Monitoring report form (Version 03.1)

Monitoring report

Title of the project activity	Chacabuquito Hydroelectric Power Project
Reference number of the project activity	Project 1052
Version number of the monitoring report	01
Completion date of the monitoring report	09/01/2013
Registration date of the project activity	07/07/2007 (Renewal Date: 04/11/2011)
Monitoring period number and duration of this monitoring period	01 (04/11/2011 – 31/12/2012)
Project participant(s)	Netherlands – Sweden – Norway – Canada – Finland - Hidroeléctrica Guardia Vieja S.A. - Netherlands International Bank for Reconstruction and Development (IBRD) as Trustee of the Prototype Carbon Fund (PCF) – Government of Sweden/Swedish Energy Agency – GDF Suez – Electrabel S.A. – Netherlands' Ministry of Infrastructure and the Environment (IenM) – Netherlands' Ministry of Economic Affairs, Agriculture and Innovation (EL&I) – Deutsche Bank AG - Government of Norway/Ministry of Foreign Affairs – Norsk Hydro ASA – Government of Canada/Ministry of Foreign Affairs and International Trade - Norsk Hydro ASA – Statoil ASA – Canada Ministry of Foreign Affairs and International Trade – Fortum Corporation - Finland Ministry of Foreign Affairs - Chubu Electric Power Co., Inc. - The Chugoku Electric Power Co., Inc. - Japan International Cooperation Agency (JICA) - Kyushu Electric Power Co., Inc. - Mitsubishi Corporation - Shikoku Electric Power Co., Inc. - Tohoku Electric Power Co. Inc. - The Tokyo Electric Power Co., Inc - Mitsui & Co., Ltd.
Host Party(ies)	Chile
Sectoral scope(s) and applied methodology(ies)	Sectoral Scope 1: Energy industries (renewable - / non-renewable sources). AM0026 (v.3): "Methodology for zero-emissions grid-connected electricity generation from renewable sources in Chile or in countries with merit order based dispatch grid".
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	88,720 tCO_2e
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	74,252 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>> The Chacabuquito Hydroelectric Power Project consists of a run-of-river power plant of 30 MW installed nameplate capacity that utilizes the waters of the Aconcagua river. The purpose of the project is to generate zero emission energy to be injected to the Central Interconnected System (SIC), the main Chilean electricity grid, using the hydrological sources and displacing the use of fossil fuels. It produces an average net annual generation of 170 GWh (with a 0.65 plant load factor, which is obtained through the division of net annual generation by the power plant installed capacity and total amount of hours of the year). The project connects to the 5th Region's at a 110 KV sub-system within the Central Interconnected System (SIC) and energy is delivered to industrial and residential consumers in the area. In addition, it is important to note that the plant does not consider a dam.

This plant is in cascade with three other upstream existent plants, Los Quilos, Aconcagua and Hornitos, which have been successfully operated since 1939, 1994 and 2008 respectively. The project uses well-proven technologies for run-of-river power generation. The design consists of a diversion weir, a system of channels and tunnels, a penstock and a powerhouse with four turbine- generator kits. In addition, the project construction costs are about US$ 37.0 million including contingencies but without financing charges. Of this, US$ 34.0 million corresponds to the cost associated with the hydro electric plant and related equipment and US$ 3.0 million is required for the expansion of the current transmission lines that connects Los Quilos and Aconcagua plants.

This project contributes to sustainable development in Chile through:

− Use of local renewable energy resources (small hydro) to displace coal and natural gas thermal power generation in the SIC.

− Increased commercial activity through clean and renewable source of power.

− Employment generation in the 5th Region where the project is located.

The Chacabuquito Hydroelectric Power Project started its operations on July 1st, 2002 and began its construction around one year before.

The total amount of emission reductions during this second monitoring period is 74,252 tonnes of CO_2e.

A.2. Location of project activity

>> Los Andes, 5th Region of Valparaíso, Chile.

Los Andes is located 100 km north from Santiago (capital of the country). The hydro power plant is located in a small valley surrounded by mountains (Aconcagua Valley). The Chacabuquito plant is in cascade with three existing upstream hydropower plants (Hornitos, Aconcagua and Los Quilos). The location of the project activity is illustrated in Figure 1.

Project coordinates are as follows:

32º51’12.35” S

70º30’22.21” W

Figure 1. Project activity geographical 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 if the Party involved wishes to be considered as project participant (Yes/No)**
Chile (host)	Hidroeléctrica Guardia Vieja S.A	No
Netherlands	International Bank for Reconstruction and Development (IBRD) as Trustee of the Prototype Carbon Fund (PCF)	Yes
Sweden	Government of Sweden - Swedish Energy Agency	Yes
France	GDF Suez	No
Netherlands	Electrabel S.A.	Yes
Netherlands	Netherlands' Ministry of Infrastructure and the Environment (IenM)	Yes

Netherlands	Netherlands' Ministry of Economic Affairs, Agriculture and Innovation (EL&I)	Yes
Netherlands	Deutsche Bank AG	Yes
Norway	Government of Norway - Ministry of Foreign Affairs	Yes
Norway	Norsk Hydro ASA	Yes
Norway	Statoil ASA	Yes
Canada (Party withdrawn from KP effective 15/12/2012)	Government of Canada- Ministry of Foreign Affairs and International Trade	Yes
Finland	Government of Finland- Ministry of Foreign Affairs	Yes
Finland	Fortum Corporation	Yes
Japan	Chubu Electric Power Co., Inc.	No
Japan	The Chugoku Electric Power Co., Inc.	No
Japan	Japan International Cooperation Agency (JICA)	No
Japan	Kyushu Electric Power Co., Inc.	No
Japan	Mitsubishi Corporation	No
Japan	Shikoku Electric Power Co., Inc.	No
Japan	Tohoku Electric Power Co. Inc.	No
Japan	The Tokyo Electric Power Co., Inc	No
Japan	Mitsui & Co., Ltd	No

A.4. Reference of applied methodology

>> 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)
http://cdm.unfccc.int/methodologies/DB/OOI7OYUFZOXN07H7EDBA9GVHJ4GK20/view.html

The applied methodology refers to the following tools:
"Tool for the demonstration and assessment of additionality (version 3)"

http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v3.pdf

A.5. Crediting period of project activity

>>2nd crediting period: 04/11/11 – 03/11/18 (7 years, Renewable)

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

>> The installed technology for the project activity implementation consists of a diversion weir, a system of canals (approximately 11 km) and tunnels (approximately 3 km), a pressure penstock, water fall of 137 m (134.58 m net water fall), a powerhouse and a high voltage line, and upgrade of existing transmission system. HGV has demonstrated a successful experience of construction, setting up and operating similar plants. The following Figure 2 shows the project design.

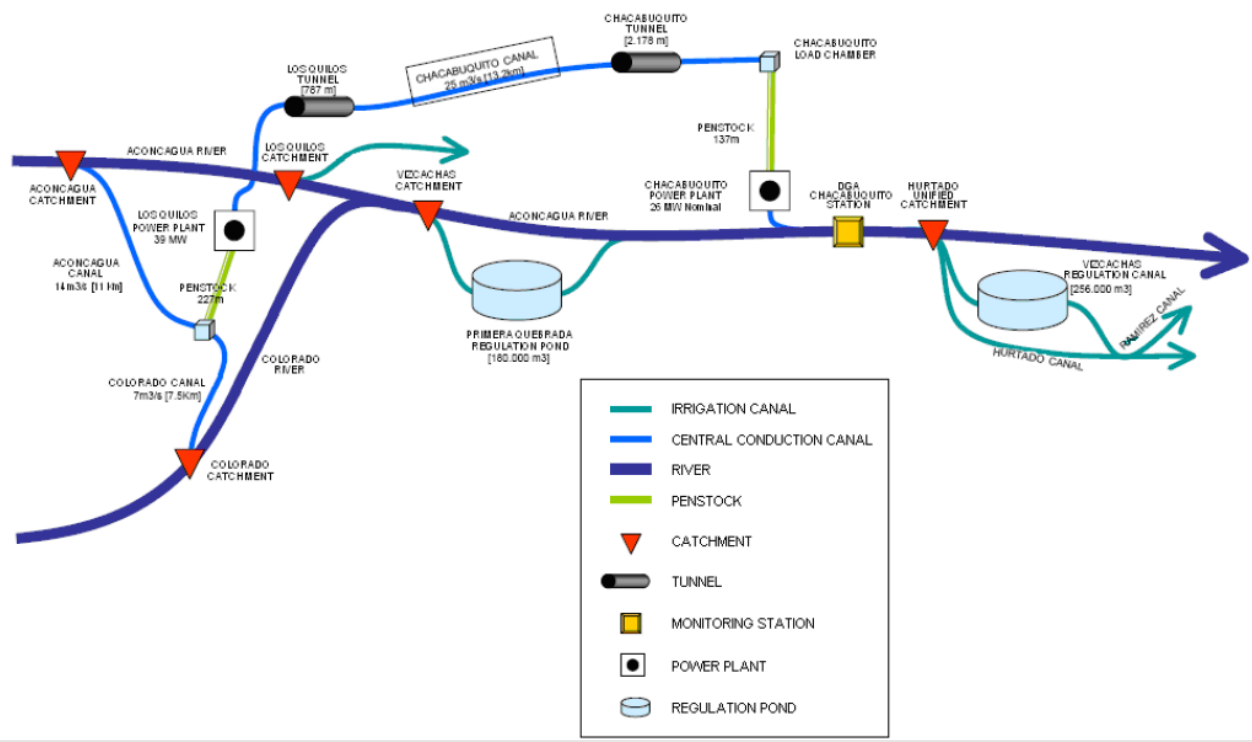


Figure 2. Diagram of the project activity

Canals, tunnels and the penstock will take the water flow from the Los Quilos plant through a series of canals and tunnels over a distance of approximately 10 km and 137 meter of water fall (134.58 meter net head penstock). From the Chacabuquito power house, the water used for energy generation will be discharged back to the Aconcagua River in order to fulfil all authority requirements regarding water flow.

The Chacabuquito Hydroelectric Power Project started its operations on July 1st, 2002 and began its construction around one year before.

During this monitoring period, Chacabuquito power plant has continuously operated with the following exceptions:

Table 1. Special events occurred during monitoring period

Unit	Start time	Start date	End time	End date	Details
Year 2011					
U1	4:48	12-11-2011	20:27	12-11-2011	Failure
U1	11:11	14-11-2011	11:28	14-11-2011	Failure
U2	1:00	01-12-2011	1:17	01-12-2011	Failure
U1	2:33	11-12-2011	8:43	11-12-2011	Failure
U2	2:33	11-12-2011	8:43	11-12-2011	Failure
U3	2:33	11-12-2011	8:43	11-12-2011	Failure
U4	2:33	11-12-2011	8:43	11-12-2011	Failure
Unit	**Start time**	**Start date**	**End time**	**End date**	**Details**

Year 2012					
Unit	**Start time**	**Start date**	**End time**	**End date**	**Details**
U2	20:48	15-01-2012	22:58	15-01-2012	Failure
U2	13:48	20-01-2012	14:20	20-01-2012	Failure
U2	10:02	31-01-2012	13:00	31-01-2012	Scheduled Maintenance
U4	13:20	31-01-2012	15:25	31-01-2012	Scheduled Maintenance
U2	9:25	08-02-2012	11:35	08-02-2012	Scheduled Maintenance
U1	9:35	08-02-2012	10:00	08-02-2012	Failure
U3	9:07	15-02-2012	11:30	15-02-2012	Scheduled Maintenance
U1	5:37	14-04-2012	23:59	30-04-2012	Failure
U3	5:38	14-04-2012	10:54	14-04-2012	Failure
U4	5:38	14-04-2012	8:29	14-04-2012	Failure
U1	9:34	07-05-2012	18:02	22-05-2012	Scheduled Maintenance
U2	13:48	23-05-2012	23:59	31-05-2012	Scheduled Maintenance
U2	0:00	01-06-2012	21:26	01-06-2012	Scheduled Maintenance
U1	10:23	09-06-2012	15:10	09-06-2012	Scheduled Maintenance
U2	10:23	09-06-2012	15:10	09-06-2012	Scheduled Maintenance
U3	10:23	09-06-2012	15:10	09-06-2012	Scheduled Maintenance
U4	10:23	09-06-2012	15:10	09-06-2012	Scheduled Maintenance
U2	19:33	10-06-2012	17:43	21-06-2012	Failure
U3	19:33	10-06-2012	12:00	13-06-2012	Failure
U1	1:46	13-06-2012	2:12	13-06-2012	Failure
U1	6:05	06-07-2012	12:54	06-07-2012	Failure
U2	6:05	06-07-2012	12:54	06-07-2012	Failure
U3	6:05	06-07-2012	12:35	06-07-2012	Failure
U4	6:05	06-07-2012	12:54	06-07-2012	Failure
U1	14:51	10-07-2012	2:36	11-07-2012	Failure
U2	14:51	10-07-2012	2:38	11-07-2012	Failure
U3	14:51	10-07-2012	2:36	11-07-2012	Failure
U4	14:51	10-07-2012	2:36	11-07-2012	Failure
U3	7:09	12-07-2012	13:44	24-07-2012	Scheduled Maintenance
U4	18:30	24-07-2012	23:59	31-07-2012	Scheduled Maintenance
U4	0:00	01-08-2012	16:40	08-08-2012	Scheduled Maintenance
U1	22:12	03-09-2012	9:36	04-09-2012	Failure
U1	3:24	20-10-2012	22:57	20-10-2012	Scheduled Maintenance
U1	21:02	31-10-2012	21:10	31-10-2012	Failure
U2	3:24	20-10-2012	22:57	20-10-2012	Scheduled Maintenance
U3	3:24	20-10-2012	23:10	20-10-2012	Scheduled Maintenance
U3	10:07	22-10-2012	18:00	26-10-2012	Scheduled Maintenance
U4	3:24	20-10-2012	23:07	20-10-2012	Scheduled Maintenance
U3	10:07	22-10-2012	18:00	26-10-2012	Scheduled Maintenance
U4	3:24	20-10-2012	23:07	20-10-2012	Scheduled Maintenance
U1	8:04	09-11-2012	10:36	09-11-2012	Failure
U1	7:44	10-11-2012	10:43	10-11-2012	Scheduled Maintenance
U2	7:46	10-11-2012	10:44	10-11-2012	Scheduled Maintenance
U3	7:48	10-11-2012	10:53	10-11-2012	Scheduled Maintenance
U4	7:49	10-11-2012	11:05	10-11-2012	Scheduled Maintenance
U1	8:03	17-11-2012	9:36	17-11-2012	Scheduled Maintenance
U2	8:04	17-11-2012	9:37	17-11-2012	Scheduled Maintenance
U3	8:05	17-11-2012	9:42	17-11-2012	Scheduled Maintenance
U4	8:08	17-11-2012	9:44	17-11-2012	Scheduled Maintenance
U1	12:31	22-11-2012	12:43	22-11-2012	Failure
U1	7:47	24-11-2012	10:08	24-11-2012	Scheduled Maintenance
U2	7:48	24-11-2012	10:10	24-11-2012	Scheduled Maintenance
U4	7:51	24-11-2012	10:14	24-11-2012	Scheduled Maintenance
U3	7:50	24-11-2012	10:25	24-11-2012	Scheduled Maintenance
U1	19:27	26-11-2012	22:30	26-11-2012	Failure
U2	19:29	26-11-2012	22:15	26-11-2012	Failure
U3	19:32	26-11-2012	22:20	26-11-2012	Failure
U4	19:34	26-11-2012	22:23	26-11-2012	Failure
U1	07:43	07-12-2012	10:07	07-12-2012	Scheduled Maintenance
U2	07:44	07-12-2012	10:16	07-12-2012	Scheduled Maintenance
U3	07:47	07-12-2012	10:15	07-12-2012	Scheduled Maintenance
U4	07:48	07-12-2012	10:17	07-12-2012	Scheduled Maintenance
U1	08:08	21-12-2012	10:25	21-12-2012	Scheduled Maintenance
U2	08:06	21-12-2012	13:18	21-12-2012	Scheduled Maintenance
U3	08:07	21-12-2012	10:32	21-12-2012	Scheduled Maintenance
U4	08:09	21-12-2012	10:45	21-12-2012	Scheduled Maintenance

Events reported in **¡Error! No se encuentra el origen de la referencia.** don't have an impact on the

applicability of the applied methodology.

B.2. Post registration changes

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

>>N/A

B.2.2. Corrections

>>N/A

B.2.3. Permanent changes from registered monitoring plan or applied methodology

>>N/A

B.2.4. Changes to project design of registered project activity

>>N/A

B.2.5. Changes to start date of crediting period

>>N/A

B.2.6. Types of changes specific to afforestation or reforestation project activity

>>N/A

SECTION C. Description of monitoring system

>> Management structure

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

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

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

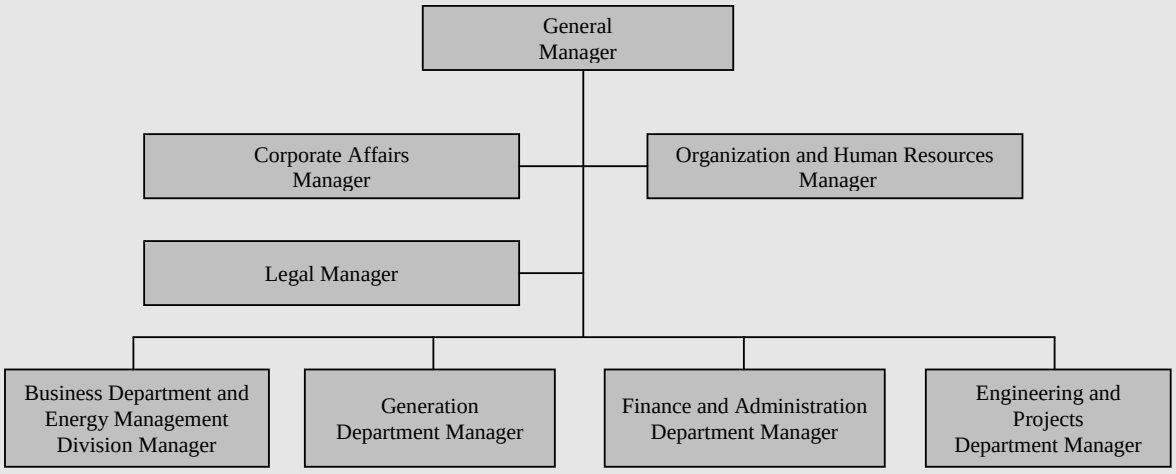


Figure 3. General Management structure

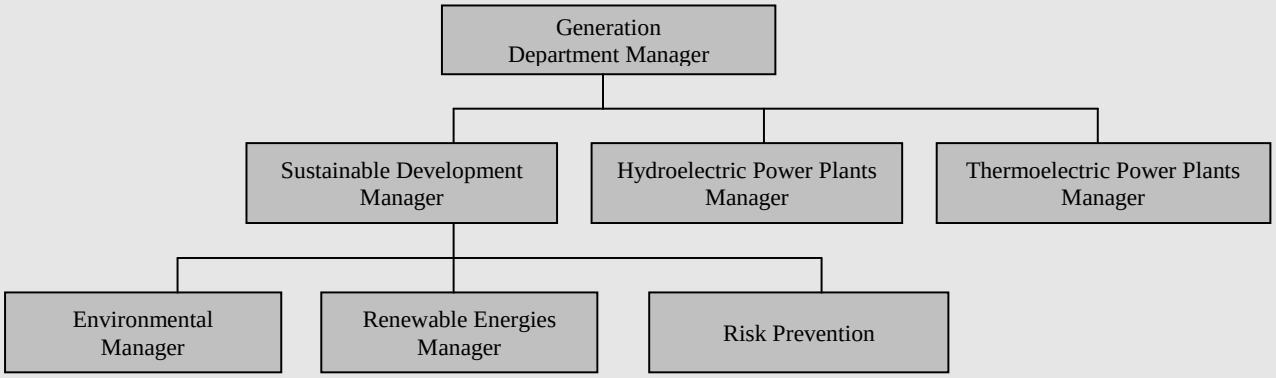


Figure 4. Generation Department structure

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 Sustainability and Climate Change Unit from the Environmental Management department.
  - II. Operator trainings are performed by a staff which is established by the Power Plant Manager (from the Hydroelectric Power Plants Manager department).
- CER's trading: Sustainability and Climate Change Unit, Environmental Management.
- Monitoring (data recording, measurements, etc): The responsible for monitoring data related to the CER's calculation are the Power Plant Staff (Operations), TI Management (from Finance and Administration Department Management), Sustainability and Climate Change Unit (as part of the Environmental Management).
- CERs calculation: This is performed by the Sustainability and Climate Change Unit (Environmental Management)

Monitoring System

Emission Factor Parameters:

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.

• Additional data needed to calculate the operating margin emission factor consistent with the AM0026 approved methodology.

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 the CDM related 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 activities of the monitoring plan.

Electricity delivered to the grid by the project activity

Chacabuquito project has three electricity meters, M1, M2 and M3. The electricity meter M1, which is located between the generation bar and the power transformer, measures the gross electricity from the four units. The meters M2 and M3 (main meters for the CDM monitoring plan) measure the electricity at the injection point. **¡Error! No se encuentra el origen de la referencia.** illustrates meters distribution for Chacabuquito project activity.

As result, M1 measurements are regularly sent and validated by CDEC-SIC (see Energy Generation Data Capture Procedure section below). These measurements are used as quality assurance procedure for CDM purposes.

It bears mentioning that energy meters are bidirectional and therefore net electricity is monitored.

Electricity delivered to the grid by the project activity is calculated as the difference between net electricity measurements from M2 and M3 (please refer to **¡Error! No se encuentra el origen de la referencia.**).

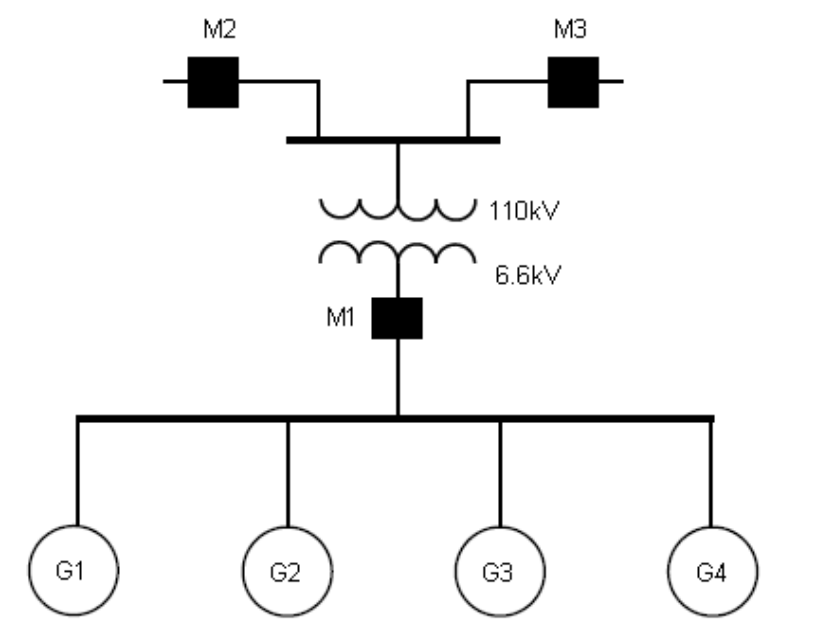


Figure 5. Metering System

There is a person in charge of the measurement which function includes maintaining the entire data acquisition system (measurement equipment, data capture and to send the data to company's personnel). The operator will operate and coordinate the dispatch of the power plant with the CDEC-SIC and periodically will send the hourly generation data.

An automatic data acquisition and measuring equipment management system operates for the Chacabuquito power plant, monitoring, capturing and storing the data continuously. Then the data is downloaded and an excel file is generated, which is sent to the operator. The spreadsheet received by the operator contains generation data acquired by the measuring system every 15 minutes. Once the data is received, it is integrated for calculating the hourly energy generation of the plant as an average of the four measurements each 15 minutes during each hour. Finally, the hourly energy generation from M2 and M3 is sent to the Sustainable Development department and M1 is sent to the CDEC-SIC as illustrated in the following figure:

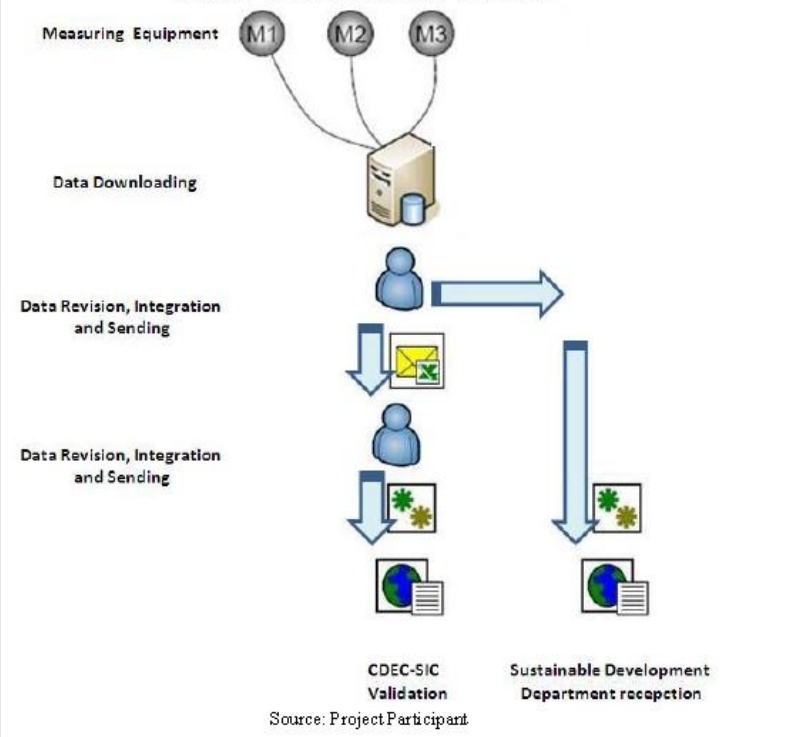


Figure 6. Information flow

Emergency procedure

In case of failure of the main electricity meters, the secondary meter measurements are validated by the CDEC-SIC and used for CDM purposes. In case of failure of the secondary electricity meter, the sum of energy measured by M2 and M3 meters is directly sent and validated by the CDEC-SIC.

Energy Measuring Equipment Periodic Verification Procedure

The verification is to be performed according to national standards (NCh 2542.Of2001), every two years by qualified and competent certifier, authorized by the national official organisms. If the equipment does not fulfil the Class 02, it will be replaced.

During this monitoring period, the meter verifications were made in the following dates:

Table 2. Verification dates during monitoring period

Date	Certifier	Equipment	Serial Number	Location
29/06/2012	Cam	ION8600	PT-0809A131-01	Generator (M1)
27/06/2012	Cam	ION8500	PQ-0502A117-03	Totoralillo Substation (M2)
27/06/2012	Cam	ION8500	PQ-0502A188-03	Totoralillo Substation (M3)

SECTION D. Data and parameters

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

Data / Parameter:	**$EF_{BM,y}$**
Unit:	tCO_2/MWh
Description:	Build margin CO_2 emission factor for the project electricity system in year y
Source of data:	PDD (ex-ante value).
Value(s) applied):	0.4481

Purpose of data:	Baseline emissions
Additional comment:	N/A

Data / Parameter:	w_{BM}
Unit:	%
Description:	Weight for Build Margin emission factor
Source of data:	"Tool to calculate the emission factor for an electricity system (v. 02)"
Value(s) applied):	75
Purpose of data:	Baseline emissions
Additional comment:	N/A

Data / Parameter:	w_{OM}
Unit:	%
Description:	Weight for Operating Margin emission factor
Source of data:	"Tool to calculate the emission factor for an electricity system (v. 02)"
Value(s) applied):	25
Purpose of data:	Baseline emissions
Additional comment:	N/A

D.2. Data and parameters monitored

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:	On-site metering system (same data submitted to CDEC-SIC)
Value(s) of monitored parameter:	Please refer to emission reductions spreadsheet.
Monitoring equipment:	The energy generation was monitored by two Power Measurement electricity meters located at Totoralillo substation, with the following characteristics: <u>Meter M2:</u> • Type: Ion 8500 • Accuracy class: 0.2% • Serial number: PQ-0502A117-03 • Calibration frequency: At least every two years • Last Calibration 27/06/2012 <u>Meter M3:</u> • Type: Ion 7650 • Accuracy class: 0.2% • Serial number: PQ-0502A188-03 • Calibration frequency: At least every two years • Last Calibration 27/06/2012

Measuring/ Reading/ Recording frequency:	Hourly measurement and daily recording.
Calculation method (if applicable):	Electricity measurements are taken automatically every 15 minutes. Then the hourly total is calculated. Electricity delivered to the grid is calculated as per net electricity measurements from e-meters located at Totoralillo substation (difference from M2 –M3).
QA/QC procedures:	Meter should have a maximum error of 0.2% and be calibrated every one or two years according to local standards for electricity transactions in CDEC-SIC. Monitored data is cross checked against electricity measurements at the generator of the power plant (M1).
Purpose of data:	Baseline emissions
Additional comment:	N/A

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 f6
Value(s) of monitored parameter:	Please refer to the ex-post emission factor calculation spreadsheet (2011 and 2012).
Monitoring equipment:	N/A
Measuring/ Reading/ Recording frequency:	Yearly
Calculation method (if applicable):	Calculation based on official data from CNE's Node Price Report and AM0026 procedures.
QA/QC procedures:	Automatic calculation.
Purpose of data:	Baseline emissions
Additional comment:	N/A

Data / Parameter:	**$EF_{OM,y}$**
Unit:	tCO_2e/MWh
Description:	Operating Margin Emission Factor for year y
Measured/ Calculated / Default:	Calculated
Source of data:	Calculated based on formula f1 using CDEC-SIC data
Value(s) of monitored parameter:	Please refer to the ex-post emission factor calculation spreadsheet (2011 and 2012).
Monitoring equipment:	N/A
Measuring/ Reading/ Recording frequency:	Yearly
Calculation method (if applicable):	Calculated based on formula f1 using CDEC-SIC data
QA/QC procedures:	Automatic calculation. Calculation should be done after CDEC-SIC makes the data official (validation).
Purpose of data:	Baseline emissions
Additional comment:	N/A

Data / Parameter:	$EF_{j,h}$
Unit:	tCO_2e/MWh
Description:	Operating Margin Emission Factor for proposed CDM project j for hour h
Measured/ Calculated / Default:	Calculated
Source of data:	Calculated based on formula f2 using CDEC-SIC data
Value(s) of monitored parameter:	Please refer to the ex-post emission factor calculation spreadsheet (2011 and 2012).
Monitoring equipment:	N/A
Measuring/ Reading/ Recording frequency:	Hourly
Calculation method (if applicable):	Calculated based on formula f2 using CDEC-SIC data
QA/QC procedures:	Automatic calculation. Calculation should be done after CDEC-SIC makes the data official (validation)
Purpose of data:	Baseline emissions
Additional comment:	N/A

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 formula f4 using CDEC-SIC data
Value(s) of monitored parameter:	Please refer to the ex-post emission factor calculation spreadsheet (2011 and 2012).
Monitoring equipment:	N/A
Measuring/ Reading/ Recording frequency:	Hourly
Calculation method (if applicable):	Calculated based on formula f4 using CDEC-SIC data
QA/QC procedures:	Automatic calculation. Calculation should be done after CDEC-SIC makes the data official (validation)
Purpose of data:	Baseline emissions
Additional comment:	N/A

Data / Parameter:	d_i
Unit:	tCO_2e/MWh
Description:	Emission factor for electricity displaced D(j,i)
Measured/ Calculated / Default:	Calculated
Source of data:	IPCC 2006 Guidelines and CNE node price report
Value(s) of monitored parameter:	Please refer to the ex-post emission factor calculation spreadsheet (2011 and 2012).
Monitoring equipment:	N/A

Measuring/ Reading/ Recording frequency:	Hourly
Calculation method (if applicable):	Calculated based on formula f5
QA/QC procedures:	Calculation based on official data.
Purpose of data:	Baseline emissions
Additional comment:	N/A

Data / Parameter:	**SFC_i**
Unit:	TJ/MWh
Description:	Specific fuel consumption per unit of electricity produced in the 'i^{th}' marginal plant.
Measured/ Calculated / Default:	Calculated
Source of data:	CDEC-SIC databases and CNE node price report.
Value(s) of monitored parameter:	Please refer to the ex-post emission factor calculation spreadsheet (2011 and 2012).
Monitoring equipment:	N/A
Measuring/ Reading/ Recording frequency:	Yearly
Calculation method (if applicable):	This parameter is obtained by the Yearly Fuel Consumption and the Annual Generation of each power source (information available in CDEC-SIC databases). If this information is not available, the Specific Fuel Consumption is used, which is presented in CNE node price report. Estimated based on official data from CNE's Node Price Report. Verification procedure shall be 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.
Purpose of data:	Baseline emissions
Additional comment:	Values from official sources may be reported in other units, for example m^3/MWh, kg/MWh, or others. As the data unit needed for the calculation is [TJ/MWh], the net calorific value of fossil fuel type i in year y ($NCV_{i,y}$) may be used for unit conversion, if deemed necessary.

Data / Parameter:	**$NCV_{i,y}$**
Unit:	TJ/mass or volume unit
Description:	Net calorific value of fossil fuel type i in year y
Measured/ Calculated / Default:	Default
Source of data:	The CNE Energy Balance Report includes Gross Calorific Values for the different fuels, these values were corrected to Net Calorific Values based on the IPCC 2006 assumption that for liquid fuels, Net Calorific Value is 5% lower than its Gross Calorific Value and for Gas fuels; Net Calorific Value is 10% lower than its Gross Calorific Value.
Value(s) of monitored parameter:	Please refer to the ex-post emission factor calculation spreadsheet (2011 and 2012).
Monitoring equipment:	N/A

Measuring/ Reading/ Recording frequency:	Yearly
Calculation method (if applicable):	Conversion is made from Gross calorific values to Net calorific values as according to the IPCC approach mentioned above (in "source of data").
QA/QC procedures:	-
Purpose of data:	Baseline emissions
Additional comment:	N/A

Data / Parameter:	**$CEF_{OM,i}$**
Unit:	tCO_2/GJ
Description:	CO_2 emission factor of fossil fuel used in i^{th} power plant
Measured/ Calculated / Default:	Default
Source of data:	IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.
Value(s) of monitored parameter:	Please refer to the ex-post emission factor calculation spreadsheet (2011 and 2012).
Monitoring equipment:	N/A
Measuring/ Reading/ Recording frequency:	Yearly
Calculation method (if applicable):	N/A
QA/QC procedures:	N/A
Purpose of data:	Baseline emissions
Additional comment:	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:	Calculation based on f3 and CDEC-SIC data
Value(s) of monitored parameter:	Please refer to the ex- post emission factor calculation spreadsheet (2011 and 2012).
Monitoring equipment:	N/A
Measuring/ Reading/ Recording frequency:	Hourly
Calculation method (if applicable):	Estimated based on CDEC-SIC databases and AM0026 procedures.
QA/QC procedures:	Automatic calculation procedure
Purpose of data:	Baseline emissions
Additional comment:	N/A

Data / Parameter:	N
Unit:	Number
Description:	List of CDM registered plants in the system
Measured/ Calculated / Default:	Calculated
Source of data:	CDEC-SIC and UNFCCC registered projects for the country
Value(s) of monitored parameter:	Please refer to the ex-post emission factor calculation spreadsheet (2011 and 2012).
Monitoring equipment:	N/A
Measuring/ Reading/ Recording frequency:	As required
Calculation method (if applicable):	N/A
QA/QC procedures:	Data is obtained from official reports.
Purpose of data:	Baseline emissions
Additional comment:	N/A

Data / Parameter:	C_j
Unit:	MWh
Description:	Electricity generated by j^{th} CDM plant in hour h
Measured/ Calculated / Default:	Measured
Source of data:	CDEC-SIC
Value(s) of monitored parameter:	Please refer to the ex-post emission factor calculation spreadsheet (2011 and 2012).
Monitoring equipment:	N/A
Measuring/ Reading/ Recording frequency:	Hourly
Calculation method (if applicable):	N/A
QA/QC procedures:	Automatic calculation procedure. Calculation should be done after CDEC-SIC makes the data official (validation).
Purpose of data:	Baseline emissions
Additional comment:	N/A

Data / Parameter:	A_i
Unit:	MWh
Description:	Generation capacity of the i^{th} plant on the margin during hour h
Measured/ Calculated / Default:	Measured
Source of data:	CDEC-SIC
Value(s) of monitored parameter:	Please refer to the ex-post emission factor calculation spreadsheet (2011 and 2012).
Monitoring equipment:	N/A
Measuring/ Reading/ Recording frequency:	Hourly

Calculation method (if applicable):	N/A
QA/QC procedures:	Data is obtained from official CDEC-SIC databases
Purpose of data:	Baseline emissions
Additional comment:	N/A

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
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 CDEC-SIC databases
Purpose of data:	Baseline emissions
Additional comment:	N/A

Data / Parameter:	**$Oxid_i$**
Unit:	%
Description:	Fraction of fuel oxidized on combustion
Measured/ Calculated / Default:	Default
Source of data:	IPCC 2006 Guidelines
Value(s) of monitored parameter:	1
Monitoring equipment:	N/A
Measuring/ Reading/ Recording frequency:	As required
Calculation method (if applicable):	N/A
QA/QC procedures:	Official data is used
Purpose of data:	Baseline emissions
Additional comment:	N/A

D.3. Implementation of sampling plan

>>N/A

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

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

>> Baseline emissions are calculated as the product of the energy delivered to the grid by the project activity and a combined margin emission factor of the grid.

The combined margin emission factor (CM), consisting of the weighted average of an operating margin (OM) and a Build Margin (BM) as stated in AM0026 (version 3).

According to the applied methodology for this second crediting period the BM was fixed ex-ante in the registered PDD. The ex-ante BM is as follows:

Table 3. Ex-ante Build Margin

Unit	$EF_{BM,y}$
tCO_2/MWh	0.4481

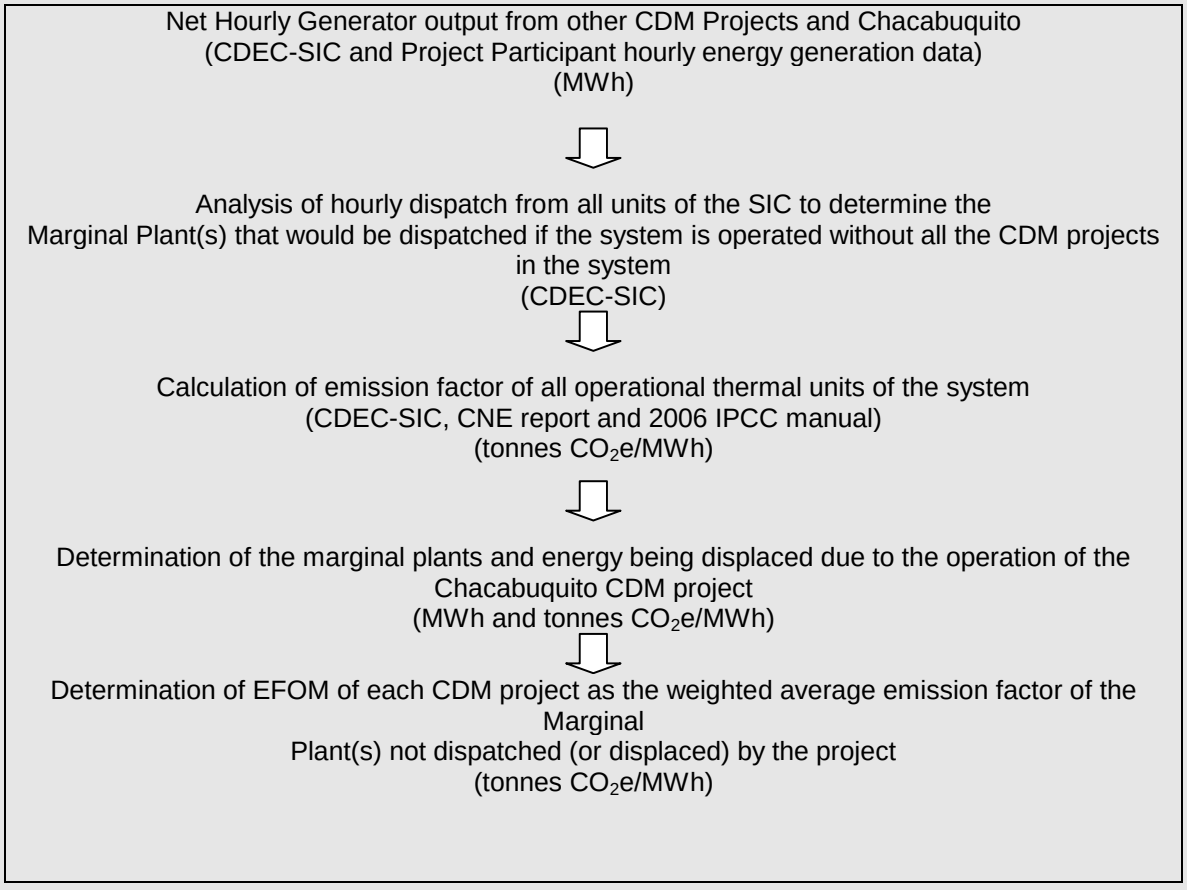
The OM emission factor is calculated ex-post for this monitoring period according to AM0026 (version 3) provisions as follows:

Calculation of the Operating Margin

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

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

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



The Emission Factor of the operating margin is calculated by the Emissions Factor Estimation Mathematical Tool as explained above and in accordance with the following equations:

$$EF_{OM,y} = \frac{\sum_{h=1}^{8760} EF_{j,h} \, x \, Generation_{j,h}}{\sum_{h=1}^{8760} Generation_{j,h}} \qquad \textbf{(f1)}$$

Where,

$EF_{i,h}$	Operating margin Emission factor for CDM project '***j***' for hour '***h***', expressed in tCO_2/MWh
$Generation_{i,h}$	Generation of 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 a 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 the Chacabuquito 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:

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

Where,

$D(j,i)$	Energy displacement of the marginal plant '***i***' due to the 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.

M is such that:

$$\sum_{j=1}^{N} C_j \leq \sum_{i=1}^{M} (A_i - B_i) \qquad \textbf{(f3)}$$

Where,

C_j	Energy generation of the CDM project 'j' expressed in MWh/h
N	Total number of CDM projects 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 CDM marginal plant 'i' expressed in MWh/h

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:

$$D(j,i) = MIN\left\{ C_j - \sum_{l=1}^{i-1} D(j,l); \quad (A_i - B_i) - \sum_{k=j+1}^{N} D(k,i) \right\} \qquad \textbf{(f4)}$$

Where,

D(j,i)	Energy displacement of the marginal plant '***i***' due to the CDM project '***j***', expressed in MWh
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 CDM marginal plant '***i***' expressed in MWh/h
C_i	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:

$$d_i = SFC_i * CEF_{OM,i} * Oxid_i \qquad \textbf{(f5)}$$

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 Chacabuquito 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, the value for the Operating Margin (OM) emission factor calculated with AM0026 is presented in the following table:

Table 4. Operating Margin (OM) Emission Factor

Unit	$EF_{OM,2011}$	$EF_{OM,2012}$
tCO_2/MWh	0.6182	0.6555

Combined Emission Factor

$$EF_y = w_{OM} * EF_{OM,y} + w_{BM} * EF_{BM,y} \quad \textbf{(f6)}$$

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.

Using the calculated values for OM and BM and weight values exposed above, the combined margin estimation is calculated as follow:

Table 5. Combined margin

Year	$EF_{OM,y}$	W_{OM}	EF_{BM}	W_{BM}	EF_y (CM)
2011	0.6182	0.25	0.4481	0.75	0.4906
2012	0.6555	0.25	0.4481	0.75	0.5000

The baseline emissions for the project are calculated as follows:

$$BE_y = EF_y * Generation_y \quad \textbf{(f7)}$$

Where,

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

BE_{2011} = 0.4906 tCO_2/MWh * 17,481 MWh = 8,579 tCO_{2e}
BE_{2012} = 0.5000 tCO_2/MWh * 131,362 MWh = 65,674 tCO_{2e}

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

According to the applied methodology AM0026 version 03, this project activity does not consider project emissions since it is a hydroelectric project with no reservoir.

E.3. Calculation of leakage

According to the applied methodology AM0026 version 03 and the registered PDD, leakage is not considered in this project.

E.4. Summary of calculation of emission reductions or net anthropogenic 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)	Emission reductions or net anthropogenic GHG removals by sinks (t CO_2e)
04/11/2012 – 31/12/2011	8,579	0	0	8,579
2012	65,674	0	0	65,674

Total	74,252	0	0	74,252

E.5. Comparison of actual emission reductions or net anthropogenic 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 ($t CO_2e$)	88,720	74,252

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

>> Emissions reductions achieved during this monitoring period are lower than the amount expected as per the PDD estimations.

E.7. Actual emission reductions or net anthropogenic GHG removals by sinks during the first commitment period and the period from 1 January 2013 onwards

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
Emission reductions or GHG removals by sinks ($t CO_2e$)	74,252	0

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Document information

Version	*Date*	*Description*
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 anthropogenic GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01	28 May 2010	EB 54, Annex 34. Initial adoption.

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