric Project does not consider any leakage (*Ly*).

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	132,657	0	0	Not applicable	132,657	132,657

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)	143,154	132,657

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 is 422,000 MWh/year. Considering that the current monitoring period has 176 days, the proportional ex-ante energy generated should have been 203,485 MWh aprox. (for the period from 09/07/2015 to 31/12/2015). However, during this period the actual energy generated was 190,541 MWh, which is approximately 6% 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.
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