Monitoring report form for CDM project activity

(Version 08.0)

Complete this form in accordance with the instructions attached 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 PDD applicable to this monitoring report	8		
Version number of this monitoring report	01		
Completion date of this monitoring report	11/05/2021		
Monitoring period number	02		
Duration of this monitoring period	01/01/2016 – 31/12/2018		
Monitoring report number for this monitoring period	N/A		
Project participants	Colbún S.A Electrabel NV/SA		
Host Party	Chile		
Applied methodologies and standardized baselines	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)		
Sectoral scopes	Sectoral Scope 1: Energy industries (renewable - / non-renewable sources).		
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013 until 31 December 2020	Amount achieved from 1 January 2021
	-	553,875 tCO_2e	-
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	890,644 tCO_2e		

SECTION A. Description of project activity

A.1. 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[1] (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 SEN electric grid (National 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 National Interconnected System (SEN[2])

The total GHG emissions reductions achieved during this monitoring period is 553,875tonnes 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 A1. Relevant dates for the project activity

Dates	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:

[1] 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.

[2] In November of 2017 the Central Interconnected System (SIC) and Grand North Interconnected System (SING) were interconnected, forming the new National Interconnected System (SEN).

Table A2. 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 A1.

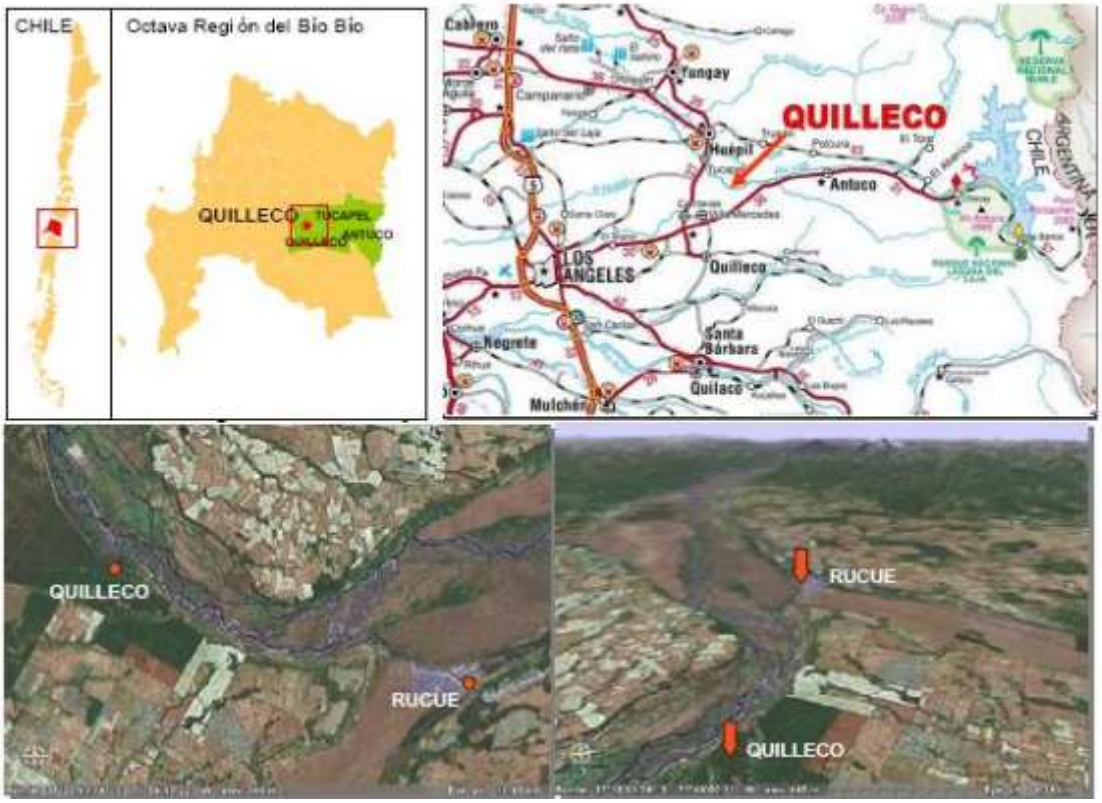

Figure A1. Project Location, Geographic Position

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Chile (Host)	Colbún S.A. (Private entity)	No
United Kingdom of Great Britain and Northern Ireland	Electrabel NV/SA (Private entity)	Yes

A.4. References to applied methodologies and standardized baselines

>> 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/filestorage/C/D/M/CDMWF_AM_IY3QJ5DOHLBPC0514FDE44V5MXIGVB/eb24_repan05_AM0026_Ver03_AM.pdf?t=UFV8cXRtYW5yfDAuXO0roEFh7um1GQn5fWWn

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

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

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

A.5. Crediting period type and duration

2nd crediting period: 09/07/2015 – 08/07/2022 (7 years, Renewable)

SECTION B. Implementation of project activity

B.1. Description of implemented 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 Colbún operating power units. Table B1 below shows a brief description of the project technology and Figure B1 shows a diagram of the project design.

Table B1. 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.[3] - 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 - Estimated cost: US$ 79.6 million including 5% contingencies and VAT

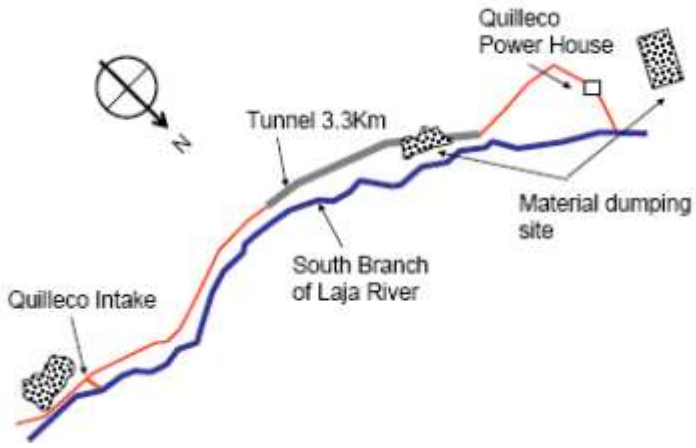

Figure B1. Project Design

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 CEN, afterwards, on 28/05/2007 Unit 2 was also delivered.

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

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 B2. Special events occurred during monitoring period

Unit	Start time	Start date	End time	End date	Details
U2	9:29	12/01/2016	13:19	12/01/2016	Scheduled Maintenance
U2	8:13	28/03/2016	-	28/03/2016	Scheduled Maintenance
U1	7:37	15/04/2016	23:30	30/04/2016	Scheduled Maintenance
U1	9:19	05/04/2016	19:07	05/04/2016	Maintenance
U2	10:02	03/05/2016	20:30	04/05/2016	Scheduled Maintenance
U1	9:27	10/05/2016	19:44	11/05/2016	Failure
U2	9:32	11/05/2016	12:26	11/05/2016	Maintenance
U1	9:57	03/07/2016	15:20	03/07/2016	Scheduled Maintenance
U2	11:00	17/08/2016	12:09	17/08/2016	Scheduled Maintenance
U1	9:04	19/10/2016	12:20	19/10/2016	Maintenance
U1	9:00	20/12/2016	15:13	20/12/2016	Maintenance
U2	7:34	06/03/2017	10:15	18/03/2017	Scheduled Maintenance
U1	7:26	20/03/2017	21:52	31/03/2017	Scheduled Maintenance
U2	18:05	22/06/2017	18:14	22/06/2017	Failure
U1	10:39	13/09/2017	13:08	13/09/2017	Scheduled Maintenance
U1	10:32	27/09/2017	17:55	27/09/2017	Failure
U2	10:41	27/09/2017	10:59	27/09/2017	Scheduled Maintenance
U1	14:30	05/10/2017	16:42	05/10/2017	Scheduled Maintenance
U1	11:30	03/10/2017	12:40	03/10/2017	Failure
U1	16:15	06/10/2017	17:44	06/10/2017	Failure
U1	15:08	10/12/2017	20:07	10/12/2017	Failure
U2	9:08	16/04/2018	17:40	28/04/2018	Scheduled Maintenance
U1	10:47	05/04/2018	19:34	23/04/2018	Scheduled Maintenance
U2	9:56	12/04/2018	18:21	12/04/2018	Scheduled Maintenance
U1	15:34	09/04/2018	18:04	09/04/2018	-
U1	7:35	07/05/2018	12:53	19/05/2018	Scheduled Maintenance
U1	12:00	27/96/2018	17:40	28/06/2018	Failure
U1	17:05	09/08/2018	0:00	10/08/2018	Scheduled Maintenance
U1	4:50	23/09/2018	8:52	23/09/2018	Failure
U2	15:28	25/09/2018	16:06	25/09/2018	Scheduled Maintenance
U2	12:07	02/10/2018	13:00	02/10/2018	Failure
U2	7:27	11/10/2018	8:44	11/10/2018	Failure
U1	9:52	06/11/2018	14:29	06/11/2018	Scheduled Maintenance
U2	14:32	06/11/2018	16:33	06/11/2018	Scheduled Maintenance
U2	4:05	06/11/2018	7:18	06/11/2018	Failure
U1	9:43	14/11/2018	17:32	30/11/2018	Scheduled Maintenance
U2	17:30	07/11/2018	15:58	07/11/2018	Failure

B.2. Post-registration changes

B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies, standardized baselines or other methodological regulatory documents

>> Not applicable

B.2.2. Corrections

>>Not applicable

B.2.3. Changes to the start date of the crediting period

>> Not applicable

B.2.4. Inclusion of monitoring plan

>> Not applicable

B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents

>> Not applicable

B.2.6. Changes to project design

>>Not applicable

B.2.7. Changes specific to afforestation or reforestation project activity

>> Not applicable

SECTION C. Description of monitoring system

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:

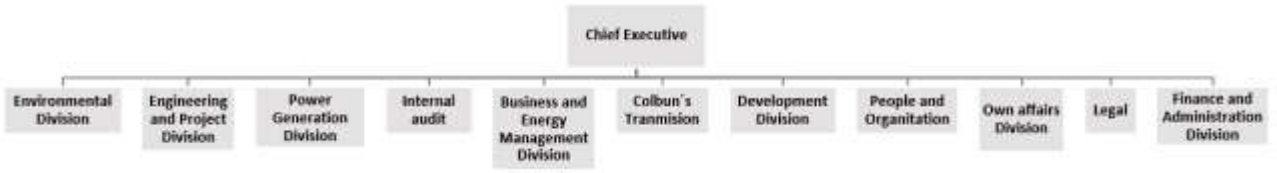

Figure C1. General Management structure

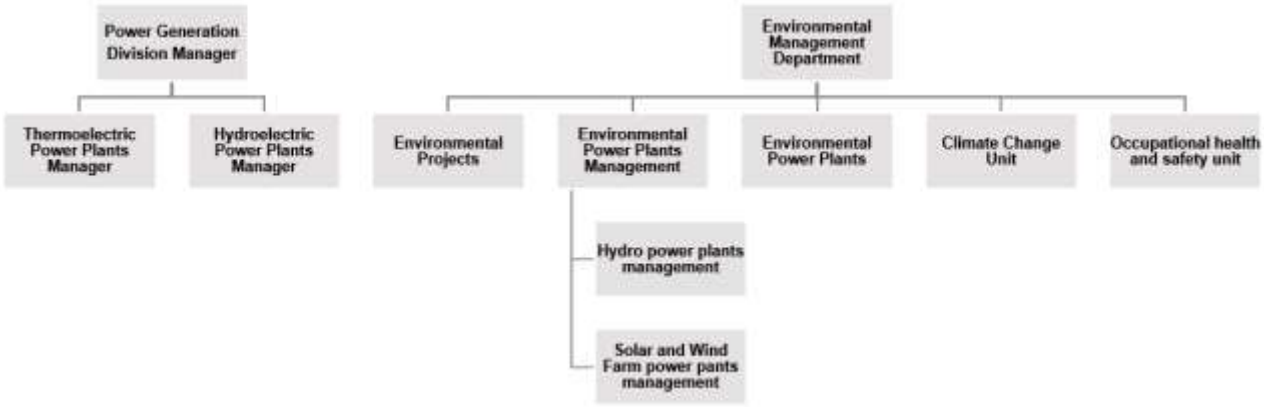

Figure C2. Generation and Environmental Department Structure

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 Corporative Procedures within the Management System, and CDM topics are executed by the Climate Change Unit (as a part of Environmental Management).

  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.

- CERs calculation: This is performed by the Climate Change Unit (as a part of Environmental Management).

Monitoring system

The monitoring methodology determines the baseline emissions by observing the actual power dispatch data from CEN 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 CEN).

- Public data on dispatch of electricity and other relevant information from the CEN. 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 Management System. In this system are included all the CERs related procedures, such as the monitoring, verification and others procedures, in order to assure the proper development of the monitoring plan activities.

Monitoring equipment

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

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

Energy measurements from M1 and M2 meters are crosschecked with the records for sold electricity, which are publicly available in the CEN 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:

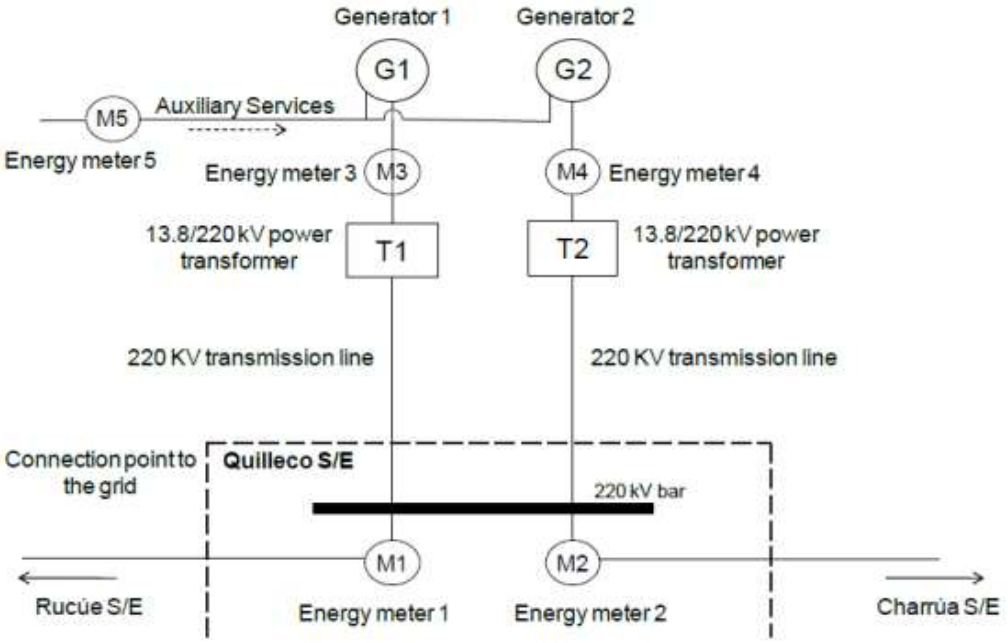

Figure C3. Measurement equipment diagram

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).

$$Generation_y = (M1+M2-M5) \quad (f1)$$

Energy Measurement Equipment Periodic Verifications:

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

Table C1. Electricity meters information

M1 (Rucúe Line/Quilleco Substation)			
Verification Dates	**Certifier**	**Equipment**	**Serial Number**
21/09/2016	CAM	ION 7650	PJ-0911A507-02
12/10/2017	CAM	ION 7650	PJ-0911A507-02
07/11/2018	CAM	ION 7650	PJ-0911A507-02
M2 (Charrúa Line/Quilleco Substation)			
Verification Dates	**Certifier**	**Equipment**	**Serial Number**
21/09/2016	CAM	ION 7650	PJ-1009A683-02
12/10/2017	CAM	ION 7650	PJ-1009A683-02
07/11/2018	CAM	ION 7650	PJ-1009A683-02
M5 (Auxiliary Consumptions)			
Verification Dates	**Certifier**	**Equipment**	**Serial Number**
22/09/2016	CAM	ION 7650	PJ-0911A866-02
12/12/2017	CAM	ION 7400	PJ.0911A866-02
08/11/2018	CAM	ION 7650	PJ-0911A866-02

Emergency procedures

The project participant has developed a Management System 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.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

Data/Parameter	**EF_{BM}**[4]
Unit	tCO_2/MWh
Description	Build margin emission factor
Source of data	View in the PDD
Value(s) applied	0.79074
Choice of data or measurement methods and procedures	N/A
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	N/A

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

Data/Parameter	**W_{OM}**
Unit	Fraction
Description	Weight for Operating Margin emission factor
Source of data	Tool to calculate the emission factor for an electricity system (v 04)
Value(s) applied	0.25
Choice of data or measurement methods and procedures	Value for the second crediting period as per the applicable methodology AM0026 v.3.0 and the referred tool.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	N/A

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

D.2. Data and parameters monitored

Data/Parameter	EF_{CM}
Unit	tCO_2/MWh
Description	Combined Margin Emission factor for displaced grid electricity
Measured/calculated/ default	Calculated
Source of data	Calculation based on CEN, CNE and IPCC data, as weighted sum of build margin (EF_{BM}) and operating margin ($EF_{OM,y}$) emission factors and in accordance to the methodology procedures described in PDD.
Value(s) of monitored parameter	Year: 2016 — EF_{CM} (tCO_2/MWh): 0.76042 Year: 2017 — 0.73306 Year: 2018 — 0.73855
Monitoring equipment	N/A
Measuring/reading/recording frequency	Annually (value is calculated ex post)
Calculation method (if applicable)	N/A (this parameter is not measured but calculated)
QA/QC procedures	Calculation based on data sources, following AM0026 v.3.0 procedures
Purpose of data/parameter	N/A
Additional comments	N/A

Data/Parameter	$EF_{OM,y}$
Unit	tCO_2/MWh
Description	Operating margin emission factor
Measured/calculated/ default	Calculated
Source of data	Calculation based on CEN, CNE and IPCC data
Value(s) of monitored parameter	Year: 2016 — EF_{OM} (tCO_2/MWh): 0.66947 Year: 2017 — 0.56001 Year: 2018 — 0.58196
Monitoring equipment	N/A
Measuring/reading/recording frequency	Annually (value is calculated ex post)
Calculation method (if applicable)	N/A (this parameter is not measured but calculated)
QA/QC procedures	Calculation based on data sources, following AM0026 v.3.0 procedures.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	N/A

Data/Parameter	$EF_{j,h}$
Unit	tCO_2/MWh
Description	Operating margin emission factor for hour h
Measured/calculated/ default	N/A
Source of data	Calculated using CEN data
Value(s) of monitored parameter	Please refer to ex – post factor emission calculation spreadsheet (EF Calc 2016 Quilleco.xls, EF Calc 2017 Quilleco.xls, EF Calc 2018 Quilleco.xls)

Monitoring equipment	N/A
Measuring/reading/recording frequency	Hourly
Calculation method (if applicable)	Calculated based on equation f5 of this monitoring report
QA/QC procedures	Automatic calculation. Calculation should be done after CEN makes the data official validation.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Values are provided in the calculation spreadsheets to the DOE.

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	Calculated based on equation f7 of this monitoring report using CEN data
Value(s) of monitored parameter	Please refer to ex – post factor emission calculation spreadsheet (EF Calc 2016 Quilleco.xls, EF Calc 2017 Quilleco.xls, EF Calc 2018 Quilleco.xls)
Monitoring equipment	N/A
Measuring/reading/recording frequency	Hourly
Calculation method (if applicable)	Calculated based on equation f7 using CEN data
QA/QC procedures	Calculation based on data sources, following AM0026 v.3.0 procedures.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	N/A

Data/Parameter	**d_i**
Unit	tCO_2/MWh
Description	Emission factor for electricity displaced $D_{(j,i)}$
Measured/calculated/ default	
Source of data	Please refer to Marginal Plants Data Base_mm.xls spreadsheets (one file per month, where “mm” refers to the specific month).
Value(s) of monitored parameter	
Monitoring equipment	N/A
Measuring/reading/recording frequency	Hourly
Calculation method (if applicable)	Calculated based on equation f8 using CEN, CNE and IPCC data
QA/QC procedures	Calculation based on data sources, following AM0026 v.3.0 procedures.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	N/A

Data/Parameter	SFC_i
Unit	kg or m^3 (for natural gas) / MWh
Description	Specific fuel consumption per unit of electricity produced in i^{th} marginal plant
Measured/calculated/ default	Calculated
Source of data	CEN databases and CNE node price report.
Value(s) of monitored parameter	Please refer to ex – post factor emission calculation spreadsheet (EF Calc 2016 Quilleco.xls, EF Calc 2017 Quilleco.xls, EF Calc 2018 Quilleco.xls)
Monitoring equipment	N/A
Measuring/reading/recording frequency	Yearly
Calculation method (if applicable)	N/A
QA/QC procedures	Calculation based on data sources, following AM0026 v.3.0 procedures.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	N/A

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	CEN data
Value(s) of monitored parameter	Please refer to ex – post factor emission calculation spreadsheet (EF Calc 2016 Quilleco.xls, EF Calc 2017 Quilleco.xls, EF Calc 2018 Quilleco.xls)
Monitoring equipment	N/A
Measuring/reading/recording frequency	Hourly
Calculation method (if applicable)	Estimated based on CEN databases and AM0026 procedures
QA/QC procedures	Automatic calculation procedure
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	N/A

Data/Parameter	N
Unit	Number
Description	List of CDM registered plants in the system
Measured/calculated/ default	N/A
Source of data	CEN and UNFCCC data.
Value(s) of monitored parameter	Year: 2016 – Number: 46 Year: 2017 – Number: 52 Year: 2018 – Number: 56
Monitoring equipment	N/A
Measuring/reading/recording frequency	As required
Calculation method (if applicable)	N/A

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

Data/Parameter	**C_j**
Unit	MWh
Description	Generation capacity of i^{th} plant on margin during hour h
Measured/calculated/ default	N/A
Source of data	CEN
Value(s) of monitored parameter	Please refer to ex – post factor emission calculation spreadsheet (EF Calc 2016 Quilleco.xls, EF Calc 2017 Quilleco.xls, EF Calc 2018 Quilleco.xls)
Monitoring equipment	N/A
Measuring/reading/recording frequency	Hourly
Calculation method (if applicable)	N/A
QA/QC procedures	Data is obtained from CEN databases.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	N/A

Data/Parameter	**A_i**
Unit	MW
Description	Generation capacity of i^{th} plant on margin during hour h
Measured/calculated/ default	N/A
Source of data	Please refer to ex – post factor emission calculation spreadsheet (EF Calc 2016 Quilleco.xls, EF Calc 2017 Quilleco.xls, EF Calc 2018 Quilleco.xls)
Value(s) of monitored parameter	70 MW
Monitoring equipment	N/A
Measuring/reading/recording frequency	Hourly
Calculation method (if applicable)	N/A
QA/QC procedures	Data is obtained from official CEN databases.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	N/A

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	

Year	Generation (MWh)
2016	211,142.78
2017	270,360.83
2018	264,202.43
Total	745,706.03

<table>
<tr><td>Monitoring equipment</td><td>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
<table>
<tr><th>Meter</th><th>Serial Number</th><th>Verification Dates</th></tr>
<tr><td>M1</td><td>PJ-0911A507-02</td><td>21/09/2016</td></tr>
<tr><td>M1</td><td>PJ-0911A507-02</td><td>12/10/2017</td></tr>
<tr><td>M1</td><td>PJ-0911A507-02</td><td>07/11/2018</td></tr>
</table>
Meter M2:
• Type: ION 7650
• Accuracy class: 0.2%
• Serial number: PJ-1009A683-02
• Calibration frequency: Every two years
<table>
<tr><th>Meter</th><th>Serial Number</th><th>Verification Dates</th></tr>
<tr><td>M2</td><td>PJ-1009A683-02</td><td>21/09/2016</td></tr>
<tr><td>M2</td><td>PJ-1009A683-02</td><td>12/10/2017</td></tr>
<tr><td>M2</td><td>PJ-1009A683-02</td><td>07/11/2018</td></tr>
</table>
Meter M5:
• Type: ION 7650
• Accuracy class: 0.2%
• Serial number: PJ-0911A866-02
• Calibration frequency: Every two years
<table>
<tr><th>Meter</th><th>Serial Number</th><th>Verification Dates</th></tr>
<tr><td>M5</td><td>PJ-0911A866-02</td><td>22/09/2016</td></tr>
<tr><td>M5</td><td>PJ.0911A866-02</td><td>12/12/2017</td></tr>
<tr><td>M5</td><td>PJ-0911A866-02</td><td>08/11/2018</td></tr>
</table>
</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Hourly</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Calculated based on equation f1 of this monitoring report. Electronic measurement system is performed every 15 minutes.</td></tr>
<tr><td>QA/QC procedures</td><td>Meter should have a maximum error of 0.2% and be calibrated every one or two years according to local standards for electricity transactions in CEN. Monitored data is cross checked against records for sold electricity which are publicly available at the CEN web page (www.coordinador.cl/).</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comments</td><td>N/A</td></tr>
</table>

Data/Parameter	**B_i**
Unit	MWh
Description	Electricity generated of the i^{th} plant on margin during hour h
Measured/calculated/ default	N/A
Source of data	CEN
Value(s) of monitored parameter	Please refer to Marginal Plants Data Base_mm.xls spreadsheets (one file per month, where “mm” refers to the specific month).
Monitoring equipment	N/A
Measuring/reading/recording frequency	Hourly

Calculation method (if applicable)	N/A
QA/QC procedures	Data is obtained from official CEN databases.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	N/A

Data/Parameter	**CEF_i**
Unit	tonCO_2/GJ
Description	Carbon emission factor of fuel used in i^{th} plant
Measured/calculated/ default	N/A
Source of data	IPCC Reports
Value(s) of monitored parameter	Please refer to ex – post factor emission calculation spreadsheet (EF Calc 2016 Quilleco.xls, EF Calc 2017 Quilleco.xls, EF Calc 2018 Quilleco.xls)
Monitoring equipment	N/A
Measuring/reading/recording frequency	IPCC publications will be checked annually in order to confirm the values of the parameter
Calculation method (if applicable)	N/A
QA/QC procedures	Data is obtained from official sources
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	IPCC 2006 was used. Because parameter is monitored ex-post, another version of IPCC might be available in the future.

Data/Parameter	**$Oxid_i$**
Unit	fraction
Description	Fraction of fuel oxidized on combustion.
Measured/calculated/ default	N/A
Source of data	IPCC Reports
Value(s) of monitored parameter	Please refer to ex – post factor emission calculation spreadsheet (EF Calc 2016 Quilleco.xls, EF Calc 2017 Quilleco.xls, EF Calc 2018 Quilleco.xls)
Monitoring equipment	N/A
Measuring/reading/recording frequency	IPCC publications will be checked annually in order to confirm the values of the parameter
Calculation method (if applicable)	N/A
QA/QC procedures	Data is obtained from official sources
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	IPCC 2006 was used. Because parameter is monitored ex-post, another version of IPCC might be available in the future.

D.3. Implementation of sampling plan

>> Not applicable

SECTION E. Calculation of emission reductions or net anthropogenic removals

E.1. Calculation of baseline emissions or baseline net removals

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

$BE_y = EF_y * Generation_y$ *(f2)*

Where,

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

The baseline 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:

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

Where,

$EF_{OM,y}$	Emission factor for operating margin power generation sources, in tCO_2/MWh;
w_{OM}	0.25, Weight for operating margin emission factor;
EF_{BM}	Emission factor for build margin power generation sources, in tCO_2/MWh;
w_{BM}	0.75, Weight for build margin emission factor.

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

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

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

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

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 CEN'S web page at www.coordinador.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 Emission Factor of the operating margin is calculated in accordance with the following equations, as per AM0026 (v.3.0):

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

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 SEN 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:

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

Where,

D(j,i)	Energy displacement of the marginal plant 'i' due to the proposed CDM project 'j', in MWh;
Di	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:

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

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. Calculation of leakage emissions.

The difference $(A_i - B_i)$ 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:

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

Where,

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

D(j,0) = 0 & D(N+1, i) = 0

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

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

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

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

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

Where,

SFCi Specific fuel consumption of i^{th} marginal power plant, expressed as (ton of fuel or TJ)/MWh;

$CEF_{OM,i}$ CO_2 emission factor of fuel used in i^{th} marginal power plant, expressed as tCO_2/(ton of fuel or TJ);

$Oxid_i$ Fraction of carbon in fuel, used in i^{th} marginal plant, oxidized during combustion.

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

The generation of Quilleco is obtained from the metering system which follows a national standard of 0.2% error allowed 10 on a KWh base. Hourly energy data obtained from the metering system is periodically submitted to CEN 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.

Table E1. Operating Margin (OM) Emission Factor

Year	$EF_{OM,y}$	Unit
2016	0.66947	tCO_2/MWh
2017	0.56001	tCO_2/MWh
2018	0.58196	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.

Table E2. Build Margin Emission

$EF_{BM,y}$	Unit
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:

$$EF_y = w_{OM} * EF_{OM,y} + w_{BM} * EF_{BM}$$

Where,

$EF_{OM,y}$	Emission factor for operating margin power generation sources, in tCO2/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.

Table E3. Combined Emission Factor Calculation

Year	EF_{OM}	W_{OM}	EF_{BM}	W_{BM}	$EF_{Y(CM)}$
2016	0.66947	0.25	0.79074	0.75	0.76042
2017	0.56001	0.25	0.79074	0.75	0.73306
2018	0.58196	0.25	0.79074	0.75	0.73855

Electricity Generation calculation

The electricity generation of the project for the monitoring period corresponds to:

Table E4. Net Generation

Year	Generation (MWh)
2016	211,142.78
2017	270,360.83
2018	264,202.43
Total	**745,706.03**

For further details on electricity generation calculation please refer to the emission reductions calculation spreadsheet for Quilleco (Generation and ER Quilleco_v1.xls).

Baseline emissions calculation

Following the equation f1, the baseline emissions correspond to:

$$BE_{2016} = 0.76033 \frac{tCO_2}{MWh} x \frac{211{,}142.78 MWh}{year} = 160{,}5357.19\ tCO_2\ /year$$

$$BE_{2017} = 0.73297 \frac{tCO_2}{MWh} x \frac{270{,}360.83 MWh}{year} = 198{,}190.71\ tCO_2\ /year$$

$$BE_{2018} = 0.73846 \frac{tCO_2}{MWh} x \frac{264{,}202.43 MWh}{year} = 195{,}126.70\ tCO_2\ /year$$

Table E5. Total Baseline emissions

$BE_{,y}$	Unit
553,875	tCO_2

For further details on emission reductions calculation please refer to the emission reductions calculation spreadsheet. (Generation and ER Quilleco_v1.xls).

E.2. Calculation of project emissions or actual net removals

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

E.3. Calculation of leakage emissions

>>No leakage emissions are considered (L_y)

E.4. Calculation of emission reductions or net anthropogenic removals

	Baseline GHG emissions	Project GHG emissions	Leakage GHG emissions	GHG emission reductions or net anthropogenic GHG removals ($t CO_2e$)

				Before 01/01/2013	From 01/01/2013	From 01/01/ 2021	Total amount
Total	553,875	0	-	-	553,875	-	553,875

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO_2e)	Amount estimated ex ante for this monitoring period in the PDD (t CO_2e)
553,875	890,644

E.5.1. Explanation of calculation of "amount estimated ex ante for this monitoring period in the PDD"

>>
Following the equation, the baseline emissions correspond to:

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

For the monitoring period 01/01/2016 to 31/12/2018 the amount estimated ex ante in the PDD is:

BE_y= 269,882 tCO_2/year + 296,882 tCO_2/year + 296,882 tCO_2/year = 890,644 tCO_2/year

E.6. Remarks on increase in achieved emission reductions

>>N/A. The emission reductions achieved during this monitoring period are lower than the estimate in the registered PDD for years 2016, 2017, 2018.

E.7. Remarks on scale of small-scale project activity

>>N/A

Document information

Version	*Date*	*Description*
08.0	6 April 2021	Revision to: • Reflect the “Clarification: Regulatory requirements under temporary measures for post-2020 cases” (CDM-EB109-A01-CLAR).
07.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Add a section on remarks on the observance of the scale limit of small-scale project activity during the crediting period; • Add "changes specific to afforestation or reforestation project activity" as a possible post-registration changes; • Clarify the reporting of net anthropogenic GHG removals for A/R project activities between two commitment periods; • Make editorial improvements.
06.0	7 June 2017	Revision to: • Ensure consistency with version 01.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Make editorial improvements.
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from *F-CDM-MR* to *CDM-MR-FORM*; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, Annex 11).

Version	*Date*	*Description*
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.

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