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 3.4
Version date: December 3th, 2010

A.2. Description of the project activity:

>>
The Chacabuquito Hydroelectric Power Project consists of a run-of-river power plant of 30 MW[1] installed capacity that utilizes the waters of the Aconcagua river. It produces an average net annual generation of 170 GWh (with a 0.65 plant load factor, which is obtained through the division of net annual generation by the power plant installed capacity and total amount of hours of the year). The project connects to the 5th Region's at a 110 KV sub-system within the Central Interconnected System (SIC) and energy is delivered to industrial and residential consumers in the area. In addition, it is important to note that the plant does not consider a dam.

This plant is in cascade with two other upstream existent plants, Los Quilos and Aconcagua, which have been successfully operated since 1939 and 1994 respectively. In addition, there is a fourth project of similar characteristics on the same river, being also submitted under carbon bonds financing. The project is being developed by Hidroeléctrica Guardia Vieja (HGV), a subsidiary of Grupo Matte.

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

This project contributes to sustainable development in Chile through:

- Use of local renewable energy resources (small hydro) to displace coal and natural gas thermal power generation in the SIC.
- Increased commercial activity through clean and renewable source of power.
- Employment generation in the 5th Region where the project is located.

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

"Issue" Area	Explanation
Local environmental benefits	– The project will contribute with clean energy for The Central Interconnected System of Chile, displacing thermal generation. – 18 hectares of reforestation with locally native trees.
Socio-economic benefits	– The project will allow the 5th Region to exploit its significant economic potential. – Two new bridges and new access roads for semi-isolated villages in the region. – Job creation during the construction period and also during the operation. – Economic activity during the construction period and also during all of its lifetime.
Capacity building	– Extensive pre-negotiations consultations have been carried out and a Post-negotiations workshop communicating the lessons learned from the project design and implementation.
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.
Environmental Impact Assessment (EIA)	– An EIA has been carried out in accordance with Chilean law and Executive Summary is being made available with other documentation for the Validation process. A more detailed impact assessment is available on request from the project operator. 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
Government of Netherlands	• International Bank for Reconstruction and Development (IBRD) as trustee of the Prototype Carbon Fund (PCF)	Yes
Sweden	• Government of Sweden - Swedish Energy Agency	Yes
France	• GDF Suez	No
Netherlands	• Electrabel S.A.	Yes
Netherlands	• The State of the Netherlands , acting through the Netherlands' Ministry of Housing Spatial Planning and the Environment (VROM)	Yes
Norway	• Government of Norway - Ministry of Foreign Affairs	Yes
Norway	• Norsk Hydro ASA	Yes
Canada	• Government of Canada - Ministry of Foreign Affairs and International Trade	Yes

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**

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 two existing upstream hydropower plants (Aconcagua of 81 MW and Los Quilos of 39 MW). The location of the project activity is illustrated in Figure A.1.

Project coordinates:

32º51'12.35" S

70º30'22.21" W

Figure A.1a: Chacabuquito Project Location. Geographic position

Figure A.1b: Chacabuquito Project Location. Road Map

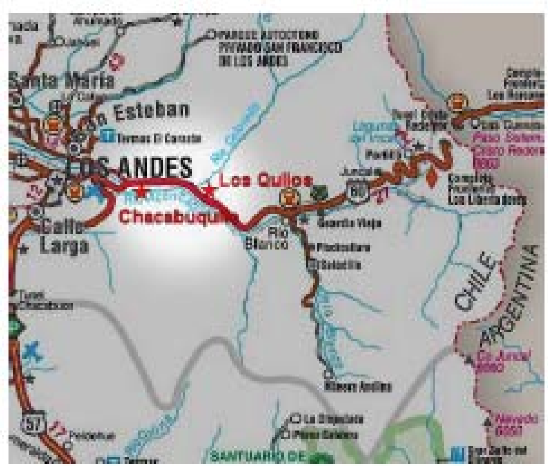


Figure A.1c: Chacabuquito Hydrolectric Power Project Project Location. Satellite Panoramic View

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

>> The Chacabuquito Hydroelectric Power Project falls into:

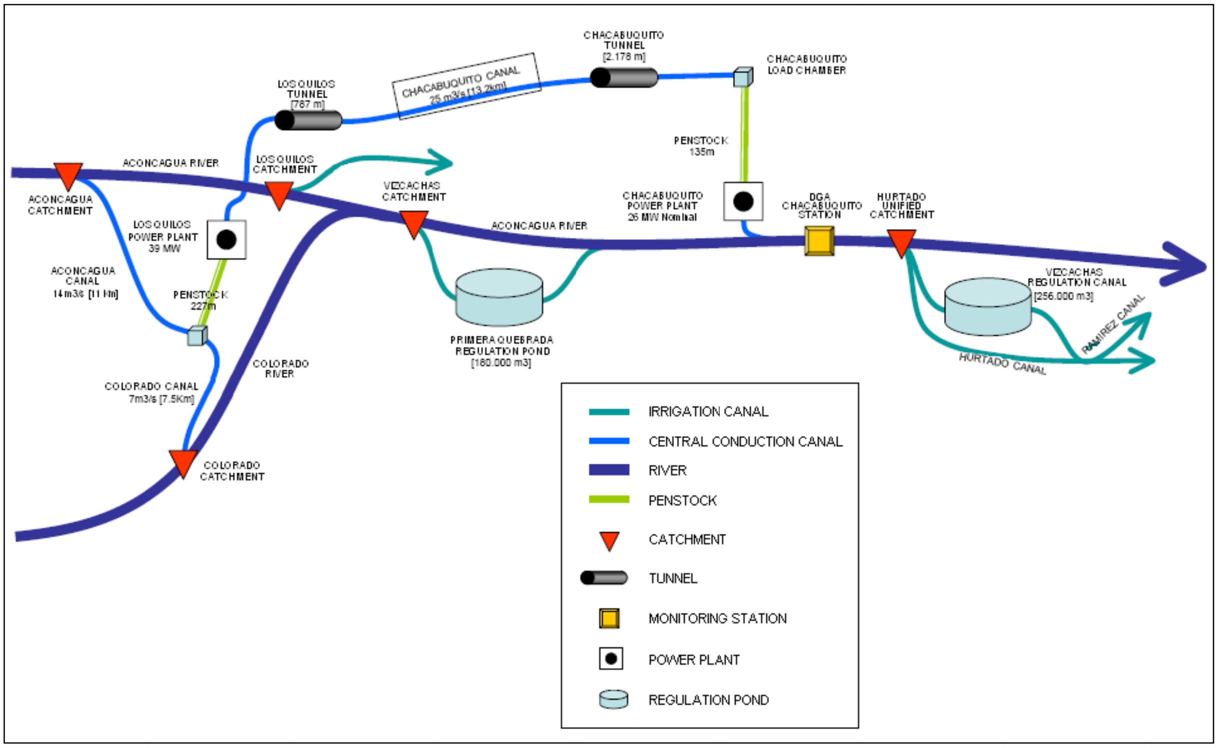
Scope number: 1

Scope: Renewable Energy, Run-of-River Hydropower

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 HGV power plants. It consists of a diversion weir, a system of channels (11 km) and tunnels (3 km), a pressure penstock, water fall of 137 m (134.58 m net water fall), a powerhouse and a high voltage line, and upgrade of existing transmission system. HGV has demonstrated a successful experience of construction, setting up and operating similar plants. Figure 2 shows the project design.

Figure A.2: Project Design



Canals and tunnels and the penstock will take the 21.5 m^3/sec from the Los Quilos plant through a series of canals and tunnels over a distance of approximately 10 km to a 440 m long and 137 meter head penstock (134.58 meter net head penstock) to the 30 MW Chacabuquito power house. From the power house, the 21.5 m^3/sec will be discharged back to the Rio Aconcagua at Chacabuquito to meet the project's water right requirement to supply 18 m^3/sec to a downstream existing hydro plant and to satisfy irrigation users.

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 in AM0026 (v.2).

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 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-post basis as the generation-weighted average emission factor (tCO2/MWh) of the most recent 20% capacity added to the SIC.

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 1.68 millions tons of CO_2 over 21 years (i.e. during three renewable seven-year crediting periods). This is approximately 80,000 tCO_2e per year.

Table A.3. Estimated amount of emission reductions during the First Crediting Period

Years	Annual Estimation of emission reductions in tonnes of CO_2 e
2002 (from July 1, 2002)	40,000
2003	80,000
2004	80,000
2005	80,000
2006	80,000
2007	80,000
2008	80,000
2009 (until June 30, 2009)	40,000
Total Estimated Reductions First Crediting Period (tonnes of CO2e)	**560,000**
Total number of crediting years	**3x7 = 21**
Annual average over the crediting period of estimated reductions (tonnes of CO2e)	**80,000**

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.2): "Baseline Methodology for zero-emissions grid-connected electricity generation from renewable sources in Chile or in countries with merit order based dispatch grid".

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 o 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 B.1. 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:

>>

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. 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 regions 1 to 3 and accounts 34 percent of the total capacity in Chile. The Central Interconnected Grid (SIC), where the Chacabuquito Project is immersed, compromises the regions 3 to 10 and accounts 64 percent of the total capacity. The Aysen and Magallanes grids are located in the 11 and 12 regions, respectively, and accounts less than one percent of the total capacity.

The relevant spatial extent of the Chacabuquito Hydroelectric Power Project boundary is the SIC, which its generation mix capacity comprises of 60% hydroelectric generation, 30% combine cycle gas turbines (fired with natural gas most of the time, but also diesel recently), and the remainder from coal, diesel, petcoke, and cogeneration. At present there are no electricity imports or exports of the SIC grid to other national or international grid, however future system expansion may include interconnection to the SING grid or Argentina grid (SADI).

Figure B.1 Chacabuquito Hydroelectric Power Project Boundary

Chile Electric Grids | **Sistema InterconectadoCentral – SIC**

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:

TableB.3a. Project Investment and costs

TableB.3.b. Investment analysis 28.872 MW

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**

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

TableB.3.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)[2]; 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.

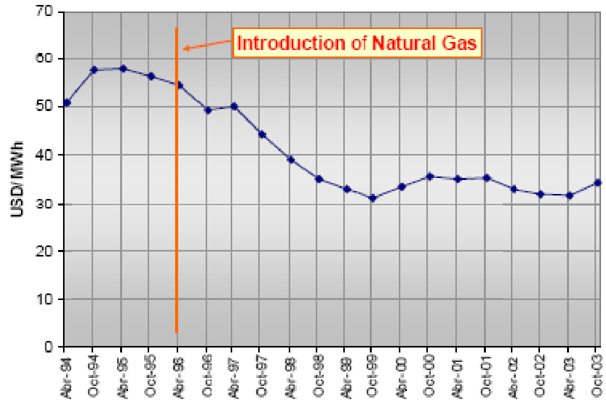
Sub-step 4a Analyze other activities similar to the proposed activity:

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.

[2] 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:

>>

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

The OM emission factor from the project activity 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.

The BM emission factor will be determined as option (i) in AM0026, i.e., following the BM emission factor estimation process described in ACM002 (v.6) Option 2, which is calculated on an ex-post basis as the generation-weighted average emission factor (tCO2/MWh) of the most recent 20% capacity added to the SIC.

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

Data / Parameter:	**Fuel Carbon Content**
Data unit:	tC/ TJ
Description:	Determination of carbon content for different fuels
Source of data used:	IPCC revised guidelines (1996)
Value applied:	Diesel: 20.2 tC/TJ Natural Gas: 15.30 tC/TJ Coal: 25.8 tC/TJ Petcoke: 27.5 tC/TJ
Justification of the choice of data or description of measurement methods and procedures actually applied :	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:	**Combustion efficiency**
Data unit:	%
Description:	Determination combustion efficiency of different fuel based generation technologies
Source of data used:	IPCC revised guidelines (1996)
Value applied:	Diesel: 99.0% Natural Gas: 99.5%

Data / Parameter:	Combustion efficiency
	Coal: 98.0% Petcoke: 98.0%
Justification of the choice of data or description of measurement methods and procedures actually applied :	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:	CO2 conversion factor
Data unit:	%
Description:	Molecular weight of carbon dioxide relative of that of carbon
Source of data used:	IPCC revised guidelines (1996)
Value applied:	44/12 = 3.67
Justification of the choice of data or description of measurement methods and procedures actually applied:	For estimating emission factor for different fuel based generation technologies, IPCC guidelines have been used in a conservative manner.
Any comment:	

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

>>

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.

The Emission Factor of the operating margin is calculated as follows:

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

Where,

$EF_{j,h}$ Operating margin Emission factor for proposed CDM project ‘***j***’ for hour ‘***h***’, expressed in tCO_2/MWh

$Generation_{j,h}$ Generation of proposed CDM project ‘***j***’ during hour ‘***h***’, expressed in MWh

H Total number of hours of the year ‘***y***’

The emission factor for 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 is 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.

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

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

Where,

A_i	Maximum energy generation of the marginal plant '***i***' expressed in MWh/h (equivalent to plant capacity in MW)
B_i	Actual Energy generation of the CDM marginal plant '***i***' expressed in MWh/h
C_j	Energy generation of the CDM project '***j***' expressed in MWh/h
N	Total number of CDM projects in the system
M	Total number of additional marginal plants that should be dispatched if the system is operated without the **N** CDM projects

Where:

$$D(j,0) = 0 \text{ and } D(N+1,i) = 0$$

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

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

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

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

Where,

SFC_i	Is the specific fuel consumption of ***i*** marginal power plant, expressed as (ton of fuel or 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 allowance on a KWh base. Hourly energy data obtained from the metering system is submitted to CDEC-SIC every two hours as for all other generating units of the system.

The Semi-annual Node Price Report and the IPCC Good Practice Guidance provide all the information to calculate the emission factors for all the power plants within the Chilean grids, including future plants projected in the expansion plan. 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.

Step 2. Calculation of the Build Margin

As described in AM0026, the emission factor for the build margin for each crediting period can be calculated based on the most recent 20% of capacity added to the grid (Option 2 for Build Margin Calculation of ACM002).

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

Where

L Group of electricity generation plants that compromise 20% of the system generation (in

	MWh) and that have been built most recently. Power plant capacity additions registered as CDM project activities should be excluded from the sample group L.
EF_{BMi}	Emission factor of ith electricity generation plant in the build margin, expressed in tCO2/MWh.
GEN_{BMi}	Projected generation for the ith electricity generation plant included in the build margin, expressed in MWh.

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

Where

$SFC_{BM,i}$	Specific fuel consumption of the ith electricity generation plant, expressed in ton of fuel /MWh or TJ of fuel /MWh. The data shall be taken from published data of electricity regulatory authority.
$CEF_{BM,i}$	CO2 content of fuel used in ith electricity generation plant, expressed as tCO2/(ton of fuel or TJ of fuel).
$Oxid_i$	Fuel oxidation factor, expressed as fraction.

For the first crediting period, the EFBM will be updated annually ex-post for the year in which actual project generation and associated emissions reductions occur (option 2 of ACM002). For subsequent crediting periods, EFBM should be calculated ex-ante, as described in Option 1 for the Build Margin Calculation of ACM0002.

Step 3. Project Emission Reductions

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

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

Where,

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

The baseline emissions for the project are calculated as follows:

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

Where,

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

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 was identified for this project activity. The emission reduction can be expressed as follows:

$$EF_y = BE_y - PE_y - L_y = BE_y$$

(f9)

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 300 USD/year. Also, node price reports, used to calculate thermal plant emission factors, can be obtained from the national's authority energy commission CNE at www.cne.cl.

The calculation of the baseline 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 for registration purposes is only for estimation purposes with rough calculations. The detailed data required to calculate the OMEF and EFBM will provided ex-post.

For estimation purposes within the PDD, the information of CDEC-SIC real dispatch data from 2002 to 2005 has been used in order to determine the real emission factor of each year and average emission factor of the period:

SIC Baseline Emission Reductions in TCO2/GWh

	2002	2003	2004	2005	Avg.
BM	302	364	363	293	**331**
OM	561	726	555	587	**607**
EF	**432**	**545**	**459**	**440**	**469**

Source HGV estimations based on CDEC-SIC data and Greenhouse Assesment Handbook

The estimated combined margin emission factor is 0.475 tCO2/MWh. The Chacabuquito Hydroelectric Power Project is expected to displace 170 GWh of electricity per year, thus reducing 80,000 tCO2e per year in the baseline scenario

Variable	Value	Data Source
$EF_{OM,y}$ (tCO_2e/GWh)	600	Estimated using an average of CDEC-SIC real dispatch data from 2002 to 2005 and IPCC manual
$EF_{BM,y}$ (tCO_2e/GWh)	350	Estimated using option ii) of ACM002 using an average of ex-post data of SIC dispatch and IPCC manual (2002 to 2005)

EF_y (tCO_2e/GWh)	475	Combined Margin result f7)
$Generation_y$ (GWh/year)	170	Average project generation
$BE_y = ER_y$ (tCO_2e/year)	≈ 80,000	Calculated

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

>>

For an estimation purpose, the following table summarizes the expected emissions reductions of the Project:

Table B.6. Estimation of Emission Reductions for the First Crediting Period

Year	Estimation of project activity emissions reductions (tonnes of CO_2 e)	Estimation of baseline emissions reductions (tonnes of CO_2/MWh)	Estimation of Leakage (tonnes of CO_2e)	Estimation of Emission Reductions (tonnes of CO_2e)
2002 (from July 1)		40,000		40,000
2003		80,000		80,000
2004		80,000		80,000
2005		80,000		80,000
2006		80,000		80,000
2007		80,000		80,000
2008		80,000		80,000
2009 (up to June 30 2009)		40,000		40,000
Total (tonnes of CO2e)		560,000		560,000

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

B.7.1 Data and parameters monitored:

Data / Parameter:	***Generation**$_h$*
Data unit:	Energy in MWh
Description:	Energy Generation of the Project for each hour ***h***
Source of data to be used:	On-site metering system (same data submitted to CDEC-SIC)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	Hourly measurement
QA/QC procedures to be applied:	Meter should have a maximum error of 0.2% and be calibrated periodically according to local standards for electricity transactions in CDEC-SIC. Metering data is sent regularly to CDEC-SIC where a balance is made for energy transactions between power generators.
Any comment:	

Data / Parameter:	$COEF_{i,y}$
Data unit:	tCO2 per mass or volume
Description:	CO2 emission factor of each plant by fuel type used, , taking into account the carbon content of the fuels used by relevant power sources ***i*** and percent of oxidation of fuel in year ***y***
Source of data to be used:	IPCC Guidelines and CNE Node Price Reports
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	Yearly or twice a year
QA/QC procedures to be applied:	Internal validation check should be performed contrasting historical data for existing plants. For new plants, validation should be accomplished through fuel type normal emission factors form similar plants.

Data / Parameter:	$COEF_{i,y}$
Any comment:	***i*** refers to the power sources delivering electricity to the grid, not including low operating cost and must run power plants, and including imports to the grid.

Data / Parameter:	EF_y
Data unit:	tCO2e/MWh
Description:	CO2e Emission factor of the displaced energy from the grid
Source of data to be used:	Calculated based on formula **f7**
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	Annually
QA/QC procedures to be applied:	Automatic calculation through a revised worksheet
Any comment:	

Data / Parameter:	$EF_{OM,y}$
Data unit:	tCO2e/MWh
Description:	Operating Margin Emission Factor
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	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	Annually
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:	***$EF_{j,h}$***
Data unit:	tCO2e/MWh
Description:	Operating Margin Emission Factor of 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	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	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(j,i)***
Data unit:	Energy in MWh
Description:	Energy displacement of the marginal plant '***i***' due to the proposed CDM project '***j***'
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	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	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 of the marginal plant '***i***',
Source of data to be used:	IPCC manual and CNE node price report
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	hourly
QA/QC procedures to be applied:	Calculation based on official data.
Any comment:	

Data / Parameter:	***SFC_i***
Data unit:	Fuel intensity in Ton/MWh or TJ/MWh
Description:	Specific fuel consumption per unit of electric energy produced in the 'i^{th}' marginal plant
Source of data to be used:	CNE node price report
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	Twice a year
QA/QC procedures to be applied:	Data is obtained from official reports. Historic comparison of each unit can provide data validation for existing and new units in the system.
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 formula 2 and CDEC-SIC data
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	Hourly
QA/QC procedures to be applied:	Electronic worksheet should be implemented to deliver automatic calculations
Any comment:	

Data / Parameter:	***N***
Data unit:	Number
Description:	List of CDM plants 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	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	As required
QA/QC procedures to be applied:	Data is obtained from official reports.
Any comment:	

Data / Parameter:	C_j
Data unit:	MWh
Description:	Electric energy of the j^{th} CDM project of the system (j = 1 .. N)
Source of data to be used:	CDEC-SIC
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	Hourly
QA/QC procedures to be applied:	Data is obtained from CDEC-SIC databases.
Any comment:	

Data / Parameter:	C_j
Data unit:	MWh
Description:	Electric energy of the j^{th} CDM project of the system in the 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	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	Hourly
QA/QC procedures to be applied:	Data is obtained from CDEC-SIC databases.
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	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	As required
QA/QC procedures to be applied:	Data is obtained from CDEC-SIC databases.
Any comment:	

Data / Parameter:	***B_i***
Data unit:	MWh
Description:	Electric energy 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	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	Hourly
QA/QC procedures to be applied:	Data is obtained from CDEC-SIC databases.
Any comment:	

Data / Parameter:	***$EF_{BM,y}$***
Data unit:	tCO2e/MWh
Description:	Build Margin Emission Factor of the grid for the year y
Source of data to be used:	Calculated based on formula f5. based on CNE Node Price Report and IPCC manual
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	Annually
QA/QC procedures to be applied:	Automatic calculation through a revised worksheet using CDEC-SIC and official databases and CNE Node Price report values.
Any comment:	

Data / Parameter:	***$EF_{BM,i}$***
Data unit:	tCO2e/MWh
Description:	Emission Factor for the ith plant in the Build Margin Cohort for the year y
Source of data to be used:	Calculated based on formula f6. CNE Node Price Report, IPCC manual, CDEC-SIC
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	Annually
QA/QC procedures to be applied:	Official data is used
Any comment:	

Data / Parameter:	***$Gen_{BM,i}$***
Data unit:	MWh
Description:	Energy generation of the ith plan on the Build Margin cohort
Source of data to be used:	CDEC-SIC (for ex-post calculation)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	Annually
QA/QC procedures to be applied:	Automatic calculation through a revised worksheet using CDEC-SIC data
Any comment:	

Data / Parameter:	***Plant name***
Data unit:	Text
Description:	Plant name. Identification of power sources
Source of data to be used:	CDEC-SIC
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	As new power plants are available in the system
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	*CEF_i*
Data unit:	TC pert ton of fuel or TJ
Description:	Carbon emission factor of fuel used in the ith plant of the Build Margin cohort
Source of data to be used:	Estimated based on official data form CNE node price reports and IPCC default values
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	Annually
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	***$Oxid_i$***
Data unit:	%
Description:	Fraction of fuel oxidized on combustion
Source of data to be used:	IPCC Guidelines
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	As required
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	**$SFC_{BM,i}$**
Data unit:	ton of fuel /MWh or TJ of fuel /MWh
Description:	Specific fuel consumption of the i^{th} electricity generation plant
Source of data to be used:	CNE node price report and CDEC-SIC
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	Yearly or twice a year
QA/QC procedures to be applied:	Internal validation check should be performed contrasting historical data for existing plants. For new plants, validation should be accomplished through fuel type normal emission factors for similar plants.
Any comment:	

Data / Parameter:	**W_{BM}**
Data unit:	%
Description:	Weight for Build Margin emission factor
Source of data to be used:	AM0026 default value = 50%
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	Annually
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	W_{OM}
Data unit:	%
Description:	Weight for Operating Margin emission factor
Source of data to be used:	AM0026 default value = 50%
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	Annually
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	**Changes in the regulatory framework that could affect the methodology**
Data unit:	Text
Description:	Changes in the regulatory framework that could affect the methodology
Source of data to be used:	Official Gazette
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	
Monitoring frequency	As required
QA/QC procedures to be applied:	
Any comment:	

B.7.2 Description of the monitoring plan:

>>

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.
- Public data on official expansion planning for the system. This data will be used to calculate the emission factor for the build margin.
- Emission Factors for every thermal power plant that operates or is included in the expansion plan.
- Data needed to calculate the build margin emission factor consistent with the Consolidated Baseline methodology for grid-connected electricity generation from renewable sources. (AM0026 - ACM002).

The marginal plant(s) are identified using the merit order and the official marginal price for that hour.

1-. Data Processing for ER calculation

Step 1. Calculation of Operating Margin Emission Factors

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
(Chacabuquito is first in order of precedence for ER abatement)
(MWh)

↓

Analysis of hourly dispatch from all units of the SIC to determine
Marginal Plant(s) not dispatched (or displaced) due to dispatch of all CDM projects
(CDEC-SIC hourly data)

↓

Calculation of emission factor of all operational thermal units of the system
(CNE report and IPCC manual)
(tonnes CO2e/MWh)

↓

Determination of the marginal plants and energy being displaced due to the operation of each CDM project
Chacabuquito (1st CDM project) and other CDM projects
(MWh and tonnes CO2e/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 CO2e/MWh)

Step 2 - Calculation of the Build Margin

Following AM0026, the Build Margin is calculated using option 2 of ACM002 for the first crediting period. For subsequent crediting periods, Build Margin EF shall be calculated ex-ante, as described in Option 1 of ACM002

Please refer to formulae stated in section B.6.3 (**f5** and **f6**)

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 (MWh)
⇩
Determination of 20% of energy generated from most recent power units (set of m plants following the ACM002 option2) (MWh)
⇩
Calculation of emission factor of thermal units in the plan (CNE reports and IPCC manual) (tonnes CO_2e/MWh)
⇩
Determination of EF_{BM} (ACM002) as the weighted average emission factor of the dispatched plants and their individual emission factor (tonnes CO_2e/MWh)

Step 3 – Calculation of the Project Emissions Reductions

The combined 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).

Please refer to formulae stated in section B.6.3 (**f7, f8** and **f9**)

Calculation of Combined Margin Emission factor of EF_{BM} and EF_{OM}
(tonnes CO2e/MWh)

↓

Energy generation of the Chacabuquito CDM Project
(from CDEC-SIC or metering data)
(MWh)

↓

Calculation of Baseline Emissions of the Project
(tonnes CO2e)

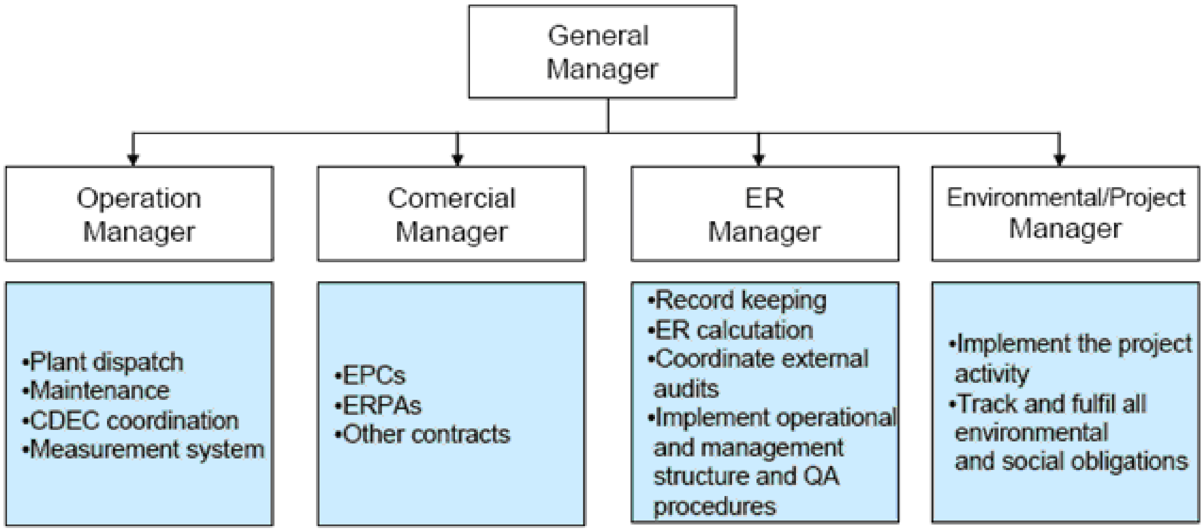
↓

Discount any leakage or project activity emissions, if any
(No leakage emissions was identified for Chacabuquito, and project emissions are null)
(tonnes CO2e)

2-. Operational and Management structure

In order to succeed with quality CERs, the project developer will implement and maintain a proper management structure as follows:

Figure B.6 HGV General Management Structure



HGV will designate a competent manager who will be in charge of and accountable for the generation of ERs including monitoring, record keeping, computation of ERs, audits and verification. An operational manager will be in charge of all plant production and maintenance activities. A commercial manager will be in charge of Power Procurement Agreements (PPA), Emission Reduction Purchase Agreements (ERPA) and other related commercial activities for this kind of project. An environmental/project manager will be in charge of developing the project and fulfil all social and environmental obligations relative to the project activities.

HGV will ensure that the required capacity and internal training is made available to its operational staff to enable them to undertake all the required tasks in transparent manner with.

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:
31/08/2006

1. Carl Weber, Hidroeléctrica Guardia Vieja S.A., Apoquindo 4775, piso 13, Santiago, Chile, tel +56-2-460-4000; cweber@hgv.cl.

2. José Manuel Contardo, Consultant, Carbon Finance Unit, The World Bank, jmcontardo@gmail.com.

Both, the World Bank and Hidroeléctrica Guardia Vieja S.A. are project participants listed on Annex 1. The Deal Manager of the Project at the World Bank is:

Pedro Huarte-Mendicoa, Deal Manager, Carbon Finance Unit, The World Bank, phuartemendicoa@worldbank.org

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 has been commissioned since July 2002

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

>> The operational lifetime of run-of-river hydropower plants is estimated over 30 years Therefore the project seeks a 7 year, twice renewable crediting period (total 21 years).

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

C.2.1. Renewable crediting period:

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

>> The first crediting period starting on: 01 July 2002

C.2.1.2. Length of the first crediting period:

>> Seven (7) years

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>

C.2.2.2. Length:

>>

SECTION D. Environmental impacts

>>

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

>>

Chilean Law 19.300 of 1994, effective in 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, such as Chacabuquito power plant, 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).

In October 2000, the project completed an Environmental Impact Statement. The report recommends 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 m3/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 for by adhering to the *Corporacion Nacional Forestal (CONAF)* requirement of planting three trees for every tree cut. However, the density of trees in the area was quite low. A Management Plan for Clearing of Vegetation and Reforestation for the Chacabuquito Project (*Plan de Manejo de Corta de Reforestacion en Obras Civiles, Proyecto Chacabuquito, January 2001*) was approved by CONAF in February, 2001 (the Plan and the Official resolution are in project files). The Plan requires the reforestation of 18 has. in an area proposed by the project sponsor, but approved by CONAF within the Los Andes municipality. The Plan established the protection of riverine vegetation along two streams that cannot be cleared during construction activities.

- 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 *Plan de Manejo de Corta de Reforestacion en Obras Civiles, Proyecto Chacabuquito,* which was approved by the National Forestry Corporation (CONAF) in February 2001 (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 (Asociacion de Usuarios del Rio Aconcagua, and Asociacion 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. Hidroelectrica 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 irragation 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

For calculating the emission factor of thermal power plants in the Central Grid of Chile the methodology uses the following sources:

- Fuel Specific Consumption for every power plant: Semi-annual CNE Node Price Report
- Calorific Content of every Fuel: Semi-annual CNE Node Price Report
- Fuel Carbon Content: Greenhouse Assesment Handbook, Worldbank, September 1998, based on UNEP/OECD/IEA/IPCC/ 1995
- Combustion Efficiency: Greenhouse Assesment Handbook, Worldbank, September 1998, based on UNEP/OECD/IEA/IPCC/ 1995

The following table shows the emissions factors for the power units available at July 2002. The following data will be periodically updated for each CNE node price report. The values in the table however do not have significant changes in time. The only changing parameters are related to the imported fuels calorific content.

1 Unit =	Kcal	Joule	BTU	KWh
Kcal	1	4.187E+03	3.968E+00	1.163E-03
Joule	2.388E-04	1	9.478E-04	2.778E-07
BTU	2.520E-01	1.055E+03	1	2.931E-04
KWh	8.598E+02	3.600E+06	3.412E+03	1

1. Coal, Petcoke and Petroleum

	Units	BOCAMINATV	VENTANAS1	VENTANAS2	GUACOLDA 1	GUACOLDA 2	HUASCOTV	LAGVERDE	PETROPOWER
Especific consumption (2)	kg/KWh	0.368	0.415	0.397	0.336	0.336	0.740	0.850	0.313
Calorific Content (2)	kcal/kg	6,458	6,650	6,650	6,544	6,544	6,333	6,650	6,790
Factor Conversión (3)	kcal/KWh	2,377	2,760	2,640	2,199	2,199	4,686	5,653	2,125
	TJ/GWh	9.95	11.55	11.05	9.21	9.21	19.62	23.67	8.90
Fuel Carbon Emision Factor (1)	tC/TJ	25.80	25.80	25.80	26.09	26.09	25.80	25.80	27.50
Carbon Emissions	tC/GWh	256.71	298.11	285.18	240.15	240.15	506.22	610.58	244.71
Combustion Efficiency (4)	%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%
CO2 conversion	tCO2/tC	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
Emisiones de Dioxido de Carl	**tCO2/GWh**	**922.46**	**1,071.20**	**1,024.74**	**862.93**	**862.93**	**1,819.03**	**2,194.02**	**879.33**

(1) Exhibit 3-6, page. 28 GHG Assesment Handbook
(2) From CNE semestral report
(1,3) Guacolda uses a mixture of petcoke (16,88%) and coal (83,12%)
(4) Exhibit 3-7, page. 29 GHG Assesment Handbook

2. Natural Gas

	Units	NUEVA RENCA	CENTRAL SAN ISIDRO	NEHUENCO	NEHUE.9B	TALTAL 1	TALTAL 2	CC CNE	NEHUENCO 2
Conversion Factor (2)	KJ/KWh	6,982	6,655	6,513	14,037	10,705	10,705	6,520	0
	TJ/GWh	6.98	6.66	6.51	14.04	10.71	10.71	6.52	0.00
Fuel Carbon Emission Factor (1	tC/TJ	15.30	15.30	15.30	15.30	15.30	15.30	15.30	15.30
Carbon Emissions	tC/GWh	106.82	101.82	99.65	214.77	163.79	163.79	99.76	0.00
Combustion Efficiency (3)	%	99.5%	99.5%	99.5%	99.5%	99.5%	99.5%	99.5%	99.5%
CO2 conversion	tCO2/tC	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
Emisiones de Dioxido de Carl	**tCO2/GWh**	**389.73**	**371.48**	**363.55**	**783.54**	**597.55**	**597.55**	**363.94**	**0.00**

(1) Exhibit 3-6, page. 28 GHG Assesment Handbook
(2) From CNE semestral report
(3) Exhibit 3-7, page. 29 GHG Assesment Handbook

3. Diesel and Oil

	Units	Turbina Gas 1	Turbina Gas 2	INDIO	RENCA	ANTILHUE50	DIEGO DE ALMAGRO	HUASCOTG	CONSTITUCION Gener	SAN FRANCISCO M.
Fule Type		Fuel	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel
Calorific Content (3)	TJ/ton	43.33	43.33	43.33	43.33	43.33	43.33	43.33	43.33	43.33
Especific Consumption (2)	kg/KWh	0.362	0.337	0.264	0.362	0.229	0.337	0.362	0.309	0.309
	TJ/GWh	15.69	14.60	11.44	15.69	9.92	14.60	15.69	13.39	13.39
Fuel Carbon Emission Factor (1	tC/TJ	20.20	20.20	20.20	20.20	20.20	20.20	20.20	20.20	20.20
Carbon Emissions	tC/GWh	316.85	294.96	231.07	316.85	200.44	294.96	316.85	270.46	270.46
Combustion Efficiency (4)	%	99.0%	99.0%	99.0%	99.0%	99.0%	99.0%	99.0%	99.0%	99.0%
CO2 conversion	tCO2/tC	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
Emisiones de Dioxido de Carl	**tCO2/GWh**	**1,150.15**	**1,070.72**	**838.78**	**1,150.15**	**727.58**	**1,070.72**	**1,150.15**	**981.76**	**981.76**

(1) Exhibit 3-6, page. 28 GHG Assesment Handbook
(2) From CNE semestral report
(3) Exhibit 3-3 page 26 From GHG Assesment Handbook.
(4) Exhibit 3-7, page. 29 GHG Assesment Handbook

The Baseline emission reductions are calculated following AM0026 methodology with real ex-post data. This procedure requires an overwhelming amount of data, considering all hourly dispatch and weekly priority lists. Anyway, all detailed system data can be easily obtained from CDEC-SIC's web page at **www.cdec-sic.cl**, with a subscription fee of 300 USD/year. Also, node price reports, used to calculate thermal plant emission factors, can be obtained from national's authority energy commission CNE at **www.cne.cl**.

SIC Baseline Emission Reductions in TCO2/GWh

	2002	**2003**	**2004**	**2005**	**Avg.**
BM	302	364	363	293	**331**
OM	561	726	555	587	**607**
EF	**432**	**545**	**459**	**440**	**469**

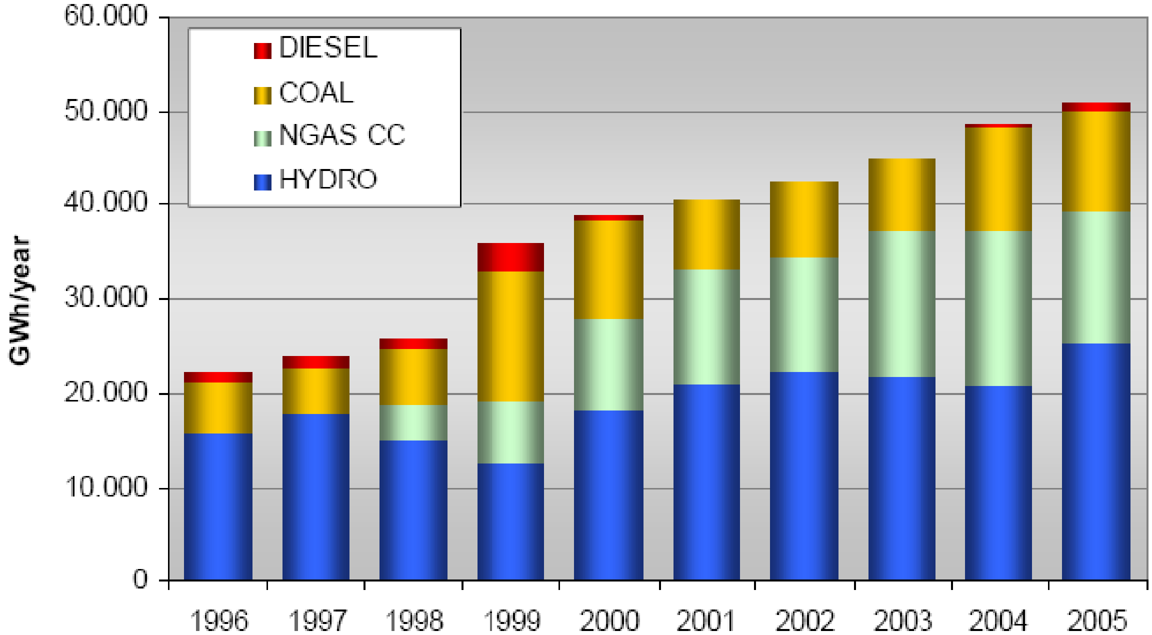
Source HGV estimations based on CDEC-SIC data and Greenhouse Assesment Handbook

>>

National and sector background

To meet its growing energy demand (approximately 7 percent annually since 1986), in the 1980s Chile began to separate its government-owned power generation, transmission and distribution assets. Over the past decade, Chile completely privatized its electricity industry and unbundled the national generation, transmission, and distribution systems. Private companies now provide 100 percent of Chile's electricity. Chile's electricity sector has served as a model for subsequent privatizations throughout the world, and despite recent shortages due to drought, is improving its efficiency and reliability. The opening of Chile's gas sector in 1996 has increased choices among energy sources, lowered the energy prices, and helped to satisfy growing demand in the industrial and power-generating sectors. Over the long term, Chile hopes to benefit from opening its energy markets to the private sector by receiving steady and reliable supplies of energy at competitive prices to meet growing demand from all economic sectors. A significant portion of this growth has come from increased power demand by the copper mining sector, the country's single biggest industry, and by growing populations in large urban areas, such as Santiago. Energy policy decisions in Chile are the shared responsibility of the Ministry of the Economy and the specialized agencies the National Energy Commission, the Superintendence of Electricity and Fuels, and the Chilean Commission of Nuclear Energy.

Chile Annual Energy Demand Through 1996 to 2005

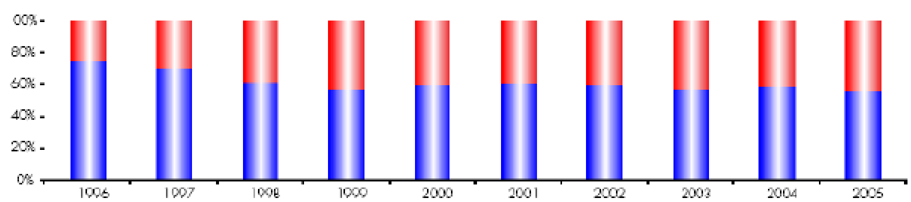


Source: CNE

Chile consumed near 50.000 GWh of electricity in 2004, from this figure, almost 21 GWh was hydropower energy. About 38 percent of Chile's installed power generation capacity is hydroelectric, which is mainly concentrated in the Central Interconnected System (SIC) representing near 60% of SIC's capacity.

Hydropower from westward flowing rivers from the Andes Mountains is Chile's single largest electricity source. The severe drought that gripped Chile from late 1997 until well into 1999 hobbled the country's electricity sector. Chile's capital city, Santiago, experienced rolling blackouts from November 1998 until May 1999. As a result, Chile now is working to become less reliant on hydropower. In 1996 Chile and Argentina signed an Agreement to allow the exportation of natural gas from Argentinean fields to Chile. Since then, 1.000 MW in Combined Cycle Power Plants have been added to the Chilean grid decreasing the energy prices dramatically (by about 45 percent to 21 US$/MWh in 1997).

Chile SIC Power Capacity Evolution Through 1996 to 2005

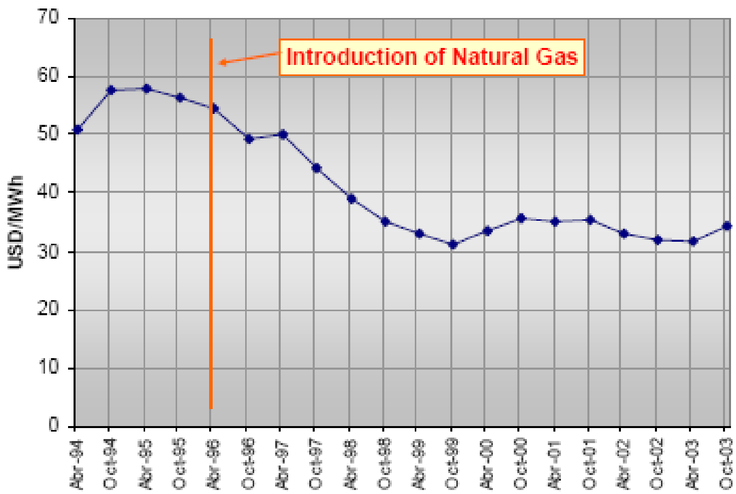


	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
TOTAL[MW]	**4.858,5**	**5.266,8**	**6.242,4**	**6.695,1**	**6.652,8**	**6.579,2**	**6.737,2**	**6.996,2**	**7.867,4**	**8.259,8**
TÉRMICO	1.191,9	1.562,2	2.350,8	2.788,8	2.622,5	2.548,9	2.681,9	2.940,9	3.172,1	3.565,0
	24,5%	29,7%	37,7%	41,7%	39,4%	38,7%	39,8%	42,0%	40,3%	43,2%
HIDRÁULICO	3.666,6	3.704,6	3.891,6	3.906,3	4.030,3	4.030,3	4.055,3	4.055,3	4.695,3	4.694,8
	75,5%	70,3%	62,3%	58,3%	60,6%	61,3%	60,2%	58,0%	59,7%	56,8%

While only an estimated 13 percent of hydroelectric potential is now utilized, large viable sites are far from Santiago (which represents 40 percent of demand), requiring large transmission line investments. Together with other fossil fuels, natural gas has become an increasingly important electricity source in the coming years.

In mid 2004 Chile was affected by a natural gas shortage due to Argentina unilateral restrictions on gas supply. The restriction commenced with slight restrictions, however this became more critical on late 2005 once it was evident that the shortage had no easy solution in the short and mid term. Since most of the expansion of the system was based no NG after 1996, the Chilean grids had to react increasing the energy prices in order to avoid mid term energy shortages.

SIC Node Price Evolution Through 1994 to 2005



Source: CNE and bls.gov CPI

i) Sector barriers:

No concession is required to become a generator and there is no entry restriction to the market for generators, who freely and competitively can sell firm capacity and energy via negotiated power contract sales and/or make power available to the system's spot market. Generators have no obligation to supply beyond the terms of their contracts. All generation is undertaken by the private sector, under the concept of merchant plants. In each interconnected system, a load dispatch center (CDEC) is responsible for coordinating and dispatching load from generating units utilizing the system. The Law establishes the obligation to optimize generation and thus, dispatch is based on a pre-programmed economic merit order based on least marginal cost of generation for the corresponding system.

Most Chilean power generation companies are organized around four grid systems, the Great North Interconnected System (SING), the Central Interconnected System (SIC) the Aysén Grid and the Magallanes Grid. These four grids are not interconnected to each other. Private sector power transmission companies transmit electricity sold by the generation companies to power distribution companies, regulated and unregulated customers and other power generation company. The Central Interconnected System (SIC) serves

over 90 percent of Chile's population and more than 40 percent of the land area. The Great North Interconnected System (SING) is mainly thermal and serves mostly mineral-processing centers in the region and the Aysén and the Magallanes systems in the south of the country serve remote areas with a combined capacity of about 1 percent of the total. Coordination within each system is carried out by the Economic Dispatching Center (CDEC), an autonomous entity composed of members from all utilities within each system to ensure efficiency and security of the electric system. Aside from these four grids, "self producers" account for about 12 percent of national generation.

ii) Sector institutions:

CDEC: The economic load dispatch center in each system is controlled by a private, independent entity CDEC (*Centro de Despacho Económico de Carga*), composed of representatives of generation and transmission companies, but its operation is fully regulated by law and supervised by the *Comisión Nacional de Energía* (CNE) and the *Superintendencia de Electricidad y Combustibles* (SEC), both described below. CDEC is in charge of planning the optimum operation of the system, based on lowest marginal costs, and of determining values of economic transactions that were carried out among the generators. The SING (Great North Interconnected System) and the SIC (Central Interconnected System) have each their own independent dispatch centers.

CDEC–SIC (Economic Dispatch Center in the Central Interconnected System) will play an important role in the quantification of the actual emission reductions achieved each year. CDEC's operation and information system enables a relatively easy quantification of the actual emission reductions achieved on an hourly basis.

CDEC-SIC is a private entity composed of representatives of generation and transmission companies, independent from the Government. Although HGV is not a CDEC member (as membership is obligatory only for generators of capacity above 2 percent of the total installed capacity in the whole SIC), all generating plants supplying electricity to the system, including Chacabuquito, are under CDEC-SIC operating supervision.

CNE: The sector is regulated by an autonomous agency: *Comisión Nacional de Energía* (CNE). Its main responsibilities for the power sector include (i) proposing sector norms and regulations; (ii) coordinating planning, policies and norms for efficient functioning of the market; and (iii) calculating and enforcing regulated prices.

Ministry of Economy: In the area of the power sector, the Ministry of Economy is responsible for (i) setting distribution tariffs and node prices (based on CNE's calculations), (ii) resolving possible conflicts among the members of CDEC, and (iii) awarding concessions.

SEC: *Superintendencia de Electricidad y Combustibles* is responsible for supervising compliance with existing laws, regulations and technical norms related to the generation, production, storage, transport and distribution of liquid fuels, gas and electricity.

Annex 4

MONITORING INFORMATION

THE MONITORING AND VERIFICATION PROTOCOL

Purpose of the MVP

In the context of the Clean Development Mechanism (CDM) of the Kyoto Protocol, monitoring describes the systematic surveillance of a project's performance by measuring and recording performance-related indicators relevant to the project or activity. Verification is the periodic auditing of monitoring results, the assessment of achieved emission reductions (ER) and of the project's continued conformance with all relevant project criteria.

This Monitoring and Verification Protocol (MVP) defines a standard against which the Chacabuquito Hydro Power Plant performance in terms of its greenhouse gas (GHG) reductions and conformance with all relevant Clean Development Mechanism (sustainable development) criteria will be monitored and verified. As such the MVP, after its validation, will be an integral part of the contractual agreement between the IBRD and Hidroélectica Guardia Vieja (HGV).

The MVP is a part of the project design documents. The MVP builds on the baseline scenario identified in the Chacabuquito Baseline Study and is fully consistent with the Baseline Study.

Use of the MVP by the Project Operator

The MVP is a working document that identifies the key project performance indicators and sets out the procedures for tracking, monitoring, calculating and verifying the impacts of the project, in particular with respect to the project's ERs.

This MVP must be used by the project operator when planning and implementing the project and during the projects operation. Adherences to the instructions in the MVP is necessary for the project operators, to successfully measure and track the project impacts, and prepare for the periodic audit and verification process that will have to be undertaken to confirm the achieved Emission Reductions (ERs). The MVP is thus the basis for the production and delivery of ERs to the IBRD or other buyers and for any related revenue stream that the operator expects to receive.

The MVP assists the operator in establishing a credible, transparent, and adequate data measurement, collection, recording and management system to successfully develop and maintain the proper information required for an audit of the collected information and for the verification and certification of the achieved ERs and other project outcomes. Specifically, the MVP provides the requirements and instructions for:

- Establishing and maintaining the appropriate monitoring system including spreadsheets for the calculation of ERs.
- Checking whether the project meets key sustainable development indicators;
- Implementing the necessary measurement and management operations;
- Preparing for the requirements of independent, third party verification and audits.

The MVP ensures environmental integrity and accuracy of crediting ERs by only allowing actual ER to be accounted for after they have been achieved. The MVP must therefore be used throughout the life of the project. It must be adopted as key input into the detailed planning of the project, and included into the operational

manuals of the project.

The MVP can be updated and adjusted to meet operational requirements, provided such modifications are approved by the Verifier during the process of initial or periodic verification. In particular, any shifts in the applicable baseline that are identified by following this MVP may lead to such amendments, which may be mandated by the Verifier.

Structure of the MVP

The MVP document contains the following parts:

- **Section 2** explains concepts and principle assumptions applied in monitoring the GHG performance of the project and in calculating ERs. The section also discusses data sources and assumption and lays out why the MVP is expected to compute ERs in a conservative manner.
- **Section 3** contains instructions regarding operational and monitoring obligations the operator is expected to assume.
- **Section 4** presents the functioning of the MVP electronic workbook. The workbook is implemented as Excel spreadsheets and is an integral part of the MVP.
- **Section 5** contains the sustainable development MVP for the project, which allows assessing the environmental and development performance of the project against set targets (to be specified during the project's detailed design).
- **Section 6** explains the management and operation system that needs to be put in place to ensure a consistent, high quality monitoring work.
- **Section 7**, finally, describes the IBRD verification regime and details the auditing and verification procedures for the project.

CONCEPTS AND PRINCIPLE ASSUMPTIONS

The MVP builds on the baseline study. In the MVP, the methodology is guided by the need and limitation of measuring the project's performance indicators and calculate ERs in an efficient and transparent way.

Emission reduction from the Chacabuquito Project

The Chacabuquito Project consists of a run-of-the-river power plant of 30 MW capacity that utilizes the waters of the Aconcagua river and will produce an average net annual generation of 170 GWh. The project is located in the 5th Region administrative division near Los Andes, about 100 km Northeast from Santiago. This plant is in cascade with two other existing upstream hydropower plants (Los Quilos and Aconcagua). Chacabuquito will be connected to the 5^{th} Region's 110 KV sub-system within the SIC and will generate power for industrial and residential consumers in the 5^{th} Region. Construction started in the July 2001; commissioning started in July 2002.

In a centrally planned system the baseline can be determined on the basis of the least cost expansion as defined by the planning authority. In Chile there is no central planning for expansion of power facilities. However, CNE (National Energy Commission) prepares an indicative plan which projects the node prices. Investors are free to choose the projects they want to develop and base their decisions on their own perception on the market. Consequently the baseline, for the purpose of *estimating* emission reduction prior to the emission reduction

taking place, should be determined as the most likely scenario of capacity additions private investors would choose on the basis of demand projections, node and spot prices, investment costs of candidates for capacity expansions and expected price of fuels. Potential candidates for capacity expansions in the SIC are mostly thermal options: coal fuelled steam plants (SP), gas fuelled combined cycle plants (CC) and gas fuelled open cycle turbines (GT), in addition to hydro power even though hydro resources are almost exhausted in the area and there are only a few small hydro projects that can be developed. The baseline study establishes that the least cost expansion option for the SIC is combined cycle gas thermal power generation. It is shown that even though combined cycle gas power generation is the predominant capacity addition, the dispatch of power, based on economic merit order determined by lowest marginal cost of supply, favors existing coal thermal generating sources. At the margin, therefore, generation from Chacabuquito and other CDM projects in the system will displace coal thermal power that would have been dispatch in the absence of these CDM projects.

As indicated in the baseline study, the actual emission reduction to be credited from the project will depend on the CNE expansion plan and the actual dispatch data for the SIC provided by the Economic Dispatch Center (CDEC)[3], considering that Emission Reductions of CDM projects must be accounted as first build, first served principle[4]. In the case of Chacabuquito project, this will be the first CDM project in the system (SIC). The methodology for carrying this out and the monitoring and verification protocol for establishing the emission reduction are provided in this document.

Geographic and System Boundaries for the MVP

The Baseline Study defines the project boundary to correspond to the Central Interconnected System (SIC) for the purpose of identifying potential emissions and leakage during the projects lifetime.

The Central Interconnected System (SIC) accounts for about 75% of the power generation capacity in Chile. Combined cycle gas generation has grown to about 22% of the total generation. Reservoir hydro generation is at about 38% of the total generation, except in the year with poor rainfall when other thermal plans have to cover the shortage in generation from hydropower. CNE projects the demand to grow at about 7% per year in the SIC. As demonstrated in the Baseline Study, the combined cycle plants represent the least-cost option generation expansion option for the SIC.

The Baseline Study has not found leakage to be a problem for the project as the project is a closed system. Therefore the MVP does not correct the calculated ERs to account for leakage.

Time Boundary and Baseline Review Protocol

The Baseline Study has opted for a 7-year renewable baseline (for a total crediting period of 21 years) for which the project is likely to generate ERs in compliance with the CDM.

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[3] The institutional set-up in the power sector is discussed in detail in subsequent section of this study

[4] The “first-built first-server” principle implies that the “last” plant, existing in the grid, that would have been dispatched to meet the electricity requirement fulfilled by all the CDM projects in the grid is considered to be displaced due to introduction of the First CDM project built in the system. Similarly the first marginal plant is considered to be displaced by the CDM plant built last. Note that all CDM projects (even projects adopting other methodologies) must be considered.

Calculating Emission Reductions

The emission reduction from the project result from the electricity from the Chacabuquito run-of-river hydro power plant displacing power generated mainly by coal and combined cycle gas or other thermal units on the margin in the Central Interconnected System.

The Central Interconnected System (SIC) is coordinated by an independent entity called Load Economic Dispatch Center (CDEC-SIC). That entity was established by law (Electric Law, DFL N° 1, 1982) and is ruled by the Electrical Ruling (Supreme Decree N° 327, 1998).

The CDEC-SIC programs the dispatch of the power units by strict economic priority, considering the river flows, the opportunity cost of the water, the operational cost of the thermal units and the filling of the hourly load curve of the demand. The outcome is the hourly generation program for each power unit and the hourly marginal cost of the whole system (that cost represents the highest operational cost of the power units generating in each hour). The CDEC must coordinate in real time the dispatch at minimum cost of the power units according to the weekly and daily programs.

The CDEC-SIC publishes daily and monthly reports of the actual operation of the SIC, including in that report the hourly generation for each power unit and the marginal cost for each hour. The information required is provided by CDEC-SIC and are available publicly through its website at a subscription fee (of US$ 300 a year).

CNE publishes every six months the Node price report with the indicative expansion plan of the system.
The information is publicly available at www.cne.cl

The outline of the method to calculate the emission reduction is as follows:

Key Steps for Estimating Operating Margin Emission Factor

Net Hourly Generator output from other CDM Projects and Chacabuquito
(Chacabuquito is first in order of precedence for ER abatement)
(MWh)

Analysis of hourly dispatch from all units of the SIC to determine
Marginal Plant(s) not dispatched (or displaced) due to dispatch of all CDM projects
(CDEC-SIC hourly data)

Calculation of emission factor of all operational thermal units of the system
(CNE report and IPCC manual)
(tonnes CO2e/MWh)

Determination of the marginal plants and energy being displaced due to the operation of each CDM project
Chacabuquito (1st CDM project) and other CDM projects
(MWh and tonnes CO2e/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 CO2e/MWh)

Key Steps for Estimating Build Margin Emission Factor

SIC Dispatch of all power units of the system (MWh)
Determination of 20% of energy generated from most recent power units (set of m plants following the ACM002 option2) (MWh)
Calculation of emission factor of thermal units in the plan (CNE reports and IPCC manual) (tonnes CO_2e/MWh)
Determination of EF_{BM} (ACM002) as the weighted average emission factor of the dispatched plants and their individual emission factor (tonnes CO_2e/MWh)

Key Steps for Estimating Chacabuquito Project Emissions

Calculation of Combined Margin Emission factor of EF_{BM} and EF_{OM}
(tonnes CO2e/MWh)

↓

Energy generation of the Chacabuquito CDM Project
(from CDEC-SIC or metering data)
(MWh)

↓

Calculation of Baseline Emissions of the Project
(tonnes CO2e)

↓

Discount any leakage or project activity emissions, if any
(No leakage emissions was identified for Chacabuquito, and project emissions are null)
(tonnes CO2e)

Why is the MVP Conservative?

Care has been taken to avoid that the MVP methodology and the simplifications and assumptions made will lead to an overestimation of ERs as compared to the "true" numbers. The MVP is based on *actual* hourly dispatch data for the Central Interconnected System and these are used to calculate the actual marginal plant that Chacabuquito run-of-the-river power plant displaces following AM0026 methodology.

OPERATIONAL AND MONITORING OBLIGATIONS

The operator of the Chacabuquito run-of-the-river hydro power project will have certain operational and data collection obligations to fulfill, in order to maximize the greenhouse gas emissions reductions and to ensure that sufficient information is available to calculate ERs in a transparent manner and to allow for a successful verification of these ERs.

Operational Obligations

The operational obligations of the Project Operator are to ensure that all reasonable steps are taken to maximize the generation from the Chacabuquito facility and thereby maximize the GHG emissions reduction. This is in the interest of the operator anyway.

Data Requirements and Project Database

The data required for the MVP is in line with the kind of information collected by an electricity utility.
The data used in this MVP will be collected by HGV and comes from the following sources:

- The hourly generation of the project is obtained from the metering system of the plant, which is submitted every 2 hours to CDEC-SIC.
- The actual dispatch of all units in the system and dispatch priority list of the power units is collected from the CDEC-SIC website (www.cdec-sic.cl).
- The expansion plan and the CO_2e Conversion Factor for thermal plants is obtained from the Node Price Fixation Report issued by the CNE (Comisión Nacional de Energía, the government agency for the energy) complemented with the IPCC manual.

PROJECT WORKBOOK

This section explains and illustrates the steps required by the operator to enable the GHG emissions reductions to be calculated on a monthly basis using the Chacabuquito project workbook. It presents the worksheets contained in the workbook and illustrates their use. The electronic workbook is an Annex to the MVP and an integral part thereof.

Main Data

The Chacabuquito Hydro Power project MVP consists of one workbook made up of the following four separate worksheets:

- **Generation and other data collected from CDEC-SIC:** Data from electricity generation of all units of the system from Load Economic Dispatch Center (CDEC-SIC), dispatch priority order of all power generation facilities based on economic merit order for each power plant in the SIC.
- **Tonnes of CO_2e (tCO_2) Emission Factors:** Emission Factor of thermal units of the system, calculated every six months form the CNE node price report
- **Dispatch estimation without CDM projects:** Determination of hourly marginal energy displacement due to CDM project activity (Chacabuquito and other CDM projects in the SIC).
- **Emission Displacement:** Determination of energy and emission displacement due to the operation of Chacabuquito project, where Chacabuquito displacement is the first CDM project in the order of displacement.

The following color key is used by the workbook:

- **Title Field:** Light blue fields describe data and are the headings for the worksheet sections, a darker blue code is used for the main headings;
- **Equation fields:** Where appropriate, algebraic representations of the calculations being performed are included in the tables in the white fields;
- **Input Field - from database:** Yellow fields indicate cells in which the project operator is required to supply data input needed to run the worksheet;
- **Input Field - from cell within workbook:** Orange fields indicate cells to which the project operator is required to transfer data from another cell in the workbook;
- **Standard Conversion Fields:** Purple fields contain constants and/or conversion factors that are needed in the equations to calculate key values;
- **Calculation Fields:** Green fields include formulas that automatically calculate a parameter once the project operator has entered the input data in the yellow fields.

All data collected for the MVP will be stored on database that can be consulted form an excel worksheet. The operator must complete the workbook per month starting with the commission of the Project. Every month, the operator must internally validate the emission reduction calculation of the project and keep a signed registry for verification purposes. The monthly reports together with the operator's database and monitoring records form the "paper trail" which is essential for auditing purposes. The monthly workbooks will be a transparent record of electricity generation, emissions reductions, sustainable development data, etc. In some instances cumulative calculations are made. For example, the workbooks present a clear record, from month to month, of the cumulative greenhouse gas emissions reductions. The following sections describe how the first three worksheets calculate ERs.

Energy Generation of The CDM Project

The hourly net generation of Chacabuquito is obtained from the metering system of the Plant. This information is submitted to CDEC-SIC every two hours, as all other plants of the SIC. With this data, CDEC-SIC provides an hourly report of the system dispatch.

Step 1- Energy Generation of Chacabuquito

		Hour				
Day		1	2	3	..	24
1	Energy Generation (MWh)					
2	Energy Generation (MWh)					
3	Energy Generation (MWh)					
	Energy Generation (MWh)					
31	Energy Generation (MWh)					

The electronic metering system of the project must have precision class of 0.2%, that is the minimum standard for the electric system in Chile. This meter is placed at the generation bus. The metering register the instantaneous sum of the power of the four generators, which is integrated in 15 minutes intervals. The data from the meter is collected by the project operator, HGV, and is then transmitted every two hours to the CDEC-SIC electronically.

Energy Generation Data of All Generating Units of the System

Data from electricity generation and dispatch Load Economic Dispatch Center (CDEC-SIC) consists of Data on actual operation of all units of the SIC, in particular the hourly dispatch of electricity generation from each power plant in the SIC.

Actual Dispatch in the CDEC-SIC

For every hour of the monitoring period, the actual dispatch of the SIC is obtained from the CDEC-SIC. This information can be retrieved through a web access or a dedicated connection that works as a file server. A sample data is reproduced below.

Sample sheet of Real Daily Dispatch data, as provided by CDEC-SIC (In MWh)

DATE

Power Units	1	2	…	23	24	Total
Reservoir	**1.128**	**1.150**	**…**	**2.199**	**1.820**	**38.596**
El Toro	0	2	…	0	0	**26**
Antuco	171	235	…	181	171	**5.113**
Machicura	19	19	…	60	60	**881**
Pangue	463	463	…	461	461	**11.117**
San Ignacio	0	0	…	20	20	**168**
Ralco	570	570	…	570	570	**13.680**
Other reservoir	…	…	…	…	…	**…**
Run-Of-River	**1.187**	**1.171**	**…**	**1.236**	**1.210**	**28.355**
Abanico	45	45	…	44	43	**1.060**
Aconcagua	28	28	…	28	28	**692**
Alfalfal	56	53	…	57	57	**1.309**
Capullo	12	12	…	11	12	**280**
Chacabuquito	19	18	…	17	17	**421**
Other r-o-r	…	…	…	…	…	**…**
Thermal	**1.626**	**1.336**	**…**	**1.511**	**1.465**	**36.432**
Constitución A.	16	15	…	15	15	**354**
Constitución	7	7	…	7	6	**146**
Horcones TG	18	17	…	16	16	**405**
Laja	3	4	…	8	6	**124**
Licantén	2	2	…	0	0	**17**
Valdivia	0	0	…	0	0	**0**
Petropower	68	68	…	68	68	**1.634**
Arauco	31	32	…	31	31	**761**
Cholguán	12	12	…	10	11	**276**
Nueva Renca	186	67	…	367	332	**6.463**
Nehuenco II	379	379	…	0	0	**4.603**
Nehuenco	351	336	…	354	356	**8.262**
San Isidro	305	167	…	352	353	**7.269**
Guacolda 1	0	0	…	0	0	**0**
Guacolda 2	150	150	…	151	152	**3.610**
Taltal 2	0	0	…	0	0	**0**
Taltal 1	97	80	…	116	117	**2.435**
Ventanas 2	0	0	…	0	0	**0**
Bocamina	0	0	…	0	0	**0**
Other Thermal	…	…	…	…	…	**…**
TOTA DISPATCH	**3.940**	**3.657**	**…**	**4.946**	**4.496**	**103.383**

Dispatch Priority List

For every week the CDEC-SIC state the dispatch priority list of the power units in the SIC according to their marginal operation cost. That information is also available from CDEC-SIC and a sample is reproduced below.

Priority	Variable Cost USD/MWh	Unit
1	0	ACONSTITUCION Arauco
2	0	CONSTITUCION Gener
3	0	HORCONES TG
4	0	LAJA
5	0	LICANTEN
6	0	P.VALDIVIA
7	0	PETROPOWER
8	2,4	ARAUCO
9	9,9	CHOLGUAN
10	12,5	NUEVA RENCA
11	16,6	NEHUENCO 2
12	16,7	NEHUENCO
13	17,3	CENTRAL SAN ISIDRO
14	20,4	GUACOLDA 1
15	20,4	GUACOLDA 2
16	21,3	TALTAL 1
17	21,3	TALTAL 2
18	27,4	VENTANAS2
19	29,4	BOCAMINATV
…	…	…

<u>The "Marginal Power Unit in the SIC"</u>

From the data issued by the CDEC-SIC on the hourly marginal power unit, it is possible to determine the marginal power plant and the next marginal plants in the priority dispatch order list.

Marginal Plant 1	Energy	MWh	B1	97,0	80,0	…	116,0	117,0
	Plan Name			TALTAL1	TALTAL1	…	TALTAL1	TALTAL1
	Capacity	MW	A1	120,0	120,0	…	120,0	120,0
	E. Factor	TCO2/GWh	d1	641,0	641,0	…	641,0	641,0
Marginal Plant 2	Energy	MWh	B2	-	-	…	-	-
	Plan Name			TALTAL2	TALTAL2	…	TALTAL2	TALTAL2
	Capacity	MW	A2	120,0	120,0	…	120,0	120,0
	E. Factor	TCO2/GWh	d2	641,0	641,0	…	641,0	641,0
Marginal Plant 3	Energy	MWh	B3	-	-	…	-	-
	Plan Name			VENT2	VENT2	…	VENT2	VENT2
	Capacity	MW	A3	212,0	212,0	…	120,0	120,0
	E. Factor	TCO2/GWh	d3	1.025,0	1.025,0	…	1.025,0	1.025,0

Every Thermal Plant has its own tCO2/GWh conversion factor according to its specific consumption and type of fuel. The emission factors can be calculates using CNE node price report and IPCC manual (see Exhibit 1 below).

Exhibit 1

PLANT NAME	CAPACITY in MW	TCO2/GWh
ACONSTITUCION Arauco	20	0
CONSTITUCION Gener	9	982
LAJA	9	0
PETROPOWER	49	879
ARAUCO	101	0
NUEVA RENCA	379	396
NEHUENCO 2	380	353
NEHUENCO	352	396
CENTRAL SAN ISIDRO	370	422
GUACOLDA 1	152	886
GUACOLDA 2	152	886
TALTAL 1	120	641
TALTAL 2	120	641
VENTANAS2	212	1025
BOCAMINATV	125	925
VENTANAS1	120	1071
NEHUE.9B	100	604
HUASCOTV	16	1829
LAGVERDE	55	2194
SAN FRANCISCO M.	24	982
DIEGO DE ALMAGRO	24	1071
RENCA	100	1150
HUASCOTG	64	1150

Calculated from CNE Node price report and complemented with IPCC manual

The "Theoretical Dispatch without CDM Projects" and Emission Displacement

Without Chacabuquito and other CDM projects, the marginal dispatched plant should increment its generation to supply the system demand in each hour. Since the generation from the marginal plant has a capacity limit, and if it is insufficient to meet the demand, a next power unit must be dispatched in the economic merit order priority to supply the required energy to meet the system demand. And if still there is not sufficient energy with the next marginal plant, then another unit must be dispatch following the same order.

In order to determine the Chacabuquito energy and emission displacement, it must be accounted all other CDM units of the system, since Chacabuquito is the first CDM project in the system.

The following table presents an example how the dispatch should change and the energy displacement that both Chacabuquito and other CDM projects will produce in the system

				H1	H2	...	H23	H24
CDM N°1 (CHACABUQUITO)		Energy in MWh	C1	19,0	18,0	...	17,0	17,0
		Capacity in MW		26,0	26,0	...	26,0	26,0
CDM N°2		Energy in MWh	C2	40,0	40,0	...	40,0	40,0
		Capacity in MW		55,0	55,0	...	55,0	55,0
Marginal Plant 1	Energy	MWh	B1	97,0	80,0	...	116,0	117,0
	Plan Name			TALTAL1	TALTAL1	...	TALTAL1	TALTAL1
	Capacity	MW	A1	120,0	120,0	...	120,0	120,0
	E. Factor	TCO2/GWh	d1	641,0	641,0	...	641,0	641,0
Marginal Plant 2	Energy	MWh	B2	-	-	...	-	-
	Plan Name			TALTAL2	TALTAL2	...	TALTAL2	TALTAL2
	Capacity	MW	A2	120,0	120,0	...	120,0	120,0
	E. Factor	TCO2/GWh	d2	641,0	641,0	...	641,0	641,0
Marginal Plant 3	Energy	MWh	B3	-	-	...	-	-
	Plan Name			VENT2	VENT2	...	VENT2	VENT2
	Capacity	MW	A3	212,0	212,0	...	120,0	120,0
	E. Factor	TCO2/GWh	d3	1.025,0	1.025,0	...	1.025,0	1.025,0

MDL N°1 (CHACABUQUITO)							
MWh Displacement							
Marginal Plant 1	min(C1, (A1-B1) - D21) =	D11	-	-	...	-	-
Marginal Plant 2	min(C1-D11; (A2-B2) - D22) =	D12	19,0	18,0	...	17,0	17,0
Marginal Plant 3	min(C1-D11-D12; (A3-B3) - D23) =	D13	-	-	...	-	-
TCO2 Displacement							
	d1*D11+d2*D12+d3*D13 =	ER1	12,2	11,5	...	10,9	10,9
MDL N°2							
MWh Displacement							
Marginal Plant 1	min(C2;(A1-B1) - 0) =	D21	23,0	40,0	...	4,0	3,0
Marginal Plant 2	min(C2-D21; (A2-B2) - 0) =	D22	17,0	-		36,0	37,0
Marginal Plant 3	min(C2-D21-E22; (A3-B3) - 0) =	D23	-	-	...	-	-
TCO2 Displacement							
	d1*D21+d2*D22+d3*D23 =	ER2	25,6	25,6	...	25,6	25,6

If other CDM projects are implemented in the system then, for each hour, the emission displacement should meet the following formulae, as stated on AM0026.

Emission Displacement for Operating Margin

$$ER(j) = \sum_{i=1}^{M} D(j,i) \times d_i$$

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

where:

- *Ai* .... Maximum energy generation of the marginal plant ***i*** in MWh/h (equivalent to plant capacity in MW)
- *Bi* .... Real Energy generation of the CDM marginal plant ***i*** in MWh/h
- *Cj* .... Real Energy generation of the CDM project ***j*** in MWh/h
- *N* .... Total number of CDM projects in the system
- *M* .... Total number of additional marginal plants that should be dispatched if the system is operated without the **N** CDM projects
- *D(j,i)* .... Energy displacement of the marginal plant ***i*** due to the CDM project ***j***
- *di* .... Emission Factor of the marginal plant ***i***

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

The calculation should be accounted in a recursive manner, starting from the latest CDM project to be implemented in the system (j=N, j=N-1, etc.).

In the event that the system is being dispatched at full capacity with all thermal units dispatched, and there is no extra marginal plant to be displaced, then this last plant will be considered to be the only marginal plant to be displaced by the CDM projects.

The Build Margin Calculation Worksheet

For the first crediting period, the Build Margin emission factor EF_{BM}, must be updated annually ex post for the year in which actual project generation and associated emissions reductions occur, accounting energy and emission form the power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

All generation data is obtained from CDEC-SIC as indicated on section 4.3. All power units in the system can be arranged chronologically with commissioning dates that can be obtained from CDEC-SIC or CNEs web page.

The following table presents an example how to calculate the Build Margin Emission Factor for the Chacabuquito project for a given year (2004)

		EF	Generation
Comm Date	Plant Name	TCO2e/GWh	GWh
...	...	...	...
1909	FLORIDA	800	138.314
1977	VENTANAS1	1.071	413.467
1977	VENTANAS2	1.025	1.050.510
1981	ANTUCO	800	1.662.081
1981	ARAUCO	800	156.044
1985	COLBUN	800	2.021.022
1985	CONSTITUCION Gener	982	50.265
1985	CURILLINQUE	800	627.902
1985	DIEGO DE ALMAGRO	1.071	6.236
1985	MACHICURA	800	453.530
1990	CANUTILLAR	800	1.094.674
1991	PEHUENCHE	800	2.567.234
1993	ACONCAGUA	800	371.391
1993	ACONSTITUCION Arauco	800	132.388
1993	ALFALFAL	800	840.860
1995	CAPULLO	800	74.237
1995	GUACOLDA 1	894	1.233.894
1995	GUACOLDA 2	894	1.235.076
1995	LAJA	800	39.483
1996	PANGUE	800	1.675.343
1996	SAN IGNACIO	800	182.344
1997	LOMA ALTA	800	276.888
1997	NUEVA RENCA	396	2.275.586
1997	PUNTILLA	800	118.339
1998	QUELTEHUES	800	357.697
1998	RUCUE	800	1.091.127
1998	CENTRAL SAN ISIDRO	424	2.705.618
1998	NEHUENCO	396	1.847.504
1998	PETROPOWER	879	526.035
2000	MAMPIL	800	173.898
2000	PEUCHEN	800	261.831
2000	TALTAL 1	641	624.403
2000	TALTAL 2	641	364.208
2002	NEHUE.9B	604	106.395
2003	CHOLGUAN	800	93.347
2003	NEHUENCO 2	412	1.996.332
2003	SAN FRANCISCO M.	982	9.380
2004	HORCONES TG	800	12.078
2004	LICANTEN	800	21.412
2004	P.VALDIVIA	800	153.204
2004	RALCO	800	1.332.259
2004	ANTILHUE TG	670	870
2004	ITATA	800	319
Energy SIC in MWh		**MWh**	**36.113.187**
Latest 20% of capacity additions		MWh	7.523.475
Emissions of Latest 20%		TCO2e	2.733.499
EF_BM			363

SUSTAINABLE DEVELOPMENT MVP

This Section of the MVP establishes a protocol for monitoring and verifying the performance of the project with respect to sustainable development. Being a CDM activity, Chacabuquito run-of-the-river hydro project must meet the requirements of the Kyoto Protocol Art. 12 for CDM projects. The Government of Chile has endorsed the Chacabuquito project as an eligible CDM activity.

This sustainable development part of this MVP seeks to ensure that the project meets the expectations with regard to its contribution to environmental sustainability as well as development over its lifetime. For this purpose, the MVP identifies a set of performance indicators as well as target values for these indicators, which the project is expected to meet or exceed.

Monitoring Sustainable Development

The MVP compares the project's actual environmental and development performance as measured by the indicators below with the set target values and determine whether the targets have been reached. As long as the monitoring process shows that the project's performance meets these targets and if this is confirmed by the verifiers, the project is automatically considered to be in compliance with the CDM's sustainable development objective - and so are the ERs generated by the project. If the host country sets targets for sustainable development and if the project's performance falls short of any of the set targets, it is the prerogative of the host Government to decided whether the project is still considered to meet the CDM's sustainable development objective. In the case of Chacabuquito project, the Chilean Government has not set any sustainable development targets.

The following local environmental benefits have been identified from the project

The following local environmental benefits have been identified from the project (see Chile Chacabuquito Project Environmental Impact Executive Summary for more details).

- The project will contribute with clean energy for the Central Interconnected System of Chile, displacing thermal generation
- 18 hectares of reforestation with local native trees.

The direct social and development impact of the project are as follows (see Chile Chacabuquito Project Environmental Impact Executive Summary for more details).

- Two new bridges and new access roads for semi-isolated villages in the region.
- Job creation during the construction period and also during the operation
- Economic activity during the construction period and also during all of its lifetime.

Monitoring, Recording and Reporting

Of the environmental, social and developmental impacts identified for the project in Section 5.1, the following two sustain beyond the construction phase of the project:

- Job creation during the operation of the power plant, particularly for the local community
- Increase in economic activity due to the Chacabuquito power plant.

Table 5.1 shows the worksheet for recording and reporting on sustainable development impacts. The first part records the expected developmental impacts during the construction phase of the project. It is expected that these targets for development impact will be met by the time of the initial verification for the project. The second part of the worksheet tries to document the impacts that sustain beyond the project construction phase.

Table 5.1 Sustainable Development Performance – Summary Sheet

Performance indicator	Performance indicator	Data collection responsibility	Project performance (unit)	Project expectations (unit)	Net perform-ance and compliance (unit, yes/no)
DURING PROJECT CONSTRUCTION PHASE					
Socio-Economic					
Reforestation	Land afforested by native species	HGV	hectares	18	
Construction	Construction of bridges to facilitate communication by local community	HGV	numbers	2	
AS A RESULT OF OPERATION OF THE PROJECT					
Socio-economic					
Job creation	Number of jobs created within Chacabuquito plant	HGV	numbers	*	
Increase on Economic activities	Description of the increase in economic activity in the region due to Chacabuquito plant.	HGV	descriptive	*	

MANAGEMENT AND OPERATIONAL SYSTEMS MVP

In order to ensure a successful operation of the Chacabuquito run-of-river hydro power plant and the credibility and verifiability of the ERs achieved, the project must have a well defined management and operational system. It is the obligation of the operator to put such a system in place for the project. It must include the operation and management of the monitoring and record keeping system that is described in this MVP. The proper functioning of the Chacabuquito management and operational system must be monitored by the operator and will be subject to third party verification as far as the ability of the project to generate credible ERs is concerned. Therefore, the project management responsibilities that concern this MVP are outlined in this section.

Allocation of Project Management Responsibilities

The management and operation of the project is the responsibility of Hidroeléctrica Guardia Vieja (HGV), the project operator. Ensuring the environmental credibility of the project through accurate and systematic monitoring of the project's implementation and operation for the purpose of achieving trustworthy ERs is the key responsibility and accountability of the operator as far as this MVP is concerned. For calculating the ERs, the operator, HGV shall rely on data published periodically by CNE and CDEC based on the actual operation of the SIC, including in that report the hourly generation for each power unit and the marginal cost for each hour.

Independent verifiers will periodically audit the operator and his management systems to ensure credibility and transparency of the reported ERs and other performance indicators of the Chacabuquito project.

For the time the IBRD has an interest in the project, the IBRD has the responsibility to ensure the credibility of the generated ERs, arrange for periodic verification in line with the Kyoto Protocol requirements and modalities for the CDM and other relevant rules, to receive the verified and certified ERs and to pay the operator as agreed.

Management and Operational Systems

It is the responsibility of the operator to develop and implement a management and operational system that meets the requirements of the project and of this MVP. The MVP can only offer general guidance in this regard. This includes:

Data handling

The establishment of a transparent system for the collection, computation and storage of data, including adequate record keeping and data monitoring systems. The operator must develop and implement a protocol that provides for these critical functions and processes, which must be fit for independent auditing.

For electronic and paper based data entry and record keeping system, there must be clarity in terms of the procedures and protocols for collection and entry of data, use of workbooks and spreadsheets and any assumptions made, so that compliance with requirements can be assessed by a third party. Stand-by processes and systems, e.g. paper based systems, must be outlined and used in the event of and to provide for the possibility of system failures. The record keeping system must provide the paper train that can be audited.

Quality assurance

The operator, HGV, must designate a competent manager who will be in charge of and accountable for the generation of ERs including monitoring, record keeping, computation of ERs, audits and verification. He or she will officially sign-off on all GHG Emission worksheets.

Well-defined protocols and routine procedures, with good, professional data entry, extraction and reporting procedures will ease time and costs, while making it considerably easier for the auditor and verifier to do their work - the more organized and transparent the organization the easier to track, monitor, verify and audit.
Proper management processes and systems records must be kept by the operator, HGV, as the auditors will request copies of such records to judge compliance with the required management systems. Auditors will accept only one set of official information, and any discrepancies between the official, signed records and on-site records will be questioned.

Reporting

The operator will report regularly to the IBRD as well as to Chilean authorities as required by them.

The operator must transmit copies of completed worksheets to the IBRD on a regular basis while maintaining

originals on file.

The operator, HGV, will prepare reports as needed for audit and verification purposes.

The project should prepare a brief annual or biannual report which should include:

- Information on overall project performance,
- Emission reductions generated and verified and comparison with targets,
- Observations regarding MVP baseline scenario indicators,
- Compliance with sustainable development targets,
- Information on adjustment of key MVP assumptions concepts,
- Calculation methods and other amendments of the MVP and the monitoring system.

The report can be combined with the periodic verification report.

Training:

It is the responsibility of the operator to ensure that the required capacity and internal training is made available to its operational staff to enable them to undertake the tasks required by this MVP. Initial staff training must be provided before the project starts operating and generating ERs.

Verification and commissioning:

The management and operational system and the capacity to implement this MVP must be put in place before the project can start generating ERs.

This will be verified before the project is commissioned by the IBRD to generate ERs that the IBRD will accept.

The following Table summarizes the roles and responsibilities of the various project partners with regard to the monitoring system.

Table 6.1 MVP Management and Operation System: Roles of Project Partners

	HGV	IBRD
Monitoring system	Review MVP and suggest adjustments if necessary Develop and establish management and operations system Establish and maintain monitoring system and implement MVP Establish or confirm sustainable development indicators and performance targets Prepare for initial verification and project commissioning	Review monitoring and management system Ensure project meets requirements and safeguards Arrange for initial verification
Data Collection	Establish and maintain data measurement and collection systems for all MVP indicators Check data quality and collection procedures regularly	Review data collection systems
Data computation	Enter date in MVP workbooks Use MVP workbooks to calculate emission reductions	Review completed worksheets
Data storage systems	Implement record maintenance system Store and maintain records (paper trail) Implement sign off system for completed worksheets Forward monthly and annual worksheet outputs	Receive copies of key records and reports Maintain IRBD records
Performance monitoring and reporting	Analyze data and compare project performance with project targets Analyze system problems and recommend improvements (performance management) Prepare and forward periodic (monthly) reports	Review reports Evaluate performance and assist with performance management
MVP Training and Capacity	Develop and establish MVP training, and skills review and feedback system Ensure that operational staff is trained and	Assist with MVP training and capacity building

	HGV	IBRD
Building	enabled to meet the needs of this MVP	
Quality assurance, audit and verification	Establish and maintain quality assurance system with a view to ensuring transparency and allowing for audits and verification Prepare for, facilitate and co-ordinate audits and verification process	Supervise projects Arrange for periodic verification

AUDITING AND VERIFICATION PROCEDURES

Audit and Verification Objectives

Periodic auditing and verification of project results is a mandatory component for all CDM projects and a IBRD requirement. The chief objective of the audit is to independently verify that the project has achieved the emission reductions reported by the operator. Audits are an integral part of the verification process and are undertaken in conjunction with verification and by the same firm.

This section of the MVP outlines the auditing and verification procedures and prerequisites. It provides instructions on how the monitoring work undertaken by the project operator in line with this MVP as well as project performance and compliance with CDM requirements will be verified.

The IBRD Audit and Verification Regime

The IBRD submits every project to third party validation and verification, which is conducted by independent firms specializing in environmental auditing services (auditors, validators, verifiers, certifiers). IBRD expects that its auditors will seek accreditation under the Kyoto Protocol regime for providing these services. The IBRD verification system for CDM projects consists of these four activities:

Validation of project design

IBRD projects undergo validation of the project's design, baseline and MVP against CDM requirements and modalities. Validation is a CDM requirement. IBRD will not implement a project unless a validator has confirmed that the project design is in compliance with all relevant CDM requirements. Validated MVP for a project must be followed by the project operator. This MVP can be adjusted or amended, if necessary, in order to improve consistency with its objectives, general concepts and project circumstances, subject to approval by the project verifier. A renewal of validation is not necessary in this case.

Initial audit and verification of project readiness

The IBRD requires that each IBRD project successfully completes an initial audit and verification process before the IBRD will commission the project and accept emission reductions delivered by it. While initial verification is not a CDM requirement, the IBRD regards it as an essential and the final step in the IBRD project preparation and implementation cycle. To prevent conflicts of interest, verification must not be conducted by the same firm and individuals that have provided validation services for the project. But the initial auditor / verifier can (and should) also provide subsequent verification services to the project. Initial verification provides an opportunity

for verifiers to become familiar with the project, its context, the project operator and management.

The purpose of the initial audit and verification process is threefold:

- Ensure that the project has been implemented as planned, that the monitoring system is in place and that the project is ready to generate and record GHG emission reductions.
- Approve adjustments and amendments to the MVP that may have become necessary during the detailed design and construction of the project.
- Assist meeting IBRD supervision obligations and clear the way for project commissioning and generation of high quality ERs.

During initial verification auditors are expected to do the following. They will:

- Familiarize themselves with the project and project circumstances,
- Introduce the project staff to the audit and verification process,
- Check whether the project has been implemented as planned,
- Check whether assumptions that have an impact on the monitoring and verification processes and its outcomes are still reasonable, in particular baseline assumptions,
- Confirm system readiness: that the MVP has been implemented in the project's management and operational procedures and that all necessary monitoring elements are in place to ensure generation of verifiable emission reductions.

Periodic verification of emission reductions

All IBRD projects must undergo periodic audits and verification of emission reductions. This is a CDM requirement and the basis for issuance of Certified Emission Reductions (CERs) and for their value in the market place. Verification is arranged for by the IBRD and conducted at annual or longer intervals as appropriate for the project.

The purpose of periodic audits and verification is to confirm that:

- The project has achieved the ERs claim for the verification period in compliance with the methodology laid down in this MVP.
- The claimed ERs are real and additional to any that would have occurred in the baseline scenario as interpreted and developed in the Baseline Study and this MVP.
- The operation of the project continues to be in compliance with all Kyoto Protocol, IBRD and host country requirements and modalities for CDM projects.
- The project maintains a high quality monitoring systems consistent with the MVP.

As part of the periodic audit and verification process auditors are expected to:

- Review and audit relevant monitoring records and reports,
- Verify that the required measurements and observations have been made for all monitorable indicators in this MVP,
- Check whether the MVP methodology has been applied correctly and consistently
- Check whether achieved ERs have been computed correctly using the provided spreadsheets, and, if

necessary, recalculate achieved ERs,
- Verify that all relevant MVP and baseline assumptions are still valid,
- Verify that the management and monitoring system, including data handling, record keeping and reporting, is in place and remains adequate,
- Verify that the social and environmental targets in this MVP have been met and that the project assists the host country in achieving sustainable development,
- Consult with the operator on the continued adequacy of the monitoring system and approve any modifications that need to be made to ensure a high quality monitoring operation.
- Undertake any other activities required by this MVP, by the Kyoto Protocol requirements and modalities for the CDM, by the appropriate host country authorities or by professional auditing and verification standards and practice.

Verification concludes with a formal verification report. The report may include a statement that may permit the renewal of the project's crediting period in line with applicable CDM rules and modalities.

Certification of emission reductions

A successfully completed verification process and the related verification report provide the basis for the issuance by the verifier of an emission reduction certificate. The certificate is a legally binding statement which confirms the (successful) verification report's conclusion that has project has achieved the stated quantity of ERs in compliance with all relevant criteria and requirements. The verifier's certificate constitutes sufficient confirmation for the IBRD as to the project's emission reduction performance.

The certificate is issued by the verifier for the project only and it does not automatically constitute or create Certified Emission Reductions (CERs) in the sense of Art. 12 Kyoto Protocol. However, the verifier's certificate may be used by the IBRD and/or Chilean authorities or authorized entities in the process of issuance and registration of CERs by the competent authority in line with applicable CDM and Kyoto Protocol modalities and procedures.

Auditing Criteria and Needs

Verification includes an audit of the project's output information and data and management systems on the basis of the following established criteria:

- Completeness
- Accuracy
- Coverage
- Risk Management Controls

Auditors / verifiers will request information (in the form of records and documentation) from the operator to determine if key performance indicators meet the objectives of the project as set out in this document. The operator is required to record all such indicators, and provide satisfactory documentation and an audit trail for verification purposes (see, for instance, the recommended protocols on recording diesel purchases and consumption for the operator, generation and sales records, etc.). The information that will be needed includes

- **Records on reported GHG emission reductions** including the electronic spreadsheets / workbooks

and supporting documentation (assumptions, data estimations, measurement methods, etc)

- **Records on reported social and environmental performance** as measured by indicators and targets laid down in this MVP
- **Records on project management,** including monitoring, data collection and management systems

The audit process followed, as with other management systems, is interactive, iterative and participatory. The auditors will determine the credibility and accuracy of the reported performance through spot checks of data measurement and collection systems and interviews with the key project participants. It is necessary for all involved in an audit to understand the audit process and verification requirements.

Audit and Verification Process

Audits procedures used to verify CDM projects are similar to audits of other environmental management systems (ISO 14000, EMS) and should complement these established processes. Principle audit tools are spot check of documents and interview with participating organizations and individuals. Auditors/verifiers are generally free to apply any method that represents good auditing practice and internationally accepted standards. Auditors typically conduct risk-based spot checks, which are checks of the key parameters and systems with the highest risks for data measurement and collection problems. The planning and scheduling of audits and the verification process is covered in this section.

Audit preparation and requests for information

The auditor will familiarize himself with the project documentation, project reports, project requirements and expected project performance. The auditor will use this MVP to prepare the audit process. He will make telephone contact with the operator, and if necessary, will request additional information from the operator, the IBRD and other project partners. Two weeks should be allowed for the receipt of this information.

Development and delivery of an audit checklist

The auditor will develop a checklist to guide the audit process. The checklist will cover the key points of the audit. The checklist will be sent to the operator (auditee) accompanied by explanatory materials prior to a site visit. Two weeks should be allowed for review, comments and preparation by the auditee.

The audit

A visit will be made to the site to undertake the audit. The length of the audit visit is to be agreed between HGV and IBRD and depends on the complexity of the project and its monitoring system and on previous performance of an experience with the project and the project operator. Audits on site require normally more than two days. The audit time will be spend checking records and undertaking interviews with staff and other individual, which will allow the auditor to complete the audit checklist. These activities are the basis for completing the verification process and for preparing the verification report.

Audit and draft verification reports

The auditor will produce an audit report and a draft verification report, which summarizes the audit findings. The draft verification report will state the number of ERs achieved by the project and will point to areas of possible non-

compliance if warranted. The report will also include conclusions on data quality, the projects monitoring and management and operational system, and other areas where corrective action may be required to come into compliance, improve performance or mitigate risks. The draft report will be submitted to the IBRD, a copy will be sent to the operator. Both parties will be given opportunity to comment on the report. The operator will also have the opportunity to come into compliance, if necessary, by submitting the appropriate evidence or by taking corrective action.

Final verification report:

The auditor will revise the draft report taking into consideration reviews, comments and further findings and issue the final verification report, if possible within two weeks of receiving all comments. If justified, the final verification report will conclude and explain that, within the verification period, the project has generated the stated quantity of ERs in compliance with all applicable CDM and other requirements. The final verification report is the basis for the issuance of a certificate by the verifier, which will state and confirm the conclusions of the report.

Non-compliance and dispute settlement

In the event of non-compliance findings, the auditee will be given sufficient time to demonstrate compliance. An eight week period from the issuance of the draft report is recommended for the operator to address identified deficiencies and come into compliance. It is the responsibility of the verifier to ensure that dispute over any non-compliance issue is communicated clearly and that any attempt is made to resolve it. The verifier will have final decision over the process. The verifier will also provide guidance as appropriate on how identified deficiencies can be met so that the operator can come into compliance in the following period.

Audit and verification schedule:

Audits and verification of the project will be conducted annually at first, then at intervals over the life of the project. The audit schedule will be determined by the IBRD in consultation with auditors and the project operator. Audit intervals will depend on audit outcomes and experience with the project's performance and compliance with the MVP, the quality of its monitoring management and operational systems, and the type and number of corrective actions required by the verifier.

Roles and Responsibilities

Audit responsibilities are allocated between the project participants as follows:

The IBRD

- The IBRD will make the arrangements for the audit and select a third party auditor/verifier in accordance with IBRD requirements and selection criteria and in consultation with the relevant host country CDM authority.
- It is the IBRD's obligation to ensure that the audit process is fair, that auditors/verifier are fully independent of the project operator and that and all possible conflicts of interests are avoided. The IBRD requires details of the experts to be used on the audit/verification team, and holds the right to veto unsuitable individuals.

- The IBRD will facilitate the audit work and verification process and will work with the project participants to ensure co-operation.

Project operator, HGV:

- The operator will prepare for the audit and verification process to the best of his abilities.
- He will facilitate the audit through providing auditors with all the required information, before, during and, in the event of queries, after the audit.
- The operator will fully cooperate with the auditors and instruct his staff and management to be available for interviews and respond honestly to all audit questions.
- It is the operator's contractual obligation and in his best interest to fully cooperate with auditors and verifier, since only successful verification will enable him to deliver ERs to the IBRD in fulfillment of his contract with the IBRD.

Auditor / verifier:

- The auditors for the project must be a professional organization with a proven track record in environmental auditing and verification, experience with CDM projects and work in developing countries. The audit firm must guarantee professional work and assure the quality of the audit and verification team.
- The auditor / verifier must undertake the audit to the best of their professional ability. The auditor's responsibilities include to
  a) Provide the checklists and request for information in good time,
  b) Allow adequate time for sufficient review and preparation,
  c) Provide publishable reports in the agreed format,
  d) Work with the operator, host country authorities and PCF as appropriate,
  e) Report on lessons learnt during the course of the project.