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:

>>

Mariposas Hydroelectric Project
Version 4.4
Version date: 29/06/2010

A.2 Description of the project activity:

>>

The Mariposas Hydroelectric Project, or hereafter the Project, consists of the construction and operation of a Run-Of-River hydropower plant of 6.3 MW. The Project will use the waters of first section of the Maule Norte Alto canal, in the San Clemente commune, Province of Talca, VII Region del Maule, at about 40 km southeast of Talca city, and 250 km south of Santiago. The project will be able to generate in average about 40 GWh per year (72.5% plant factor), and its commercial operation is expected on late 2010.

The Mariposas Hydroelectric Project will operate with one vertical Compact Axial Turbine (CAT) connected directly to a synchronous generator, obtaining an installed total power of 6.3 MW. The generator will connect to a power transformer elevating the voltage from 6.6 KV to 69 kV in the Mariposas substation. The Project electric generation will be supplied to the Central Interconnected Grid (Sistema Interconectado Central in Spanish, hereafter SIC) by a single-circuit 69 kV transmission line, connecting the Project to the existing Lircay substation at 7 km north from the Mariposas powerhouse. Total Project Investment costs is estimated in US$ 18.1 million.

The aim of the Mariposas Hydroelectric project is to generate electricity from renewable hydrological resources, using water utilized by the local community for irrigation purposes. The development of the Project however, does not affect the local irrigators since the water used for generating electricity will be restored to the same irrigation system, before the local community uses it.

The Mariposas Hydroelectric Project will directly reduce greenhouse gas emissions produced by thermal electric plants, fired with fossil fuels, that are currently in operation in Chile. With an average annual generation of approximately 40 GWh, the Project will reduce emissions by 21,000 tons of CO_2e per year.

The Mariposas Hydroelectric Project will be developed by Hidroeléctrica Río Lircay S.A., related to Hidromaule S.A.[1], company formed on June 2005 with the aim to develop small hydro projects in Chile. Its first project is the Lircay Run-Of-River Project (CDM Project id 2417), which started with the agreement between Hidromaule S.A. and Asociación Canal Maule (ACM).

---

[1] Hidromaule S.A. has de same shareholders that Hidroeléctrica Rió Lircay S.A., however they do not have equity participation on each other.

In October of 2009 Hidroeléctrica Río Lircay S.A. and ACM signed the agreement for water rights use for the Mariposas Hydroelectric Project, which state a non consumptive water use of 20 m^3/s for electric generation purposes.

ACM consist of near 2,200 independent local irrigators with consumptive water rights in the Maule basin for about 54.3 m3/s, who have agreed the construction of the Project and use 20 m^3/s as non-consumptive water rights, subject to annual payments for the use of the water rights.

Since The Mariposas Hydroelectric Project is only a 6.3 MW power unit, it is to be considered under the Chilean legislation as Non-Conventional Generation Means (MGNC in Spanish), as per article 79 of the Chilean General Electric Service Law Directive (DFL4/2006), published on 17/01/2006 in the Official Gazette (available at **www.bcn.cl**). Also, under the CDM scheme, the project is considered a small scale project activity.

The Mariposas Hydroelectric Project was submitted to the Environmental Impact Assessment process on January 2009, through an Environmental Impact Statement (DIA in Spanish), not requiring a full Environmental Impact Assessment Study due to its low environmental impact. The Environmental Authority, CONAMA, formally approved the Project on 29/05/2009. Under the document *Resolución Exenta N° 139, COREMA VII Región del Maule*. A slight modification of the Project was submitted for Environmental Impact Assessment process, being this officially approved on 22/07/2010 through *Resolución Exenta N° 135*, COREMA VII Región del Maule.

The Mariposas Hydroelectric Project contributes to the sustainable development in Chile through:

- Use of local renewable energy resources (small hydro) to displace coal, diesel and natural gas thermal power generation in the SIC.
- Increased commercial activity through clean and renewable source of power.
- Employment generation in the 7th Region where the project is located, improving economic benefits to the surrounding communities which have a high rate of unemployment and poverty.
- Improvement of the ACM irrigation system (near 2,200 irrigators), through annual payments for the water rights.
- Demonstrations of finance and development of renewable energy projects through a small startup company using CDM as a relevant finance source.

The Project's local environmental and socio-economic benefits are summarized in Table A.1.

Table A.1: Domestic and local benefits

Area	Description
Local environmental benefits	• The project will contribute with clean energy for the SIC Grid of Chile, contributing to national development.

Socio-economic benefits	• A total of 250 local jobs will be created during the construction phase of the Project, with an average of 40 place jobs per month during the construction, and 5 permanent jobs during its operation, positively impacting the surrounding communities of San Clemente, Pelarco, Colbún, Linares, Curicó and Talca, which have a high level of rural population, poverty and unemployment compared to the national average. • Increased economic activity during the construction period and during all of its lifetime. • Annual payment to Asociación Canal Maule (ACM) for the water rights that will benefit near 2,200 irrigators through improvements in their irrigation system that extends in near 1000 km in the Maule valley.
Technology transfer	• Introduction and demonstration of environmentally friendly power production techniques for the 7th Region is an explicit objective of the project. • The demonstration that emission reductions obtained from renewable energy can earn additional income and the introduction of CDM know-how is expected to raise environmental awareness. • Demonstration on how small start-up companies can finance and develop a project with these CDM incentives.
Environmental Impact Assessment (EIA)	• Since the Project is a small hydro project, considered with low environmental impact, it only required an Environmental Impact Statement (DIA), in accordance with Chilean environmental law 19,300 and approved by CONAMA in December 2000. • The Project was submitted to the Environmental qualification process on 13/01/2009, and was approved on 29/05/2009. (Resolución Exenta N° 139 COREMA VII Región del Maule). A modification of the project was submitted for Environmental Impact Assessment process, being this officially approved on 22/07/2010 through Resolución Exenta N° 135, COREMA VII Región del Maule. Full DIA and Project commitments can be downloaded from the national environmental impact assessment system at **www.e-seia.cl**

A.3 Project Participants:

>>

Table A.2: Project Participants

Name of Party involved(*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants(*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Chile (Host Party)	• Hidroeléctrica Río Lircay S.A.	No
Other (To be defined)	• No purchasing parties have been engaged yet	-

(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.

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.:

>>

VII Región del Maule

A.4.1.3. City/Town/Community etc:

>>

Provincia de Talca, Comuna de San Clemente

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

>>

Mariposas Hydroelectric Project is located in the 7th Region of Maule, Chile, at about 40 km southeast from Talca city and 250 km south from Santiago.

The Project’s intake is placed in the Maule Norte Alto canal, and the Powerhouse facilities are placed in Bramadero sector.

The water’s restoration take place through a tailrace channel, delivering the water to the Mariposas canal, restoring the water to their previous course, where it is used for the local community to irrigate their fields.

The project coordinates are:

Table A.3: Project Coordinates (Geographic Coordinate System, WGS84, Zone 19, Southern Hemisphere)

	Latitude	Longitude
Intake	35°35’49.2" S	71°15’43.2" W
Power house	35°35’45.6" S	71°15’50.4" W

Figure A.1: Geographic position

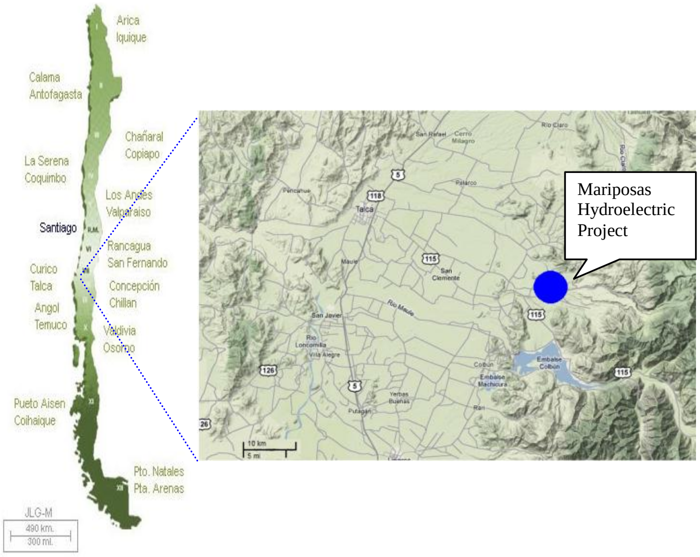
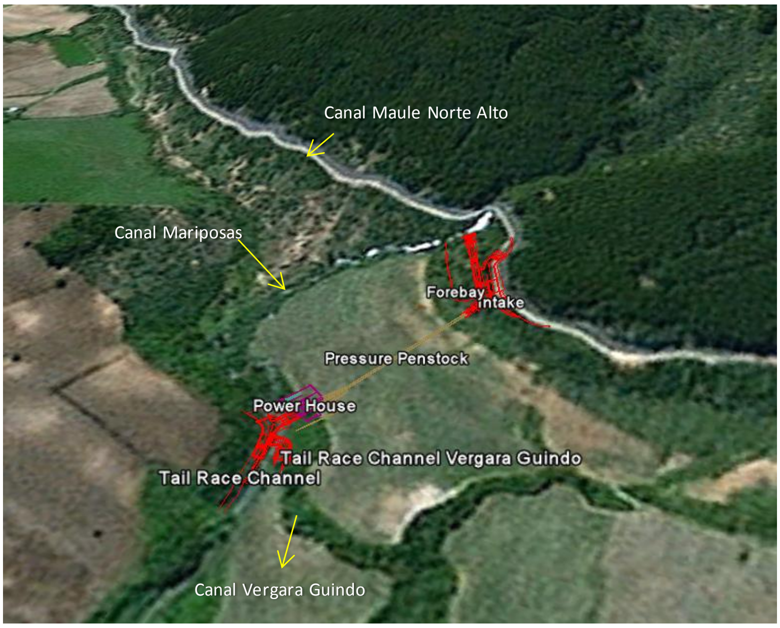


Figure A.2: Satellite view of the project



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

>>

The Mariposas Hydroelectric Project falls into:
Scope number: 1
Scope: Renewable Energy, Run-of-River Hydropower

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

>>

Electric power generation will be accomplished through well-proven technologies. The project considers the construction of: a water intake in the Maule Norte Alto canal with 20 m^3/s design flow, a pressure penstock with 36.4 meter head, a power house with a vertical Compact axial Turbine of 6.3 MW, a 6.6 kV generator of 7 MVA (6,959 KVA as in nameplate), a 6.6 to 69 KV power transformer of 7.5 MVA and 7 km of a single circuit 69 kV transmission line, which connects the project to the SIC grid through the existing Lircay substation.

Table A.4: Project Details[2]

PHYSICAL INFRASTRUCTURE	POWER PLANT
• 1 vertical Compact Axial Turbine and • 1 power generator of 7 MVA • Design flow: 20 m^3/s • 36.4 m head • 1 power transformer of 6.6 to 69 KV and 7.5 MVA capacity • 69 KV power substation • 7 km, 69 KV transmission line • 72.5% plant factor	• Capacity: 6.3 MW • Average Net Generation: 40 GWh/year. • Located 40 km southeast from Talca city and 250 km south from Santiago • Construction time: 11 months • Estimated cost: US$ 18.1 million

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

>>

Projects 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 s

[2] Project details are based on the projects engineering calculations before the project actual implementation. After the project final implementation, these values may have minor changes that will not have significant impact on the project generation or its installed capacity.

tated in AM0026.

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 Mariposas Hydroelectric Project in the generation mix in the SIC. The monitoring and verification plan for the project utilizes the data provided by CDEC-SIC.

The BM emission factor will be determined in an ex-post basis as the generation-weighted average emission factor (tCO2/MWh) of all power units during the most recent year for which power generation is available on 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 441,000 tons of CO2e over 21 years (i.e. during three renewable seven-year crediting periods). This is approximately 21,000 tCO2e per year.

Table A.5: Estimated amount of emission reductions during the First Crediting Period

Years	**Annual Estimation of emission reductions in tons of CO_2e**
2010 (from 01/11/2010)	3,500
2011	21,000
2012	21,000
2013	21,000
2014	21,000
2015	21,000
2016	21,000
2017 (until 31/10/2017)	17,500
Total Estimated Reductions (tonnes of CO_2e)	**147,000**
Total number of crediting years	**3 x 7 = 21**
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	**21,000**

A.4.5. Public funding of the project activity:

>>
No public funding is involved in the project activity. The fund used to financing is not diversion of ODA

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: "Baseline Methodology for zero-emissions grid-connected electricity generation from renewable sources in Chile or in countries with merit order based dispatch grid" (version 3), together with the "Tool to calculate the emission factor for an electricity system" (version 2) and the "Tool for the demonstration and assessment of additionality" (version 5.2).

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 Chilean Power sector.

The project meets every condition stated in the approved methodology.

The project:

- is connected to the central grid of Chile;
- is a run-off-river hydro power plant with no reservoirs;
- uses renewable sources to generate electricity; and
- fulfills all the legal obligations for this kind of projects, including applicable 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_2	Yes	Emission due to thermal power plant dispatch
		CH_4	No	
		N_20	No	
Project Activity	SIC thermal dispatch	CO_2	Yes	
		CH_4	No	
		N_20	No	

Project Boundary

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 in Figure B.1 below). According to CNE (**www.cne.cl**), the Northern Interconnected Grid (SING) compromises the regions I to II and accounts 24 percent of the total capacity. The SIC, where the Mariposas Hydroelectric Project is immersed, compromises the regions III to X and accounts 75 percent of the total capacity. The Aysen and Magallanes grids are located in the XI and XII regions, respectively, and account about one percent of the total capacity.

The generation mix capacity of the SIC comprises of 58% hydroelectric generation, 16% diesel, 17% coal, and the remainder from natural gas, wind and cogeneration (see Annex 3).

At present there are no electricity imports or exports of the SIC grid to other national or international grids. However, future system expansion may include interconnection to the SING grid or Argentina grid (SADI).

Figure B.1: Project Boundary

Chile Electric Grids **Sistema Interconectado Central – SIC**

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 the Chilean system, 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 (Comisión Nacional de Energía or CNE in Spanish) hereafter CNE, prepares an indicative expansion plan, which is used to calculating 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 Mariposas Hydroelectric Project boundary (which is the SIC grid) 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 Mariposas Hydroelectric Project is the continuing operation of the existing and future power plants, without the Mariposas Hydroelectric Project electricity generation, to meet the

actual electricity demand. In the project scenario the same electricity demand is met with the Mariposas Hydroelectric Project 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 produced by the displaced generation from the 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 information systems.

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.

CDM has been considered at an early stage of the project feasibility analysis. The feasibility report of the project showed that carbon credits sales are a relevant part of the project finance and essential to the project implementation. The following schedule shows some of the relevant milestones of the project development:

- January 2009, Hidroeléctrica Río Lircay S.A. submits the project for environmental qualification process.
- April 2009, Hidroeléctrica Río Lircay S.A. sent a letter to CONAMA, the Chilean DNA, indicating the prior consideration of CDM for Mariposas Hydroelectric Project in accordance of EB41 Annex 46, "Guidelines on the Demonstration and Assessment of Prior Consideration of the CDM - Version 01"
- May 2009, Hidroeléctrica Río Lircay S.A. starts negotiating with local banks for the financial closure of the project: Bice Bank, Santander Bank in Chile and the IFC, KFW Bank abroad.
- 29/05/2009 the Project gets its official environmental approval by COREMA (Comisión Regional del Medio Ambiente).
- 09/10/2009 Hidroeléctrica Río Lircay S.A. and Asociación Canal Maule signed the agreement for water rights use for the Mariposas Hydroelectric Project
- 19/11/2009 The Project achieves its financial closure with the BICE Bank (a local bank).
- November 2009, Hidroeléctrica Río Lircay S.A. sent to UNFCC the F-CDM-Prior Consideration Form for the Mariposas Hydroelectric Project, in accordance of EB 49, Annex 22 "Guidelines on the Demonstration and Assessment of Prior Consideration of the CDM - Version 03"
- 19/11/2009, Hidroeléctrica Río Lircay S.A. instructs ICAFAL (the Construction Company), to proceed with the Project construction.
- February 2010, Hidroeléctrica Río Lircay S.A. instructs Det Norske Veritas to proceed with the project validation

The following steps are used to demonstrate Mariposas Hydroelectric Project additionality. These steps are based on the latest “Tool for the demonstration and assessment of additionality” (version 5.2).

Step 1) Identification of alternatives to the project activity, based on the Chilean national authority indicative expansion plan; this step shows that Mariposas Hydroelectric Project is not the only alternative for the expansion of the system and nor the least cost alternative, which are combined cycle natural gas or diesel fired power plants, coal and hydro dams (non run-of-river). Step 2) Investment Analysis is included optionally, as per guidance of the “Tool for the demonstration and assessment of additionality” (version 5.2). This analysis is done through a Benchmark Analysis (Option III), showing that the Project is not financially attractive. Step 3) Barrier Analysis shows that the project faces several particular and identifiable barriers that other generation projects do not. Finally, Step 4) With a common practice analysis, other projects similar to Mariposas Hydroelectric Project were searched for, showing that there are no similar activities observed in the SIC, with the exception of those projects that have been submitted under, or are seeking, carbon finance under the CDM.

Additionality Assessment

- ***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 (Node 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. The investors uses the expansion plan as reference to take the investment decision, so the construction plan is a clear view the investment conditions of the system.

$$Min\left\{\sum Investment + Op\,\&\,MantCosts + VariablesCosts - ResidualValue\right\}$$

Following the previous rationale, the alternatives the proposed Project activity are:

a. The proposed Project Activity implemented, not undertaken as a CDM project

As it is supported later in this section, this alternative is not realistic for the project developer, since it is not economically attractive without CDM revenues.

b. Continuation of the current baseline for Chile, being this the implementation of fossil fuel power plants

The projected tendency in Chile is generally towards the continuation of large scale nonrenewable sources, as described in the step 4) common practice analysis.

- ***Step 2. Investment analysis (Sub-step 2b Option III. Benchmark analysis)***

Taking into account that the additionality of the Project is also justified by using the Barrier Analysis in the Step 3, supply of the investment information would not be necessary and therefore the analysis could jump directly from the Step 1 to Step 3. Nevertheless, it is considered also interesting to demonstrate that the Project Activity is economically or financially less attractive than other alternatives without additional revenues from the sale of emission reductions.

Sub-step 2a) Determine de appropriate analysis method

Since the proposed project will earn revenues from not only ER sales but also electricity sales, the simple cost analysis method is not appropriate. Instead, Benchmark analysis (Option III) will be applied.

Sub-step 2b) Option III. Apply Benchmark Analysis

The financial indicator for this analysis is the IRR, which is the most commonly used parameter to determine the investment decisions. According to the Chilean electric law (DFL 4/2006), the official rate of return for electric projects is 10%, used to determine Node Prices, transmission line and distribution investments. Based on this benchmark, calculation and comparison of financial indicator are carried out in sub-step 2c.

It should be noted that the IRR Benchmark is a conservative rate, applicable to the Chilean power sector where most of the projects investments come from large companies that benefit from scale economies, which is not the case of Mariposas Hydroelectric project that would require higher financing rates (Company scale barrier is analyzed in the in Step 3 Barrier analysis).

Sub-step 2c) Calculation and comparison of financial indicator.

Calculation and comparison of financial indicator of the Project is implemented according to the *Guidance on Assessment of Investment Analysi*s. According to the feasibility study of the project, the parameters needed for calculation of key indicators are the following.

Table B.2: Mariposas Hydroelectric Project Valuation Parameters

Installed Capacity	6.3 MW
Firm capacity	2.3 MW
Energy production (1)	40 GWh / year
Contract and Spot sales	70% at Node Price and 30% at Spot
Total Investment	USD 18.1 million
Operation Life	40 years
Income Tax	17%
Debt rate	4%
Avg. Node Energy Price (2)	56.20 USD/MWh
Avg. Spot Energy Price (2)	57.25 USD/MWh
Capacity Price	105.98 USD/KW-year
CERs Price	12 USD/CER
O&M costs	USD 0.29 million / year
Water rights costs	USD 0.08 million / year
Transmission toll	USD 0.12 million / year
Administrative costs	USD 0.20 million / year

Source: Hidroeléctrica Río Lircay S.A. according to the Mariposas Hydroelectric Project Feasibility Study

(1) Based on 40 years statistical average (1960 to 1999), resulting in 72.5% plant factor

(2) Average over 40 years of plant operation. As shown in the feasibility study and confirmed in the CNE Node Price Report, system prices tend to decrease in the mid and long term, because of the construction of new coal, natural gas and hydro power plants, thus reducing the more expensive operation of oil power in the SIC

In accordance with the Benchmark Analysis, if the financial indicators of the Project, such as the Project IRR, are lower than the benchmark, the Project is not considered to be financially attractive.

Table B.3: Financial Indicator Comparison

	IRR Over Assets	**NPV in USD x 1000 (10% discount rate)**
Project with ER Income	10.32%	442
Project without ER Income	9.22%	-985

Table B.3 shows the Project IRR of the Project with and without the sales of CERs. Without the sales of CERs the Project IRR is 9.22 percent which is lower than the financial benchmark. Thus the Project is not considered to be financially attractive.

However, taking into account the de additional revenues from CDM, the project IRR is 10.32 percent, which is higher than the financial benchmark. Therefore the CDM revenues enable the project to overcome the investment barrier and the additionality of the Project is demonstrated.

Sub-step 2d) Sensitivity analysis

The sensitivity analysis shall show whether the conclusion regarding the financial attractiveness is robust to reasonable variations in the critical assumptions. For the Project, four parameters where selected as sensitive factors to check out the financial attractiveness, plus a fifth parameter to see the

ER sales impact on the Mariposas Hydroelectric Project: 1) Total investment cost. 2) Hydrological impact during the first two years of operation. 3) Energy Node Prices during the six two years of operation. 4) O&M Costs. and 5) ER Sales

The results of sensitive analysis are shown in Table B.4 and Figure B.3 below.

Table B.4: Sensitive Analysis

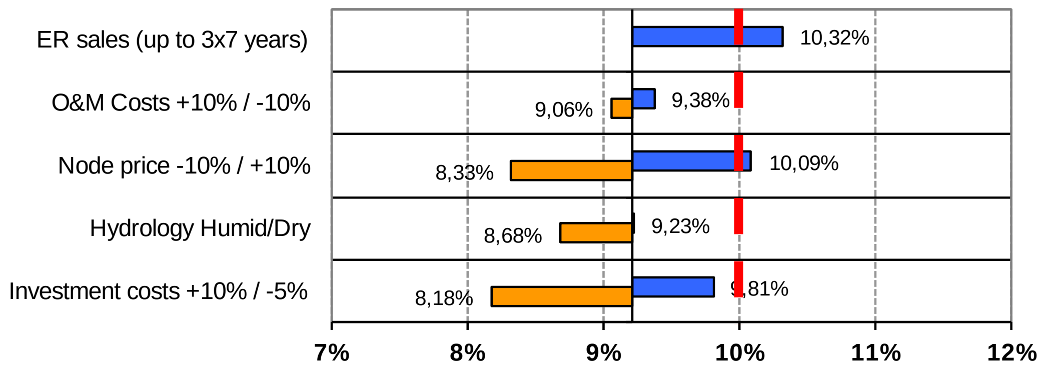
Sensitive variable	LOW	HIGH	To Benchmark
Investment costs	+10%	–5%	–6.5%
IRR over assets	**8.18%**	**9.81%**	**10.0%**
Hydrology variations	Humid	Dry	(see comment)
IRR over assets	**8.68%**	**9.23%**	**-**
Energy Node price	–10%	+10%	+9%
IRR over assets	**8.33%**	**10.09%**	**10.0%**
O&M Costs	+10%	–10%	–52%
IRR over assets	**9.06%**	**9.38%**	**10.0%**

Table B.5: ER sales impact

	IRR over assets
ER sales up to 2012	9.44%
ER sales up to 3x7 years	10.32%

Due the proximity of the year 2012, the ER sales up to 2012 have little relevance in the improvement of the IRR, so it becomes strictly necessary extend the ER sales up to 3x7 years in order to increase the IRR over the financial benchmark, as shown in Table B.5.

Figure B.3: Sensitive Analysis IRR Over Assets



The total IRR of the Project varies to different degrees in accordance with the fluctuation of the selected 4 parameters within the range of +8.18% to +10.09% if ER sales are not considered.

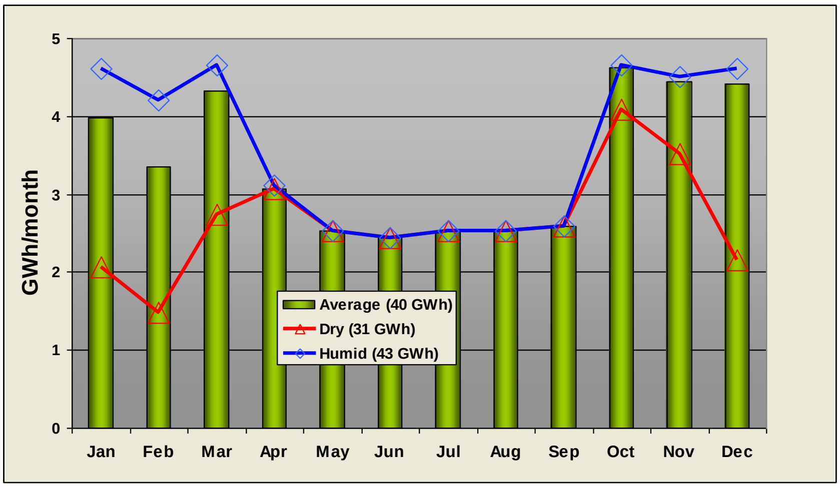
- Analysis over Node Price Variations:

Energy Node Prices sensitivity for the first five years of operation shows that an increase by 10 percent results in an increase of the Project IRR by 10.09%, positioning the Project IRR slightly over the financial Benchmark. To stay over the Benchmark it would be required an increase over the energy node prices of 9%. Below this level, the Project IRR would remain under the benchmark. It should be noted that Node Prices reflect a long term average of the system operation, considering most plausible capacity additions, available technologies and fuel prices. Taking into account that diesel fuel plants are gradually been replaced by lower cost plants such as coal, liquefied natural gas plants and hydroelectric plants, as shown in Annex 3, it is unlikely to expect un increase on long term system prices.

- Analysis over Hydrology Variations:

Hydrology variations do have impact in the IRR, however the effects are mostly negative and keeps the IRR below the Benchmark. Since it is unlikely that a hydropower project would face an extreme hydrological scenario for many years, the sensitivity analysis for hydrology variations only considers the first three years of operation facing a Dry or Humid condition. These first three years have the largest impact in the project Net Present Value and IRR, and show a realistic scenario over hydrology variations impacts. For the remaining years of this analysis, the project is expected to produce an average generation output (40 GWh/year). The Humid condition produces 43 GWh of energy generation and a Dry condition produces 31 GWh of energy generation (See figure B.5 Below). It is important to note that hydrological scenarios not only affect the project generation output but it is also inversely correlated with system spot prices, where low spot prices appear in Humid conditions (near 20 USD/MWh) and high spot prices appear in Dry conditions (near 150 USD/MWh). As it is shown in the table B.4 above, the Humid condition presents a more negative result compared to the average case. The Dry scenario, does not present a significant variation, where the lower generation is compensated by higher spot prices revenues. Still, both conditions, Dry and Humid, remain under the Benchmark of 10% IRR.

Figure B.5: Mariposas Hydroelectric Project Monthly Projected Generation



Source: Hidroeléctrica Río lircay S.A. estimate based on hydrological data for 39 years (1960 to 1999).

Since the Benchmark cannot be reached on any of the extreme conditions, a simplified example can show the unlikelihood of reaching the Benchmark: For the Dry scenario, it would be required a price increase of 55% of the system spot prices (232 USD/MWh as average for the first three years of operation in dry conditions). In the Humid scenario, it would be required an increase of near 515% in the average system spot prices to reach the 10% IRR Benchmark (123 USD/MWh as average price for the first three years of operation in humid conditions). In each case, such increase in the system prices are not likely to occur considering the latest CNE Node Price fixations reports (Oct-2008, Apr-2009, Oct-2009), all of which estimate a relatively stable result for the projected spot prices for the next 10 years of the system operation, with an average of near 55 USD/MWh.

- Analysis over O&M Costs Variations:

Compared with the total investment, the annual O&M cost has almost no impact on the IRR and can be regarded as an insensitive factor. To reach the Benchmark, O&M costs should be decreased by 52%.

- Analysis over Investment Costs Variations:

The investment costs have a relevant impact in the IRR. If the investment costs are increased by 10 % results in a decrease of the project IRR by 8.18%. In the opposite scenario, if the investment costs are decreased by 5%, results in an increase of the project IRR by 9.81%, but in both cases, the IRR remain under the Benchmark of 10% IRR .

It's highly unlikely that the investment costs can decrease more than 5%. This is explained due to the recovering of the raw material prices to levels before the crisis of October 2008, as shown in the data available in the London Metal Exchange web site (see section B.5 step 4a for a deeper explanation). The development of the engineering of Mariposas Hydroelectric Project is in the final stage, where all the basic engineering, electromechanical equipment is already defined and the contracts are already closed, thus the budget could not suffer great variations, except for possible contingencies as problems with soil mechanics or other unexpected difficulties that just would increase the investment costs instead of decreasing them.

Through the previous sensitivity analysis, it is clearly shown the relevance of the ER sales in the success of the Project. The additional revenues change substantially the IRR of the project, positioning the Project IRR over the Benchmark, thus evidencing the impact of these revenues on the investment decision, as shown in Table B.3, and Figure B.3.

- ***Step 3. Barrier Analysis***

The following barriers have been identified as the crucial barriers affecting the owners in undertaking the Project Activity.

  - **Sub-step 3a. Identification of barriers that would prevent the implementation of type of the proposed project activity:**

Water Availability Barrier:

Hydrology is one of the main barriers that run-of-river projects must face, that is not present on thermal technology projects, which are the least cost expansion alternatives indicated by CNE. As a result, there is no way the Project can mitigate against drought and low inflow periods. Consequently, Project incomes are highly variable.

However, besides the natural hydrology fluctuations the Mariposas Hydropower Project may suffer, the actual water distribution depends on the actual operation of the irrigation system. Canal Maule Norte is only one of many irrigation channels in the basin, and normally whenever there is difficulty to deliver the waters from the Canal Maule Norte Alto, this can be compensated to irrigators by delivering the water through other upstream or downstream channels or even through the main Colbún reservoir discharge. In fact, the irrigation channels in the area are a very vast and complex structure of channels that covers many hundreds of kilometers. Nevertheless, reductions of water flows in the Canal Maule Norte Alto will reduce Mariposas Hydroelectric generation.

Finance and Company scale Barrier:

Before entering into the implementation phase, several preliminary steps are required for the identification and scope of the Project. These steps include pre-feasibility study, feasibility study, topography, environmental assessment, basic and detailed engineering, etc. These sunk costs are a significant barrier for a small generation projects like Mariposas, which do not benefit from scale economies that large energy companies have. The same applies to obtain competitive financing rates, due to the higher inherent risk. This is indeed a significant barrier for a small company with a sole generation project.

Hidroeléctrica Río Lircay S.A., the project developer, is a small startup company with young experience in the Chilean power sector. The high cash expenses required to develop the project will depend on the availability to get the project finance structure with banks willing to support the construction risk, as the reimbursement of the loan will depend on the cash flows produced by a successful implementation of the project. Banks will require a thorough due diligence and milestone based disbursements along the project execution. However, small to medium variations in the project budget could jeopardize the project development if the shareholders do not have the flexibility to support the budget variations.

The company does not account further assets, all common finance and acquisition procedures required for the development of the Mariposas Hydroelectric Project are very restricted. Thus additional finance provided by the carbon credits are then a relevant finance tool for the project success.

- **Sub-step 3b. Show that the identified barriers would not prevent the implementation of at least one of the alternatives**

Water Availability Barrier:

Mariposas Hydroelectric Project water resources do not only depend on the natural hydrological fluctuations, but also to the actual operation of the Canal Manuel Norte Alto irrigation channel. As explained before, whenever there is difficulty to deliver the irrigations waters from Canal Maule Norte

Alto, this can be compensated to irrigators by delivering the water through other upstream or downstream channels or even through the main Colbún reservoir discharge.

Changes on the Canal Maule Norte Alto operation, will effectively reduce the Project Activity dispatch, even beyond the natural hydrology fluctuations, decreasing the project incomes.

The least cost expansion alternatives are not affected by hydrology conditions or water availability restrictions as the case of Mariposas Hydroelectric Project. In fact, in case of thermal power plants, they are able to use alternative fuels in case of fuel restrictions (such as natural gas power units that can operate with diesel), and in case hydropower plants with water rights over a basin, they do not depend on the operation of irrigation channels.

Finance and Company scale barrier:

Large to medium operators in the electric sector have considerable assets background allowing them for better financing conditions and rates, aiding in the development of new projects. Hidroeléctrica Río Lircay S.A. is a small private company owned by local and foreign shareholders with no other asset background but the Mariposas Hydroelectric Project and must mitigate its financing barrier by itself.

Hidroeléctrica Río Lircay S.A. started negotiating with local and foreign banks in May 2009, in order to obtain the main finance of the Project. In this finance negotiations, additional incomes from ER sales where already considered crucial part of the Project cash flow and finance, and relevant for the investment decision

The Project loan through the Bice and KFW reaches USD 16.9 million (93%), and the remainder will be contributed directly by Hidroeléctrica Río Lircay's shareholders.

- ***Step 4. Common practice analysis.***

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

    Annex 3 shows SIC's historic energy price variations. The actual price levels are explained by the effect of natural gas restrictions from Argentina, the contraction of investment levels and the worldwide increase of the diesel level prices, where natural gas units are being dispatch with diesel fuel to supply the system demand.

    As shown in Annex 3, even with the actual Node Price scenario, where monomic price levels are over 80 USD/MWh, thermal generation alternatives are still the minimum cost option for capacity additions, as indicated by CNE in its node Price and construction plan published in October 2009 (see table B.6). This is explained by the increasing development cost that hydroelectric projects face worldwide, where today all commodities and raw materials required for the construction of this kind of projects, have recovered the prices previous to the international crisis occurred in September – October 2008 (**www.lme.com**). In the same way, electromechanical equipment involved in similar projects, face higher

costs and larger delivery dates, explained by the reduced availability of manufacturers of hydropower equipment worldwide.

- **Sub-step 4b. Discuss similar options that are occurring:**

The effective CNE Node Price Report at the time the project was considered as an investment option is the October 2009 report, and thus, the one that affected the investment decision. The following Table B.6 shows the Construction plan from that report (**www.cne.cl**).

Table B.6: CNE Construction Plan for the SIC

Month	Year	Project	Capacity
October	2009	Turbina Diesel San Lorenzo	60 MW
October	2009	Central Termoeléctrica Punta Colorada 01 Fuel	16,3 MW
October	2009	Central Diesel Termopacífico	96 MW
October	2009	Turbina Diesel Campanario 04 CA	42 MW
October	2009	Central Diesel Chuyaca	20 MW
October	2009	Central Diesel EMELDA	72 MW
November	2009	Central Eólica Monte Redondo	38 MW
November	2009	Central Eólica Canela II	60 MW
November	2009	Central Eólica Totoral	46 MW
January	2010	Nueva capacidad Planta cogeneradora Arauco	16,6 MW
January	2010	Central Carbón Nueva Ventanas	242 MW
January	2010	Central Hidroeléctrica Licán	17 MW
February	2010	Central Diesel Calle-Calle	20 MW
February	2010	Central Eólica Punta Colorada	20 MW
February	2010	Turbina Diesel Campanario IV CC	60 MW
April	2010	Central Hidroeléctrica La Higuera	153 MW
April	2010	Central Hidroeléctrica San Clemente	5,4 MW
May	2010	Central Carbón Guacolda 04	139 MW
July	2010	Central Hidroeléctrica Confluencia	159 MW
December	2010	Central Carbón Bocamina 02	342 MW
December	2010	Central Hidroeléctrica La Paloma	4,5 MW
January	2011	Central Carbón Santa María	343 MW
September	2011	Biomasa Lautaro	20 MW
October	2011	Chacayes	106 MW
January	2012	Central Carbón Campiche	242 MW
April	2012	Central Hidroeléctrica San Pedro	144 MW
April	2012	Central Hidroeléctrica Laja I	36,8 MW

Source: Node Price Report October 2009 **www.cne.cl**

As shown above, the least cost alternative for the construction plan of the SIC are thermal power plants (Coal and Diesel), with the exception of Central Hidroeléctrica San Pedro 144 MW in April 2012, which is a hydroelectric reservoir project and faces particular conditions in the system. The rest of the projects in the construction plan are renewable energy CDM projects in development, additional to the baseline. The CDM status of these projects is shown in table B.7 below:

Table B.7: Projects Considered Additional Undergoing CDM Registration Process

Project	Technology	CDM status
Central Eólica Monte Redondo	Wind	In validation process. DOE: TÜV Rheinland Japan Ltd.
Central Eólica Canela II	Wind	In validation process. DOE: Bureau Veritas Certification Holding SAS
Central Eólica Totoral	Wind	In validation process. DOE: SGS United Kingdom Ltd.
Central Hidroeléctrica Licán	Run-Of-River	In validation process. DOE: Bureau Veritas Certification Holding SAS
Central Eólica Punta Colorada	Wind	Letter of approval from DNA obtained, initiating Validation Process
Central Hidroeléctrica La Higuera	Run-Of-River	CDM Project id 0248, Registration date: 20/03/06
Central Hidroeléctrica San Clemente	Run-Of-River	In validation process. DOE: TÜV NORD CERT GmbH
Central Hidroeléctrica Confluencia	Run-Of-River	In validation process. DOE: Det Norske Veritas Certification AS
Central Hidroeléctrica La Paloma	Run-Of-River	In validation process. DOE: Spanish Ass. for Standardisation and Certification
Chacayes	Run-Of-River	Initiating Validation Process
Central Hidroeléctrica Laja I	Run-Of-River	Initiating Validation Process

Source: **http://cdm.unfccc.int/index.html**

Following the above evidence, there are no similar activities observed in the SIC being carried at the Project start date, with the exception of those projects that have been submitted under, or are seeking, carbon finance under the CDM, thus they are considered additional to the baseline.

Most comparable development actually occurring in the SIC grid is the case of San Clemente 6 MW Run-Of-River project, being under development by Colbun S.A. the second largest player in the market. This project considers an investment of USD 12.9 million according to information provided by the project developer in the Environmental Qualification process (**www.e-seia.cl**). Despite it has a lower unitary investment cost than Mariposas, this project is also considering CDM registration to obtain additional finance for its development.

The Mariposas Hydroelectric Project Feasibility Study, presented to obtain the project finance, accounted the additional incomes from ER sales, and where a relevant part of the project finance structure.

Since all above steps are satisfied, the additionality of the proposed CDM Project Activity is fulfilled, according to the "Tool for the demonstration and assessment of additionality" (version 5.2).

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 (version 3) 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 Mariposas Hydroelectric Project in the generation mix in the SIC. The monitoring and verification plan for the Project utilizes the data provided by CDEC-SIC.

The BM emission factor will be determined as option (i) in AM0026 (version 3), i.e., following the BM emission factor estimation process described in the: "Tool to calculate the emission factor for an electricity system" (version 2), which is calculated on an *ex-post* basis as the generation-weighted average emission factor (tCO2/MWh) of all the power units during the most recent year for which power generation data is available.

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

Data / Parameter:	w_{BM}
Data unit:	%
Description:	Weight for Build Margin emission factor
Source of data used:	Proposed value
Value applied:	25%
Justification of the choice of data or description of measurement methods and procedures actually applied :	See Section B.6.3 Step 3) analysis for w_{BM} and w_{OM}
Any comment:	

Data / Parameter:	$\boldsymbol{w_{OM}}$
Data unit:	%
Description:	Weight for Operating Margin emission factor
Source of data used:	Proposed value
Value applied:	75%
Justification of the choice of data or description of measurement methods and procedures actually applied :	See Section B.6.3 Step 3) analysis for $\boldsymbol{w_{BM}}$ and $\boldsymbol{w_{OM}}$
Any comment:	

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

>>

AM0026 (version 3) 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.

Step 1) The Emission Factor of the Operating Margin – OM

$$EF_{OM,y} = \frac{\sum_{h=1}^{H} EF_{j,h} x Generation_{j,h}}{\sum_{h=1}^{H} Generation_{j,h}}$$

:AM0026 (version 3) formula **(8)**

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.

The emission factor for any hour '***h***' for a CDM project '***j***' in system is estimated as the 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:

$$\mathrm{EF_{j,h}} = \sum_{i=1}^{M} D(j,i) * d_i \quad / \sum D(j,i)$$: AM0026 (version 3) formula **(9)**

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:

$$D(j,i) = MIN\left\{ C_j - \sum_{l=1}^{i-1} D(j,l); \quad (A_i - B_i) - \sum_{k=j+1}^{N} D(k,i) \right\}$$: AM0026 (version 3) formula **(11)**

Where,

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

Where:

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

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

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

$\boldsymbol{d_i}$, the emission factor for displaced marginal plant, is estimated as follows:

$$\mathrm{d_i} = \mathrm{SFC}_i * \mathrm{CEF_{OM,i}} * \mathrm{Oxid_i}$$: AM0026 (version 3) formula **(12)**

Where,

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

The marginal plant(s) are those power plants 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 Mariposas Hydroelectric Project is obtained from the metering system which follows a national standard NCh 2542, which states 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. Periodic calibration (every two years) will be conducted through independent certified entities (see Annex 4, Section An 4.4.2)

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 thermal 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 – BM

As described in AM0026 (version 3), Option i), for *ex-post* Build Margin Calculation it must be used the Build margin emission factor estimation process described in "Tool to calculate the emission factor for an electricity system" (version 2).

According the chosen option above, the build margin emission factor for the first crediting period can be calculated annually, based on the set of power units that comprises the larger annual generation of the following two options:

- the most recent 20% of capacity added to the grid in, *ex-post*; or
- The set of five power units that have been built most recently

Taking in consideration the option above, the build margin is calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_{m=1} EG_{m,y} \times EF_{EL,m,y}}{\sum_{i=1}^{m} EG_{m,y}}$$: actually am-tool-07[3] (version 2) formula **(13)**

Where,

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

$$EF_{EL,m,y} = \frac{\sum_{i} FC_{i,m,y} * NCV_{i,y} * EF_{CO2,i,y}}{EG_{m,y}}$$: actually am-tool-07 (version 2) formula **(2)**

Where,

$EF_{EL,m,y,}$....... CO_2 emission factor of power unit ***m*** in year ***y*** (tCO_2/MWh)
$FC_{i,m,y}$.......... Amount of fossil fuel type ***i*** consumed by power unit ***m*** in year ***y*** (Mass or volume unit).
$NCV_{i,y}$ .... Net calorific value (energy content) of fossil fuel type ***i*** in year ***y*** (GJ/mass or volume unit).
$EF_{CO2,i,y}$....... CO_2 emission factor of fossil fuel type ***i*** in year ***y*** (tCO2/GJ)
$EG_{m,y}$.......... Net quantity of electricity generated and delivered to the grid by power unit ***m*** in year ***y*** (MWh)
m................ Power units included in the build margin
i.................. All fossil fuel types combusted in power unit ***m*** in year ***y***
y................. Most recent historical year for which power generation data is available

Step 3. Project Emission Reductions

The combined emission factor for the proposed Mariposas Hydroelectric Project, according to AM0026 (version 3), is calculated with the weighted average for both the Operating Margin (OM) and the Build Margin (BM) as follows:

$$EF_y = w_{OM} * EF_{OM,y} + w_{BM} * EF_{BM,y}$$: AM0026 (version 3) formula **(7)**

[3] Tool to calculate the emission factor for an electricity system

Where,

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

Proposed w_{OM} and w_{BM} values according to the following analysis:

1) According to the Official Price fixation decree (DS 385/2008) and CNEs node price report, the peak season in the SIC is defined between the months of April to September. As it is shown in the table B.8 below, 62% of the total generation will be produced during off peak season, producing just a 38% of the generation in peak season. This situation is explained due that the Project dispatch follows the actual demand of the irrigation channel, where the mayor demand is in the summer season, this is, in the OFF-Peak season of the system (see figure B.5).

Table B.8 Distribution of Mariposas Annual Generation (GWh)

Peak Season (April-September)	% of the Total	OFF-Peak Season (October-March)	% of the Total	Total
15.26	38%	24.74	62%	40

Source: Hidroeléctrica Río lircay S.A. estimate based on hydrological data for 40 years (1960 to 1999).

2) The size of the Project activity is relatively small (6.3MW) compared to the SIC grid total installed capacity that reaches near 10,000 MW, meaning the project represents less than 0.06% of total system installed capacity. Also the Project Activity is relatively small compared to the average yearly power additions required to satisfy the always increasing system demand, which are near 400 MW per year, meaning that the Project activity represents less than 2% of yearly system power additions.

Following the above arguments, the Project will have a very limited impact in displacing future power developments in the grid and it is unlikely that the Mariposas Hydroelectric Project could prevent or delay the development of new power units.

The baseline emissions for the Project are calculated as follows:

$$BE_y = EF_y * Generation_y$$: AM0026 (version 3) formula **(6)**

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 (ER_y) by the project activity during year y is equal to the Baseline Emissions. Since the Mariposas Hydroelectric Project consists of a hydro power plant, there are no Project Emissions (PE_y). Additionally, as per AM0026 (version 3), no leakage was identified for this project activity. The emission reduction can be expressed as follows:

$$ER_y = BE_y - PE_y - L_y = BE_y$$: AM0026 (version 3) formula **(2)**

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 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 this PDD for the calculation of the current baseline for registration is only for estimation purposes with rough calculations. The detailed data required to calculate the EF_{OM} and EF_{BM} will be provided *ex-post* (Please refer to section B 6.1 for deeper details).

For estimation purposes within the PDD, the information of CDEC-SIC real dispatch data from 2003 to 2008 has been used in order to determine the real emission factor of each year and average emission factor of the period:

Table B.9: SIC Baseline Emission Reductions in Tonnes CO2e/GWh

	2003	2004	2005	2006	2007	2008	2009	Avg.
$EF_{OM,y}$	419	589	539	408	600	783	758	585
$EF_{BM,y}$	376	362	279	226	451	413	297	344
EFy	**408**	**532**	**474**	**362**	**563**	**691**	**643**	**525**

Source: Preliminary estimations based on CDEC-SIC data and IPCC Guidelines

The following table provides information and data used to determine baseline emissions

Table B.10: Summarized Data to Calculate the Baseline Emissions

Variable	Value	Data source
$EF_{BM,\,y}$ (tCO_2e/GWh)	343	Estimated using an average of CDEC-SIC real dispatch data from 2003 to 2009 and latest IPCC Guidelines following the latest Tool to calculate the emission factor for an electricity system, actually (version 2) formula **(13)**
$EF_{OM,\,y}$ (tCO_2e/GWh)	585	Estimated using an average of ex-post data of SIC dispatch (2003 to 2009) and latest IPCC Guidelines following AM0026 (version 3) formula **(8)**
EF_y (tCO_2e/GWh)	525	Combined Margin result following AM0026 (version 3) formula (7)
EG_y (GWh/year)	40	Average project generation
$BE_y = ER_y$ (tCO_2e/year)	≈21,000	Calculated following AM0026 (version 3) formula **(6)** and **(2)**

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

>>

For estimation purposes, the following table summarizes the emissions reductions of the first seven years of operation and the expected emissions reductions:

Table B.11: Estimation of Emission Reductions for the First Crediting Period

Year	**Estimation of project activity emissions (tonnes of CO_2e)**	**Estimation of baseline emissions (tonnes of CO_2e)**	**Estimation of leakage (tonnes of CO_2e)**	**Estimation of overall emission reductions (tonnes of CO_2e)**
2010 (from 01/11/2010)	0	3,500	0	3,500
2011	0	21,000	0	21,000
2012	0	21,000	0	21,000
2013	0	21,000	0	21,000
2014	0	21,000	0	21,000
2015	0	21,000	0	21,000
2016		21,000		21,000
2017 (until 31/10/2017)	0	17,500	0	17,500
Total (tonnes of CO2e)	**0**	**147,000**	**0**	**147,000**

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	40,000 MWh
Description of measurement methods and procedures to be applied:	Electronic measurement system each 15 minutes and integrated hourly for recording and submitting to CDEC-SIC Verification procedures shall be applied based on redundant energy meters.
QA/QC procedures to be applied:	Meter shall have a maximum error of 0.2% according to NCh 2542 official standard, and will be calibrated every two years through independent certified entities (see Annex 4, Section An 4.4.2) Metering data is sent regularly to CDEC-SIC where a balance is made for energy transactions between power generators. This data results in receipts of sales that represent a double check for the generation of the Project Activity. A periodic calibration every two years will be conducted to check Mariposas project power generation.
Any comment:	

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:	Latest IPCC Guidelines, CDEC-SIC databases and CNE official reports Calculated based on AM0026 (version 3) formula **(7)**
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.525 tCO2e/MWh
Description of measurement methods and procedures to be applied:	Calculation based on official data and AM0026 procedures. Estimation shall be calculated annually
QA/QC procedures to be applied:	Automatic calculation procedure 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:	Latest IPCC Guidelines, CDEC-SIC databases and CNE official reports Calculated based on AM0026 (version 3) formula **(8)** using CDEC-SIC data
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.585 tCO2e/MWh
Description of measurement methods and procedures to be applied:	Calculated using CDEC-SIC dispatch data and AM0026 procedures. Estimation shall be calculated annually.
QA/QC procedures to be applied:	Automatic calculation procedure through a revised worksheet. 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:	Latest IPCC Guidelines, CDEC-SIC databases and CNE official reports Calculated based on AM0026 (version 3) formula **(9)** using CDEC-SIC dispatch data
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Average estimation is 0.585 tCO2e/MWh (EF_{OM})
Description of measurement methods and procedures to be applied:	Calculated hourly from CDEC-SIC dispatch data and AM0026 procedures.
QA/QC procedures to be applied:	Automatic calculation procedure through a revised worksheet. 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:	CDEC-SIC databases Calculated based on AM0026 (version 3) formula (**11)** using CDEC-SIC dispatch data
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Displaced energy is calculated for each system unit. Total energy displacement for the proposed Project Activity is equivalent to project generation (40 GWh per year)
Description of measurement methods and procedures to be applied:	Calculated hourly from CDEC-SIC dispatch data and AM0026 procedures.
QA/QC procedures to be applied:	Automatic calculation procedure through a revised worksheet. 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:	Latest IPCC Guidelines, CNE official reports and CDEC-SIC databases Calculated based on AM0026 (version 3) formula **(9)** based on official data whenever available
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Average for Coal powered units = 1.29 tCO2e per MWh Average for diesel powered units = 0.81 tCO2 per MWh Average for natural gas powered units = 0.55 tCO2 per MWh
Description of measurement methods and procedures to be applied:	Hourly calculation based on official data and the latest IPCC manual. Verification procedure shall be applied based on historical data per fuel type.
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 official reports and CDEC-SIC databases
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Average for Coal powered units = 0.547 tons per MWh Average for diesel powered units = 0.291 m^3 per MWh Average for natural gas powered units = 0.227 m^3 per MWh
Description of measurement methods and procedures to be applied:	Calculation based on official data. Verification procedure shall be applied based on historical data per fuel type. Estimation shall be calculated annually or 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	Several results per hour base
Description of measurement methods and procedures to be applied:	Calculated hourly from CDEC-SIC databases and AM0026 procedures.
QA/QC procedures to be applied:	Electronic worksheet shall be implemented to deliver automatic calculations through revised worksheet
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 SIC grid
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N=1 For estimation purposes, only one CDM unit was considered. According to AM026 methodology, the identification of marginal plant(s) displaced by CDM projects is based on the "first-built first served" principle. Assuming only one CDM unit in the system is equivalent to assume that the proposed project is the last CDM project of the system. Actual number of CDM units will be determined according to the official information from UNFCCC project registry and CDEC-SIC actual dispatch
Description of measurement methods and procedures to be applied:	Determined from CDEC-SIC dispatch data
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) in the hour ***h***
Source of data to be used:	CDEC-SIC dispatch data
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Since N = 1, as describes in the previous table, all CDM energy considered for estimation purposes is equivalent to 40 GWh per year.
Description of measurement methods and procedures to be applied:	Calculated hourly from CDEC-SIC dispatch data and AM0026 procedures.
QA/QC procedures to be applied:	Automatic calculation procedure through a revised worksheet. Calculation should be done after CDEC-SIC energy balance to ensure data validity
Any comment:	

Data / Parameter:	***A_i***
Data unit:	MW
Description:	Maximum energy generation of the i^{th} marginal plant at hour ***h*** (equivalent to the actual plant ***i*** capacity selected from the Ai set at 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	Several system units are considered in the estimation. Official CDEC-SIC dispatch data was used
Description of measurement methods and procedures to be applied:	Determined from CDEC-SIC official data
QA/QC procedures to be applied:	Data is obtained from CDEC-SIC official data
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	Several system units are considered in the estimation.
Description of measurement methods and procedures to be applied:	Determined hourly from CDEC-SIC databases.
QA/QC procedures to be applied:	Data is obtained from official 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 the latest Tool to calculate the emission factor for an electricity system, actually (version 2) formula **(13)**. based on official data, the latest IPCC Guidelines and CDEC-SIC databases
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.344 tCO2e/MWh
Description of measurement methods and procedures to be applied:	Calculated annually using CDEC-SIC dispatch data and the latest Tool to calculate the emission factor for an electricity system procedures
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:	$EF_{EL,m,y}$
Data unit:	tCO_2e/MWh
Description:	CO_2 Emission Factor of power unit *m* in the Build Margin cohort for the year ***y***
Source of data to be used:	Calculated based on the latest Tool to calculate the emission factor for an electricity system, actually (version 2) formula **(2)**. Based on the latest IPCC manual and CDEC-SIC dispatch data
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Average estimation is 0.344 tCO_2e/MWh (EF_{BM})
Description of measurement methods and procedures to be applied:	Calculated annually from CDEC-SIC databases and the latest Tool to calculate the emission factor for an electricity system procedures.
QA/QC procedures to be applied:	Official data is used
Any comment:	

Data / Parameter:	$EG_{m,y}$
Data unit:	MWh
Description:	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
Source of data to be used:	CDEC-SIC dispatch data
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Several system units are considered in the estimation.
Description of measurement methods and procedures to be applied:	Determined annually from CDEC-SIC dispatch data
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	Several system units are considered in the estimation.
Description of measurement methods and procedures to be applied:	Determined from CDEC-SIC databases, as new power plants are available in the system
QA/QC procedures to be applied:	Based on CDEC-SIC identification names. A revised worksheet is used to properly identify each plant name on the system.
Any comment:	

Data / Parameter:	$CEF_{OM,i}$
Data unit:	TC per ton of fuel or TJ
Description:	Carbon emission factor of fuel used in the i^{th} plant of the Operating Margin cohort
Source of data to be used:	Latest IPCC default values following AM0026 procedures
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Coal powered units = 95,600 tCO2e per MWh Diesel powered units = 74,100 tCO2 per MWh Natural gas powered units = 56,100 tCO2 per MWh
Description of measurement methods and procedures to be applied:	Determined from IPCC guidelines
QA/QC procedures to be applied:	IPCC recommended data is used
Any comment:	

Data / Parameter:	***Oxid**$_i$*
Data unit:	%
Description:	Fraction of fuel oxidized on combustion
Source of data to be used:	Latest IPCC default values following AM0026 procedures
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Average for Coal powered units = 100% Average for diesel powered units = 100% Average for natural gas powered units = 100%
Description of measurement methods and procedures to be applied:	Determined from IPCC guidelines
QA/QC procedures to be applied:	IPCC recommended data is used
Any comment:	

Data / Parameter:	$FC_{i,m,y}$
Data unit:	Mass or volume unit
Description:	Amount of fossil fuel type *i* consumed by power unit *m* in year *y*
Source of data to be used:	CDEC-SIC databases and CNE official reports
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Several system units are considered in the estimation.
Description of measurement methods and procedures to be applied:	AM0026 procedures and the latest Tool to calculate the emission factor for an electricity system.
QA/QC procedures to be applied:	Automatic calculation through a revised worksheet
Any comment:	

Data / Parameter:	***$NCV_{i,y}$***
Data unit:	Energy per mass or volume unit
Description:	Net calorific value (energy content) of fossil fuel type *i* in year *y*
Source of data to be used:	Estimated based on official data or the latest IPCC default values
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Average for Coal powered units = 7,000 Kcal per Kg Average for diesel powered units = 10,900 Kcal per Kg Average for gas powered units = 9,341 Kcal per m^3
Description of measurement methods and procedures to be applied:	Determined from CNE official data or the latest IPCC guidelines following AM0026 procedures
QA/QC procedures to be applied:	Official data or IPCC recommended data is used
Any comment:	

Data / Parameter:	***$EF_{CO2,i,y}$***
Data unit:	tCO2 per GJ
Description:	CO2 emission factor of fossil fuel type i in year y
Source of data to be used:	Latest IPCC default values at the lower limit of the uncertainty at a 95% confidence interval following the latest Tool to calculate the emission factor for an electricity system.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Coal powered units = 87,300 kgCO2 per TJ Diesel powered units = 72,600 kgCO2 per TJ Natural gas powered units = 54,300 kgCO2 per TJ
Description of measurement methods and procedures to be applied:	Determined from IPCC guidelines
QA/QC procedures to be applied:	IPCC recommended data is used
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 the official expansion plan provided by CNE.

Please refer to section **B.6.3** for formulae reference

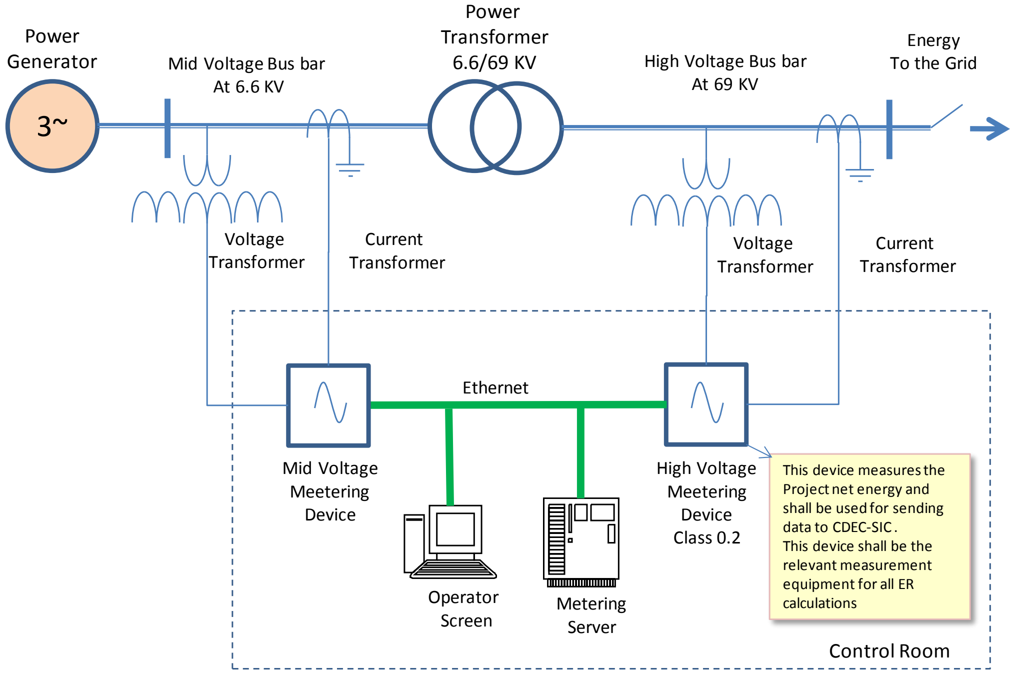
The monitoring methodology involves the monitoring of the following:

- 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..

All data monitored and required for verification and issuance are to be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later.

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

1-. Project Generation metering system diagram



2-. 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 Mariposas Hydroelectric Project:

Net hourly Generation output from Mariposas Hydroelectric Project and all other units in the system (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 existing CDM projects
(CDEC-SIC hourly data)

⇩

Calculation of emission factor of all operational units of the system
(CNE report and latest IPCC Guidelines following AM0026 procedures)
(tonnes CO2e/MWh)

⇩

Determination of the marginal plants and energy being displaced due to the operation of the CDM Project Activity following the "first-built first-served"[4] principle stated on AM0026
(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 each CDM Project Activity
(tonnes CO2e/MWh)

- **Step 2 – Calculation of the Build Margin**

Following AM0026 (version 3) option i), the Build Margin emission factor is calculated using option 2) of the "Tool to calculate the emission factor for an electricity System" (version 2). Please refer to formulae stated in section B.6 (Tool to calculate the emission factor for an electricity system, actually (version 2) formulas **(13)** and **(2)**). The next diagram shows the complete process for calculating and assigning the Build Margin emission factor:

[4] The "first-built first-served" 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

SIC Dispatch of all power units of the system
(MWh)
⇩
Determination of 20% of energy generated from most recent power units; or
The set of five power units that have been built most recently
It will depend in which method has the largest annual generation
(set of m plants following the Tool to calculate the emission factor for an electricity system)
(MWh)
⇩
Calculation of emission factor of thermal units in set of m plants considered un the Build Margin
(CNE reports, latest IPCC guidelines and CDEC-SIC databases)
(tonnes CO2e/MWh)
⇩
Determination of EF_{BM} as the weighted average emission factor of the dispatched plants and their individual emission factor
(tonnes CO2e/MWh)

- **Step 3 – Calculation of the Project Emissions Reductions**

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

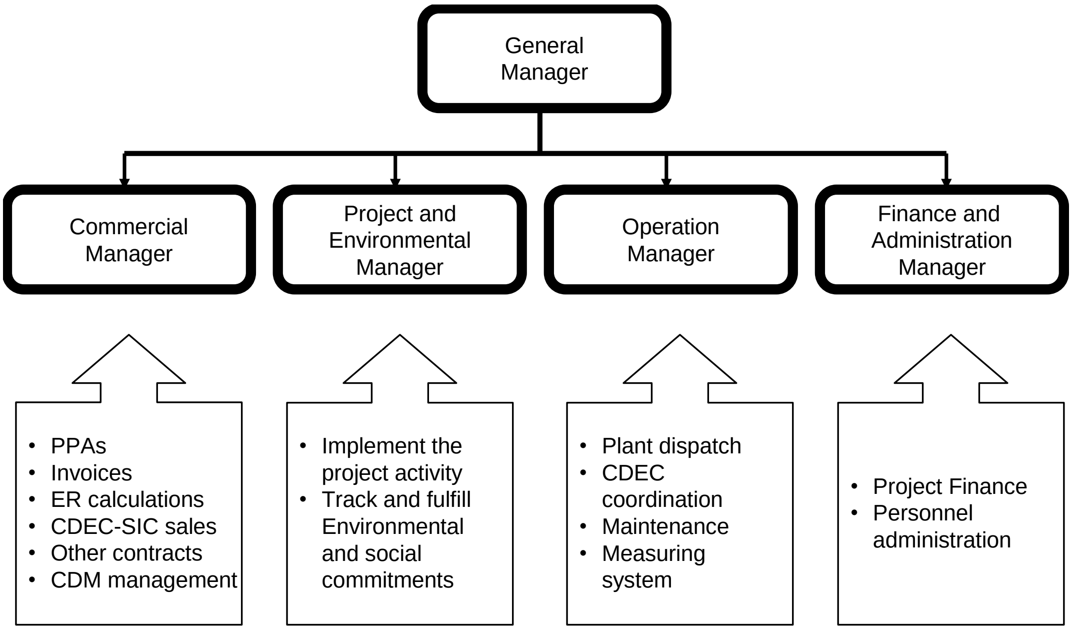
Please refer to formulae stated in section B.6.3 (AM0026 (version 3) formula **(7)**, **(6)** and **(2)**)

Calculation of Combined Margin Emission factor of EF_{BM} and EF_{OM}
(tonnes CO2e/MWh)
⇩
Energy generation of the Project Activity
(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 emission was identified for Mariposas Hydroelectric Project, and project emissions are null)
(tonnes CO2e)

3-. Operational and Management structure

In order to secure a correct emission reduction calculation, the project developer will implement and maintain a proper management structure as follows:

Figure B.6: General Management Structure for Hidroeléctrica Río Lircay S.A.



Hidroeléctrica Río Lircay S.A. 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 fulfill all social and environmental obligations relative to the project activities.

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:
02/01/2010

- Carl Weber, General Manager, Hidroeléctrica Río Lircay S.A., Av. Presidente Kennedy 5757, Of 802, Santiago, Chile, tel +56-2-2453600; **cweber@hidrolircay.cl**
- José Manuel Contardo, Project Manager, Hidroeléctrica Río Lircay S.A., Av. Presidente Kennedy 5757, Of 802, Santiago, Chile, tel +56-2-2453600, **jmcontardo@hidrolircay.cl**

Hidroeléctrica Río Lircay S.A. is a project participant listed on Annex 1.

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 start date is 19/11/2009 (Financial closure and Instruction date to ICAFAL to start the project construction)

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

>>

The operational lifetime of Mariposas hydropower plants is estimated over 40 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:

>>

01/11/2010

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:

>>

Following article 10, letter c) of the Environmental Law Nº19,300 (Ley sobre Bases Generales del Medio Ambiente), and article 3, letter c) of its Regulation (Supreme Decree N°95 of 2001, Reglamento del Sistema de Evaluación de Impacto Ambiental - RSEIA), all energy generation projects having more than 3 MW of installed capacity, must meet the terms of Environmental Impact Evaluation System (SEIA). Further, section II, article 8 of the Environmental Law 19,300 indicates that this kind of projects will not be able to be executed or modified if they do not have the subsequent approval of the Environmental Qualification Resolution (R.C.A. in Spanish).

According the previous paragraph, Mariposas Hydroelectric Project was submitted to the SEIA through an Environmental Impact Statement (DIA in Spanish), not requiring an Environmental Impact Assessment (EIA in Spanish). The project has little impacts and does not present any of the effects, characteristics or circumstances stated the Article 11 of the Environmental Law 19,300, thus it was not required to enter the project through a full Environmental Impact Assessment (EIA).

Mariposas Hydroelectric Project RCA was approved on 29/05/2009 (Resolución Exenta Nº 139 COREMA VII Region del Maule), fulfilling all environmental requirements. A modification of the project was presented for Environmental Impact Assessment process, being this officially approved on 22/07/2010 through Resolución Exenta N° 135, COREMA VII Región del Maule.

Mariposas Hydroelectric Project DIA discusses a wide range of environmental impacts during the construction, operation and end of the project operation, such as: land use, air quality, noise emissions, solid emissions, liquid emissions, etc. It identifies the risk or contingency zones and the type of risk associated to them. It also discusses a number of corrective measures and establishes an environmental management plan to deal with the identified impacts. This plan addresses the significant and medium impacts providing measures for their mitigation, restoration or compensation. In general terms, the project states that:

- The project will not entail any health risks to the surrounding population, related to the quantity and quality of liquid and solid emissions during the construction and operation stages (article 5 RSEIA)
- The project will not entail adverse effects over the quantity and quality of the natural renewable resources, including land, water and air (Article 6 RSEIA).
- The project will not entail emissions that may cause health risks or adverse effects over natural sources (Article 7 RSEIA)
- The project will not entail human resettlement nor any significant alteration of actual human living conditions or cultural groups (Article 8 RSEIA)

- The project will not be placed near any population, protected sources or areas that may be affected. And will not affect the environmental value of the place where the project will be built (Article 9 RSEIA)
- The project will not entail any significant change in terms of magnitude and duration of the touristy and land sight in the surrounding zones (Article 10 RSEIA)
- The project will not entail any changes of monuments, sites with anthropological, archaeological or historic value or, in general, those belonging to cultural heritage. (Article 11 RSEIA)
- The Mariposas Hydroelectric Project uses the same civil works and water handling of Asociación Canal Maule (ACM), following the national water authority (D.G.A.) resolution N°105 of 19/04/1983, without affecting in any way the water rights of ACM irrigators downstream. All water uses are governed by a private contract between ACM and Hidroeléctrica Río Lircay S.A.

There is no minimum ecological flow considered for this project activity since waters come from consumptive water rights for irrigation purposes, conducted through existing artificial civil works with no river bed intervention.

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:

>>

As mentioned above, no relevant impacts where detected for the project

All objections were assessed and officially cleared up by COREMA in a meticulous way. Specific measures are considered for soil, natural watercourses, transport, risk and emergency control, specially fire and spills.

Mariposas Hydroelectric Project does not entail any physical construction such as dams and dikes, or cause reservoir-like impoundments on the Maule Norte Alto Canal.

SECTION E. Stakeholder's comments

>>
Mariposas Hydroelectric Project SEIA project file can be publicly accessed through CONAMA website at **www.e-seia.cl** containing all project details and the Official Environmental Qualification.
Link:

https://www.e-seia.cl/expediente/ficha/fichaPrincipal.php?modo=ficha&id_expediente=3480223
https://www.e-seia.cl/expediente/ficha/fichaPrincipal.php?modo=ficha&id_expediente=4499635

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

In compliance with the Chilean Environmental Law 19,300 and the SEIA procedures, the project's DIA collected opinions and information from all relevant authorities selected by COREMA, in consideration to their legal relation to identified impacts of the project. These comments were received between 15/01/2009 to 12/05/2009 and 15/04/2010 to 25/07/2010.

Local Authorities:
The local authorities that presented comments to the project are the following:

- CONAMA VII, Región del Maule
- Corporación Nacional Forestal CONAF, Región del Maule
- Dirección de Obras Hidráulicas DOH, Región del Maule
- Dirección General de Aguas Región del Maule
- Dirección Regional de Vialidad, Región del Maule
- Ilustre Municipalidad de San Clemente
- SEREMI de Agricultura Región del Maule
- Seremi de Bienes Nacionales, Región del Maule
- SEREMI de Salud, Región del Maule
- SEREMI de Transporte y Telecomunicación, VII Región
- SEREMI de Vivienda y Urbanismo
- SEREMI MOP, Región del Maule
- Servicio Agrícola Ganadero SAG, Región del Maule
- Servicio Nacional de Pesca,SERNAPESCA, Región del Maule
- Servicio Nacional de Turismo, SERNATUR, Región del Maule
- Superintendencia de Electricidad y Combustible, Región del Maule
- Dirección Regional SERNAGEOMIN Zona Sur
- Comisión Nacional de Energía
- Consejo de Monumentos Nacionales
- Superintendencia de Servicios Sanitarios

Local Community:

Chilean Environmental Law 19,300 does not include officially community participation for DIA. procedures (differing ftom the a full Environmental Impact Assesment procedures). However, any person

has the right to present petitions and clarifications to the authority of any public or private interest matter. Consequently, anyone could send their opinion or questions to the projects DIA, regardless the merit that the legal authority must apply on them for the RCA approval.

In the case of Mariposas Hydroelectric Project, the community to be affected by the Project is essentially the same community of Asociacion Canal Maule (ACM), which consists of near 2,200 irrigators. In the middle of 2007 and 2008 board committees where organized exposing the Project to all participants, where the project was presented and approved, and its water rights have been ratified by the irrigators.

E.2 Summary of the comments received:

>>
Comments received relate mainly to the following aspects: land use and treatments, hydrological resources, debris management, level improvement, rubble movement, biodiversity, landscape intervention, etc.

Details of each of the comments received can be obtained from the SEIA process at CONAMA's web site

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

>>
Comments, observations and questions received from above mentioned authorities were answered by Hidroeléctrica Río Lircay S.A during the SEIA process. The answers were compiled in three addenda added to the SEIA for the initial environmental qualification process (Resolución Exenta N° 139, COREMA VII Región del Maule) and one addenda for the final modification (Resolución Exenta N° 135, COREMA VII Región del Maule). Most legal permissions and authorizations required to carry out the project were obtained in 2009.

Details of the addenda can be obtained from the SEIA process at CONAMA's web site

Resolución Exenta Nº 139 COREMA VII Región del Maule (29/05/2009)
Addenda 1: **https://www.e-seia.cl/documentos/documento.php?idDocumento=3622481**
Addenda 2: **https://www.e-seia.cl/documentos/documento.php?idDocumento=3688000**
Addenda 3: **https://www.e-seia.cl/documentos/documento.php?idDocumento=3767361**

Resolución Exenta N° 135, COREMA VII Región del Maule (22/07/2101)
Addenda 1: **https://www.e-seia.cl/documentos/documento.php?idDocumento=4658694**

Besides from the above comments, 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 for the construction and operation of the project.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Hidroeléctrica Río Lircay S.A.
Street/P.O.Box:	Av. Presidente Kennedy 5757, Torre Oriente, Of. 802, Las Condes
Building:	
City:	Santiago
State/Region:	Metropolitana
Postfix/ZIP:	-
Country:	Chile
Telephone:	56-2-245-3600
FAX:	56-2-245-3665
E-Mail:	**jmcontardo@hidrolircay.cl**
URL:	
Represented by:	Represented by:
Title:	Project Manager
Salutation:	Mr.
Last Name:	Contardo
Middle Name:	Manuel
First Name:	Jose
Department:	
Mobile:	
Direct FAX:	
Direct tel:	56-2-245-3600
Personal E-Mail:	**jmcontardo@hidrolircay.cl**

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There is no public funding in the projects. The fund used to financing is not diversion of ODA

Annex 3

BASELINE INFORMATION

AN 3.1. SYSTEM EMISSION FACTORS

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 October 2009. The following data will be periodically updated for each CNE node price report. The values in the table however do not have significant changes. 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

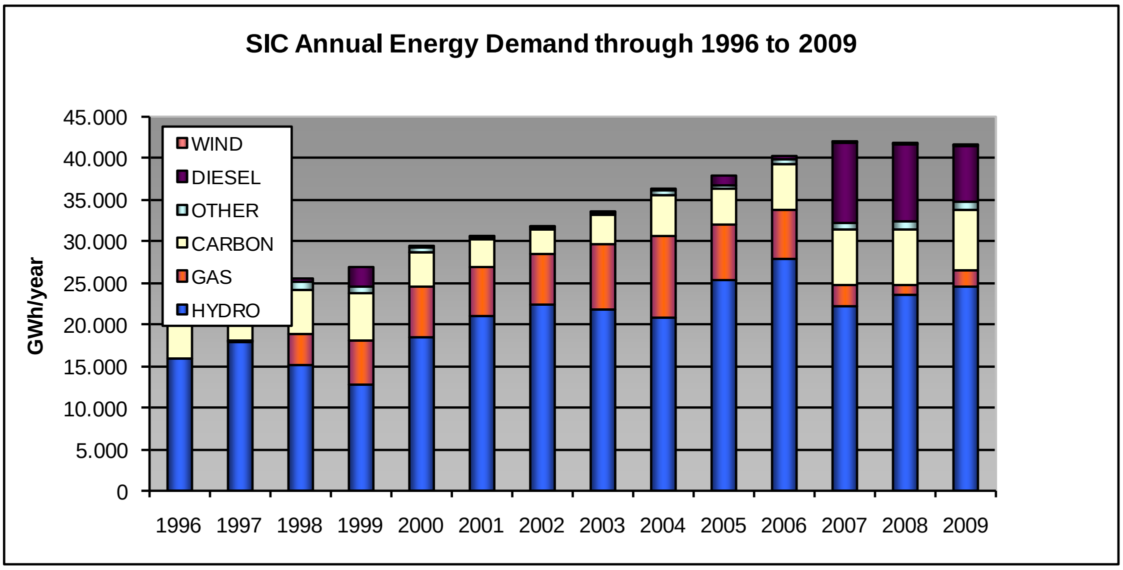
AN 3.2. NATIONAL AND SECTOR BACKGROUND

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 Energy and the specialized agencies the National Energy Commission and the Superintendence of Electricity and Fuels.

Chile’s transmission system is composed by four different grids the SING, SIC, Aysen and Magallanes grids (see section B.3 for a deeper description).

The Mariposas Hydroelectric Project is located in the SIC grid. According to data available at **www.cne.cl**, SIC consumed near 42,000 GWh of electricity in 2009, from this figure, almost 25,000 GWh was hydropower energy, representing about 59% of SIC’s total generation. Also, About 47 percent of SIC's installed power generation capacity is hydroelectric. Hydropower from westward flowing rivers from the Andes Mountains is Chile's single largest electricity source.

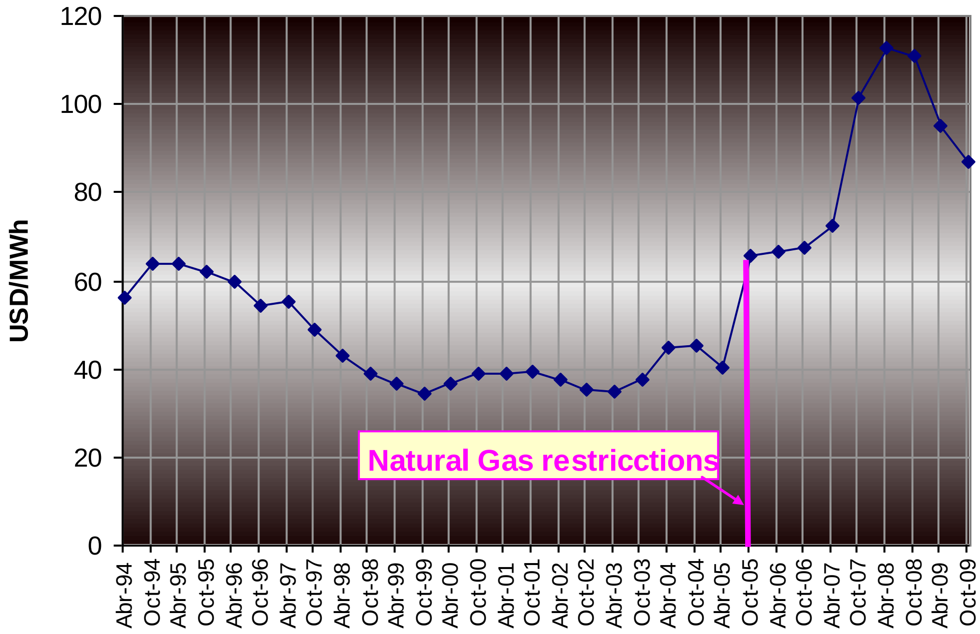
CNEs estimates that Chile is only exploiting 13 percent of its hydroelectric potential, however large viable sites are far from Santiago (which represents 40 percent of demand), requiring large transmission line investments. This is the case of Hidroysén Reservoir Power project of 2750 MW, that will require a transmission line of near two thousand kilometers long (**www.hidroaysen.cl**) . Together with other fossil fuels, natural gas and coal has become an increasingly important electricity source in the coming years.



Source: CNE – Statistics – Generación Bruta SIC-SING

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 on natural gas after 1996, the Chilean grids had to react increasing the diesel dispatch, thus increasing the energy prices in order to avoid mid term energy shortages.

CNE Monomic SIC Node Prices 1994 to 2009



Source: CNE node price reports **www.cne.cl** and **www.bls.gov** CPI adjustment

In October 2005 Node Price fixation returned monomic prices to levels similar to those before the natural gas introduction, adjusting the system to the new fuel availability conditions. Subsequent fixations by CNE in 2006 kept node energy prices around 50 USD/MWh until October 2007.

In April 2007 Node Price begun to rise significantly, reaching a peak around 120 USD/MWh due to the large increase in the diesel prices (Worldwide) and the declining of electric power investment levels in the country during the reduction of system prices for almost eight years while natural gas was the prevailing low cost technology in the sector.

Today system prices are returning gradually to a stable level, that will reflect in average prices of Natural Gas and Coal powered units, that together with the high hydroelectric component, will impose an average system price of near 55 USD/MWh in the mid and long term.

An 3.2.1. Sector barriers:

No concession is required to become a generator and there is no formal 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 *Sistema Interconectado Norte Grande (SING)*, the *Sistema Interconectado Central* (**SIC**), the Aysen 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 companies. According to the last official demographic study 2002 (**www.ine.cl**), the central grid (SIC) serves over 92 percent of Chile's population and more than 40 percent of the land area. The northern grid (SING) is mainly thermal and serves mostly mineral-processing centers in the region and the Aysen 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 companies 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.

An 3.2.2. Sector Institutions:

- **CDEC**: The economic load dispatch center in each grid is controlled by a private, independent entity CDEC (*Centro de Despacho Económico de Carga*), composed mainly of representatives of generation and transmission companies, but its operation is fully regulated by law and supervised by the 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 its security, and of determining values of economic transactions that were carried out among the generators. The SING (Northern Grid) and the SIC (Central Grid) have each their own independent dispatch centers.

CDEC–SIC (Economic Dispatch Center in the SIC Grid) 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, transmission and distribution companies, independent from the Government. All generating plants supplying electricity to the system, including Mariposas Hydroelectric Project, are under CDEC-SIC operating supervision and are obliged to perform its dispatch instructions.

- **CNE:** *Comisión Nacional de Energía.* The sector is regulated by an autonomous agency, 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 Energy**: In the area of the power sector, the Ministry of Energy 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

AN 4.1. 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 project 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 Project Sponsor, the Project Operator and the ERs Buyer(s). The MVP builds on the baseline scenario identified in the Baseline Study and is fully consistent with the Baseline Study.

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. The MVP must therefore be used throughout the life of the project. 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 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.

AN 4.2. CONCEPTS AND PRINCIPLE ASSUMPTIONS

An 4.2.1. The Mariposas Hydroelectric Project Activity

The Mariposas power plant (the Project Activity), consists of a run-of-river power plant of 6.3 MW capacity that utilizes the waters of the Maule Norte Alto canal. The project developer and operator (the Project Operator) is Hidroeléctrica Río Lircay S.A.

Being a CDM activity, Mariposas Hydroelectric Project must meet the requirements of the Kyoto Protocol Art. 12 for CDM projects. The methodology for carrying this out and the monitoring and verification protocol for establishing the emission reduction are provided in this document.

An 4.2.2. Emission reductions from the Project Activity

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)[5]. Emission Reductions of CDM projects shall be accounted as stated in the AM0026 (version 3).

An 4.2.3. Geographic and System Boundaries for the MVP

The Baseline Study defines the project boundary to correspond to the SIC Grid for the purpose of identifying potential emissions and leakage during the projects lifetime.

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.

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

An 4.2.4. 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.

An 4.2.5. Calculating Emission Reductions

The emission reduction calculation results from the electricity generated by the Project Activity displacing power generated mainly by coal and combined cycle gas or other thermal units on the margin in the SIC Grid.

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 the Project Activity and all other system generators (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 factors of all operational units of the system (CNE report and latest IPCC Guidelines following AM0026 procedures) (tonnes CO2e/MWh)

⇩

Determination of the marginal plants and energy being displaced due to the operation of the CDM Project Activity following the "first-built first-served"[6] principle stated on AM0026 (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 each CDM Project Activity (tonnes CO2e/MWh)

[6] The "first-built first-served" 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

- **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; or
The set of five power units that have been built most recently
It will depend in which method has the larger annual generation
(set of m plants following the Tool to calculate the emission factor for an electricity system)
(MWh)
⇩
Calculation of emission factor of thermal units in set of m plants considered un the Build Margin
(CNE reports, latest IPCC guidelines and CDEC-SIC databases)
(tonnes CO2e/MWh)
⇩
Determination of EF_{BM} as the weighted average emission factor of the dispatched plants and their individual emission factor
(tonnes CO2e/MWh)

- **Key Steps for Estimating Project Emissions**

Calculation of Combined Margin Emission factor of EF_{BM} and EF_{OM}
(tonnes CO2e/MWh)
⇩
Energy generation of the CDM Project Activity
(from CDEC-SIC or metering data)
(MWh)
⇩
Calculation of Baseline Emissions of the Project Activity
(tonnes CO2e)
⇩
Discount any leakage or project activity emissions, if any
(No leakage emission was identified for Mariposas Hydroelectric Project, and project emissions are null)
(tonnes CO2e)

AN 4.3. OPERATIONAL AND MONITORING OBLIGATIONS

An 4.3.1. Operational Obligations

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

An 4.3.2. 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 the project operator 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 two 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 complemented with the IPCC manual.

AN 4.4. PROJECT WORKBOOK

An 4.4.1. Main Data

The 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).
- **Tonnes of CO_2e (tCO_2) Emission Factors:** Emission Factor of thermal units of the system, calculated every six months form the CNE official node price reports.
- **Emission Displacement:** Calculation of the Operating Margin and the Build Margin. Determination of emission displacement due to the operation of the project.

The following sections describe how the first three worksheets calculate ERs.

An 4.4.2. Energy Generation of The CDM Project

The hourly net generation of the Project Activity is obtained from the metering system of the power 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.

		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 Activity must have precision class of 0.2%, according th NCh 2542 / 2001, which is the general standard in the electric system in Chile for all power generating

units. This meter will be placed at the high voltage bus. The metering register the instantaneous sum of the power of the generators, which is integrated in 15 minutes intervals. The data from the meter will be collected by the Project Operator, and is then transmitted every two hours to the CDEC-SIC electronically.

Every meter in the system, including the Project Activity meters, are equipment that fulfill highly reliability and quality standards. Actually, there is no official indication or regulations that require a periodic calibration of metering equipment, however they will be calibrated every two years by independent and accredited third parties that will certify the meters fulfill the precision requirements. The calibration procedure consists in comparing the measuring system with a higher precision reference meter. A calibration report is then issued for each meter.

An 4.4.3. Energy Generation Data of All Generating Units of the System

- **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 shown below.

DATE	DD-MM-YYYY

Type	V.COST	PLANT	POWER	Hr01	Hr02	Hr…	Hr23	Hr24	TOT
Reservoir		ANTUCO	300	171	235	…	181	171	5,113
		MACHICURA	90	19	19	…	60	60	881
		RANGUE	467	463	463	…	461	461	11,117
		SANIGNACIO	37	…	…	…	20	20	168
		RALCO	570	570	570	…	570	570	13,680
		…	…	…	…	…	…	…	…
Total of Reservoir				1,512	1,534	…	2,602	2,224	48,005
Run-of-River		ABANICO	136	45	45	…	44	43	1,060
		ACONCAGUA	72.9	28	28	…	28	28	692
		ALFALFAL	160	56	53	…	57	57	1,309
		CAPULLO	10.7	12	12	…	11	12	280
		CDM CHACABUCO	26	19	18	…	17	17	421
		CDM QUILLECO	70	40	40	…	40	40	960
		CDM OTHER	…	…	…	…	…	…	…
		CDM MARIPOSAS	6	6	6	…	6	6	144
Total of Run-of-River				803	787	…	833		18,850
Thermal	0	ACONSTITUCION	20	16	15	…	15	15	354
	0	CONSTITUCION	8.7	7	7	…	7	6	146
	0	HORCONES TG	12.1	18	17	…	16	16	405
	0	LAJA	8.7	3	4	…	8	6	124
	0	LICANTEN	13	2	2	…	…	…	17
	0	P.VALDIVIA	70	…	…	…	…	…	…
	0	PETRPOWER	48.6	68	68	…	68	68	1,634
	2.4	ARAUCO	101.3	31	32	…	31	31	761
	9.9	CHOLGUAN	15	12	12	…	10	11	276
	12.5	NUEVA RENCA	379	186	67	…	367	332	6,463
	16.6	NEHUENCO 2	380	379	379	…	…	…	4,603
	16.7	NEHUENCO 2	352	351	336	…	354	356	8,262
	17.3	CENTRAL SAN	370	305	167	…	352	353	7,269
	20.4	GUACOLDA 1	152	…	…	…	…	…	…
	20.4	GUACOLDA 2	152	150	150	…	15.1	152	3,610
	21.3	TALTAL 1	120	97	80	…	116	117	2,435
	21.3	TALTAL 2	120	…	…	…	…	…	…
	27.4	VENTANAS2	212	…	…	…	…	…	…
	29.4	BOCAMINATV	125	…	…	…	…	…	…
	…	…	…	…	…	…	…	…	…
Total Thermal				1,626	1,336	…	1,511	1,465	36,432
Total				3,940	3,657	…	4,946	4,496	103,287

- **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
…	…	…

- **The "Marginal Power Unit in the SIC"**

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 that would be dispatch in the system if no CDM project activities were present in the system.

Every thermal plant has its own tCO2/GWh conversion factor according to its specific consumption and type of fuel. The emission factors can be calculated using CNE node price report and IPCC manual.

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

- **The "Theoretical Dispatch without CDM Projects" and the Emission Displacement**

Without the Project Activity 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 limited capacity, and it´s increment may not be sufficient to meet the system demand, a next power unit must be dispatched in the economic merit order priority to supply the required energy. And if there is still not sufficient energy with the next marginal plant, then other unit(s) must be dispatched following the same order. In order to determine the Project Activity's energy and emission displacement, it must be taken into account all other CDM units of the system. The following table presents an example how the dispatch should change and the energy displacement that CDM projects will produce in the system.

				Hr1	Hr2	Hr…	Hr23	Hr24
CDM N°1 (CHACABUQUITO)		Energy in MWh	C1	19	18	…	17	17
		Capacity in MW		26	26	…	26	26
CDM N°2 (QUILLECO)		Energy in MWh	C2	40	40	…	40	40
		Capacity in MW		70	70	…	70	70
CDM N°N-1 (--)		Energy in MWh	C3	25	30	…	30	30
		Capacity in MW		55	55	…	55	55
CDM N°N (MARIPOSAS)		Energy in MWh	C4	6	6	…	5	6
		Capacity in MW		6	6	…	6	6
Marginal Plant 1	Energy	MWh	B1	97	80	…	116	117
	plant Name			TALTAL1	TALTAL1	…	TALTAL1	TALTAL1
	Capacity	MW	A1	120	120	…	120	120
	E. Factor	TCO2/GWh	d1	641	641	…	641	641
Marginal Plant 2	Energy	MWh	B2	-	-	…	-	-
	plant Name			TALTAL2	TALTAL2	…	TALTAL2	TALTAL2
	Capacity	MW	A2	120	120	…	120	120
	E. Factor	TCO2/GWh	d2	641	641	…	641	641
Marginal Plant 3	Energy	MWh	B3	-	-	…	-	-
	plant Name			VENT2	VENT2	…	VENT2	VENT2
	Capacity	MW	A3	212	212	…	120	120
	E. Factor	TCO2/GWh	d3	1,025	1,025	…	1,025	1,025

If other CDM projects are implemented in the system then, for each hour, the emission displacement should meet the formulae stated on AM0026 (version 3).

- **Emission Displacement for Operating Margin**

The emission factor form the Operating Margin can be estimated following formulas indicated en AM0026 (version 3). The following table presents an illustrated example to calculate the emission displacement of the Operating Margin.

		Hr1	Hr2	Hr…	Hr23	Hr24
MDL N°1 (CHACABUQUITO)						
MWh Displacement						
Marginal Plant 1	min(C1; (A1-B1) - D21-D31-D41) = D11	0	0	…	0	0
Marginal Plant 2	min(C1-D11; (A2-B2) - D22-D32-D42) = D12	19	18	…	17	17
Marginal Plant 3	min(C1-D11-D12; (A3-B3) - D23-D33-D43) = D13	0	0	…	0	0
TCO2 Displacement						
	d1*D11+d2*D12+d3*D13 = ER1	12.2	11.5	…	10.9	10.9
MDL N°2 (QUILLECO)						
MWh Displacement						
Marginal Plant 1	min(C2, (A1-B1) - D31-D41) = D21	0	4	…	0	0
Marginal Plant 2	min(C2-D21; (A2-B2) - D32-D42) = D22	40	36	…	40	40
Marginal Plant 3	min(C2-D21-D22; (A3-B3) - D33-D43) = D23	0	0	…	0	0
TCO2 Displacement						
	d1*D21+d2*D22+d3*D23 = ER2	25.6	25.6	…	25.6	25.6
MDL N°N-1 (---)						
MWh Displacement						
Marginal Plant 1	min(C3, (A1-B1) - D41) = D31	17	30	…	0	0
Marginal Plant 2	min(C3-D31; (A2-B2) - D42) = D32	8	0	…	30	30
Marginal Plant 3	min(C3-D31-D32; (A3-B3) - D43) = D33	0	0	…	0	0
TCO2 Displacement						
	d1*D31+d2*D32+d3*D33 = ER3	16.0	19.2	…	19.2	19.2
MDL N°1 (MARIPOSAS)						
MWh Displacement						
Marginal Plant 1	min(C4, (A1-B1) - 0) = D41	6	6	…	4	3
Marginal Plant 2	min(C4-D41; (A2-B2) - 0) = D42	0	0	…	1	3
Marginal Plant 3	min(C4-D41-D42; (A3-B3) - 0) = D43	0	0	…	0	0
TCO2 Displacement						
	d1*D41+d2*D42+d3*D43 = ER4	3.8	3.8	…	3.2	3.8

- **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), or the set of five power units that have been built most recently, it will depend on which method has the larger annual generation. The following table presents an illustrated example of how the Build Margin Emission Factor for the Project is calculated for a given year

COMM DATE	Plant Name	Type	EF	Energy
	OTHERS			3.853.386
1970	BOCAMINATV	Thermal	925	300.051
1973	EL TORO	Reservoir	0	1.693.974
1977	HUASCOTG	Thermal	1002,9	29.064
1977	VENTANAS1	Thermal	1071	413.467
1977	VENTANAS2	Thermal	1024,96	1.050.510
1981	ANTUCO	RoR	0	1.662.081
1981	ARAUCO	Thermal	0	156.044
1985	COLBUN	Reservoir	0	2.021.022
1985	CONSTITUCION Gener	Thermal	982	50.265
1985	CURILLINQUE	RoR	0	627.902
1985	DIEGO DE ALMAGRO	Thermal	1071	6.236
1985	MACHICURA	RoR	0	453.530
1990	CANUTILLAR	Reservoir	0	1.094.674
1991	PEHUENCHE	Reservoir	0	2.567.234
1993	ACONCAGUA	RoR	0	371.391
1993	\CONSTITUCION Arauc	Thermal	0	132.388
1993	ALFALFAL	RoR	0	840.860
1995	CAPULLO	RoR	0	74.237
1995	GUACOLDA 2	Thermal	893,697	2.468.970
1995	LAJA	Thermal	0	39.483
1996	PANGUE	Reservoir	0	1.675.343
1996	SAN IGNACIO	RoR	0	182.344
1997	LOMA ALTA	RoR	0	276.888
1997	NUEVA RENCA	Thermal	396	2.275.586
1997	PUNTILLA	RoR	0	118.339
1998	QUELTEHUES	RoR	0	357.697
1998	RUCUE	RoR	0	1.091.127
1998	CENTRAL SAN ISIDRO	Thermal	424,012	2.705.618
1998	NEHUENCO	Thermal	396,115	1.847.504
1998	PETROPOWER	Thermal	879	526.035
2000	MAMPIL	RoR	0	173.898
2000	PEUCHEN	RoR	0	261.831
2000	TALTAL 1	Thermal	641	624.403
2000	TALTAL 2	Thermal	641	364.208
2002	NEHUE.9B	Thermal	604	106.395
2003	CHOLGUAN	Thermal	0	93.347
2003	NEHUENCO 2	Thermal	411,691	1.996.332
2003	SAN FRANCISCO M.	Thermal	982	9.380
2004	ANTILHUE TG (*)	Thermal	0	160
2004	ANTILHUE TG	Thermal	820	710
2004	HORCONES TG (*)	Thermal	0	12.023
2004	HORCONES TG	Thermal	944	56
2004	ITATA	Thermal	0	319
2004	LICANTEN	Thermal	0	21.412
2004	P.VALDIVIA	Thermal	0	153.204
2004	RALCO	Reservoir	0	1.332.259
Total SIC Energy Generation of 2004			MWh	36.113.187
Latest 20% of Capacity additions Generation			MWh	7.523.475
Total Emiission of latest 20%			TCO2e	2.723.889
EF_BM			**TCO2/GWI**	**362**

(*) Commisioning tests

AN 4.5. PROJECT ACTIVITY SUSTAINABLE DEVELOPMENT MVP

An 4.5.1. 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. The following local environmental benefits have been identified from the Mariposas Hydroelectric Project

(see Mariposas Hydroelectric Project DIA from CONAMA's official website **www.e-seia.cl** for more details).

- The project will contribute with clean renewable energy for the SIC Grid of Chile, displacing thermal generation

The direct social and development impact of the project are as follows (see Mariposas Hydroelectric Project DIA from CONAMA official website **www.e-seia.cl** for more details).

- Job creation during the construction period and also during the operation
- Economic activity during the construction period and also during all of its lifetime.

An 4.5.2. Monitoring, Recording and Reporting

For the monitoring, recording and reporting of the environmental, social and developmental impacts identified for the Project, the following two points 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 Project Activity.

AN 4.6. MANAGEMENT AND OPERATIONAL SYSTEMS MVP

An 4.6.1. Allocation of Project Management Responsibilities

The management and operation of the project, related to CDM activities, is part of the Project Operator's responsibilities. 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 sponsor as far as this MVP is concerned.

An 4.6.2. Management and Operational Systems

- **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 Project Operator must develop and implement a protocol that provides for these critical functions and processes, which must be fit for independent auditing.

- **Quality assurance**

The Project Operator 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. Proper management processes and

systems records must be kept by the Project Operator, as the auditors will request copies of such records to judge compliance with the required management systems.

- **Reporting**

The Project Operator will report regularly to the ERs Buyer(s) as well as to Chilean authorities as required by them.

- **Training:**

It is the responsibility of the Project 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.

AN 4.7. AUDITING AND VERIFICATION PROCEDURES

An 4.7.1. Audit and Verification Regime

The Project Activity must be submitted to third party validation and verification, which is conducted by independent firms specialized in environmental auditing services (auditors, validators, verifiers, certifiers). The verification system for the Project Activity consists of these four activities:

- **Validation of project design**

The Project Activity must undergo a CDM validation of the project's design, baseline and MVP against CDM requirements and modalities. Validated MVP for a project must be followed by the Project Operator.

- **Initial audit and verification of project readiness**

The Project Activity is required to successfully complete an initial audit and verification process before commissioning the project and acceptance of emission reductions delivered by it. To prevent conflicts of interest, verification must not be conducted by the same firm and individuals that have provided validation services for the project.

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 complying any buyer supervision obligations and clear the way for project commissioning and generation of high quality ERs.

- **Periodic verification of emission reductions**

The Project Activity 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 must be arranged and conducted at annual or longer intervals as appropriate for the Project Sponsor or ERs Buyers. 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.

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

- The project has achieved the ERs for the verification period in compliance with the methodology laid down in this PDD.
- 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, host country requirements and modalities for CDM projects, and the ERs buyer(s).
- The project maintains a high quality monitoring systems consistent with the MVP.

- **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 project has achieved the stated quantity of ERs in compliance with all relevant criteria and requirements.

- **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 and risk management controls.

The auditor will produce an audit report and 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.