CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

CONTENTS

Annexes

SECTION A. General description of project activity

A.1. Title of the project activity:

>>

"Chacabuquito Hydroelectric Power Project"

Version 5

Version date: 21/04/2011

A.2. Description of the project activity:

>>

The Chacabuquito Hydroelectric Power Project consists of a run-of-river power plant. The nameplate capacity of Chacabuquito power plant, as seen during the validation audit for the second crediting period, is 30 MW[1]. The average net annual generation of the project is 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. The plant does not consider a dam.

This plant is in cascade with three other upstream existent power plants, Los Quilos, Aconcagua and Hornitos, which have been successfully operated since 1939, 1994 and 2008 respectively.

This project uses well-proven technologies for run-of-river power generation. The design consists of a diversion weir, a system of canals 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.

Furthermore, domestic and local environmental and socio-economic benefits are summarized in Table A.1.

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[1] 30 MW installed capacity is given by the turbines, but the effective capacity is limited to 28.872 MW by the generators.

Additionally, it should be clarified that Chacabuquito Hydroelectric Power Plant can not produce more than 26 MW due to physical constrains in the water intake civil works, which allow a maximum inflow of 21.5 m3/s, situation that is indirectly monitored by the hourly energy generation measurement. Slight over generation capacity can be achieved in isolated situations (less than 1 MW over less than a 3% of the time) due to the intake civil works standard accuracy, which are anyway covered by the 24 m3/s water rights granted by the DGA (General Water Direction).

Table A.1.: Domestic and Local Benefits

Subject	Explanation
Local environmental benefits	▪ The project contributes to clean energy provision to The Central Interconnected System of Chile, displacing thermal generation.
	▪ The project provides 18 hectares of reforestation with locally native trees.
Socio- economic benefits	▪ The project allows the 5th Region to exploit its significant economic potential.
	▪ Two new bridges and new access roads for semi-isolated villages in the region have been developed.
	▪ Job creation during the construction period and also during the operation.
	▪ Economic activity during the construction period and also during all of its lifetime.
Technology transfer	▪ Introduction and demonstration of environmentally friendly power production techniques for the 5th Region is an explicit objective of the project.
	▪ The demonstration that ERs from renewable energy can earn additional income and the introduction of CDM know-how is expected to raise environmental awareness and may create interest in low carbon energy technologies.
Project Authorization Request	▪ During December 1994 the Project Participant requested to the proper authorities the project approval and the authorization to build the Chacabuquito run-off-river power plant. The project was approved in November 1996 and it is mentioned that the authorized works construction will not affect the safety of others and will not produced water pollution. ▪ World Bank safeguard policies were applied as part of the detailed project design. Typically, small scale run-of-river hydropower projects have very limited environmental impacts.

A.3. Project participants:

>>>> See table A.2. below for a list of Project Participant

Table A.2.: Project Participants

Name of Party involved	Private and/or public entity(ies) Project Participants	Does the Party involved wish to be considered as project participant?
Chile (Host Party)	▪ Hidroeléctrica Guardia Vieja S.A.	No
Netherlands	▪ International Bank for Reconstruction and Development (IBRD) as trustee of the Prototype	Yes

Name of Party involved	Private and/or public entity(ies) Project Participants	Does the Party involved wish to be considered as project participant?
	Carbon Fund (PCF)	
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	▪ Ministry of Foreign Affairs and International Trade	Yes
Finland	▪ Ministry of Foreign Affairs	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	▪ MIT Carbon Fund Co., Ltd. (MIT)	No

Name of Party involved	Private and/or public entity(ies) Project Participants	Does the Party involved wish to be considered as project participant?
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

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

>>

A.4.1.1. Host Party(ies):

>> Chile

A.4.1.2. Region/State/Province etc.:

>> 5th Region of Valparaiso

A.4.1.3. City/Town/Community etc.:

>> Los Andes

A.4.1.4. Details of physical location, including information allowing the unique identification of this project activity (maximum one page):

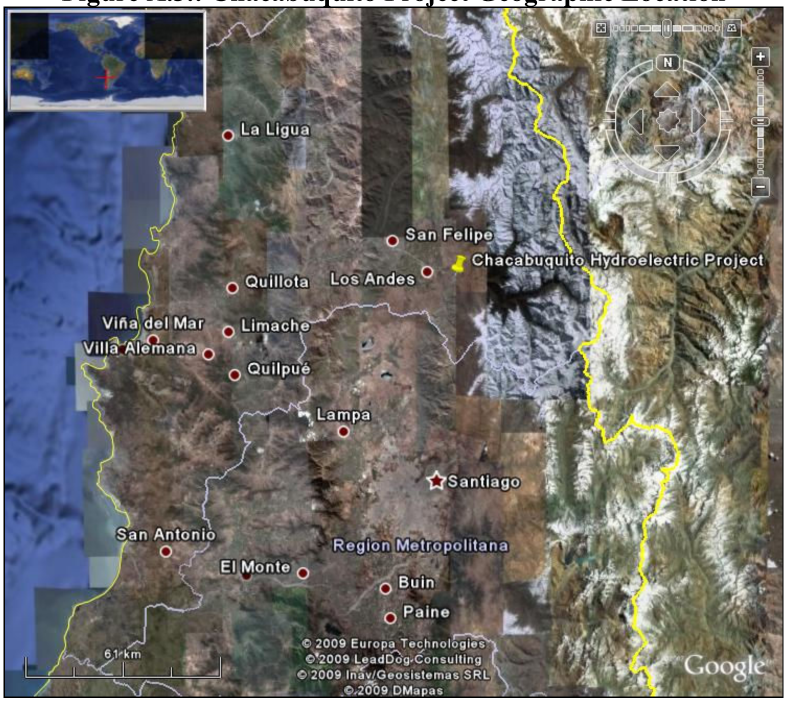
>>

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 A.3.

Project coordinates:

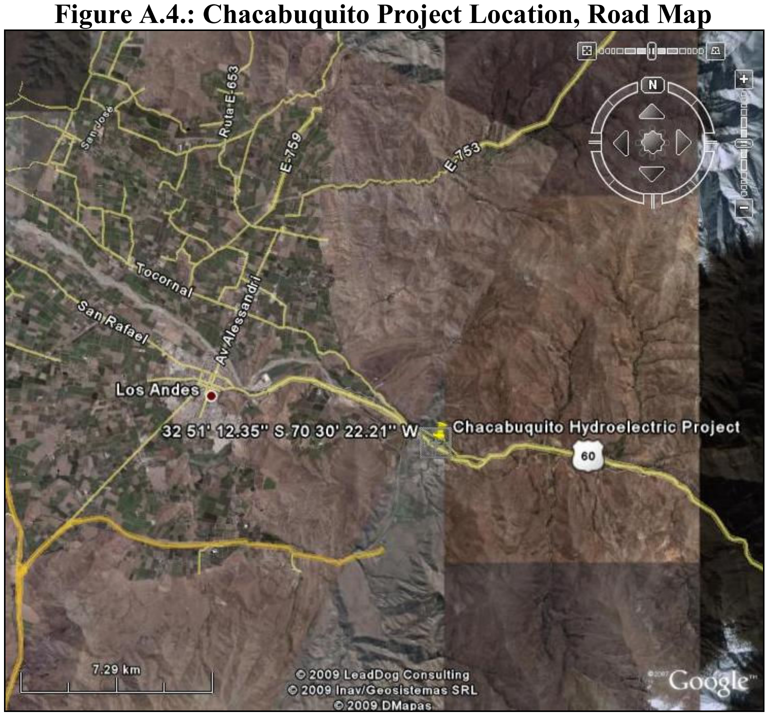
32º51’12.35” S
70º30’22.21” W

Figure A.3.: Chacabuquito Project Geographic Location



Source: GoogleEarth

Figure A.4.: Chacabuquito Project Location, Road Map



Source: GoogleEarth

Figure A.5.: Chacabuquito Hydroelectric Power Project Location, Project View

Source: GoogleEarth

A.4.2. Category(ies) of project activity:

>> The Chacabuquito Hydroelectric Power Project falls into:

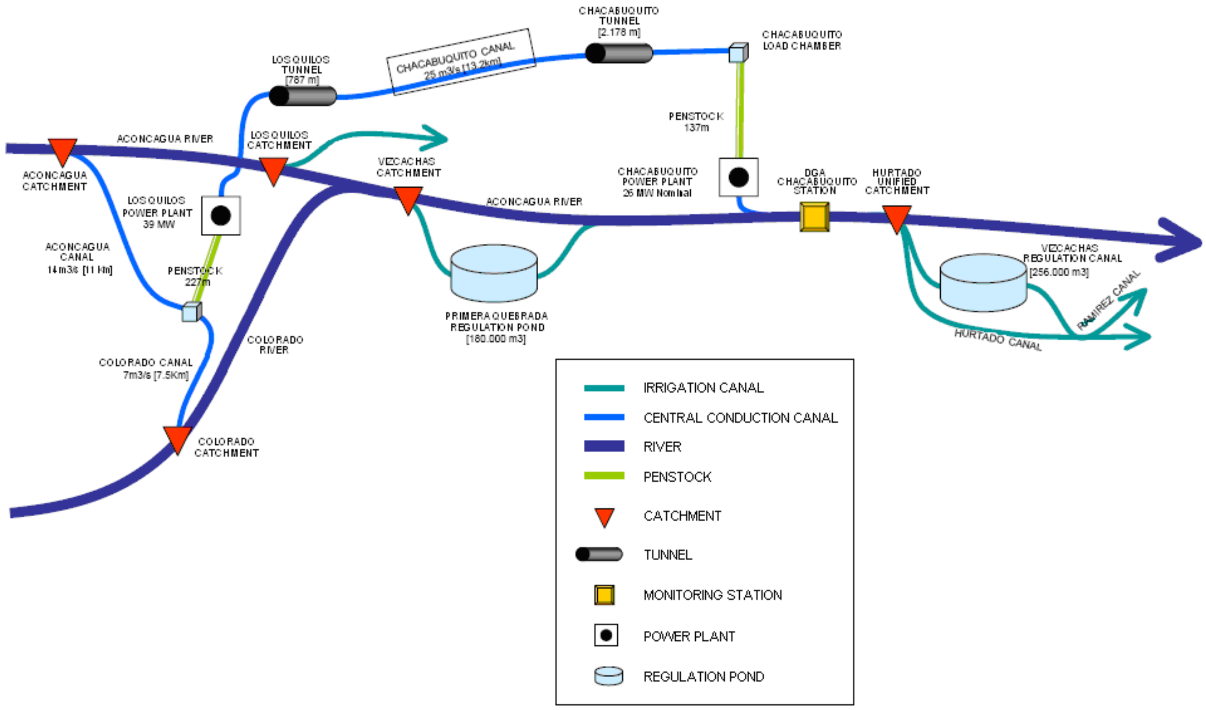
Scope number: 1
Scope: Energy industries (renewable - / non-renewable sources)

A.4.3. Technology to be employed by the project activity:

>>
The Chacabuquito Hydroelectric Power Project uses a simple layout and well proven technologies in Chile and worldwide and used in other Hidroelectrica Guardia Vieja S.A. (HGV) power plants. It consists of a diversion weir, a system of canals (approximately 11 km) and tunnels (approximately 3 km), a pressure penstock, water fall of 137[2] 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 shows the project design.

[2] In accordance to the project approval document DGA Nº3058, signed by the Ministry of Public Works (*Ministerio de Obras Públicas, MOP*), which is the Chilean authority in construction and administration of public civil works and water use.

Figure A.6.: Project Diagram



Source: Project Participant

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.

A.4.4. Estimated amount of emission reductions over the chosen crediting period:

>>

Project emission reductions are calculated as a combined margin emission factor (CM), consisting of the weighted average of an operating margin (OM) and a Build Margin (BM) as stated on Pg. 7 in AM0026 (v.3).

The OM will depend on the actual generation data from the Central Interconnected System (SIC in Spanish) which will be provided ***ex-post.***. The monitoring and verification plan for the project utilizes the data provided by the Load Economical Dispatch Center of the Central Interconnected System (CDEC-SIC in Spanish)[3].

For the second crediting period, the build margin (BM) emission factor is calculated ***ex-ante*** based on the most recent information available on units already built at the time of the submission of the request for renewal of the crediting period to the DOE. The sample group of power units to be included in the build

[3] The CDEC-SIC is the organism created by law whose purpose is to coordinate the operation of the electric power stations interconnected under the SIC.

margin considers the set of capacity additions in the electricity system that comprise 20% of the system generation and that have been built most recently.

The estimates of emission reduction are provided to facilitate evaluation of emission reduction from the project. The total estimated emission reduction to be achieved by the project is about 1.092 millions tons of CO_2 over 14 years (i.e. during the 2nd and 3rd renewable seven-year crediting periods). This is approximately 82,746 tCO_2e per year.

Table 3: Estimated amount of emission reductions during the Second Crediting Period

Years	Annual estimation of emission reductions in tonnes of CO_2 e
2009 (from July 1st)	0
2010	0
2011 (from December 1st)	6,896
2012	82,746
2013	82,746
2014	82,746
2015	82,746
2016 (up to June 30th)	41,373
Total estimated reductions (tonnes of CO_2e)	**379,253**
Total number of crediting years	7 years
Annual average over the crediting period of estimated reductions (tonnes of CO_2 e)	**54,179**

A.4.5. Public funding of the project activity:

>> No public funding is involved in the project activity.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

>> 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".

http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_IY3QJ5DOHLBPC0514FDE44V5MXIGVB

In order to estimate the emission factor for the grid, AM00026 (v.3) refers to the "Tool to calculate the emission factor for an electricity system (v 02)", EB 50, available on the CDM-Executive Board website under the following link:

http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.pdf

B.2. Justification of the choice of the methodology and why it is applicable to the project activity:

>>

The proposed methodology has been specifically tailored for the Chile Power sector.

The project meets every condition stated in the approved methodology.

The project:

- is connected to the Central Grid of Chile;
- is run-off-river hydro power plant with no reservoirs
- uses renewable sources to generate electricity; and
- fulfils all the legal obligations for this kind of projects, such as water rights, electric license, and environmental regulations.

B.3. Description of the sources and gases included in the project boundary:

>>

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

Table 4: Emission Sources

	Source	Gas	Included?	Justification/Explanation
Baseline	SIC thermal dispatch	CO_2e	Yes	Emission due to thermal power plant dispatch
		CH_4	No	
		N_2O	No	
Project Activity	SIC thermal dispatch	CO_2e	No	
		CH_4	No	
		N_2O	No	

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

>>

The following paragraphs represent the *Identification and Description of the Baseline Scenario* provided for the implementation of the Chacabuquito Project in the CDM context as part of the version of the Chacabuquito Hydroelectric Project Design Document presented for its first crediting period. There are no new relevant national and/or sectoral policies and circumstances which may affect the identified baseline.

Identification of the Baseline Scenario

In a centrally planned system, such as Chile, the baseline scenario can be determined on the basis of the least cost expansion and operation of the electric grid as defined by the planning authority. In Chile there is no central planning for expansion of power facilities. However, the National Energy Commission (CNE) prepares an indicative expansion plan, which is used to calculate system energy and power node prices and

all this data is included in the Node Price Report[4]. This calculation is based on the most plausible scenario for least cost capacity additions on the grid. However, sector investments come from private investors who are free to choose the projects they want to develop and base their decisions regarding investments and operation of plants on their own perception of the market, where the CNE node price determination is a key factor.

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

Description of the identified Baseline Scenario

The baseline scenario for the Project is the continuing operation of the existing and future power plants, but without the Chacabuquito electricity generation, necessary to meet the actual electricity demand. In the project scenario the same electricity demand is met with the Chacabuquito electricity generation dispatched in the base load, displacing the generation from existing power plants and future power developments. Because the project uses renewable sources to produce electricity, there are no additional emissions from the project activity and the emissions reductions are generated by the displaced generation.

Chile has four different grids and there are no interconnections between them. Therefore, each grid defines the geographical and system boundaries for proposed projects located within it (see map below). The Northern Interconnected Grid (SING) compromises the national territory between Arica and Tal-Tal and accounts for 28 percent of the total capacity in Chile. The Central Interconnected Grid (SIC), where the Chacabuquito Project is immersed, compromises the territory between Tal-Tal and Chiloé and accounts for 71 percent of the total capacity. The Aysén and Magallanes grids are located in the Aysén and Magallanes Regions, respectively, and account for less than one percent of the total capacity[5].

The relevant spatial extent of the Chacabuquito Hydroelectric Power Project boundary is the SIC, which its generation mix capacity comprises of 53% hydroelectric generation, 30% combine cycle gas turbines (used to be fired with natural gas most of the time, but nowadays primarily diesel), and the remainder from coal, diesel, petcoke, cogeneration and wind. At present there are no electricity imports or exports of the SIC grid to other national or international grid.

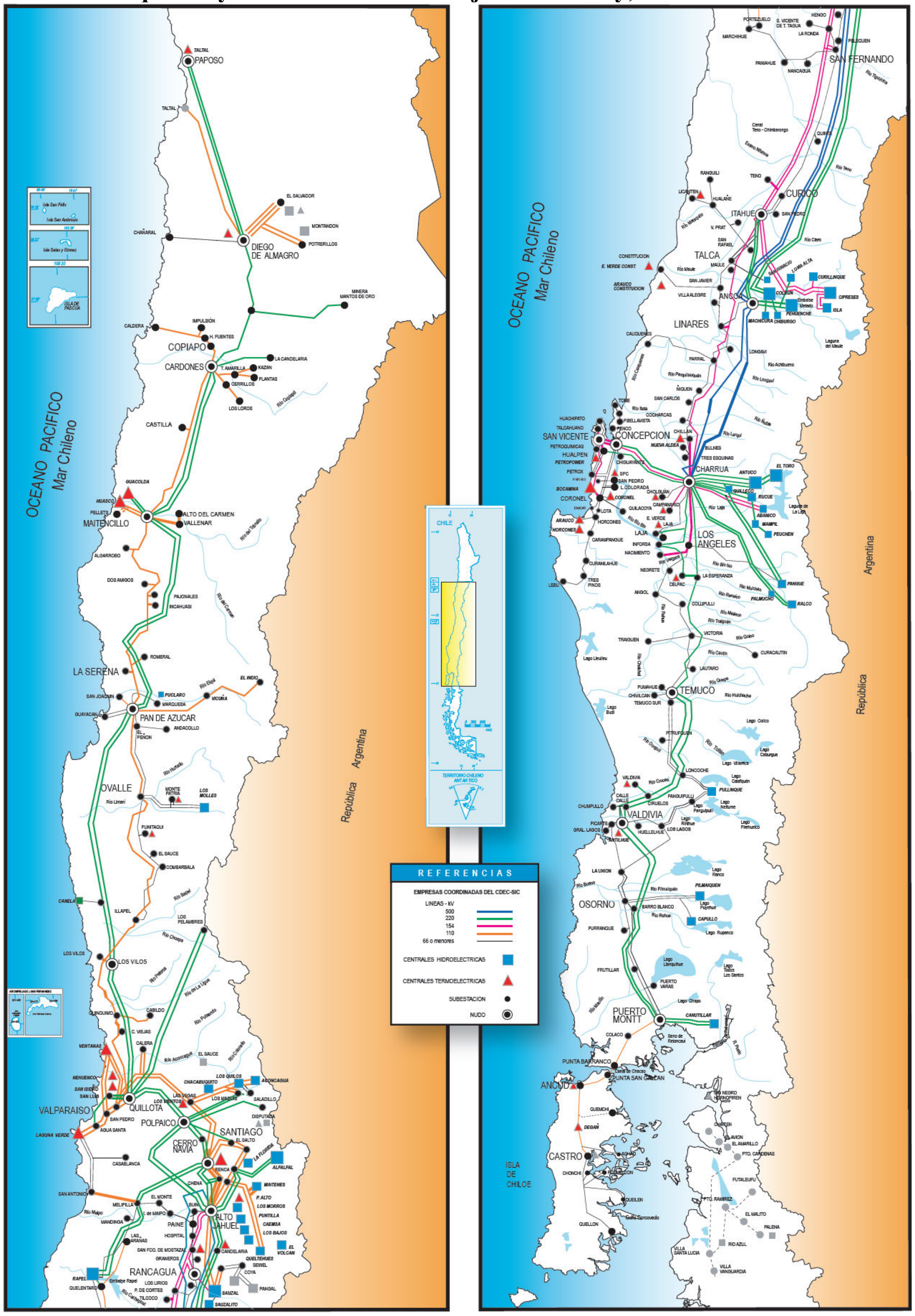
4
http://www.cne.cl/cnewww/opencms/07_Tarificacion/01_Electricidad/Otros/Precios_nudo/otros_precios_de_nudo/precios_de_nudo.html

5 Source: www.cne.cl

Figure B.1.: Chacabuquito Hydroelectric Power Project Boundary, National Territory Map

Source: www.gochile.cl

Figure B.2.: Chacabuquito Hydroelectric Power Project Boundary, Central Interconnected Grid Map



" Autorizada su circulación por resolución N°75 del 9 de abril de 2003 de la Dirección Nacional de Fronteras y Límites del Estado. La edición y circulación de mapas cartas geográficas u otros impresos que se refieran o relacionen con los límites y fronteras de Chile no comprometen en modo alguno al Estado de Chile de acuerdo con el Art. 2° letra g) del DFL N° 83 de 1979 del Ministerio de Relaciones Exteriores"

Nota: Actualizado hasta Abril de 2008.

Source: http://www.cdec-sic.cl/imagenes/contenidos/File/documentos/mapa_sic.pdf

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

>>

How the anthropogenic GHG emissions are to be reduced

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

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

Additionality Assessment

The following steps are used to demonstrate the additionality of the project.

Step 0. Preliminary screening based on the starting date of the project activity.

The Chacabuquito Hydroelectric Power Project started its operations on July 1st, 2002 and began its construction around one year before. Before its implementation HGV submitted this project to the Prototytpe Carbon Fund of the World Bank (PCF) seeking for additional funding from the Emissions Reductions generated by the project. In March 2001 HGV and the PCF signed a Letter of Intent for the purchase of Emissions Reductions; in April, 2001 the government of Chile endorsed the project for the purpose CDM component of the project and the PCF as buyer were crucial for the investment decision of the Article 12 of the Kyoto Protocol; and in February 2002 an Emission Reduction Purchase Agreement (ERPA) was signed, reflecting what was originally agreed in the Letter of Intent. Therefore, the CDM was seriously considered before the start of the project and the expected revenues from the CDM component of the project and the PCF as buyer were crucial for the investment decision

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

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

$$Min\left\{\sum \text{Investments} + \text{O\&M} + \text{VariableCosts} - \text{ResidualValues}\right\}$$

The relevant report at the time was the Node Price Report of April 2001 and thus, the one that impacted on the investment decision; it is thus the relevant report to test the additionality of the Chacabuquito Project. The following table shows the expansion plan from that report (page 5 of Annex 5 of the Report available at www.cne.cl).

Power Plant	Capacity [MW]	Commissioning Date	Chilean Region
Optimal Plan			
Taltal combined cycle	360.0	Jan.2003	Third
SIC-SING Interconnection	250.0	Jan.2004	Third
Combined cycle 1	372.6	Apr.2004	Fifth
Combined cycle 2	372.6	Apr.2005	Fifth
Combined cycle 3	372.6	Apr.2006	Fifth
SIC-SADI Interconnection	400.0	Jan.2007	Metropolitan
Combined cycle 4	372.6	Apr.2007	Fifth
Neltume hydro	400.0	Jan.2008	Tenth
Combined cycle 5	372.6	Apr.2008	Fifth
Combined cycle 6	372.6	Jan.2009	Fifth
Combined cycle 7	372.6	Apr.2009	Fifth
Combined cycle 8	372.6	Apr.2010	Fifth
Plants under construction			
Ralco hydro	570.0	Jul.2003	Eighth

As shown above, the least cost alternative for the expansion of the SIC are combined cycle natural gas fired power plants and two hydro dams called Ralco (570 MW, 2003) and Neltume (400 MW, 2007). The Ralco hydro dam is under construction and it was expected to start generating electricity by July 2003. There are no run-of-the-river hydroelectric power plants picked by the model.

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

The Official Expansion Plan elaborated by the CNE is the primary source to test the additionality. The methodology requires an extra test to confirm additionality. This test consists of running the expansion model again with the same information from the CNE but adding the project official data (hydrological data, construction cost and operation and maintenance cost), and comparing both results. The comparison was done in two scenarios, the effective capacity (28.872 MW) and the total installed capacity (30 MW). The outcome of this comparison is shown below, annually and in net present value:

Table B.1.a. Project Investment and costs

In million USD	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Baseline Scenario										
Generation	157,8	182,7	186,3	205,1	239,9	281,7	328,6	371,8	444,1	517,9
Unserved Energy	0,1	7,9	22,3	10,7	7,3	5,2	1,1	0,6	0,4	2,8
TOTAL	**157,9**	**190,6**	**208,6**	**215,8**	**247,2**	**286,9**	**329,7**	**372,4**	**444,5**	**520,7**
Including Project										
Generation	156,7	179,9	183,2	202,4	237,4	278,9	325,5	369,0	440,9	514,6
Unserved Energy	0,1	7,5	21,0	10,1	6,8	4,9	1,0	0,6	0,3	2,5
Project Investment	-	40,7	-	-	-	-	-	-	-	-25,9
Project O&M costs	-	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
TOTAL	**156,8**	**228,4**	**204,5**	**212,8**	**244,5**	**284,1**	**326,8**	**369,9**	**441,5**	**491,5**

In Million USD	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Baseline Scenario										
Generation	157.8	182.7	186.3	205.1	239.9	281.7	328.6	371.8	444.1	517.9
Unserved Energy	0.1	7.9	22.2	10.7	7.3	5.2	1.1	0.6	0.4	2.8
TOTAL	**157.9**	**190.6**	**208.5**	**215.8**	**247.2**	**286.9**	**329.7**	**372.4**	**444.5**	**520.7**
Including Project 28.872 MW										
Generation	156.6	179.8	183	202.3	237.3	278.8	325.3	368.9	440.7	514.3
Unserved Energy	0.1	7.4	20.9	9.9	6.7	4.9	1.0	0.6	0.3	2.4
Project Investment	0	40.7	0	0	0	0	0	0	0	-25.9
Project O&M Costs	0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
TOTAL	**156.7**	**228.2**	**204.2**	**212.5**	**244.3**	**284.0**	**326.6**	**369.8**	**441.3**	**491.1**
Including Project 30 MW										
Generation	156.5	179.6	182.9	202.2	237.2	278.6	325.1	368.7	440.6	514.1
Unserved Energy	0.1	7.4	20.8	9.9	6.7	4.8	1.0	0.6	0.3	2.4
Project Investment	0	40.7	0	0	0	0	0	0	0	-25.9
Project O&M Costs	0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
TOTAL	**156.6**	**228.0**	**204.0**	**212.4**	**244.2**	**283.7**	**326.4**	**369.6**	**441.2**	**490.9**

Table B.1.b. Investment analysis 28.872 MW

In million USD (*)	
Baseline Scenario	
Generation	1.773,8
Unserved Energy	44,3
TOTAL	**1.818,1**
Including Project	
Generation	1.756,1
Unserved Energy	41,6
Project Investment	26,0
Project O&M costs	2,0
TOTAL	**1.825,7**
Generation+Unserved	-20,4
Project Costs	28,0
Cost Difference	7,6
Investment Cost (apr-01)	37,0
Commissionig date	Jul-02
Annua Discount rate	10%
Annual O&M costs	0,3

In Million USD*	
Baseline Scenario	
NPV Generation	1,773.8
NPV Unserved Energy	44.2
TOTAL	**1,818.0**
Including Project 28.872 MW	
NPV Generation	1,755.1
NPV Unserved Energy	41.2
Project Investment	26.0
Project O&M Costs	1.7
TOTAL	**1,824.0**
Generation+Unserved	-21.7
Project Costs	27.7
Costs Difference	**6.0**
Invesment cost (apr-01)	37.0
Commisionig date	Jul.02
Annual Discount rate	10%
Annual O&M costs	0.3

(*) As in April 2001

Table B.1.c. Investment analysis 30 MW

In Million USD*	
Baseline Scenario	
NPV Generation	1,773.8
NPV Unserved Energy	44.2
TOTAL	**1,818.0**
Including Project 30 MW	
NPV Generation (10%)	1,754.1
NPV Unserved Energy (10%)	41.0
Project Investment	26.0
Project O&M Costs	1.7
TOTAL	**1,822.9**
Generation+Unserved	-22.8
Project Costs	27.7
Costs Difference	**4.9**
Invesment cost (apr-01)	37.0
Commisionig date	Jul.02
Annual Discount rate	10%
Annual O&M costs	0.3

The above tables show the proposed CDM project has the following economic impact on the overall system:

To the 28.872 MW case:

- Savings in the system operation cost of US$ 18.7 million (US$ 1,773.8 - US$ 1,755.1);
- Savings in expected shortage of US$ 3 million (US$ 44.2 – US$ 41.2); and

- US$ 27.7 million of additional investment and maintenance and operation of the Project.

To the 30 MW case:

- Savings in the system operation cost of US$ 19.7 million (US$ 1,773.8 - US$ 1,754.1);
- Savings in expected shortage of US$ 3.144 million (US$ 44.186 – US$ 41.042)[6]; and
- US$ 27.7 million of additional investment and maintenance and operation of the Project.

The overall outcome is US$ 6 and US$ 4.9 millions of additional cost for the system in the 28.872 MW and 30 MW respectively, for serving the same energy demand in the scenario with the project activity.

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

Therefore, according to the investment analysis, the Project is additional in both cases.

Step 4. Common practice analysis.

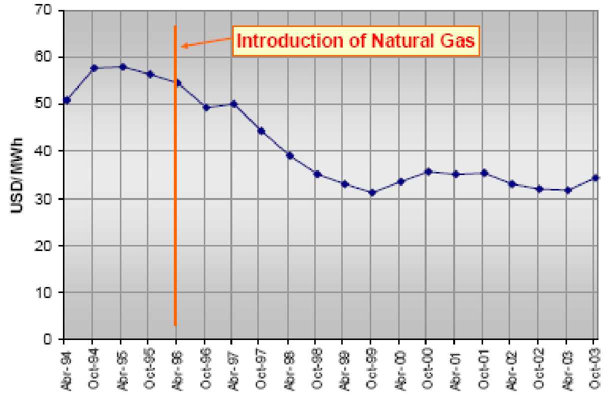
Sub-step 4a Analyze other activities similar to the proposed activity:

Since natural gas was introduced as a resource to Chile in 1996, system prices where significantly reduced, completely changing the business environment in both main grids (SICS and SINGS). While this situation prevailed in the country, all other generating technologies using renewable resources became non-competitive, with the exception of big hydro dam power projects. Since 1996, only one other hydro run-of-the-river power project was built in the Chilean interconnected central grid (the Peuchen and Mampil Project),

The following figure B.3 shows SIC's historic energy price variations. It can be clearly identified an energy price reduction in the system after natural gas introduction. As indicated on Step 0. Chacabuquito investment decision was taken in early 2001, only after seeking additional funding from carbon credits.

[6] Numbers presented in tables B.3.b and B.3.c were rounded to one decimal.

Figure B.3. CNE Node Price Fixation (in Real USD as of Oct-2003)



Source: CNE price reports and bls.gov CPI

<u>Sub-step 4b. Discuss similar options that are occurring:</u>

There are no similar activities observed in the SIC being carried at the time the project initiated its construction and its operation, with the exception of those projects that have been submitted under, or are seeking, carbon credits finance under the CDM.

Step 5. Impact of CDM Registration

The revenues from the sales of Emissions Reductions have two main impacts for the project: First, the revenues come from one of the most creditworthy organization in the world, reducing the overall risk of the project and the exchange risk of the cash flows. Second, the additional revenues, in US dollar, increases the IRR by about 2.5 points of the internal rate of return of the project, making the project attractive to the investors.

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

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

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Project emission reductions are calculated as a combined margin emission factor (CM), consisting of the weighted average of an operating margin (OM) and a Build Margin (BM) as stated in AM0026 (version 3) The OM 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 Hydroelectric project in the generation mix in the SIC. The monitoring and verification plan for the project utilizes the data provided by CDEC-SIC.

The BM emission factor will be determined in an ex-ante basis as the generation-weighted average emission factor (tCO_2/MWh) of the most recent 20% capacity added to the SIC or the latest five power units that have been built most recently, selecting the set of power units that comprises the larger annual generation.

Calculation of the Project Emissions Reductions

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

The amount of data to be analyzed and processed and 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 programmed a Mathematical Tool for the Emissions Factor Estimation. This Mathematical Tool permits qualified personnel to conduct ex-ante and ex-post emissions factor estimations based on available data.

In general terms, the procedure executed by the Emission Factor Estimation Mathematical Tool consider the following stages:

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

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

The second, third and four stage of the estimation use the information previously uploaded, following the estimation procedures stated in the approved baseline and monitoring methodology AM0026 and Tool to Calculate the Emission Factor for an Electricity System.

The Mathematical Tool counts with an audit mode, which allows the Designated Operational Entity to access and verify the assumptions, calculations and procedures.

Finally, and using the emission factor estimated by the Mathematical Tool, the emissions reductions associated to the operation of the project activity can be calculated.

The following procedure represents a description of the emissions reduction estimation associated to the project, which are applied in the Mathematical Tool for the Emissions Factor Estimation developed by the project participant.

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:

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

↓

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

↓

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

↓

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

↓

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

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[7] www.cdec-sic.cl

[8] Energy generation data and Merit Order.

[9] www.cne.cl

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:

Where,

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

$EF_{j,h}$	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 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 jth CDM plant. The emission factor is estimated as follows:

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

Where,

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

M is such that:

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

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 ($Ai - Bi$) represents the maximum possible additional electric energy that can be supplied by the ith marginal plant.
Energy displacement of the marginal plant '***i***' due to the proposed CDM project '***j***', is calculated as follows:

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

Where:

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

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

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

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

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

Where,

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

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

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

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

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[10] Chilean Regulation NCH 2542.

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

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

Calculation of the Build Margin

The Build Margin emission factor will be calculated with Option (i) of the approved baseline methodology AM0026, i.e. as described in the "Tool to calculate the emission factor for an electricity system". The sample group of power units to be included in the build margin considers the set of capacity additions in the electricity system that comprise 20% of the system generation and that have been built most recently which represents Option (b) of *Step 5 Identify the group of power units to be included in the build margin* of the "Tool to calculate the emission factor for an electricity system". As shown in Annex 3 Table 13, the selection of plants, that comprises 20% of annual generation from plants that have been built most recently, has clearly more than five power plants, making option (a) inapplicable.

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

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

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

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

⇩

Determination of 20% of energy generated from most recent power units and the generation from the five most recently build plants. The set of power plants that comprises the larger annual generation, which is the set of power units that comprises the 20% of the system generation, is chosen.
(set of m plants following the "Tool to calculate the emission factor for an electricity system (v02)")
(MWh)

⇩

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

⇩

Determination of EF_{BM} ("Tool to calculate the emission factor for an electricity system (v02)", step 4 (a)) as the weighted average emission factor of the dispatched plants and their individual emission factor
(tonnes CO_2e/MWh)

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

Where,

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \cdot EF_{EL,m,y}}{\sum_m EG_{m,y}} \qquad \textbf{(f6)}$$

Where:

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

The CO2 emission factor of the power units included for estimating the BM is determined using option A1, A2 or A3 presented in *Step 4 (a) Simple OM* of the "Tool to calculate the emission factor for an electricity system" during the most recent year y for which power generation data is available.

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

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \cdot NCV_{m,i,y} \cdot EF_{CO2,i,y}}{EG_{m,y}} \qquad \textbf{(f7)}$$

Where:

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

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

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} \cdot 3.6}{\eta_{m,y}} \qquad \textbf{(f8)}$$

Where:

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

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

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

Project Emission Reductions

The combined margin emission factor for the proposed Chacabuquito project, according to AM0026, is calculated with weighted average for both the Operating Margin (OM) and the Build Margin (BM).

Calculation of Combined Margin Emission factor of EFBM and EFOM
(tonnes CO_2e/MWh)

⇩

Energy generation of the Chacabuquito CDM Project
(Project Developer)
(MWh)

⇩

Calculation of Baseline Emissions of the Project
(tonnes CO_2e)

⇩

Discount any leakage or project activity emissions, if any
(No leakage emission was identified for Chacabuquito, and project emissions are null)
(tonnes CO_2e)

The combined margin emission factor for the proposed Chacabuquito project, according to AM0026, is calculated by the Emissions Factor Estimation Mathematical Tool considering the weighted average for both the Operating Margin (OM) and the Build Margin (BM) as follows:

$$EF_y = w_{OM} \bullet EF_{OM,y} + w_{BM} \bullet EF_{BM,y}$$ **(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.

The AM0026 methodology determines the w_{BM} and w_{OM} by using the "Tool to calculate the emission factor for an electricity system" which states that for the second crediting period a value of 75% and 25% should be used for the build margin and operating margin emission factors weight for estimating the combined emission factor.

The baseline emissions for the project are calculated as follows using the emissions factor estimated by the Emissions Factor Estimation Mathematical Tool and the energy generated by the project activity:

$$BE_y = EF_y \bullet Generation_y$$ **(f10)**

Where,

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

Finally, the project mainly reduces CO_2 emissions through substitution of power generation supplied by the existing generation sources connected to the grid and likely future additions to the grid. The emission reduction (*ERy*) by the project activity during year *y* is equal to the Baseline Emissions. Since the Chacabuquito project consists of a hydro power plant, there are no Project Emissions (*PEy*). Additionally, as per AM0026, no leakage (L_y) was identified for this project activity. The emission reduction can be expressed as follows:

$$ER_y = BE_y - PE_y - L_y = BE_y$$ **(f11)**

Where,

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

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, with a subscription fee of 350 USD/year. Also, node price reports, used to calculate thermal plant fuel consumption for the OM emission factor, can be obtained from the National Energy Commission CNE at www.cne.cl.

The calculation of the Operating Margin will be provided ex-post with real data according the approved methodology; hence, the data used in the PDD for the calculation of the current baseline is only used for

estimation purposes**.** The data required for the estimation of the EF_{BM}, which is fixed for the second crediting period, is provided in Annex 3.

B.6.2. Data and parameters that are available at validation:

This section includes all the data and parameters that are not monitored through the crediting period, mainly related to the Build Margin emission factor, which is calculated ex-ante according to the "Tool to calculate the emission factor for an electricity system". The detailed source for each parameter is presented in Table 19 (Annex 3).

Data / Parameter:	$\mathbf{EG_{m,y}}$
Data unit:	MWh
Description:	Net electricity generated and delivered to the grid by power plant / unit *m* included in the build margin calculation in year *y*.
Source of data used:	CDEC-SIC 2007 Annual Report, http://www.cdec-sic.cl/datos/anuario2008/index.html
Value applied:	Values in Table 13 of Annex 3.
Justification of the choice of data or description of measurement methods and procedures actually applied:	EF_{BM}: For the second crediting period, the EF_{BM} is calculated only once *ex-ante* at the start of the second crediting period. The data from the CDEC-SIC 2007 represents the most recent and reliable information available.
Any comment:	

Data / Parameter:	$\mathbf{EF_{CO2,m,i,y}}$
Data unit:	tCO_2/GJ.
Description:	Average CO_2 emission factor of fuel type i used in power unit *m* included in the build margin calculation in year *y*
Source of data used:	IPCC revised guidelines (2006).
Value applied:	Values in Table 15 of Annex 3.
Justification of the choice of data or description of measurement methods and procedures actually applied :	EF_{BM}: For the second crediting period, the EF_{BM} is calculated only once *ex-ante* at the start of the second crediting period. No other data is publicly available. For estimating emission factor for different fuel based generation technologies, IPCC guidelines have been used in a conservative manner.
Any comment:	

Data / Parameter:	$\mathbf{FC_{i,m,y}}$
Data unit:	For Diesel: kg/year, for Natural Gas: m3/year.
Description:	Amount of fossil fuel type *i* consumed by power plant / unit *m* included in the build margin calculation in year *y*
Source of data used:	CDEC-SIC 2007 Annual Report, http://www.cdec-sic.cl/datos/anuario2008/index.html or CNE Node Price Report.
Value applied:	Values in Table 13 of Annex 3.
Justification of the choice of data or	EF_{BM}: For the second crediting period, the EF_{BM} is calculated only once ex-ante at the start of the second crediting period. The data from the CDEC-SIC and CNE

Data / Parameter:	**$FC_{i,m,y}$**
description of measurement methods and procedures actually applied:	represents the most recent and reliable information available.
Any comment:	Annual information is used if available; if not, CNE information is used.

Data / Parameter:	**$NCV_{m,i,y}$**
Data unit:	For Diesel: (TJ / mass or volume unit) and For Natural Gas: (TJ / mass or volume
Description:	Net calorific value of fossil fuel type *i* consumed by power plant / unit *m* included in the build margin calculation in year *y*
Source of data used:	National Energy Commission Annual Energy Balance Report and IPCC 2006.
Value applied:	Values in Table 14 of Annex 3.
Justification of the choice of data or description of measurement methods and procedures actually applied:	EF_{BM}: For the second crediting period, the EF_{BM} is calculated only once *ex-ante* at the start of the second crediting period. The data from the CNE and the IPCC 2006 represent the most recent and reliable information available.
Any comment:	The CNE Energy Balance Report includes Gross Calorific Values for the different fuels, these values were corrected to Net Calorific Values based on the IPCC 2006 assumption that for Diesel, Net Calorific Value is 5% lower than its Gross Calorific Value and for Natural Gas; Net Calorific Value is 10% lower than its Gross Calorific Value.

Data / Parameter:	**$\eta_{m,y}$**
Data unit:	[%]
Description:	Energy conversion efficiency
Source of data used:	"Tool to calculate the emission factor for an electricity system (v 02)"
Value applied:	Values in Table 16 of Annex 3.
Justification of the choice of data or description of measurement methods and procedures actually applied:	There are not local values for efficiency.
Any comment:	

Data / Parameter:	**w_{BM}**
Data unit:	%
Description:	Weight for Build Margin emission factor
Source of data used:	"Tool to calculate the emission factor for an electricity system (v 02)"
Value applied	75
Justification of the	The AM0026 methodology determines the w_{BM} by using the "Tool to calculate

Data / Parameter:	w_{BM}
choice of data or description of measurement methods and procedures actually applied:	the emission factor for an electricity system" which states that for the second crediting period a value of 75% should be used for the build margin weight.
Any comment:	

Data / Parameter:	w_{OM}
Data unit:	%
Description:	Weight for Operating Margin emission factor
Source of data used:	"Tool to calculate the emission factor for an electricity system (v 02)"
Value applied	25
Justification of the choice of data or description of measurement methods and procedures actually applied:	The AM0026 methodology determines the w_{OM} by using the "Tool to calculate the emission factor for an electricity system" which states that for the second crediting period a value of 25% should be used for the operating margin weight.
Any comment:	

B.6.3. Ex-ante calculation of emission reductions:

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Operating Margin Emission Factor

AM0026 calculates ex-post the emission factor for the operating margin by observing actual dispatch data, the generation from the power plants and the merit order. The emission factor for the operating margin is determined by the generation that would be dispatched in the absence of this CDM Project based on the latest available data at time of submission of the PDD to the DOE, which is year 2007.

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

Table 8: Operational Margin Emission Factor

Operational Margin Emission Factor $EF_{grid,OM,2007}$ [tCO2/MWh]
0.6708

Build Margin Emission Factor

A transparent ex-ante calculation of the build margin emission factor is presented bellow applying all relevant equations and methodological choices described in section B.6.1 and using the data presented in Annex 3.

As explained in section B.6.1, the Build Margin emission factor will be calculated with Option (i) of the approved baseline methodology AM0026, i.e. as described in the "Tool to calculate the emission factor for an electricity system". The sample group of power units to be included in the build margin considers the set of capacity additions in the electricity system that comprise 20% of the system generation and that have been built most recently which represents Option (b) of *Step 5 Identify the group of power units to be included in the build margin* of the "Tool to calculate the emission factor for an electricity system". This option is chosen because it comprises a larger annual generation compared to the set of five power units that have been built most recently. As shown in Annex 3 Table 13, the selection of plants that comprises 20% of annual generation from plants that have been built most recently, includes 47 power plants built between years 2000 and 2007, therefore, their generation is larger than the generation of the set of the five power units built most recently, which are all included in the chosen group.

Tables 9 below represents the values used for estimating the emission factor for each power unit included in the build margin emission factor calculation in accordance to equation (f7) and (f8) exposed in section B.6.1. In order to estimate the emission factor for each power unit options A1 and A2 were applied. For those plants that annual fuel consumption information was available Option A1 was used. For the rest of the power units, the CNE Node Price Report includes power plant fuel specific consumption which was used to estimate the power plants efficiency, for those power plants not included in the CNE Node Price Report, default energy conversion efficiency was used in accordance with the "Tool to calculate the emission factor for an electricity system".

An example of the calculation with equation (f7) is provided using Campanario Power Unit:

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{EG_{m,y}} \qquad \textbf{(f7)}$$

Where:

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

Campanario Natural Gas:

$$EF_{EL,m,y} = \frac{8{,}390{,}000(m^3) \bullet 0.03517(GJ/m^3) \bullet 0.0543(tCO_2/GJ)}{24{,}508(MWh)} = 0.653(tCO_2/MWh)$$

Campanario Diesel:

$$EF_{EL,m,y} = \frac{65{,}710{,}000(kg) \bullet 0.043325(GJ/kg) \bullet 0.0726(tCO_2/GJ)}{265{,}347(MWh)} = 0.779(tCO_2/MWh)$$

and

An example of the calculation with equation (f8) is provided using Cañete Power Unit:

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} \cdot 3.6}{\eta_{m,y}} \qquad \textbf{(f8)}$$

Where:

$EF_{EL,m,y}$ — CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
$EF_{CO2,m,i,y}$ — Average CO_2 emission factor of fuel type i used in power unit *m* in year *y* (tCO_2/GJ)
$\eta_{m,y}$ — Average net energy conversion efficiency of power unit *m* in year *y* (%)
y — Most recent historical year for which power generation data is available.

For Cañete Power Unit:

$$EF_{EL,m,y} = \frac{0.0726(tCO_2/GJ) \bullet 3.6}{0.395} = 0.6616(tCO_2/MWh)$$

Table 9: Build Margin Power Units CO2 Emission Factor

Power Plant m	Fuel i	Fossil Fuel Consumption $FC_{i,m,2007}$ [kg o m3]	Net Calorific Value $NCV_{i,2007}$ [GJ/kg & GJ/m3]	Fuel CO_2 Emission Factor $EF_{CO2,i,2007}$ [tCO2/GJ]	Energy Convertion Efficiency Considered $\eta_{m,y}$ [%]	Energy Generated $EG_{m,2007}$ [MWh]	Power Unit CO_2 Emission Factor $EF_{EL,m,2007}$ [tCO2/MWh]
Angol	Diesel Oil	0	0.04333	0.0726	0.395	4,703	0.662
Campanario	Diesel Oil	65,710,000	0.04333	0.0726	0.000	265,347	0.779
Campanario	Natural Gas	8,390,000	0.03517	0.05430	0.000	24,508	0.65386
Canela	Wind	0	0.00000	0.00000	0.000	2,823	0.000
Cañete	Diesel Oil	0	0.04333	0.07260	0.395	4,418	0.662
Casablanca 1	Diesel Oil	1,012,305	0.04333	0.07260	0.000	4,717	0.675
Casablanca 2	Diesel Oil	53,323	0.04333	0.07260	0.000	180	0.93092

Power Plant	Fuel	Fossil Fuel Consumption	Net Calorific Value	Fuel CO_2 Emission Factor	Energy Convertion Efficiency Considered	Energy Generated	Power Unit CO_2 Emission Factor
m	i	$FC_{i,m,2007}$	$NCV_{i,2007}$	$EF_{CO2,i,2007}$	$\eta_{m,y}$	$EG_{m,2007}$	$EF_{EL,m,2007}$
		[kg o m3]	[GJ/kg & GJ/m3]	[tCO2/GJ]	[%]	[MWh]	[tCO2/MWh]
Chiburgo	Run of the River	0	0.00000	0.0000	0.000	39,048	0.000
Chufken	Diesel Oil	0	0.04333	0.0726	0.395	3,630	0.662
Collipulli	Diesel Oil	0	0.04333	0.0726	0.395	5,671	0.662
Concon	Diesel Oil	1,946,505	0.04333	0.0726	0.000	8,396	0.729
Constitucion 1	Diesel Oil	967,034	0.04333	0.07260	0.000	3,429	0.887
Curacautin	Diesel Oil	0	0.04333	0.07260	0.395	7,522	0.662
Curauma	Diesel Oil	1,363,521	0.04333	0.07260	0.000	6,569	0.65289
Degan	Diesel Oil	16,770,000	0.04333	0.0726	0.000	77,660	0.679
Esperanza 1	Diesel Oil	489,631	0.04333	0.0726	0.000	2,242	0.687
Esperanza 2	Diesel Oil	496,818	0.04333	0.07260	0.000	2,199	0.711
Esperanza TG	Diesel Oil	81,031	0.04333	0.07260	0.000	238	1.073
Eyzaguirre	Run of the River	0	0.00000	0.00000	0.000	6,697	0.00000
Fopaco	Biomass	0	0.00000	0.0000	0.000	46,797	0.000
Hornitos	Run of the River	0	0.00000	0.0000	0.000	4,859	0.000
Las Vegas	Diesel Oil	1,613,373	0.04333	0.07260	0.000	6,984	0.727
Lebu	Diesel Oil	0	0.04333	0.07260	0.395	4,641	0.662
Los Vientos	Diesel Oil	110,720,000	0.04333	0.07260	0.000	418,825	0.83151
Maule	Diesel Oil	306,196	0.04333	0.0726	0.000	1,086	0.887
Montepatria	Diesel Oil	0	0.04333	0.0726	0.395	8,306	0.662
Palmucho	Run of the River	0	0.00000	0.00000	0.000	23,279	0.000
Punitaqui	Diesel Oil	0	0.04333	0.07260	0.395	6,397	0.662
Quilleco	Run of the River	0	0.00000	0.00000	0.000	282,112	0.00000
Rincon	Run of the River	0	0.00000	0.0000	0.000	1,735	0.000
San Isidro 2	Natural Gas	0	0.03517	0.0543	0.395	20,516	0.495
San Isidro 2	Diesel Oil	176,830,000	0.04333	0.07260	0.000	745,740	0.746
Ancud	Diesel Oil	1,799,851	0.04333	0.07260	0.000	7,437	0.761
Nueva Aldea 2	Diesel Oil	2,861,746	0.04333	0.07260	0.000	9,875	0.91154
Antilhue TG	Diesel Oil	82,370,000	0.04333	0.0726	0.000	347,113	0.746
Candelaria 1	Diesel Oil	57,563,836	0.04333	0.0726	0.000	211,066	0.858
Candelaria 1	Natural Gas	27,167,587	0.03517	0.05430	0.000	83,796	0.619
Candelaria 2	Diesel Oil	52,246,164	0.04333	0.07260	0.000	191,568	0.858
Candelaria 2	Natural Gas	19,045,453	0.03517	0.05430	0.000	58,744	0.61923
Coronel	Diesel Oil	26,930,000	0.04333	0.0726	0.000	121,739	0.696
Coronel	Natural Gas	16,510,000	0.03517	0.0543	0.000	65,662	0.480
Quellon	Diesel Oil	3,470,826	0.04333	0.07260	0.000	14,366	0.760
Horcones	Diesel Oil	15,620,000	0.04333	0.07260	0.000	46,154	1.064
Horcones	Natural Gas	5,660,000	0.03517	0.05430	0.000	15,059	0.71786
Licanten	Biomass	0	0.00000	0.0000	0.000	9,707	0.000
Ralco	Dam	0	0.00000	0.0000	0.000	1,918,154	0.000
Valdivia	Biomass	0	0.00000	0.00000	0.000	248,573	0.000
Nehuenco 2	Natural Gas	78,180,000	0.03517	0.05430	0.000	412,702	0.362

Power Plant m	Fuel i	Fossil Fuel Consumption $FC_{i,m,2007}$ [kg o m3]	Net Calorific Value $NCV_{i,2007}$ [GJ/kg & GJ/m3]	Fuel CO_2 Emission Factor $EF_{CO2,i,2007}$ [tCO2/GJ]	Energy Convertion Efficiency Considered $\eta_{m,y}$ [%]	Energy Generated $EG_{m,2007}$ [MWh]	Power Unit CO_2 Emission Factor $EF_{EL,m,2007}$ [tCO2/MWh]
Nehuenco 2	Diesel Oil	308,880,000	0.04333	0.07260	0.000	1,857,599	0.52301
Nehuenco 9B	Diesel Oil	27,820,000	0.04333	0.0726	0.000	97,626	0.896
Nehuenco 9B	Natural Gas	17,340,000	0.03517	0.0543	0.000	51,172	0.647
San Francisco Mostazal	Diesel Oil	7,410,000	0.04333	0.07260	0.000	24,332	0.958
Mampil	Run of the River	0	0.00000	0.00000	0.000	121,220	0.000
Taltal 1	Natural Gas	60,950,522	0.03517	0.05430	0.000	169,830	0.68546
Taltal 2	Diesel Oil	110,079,087	0.04333	0.0726	0.000	538,398	0.643
Taltal 2	Natural Gas	21,230,000	0.03517	0.0543	0.000	59,147	0.686

Table 9 contains the Power Units CO2 Emission Factor values and the Energy Generated during 2007 by all power units included in the Build Margin emission factor estimation. Using this data the Build Margin Emission Factor is calculated in accordance to equation (f6) exposed in section B.6.1.

Where,

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \cdot EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:

$EF_{grid,BM,y}$ Build margin CO_2 emission factor in year *y* (tCO_2/MWh).
$EG_{m,y}$ Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh).
$EF_{EL,m,y}$ CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh).
m Power units included in the build margin.
y Most recent historical year for which power generation data is available.

Using the values presented in Table 9, the following is calculated:

$$EF_{grid,BM,y} = \frac{3{,}908{,}744.176(tCO_2)}{8{,}722{,}313.18(MWh)} = 0.4481(tCO_2/MWh)$$

Table 10: Build Margin Emission Factor

Build Margin Emission Factor
$EF_{grid,BM,2007}$
[tCO2/MWh]
0.4481

Project Emission Reductions

Combined Emission Factor

In accordance with equation (f9) as stated in section B.6.1:

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

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:

$$EF_y = 0.25 \bullet 0.6708(tCO_2/MWh) + 0.75 \bullet 0.4481(tCO_2/MWh) = 0.5038(tCO_2/MWh)$$

Baseline Emissions

In accordance with equation (f10) as stated in section B.6.1:

$$BE_y = EF_y \bullet Generation_y$$

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 total energy generation during 2007 was **164,248.3 MWh.**

$$BE_y = 0.5038(tCO_2/MWh) \bullet 164{,}248.3(MWh) = 82{,}746.7(tCO_2eq) \approx 82{,}746(tCO_2eq)$$

Project Activity Emissions

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

Leakage

The project does not consider any leakage.

Project Emission Reductions

Finally and in accordance with equation (f11) as stated in section B.6.1:

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

Where,

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

And using all the values estimated above:

$$ER_y = 82{,}746(tCO_2) - 0(tCO_2) - 0(tCO_2) = 82{,}746(tCO_2eq)$$

Summarizing, the Chacabuquito Hydroelectric Power Project is expected to reduce approximately 82,746 tCO_2e per year. The actual combined emission factor shall be determined using a proper estimation of the OM emission factor in accordance with the AM0026 (v.3) approved methodology based in ex-post data. Table 11 summarizes the emission factor and emission reduction values estimated above.

Table 11: Emission Reduction Estimation Data

	Value	Unit	Source
$EF_{BM,y}$	**0.4481**	[tCO2e/MWh]	Estimated ex-ante in accordance with the AM0026 (v.3) approved methodology. Fixed value for the second crediting period.
$EF_{OM,y}$	**0.6708**	[tCO2e/MWh]	Referential value only. The OM emission factor shall be estimated ex-post in accordance with the AM0026 (v.3) approved methodology.
EF_y	**0.5038**	[tCO2e/MWh]	Referential value only. The OM emission factor shall be estimated ex-post in accordance with the AM0026 (v.3) approved methodology.
$Generation_y$	**164,248.3**	[MWh]	2007 project energy generation.
ER_y	**82,746**	[tCO2e]	Calculated

B.6.4 Summary of the ex-ante estimation of emission reductions:

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Table 12: Summary of ex-ante Emission Reductions

Year	**Estimation of project activity emissions (tonnes of CO2 e)**	**Estimation of baseline emissions (tonnes of CO2 e)**	**Estimation of leakage (tonnes of CO2 e)**	**Estimation of overall emission reductions (tonnes of CO2 e)**
2009 (from July 1st)	0	**0**	0	**0**
2010	0	**0**	0	**0**
2011 (from December 1st)	0	**6,896**	0	**6,896**
2012	0	**82,746**	0	**82,746**
2013	0	**82,746**	0	**82,746**
2014	0	**82,746**	0	**82,746**
2015	0	**82,746**	0	**82,746**
2016 (up to June 30th)	0	**41,373**	0	**41,373**
Total (tonnes of CO2 e)	0	**379,253**	0	**379,253**

B.7. Application of the monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

The detailed source for each parameter is presented in Table 19 (Annex 3).

Data / Parameter:	$\mathbf{EF}_{OM,y}$
Data unit:	tCO_2e/MWh
Description:	Operating Margin Emission Factor for year y.
Source of data to be used:	Calculated based on formula **f1** using CDEC-SIC data
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.6708[tCO2/MWh]
Description of measurement methods and procedures to be applied:	Annually
QA/QC procedures to be applied:	Automatically calculated from CDEC-SIC databases and AM0026 procedures. Calculation should be done after CDEC-SIC makes the data official (validation).
Any comment:	

Data / Parameter:	$EF_{j,h}$
Data unit:	tCO_2e/MWh
Description:	Operating margin Emission factor for proposed CDM project '***j***' for hour '***h***'
Source of data to be used:	Calculated based on formula **f2** using CDEC-SIC data.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Due to the amount of data required and difficulties associated with its process, the emission factor estimation procedures of the AM0026 methodology is programmed into a Mathematical Tool that enables an efficient and secure estimation. All values are in the validation spreadsheet given to auditors.
Description of measurement methods and procedures to be applied:	Calculated annually for each hour.
QA/QC procedures to be applied:	Automatically calculated from CDEC-SIC databases and AM0026 procedures. Calculation should be done after CDEC-SIC makes the data official (validation).
Any comment:	

Data / Parameter:	$Generation_y$
Data unit:	Energy in MWh
Description:	Electricity exported to the grid by proposed CDM project, in year y
Source of data to be used:	On-site metering system
Value of data applied for the purpose of	Energy Generated during 2007 equals 164,248.3 MWh, all hourly values are in the validation spreadsheet given to auditors.

calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Hourly measurement
QA/QC procedures to be applied:	Meter should have a maximum error of 0.2% and be verified periodically according to local standards for electricity transactions in CDEC-SIC. Metering data is regularly cross checked against the CDEC-SIC data, where a balance is made for energy transactions between power generators.
Any comment:	

Data / Parameter:	***D(j,i)***
Data unit:	Energy in MWh
Description:	Energy displacement of the marginal plant i^{th} due to the proposed CDM project j^{th}
Source of data to be used:	Calculated based on formula **f3** using CDEC-SIC data
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Contained in Mathematical tool.
Description of measurement methods and procedures to be applied:	Hourly
QA/QC procedures to be applied:	Automatically calculated from CDEC-SIC databases and AM0026 procedures. Calculation should be done after CDEC-SIC energy balance to ensure data validity.
Any comment:	

Data / Parameter:	d_i
Data unit:	tCO_2e/MWh
Description:	Emission factor for electricity displaced D(j,i)
Source of data to be used:	IPCC Guidelines and CNE node price report
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Contained in Mathematical tool.
Description of measurement methods and procedures to be applied:	Hourly
QA/QC procedures to be applied:	Calculation based on official data.
Any comment:	

Data / Parameter:	**M**
Data unit:	Number
Description:	Number of electricity generation plants on the margin, that would supply to the system in the absence of the CDM projects in the system
Source of data to be used:	Calculation based on CDEC-SIC data
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Contained in Mathematical tool.
Description of measurement methods and procedures to be applied:	Hourly
QA/QC procedures to be applied:	Electronic worksheet should be implemented to deliver automatic calculations
Any comment:	

Data / Parameter:	A_i
Data unit:	MWh
Description:	Generation capacity of the i^{th} plant on the margin during hour h
Source of data to be used:	CDEC-SIC
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Contained in Mathematical tool.
Description of measurement methods and procedures to be applied:	Hourly
QA/QC procedures to be applied:	Data is obtained from CDEC-SIC databases.
Any comment:	

Data / Parameter:	B_i
Data unit:	MWh
Description:	Electricity generated by ith plant on the margin during hour h
Source of data to be used:	CDEC-SIC
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Contained in Mathematical tool.
Description of measurement methods	Hourly

Data / Parameter:	B_i
and procedures to be applied:	
QA/QC procedures to be applied:	Data is obtained from CDEC-SIC databases.
Any comment:	

Data / Parameter:	C_j
Data unit:	MWh
Description:	Electricity generated by jth CDM plant in hour h
Source of data to be used:	CDEC-SIC
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Contained in Mathematical tool.
Description of measurement methods and procedures to be applied:	Hourly
QA/QC procedures to be applied:	Data is obtained from CDEC-SIC databases.
Any comment:	

Data / Parameter:	**N**
Data unit:	Number
Description:	Total number of CDM projects in the system, where N is the CDM project built first and 1 is the last CDM project built in the system.
Source of data to be used:	CDEC-SIC and UNFCCC registered projects for the country
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Contained in Mathematical tool.
Description of measurement methods and procedures to be applied:	Hourly
QA/QC procedures to be applied:	Data is obtained from the Clean Development Mechanism web site.
Any comment:	

Data / Parameter:	SFC_i
Data unit:	TJ/MWh
Description:	Specific fuel consumption per unit of electric energy produced in the ‘i^{th}’ marginal plant
Source of data to be used:	CDEC SIC Annual Report and CNE node price report

Data / Parameter:	***SFC_i***
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Values in Table 18 of Annex 3.
Description of measurement methods and procedures to be applied:	Yearly. 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 (parameter presented below).
QA/QC procedures to be applied:	Annual information is used if available; if not, CNE information is used. For ex-post estimations, the values will be updated in accordance to the latest report available.
Any comment:	

Data / Parameter:	**$NCV_{i,y}$**
Data unit:	For Natural Gas: (TJ / mass or volume unit) and for other fuels: (TJ / mass or
Description:	Net calorific value of fossil fuel type *i* in year *y*
Source of data to be used:	National Energy Commission Annual Energy Balance Report and IPCC 2006.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Values in Table 18 of Annex 3.
Description of measurement methods and procedures to be applied:	The data from the CNE and the IPCC 2006 represent the most recent and reliable information available.
QA/QC procedures to be applied:	
Any comment:	The CNE Energy Balance Report includes Gross Calorific Values for the different fuels, these values were corrected to Net Calorific Values based on the IPCC 2006 assumption that for Diesel, Net Calorific Value is 5% lower than its Gross Calorific Value and for Natural Gas; Net Calorific Value is 10% lower than its Gross Calorific Value.

Data / Parameter:	**$CEF_{OM,i}$**
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor of fuel used in ***i***th marginal power plant.
Source of data to be used:	IPCC Guidelines (2006)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Values in Table 18 of Annex 3.
Description of measurement methods	For estimating emission factor for different fuel based generation technologies, IPCC guidelines will used in a conservative manner.

Data / Parameter:	$CEF_{OM,i}$
and procedures to be applied:	
QA/QC procedures to be applied:	
Any comment:	This parameter is used only in the operation margin calculation.

Data / Parameter:	$Oxid_i$
Data unit:	%
Description:	Fraction of fuel oxidized on combustion
Source of data to be used:	IPCC Guidelines (2006)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The value is 1
Description of measurement methods and procedures to be applied:	For estimating emission factor for different fuel based generation technologies, IPCC guidelines will used in a conservative manner.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	EF_y
Data unit:	tCO_2e/MWh
Description:	CO_2e Emission factor of the displaced energy from the grid
Source of data to be used:	Calculated based on formula **f9**
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.5038
Description of measurement methods and procedures to be applied:	Annually
QA/QC procedures to be applied:	Automatic calculation through a revised worksheet
Any comment:	

B.7.2. Description of the monitoring plan:

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

Please refer to section B.6.3 for formulae reference.

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 fulfillment 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.

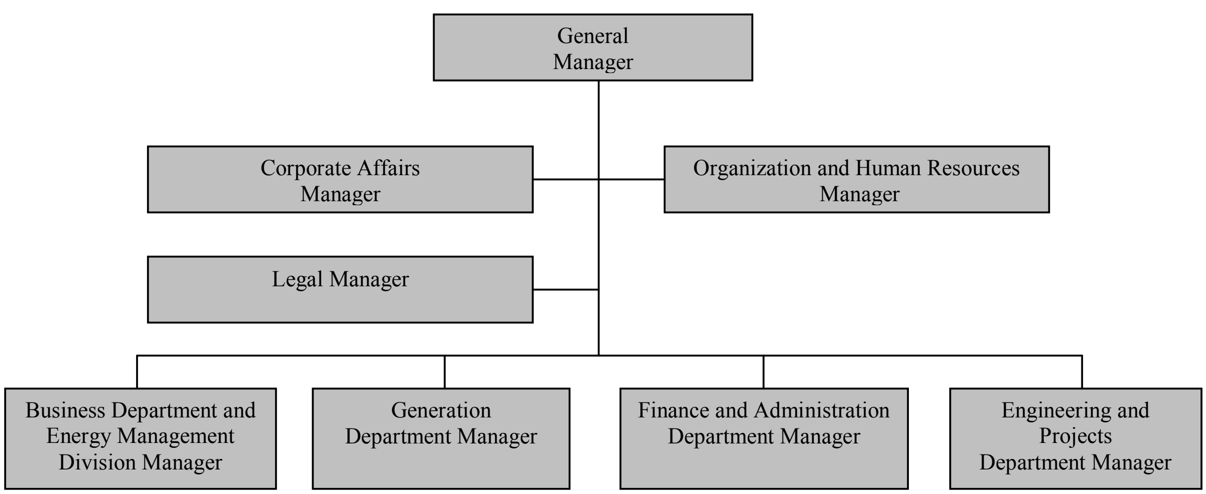
1-. Operational and Management structure

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 the Chacabuquito Power Plant is currently conducted by Colbún S.A.

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

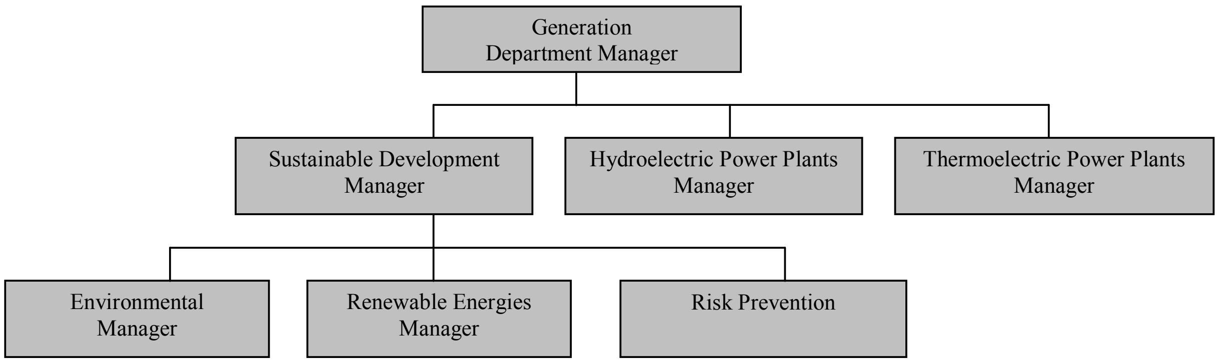
Figure B.4.: General Management Structure



The Generation Department Manager of Colbún S.A. is actually the General Manager of Hidroeléctrica Guardia Vieja S.A.

In addition, Colbún S.A. has the following structure inside the Generation Department:

Figure B.5.: Generation Department structure



Under this structure, the Sustainable Development Manager has with the responsibility, among other things, of managing the administrative and commercial aspects of the projects related to the carbon market, as Chacabuquito and as other Colbún S.A. projects in different development stages, and ensuring the fulfilment of all applicable environmental and social obligations by the Chacabuquito power plant. Social aspects are also supported by Corporate Affairs Manager.

The Hydroelectric Power Plants Manager is responsible of ensuring the operation of the Chacabuquito Power Plant, such as other hydroelectric power plants owned by the company, in accordance with the commitments acquired, which include the proper monitoring, data registration, internal audits and verifications.

Besides, Colbún S.A. will continue performing the necessary training to the operators in order to fulfil the tasks in an adequate and transparent manner.

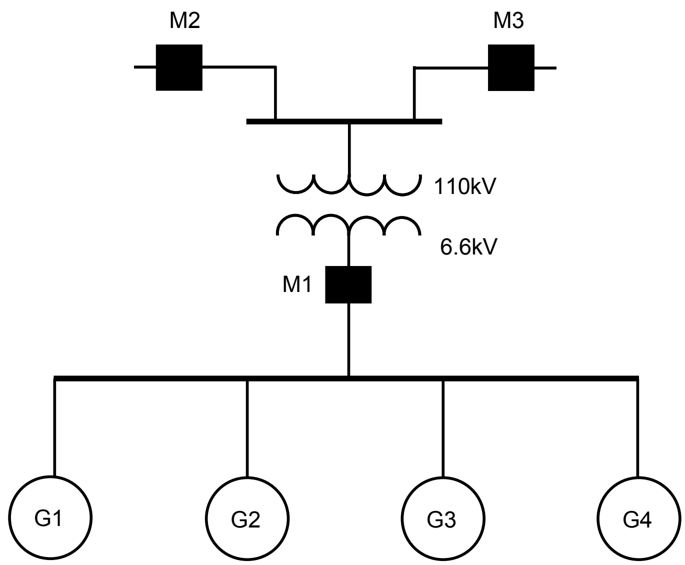
2-. Monitoring Procedures

Chacabuquito project has three electricity meters, M1, M2 and M3 in Figure B.6.. The electricity meter M1, which is located between the generation bar and the power transformer, measures the electricity from the four units. The meters M2 and M3 (main meters for the CDM monitoring plan) measure the electricity at the injection point. Figure B.6. depicts meters distribution for Chacabuquito Project.

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. Their location and function is shown in the Figure B.6..

Figure B.6.: Energy meters location scheme

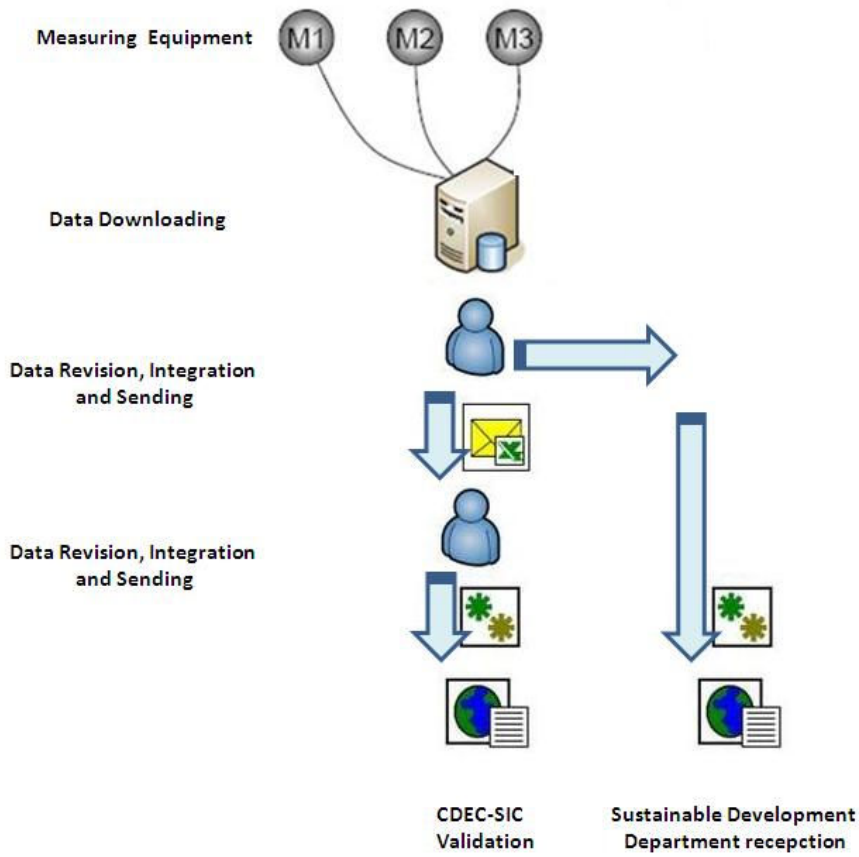


Energy Generation Data Capture Procedure

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.

Figure B.7.: Data Capture and Storage



Source: Project Participant

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 power plant's Head of Control and Dispatch considers, as part of its annual programme, the periodic verification of the energy measurement equipments, by an accredited certifier.

For the verification of the energy measuring equipments, the Chilean Official Regulation NCh 2542.Of2001 "Alternating Current Watt-Meter for Active Energy (Classes 0.2 S and 0.5 S)" will be applied. The elaboration of the NCh 2542 considered the international norm IEC 60687 "Alternating Current Watt-Meter for Active Energy (Classes 0.2 S and 0.5 S)" in addition to others like NCh 2024/1 and IEC 61036.

The verification is to be performed 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.

3-. Maintenance

For every mayor maintenance of Power Plant Colbún sends a letter to CDEC informing the arranged date.

4-. Training

Colbún has an annual training program, which includes different subjects such as safety, electricity, computer programming, among others. Colbún has a procedure for Annual Maintenance Needs Detection which identifies type of training, number of hours, number of participants and the estimated date for the training.

B.8. Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies):

>>
The baseline and monitoring methodology application study was completed on:
28/08/2009

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

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The entity is not a project participant.

SECTION C. Duration of the project activity / crediting period

C.1. Duration of the project activity:

C.1.1. Starting date of the project activity:

>>
The project starting date is 12/03/2001, being the date where the first critical contract was awarded.

C.1.2. Expected operational lifetime of the project activity:

>>
30 years and 0 months.

C.2. Choice of the crediting period and related information:

C.2.1. Renewable crediting period:

C.2.1.1. Starting date of the second crediting period:

>>
The second crediting period starting date will be 01/07/2009.

C.2.1.2. Length of the second crediting period:

>>
7 years and 0 months.

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>
Not applicable.

C.2.2.2. Length:

>>
Not applicable.

SECTION D. Environmental impacts

>>

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

>>
During December 1994 the Project Participant requested to the proper authorities the project approval and the authorization to build the Chacabuquito run-off-river power plant. In the approval it is stated that the authorized works construction will not affect the safety of others and will not produced water pollution.

Chilean Law 19.300 of 1994, effective since 1997, established an Environmental Impact Assessment System (SEIA) in the country. This system requires projects to either prepare a full scale Environmental Impact Assessment (EIA) or, for projects with lesser or insignificant impacts, an Environmental Impact Statement (DIA) would be required. Review and clearance of all EIAs or DIAs is a perquisite for an environmental license issued by the National Commission for the Environment (CONAMA).

The implementation of the Chacabuquito power plant was approved in November 1996 and the studies and part of its construction began before the date the Chilean Law 19.300 became effective.

The Project Participant required the national authorities to authorize the construction of the Chacabuquito power plant without being submitted to the SEIA. In October of 2000 it was decided that the Chacabuquito power plant was not obligated to be submitted to the SEIA.

The project considers a number of measures to mitigate environmental impacts during the construction and implementation phases:

- Minimum Ecological Flow: The project commissioned a specific study to analyze and propose minimum ecological flows in that stretch of the Aconcagua river. The DGA established a minimum ecological flow of 3 m^3/s. This minimum flow is considered adequate and any potentially negative impacts on aquatic biodiversity are further minimized by the presence of a major affluent to the Aconcagua downstream from the intake.
- Land Acquisition and Compensation: This processes considered the acquisition of 17,5 hectares along the canal and power house. A private compensation was made for each land owner affected by the project.
- Reforestation Plan: In addition, any tree removed due to construction activity needs to be compensated by adhering to the National Forestry Corporation (CONAF, *Corporación Nacional Forestal* in Spanish) requirements. A Management Plan for Clearing of Vegetation and Reforestation for the Chacabuquito Project (*Plan de Manejo de Corta y Reforestación para Ejecutar Obras Civiles, Proyecto Chacabuquito*, June 2005) was approved by CONAF in August 2005, by means of

the Resolution N° 1415 (the Plan and the Official resolution are in project files). The Plan requires the reforestation of 18 hectares in an area proposed by the project sponsor, but approved by CONAF together with the Los Andes municipality. The Plan established the protection of riverine vegetation along two streams that cannot be cleared during construction activities. This plan was carried out during 2006 and its maintenance works were made in 2009.

- Environmental Management during Construction: Environmental and social mitigatory measures implemented during the construction phase where included in technical specifications in bidding documents and Supervision of the Construction as part of the civil works supervision contract. These specifications considered all construction activities.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

>>

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

The main negative impact of the Chacabuquito Hydroelectric Power Project relates to the deforestation area due to civil works such as canals and power house. The total area considered for mitigation was 18 hectares. Mitigation measures are considered in the Management Plan for Clearing of Vegetation and Reforestation for the Chacabuquito Project (*Plan de Manejo de Corta y Reforestacion para Ejecutar Obras Civiles, Proyecto Chacabuquito*), which was approved by the National Forestry Corporation (CONAF) in August 2005 (the Plan and the Official resolution are in project files).

SECTION E. Stakeholders' comments

>>

E.1. Brief description how comments by local stakeholders have been invited and compiled:

>>

Since Chacabuquito Hydroelectric Power Project is a small project with a minor impact in the area, and did not require a full Environmental Impact Assessment, there was no obligation to carry out a public consultation. Nevertheless, the project sponsors carried out direct consultations with all directly affected people or institutions. Also, the project sponsor actively participated, and still participates, in local community assemblies such as Asociación del Rio Aconcagua, Asociación de Regantes and Corporación de Empresas Pro Aconcagua. Pro Aconcagua is an environmentally focused institution that develops several community projects in the Aconcagua Valley. Many of the comments received by the project sponsors came from these institutions.

E.2. Summary of the comments received:

>>

Extensive consultation and negotiations have taken place with downstream water users (Asociación de Usuarios del Rio Aconcagua, and Asociación de Regantes) concerning the need for a unified water outlet for irrigation control purposes. An agreement was reached to build a new reservoir downstream the Chacabuquito power plant for irrigation purposes. Hidroeléctrica Guardia Vieja S.A. covered the cost of construction and maintenance of this reservoir.

Also, individual agreements were reached with each property owner affected by the project. All in all, consultations have been extensive with the owners of the Los Quilos Canal, the downstream farmers, and the

affected landowners. The latter consultations resulted in several reroutes for the canals (for example, at entrance to the "Tunnel Chacabuquito").

E.3. Report on how due account was taken of any comments received:

>>

Apart from the above comments and negotiations, no major issues were raised that could be related to the environmental or CDM aspect of the project. All comments and questions were duly taken into account by the project developer. The main concern of the community was related to the construction and location of bridges and the Vizcachas downstream irrigation reservoir. All concerns where addressed by the project developer.

Annex 1

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There is no public funding in the project.

Annex 3

BASELINE INFORMATION

(i) Build Margin Emission Factor:

- Selection of the set of power capacity additions in the SIC that comprise 20% of the system generation and that have been built most recently (Table 13).
- Energy Generation of every power plant included for the year representing the most recent information available: provided by the CDEC-SIC (Table 13).
- Annual Fuel Consumption for every power plant included: Official Annual Report by CDEC-SIC 2007 and CNE Node Price Report (Table 13).
- Fuel Net Calorific values: National Energy Commission (CNE) Annual Energy Balance and 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Gas Inventories (Table 14).
- Fuel CO_2 Emission Factor: 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Gas Inventories (Table 15).

Table 13: Power capacity additions that comprise 20% of total 2007 generation and built most recently

N°	Power Plant	Fuel	Connection Date	Energy Generated $EG_{m,2007}$ [MWh]	Fuel consumption $FC_{i,m,2007}$ [kg/y or m3/y]
1	Angol	Diesel Oil	2007	4,703	0
2	Campanario	Diesel Oil	2007	265,347	65,710,000
2	Campanario	Natural Gas	2007	24,508	8,390,000
3	Canela	Wind	2007	2,823	0
4	Cañete	Diesel Oil	2007	4,418	0
5	Casablanca 1	Diesel Oil	2007	4,717	1,012,305
6	Casablanca 2	Diesel Oil	2007	180	53,323
7	Chiburgo	Run of the River	2007	39,048	0
8	Chufken	Diesel Oil	2007	3,630	0
9	Collipulli	Diesel Oil	2007	5,671	0
10	Concon	Diesel Oil	2007	8,396	1,946,505
11	Constitucion 1	Diesel Oil	2007	3,429	967,034
12	Curacautin	Diesel Oil	2007	7,522	0
13	Curauma	Diesel Oil	2007	6,569	1,363,521
14	Degan	Diesel Oil	2007	77,660	16,770,000
15	Esperanza 1	Diesel Oil	2007	2,242	489,631
16	Esperanza 2	Diesel Oil	2007	2,199	496,818
17	Esperanza TG	Diesel Oil	2007	238	81,031
18	Eyzaguirre	Run of the River	2007	6,697	0
19	Fopaco	Biomass	2007	46,797	0
20	Hornitos	Run of the River	2007	4,859	0
21	Las Vegas	Diesel Oil	2007	6,984	1,613,373
22	Lebu	Diesel Oil	2007	4,641	0
23	Los Vientos	Diesel Oil	2007	418,825	110,720,000
24	Maule	Diesel Oil	2007	1,086	306,196
25	Montepatria	Diesel Oil	2007	8,306	0
26	Palmucho	Run of the River	2007	23,279	0

N°	Power Plant	Fuel	Connection Date	Energy Generated $EG_{m,2007}$ [MWh]	Fuel consumption $FC_{i,m,2007}$ [kg/y or m3/y]
27	Punitaqui	Diesel Oil	2007	6,397	0
28	Quilleco	Run of the River	2007	282,112	0
29	Rincon	Run of the River	2007	1,735	0
30	San Isidro 2	Natural Gas	2007	20,516	0
30	San Isidro 2	Diesel Oil	2007	745,740	176,830,000
31	Ancud	Diesel Oil	2006	7,437	1,799,851
32	Nueva Aldea 2	Diesel Oil	2006	9,875	2,861,746
33	Antilhue TG	Diesel Oil	2005	347,113	82,370,000
34	Candelaria 1	Diesel Oil	2005	211,066	57,563,836
34	Candelaria 1	Natural Gas	2005	83,796	27,167,587
35	Candelaria 2	Diesel Oil	2005	191,568	52,246,164
35	Candelaria 2	Natural Gas	2005	58,744	19,045,453
36	Coronel	Diesel Oil	2005	121,739	26,930,000
36	Coronel	Natural Gas	2005	65,662	16,510,000
37	Quellon	Diesel Oil	2005	14,366	3,470,826
38	Horcones	Diesel Oil	2004	46,154	15,620,000
38	Horcones	Natural Gas	2004	15,059	5,660,000
39	Licanten	Biomass	2004	9,707	0
40	Ralco	Dam	2004	1,918,154	0
41	Valdivia	Biomasa	2004	248,573	0
42	Nehuenco 2	Natural Gas	2003	412,702	78,180,000
42	Nehuenco 2	Diesel Oil	2003	1,857,599	308,880,000
43	Nehuenco 9B	Diesel Oil	2002	97,626	27,820,000
43	Nehuenco 9B	Natural Gas	2002	51,172	17,340,000
44	San Francisco Mostazal	Diesel Oil	2002	24,332	7,410,000
45	Mampil	Run of the River	2000	121,220	0
46	Taltal 1	Natural Gas	2000	169,830	60,950,522
47	Taltal 2	Diesel Oil	2000	538,398	110,079,087
47	Taltal 2	Natural Gas	2000	59,147	21,230,000

Source: Project Participant and CDEC-SIC

As shown in Table 13, the set of power capacity additions that comprise 20% of total 2007 generation and built most recently includes 47 power plants, therefore their generation is larger than the generation of the five power units built most recently (these power plants are included in the Table 13 with the most recent date of connection, year 2007).

The following table shows the Net Calorific Values used for estimating the Build Margin emission factor. The power fossil fuel plants included only consider diesel and/or Natural gas.

Table 14: Fuel Net Calorific Values

	Gross Calorific Value [GJ/kg] & [GJ/m^3]	GCV to NCV Conversion Factor	Net Calorific Value [GJ/kg] & [GJ/m^3]
Diesel	0.045605	0.95	0.043325
Natural Gas	0.039082	0.90	0.035174

Source: CNE and IPCC 2006.

Table 15: Fuel CO2 Emission Factor

	CO_2 Emission Factor [Ton CO_2/GJ]
Diesel	0.0726
Natural Gas	0.0543
Coal	0.0895
Petcoke	0.0829

Source: IPCC 2006.

The energy conversion efficiency considered for each power unit without annual fuel consumption or specific unit fuel consumption information, default efficiency was used in accordance with the "Tool to calculate the emission factor for an electricity system".

Table 16: Energy Conversion Efficiency Considered

Power Plant	Fuel	Energy Conversion Efficiency Considered [%]
Angol	Diesel Oil	39.5%
Cañete	Diesel Oil	39.5%
Chufken	Diesel Oil	39.5%
Collipulli	Diesel Oil	39.5%
Curacautin	Diesel Oil	39.5%
Lebu	Diesel Oil	39.5%
Montepatria	Diesel Oil	39.5%
Punitaqui	Diesel Oil	39.5%
San Isidro 2	Natural Gas	39.5%

Source: "Tool to calculate the emission factor for an electricity system".

(ii) Operating Margin Emission Factor:

- Hourly Energy Generation of every power plant in the SIC: to be provided ex-post by the CDEC-SIC,
- Fuel Specific Consumption for every power plant: Semi-annual CNE Node Price Report: to be provided ex-post.
- Fuel CO_2 Emission Factor: 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Gas Inventories, (Table 15 above)
- Oxidation Factor: 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Gas Inventories (Table 17).

Table 17: Fuel Oxidation Factor

	Fuel Oxidation Factor
Diesel	1
Natural Gas	1
Coal	1
Petcoke	1

Source: IPCC 2006,

Table 18: Power Plants data and parameters for OM calculation.

Power Plant	Fuel Type	Power [MW]	Starting Date	SFCi [kg/MWh] or [m3/MWh]	CEF [tCO2/GJ]	NCVi [GJ/kg] or [GJ/m3]	Yearly Generation [MWh/y]	Fuel Consumption [kg/y] or [m3/y]
Abanico	Run of the River	128.6	01-Ene-48				360727	
Aconcagua	Run of the River	89	01-Ene-93				404645	
Alfalfal	Run of the River	177.64	01-Ene-91				939242	
Ancud	Diesel Oil	2.475	01-Ene-06	242.00	0.0726	0.043325	7437	1799851
Antilhue TG	Diesel Oil	100.6	01-Ene-05	237.30	0.0726	0.043325	347113	82370000
Antuco	Run of the River	327.16	01-Ene-81				1663655	
Arauco	Biomass	36.3	01-Ene-96				16878	
Bocamina	Bituminous Coal	119.38	01-Ene-70	389.85	0.0895	0.027824	1008653	393223236
Campanario	Natural Gas	326.64	01-Ene-07	342.34	0.0543	0.035174	24508	8390000
Campanario	Diesel Oil	326.64	01-Ene-07	247.64	0.0726	0.043325	265347	65710000
Candelaria 1	Natural Gas	270.64	01-Ene-05	324.21	0.0543	0.035174	83796	27167587
Candelaria 1	Diesel Oil	270.64	01-Ene-05	272.73	0.0726	0.043325	211066	57563836
Candelaria 2	Natural Gas	270.64	01-Ene-05	324.21	0.0543	0.035174	58744	19045453
Candelaria 2	Diesel Oil	270.64	01-Ene-05	272.73	0.0726	0.043325	191568	52246164
Canela	Wind	17.968	01-Ene-07				2823	
Canutillar	Dam	171.6	01-Ene-90				1137902	
Cañete	Diesel Oil	1.65	01-Ene-07		0.0726	0.043325	4418	
Capullo	Run of the River	10.885	01-Ene-95				67110	
Casablanca 1	Diesel Oil	0.8	01-Ene-07	214.63	0.0726	0.043325	4717	1012305
Casablanca 2	Diesel Oil	0.8	01-Ene-07	295.96	0.0726	0.043325	180	53323
Celco	Biomass	20	01-Ene-96				40578	
Chacabuquito	Run of the River	28.4	01-Ene-02				164248	
Chiburgo	Run of the River	19.16	01-Ene-07				39048	
Chiloe	Diesel Oil	9	01-Ene-08	269.00	0.0726	0.043325		
Cholguan	Biomass	30	01-Ene-03				85584	
Chufken	Diesel Oil	3.3	01-Ene-07		0.0726	0.043325	3630	
Cipreses	Dam	99.73	01-Ene-55				598478	
Colbun	Dam	476.81	01-Ene-85				2109736	
Concon	Diesel Oil	2.72	01-Ene-07	231.84	0.0726	0.043325	8396	1946505
Constitucion	Biomass	10.056	01-Ene-95				57241	
Constitucion 1	Diesel Oil	9.3	01-Ene-07	282.00	0.0726	0.043325	3429	967034
Coronel	Natural Gas	91.4	01-Ene-05	251.44	0.0543	0.035174	65662	16510000
Coronel	Diesel Oil	91.4	01-Ene-05	221.21	0.0726	0.043325	121739	26930000
Curacautin	Diesel Oil	2.998	01-Ene-07		0.0726	0.043325	7522	
Curanilahue	Diesel Oil		02-Ene-00		0.0726	0.043325	0	

Power Plant	Fuel Type	Power [MW]	Starting Date	SFCi [kg/MWh] or [m3/MWh]	CEF [tCO2/GJ]	NCVi [GJ/kg] or [GJ/m3]	Yearly Generation [MWh/y]	Fuel Consumption [kg/y] or [m3/y]
Curauma	Diesel Oil	2.501	01-Ene-07	207.57	0.0726	0.043325	6569	1363521
Curillinque	Run of the River	85.28	01-Ene-93				713009	
Degan	Diesel Oil	36.3	01-Ene-07	215.94	0.0726	0.043325	77660	16770000
Diego de Almagro	Diesel Oil	47.338	01-Ene-81	348.90	0.0726	0.043325	58900	20550000
El Sauce Andes	Run of the River	1.12	01-Ene-09				8757	
Puntilla	Run of the River	22.13	01-Ene-14				147930	
Esperanza 1	Diesel Oil	1.6	01-Ene-07	218.40	0.0726	0.043325	2242	489631
Esperanza 2	Diesel Oil	1.59	01-Ene-07	225.96	0.0726	0.043325	2199	496818
Esperanza TG	Diesel Oil	18.32	01-Ene-07	341.04	0.0726	0.043325	238	81031
Eyzaguirre	Run of the River	2.119	01-Ene-07				6697	
Florida	Run of the River	29	01-Ene-09				149489	
Fopaco	Biomass	13.125	01-Ene-07				46797	
Guacolda 1	Bituminous Coal	150	01-Ene-95	370.88	0.0895	0.027824	1289427	478220000
Guacolda 2	Bituminous Coal	150	01-Ene-96	366.28	0.0895	0.027824	1261249	461975057
Horcones	Natural Gas	50	01-Ene-04	375.85	0.0543	0.035174	15059	5660000
Horcones	Diesel Oil	50	01-Ene-04	338.43	0.0726	0.043325	46154	15620000
Hornitos	Run of the River	55	01-Ene-07				4859	
Huasco TG	Residual Fuel Oil	75.38	01-Ene-77	359.27	0.0755	0.041735	184625	66330000
Huasco TV	Bituminous Coal	15.04	01-Ene-65	937.00	0.0895	0.027824	0	0
Isla	Run of the River	66.486	01-Ene-63				529516	
Laguna Verde TG	Diesel Oil	18.665	01-Ene-90	254.57	0.0726	0.043325	39949	10170000
Laguna Verde TV	Bituminous Coal	45.6	01-Ene-39	743.26	0.0895	0.027824	210977	156810000
Laja	Biomass	11.7	01-Ene-95				47347	
Las Vegas	Diesel Oil	2.32	01-Ene-07	231.00	0.0726	0.043325	6984	1613373
Lebu	Diesel Oil	1.65	01-Ene-07		0.0726	0.043325	4641	
Licanten	Biomass	27	01-Ene-04				9707	
Loma Alta	Run of the River	37.93	01-Ene-97				314148	
Los Molles	Run of the River	19.802	01-Ene-52				59142	
Los Morros	Run of the River	2.955	01-Ene-30				17943	
Los Vientos	Diesel Oil	124.38	01-Ene-07	264.36	0.0726	0.043325	418825	110720000
Machicura	Run of the River	95.76	01-Ene-85				481012	
Maitenes	Run of the River	30.9	01-Ene-23				130612	
Collipulli	Diesel Oil	2.475	01-Ene-07		0.0726	0.043325	5671	
Mampil	Run of the River	49.2	01-Abr-00				121220	
Maule	Diesel Oil	6.1	01-Ene-07	282.00	0.0726	0.043325	1086	306196
Nehuenco 1	Diesel Oil	373.56	01-Ene-98	211.17	0.0726	0.043325	1511334	319152254
Montepatria	Diesel Oil	9.2	01-Ene-07		0.0726	0.043325	8306	
Nehuenco 1	Natural Gas	373.56	01-Ene-98	157.64	0.0543	0.035174	383410	60439055
Nehuenco 2	Diesel Oil	382.49	01-Ene-03	166.28	0.0726	0.043325	1857599	308880000
Nehuenco 2	Natural Gas	382.49	01-Ene-03	189.43	0.0543	0.035174	412702	78180000
Nehuenco 9B	Diesel Oil	203.94	01-Ene-02	284.97	0.0726	0.043325	97626	27820000
Nehuenco 9B	Natural Gas	203.94	01-Ene-02	338.86	0.0543	0.035174	51172	17340000
Nueva Aldea 1	Biomass	29.3	01-Ene-05				109302	
Nueva Renca	Diesel Oil	370.88	01-Ene-97	174.56	0.0726	0.043325	1414437	246910000

Power Plant	Fuel Type	Power [MW]	Starting Date	SFCi [kg/MWh] or [m3/MWh]	CEF [tCO2/GJ]	NCVi [GJ/kg] or [GJ/m3]	Yearly Generation [MWh/y]	Fuel Consumption [kg/y] or [m3/y]
Nueva Aldea 3	Biomass	63.9	01-Ene-06				82455	
Nueva Renca	Natural Gas	370.88	01-Ene-97	211.27	0.0543	0.035174	718420	151778873
Palmucho	Run of the River	32	01-Ene-07				23279	
Pangue	Run of the River	454.86	01-Ene-96				1366732	
Pehuenche	Dam	545.48	01-Ene-91				2476215	
Petropower	Fuel Oil	61.8	01-Ene-98		0.0829	0.041735	484300	
Peuchen	Run of the River	79.8	01-Ene-00				177207	
Pilmaiquen	Run of the River	38.86	01-Ene-44				222636	
Pullinque	Run of the River	48.3	01-Ene-62				191672	
Punitaqui	Diesel Oil	9.3	01-Ene-07		0.0726	0.043325	6397	
Quellon	Diesel Oil	5.64	01-Ene-05	241.60	0.0726	0.043325	14366	3470826
Queltehues	Run of the River	48.84	01-Ene-28				356469	
Quilleco	Run of the River	72.048	01-Ene-07				282112	
Quilos	Run of the River	39.9	01-Ene-43				264363	
Ralco	Dam	756.16	01-Ene-04				1918154	
Rapel	Dam	378.63	01-Ene-68				541709	
Renca	Diesel Oil	92	01-Ene-62	319.99	0.0726	0.043325	6594	2110000
Rincon	Run of the River	0.299	01-Ene-07				1735	
Rucue	Run of the River	177.73	01-Ene-98				1121643	
San Francisco Mostazal	Diesel Oil	24.9	01-Ene-02	304.54	0.0726	0.043325	24332	7410000
San Ignacio	Run of the River	36.914	01-Ene-96				200299	
San Isidro 1	Natural Gas	367.73	01-Ene-98	217.56	0.0543	0.035174	639989	139238018
San Isidro 1	Diesel Oil	367.73	01-Ene-98	172.50	0.0726	0.043325	1404952	242352238
San Isidro 2	Diesel Oil	172.96	01-Ene-07	237.12	0.0726	0.043325	745740	176830000
San Isidro 2	Natural Gas	172.96	01-Ene-07		0.0543	0.035174	20516	
Sauzalito	Run of the River	11.88	01-Ene-59				69662	
Sauzal	Run of the River	76.377	01-Ene-48				419284	
Taltal 1	Natural Gas	239.52	01-Abr-00	358.89	0.0543	0.035174	169830	60950522
Taltal 1	Diesel Oil	239.52	01-Abr-00	279.00	0.0726	0.043325		
Taltal 2	Diesel Oil	239.52	01-Mar-00	204.46	0.0726	0.043325	538398	110079087
Taltal 2	Natural Gas	239.52	01-Mar-00	358.94	0.0543	0.035174	59147	21230000
Trongol	Diesel Oil		02-Ene-00		0.0726	0.043325		
Valdivia	Biomass	70	01-Ene-04				248573	
Ventanas 1	Bituminous Coal	108.68	01-Ene-64	402.82	0.0895	0.027824	863988	348032064
Ventanas 2	Bituminous Coal	207.14	01-Ene-77	360.08	0.0895	0.027824	1570950	565660000
Nueva Aldea 2	Diesel Oil	22	01-Ene-06	289.80	0.0726	0.043325	9875	2861746
Angol	Diesel Oil	3.3	01-Ene-07		0.0726	0.043325	4703	
proyecto	Biomass		03-Ene-00					
Victoria	Diesel Oil		02-Ene-00		0.0726	0.043325	0	
Volcan	Run of the River	13.99	01-Ene-44				105287	
El Toro	Dam	446.75	01-Ene-73				2245538	

Table 19: Data and parameters sources

Sheet	AM0026 v3 Parameter	Entity Source	Name File	Comment	Web link
OP-Energy	Cj=Generationj,h, and Bi	CDEC-SIC	OPddmmyy.xls	One file per day. Files can be downloaded with a subscription fee. A Excel Macros has been created to compile the daily files in one Excel sheet. The result of the Excel Macros is the "OP-Energy" sheet.	https://www.cdec-sic.cl/index_es.php
Pri-Priority		CDEC-SIC	yyyyy-mm-dd.xls	One file per week. Files can be downloaded with a subscription fee. A Excel Macros has been created to compile the weekly files in one Excel sheet. The result of the Excel Macros is the "Pri-Priority" sheet.	https://www.cdec-sic.cl/index_es.php
Power Plants	Max. Power (MW)= Ai	CDEC-SIC	empresas_generadoras.xls	Publicly available.	https://www.cdec-sic.cl/norma_calidad_y_seguridad/capitulo9/inf_tca_sic/empresas_generadoras.xls
		CDEC-SIC	pequenos_medios_generacion.xls	Publicly available.	https://www.cdec-sic.cl/norma_calidad_y_seguridad/capitulo9/inf_tca_sic/pequenos_medios_generacion.xls
	Max. Power Data Year	CDEC-SIC		Year of "Max. Power Data", for updating purposes only.	
	OperationStartingDate	CDEC-SIC	OPddmmyy.xls	For EFBM selection of 20%. Main sources indicate only the year of operation. When power unit is near the 20%, real operation data from CDEC-SIC is used to establish operating start date. If not, January 1st is used.	https://www.cdec-sic.cl/index_es.php
	SFCi (kg/MWh or m3/MWh)	CNE	Informe Tecnico Definitivo.	Specific fuel consumption from "ChartN°6" from last CNE node price report.	http://www.cne.cl/cnewww/opencms/07_Tarificacion/01_Electricidad/Otros/Precios_nudo/otros_precios_de_nudo/precios_de_nudo.html
	Tool Efficiency	Methodological Tool	am-tool-07-v 2.pdf	Only applied for EFBM calculation if no information on fuel consumption is available. Default values from "Tool to calculate the emission factor for an electricity system" are considered.	http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.pdf
	CEF (tCO2/GJ)	IPCC	2006 IPCC Guidelines for National Greenhouse Gas Inventories	Volume 2. Energy. Chapter 1. Table 1.4.	http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html
	Oxid	IPCC	2006 IPCC Guidelines for National Greenhouse Gas Inventories	Volume 2. Energy. Chapter 1. Table 1.4. The value considered is 1.	http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html
	NCVi (TJ / mass or volume unit)	CNE	Balance Nacional de Energía 2007. Cuadro A2. 2006 IPCC Guidelines for National Greenhouse Gas Inventories	Gross calorific value of CNE multiplied by: 0,9 for gas and 0,95 for liquid and solid fuels from IPCC 2006. Volume 2. Energy. Chapter 1. Section 1.4.1.2. Units conversion from Kcal to GJ.	http://www.cne.cl/cnewww/export/sites/default/06_Estadisticas/Documentos/BNE2007.xls http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html
	Energy Year	CDEC-SIC		Year of "Energy data", for updating purposes only.	
	Yearly Generation (MWh/y)	Calculation		Sum of energy per power unit from "OP-Energy" Excel Macros.	
	Fuel Consumption (kg/y or m3/y)	CDEC-SIC	cdec-esp.pdf	If available, Annual Fuel Consumption per power unit from Official Annual Report by CDEC-SIC 2008, divided by total energy generation per power unit from "OP-Energy" is used. Otherwise, specific fuel consumption from CNE is used.	https://www.cdec-sic.cl/contenido_es.php?categoria_id=11&contenido_id=000034
	CDM Reg	UNFCCC		From UNFCCC website.	http://cdm.unfccc.int/Projects/projsearch.html

Sheet	AM0026 v3 Parameter	Entity Source	Name File	Comment	Web link
Energy Trans				In order to match energy generated with priority of each power unit, a common name per power unit is established. This is the "common name" asignment for Energy.	
Priority Trans				In order to match energy generated with priority of each power unit, a common name per power unit is established. This is the "common name" asignment for Priority.	
Calc Example				This sheet explains step by step how the methodology is applied.	
OM EF				This is the result of hourly 2007 OM calculation of the Mathematical Tool.	
BM EF				This is the result of the build margin calculation.	
CM EF				This is the result of the Combined Margin calculation.	

Annex 4

MONITORING INFORMATION

All the information required is provided in section B.7.2.