CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-SSC-PDD)
VERSION 03 - IN EFFECT AS OF: 22 DECEMBER 2006

CONTENTS

Annexes

Revision history of this document

Version Number	Date	Description and reason of revision
01	21 January 2003	Initial adoption
02	8 July 2005	• The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document. • As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>.
03	22 December 2006	• The Board agreed to revise the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM.

SECTION A. General description of small-scale project activity

A.1 Title of the small-scale project activity:

Choloma Hydroelectric Project
Version: 3.4
Date: 5/12/2012

A.2. Description of the small-scale project activity:

The purpose of the proposed project activity is to generate renewable electricity using small-scale hydroelectric resources and to sell the generated output to the national grid. The project activity has the capacity to reduce CO_2 emissions by avoiding electricity generation by fossil fuel-fired power plants connected to the grid. In the baseline scenario and the situation existing prior to the implementation of the project activity, the electricity delivered to the grid is generated by the operation of existing grid-connected power plants and by additions of new generation sources, as is reflected in the combined margin to calculate baseline emissions.

The project activity consists of the construction and operation of the Choloma Hydroelectric Project, a small-scale hydroelectric power plant with an installed capacity of 9.7 MW[1], which will produce electricity free of greenhouse gases. The developer and owner of the project is Hidroeléctrica Choloma, S.A., a company based in Guatemala.

The goals of the Choloma Hydroelectric Project are as follows:

1. To produce electricity to be injected into the electric grid of Guatemala, with the purpose of contributing to meet the country´s growing electricity demand. It is estimated that the power plant will produce an average of 36.538 GWh[2] of electricity per year, which will be sold in the Guatemalan energy market. The Guatemalan legal framework, under the Guatemalan General Electricity Law (*Ley General de Electricidad*), allows private investments in the power generation sector with the objective of increasing electricity supply.

2. To increase the use of renewable resources in Guatemala in order to produce clean electric energy and to substitute fossil fuel based generation.

3. To contribute to the sustainable development of Guatemala, utilizing the renewable resources responsibly, and strengthening local synergies to foster the development of the communities in the area of influence of the project activity through the following measures:

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[1] As per the version 17 of the General Guidelines to SSC CDM methodologies, the installed capacity of the plant is determined by the rated output of the generator, which is 9.7 MW, as per equipment manufacturer data. This information is indicated in the generator nameplate.

[2] See calculation procedure in section A.4.2 of the PDD (page 7).

- Environmental dimension

  - The project activity avoids the emission to the atmosphere of approximately 18,926 tons of CO_2 per year, through the utilization of renewable resources to generate electric power, thus contributing to the mitigation of global climate change. In addition to CO_2 emissions reductions, the project activity will also mitigate other pollutants, such as SO_2, NO_x, and particles associated with power generation by displacing fossil fuels.
  - It contributes to the preservation of local natural resources of the sub-basin of the Choloma River, by means of projects aimed at environmental conservation and protection. In addition to reforestation projects that will be supported, the surrounding area of the project property contains more than 800 hectares (8 million square meters) of natural rainforests, which will be conserved.
  - Over the long-term, because of its size and general characteristics (rural area, local electricity needs), this project has a high probability of being replicated in other parts of Guatemala. This fact magnifies the global and local environmental benefits generated by the project activity.

- Economic dimension

  - The project activity contributes to poverty reduction by creating employment opportunities through the construction and operation of the hydroelectric plant and by the implementation of reforestation programs, as well as projects carried out by the sponsoring company´s corporate social responsibility efforts that improve infrastructure, health and educational aspects in the surrounding communities.
  - On a national scale, the project activity provides clean electricity to the power market, thus reducing dependence on fossil fuel imports.

- Social dimension

  - The project participant plans to support community projects that improve the quality of life of people living close to the hydroelectric plant. As part of the project development, a potable water grid for the neighbouring indigenous communities is planned.
  - As part of the social responsibility program of the project activity, projects aimed at improving living standards and economic development of the surrounding indigenous communities will be designed and implemented, including activities such as: Assisting a local health centre, supporting community organization in order for them to be able to access government programs and international aid projects, providing vocational training courses, and in general assisting with education, health, infrastructure (and other) requirements, through the establishment of cooperation agreements between Choloma and various local and international NGOs, and by coordinating and implementing projects directly.

From its inception the project activity considered the reduction of CO_2 emissions and the related revenues to overcome project financial barriers. CDM income (from the sale of CERs) will enable the execution of the Project, thereby contributing to Guatemala's sustainable development and to global climate change mitigation.

The project participant is anticipating to direct, at a minimum, 10% of the annual revenues generated through the sale of CERs to be invested in social and environmental programmes, with the objective of assisting the local environment and communities in areas such as community organization and leadership, school education, health, infrastructure and sustainable productive projects, as previously described. The main objective in the medium term is for communities to develop self-sustaining and environmentally sound economic activities to improve living standards in general.

A.3. Project participants:

Name of party involved	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)
Guatemala (host Party)	Private entity: Hidroeléctrica Choloma, S.A.	No

A.4. Technical description of the small-scale project activity:

A.4.1. Location of the small-scale project activity:

A.4.1.1. Host Party(ies):

Guatemala

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

Alta Verapaz

A.4.1.3. City/Town/Community etc:

San Antonio Senahú

A.4.1.4. Details of physical location, including information allowing the unique identification of this small-scale project activity :

The Choloma hydroelectric plant is located on the Choloma River, in the Department (State) of Alta Verapaz, around 200 kilometers North-east of Guatemala City. The geographical coordinates of the location are:

Table 1. Coordinates of the Choloma hydroelectric plant (Power plant) location

Latitude	15.41656531
Longitude	- 89.74165110

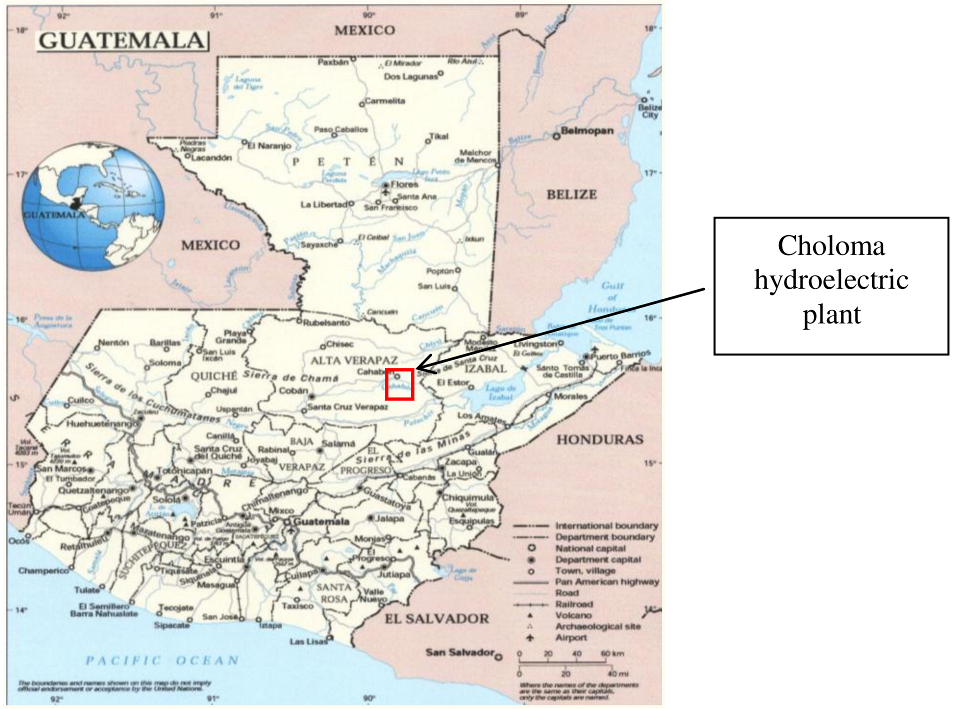


Fig. 1. Choloma Hydroelectric Project location

A.4.2. Type and category(ies) and technology/measure of the small-scale project activity:

The project activity is type I (Renewable energy projects < 15 MW), classified as ID category for Grid connected renewable electricity generation, sectoral scope 01. The technology of the small-scale project activity consists of hydro renewable energy generation units, supplying electricity to a national grid.

Electricity from a renewable source will be generated by a small-scale hydroelectric plant with a daily regulation reservoir (tank), which will allow a constant power supply during the daily peak demand hours that in the Guatemalan electric market occur from 6 to 10 pm.

The small-scale hydroelectric plant is located in a region with high variations in the annual hydrologic pattern between the rainy and the dry seasons. The hydroelectric plant is designed as a peaking or daily regulation plant. It includes a small artificial reservoir (water storage tank) that will allow water storage during daily low demand hours, which is then released during daily peak demand hours, thus contributing renewable energy to the power grid at the time of maximum power requirement, which directly results in a greater avoidance of higher levels of fossil fuel based power generation. The power plant, which uses the water flows from the Choloma River and its tributaries Secampana, Secampanita, Golondrinas and Caquipek, is illustrated in Figure 2.

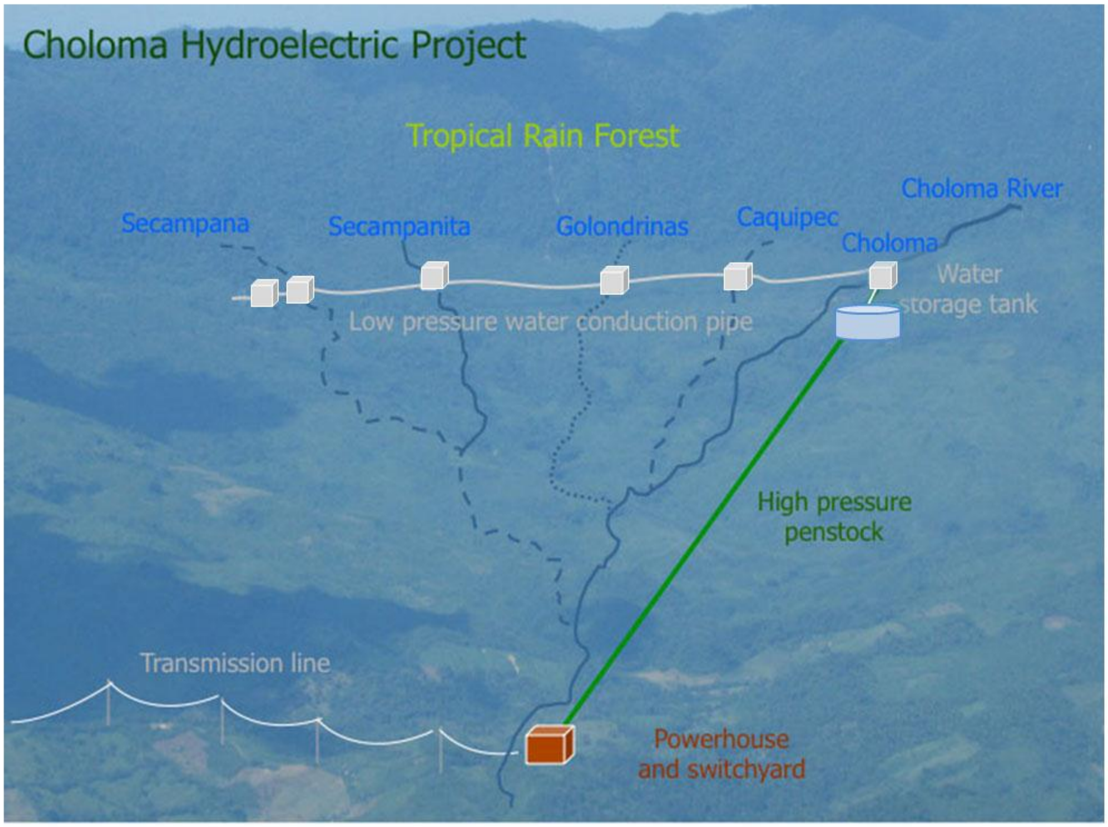


Fig. 2. Layout of Choloma Hydroelectric Project

Project installed capacity and annual energy generation

The Choloma hydroelectric project has a gross head (altitude differential from the maximum water level in reservoir (tank) to the turbine axis elevation) of 461 meters, and has a design flow of 2.5 cubic meters per second. The powerhouse is equipped with a 9.577 MW turbine and a 9.7 MW generator. The yearly average electricity production is expected to be 36.538 Gigawatt hours (GWh), assuming a plant factor of 0.43.

The hydroelectric plant will have a water storage tank with a capacity of 20,000 cubic meters of live storage volume, which will provide power delivery at a capacity of at least 5 Megawatts during peak demand hours year round (6 to 10 pm each day), and up to full capacity in the rainy season due to the increased water flows.

Site geology

The geology of the area is composed mainly of Karst type geologic formations, and Geological and Geotechnical exploration studies were undertaken to establish the design criteria and requirements for an adequate final design, in particular for the powerhouse foundations, the main thrust block (concrete block that holds the high pressure penstock at its connection to the powerhouse), and the tank. In order to ascertain the completeness and adequacy of the geological explorations, the US consulting firm *EES Consulting* issued the "Choloma Hydroelectric Project Geotechnical Investigation Scope of Work."

The Geologic studies were contracted with the Guatemalan company Rodio-Swissboring (http://www.rodio-swissboring.com/empresa.html), a subsidiary of the Spanish company Rodio (http://www.rodio.com/eng/presentacion.asp). The results from the various studies were used for final designs of the project's water storage tank, the penstock thrust blocks, machine house and switchyard foundations.

Hydrology and climate

The water flow to be used by the project activity comes from the Choloma River and its four tributaries Secampana, Secampanita, Golondrinas and Caquipec; this system is part of the larger Polochic river basin located in the central Alta Verapaz region. The water flow contributions from the four tributaries will be collected and conducted through a 6.44 kilometre long low-pressure pipeline to a water storage tank to be built next to the Choloma River, where the flow from this fifth and most important river is added to the system.

The average annual rainfall at the project area is approximately 4,050 millimetres. The rainy season starts in early June and ends in late October. Some rainfall during the dry season occurs sporadically, induced by weather systems coming from the Caribbean ocean. Historically, the month with most rainfall is July, while the driest month is April. Daily rainfall records have been collected since 1996.

Using the results obtained from the hydrological study and the water measurements taken over time, the hydroelectric plant has been conceptualized with a design flow of 2.5 m^3/s. Average annual water flow is 1.07 m^3/s, with a minimum daily flow of 0.210 m^3/s occurring in April. The flow duration curve of the power plant is presented next.

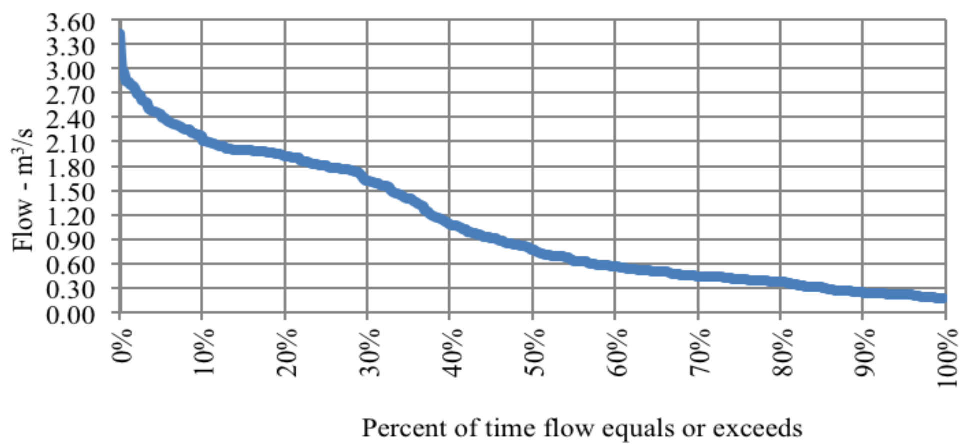


Fig. 3. Flow duration curve

Water intake dams and low-pressure pipeline

Small water diversion dams will be built at each of the four tributaries and on the Choloma River. The diversion dams will divert water from the Choloma River and its tributaries and will form small water bodies, which will not be used as daily regulation reservoirs.

The water will flow into the low-pressure pipes through the intakes, which are constructed with self-cleaning sluiceways and trash-rack covered pipe-inlets in order to keep sediment, leaves and other debris out. The pipes from each intake will merge with a main low-pressure pipeline in order to conduct the combined water to the water storage tank at the Choloma River. The entire low pressure system is 6.45 km long, and most of it will be installed underground, buried next to an existing road, saving the project the high cost, and avoiding the environmental effects, of having to construct a new trench through very difficult terrain.

Water storage tank

The project will have a water storage tank with a live storage volume (water available for power generation) of approximately 20,000 cubic metres, enabling the plant to constantly deliver 5.0 MW during the 4 daily peak demand hours, year round.

The tank will be of steel, with a diameter of 60 meters and a height of 10.6 meters. The geometric shape of the tank is cylindrical; therefore its area is constant at any water level. The innovative and environmentally friendly idea of building a water tank as water reservoir, instead of a dam, is already being replicated in at least one small hydro project in Guatemala that is currently under construction.

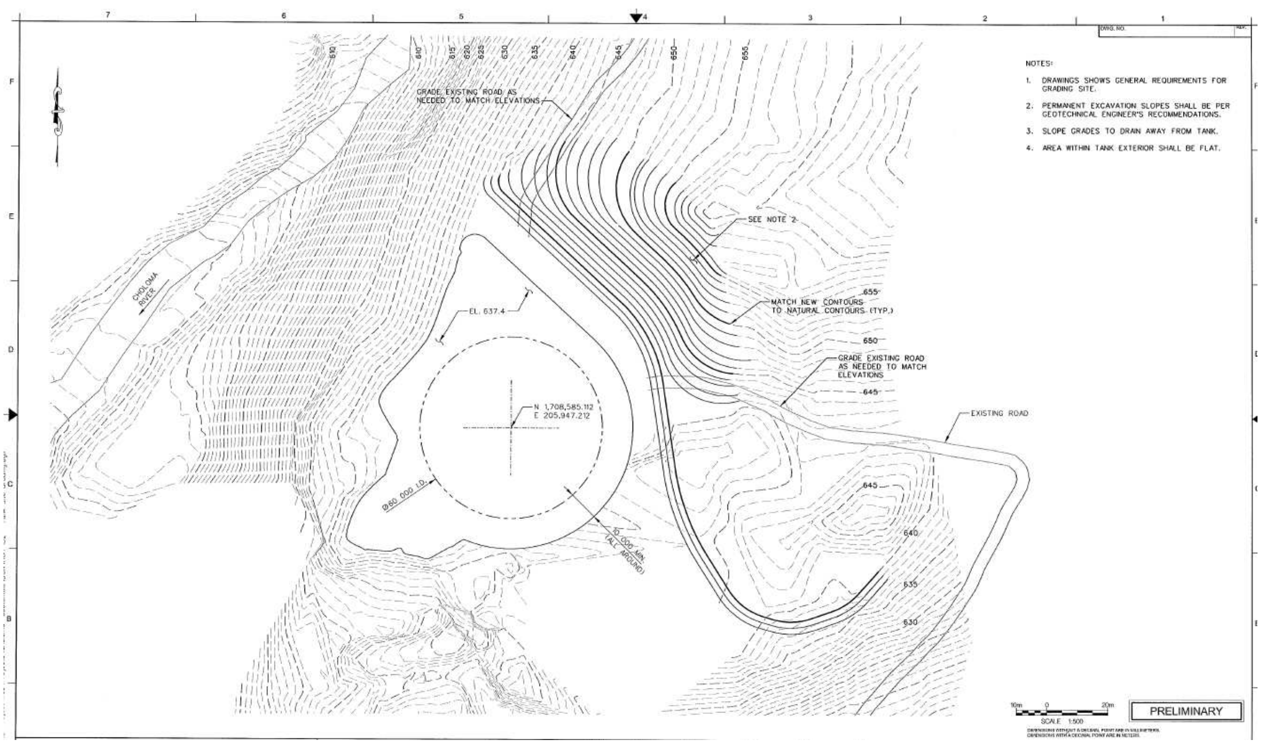


Fig. 4. Footprint and location of the water storage tank

The high-pressure penstock begins at the tank. The controlled turbine output will manage the water level in the tank continuously, so that a full tank can be established daily ahead of the peak demand period during which the complete live storage volume will be released over 4 hours to increase plant output.

High pressure penstock

The high-pressure penstock will be of steel. The pipe diameter ranges from 0.96 to 1.1 metres, and the complete pipeline will be 2.68 kilometres long.

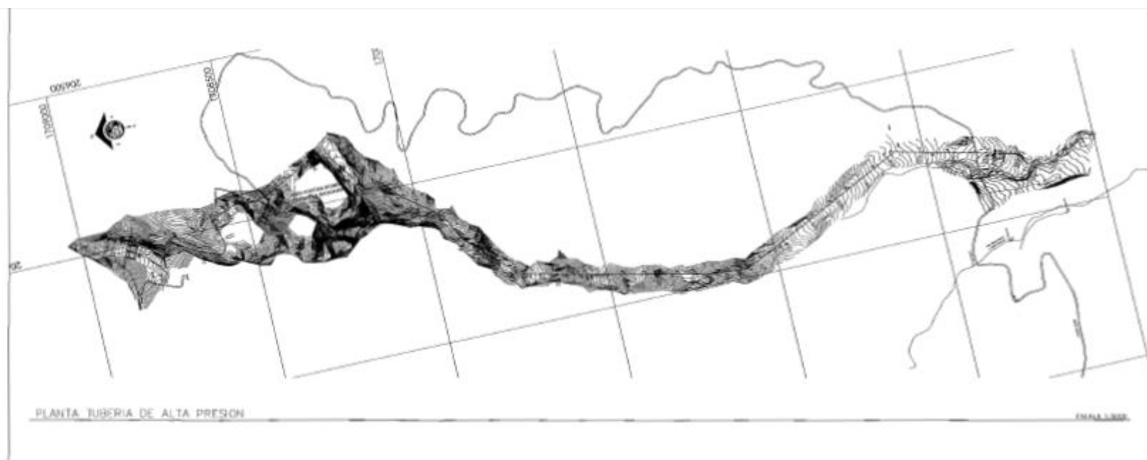


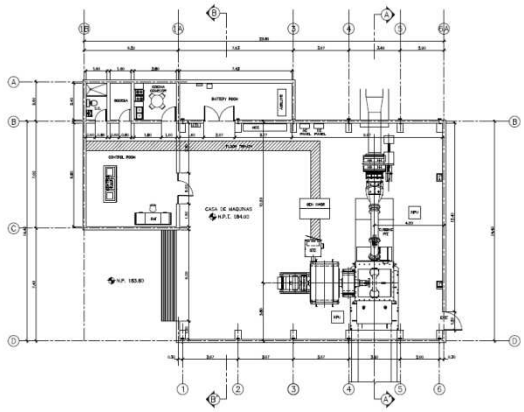
Fig. 5. Top View of high pressure penstock (2,684 meters)

The penstock will be installed in an earthen trench, which will be refilled with the extracted soil as fill-material. Pipe sections will be stored at general staging areas, from where they will be transported and placed into the trench utilizing the developer's own overhead cable-crane, a very efficient installation method that does not require the construction of extensive and expensive roads and reduces environmental impacts.

Powerhouse (Machine House)

The machine house will be composed of a concrete foundation and a steel structure, covered with metal siding. It will house the turbine, generator, lubrication and hydraulic pump units, switchgear, control and protection equipment. It will contain an overhead travelling crane with sufficient capacity to lift the heaviest parts (oil filled main step-up transformer); the crane will be used for equipment unloading and assembly. Adjacent to the power house will be the operating and control room from where the plant operator will be shielded from the noise and higher temperatures but will be able to observe the power-house floor on one side, and the exterior switchyard on the opposite side. The control room will include all equipment necessary for automatic and manual plant operation and control. Additional rooms adjacent to the powerhouse and control room will contain emergency battery racks, operator kitchenette, restroom, and storage area.

Water discharge from the turbine will flow into a tailrace channel underneath the powerhouse, which will extend out to the original Choloma river basin for water release.



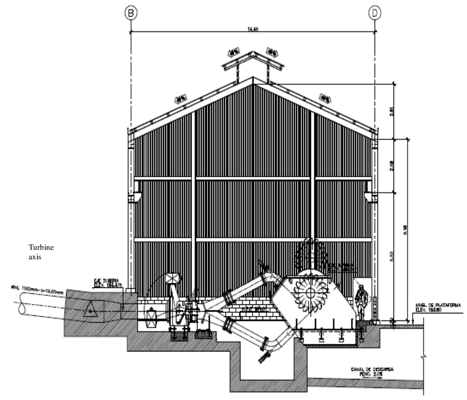


Fig. 6. Machine House Layout and Machine House Side-View

Choloma Switchyard and Transmission Line

Outside of the control room a 180 square meter electrical switchyard will be built. It will contain the main step-up transformer and related switchgear. To prevent environmental damage, an oil trap will be built with the capacity to hold 100% of the transformer oil in the event of leakage/spillage.

A 4-kilometre long 69-kilovolt-transmission line has been installed, which will connect the Choloma substation with the existing Secacao substation. From here, the net electricity produced by the project activity will be delivered to the Guatemalan transmission grid.

The electricity metering equipment will be installed at the Secacao substation and consists of two electricity meters (main and back-up), voltage and current transformers, power supply and a communication system.

In addition to the high-voltage transmission line, an “internal” low-voltage power line has been built which extends from the machine house up to the main Choloma dam and the 5 intakes at the other rivers. This line provides electricity for illumination and gate operation, and will also hold a fibre-optic cable to allow for data transfer between the dam and the powerhouse for plant monitoring and control.

Project technical data summary[3]

River Basin:	Polochic River (sub-basin: Choloma River)
Main River:	Choloma
Secondary flows:	Secampana, Secampanita, Golondrinas, Caquipek
Installed Capacity[4]:	9.7 MW
Design flow:	2.5 m^3/s
Gross head:	461 m
Turbine:	Single Pelton turbine, twin jets, horizontal shaft, 9.577 MW

[3] As per feasibility studies and final design.

[4] In accordance to generator nameplate data.

Generator:	9.7 MW, 60 Hz, synchronous, enclosed water/air-cooling unit
Water Storage Tank:	Steel, 60 meter diameter, 10.6 meter height; live storage capacity of 20,000 m^3
Low pressure penstock:	6.45 km HDPE[5] pipe with diameters ranging from 0.45 to 1.2 meters
High-pressure penstock:	2.68 km steel penstock, diameters from 0.96 meters to 1.1 meters.
Power House:	Concrete foundation, steel structure with steel siding; approximate area of 336 m^2
Main step-up Transformer:	12.2 MVA, 6.6 to 69 kV
Transmission voltage:	69 kV
Main transmission line:	4 km
Average electricity generation:	36.538 GWh / yr
Plant factor:	43%

A.4.3 Estimated amount of emission reductions over the chosen crediting period:

The renewable crediting period (7 years * 3) is chosen and it is expected that the Project Activity will reduce 132,482 tCO_2e in the first crediting period.

Table 2. Annual estimation of emission reductions during the first crediting period

	Annual estimation of emission reductions (t CO_2)
2013 (March-December)	15,772
2014	18,926
2015	18,926
2016	18,926
2017	18,926
2018	18,926
2019	18,926
2020 (January-February)	3,154
Total estimated reductions (t CO_2)	132,482
Total number of crediting years	7
Annual average over the first crediting period of estimated reductions (t CO_2)	18,926

[5] High density polyethylene.

A.4.4. Public funding of the small-scale project activity:

Public funding from an Annex I is not used by the project.

A.4.5. Confirmation that the small-scale project activity is not a debundled component of a large scale project activity:

According to the version 03 of the "Guidelines on assessment of debundling for SSC project activities" (EB 54; Annex 13), the Choloma Project is not part of a larger CDM project activity, as there is no registered small-scale activity or an application to register another small-scale activity with the same project participants, in the same project category and technology, and registered within the previous two years.

There are two existing hydropower plants, Secacao (16 MW) and Candelaria (4 MW), located next to the boundaries of the project activity, using the flow from the Trece Aguas River. The mentioned hydropower plants began operations in 1998 and 2006, respectively. They are not part of the proposed project activity because Secacao was not registered as a CDM project and Candelaria was registered on November 6, 2006 under UNFCCC, reference number 0604.

Nor are any other CDM projects to be submitted by the project sponsor in the future on the same river and within 1 km of the project boundary of the proposed small scale activity. Thus, the proposed Choloma Hydroelectric Project is not part of a larger, debundled CDM activity.

SECTION B. Application of a baseline and monitoring methodology

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

AMS-ID: Grid connected renewable electricity generation, version 17.0.

Type I. Renewable energy projects

Sectoral scope: 1

B.2 Justification of the choice of the project category:

The project activity qualifies in this category because it fulfills the eligibility criteria of the version 17 of AMS I.D methodology.

AMS I.D Eligibility criteria	Application to the Project Activity
This methodology comprises renewable energy generation units, such as photovoltaic, hydro, tidal/wave, wind, geothermal and renewable biomass: *a) Supplying electricity to a national or a regional grid; or* *b) Supplying electricity to an identified consumer facility via national/regional grid through a contractual arrangement such as wheeling.*	The Choloma hydroelectric plant uses water (renewable resource) from the Choloma River. The electric energy produced is delivered to the National Electricity System (grid).
This methodology is applicable to project activities that: (a) Install a new power plant at a site where there was no renewable energy power plant operating prior to the implementation of the project activity (Greenfield plant); (b) Involve a capacity addition; (c) Involve a retrofit of (an) existing plant(s); or (d) Involve a replacement of (an) existing plant(s)	It is a greenfield plant because it consists of the construction of a new power plant at a site where there was no renewable energy power plant operating prior to the implementation of the project activity.
Hydro power plants with reservoirs that satisfy at least one of the following conditions are eligible to apply this methodology: • *The project activity is implemented in an existing reservoir with no change in the volume of reservoir;* • *The project activity is implemented in an existing reservoir, where the volume of reservoir is*	The facility of the hydroelectric plant includes new multiple reservoirs, with a total area of 3,751.97 m^2 at maximum level and the power densities of each reservoir as well as of the whole power plant are greater than 4 W/m^2. As per the information provided in the project emissions section, the power density of the project

increased and the power density of the project activity, as per definitions given in the project emissions section, is greater than 4 W/m²; • *The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the project emissions section, is greater than 4 W/m².*	activity is greater than 4 W/m².
If the new unit has both renewable and non-renewable components (e.g. a wind/diesel unit), the eligibility limit of 15 MW for a small-scale CDM project activity applies only to the renewable component. If the new unit co-fires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15 MW.	The project activity does not include both renewable and non-renewable components; and the project activity does not co-fires any fossil fuels. The project activity includes only a renewable component that does not exceed 15 MW. It consists of the construction and operation of the Choloma hydroelectric plant that has an installed capacity below 15 MW. The capacity of the electric generator is 9.7 MW.
Combined heat and power (co-generation) systems are not eligible under this category.	Not applicable, the project activity is not a combined heat and power (cogeneration) system.
In the case of project activities that involve the addition of renewable energy generation units at an existing renewable power generation facility, the added capacity of the units added by the project should be lower than 15 MW and should be physically distinct from the existing units.	Not applicable, the project activity is a new project; therefore it does not involve the addition of renewable generation units at an existing renewable generation facility.
In the case of retrofit or replacement, to qualify as a small-scale project, the total output of the retrofitted or replacement unit shall not exceed the limit of 15 MW.	Not applicable, the project activity is not a retrofit nor a replacement.

B.3. Description of the project boundary:

According to the version 17.0 of the AMS-I.D. Grid connected renewable electricity generation, “the spatial extent of the project boundary includes the project power plant and all power plants connected physically to the electricity system[6] that the CDM project power plant is connected to.”

The power plant includes the area occupied by the components of the hydroelectric plant, which are:

- Water intake structures, conveyance system and daily regulation water storage tank;
- High pressure penstock and powerhouse and;
- Step-up substation.

[6] Refer to section B.6.1 for definition of an electricity system.

- A transmission line from the step-up substation to the Secacao interconnection substation[7] that connects to the National Electricity System.
- The electricity metering equipment installed in the 69 kV bus of Secacao interconnection substation to measure the electricity delivered to the grid.

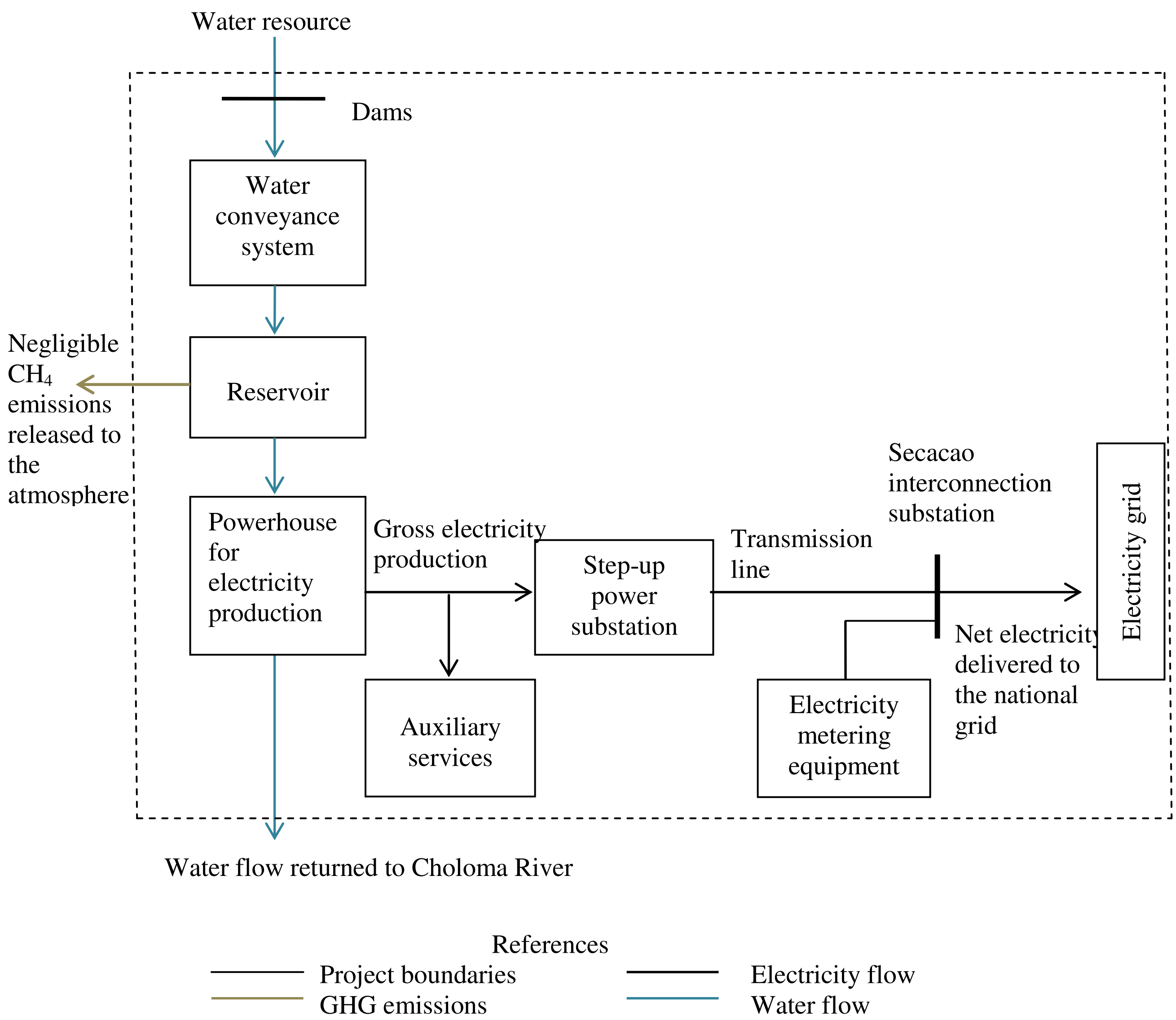


Fig. 7. Boundaries of the project activity

[7] Secacao interconnection substation is not a component of the Choloma Hydroelectric Plant.

B.4. Description of baseline and its development:

Because the project activity is the installation of a new grid-connected renewable power plant, the baseline scenario is the electricity delivered to the grid by the project activity that otherwise would have been generated by the operation of grid-connected power plants and by the addition of new generation sources as AMS-I.D methodology, version 17.0, indicates.

1. Legal framework

With the passing of the General Electricity Law by the Guatemalan Congress in 1996, the Electricity Wholesale Market initiated operations and began administrating and dispatching the energy and power transactions between market agents under free market conditions. The electricity market includes energy transactions in the opportunity or spot market, and capacity and energy transactions in the contract market, according to short to long-term contracts between market agents.

Private entities are free to invest in the electricity generation sector in Guatemala. There is no centralized state control/planning for the country´s expansion of the generation system[8]. Nevertheless, the government, through the Ministry of Energy and the Energy Market Regulating Authority (CNEE – Comisión Nacional de Energía Eléctrica), by law must periodically develop long-term projections and establish the country´s "desirable" future investment requirements of the various fuel types for power production (generation matrix). Once established, CNEE attempts to direct or "steer" investments in the desired direction by means of tender procedures through which the country´s power distributors sign long-term contracts with power producers.

Regarding the operation of the countrywide electricity system, the Wholesale Market´s regulatory framework requires that all generating plants be dispatched so as to minimize the cost for the entire electric market.[9] To attain this objective, the Wholesale Market Operator (AMM) coordinates the operation of the generating plants and makes the economic load-dispatch in order of the "merit list" of the available plants (dispatching the system with the least costly mix of generation possible, by dispatching plants from the least expensive to the next least expensive, and so on until demand is met, on a continuous basis).

2. Analysis of the current situation

Currently, the baseline of the generation system in Guatemala is characterized by a mix of plants that use fossil fuels and renewable resources, and electricity imports have not been significant. According to the Wholesales Electricity Administrator (AMM), capacity additions over the most recent years have been as follows[10]:

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[8] Electricity Law, Title I, Chapter I, Article 1, http://www.amm.org.gt/pdfs/AMM-ley-general-electricidad.pdf

[9] http://www.amm.org.gt/pdfs/AMM-reglamento-amm.pdf . AMM Regulation, page 16.

[10] Projects registered as CDM have been excluded from baseline analysis.

Table 3. Capacity additions over the last years (power plants included in the build margin)

Unit power	Starting year	Capacity (MW)	Fuel
Panan	2010	7.320	Hydro
Los Cerros	2010	1.250	Hydro
Covadonga	2010	1.600	Hydro
Jesbon Maravillas	2010	0.750	Hydro
El Prado	2010	0.500	Hydro
Oscana	2010	<5MW	Hydro
Cuevamaría	2009	1.500	Hydro
Kaplan Chapina	2009	2.000	Hydro
La Unión 2	2009	10.000	Biomass
Electrocristal bunker	2009	10.000	Fuel Oil No. 6
Magdalena 5	2008	44.334	Biomass
La Libertad	2008	20.000	Coal
Santa Elena	2008	0.160	Hydro
COENESA	2008	10.000	Diesel
GECSA II	2008	37.800	Fuel Oil No. 6
Amatex 3	2008	24.336	Fuel Oil No. 6
Arizona Vapor 1	2008	12.500	Wasted heat
GECSA	2007	15.744	Fuel Oil No. 6
El Recreo	2007	26.000	Hydro
Montecristo	2006	13.500	Hydro
Trinidad	2006	26.000	Biomass
Palín II	2005	5.800	Hydro
Magdalena 4	2005	30.00	Biomass
Pantaleon II	2005	20.000	Biomass
San Diego	2004	5.000	Biomass
Renace	2004	68.100	Hydro
Arizona	2003	160.000	Fuel Oil No. 6

Source: AMM Statistical Reports and Installed Capacity in the National Electricity System

Over the last years, the investments carried out in power plants using fuel oil No. 6 have been significant. The technology of these generating units is based on internal combustion engines, which require shorter up-front times and lower development/construction costs than power plants using renewable resources.

In the short- and medium-term, important investments in mainly coal and hydroelectric plants are expected, under the objectives of Guatemala´s Energy Policy, which seeks a more diversified energy matrix[11] with the intent of reducing dependence on imported petroleum based fuels, in order to reduce electricity prices.

As examples of coal fired plants entering the system, a coal based power plant of 80+ MW is being relocated and installed in Guatemala by Duke Power at the time of this PDD submittal. Previously, in November 2007, CNEE directed an international bid call to Union Fenosa, the owner of two large distribution grids in Guatemala (DEOCSA and DEORSA), through which a contract was issued in order to purchase electricity from a new 275 MW coal plant[12] under a 15 year power purchase agreement. This coal plant project is under development, and will be constructed by Jaguar Energy. It is expected to initiate commercial operation in 2013.

In the near future (within 5 years), CNEE plans to bid out two additional large generation blocks based on coal, with a total capacity of 400 MW, which will begin operations between the years 2014 and 2015. As a result, coal plants are expected to supply approximately 46% of energy demand by the year 2015. The coal-based plants are the most probable electricity generation sources in Guatemala.

Regarding hydroelectric generation, the Xacbal hydroelectric plant (94 MW) began operations in 2010, and the Palo Viejo hydropower plant of 80 MW is expected to initiate operations in 2013. The theoretical capacity additions (under CNEE´s plans) of hydroelectric projects plus electricity imports are similar to the total capacity to be installed in coal-based plants in the long-term, although hydropower in Guatemala is facing growing barriers that make this target unlikely.

As of 2009 Guatemala trades electricity with Mexico through a 400 kV transmission system with a transmission capacity of 200 MW.

In the report "Midterm tendencies for the electricity supply of the National Interconnected System" by CNEE, six generation scenarios are described, considering two hydrological conditions (high and low rainfall) and two conditions for petroleum fuel prices. The results for 2010 through 2015 show that electricity produced by hydroelectric plants will remain at similar to current levels, supplying between 40 to 47% of electricity demand, while the share of coal will strongly increase from 16% to 40% of demand, as the new coal plants will substitute the currently operating older bunker-fuel powered plants, and energy imports.

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[11] Comisión Nacional de Energía (CNEE), Tendencies in the midterm for the supplying of electricity of the National Interconnected System (Perspectivas de mediano plazo 2012-15), page 50, http://www.cnee.gob.gt/PEG/Docs/Perspectivas%20PEG.pdf

[12] http://www.cnee.gob.gt/pdf/informacion/licitaciones/LICITACION%20UNION%20FENOSA.PDF

3. Analysis of national policies and circumstances that determinate future investment tendencies in Guatemala

The central objective of the Energy Policy approved by the Ministry of Energy and Mines is to modify Guatemala´s electric power generation matrix, in order to reduce dependence on power generation by petroleum fuels. The policy states that investments in mainly hydroelectric and coal plants are required, as well as an increase in regional energy exchanges, in order to cover the country´s total electricity demand at reduced prices[13].

The market regulator (CNEE) developed the Generation Expansion Plan 2008-2022[14], which is an indicative plan that outlines the desirable conditions in order to modify the energy matrix towards greater hydro and coal (and potentially other base-load types of generation), away from petroleum fuels. The objective is to reduce petroleum dependence in the long-term, with the utmost objective of reducing electricity prices. In order to diversify the energy matrix and change the baseline conditions, at least 418 MW of hydroelectric plants will need to be added in the mid-term to substitute plants that currently utilize petroleum (bunker) fuel oil No. 6.

To reach the objectives of the Generation Expansion Plan 2008-2022, the Guatemalan government needs to encourage investments in renewable resources, and severe development barriers the projects are currently facing need to be addressed. These barriers include opposition groups (NGOs) to hydropower development, insufficient transmission grid coverage, water resource availability risks as a consequence of climate change and the need to compete with coal fueled generating plants.

Of these barriers, the only one being addressed is the transmission grid coverage, through a large-scale expansion of the grid, a process underway since 2009 expected to be concluded between 2013 and 2014.

Regarding the barrier that refers to coal plants, this circumstance poses a significant risk for mainly small and medium hydropower developments in Guatemala, as coal is being heavily promoted by national authorities, and because the types of plants being built tend to make it difficult for hydropower to be competitive under Guatemala´s market structure due to a series of factors. The plants that are being built are most likely not "clean-coal" and thus pricier technologies. In addition, coal as a fuel type depresses the Guatemalan energy SPOT prices, as the SPOT price is based on a fuel´s related variable production cost only and does not reflect environmental costs nor capital expenditure costs related to plant installation. (Capital expenditures, in the Guatemalan market, are covered by capacity payments separate from energy income, from which base-load generating plants such as coal plants derive most of their revenues.)

As the analyses and simulations carried out by CNEE in order to determine the future scenarios for the Generation Expansion Plan 2008-2022 reflect; hydroelectric plants become competitive and most economical

[13] Comisión Nacional de Energía Eléctrica (CNEE), Expansion Plan of Electricity Generation System 2008-2022, http://www.cnee.gob.gt/PET/Docs/PET%20INGLES.pdf .

[14] Comisión Nacional de Energía Eléctrica (CNEE), Expansion Plan of Electricity Generation System 2008-2022, http://www.cnee.gob.gt/PET/Docs/PET%20INGLES.pdf

compared to plants using petroleum- and coal-based fuels when the environmental cost is added to these last ones. This cost corresponds to the neutralization of greenhouse emissions that they produce[15].

Consequently, to achieve the targets of the Expansion Plan, the environmental cost has to be transferred as an economical incentive to power plants based on renewable resources, or it has to be charged against high emissions producing power-generating technologies (coal and bunker fueled).

It is concluded that the baseline conditions will prevail during the first crediting period, as investments in technologies using fossil fuels constitute the option with lower up-front times and with less barriers for satisfying electricity demand.

The CDM is critical and decisive in order to modify the baseline tendency in Guatemala and is essential to encourage investments in renewable resources.

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 small-scale CDM project activity:

Consideration of CDM in the initial stages of the Project

The most relevant milestones of the project are listed below:

1. Feasibility study was concluded in March, 2009.
2. Hidroeléctrica Choloma, S.A. informed Guatemala´s Designated National Authority and the UNFCCC Secretariat regarding the prior consideration of the CDM, on June 9, 2009.
3. Financial closing took place in June 8, 2010 (Investment decision date).
4. Contract for “Supply, Start-up and Testing of Turbine, Generator, Controls and Associated Equipment” with Gilbert Gilkes & Gordon Ltd. (Gilkes), was signed in June 24, 2010 (Starting date of the project activity).
5. On July 22, 2010 the construction and civil works contract was signed between Choloma and Constructora Nacional, S.A. (CONASA), for the construction of the hydroelectric project.
6. Hidroeléctrica Choloma, S.A. submitted a PDD draft to the DNA on January 27, 2011 and requested the letter of approval for the CDM project.
7. The DNA’s letter of approval was issued on March 23, 2011.
8. The PDD was published on the UNFCCC CDM webpage on May 21, 2011 for global stakeholder consultation.
9. The starting date of the first crediting period is expected to be on March 1, 2013.

Since the project start date is on June 24, 2010, and DNA and the UNFCCC Secretariat were notified on June 9, 2009, prior to project start date, the project meets the condition on prior consideration.

[15] Generation Expansion Plan 2008-2022, pages 19 and 20 - CNEE.

Additionality assessment

Additionality of the Project is demonstrated based on the requirements of the *Guidelines on the Demonstration of Additionality of Small-Scale Project Activities* (EB 68 Annex 27).

Investment barrier

The project activity faces investment barriers due to the possible revenue shortfalls resulting from the variations in electricity production caused by the alteration of the hydrologic cycles. It also faces risks stemming from low-cost coal fired generation plants that depress SPOT market energy prices in the Guatemalan Electricity Market.

The Project´s profitability is evaluated using the Equity Internal Rate of Return (IRR) post-tax method, which is carried out in nominal terms. The Equity IRR post-tax for the project activity is calculated under the following financial assumptions[16]:

General assumptions

	Value	Units	Source and comments
Period of assessment	21	Years	According to Annex 5, Guidelines on the Assessment of Investment Analysis, in general a minimum period of 10 years and a maximum of 20 years will be appropriate for the assessment period.
Residual value	0	$	As per Article 19 of the "*Decreto Número 29-92: Ley del Impuesto Sobre la Rent*a" (Guatemalan Income Tax Law).
Depreciation	5	%/year	As per Article 19 of the "*Decreto Número 29-92: Ley del Impuesto Sobre la Rent*a" (Guatemalan Income Tax Law).
Income tax	31	%	As per "Decreto Número 29-92: Ley del Impuesto Sobre la Renta"(Guatemalan Income Tax Law). Income tax exemption for the first 10 years; the project activity has obtained this authorization by the Ministry of Energy and Mines under the "Incentives Law for Promotion of Renewable Sources of Power;" then, from year 11 on, an income tax rate of 31%.
Value Added Tax	12	%	As per Article 10 of the "*Decreto Número 27-92: Ley del Impuesto al Valor Agregado*" (Guatemalan Value Added Tax Law). On sales (debit) and purchases (credit). As per Article 5 of the Incentives Law for Promotion of Renewable Sources of Power, imported equipment

[16] See spreadsheet of the financial calculations for assumptions details.

			for electricity generation is exemt of VAT.
Inflation rate	4.988	%	Average forecasted inflation rate for Guatemala, published by the IMF for the next five years after the start of the project activity; as per item 7 in the Appendix of the Guidelines on the Assessment of Investment Analysis.
Default value for the expected return on equity for energy industries in Guatemala	12.5	%	As per paragraph 8 of the Appendix "Default Values for the expected return on equity" of Annex 5 "Guidelines on the Assessment of Investment Analysis (Version 05)".
Benchmark (nominal term)	17.488	%	As per paragraph 7 of the Appendix "Default Values for the expected return on equity" of Annex 5 "Guidelines on the Assessment of Investment Analysis (Version 05)", in situations where an investment analysis is carried out in nominal terms, project participants can convert the real term values provided to nominal values by adding the inflation rate.

Investment assumptions

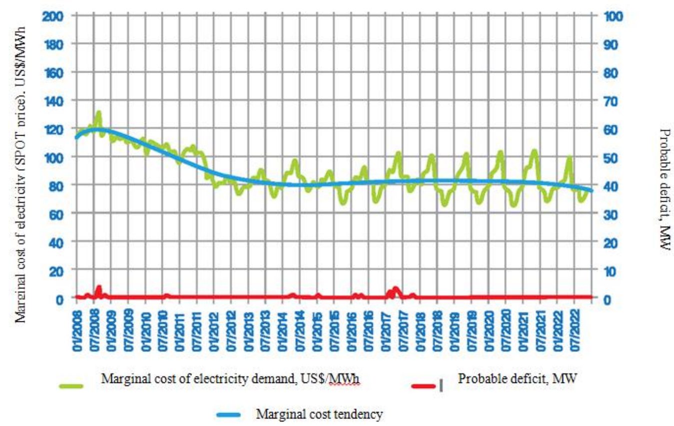
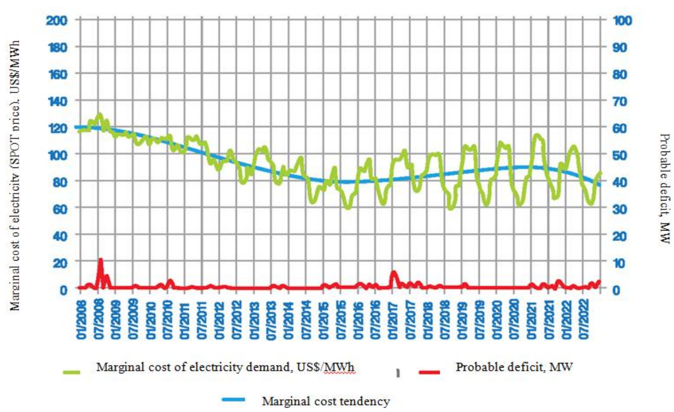
	Value	Units	Source and comments
Investment costs	21,878,038	US$	Capital expenditures budget as established in the *Hidroeléctrica Choloma, S.A. "Proyecto Hidroeléctrico Cholomá: Prefactibilidad Técnica y Financiera*" (Technical and Financial Pre-Feasibility Study), March 2009, page 17). Investment costs include studies, designs, construction, equipment and its installation, bank fees, interests and taxes during construction.
Equity	50	%	As per paragraph 18 of the Guidelines on the "Assessment of Investment Analysis" (v.05), a 50% debt and 50% equity financing is assumed as a default, as the benchmark is based on parameters that are standard in the market and information of the typical debt/equity finance structure observed in the sector of the country is not available.
Debt	50	%	
Debt term	10.25	years	Syndicated Loan Term Sheet.
Grace period (from July 2010 through August 2012)	26	months	
Amortizations (principal payments)	33	Quarterly payments	
Interest rate	9.75	%	

Assumptions for revenues estimation

	Value	Units	Source and comments
Installed capacity	9.7	MW	Capacity of the electric generator as per manufacturer data.
Plant Factor	43%	-	Hidroeléctrica Choloma, S.A. "Proyecto Hidroeléctrico Cholomá: Prefactibilidad Técnica y Financiera" (Technical and Financial Pre-Feasibility Study), March 2009, page 12. -available at the time of decision making-
Electricity production	36,538	MWh	As per 9.7MW Installed capacity and 43% Plant factor
Guaranteed power capacity	5.07	MW	Power Purchase Agreement (PPA) Term sheet. It is the capacity guarantee during daily peak-demand hours.
PPA energy price (10yr)	(see Table 4.)	$/MWh	Power Purchase Agreement (PPA) Term sheet. Prices negotiated by the project participant for a 10-year power purchase agreement are shown in the following table: (Table 4, below) Under the Power Purchase Agreement Term Sheet, an annual energy price range was established for the 10-year period, with a minimum and a maximum price for each year. The project activity will receive the hourly market SPOT price as long as it remains in the range. Should SPOT prices fall below the minimum, then it receives the minimum guaranteed energy price, and when SPOT prices increase above the range, then the buyer has a “ceiling price” as a hedge in case of expensive energy prices (the max price). As the table reflects, the min-max range for the 1st contract year is $85-$100/MWh, with slightly different values each year to end at $80-$105/MWh in year 10.
PPA guaranteed capacity price	7.25	$/kW per month	Power Purchase Agreement (PPA) Term sheet. This price is fixed for the 10 year contract period.
Energy spot price (post-PPA)	80	$/MWh	According to the forecasted price by CNEE for year 2022 and stated in the document "*Plan de Expansión Indicativo del Sistema de Generación 2008-2022*", February 2009, pages 36-38. Energy spot price (post-PPA) is affected by the inflation rate, as of 2023. The graphs, below, show the expected SPOT prices in the

Table 4. Choloma Power Purchase Agreement Prices

Contract year	1	2	3	4	5	6	7	8	9	10
Min price ($/MWh)	$85	$85	$84	$84	$84	$82	$82	$82	$80	$80
Max price ($/MWh)	$100	$101	$101	$102	$102	$103	$103	$103	$105	$105

			Guatemalan energy wholesale market through the year 2022 for two demand-growth scenarios, resulting from CNEE´s plan to promote a significant expansion in coal plants, in addition to other generating plants including ones based on renewable resources:  Fig. 8. Expected SPOT prices through 2022, LOW energy-demand scenario (Source: CNEE - "Indicative expansion plan of the generation system 2008-2022 ")  Fig. 9. Expected SPOT prices through 2022, HIGH energy-demand scenario (Source: CNEE - "Indicative expansion plan of the generation system 2008-2022 ")
Guaranteed capacity price (post-PPA)	7.25	$/kW per month	Reference: PPA price. Guaranteed capacity price (post-PPA) is affected by the inflation rate, as of 2022.

"Nodal-loss Factor" (Shared 50/50 with PPA offtaker during the 10 yr contract period, as per section 10 of the PPA Term Sheet)	0.9452		As per section 10 "Pérdidas de Transmisión" of the Power Purchase Agreement Term Sheet, parties agree to equally share (50% each) the electrical transmission system losses between the plant and the delivery point. The electrical losses are based on the monthly "Nodal-loss Factors" determined by the Wholesale Electricity Administrator as per Commercial Coordination Norm No.7 ("Norma de Coordinación Comercial No. 7, Factores de Pérdidas Nodales"). For additionality analysis and conservative purposes, the higher annual average (the most conservative value) of nodal-loss factors (Jun'09-May'10) for the period between June 2007 - May 2010 of Secacao Substation (where the project activity is going to be connected to) is used to estimate the electrical losses. Losses, in %, are 1 minus the nodal-loss factor * 100. Electrical losses are applied against revenues.

Assumptions for running costs

	Value	Units	Source and comments
Plant expenses	368,136.00	$	As per Operating Budget. All running costs are affected by the inflation rate, excepting the property tax costs.
Salaries & related worker benefits	184,560.00	$	
O&M	183,576.00	$	
Administrative expenses	117,250.00	$	
Salaries & related worker benefits	9,000.00	$	
Office Expenses	8,250.00	$	
Insurance	100,000.00	$	
Property tax	5,940.00	$	
Transmission toll charges and Wholesale Market (AMM) fee (contract years)	67,714.00	$	
Transmission toll charges and Wholesale Market (AMM) fee (post-contract years)	125,428.00	$	

Investment analysis result

The resulting equity IRR is 12.39%, which is below the Benchmark 17.488%. The resulting equity IRR considering CERs-Income is 13.91% (assuming a CERs price of $14.00 – available at the time of decision making-).

Sensitivity analysis

The Equity Internal Rate of Return (IRR) is calculated under a series of scenarios in order to evaluate the project's financial sensitivity. According to the Guidelines of Investment Analysis, variables that constitute more than 20% of either total project costs or total project revenues are subjected to a variation of +10% and -10%. These variables are: annual power generation, electricity price, total investment costs, capacity price and O&M costs.

The following table presents the Equity IRR results under the various sensitivity scenarios evaluated.

Table 5. Sensitivity Analysis

	Base case -10%	Base case	Base case +10%
Benchmark	17.49%	17.49%	17.49%
Annual Power Generation	10.01%	12.39%	14.73%
Electricity Price	10.01%	12.39%	14.73%
Capacity Price	12.06%	12.39%	12.72%
Total Investment	14.89%	12.39%	10.32%
O&M Costs	12.75%	12.39%	12.02%

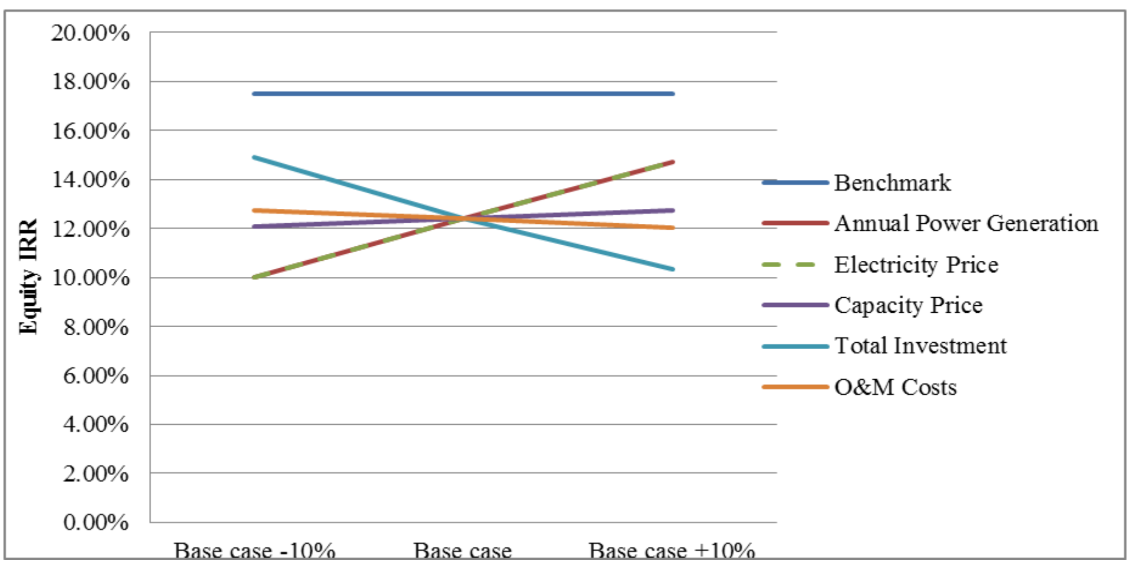


Fig. 10. Sensitivity Analysis

As shown in the Sensitivity Analysis, the benchmark is not matched even with a +/-10% variation of each evaluated parameter. Most variations are very unlikely to occur in a way to positively affect the project's activity, as explained below:

- Analysis of the variation of the annual power generation

For sensitivity analysis, it is assumed that the availability of water and thus plant output for the project activity has 10% variations from the base case. The hydrological regime could be negatively affected by climate change, which affects electricity production directly. The tendency towards greater variations in hydrological cycles (rainfall) affects the water flow availability and consequently energy production. This situation is caused by gradually more intensified global climatic phenomena like "el Niño" or "la Niña," and local conditions that include deforestation, increased erosion and river basin degradation[17].

Several studies have analysed the consequences of climate change in Guatemala and its effects on hydrologic cycles. The Economic Commission for Latin America and the Caribbean (ECLAC), in the report "Climate change: a regional perspective," indicates that climate will have serious consequences in Central America with a significant deterioration in the quality, quantity, and availability of water used for human consumption and agriculture, and a decline in the amount available to generate electricity. The First National Communication on Climate Change, submitted by Guatemala to UNFCCC, concludes that intensified floods and droughts will occur in Guatemala as a consequence of climate change, having negative impacts on basin runoffs. The Communication indicates that basin runoff in general will drop 10% on average with respect to the baseline in the 38 watersheds of the country, under the conditions of the climate scenarios analysed.

On the other hand, the INSIVUMEH[18] has reported that weather has been highly irregular in Guatemala. For example, the *canicula* phenomenon, a recession (interruption) during the rainy season, lasted significantly longer in 2009, causing the worst drought of the last 30 years. Guatemala is located in Central America, where the El Niño phenomenon has implications in weather and rain regimes. The El Niño system, when present, has caused an important reduction in rainfall with implications of reduced availability of water.

The analysis results show that the project´s equity IRR is sensitive to the variations in electricity production caused by the alteration of the flow regime: A 10% reduction in the availability of water flow causes equity IRR to fall to 10.01%. Conversely, an increase of 10% results in an equity IRR of 14.73%, which does not imply a proportional increase in electricity production due to the limitation on the installed capacity of the power plant.

[17] According to the National Institute of Forests (Instituto Nacional de Bosques) the deforestation rate is 1.22 % annually in Alta Verapaz directly causing forest cover losses all over the Polochic River Basin and its tributaries (which include the Choloma River and its tributaries).

[18] Instituto Nacional de Sismología, Vulcanología, Meteorología e Hidrología.

- Analysis of the variation of the electricity price

The base case is considered optimistic due to the high probability of actual price pressure due to the effect of coal plants on SPOT prices in the near and medium term, therefore a +10% variation in electricity prices is considered unlikely.

The CNEE´s “Guatemala´s Electrical Sector Expansion Plans: A Long-Term Perspective” states that the expected level for SPOT prices is low, falling from over $120 to around $80/MWh between 2013 and 2014, and remaining at or close to this level through the year 2022. Based on this information, due to the future “depression” in SPOT prices resulting from significant investments in coal powered generating plants, it is very likely that the project activity will tend to generally receive the minimum contract price throughout the 10-year contract-term.

- Analysis of the variation of the capacity price

Results show that the resulting equity IRR levels are less sensitive to +/-10% variation of this parameter; this parameter would need to be over 150% higher than projected to reach the benchmark.

- Analysis of the variation of the total investment

Based on what is considered an adequate and realistic budget and the high degree of complexity of the project, the likelihood of achieving a lower capital use is very low. Nevertheless, a 10% savings would produce an equity IRR of 14.89%, whereas a CAPEX cost overrun of 10% would result in 10.32%.

- Analysis of the variation of the O&M costs

Results show that the resulting equity IRR levels are less sensitive to +/-10% variation of this parameter, as even a reduction of 100%, assuming O&M costs are zero, is not enough to reach the benchmark.

The registration of the Choloma Hydroelectric Project as a CDM project will create the necessary and critically important financial benefits from the CERs revenue. This will allow Hidroeléctrica Choloma, S.A. to generate clean electric energy free of GHG emissions.

In conclusion, the equity IRR of the project activity, including the variations reflected in the sensitivity analysis conducted, is under the Benchmark. The Choloma Hydroelectric Project would not be carried out in the absence of CDM revenues. Income from emission reductions helps the project become more attractive to the developers. **Based on this analysis, the project is additional.**

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

1. Calculation of the emission factor

The emission factor of the electrical grid is calculated following the procedures established in the approved "Tool to calculate the emission factor for an electricity system", version 2.2.1 (hereafter referred to as the Tool).

Step 1. Identification of the relevant electricity systems

Guatemala´s DNA has not published a delineation of the project electricity system, therefore the National Interconnected System (*Sistema Nacional Interconectado*, SNI) is assumed as the project electricity system and the Interconnected Central American System as the connected electricity system.

The project electricity system is the spatial extent of the power plants connected to the SNI, which are economically dispatched without significant transmission constraints. See the AMM´s Statistic Report 2010, page 30[19], to check out detail of the diagram of the National Interconnected System.

The connected electricity system is formed by the electrical grids of El Salvador, Honduras, Nicaragua, Costa Rica, Panama and Mexico. The SNI is interconnected to El Salvador through a 230 kV transmission line and to Mexico through a 400 kV transmission line. At the moment of submittal of the PDD, the electricity system that interconnects the Central American countries is in the process of being expanded by the Interconnection System for Central America and Mexico (*Sistema de Interconexión Eléctrico para Centroamérica y México*, SIEPAC) in order to increase the international transmission capacity. The construction of the SIEPAC system has not been completed and a transmission line will be constructed to interconnect Guatemala and Honduras.

The power system of each country is coordinated independently, while energy exports and imports are coordinated by the Central America Market Operator (Ente Operador Regional, EOR)[20]. National dispatch has priority over the regional Central American dispatch.

Step 2. Inclusion off-grid power plants in the project electricity system

Off-grid power plants are not included in the project electricity system; option 1 is chosen.

Step 3. Selection of a method to determine the operating margin

The method selected is the Simple adjusted OM method because low-cost/must run resources, including CDM projects, constitute more than 50% of total grid generation on average for the five most recent years. The low-cost/must run resources include hydro, geothermal and biomass (sugar cane bagasse) power plants.

[19] www.amm.org.gt

[20] http://www.enteoperador.org/Contexto.jsp

Ex-post is chosen for vintages of data. The Operating Margin emission factor will be updated annually during monitoring for the first crediting period. And it will be updated and calculated ex-ante at the renewal of the crediting period.

Step 4. Calculation of Operating Margin emission factor according to the selected method

The simple adjusted OM method is calculated based on the CO_2 emission factor of the fuel type used and the efficiency of the power unit, because data on electricity generation and fuel types are known (option A2). Option A1 is not used since the amount of fuel consumed by each generating unit is not available publicly.

Assumptions:

- For Operating Margin emission factor calculation, the emission factor of the imports is considered equal to 0 tCO_2 per MWh because the electricity imports come from connected electricity systems in other countries in Central America.
- For the *ex-ante* calculation of the OM emission factor, 2010 data is used, based on the most recent statistics available at the time of PDD submission.
- The cohort of power units for OM includes CDM projects registered.
- The set of power plants m, fuel fired plants, comprises units that burn fuel oil No. 6 and diesel. It includes electricity generation of cogenerating power plants during non-harvest (sugar cane bagasse) because they burn fuel oil No.6 during this time-period.
- San Jose is a coal based power plant with an installed capacity of 139 MW. It has a power purchase agreement for 120 MW with a clause of obligatory dispatch of 65% of the contracted power[21], therefore the electricity production proportional to the 78 MW is considered as must run production. This PPA is a pre-existing contract to the electricity law and expires in 2013; therefore, this situation has to be considered for the ex-post calculation of the operating margin.
- The low-cost plants are the hydroelectric, geothermal and cogenerating power plants connected to the grid and also the imports that are modeled as a power plant connected to the grid. Cogenerators are considered must-run plants that burn cane bagasse during sugar cane harvest periods and are dispatched obligatorily due to the structure of their pre-deregulated-market dating power purchase agreements. These PPAs are pre-existing contracts to the electricity law and expire in 2013; therefore, this situation has to be considered for the ex-post calculation of the operating margin.

The Operating Margin emission factor is calculated using Equation 1 and data vintages of the year with the most recent information. It is calculated as the generation-weighted average emissions per electricity units serving the system.

$$EF_{grid,OM-adj,y} = (1-\lambda_y) \bullet \frac{\sum_m EG_{m,y} \bullet EF_{EL,m,y}}{\sum_m EG_{m,y}} \oplus \lambda_y \bullet \frac{\sum_k EG_{k,y} \bullet EF_{EL,k,y}}{\sum_k EG_{k,y}} \quad \text{Eq. 1}$$

21 Letter from the Wholesale Electricity Administrator (Administrador del Mercado Mayorista, AMM)

Where:

$EF_{grid,OM\text{-}adj,y}$	=	Simple adjusted operating margin CO_2 emission factor in year y (t CO_2/MWh).
y	=	2010
λ_y	=	Factor expressing the percentage of time when low-cost/must-run power units are on the margin in year y.
$EF_{EL.m,y}$	=	CO_2 emission factor of power unit *m* in year *y* and given in tCO_2/MWh. It is determined using Equation 2.
$EF_{EL,k,y}$	=	CO_2 emission factor of power unit *k* in year *y* and given in tCO_2/MWh. It is determined using Equation 2.
$EG_{m,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh). These data are obtained directly from the Generation Report published on AMM´s website, section "Generation". See annex 3.
$EG_{k,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit *k* in the year y (MWh). These data are obtained directly from the AMM´s Generation Report published on AMM´s website, section "Generation". See Annex 3.
m	=	All grid power units serving the grid in year *y* except low-cost/must-run power units.
k	=	All low-cost/must run grid power units serving the grid in year *y*.

The emission factor for the subset of power plants, $EF_{EL,m,y}$ and $EF_{EL,k,y}$, connected to Interconnected National System, SNI, is calculated as per option A2 stated in the tool, using the average CO_2 emission factor of fuel type i used in each generating unit and the default efficiencies, as describes the following equation:

$$EF_{EL\ m,y} = \frac{EF_{co2,m,i,y} \bullet 3.6}{\eta_{m,y}} \qquad \text{Eq. 2}$$

Where:

$EF_{EL,m,y}$	=	Emission factor of power units *m* in year y, given in tCO_2/MWh
$EF_{CO2,m,i,y}$	=	Average CO_2 emission factor of fuel type *i*, used in power unit *m* in year *y*, given in tCO_2/TJ.
3.6	=	Energy conversion factor, given in TJ/MWh according to the International System Units.
$\eta_{m,y}$	=	Average net energy conversion efficiency of power unit *m* in year *y* (ratio).
m	=	All power units serving the grid in year *y* except low-cost/must-run power units
y	=	2010

Default CO_2 emissions factor for combustion at a low level of uncertainty are obtained from Table 1.4, chapter 1, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, where oxidation factor is equal 1. The type of fuel for each power unit is obtained from the table "Installed Capacity in the Electric System", AMM´s website, "Generation" section.

Table 6. Effective CO_2 emission factors for fuel types used in Guatemala

	tCO_2/TJ
Diesel or fuel oil No. 5	72.6
Bunker or fuel oil No. 6	75.5
Bituminous coal	89.5

The efficiency factors for power units are considered confidential information in Guatemala, therefore the default values from Annex I of the Version 02.2.1 of the Tool to calculate the emission factor for an electricity system are used, which are indicated in next table. The efficiency factor is selected according the operations starting year and technology of each generating unit, data given by AMM.

Table 7. Default efficiency factors for power plants

Technology	Old power plants (before 2000)	New power plants (after 2000)
Coal	37%	39%
Oil:		
Steam turbine	37.5%	39%
Open cycle	30%	39.5%
Combined cycle	46%	46%

Finally, the denominator of the Operating Margin Equation is:

$\sum_m EG_{m,y}$ = The summation of electricity generation from each relevant power source m (MWh), during the year *y,* expressed in MWh.

$\sum_k EG_{k,y}$ = The summation of electricity generation from each relevant power source k (MWh), during the year *y,* expressed in MWh.

Lambda is calculated as follow:

$$\lambda(\%) = \frac{Number\ of\ low-cost/must-run\ sources\ are\ on\ the\ margin\ in\ year\ y}{8760\ hours\ per\ year}$$

Eq. 3

The value of lambda used is 0.119 for 2010 as is indicated in the next table:

Table 8. Lambda results

Parameter		2010
No. hours low cost / must-run power plants are on the margin + imports	Hours	1044
λ	%	0.119
1 - λ	%	0.881

Step 5. Calculation of Build Margin emission factor

The Build Margin emission factor represents the tendency of the mix of power generation and is calculated similarly to the Operating Margin emission factor, considering the group of power units whose generation is at least 20% of total generation.

Assumptions:

- For the first crediting period, the build margin emission factor shall be updated annually, ex-post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available.

- For the *ex-ante* calculation of the BM emission factor, 2010 data is used, based on the most recent statistics available at the time of PDD submission.

- The set of power plants selected for the build margin are selected according to the following premises:

    - Power units registered as CDM project activities are excluded from the cohort of power plants: Hidro Xacbal, El Canada, Matanzas, San Isidro, Las Vacas, Candelaria and Ortitlan Limitada (Amatitlan Geothermal Project).
    - Capacity additions from retrofits of power plants, according to 2007 AMM Statistical Report, are not included. These cases are:
        - Gas 1 and Gas 2 are excluded because they are existing power units that were repaired.
        - Renace and Poza Verde are existent hydroelectric plants that grew in capacity but not energy production, and therefore, are not considered as new additions to the grid.
        - Textiles U10 power unit does not have an individual meter and the electricity produced cannot be reported individually, therefore it is not possible to analyze it as a new power unit.

- The selection of the set of power plant/unit is according to the following steps:

    - Identification of the set of five power units, excluding CDM project activities, which started to supply electricity to the grid most recently. See tables of annex 3.

    - Calculation of the total annual generation of the project electricity system (AEGtotal), excluding CDM project activities.

    - Identification of the sample group of power plants/units used to calculate the build margin that consists of the set of power plants in the electricity system that comprise 20% of the generation system and have been built most recently, see annex 3.

- The group of power plants/units used is the group that comprises the 20% of the generation system because the electricity generation from this group is larger than the group of the five power plant/units.

The build margin is calculated using the following equation:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \bullet EF_{EL,m,y}}{\sum_m EG_{m,y}} \qquad \text{Eq. 4}$$

Where:

$EF_{grid,BM,,y}$	=	Building Margin CO_2 emission factor in year y (t CO_2/MWh)
$EF_{EL,m,y}$		CO_2 emission factor of power unit m in year y (tCO_2/MWh). It is determined using equation 2 according to option A2 of the Tool.
y	=	2010
$EG_{m,y}$		Net quantity of electricity generated and delivered to the grid by power unit m, during the year *2010*, given in MWh. See Annex 3.
m	=	Power units included in the build margin

<u>Step 6. Calculation of the combined margin emission factor</u>

The emission factor of the electrical system is calculated as following equation:

$$EF_{grid,CM,y} \text{ (t } CO_2\text{/MWh)} = EF_{grid,OM,y} \bullet W_{OM} + EF_{grid,BM,y} \bullet W_{BM} \qquad \text{Eq. 5}$$

Where:

$EF_{OM\,y}$	=	Operating Margin emission factor (t CO_2/MWh)
$EF_{BM\,y}$	=	Building Margin emission factor (t CO_2/MWh)
W_{OM}	=	Weighting of operating margin emissions factor (%)
W_{BM}	=	Weighting of build margin emissions factor (%)

The default values are chosen for the weighting factors, $w_{OM} = 0.5$ and $w_{BM} = 0.5$ for the first crediting period. The emission factor of the grid shall allow the calculation of the baseline emissions and the calculations of the emissions reduced by the project activity.

2. Estimation of project emissions

According to the version 17 of the AMS I.D. methodology, the project emissions due to hydro power plants may be emitted from the reservoirs; which is proven through the power density calculation.

The equation to calculate power density (PD) according to the version 13 of the ACM0002 is described in next equation and if the result of this calculation is greater than 10 W/m^2, then the project emissions are equal to zero:

$$PD = \frac{Cap_{PJ} - Cap_{BL}}{A_{PJ} - A_{BL}} \qquad \text{Eq. 6}$$

Where:

PD = Power density of the project activity (W/m^2)

Cap_{PJ} = Installed capacity of the hydro power plant after the implementation of the project activity(W)

Cap_{BL} = Installed capacity of the hydro power plant before the implementation of the project activity (W). For new hydro power plants, this value is zero.

A_{PJ} = Area of the single or multiple reservoirs measured in the surface of the water, after the implementation of the project activity, when the reservoir is full (m^2).

A_{BL} = Area of the single or multiple reservoirs measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m^2). For new reservoirs, this value is zero.

The project reservoirs consist of the small water bodies resulting from the diversion dams and the reservoir-tank used for the daily regulation.

The reservoir-tank of the project activity has a cylindrical shape with a radius of 30 m. Therefore, the surface area is equal to:

$$A_{tank} = \pi r^2 \qquad \text{Eq. 7}$$

Where:

A_{tank} = Area of the tank-reservoir measured in the surface of the water

π = Pi (3.14159265)

r = radius of the water storage tank

The surface area is considered at a full tank-reservoir level. Due to the cylindrical shape of the tank, the area is constant at any water level (see description in Section A of the PDD).

Power density of the multiple reservoirs will be monitored in order to assure that project emissions will remain zero during the crediting period(s).

3. Estimated leakage

As per the version 17 of the AMS I.D. methodology, leakages, LE_y, are not considered because energy generating equipment is not transferred from another activity.

4. Calculation of baseline emissions

Because the project activity is the installation of a new grid-connected renewable power plant/unit at a site where no renewable power plant was operated prior to the implementation of the project activity, then, the baseline emissions reductions per year are calculated using the following equation as the version 17 of the AMS I.D. methodology states:

$$BE_y \text{ (t } CO_2) = EG_{BL,y} \text{ (MWh)} \bullet EF_{CO2,grid,y} \text{ (t } CO_2\text{/MWh)} \qquad \text{Eq. 8}$$

Where:

BE_y = Emissions in year y (t CO_2)

$EG_{BL,y}$ = Quantity of net electricity supplied to the grid as a result of the implementation of the CDM project activity in year *y* (MWh)

$EF_{CO2,grid,y}$ = CO_2 emission factor of the grid calculated ex-post in year y (t CO_2/MWh)

y = year

5. Calculation of emission reductions

Emission reductions are calculated according to the version 17 of the I.D. methodology as follow:

$$ER_y = BE_y - PE_y - LE_y \qquad \text{Eq. 9}$$

Where:

ER_y = Emission reductions in year *y* (t CO_2/y)

BE_y = Baseline Emissions in year *y* (t CO_2/y)

PE_y = Project emissions in year *y* (t CO_2/y)

LE_y = Leakage emissions in year *y* (t CO_2/y)

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

Information regarding the parameters described in the following tables will be available at validation.

Table 9. Parameters available at validation

Data / Parameter:	Cap_{BL}
Data unit:	W
Description:	Installed capacity of the hydro power plant before the implementation of the project.
Source of data used:	Project site
Value applied:	zero
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Data / Parameter:	A_{BL}
Data unit:	m_2
Description:	Area of the reservoir measured in the surface of the water, before the implementation of the project activity.
Source of data used:	Project activity site
Value applied:	zero
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

The combined emission factor of the grid is calculated *ex-ante* according to equation 5, described in Section B.6.1, as follow:

$$EF_y \quad (t\ CO_2/MWh) = 0.5 \bullet 0.688 + 0.5 \bullet 0.348 = 0.518\ t\ CO_2/MWh$$

Where, 0.688 represents the value of the operation margin adjusted and 0.348 the building margin. Please see Annex 3 for more details.

Substituting the annual energy estimated for the power plant and the value of the emission factor for the grid in equation 8, results in an *ex-ante* calculation of baseline emissions of the following values:

Table 10. Estimation of baseline emissions for the first crediting period

Variable	**$EG_{BL,y}$**	**$EF_{CO2,grid.y}$**	**BE_y**
Description	**Net electricity supplied by the project activity to the grid**	**Emission factor**	**Baseline emissions**
Unit	**MWh**	**t CO_2/MWh**	**t CO_2**
Definition	**A**	**B**	**A*B**
2013	30,448	0.518	15,772
2014	36,538	0.518	18,926
2015	36,538	0.518	18,926
2016	36,538	0.518	18,926
2017	36,538	0.518	18,926
2018	36,538	0.518	18,926
2019	36,538	0.518	18,926
2020	6,090	0.518	3,154

Since the project activity results in multiple reservoirs, the power density of each single reservoir and of the whole power plant is calculated using equation 6.

Table 11. Power density of each reservoir and power plant

Reservoir	**Area of the reservoir (m^2)**	**Power density calculation**	**Power density (w/m^2)**
Secampana I	137.21	$(9.7 \text{ X } 10^6 \text{ W} – 0 \text{ W}) / (137.21 \text{ m}^2 – 0 \text{ m}^2)$	70,694.56
Secampana II	145.01	$(9.7 \text{ X } 10^6 \text{ W} – 0 \text{ W}) / (145.01 \text{ m}^2 – 0 \text{ m}^2)$	66,891.94
Secampanita	85.95	$(9.7 \text{ X } 10^6 \text{ W} – 0 \text{ W}) / (85.95 \text{ m}^2 – 0 \text{ m}^2)$	112,856.31
Caquipec	43.93	$(9.7 \text{ X } 10^6 \text{ W} – 0 \text{ W}) / (43.93 \text{ m}^2 – 0 \text{ m}^2)$	220,805.83
Golondrinas	115.2	$(9.7 \text{ X } 10^6 \text{ W} – 0 \text{ W}) / (115.20 \text{ m}^2 – 0 \text{ m}^2)$	84,201.39
Choloma	397.23	$(9.7 \text{ X } 10^6 \text{ W} – 0 \text{ W}) / (397.23 \text{ m}^2 – 0 \text{ m}^2)$	24,419.10
Reservoir-tank	2827.44	$(9.7 \text{ X } 10^6 \text{ W} – 0 \text{ W}) / (2827.44 \text{ m}^2 – 0 \text{ m}^2)$	3,430.67
Power plant	**3751.97**	**$(9.7 \text{ X } 10^6 \text{ W} – 0 \text{ W}) / (3751.97 \text{ m}^2 – 0 \text{ m}^2)$**	**2,585.31**

Thus, it is proven that the project emissions are zero because the power densities result greater than 10 W/m^2 for each reservoir and for the whole power plant.

The ex-ante calculation of emission reductions is calculated using equation 9, where project emissions and leakages are equal to zero; then the emissions reductions due to the project activity are equal to the baseline emissions as is indicated in Table 12.

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

The *ex-ante* estimation of the emissions reductions for the first crediting period is summarized in the following table:

Table 12. Emissions reductions estimated for the first crediting period

Year	PE_y Estimation of project activity emissions t CO_2e	BE_y Estimation of baseline emissions t CO_2e	LE_y Estimation of leakages t CO_2e	ER_y Estimation of emission reductions t CO_2e
Definition	**A=** 0 because power density > 10 W/m^2	**B**	**C**	**A - B - C**
2013	0	15,772	0	15,772
2014	0	18,926	0	18,926
2015	0	18,926	0	18,926
2016	0	18,926	0	18,926
2017	0	18,926	0	18,926
2018	0	18,926	0	18,926
2019	0	18,926	0	18,926
2020	0	3,154	0	3,154
Total	**0**	**132,482**	**0**	**132,482**

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

B.7.1 Data and parameters monitored:

Table 13. Data and parameters monitored during monitoring

Data / Parameter:	**$EG_{facility,y}$**
Data unit:	MWh
Description:	Quantity of net electricity supplied to the grid in year y.
Source of data to be used:	Electricity meters
Value of data:	36 538
Description of measurement methods and procedures to be applied:	• The monitoring of the parameter is conducted through the authorized metering equipment by the Wholesale Electricity Administrator (Administrador del Mercado Mayorista, AMM). The meters (main and back-up) fulfill Norms IEC 687 o ANSI/IEEE 12.20 or an updated standard, according to AMM´s Commercial Norm No.14. For example, accuracy certificates from manufacturer could be used as evidence during verification. • According to Norm No. 14, the meters has to be provided with a function to integrate real-time measured values in programmable intervals and with a non-volatile internal memory to save measured data for at least 37 days. • The measurement methods and procedures applied are according to the AMM´s market Norm on Commercial Measuring Systems (Norm NCC-14). - Monitoring data: All monitoring data of the electricity delivered and consumed from the grid is monitored continuously and automatically by the main and back-up electricity meters authorized by AMM. - Measurement data: The measured data is downloaded from the meters monthly by means of an interface device and measured data is saved in an hourly basis. - Recording data: Data downloaded from meters is recorded monthly in an electronic form. - Storing data: All data collected as part of monitoring should be archived in electronic and hard formats, and be kept at least for 2 years after the end of the last crediting period. • Emergency procedures in case a calibration audit is delayed If during verification of a certain monitoring period, the calibration has been delayed and the calibration has been implemented after the monitoring period in consideration, the following conservative approach is adopted in the calculation of emissions reductions: (a) If the results of the delayed calibration do not show any errors in the measuring equipment, or if the error is smaller than the maximum permissible error, the maximum permissible error of the instrument to the measured values is applied, or (b) If the error is beyond the maximum permissible error of the main and back-up measuring equipment, the error identified in the delayed calibration is applied.

	The error shall be applied for all measured values taken during the period between the scheduled date of calibration and the actual date of calibration. • Emergency procedures in case of erroneous measurement In case of a meter failure, erroneous or lost data the following procedure is followed (as per Commercial Coordination norm 14 AMM (NCC-14)): (a) If main meter fails then data recorded by the back-up meter is used. When both meters fail, AMM uses the average of the historical information registered during the last six months.
QA/QC procedures to be applied:	• A quality management system will be implemented and procedures will be followed. The procedures will describe the following information: - Name of the procedure - Description of the procedure - Responsible person - Monitoring frequency - Data registration • A cross-check procedure will be followed: - The monitored data will be compared monthly with the commercial data (electricity invoices or AMM´s Monthly Transactions Report) - The monitored data will be compared with the data registered manually by the plant operator • Equipment calibration and/or audits: - Electricity meter is calibrated initially by the manufacturer. For example, accuracy certificates from manufacturer could be used as evidence. - The equipment accuracy audits are carried out annually by a third party authorized by the AMM.
Any comment:	

Data / Parameter:	**Cap_{PJ}**
Data unit:	W
Description:	Installed capacity of the hydro power plant after the implementation of the project activity.
Source of data to be used:	Generator nameplate
Value of data:	9.7×10^6
Description of measurement methods and procedures to be applied:	The installed capacity will be confirmed annually by a visual verification of the generator nameplate on site.
QA/QC procedures to be applied:	• To assure quality a procedure will be followed. The procedure to check the nameplates will describe the following information: - Name of the procedure - Description of the procedure - Responsible person - Monitoring frequency - Data registration

	• A cross-check procedure will be followed: The installed capacity can be confirmed by generator nameplate, or by generator manufacturer declaration of true final installed capacity (if different).
Any comment:	Data from manufacturer and equipment manuals will be stored in duplicated files, in the power plant and in headquarters.

Data / Parameter:	**A_{PJ}**
Data unit:	m^2
Description:	Area of the multiple reservoirs measured in the surface of the water, after the implementation of the project activity, when the reservoir is full (m^2)
Source of data to be used:	Power plant site
Value of data:	The sum of the areas of the multiple reservoirs and the reservoir-tank is 3751.97
Description of measurement methods and procedures to be applied:	The area of the multiple reservoirs formed by the diversion dams in the surface of the water, when the reservoirs are full, will be checked using the design maps with level curves and borders of each reservoir. The surface area of the tank-reservoir is simple to establish as this structure is a circular tank of known dimensions (60 meter diameter), therefore their geometrical dimensions are checked. The surface area of the reservoirs will be checked annually in order to assure that the power density is greater than 10 W/m^2.
QA/QC procedures to be applied:	• To assure quality a procedure will be followed. The procedure to check the reservoir area will describe the following information: - Name of the procedure - Description of the procedure - Responsible person - Monitoring frequency - Data registration
Any comment:	

Data / Parameter:	***$EF_{CO2,y}$***
Data unit:	t CO_2e/MWh
Description:	CO_2 emission factor of the grid electricity in year *y*
Source of data to be used:	• Electricity generation data per power plant and demand curve: AMM´s reports, www.amm.org • Default values for emission factors of fossil fuels: IPCC Guidelines 2006. • Default efficiencies values for power plant/unit: ‘Tool to calculate the emission factor for an electricity system’
Value of data:	0.518
Description of measurement methods and procedures to be applied:	Annual calculation of the combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the ‘Tool to calculate the emission factor for an electricity system’.
QA/QC procedures to	Not applicable

be applied:	
Any comment:	It is calculated as indicated in Section B6.1

Data / Parameter:	$EG_{m,y}$ and $EG_{k,y}$
Data unit:	MWh
Description:	Net electricity generated by power plant/unit in year *y*
Source of data to be used:	Electricity generation data per power plant/unit: AMM´s Generation Reports, www.amm.org .
Value of data:	See annex 3
Description of measurement methods and procedures to be applied:	These values are determined annually during the crediting period for the relevant year as per the 'Tool to calculate the emission factor for an electricity system'.
QA/QC procedures to be applied:	Not applicable
Any comment:	

Data / Parameter:	$EF_{CO2,m,i,y}$
Data unit:	tCO_2/TJ
Description:	CO_2 emissions factor of fuel type *i,* used in generating units *m and k.*
Source of data to be used:	IPCC Guidelines 2006, chapter I, volume 2 (Energy)
Value of data:	See table 6 of the PDD
Description of measurement methods and procedures to be applied:	Default values for emission factors of fossil fuels at the lower limit of the uncertainty at 95% of confidence interval are used annually during the crediting period for the relevant year, in accordance to the 'Tool to calculate the emission factor for an electricity system'.
QA/QC procedures to be applied:	Not applicable
Any comment:	

Data / Parameter:	$\eta_{m,y}$ and $\eta_{k,y}$
Data unit:	Not applicable
Description:	Average net energy conversion efficiency of power unit m or k in year y
Source of data to be used:	These values are determined annually during the crediting period for the relevant year in accordance to the annex 1 of the 'Tool to calculate the Emission Factor for an electricity system'.
Value of data:	See table 7 of the PDD
Description of measurement methods and procedures to be applied:	Default efficiencies values for power plant/unit are used as per 'Tool to calculate the Emission Factor for an electricity system'.
QA/QC procedures to be applied:	Not applicable
Any comment:	

B.7.2 Description of the monitoring plan:

The monitoring plan comprises the compilation and filling of all the relevant data needed to estimate the emissions reductions by the plant as specified in the decision 17/CP.7, document FCCC/CP/2001/13Add.2.

Objective:

The objective of the monitoring plan is to assure the complete, consistent, clear, and accurate monitoring and calculation of the emissions reductions, within the project activity boundaries, during the crediting period.

Methodology:

Monitoring will be according to the version 17 of the "Simplified baseline methodologies for selected small-scale CDM project activity."

Boundaries

The boundaries of the project activity will remain constant during the entire crediting period and comprise the spatial extent of the project boundary including the project power plant and all power plants connected physically to the electricity system that the CDM project power plant is connected to.

Description of processes and activities

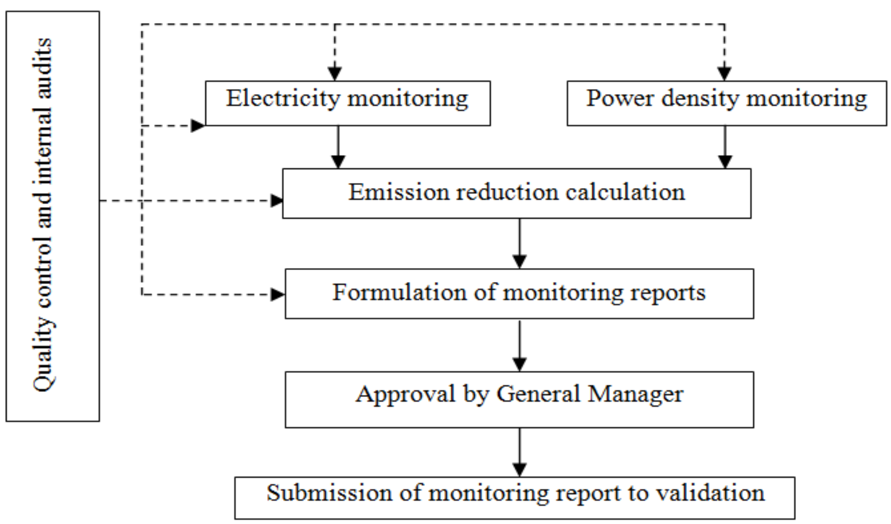


Fig. 11. Operational structure of the monitoring plan

Monitoring plan involves different processes. Each process is fed by an input and consists of a series of activities that produce a result or output. The following chart illustrates how the monitoring processes are interrelated.

Responsible personnel

The following table describes the responsibilities assigned to the personnel in charge of the monitoring process.

Table 14. Description of monitoring responsibilities

Personnel	Responsibilities
General Manager	• Responsibility of the monitoring plan. • Authorization to submit monitoring plans to DOE. • Authorization to contract CDM consultants for training, validation and verification activities. • Assignment of the personnel in charge of quality control and internal audits. • DOE and consultants contracting.
CDM coordinator	• CDM process coordination: assessment of CDM training requirements, planning of CDM training activities, coordination of meetings to revise process, etc. • Revision of monitoring parameters data. • Calculation of baseline emissions, project activity emissions and emission reductions. • Formulation of monitoring reports. • Documentation of monitoring processes for verification audits. • Data storing in hard and electronic.
Plant chief	• Parameters monitoring in power plant site. • Data registration. • Assignment of monitoring activities to plant personnel.
Commercial analyst	• Review of data from electricity meters against the AMM´s commercial data.
Internal auditor	• Annual review of CDM process. • Revision of monitoring reports before submittal to DOE

Quality control

The quality control and quality assurance procedures observed during the monitoring stage involve:

- Establishment of clear and defined procedures for data monitoring, downloading/reading and recording.
- Establishment of clear and defined procedures for baseline emissions and emissions reductions calculations.
- The General Manager appoints an officer to assure quality. A non-conformance and corrective/prevention actions procedure will be established in order to reduce the remaining uncertainties of the monitored emissions reductions.

- The monitoring process is reviewed once a year, including any non-conformance and corrective actions and whether these have been satisfactorily closed or not. The monitoring report is also reviewed before submission to a DOE for verification.

Data registration

The CDM coordinator is responsible that a file is kept, electronically and as a hard copy, during the crediting period plus two years, including:

- Electronic files containing data downloaded from electricity meters.
- All documents and information generated during each monitoring process.
- If the monitoring plan is modified or improved, the CDM coordinator will file the versions submitted to the Executive Board.
- Non-conformity reports where there is full detail of each non-conformity, from the moment of appearance to final closing.
- Information generated during training activities.

Training

Personnel in charge of the Monitoring Plan are trained as is indicated in the annual training plan. New personnel undergo a training program and are formed in the specific skills required to carry out the Monitoring Plan.

The CDM Project Manager is responsible for:

- Drafting and planning the training activities.
- Carrying out the training activities in accordance with the approved plans.
- Hiring of experts when necessary.
- Training of new personnel.

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

Date of completion the final draft of this baseline section:
05/12/2012

Name of the people determining the baseline methodology:
Alaide González Leche, Energía y Medio Ambiente, alaidegl@itelgua.com .
The consultant is not a Project participant.

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

24/06/2010

Starting date of the project activity is fixed by the date when the contract for "Supply, Start-up and Testing of Turbine, Generator, Controls and Associated Equipment" with Gilbert Gilkes & Gordon Ltd. (Gilkes) was signed.

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

30 years (as per equipment operational lifetime).

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

C.2.1. Renewable crediting period

7 years and 0 months.

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

01/03/2013

C.2.1.2. Length of the first crediting period:

7 years and 0 months.

C.2.2. Fixed crediting period:

Not applicable.

C.2.2.1. Starting date:

Not applicable.

C.2.2.2. Length:

Not applicable.

SECTION D. Environmental impacts

D.1. If required by the host Party, documentation on the analysis of the environmental impacts of the project activity:

Plant design blueprints, Environmental Impact Study, hydrological study, geological and geophysical studies, topographical mappings, electric stability and interconnection studies, have all been completed. No significant negative impacts are reported in these studies.

Environmental Legislation

The Guatemalan Political Constitution (1985) establishes that the State must promote social, economical and technological development to prevent environmental degradation and maintain ecological balance. In its Article 97 it states: *"all necessary norms to guarantee the rational utilization and usage of the fauna, flora, soil and water shall be dictated."*

The specific environmental norm that regulates these matters is the *Law of Protection and Improvement of the Environment* (Decree 68-86 of Congress), which seeks to contribute to the protection, conservation and improvement of the natural resources of the country, as well as the prevention of the deterioration and misuse or destruction of the resources and of the environment in general. Article 8 of this Law establishes that prior to the development of any project it is necessary to present an Environmental Impact Assessment Study (EIA) to the National Commission of Environment (CONAMA).

In the year 2000 Congressional Decree 90-2000 created the Ministry of Environment and Natural Resources, which replaced CONAMA. In 2003, through the Governmental Accord 23-2003[22], a new Regulation for Environmental Evaluation, Control and Follow-up was approved, which contains the guidelines for the preparation and presentation of the Environmental Impact Assessment Studies (EIA).

The Ministry of Environment and Natural Resources (MARN - by its abbreviation in Spanish) established an official list[23] of projects, industries and activities that must comply with EIA studies, classifying them into categories according to their characteristics, nature, level of potential environmental impact and environmental risk. This list classifies all hydroelectric projects as having "high environmental impact," which therefore requires such projects to present an EIA study for approval by the Ministry.

Environmental Impact Assessment Study

The project participant commissioned the consulting firm "Asesoría Manuel Basterrechea Asociados, S.A." (AMBA) to develop the Environmental Impact Assessment Study of the project activity.

[22] This Governmental Accord was reformed by the Governmental Accord 431-2007.

[23] Governmental Accord 23-2005.

The objectives of the EIA are to evaluate the impacts to the physical, biological and socioeconomic environment that the development of the project might cause, and to establish negative impact mitigation measures where necessary.

Identification of Impacts

As specified in the Environmental Impact Assessment rules of the Ministry of Environment (MARN), the aspects that have to be taken into consideration when identifying and valuing the various impacts are as follows: *i) air quality, ii) noise and vibrations, iii) superficial and underground water, iv) soil and subsoil, v) flora, fauna, aquatic and terrestrial biotopes, vi) historical and cultural resources, vii) landscape, viii) occupational health and safety, ix) socio-economic factors.*

For each of the project phases, next table shows the potential impacts that are evaluated.

Table 15. Impacts during the project phases

Construction	Operation and Maintenance	Abandonment
• Air quality • Noise • Soil and subsoil • Superficial and underground water • Flora, fauna, and aquatic and terrestrial biotopes Historical and cultural resources • Landscape • Occupational health and safety • Socio-economic factors	• Air quality • Noise • Soil and subsoil • Superficial and underground water • Flora, fauna, and aquatic and terrestrial biotopes • Landscape • Occupational health and safety • Socio-economic factors	The project is expected to have a useful life of 50 years, so that the abandonment phase will occur in the long term.

After identifying these impacts, a baseline is developed in order to have the information for future monitoring activities, taking into consideration that all activities will be developed on a private property. An estimate of how much the baseline will change by the impacts generated by the different phases of the project is made. Finally, a valuation (measurement of significance) of the impacts is assessed.

Valuation of Impacts

This valuation of impacts is performed with the intention of estimating their magnitude and, when necessary, selects the corrective measures that will have to be incorporated into the project. First the project is evaluated without considering any mitigating measures, in order to evaluate the sufficiency of those measures and analyze if it is necessary to include new corrective measures.

Mitigating Measures

The Environmental Impact Assessment Study includes an Environmental Management Plan, which includes the mitigating measures to be implemented during the construction and operation phases of the hydroelectric project, in order to prevent, control and mitigate the impacts to the physical, biotical and socio-economical environment and to maximize the significant positive impacts that will originate from the project construction.

EIA approval

The Environmental Impact Assessment for the Choloma Hydroelectric Project was approved by The Ministry of Environment and Natural Resources, MARN, according to resolution 1744-2008/ECM/MFG on April 4, 2008.

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:

No significant negative environmental impacts are expected by the development and implementation of the project activity.

SECTION E. Stakeholders' comments

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

As previously indicated, the Choloma Hydroelectric Project will be located in the San Antonio Senahú area, Department of Alta Verapaz, in northeastern Guatemala. The nearby communities include Nuevo San Carlos, La Montañesa, Santa Lucía Secacao, Candelaria Secacao, Santa Elena Secacao, Miralvalle Secacao, Las Margaritas Semococh.

The properties where the project activity will be located are privately owned, no municipal or communal lands are used. The project participants have undertaken several presentation meetings with representatives from the neighboring communities, in order to explain the project activity and to invite questions and comments.

Because the project participants have experience in the area through two existing hydroelectric plants[24], before the project activities were initiated informative meetings were held with representatives from the local communities, as follows:

1. First Stage of Information

On June 8th 2007, project executives held a meeting with 39 representatives from the Nuevo San Carlos, La Montañesa, Santa Lucía Secacao and Las Margaritas Semococh communitites. The objective of this meeting was to inform these representatives about the Choloma hydroelectric project. The presentation included a description of the existing Secacao and Candelaria hydroplants and a description of the activities and objectives of the related reforestation company "Reforestadora Polochic, S.A." [25]

During the meeting a survey was taken in order to obtain opinions regarding the development and construction of the new Choloma hydroelectric project.

On July 30th 2007 the project executives presented the Choloma Hydroelectric Project to the members of the Municipal Board, including the Mayor, of the Municipality of the Senahú Township. The Municipal Decree No. 30-2007, dated July 30th 2007, issued the construction approval for the Choloma Hydroelectric plant.

2. Second Stage of Information

With the intention of corroborating and enriching the information previously obtained, the consultant in charge of the undertaking of the project´s Environmental Impact Assessment Study held meetings with the legally established Community Councils for Development – COCODES (by their abbreviation in Spanish), which are community councils of the nearby communities. In addition, authorities from the Municipality of San Antonio Senahú participated.

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[24] Secacao and Candelaria Hydroelectric Plants.

[25] Company in charge of reforestation activities.

On September 13th 2007, a meeting with leaders of COCODES took place. This meeting was attended by representatives of the Nuevo San Carlos, La Montañesa and Santa Lucía Secacao communities. Table 15 below shows the name and council position of the attendees.

Table 16. Meeting attendance

Community	Name	Council Position
Nuevo San Carlos	Martín Coc	President
	Jorge Chub Jaal	Coordinator
	Mario Cac Coc	Secretary
	Lorenzo Cac	Treasurer
	Santiago Choc	Board Member
La Montañesa	José Choc	President
	Alejandro Chuc Col	Coordinator
	Emilio Chu	Secretary
Santa Lucía Secacao	Juan Rax	President
	Raúl Pérez Tox	Coordinator
	Mardoqueo Maquín	Secretary
	Pedro Choc	Board Member
	Santiago Maquí	Board Member
Choloma Project Representatives	Rudolf Jacobs	Executive
	Javier Luengo	Executive
	Rodrigo Tormo	Executive
	Rodrigo Lux	Translator Castilian-Q'eqchi
Basterrechea Asociados, S.A.	Manuel Basterechea	Study coordinator
	Carlos Quezada	Sociologist
	Hugo Enríquez	Biologist
	Roberto Sagastume	Cartographer

On September 18th 2007, a meeting with members of the Municipal Board was held in the Municipality of San Antonio Senahú. The EIA consultant explained that the objective of the meeting was to gather opinions of the board members regarding the development of the Choloma hydroelectric project. The Municipality representatives confirmed that they had prior knowledge of the project, and that they had been informed about the project details in due course. Table 16 below shows the attendee list of this meeting.

Table 17. Meeting attendance

Name	Municipality Position
José Salvador Buenafé Reyes	Councillor I
Mario Eduardo Hassen Ovalle	Councillor V and Mayor in functions
Alejandro Argueta	Municipal Secretary

In addition, a series of random interviews were performed, Table 17 lists the names of the persons that were interviewed.

Table 18. People randomly interviewed

Name
Alfredo Xixel
Eduardo Mú
Mariano Díaz
Haroldo Toch Chen
Julio Chum
Domingo Tot

The documentation that supports this information, such as meeting minutes, lists of participants / attendees, surveys, etc., is included in the EIA (Environmental Impact Assessment study) of the project.

3. Third and Final Stage of Information

Finally, on February 17th, 2011, a Stakeholder Consultation to representatives from several nearby communities was undertaken. This consultation intended to collect comments from leaders and representatives from local communities.

Invitations were sent out for this event, and 65 attendees from seven nearby communities participated, as documented in the attendance sheet. Ing. Raúl Castañeda, from the Guatemalan Designated National Authority (DNA), participated as an observer.

The event included a presentation by Mr. Rodrigo Tormo and Ms. Laura Ruiz, General Manager and CDM Assistant, respectively, of Hidroeléctrica Choloma, S.A. (project participant), a comments/questions session with the registration of written comments, a guided plant-tour to project installations of the existing Secacao hydroelectric plant, a demonstration of how a hydroelectric plant functions with the help of a miniature model (see photos), and a closing luncheon.

E.2. Summary of the comments received:

Comments received during the ***first and second information stages*** are presented in the table below.

Table 19. Stakeholders' comments

Stakeholder	Comments
COCODES	• Community representatives were aware of the development of the project and were agreeable with the plans to develop it. • The project roads contribute to the mobilization of the nearby communities. • Because meeting participants were familiar with hydroelectric energy generation they were neither concerned nor worried about being affected. Mr. Mario Cac indicated that "jobs have been generated, we see no problems. Also, trees are being planted." • Representatives asked for support in the construction of water tanks. • Various representatives were thankful for having been invited and heard. • Representatives expressed support and acceptance regarding the construction of the Choloma project.
Municipality	• Representatives requested for the Company to collaborate with the supply of road materials for the rehabilitation or nearby municipal access roads. • The Municipal authorities thanked the project developers for their visit and expressed being in agreement with the project construction.
Inhabitants	• These kinds of projects benefit our communities by offering jobs, building new and fixing old roads, assisting with access to electricity and by reforesting the area. In favor regarding the construction of the Choloma hydroelectric project.

The comments received from local stakeholders during the ***third information stage and consultation process*** of Feb. 17th, 2011 are presented next, in a summarized and graphical form. Comments were, for the most part, very positive. Local stakeholders expressed that the Choloma Hydroelectric Project will bring benefits to their communities, generate new jobs and increase electricity generation from a non-polluting source.

Local stakeholders also stated that the project activity will not only generate clean electricity but will also improve the labour and health conditions of the area through reforestation efforts, providing better environmental conditions for the local communities.

Comments received during the stakeholder consultation (17.02.2011): 51 attendees registered their comments, on 45 comment sheets (forms):

1 Based on the available information and your knowledge regarding the Environment, Climate Change, Kyoto Protocol and Clean Development Mechanism, briefly express your opinion about the Choloma Hydroelectric Project.

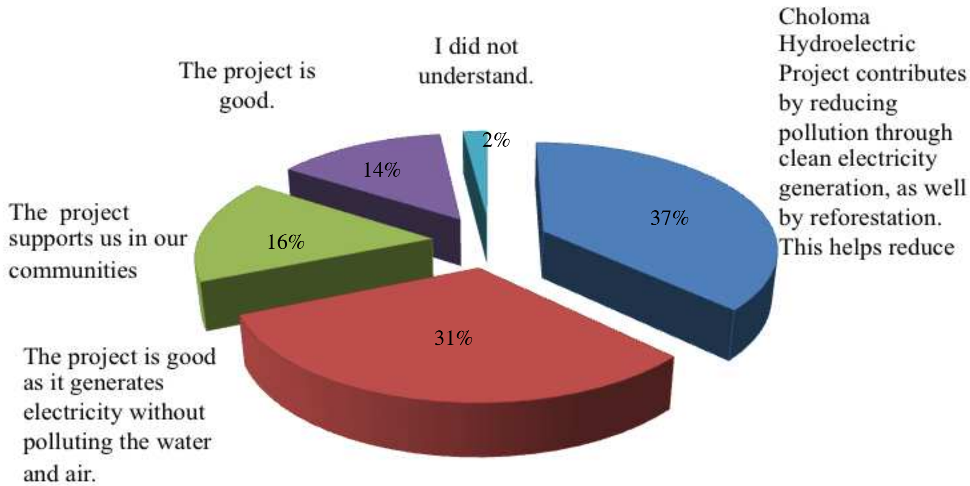


Fig. 12. Comments on Choloma Hydroelectric Project

2 Would you recommend private companies, governmental authorities or other organizations to develop projects of this kind: electricity generation from renewable resources as a contribution to the mitigation of climate change?

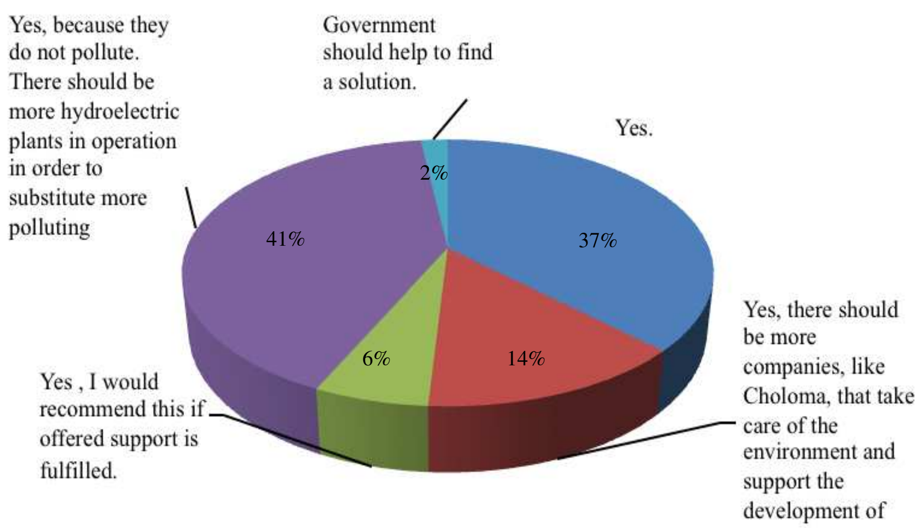


Fig. 13. Comments on electricity generation from renewable resources

3 Do you believe that Choloma Hydroelectric Project will contribute to the environmental, social and economic development (sustainable development) of the region and of Guatemala?

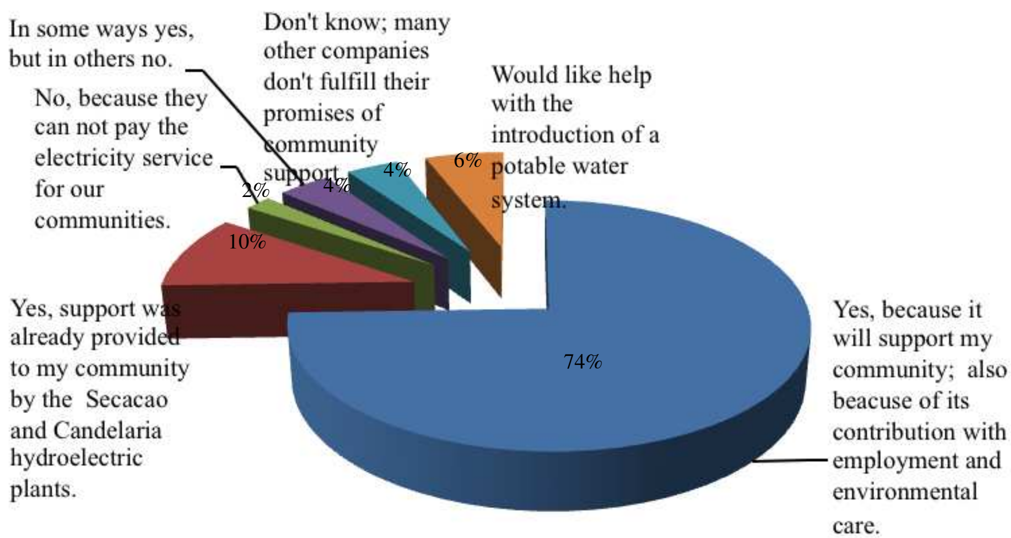


Fig. 14. Comments on contribution of the project to sustainable development

4 Express any additional comments.

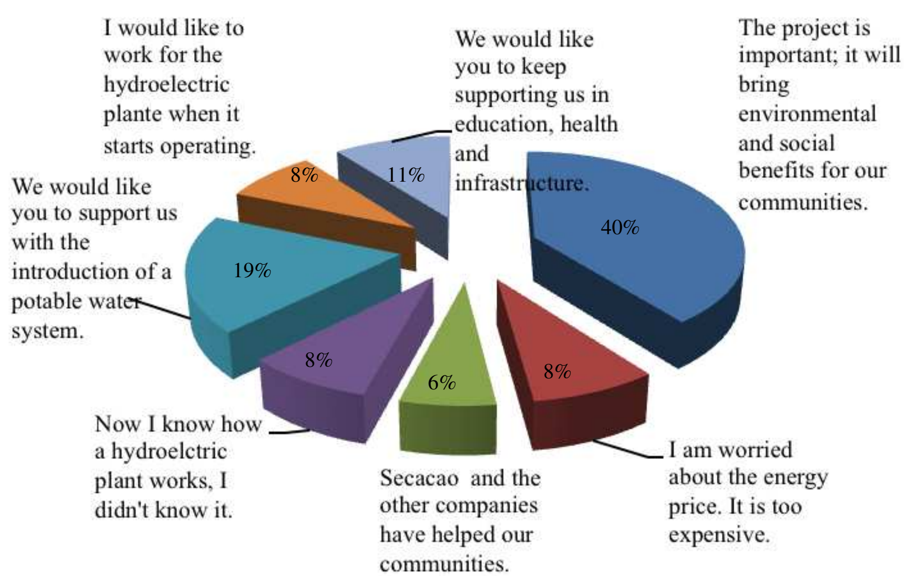
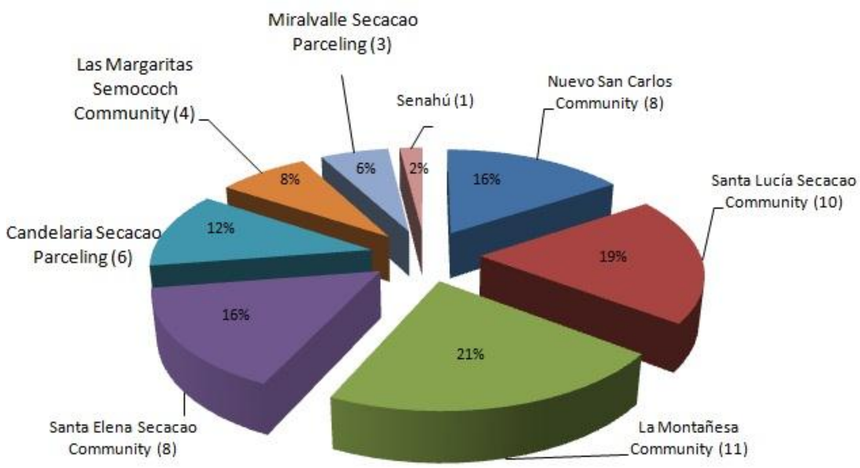


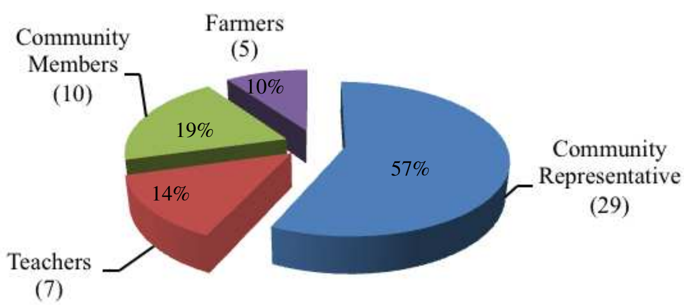
Fig. 15. Additional comments

*** General information**

a Community Representation:



b Position / profession:



c Attendees:

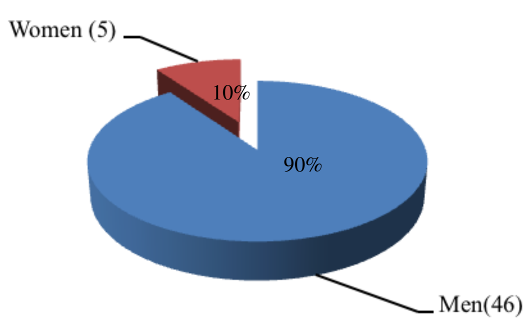


Fig. 16. Characterization of stakeholders consulted

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

Community infrastructure:

Regarding the expressed and observed need that local communities have with the lack of adequate water distribution systems, and the absent action by the local and national governments (Municipality of Senahú and Federal Government ministries), the project participant is evaluating different alternatives on how to assist, recognizing the strong and direct relationship that exists between inadequate water and elevated health problems, general child development and lower living standards due to time and effort required to collect water.

For three neighboring communities, a quantification of water sources and volumes present in the dry season are being identified and measured. With this information and a mapping of the distribution of houses in these communities, including population per house density (and population growth in a design period of 20 years), a water distribution system is being evaluated, and if feasible, is to be designed and constructed. The final goal is to present to the communities the resulting designs, and to seek to establish a mutual cooperation agreement where, in essence, the project activity would assist with the design and construction of the system, with contributions by the community members with respect to labor and a long-term commitment by the community organizations and members to maintain and administer their water system to guarantee its functionality and longevity.

Community support:

As part of the capital investment into the project activity, a new ambulance will be put into service, which will be operated by the sponsors and will tend to health emergencies that require transportation to better equipped medical centers, that usually lie from a few to several hours away from the neighboring communities.

In addition, the project activity will join the efforts with the existing Secacao and Candelaria hydroelectric power companies, in maintaining and stocking a community health center that was built by these companies to tend to the nearby population (of 4,000+) regarding non-emergency health care, including pregnancy and child-birthing assistance.

The project participant, on its own land area that surrounds the physical project components, will implement reforestation projects, aimed at job-creation, water resource management and general ecosystem recovery. As part of this effort, the project activity will, on a long-term basis, tend to the conservation and protection of the natural tropical forests that cover the higher project areas where the water resources used by the project come from.

General infrastructure:

Continuous assistance is provided to the Municipality of Senahú, and the local communities, especially with respect to providing road construction and maintenance materials (sand, fill, rock, etc.), in particular when these maintenance programs are focused on the general roads that serve and connect the surrounding communities. Often construction equipment is also provided.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Hidroeléctrica Choloma, S.A
Street/P.O.Box:	16 Calle 0-26 Zona 14
Building:	
City:	Guatemala City
State/Region:	Guatemala, Central America
Country:	Guatemala
Telephone:	+(502) 2313-8383
FAX:	+(502) 2313-8383
E-Mail:	info@gruposecacao.com
URL:	
Represented by:	
Title:	General Manager
Salutation:	Lic.
Last Name:	Tormo
Middle Name:	
First Name:	Rodrigo
Department:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	rtormo@gruposecacao.com

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding from parties included in Annex I is available to the project activity.

ANNEX 3

BASELINE INFORMATION

Information sources

Variable	Description	Units	Source
	Name of the power plant/unit connected to the grid		Wholesale Electricity Market, "Generation" section, table "Installed Capacity in the Electric System" http://www.amm.org.gt/pdfs/capacidad_instalada.pdf
	Available capacity of the power units connected to the grid	MW	Wholesale Electricity Market, "Generation" section, table "Installed Capacity in the Electric System" http://www.amm.org.gt/pdfs/capacidad_instalada.pdf
	Starting year of the power units connected to the grid		Wholesale Electricity Market, "Generation" section, table "Installed Capacity in the Electric System" http://www.amm.org.gt/pdfs/capacidad_instalada.pdf
$EGm_{,2010}$	Energy produced by plants/units m in 2010	(MWh)	Wholesale Electricity Market, "Generation" section, table of Generation by power plant (2010) http://www.amm.org.gt/pdfs/2010/generacion/Generacion_2010_WEB.xls
i	Fuel Type of power units		Wholesale Electricity Market, "Generation" section, table "Installed Capacity in the Electric System" http://www.amm.org.gt/pdfs/capacidad_instalada.pdf
$EF_{CO2,m,i,y}$	Average emission factor of fuel type i	(t CO_2/TJ)	IPCC, 2006, Inventory Workbook
	Conversion factor of power units	TJ/MWh	Conversion factor from the International System of Units
η_m	Default efficiency factors of power units	%	Meth tool, annex I
$EF_{EL,m,y}$	Emission factor of unit m in 2010	t CO_2/MWh	Calculated
	CO_2 emissions 2010 of power units	t CO_2	Calculated

Table A3.1 Selection of set of power plants m for operating margin calculation

Name of the power plant/unit (clasified by technology)			EGm_{2010}	i	$EF_{CO2,m,i,y}$		η_m	$EF_{EL,m,y}$	
	Installed capacity	Starting year	Energy produced 2010	Fuel Type	Average emission factor of fuel type i	Conversion factor	Default efficiency factors	Emission factor of unit m	CO_2 emissions 2010
	MW		(MWh)		(t CO_2/TJ)	TJ/MWh	%	t CO_2/MWh	t CO2
	AMM	AMM	AMM	AMM	Inventory Workbook (IPCC, 2006)	Conversion factor from the International System of Units	Meth tool, annex I	Calculated	Calculated
Coal			**506,711**						**432,289.90**
La Libertad	20.00	2008	93,078	Bituminous coal	89.5	3.6	39.0%	0.826	76,897.02
San Jose	139.00	2000	413,632	Bituminous coal	89.5	3.6	37.5%	0.859	355,393
Combined cycle			**7,797**						**0.0**
Arizona Vapor 1	12.50	2008	7,797	Waste Heat	0.0	3.6	0%	-	0
GAS TURBINES			**3,533**						**3,078.36**
Tampa	80.00	1995	2,026	Diesel	72.6	3.6	30.0%	0.871	1,765.39
S&S	51.00	1995	844	Diesel	72.6	3.6	30.0%	0.871	735.63
Escuintla Gas 5	41.85	1985	155	Diesel	72.6	3.6	30.0%	0.871	134.90
Laguna Gas 2	26.00	1978	388	Diesel	72.6	3.6	30.0%	0.871	337.96
Escuintla Gas 3	35.00	1976	120	Diesel	72.6	3.6	30.0%	0.871	104.47
Laguna Gas 1	17.00	1978	-	Diesel	72.6	3.6	30.0%	0.871	-
Internal combustion motors			**1,861,882**						**1,399,063.79**
Electrocristal bunker	10.000	2009	25,984	Fuel Oil No.6	75.5	3.6	39.5%	0.688	17,879.44
Amatex 3	24.336	2008	42,800	Fuel Oil No.6	75.5	3.6	39.5%	0.688	29,450.59
GECSA 2	37.800	2008	48,847	Fuel Oil No.6	75.5	3.6	39.5%	0.688	33,612.01
COENESA	10.000	2008	136	Diesel	72.6	3.6	39.5%	0.662	89.76
GECSA	15.744	2007	8,906	Fuel Oil No.6	75.5	3.6	39.5%	0.688	6,128.57
Arizona	160.000	2003	643,014	Fuel Oil No.6	75.5	3.6	39.5%	0.688	442,458.58
Amatex 2	15.000	2003	63,967	Fuel Oil No.6	75.5	3.6	39.5%	0.688	44,016.01
Electrogeneración	15.750	2003	32,383	Fuel Oil No.6	75.5	3.6	39.5%	0.688	22,282.93
La Esperanza (Poliwatt)	129.360	2000	454,749	Fuel Oil No.6	75.5	3.6	39.5%	0.688	312,913.24
Las Palmas	66.800	1998	211,982	Fuel Oil No.6	75.5	3.6	30.0%	0.906	192,055.47
GENOR	96.240	1998	215,690	Fuel Oil No.6	75.5	3.6	30.0%	0.906	195,415.35
LAGOTEX (Textiles del Lago)	90.000	1996	23,400	Fuel Oil No.6	75.5	3.6	30.0%	0.906	21,200.29
SIDEGUA	44.000	1995	22,692	Fuel Oil No.6	75.5	3.6	30.0%	0.906	20,559.01
PQPC (Puerto Quetzal Power)	118.000	1993	40,223	Fuel Oil No.6	75.5	3.6	30.0%	0.906	36,442.44
Generadora Progreso	21.968	1993	27,108	Fuel Oil No.6	75.5	3.6	30.0%	0.906	24,560.11
Cogenerators (bunker)			**16**						**11.49**
Tulula (bunker)	19.00	2001	0.00	Fuel Oil No.6	75.5	3.6	39.0%	0.697	0.00
Madre Tierra (bunker)	28.00	1996	0	Fuel Oil No.6	75.5	3.6	37.5%	0.725	0.04
Pantaleon I (bunker)	35.00	1991	2	Fuel Oil No.6	75.5	3.6	37.5%	0.725	1.65
Santa Ana (bunker)	40.00	1995	2	Fuel Oil No.6	75.5	3.6	37.5%	0.725	1.12
La Unión (bunker)	65.00	1995	11	Fuel Oil No.6	75.5	3.6	37.5%	0.725	8.32
Concepcion (bunker)	27.50	1994	0	Fuel Oil No.6	75.5	3.6	37.5%	0.725	0.07
Magdalena (bunker)	130.00	1994	0	Fuel Oil No.6	75.5	3.6	37.5%	0.725	0.29

Table A3.2 Selection of set of power plants k for operating margin calculation

			$EG_{k,2010}$	i	$EF_{CO2,k,i,y}$		η_k	$EF_{EL,k,y}$	
Name of the power plant/unit (clasified by technology)	**Installed capacity**	**Starting**	**Energy produced 2010**	**Fuel Type**	**Average emission factor of fuel type i**	**Conversion factor**	**Default efficiency factors**	**Emission factor of unit k**	**CO_2 emissions 2010**
	MW	year	(MWh)		(t CO_2/TJ)	TJ/MWh	%	t CO_2/MWh	t CO2
	AMM	AMM	AMM	AMM	Inventory Workbook (IPCC, 2006)	Conversion factor from the International System of Units	Meth tool, annex I	Calculated	Calculated
Coal			**528,907**						**454,437**
San Jose	139.00	2000	528,907	Bituminous coal	89.5	3.6	37.5%	0.859	454,437
Cogenerators (biomass)			**978,902**						0.0
La Unión 2 (biomass)	10.00	2009	1,784	Cane bagasse	0	-	0		0
Magdalena 5(biomass)	44.344	2008	168,448	Cane bagasse	0	-	0		0
San Diego (biomass)	5.00	2004	1,386	Cane bagasse	0	-	0		0
Trinidad (biomass)	26.00	2006	38,299	Cane bagasse	0	-	0		0
Magdalena 4 (biomass)	30.00	2005	99,910	Cane bagasse	0	-	0		0
Pantaleon II (biomass)	20.00	2005	39,777	Cane bagasse	0	-	0		0
Tulula (biomass)	19.00	2001	11,263	Cane bagasse	0	-	0		0
Madre Tierra (biomass)	28.00	1996	87,927	Cane bagasse	0	-	0		0
Pantaleon I (biomass)	35.00	1991	141,246	Cane bagasse	0	-	0		0
Santa Ana (biomass)	40.00	1995	122,504	Cane bagasse	0	-	0		0
La Unión (biomass)	65.00	1995	149,609	Cane bagasse	0	-	0		0
Concepcion (biomass)	27.50	1994	68,544	Cane bagasse	0	-	0		0
Magdalena (biomass)	130.00	1994	48,204	Cane bagasse	0	-	0		0
Geothermal			**259,308**						0.0
Ortitlan Limitada	25.20	2007	144,879	Geothermal stean	0	-	0		0
Zunil	24.00	1999	114,429	Geothermal stean	0	-	0		0
Hydroelectrics			**3,767,038**						0.0
Finca Las Margaritas	0.438	2010	-	Water	0	-	0		0
Hidro Xacbal	94.00	2010	259,556	Water	0	-	0		0
Panan	7.32	2010	34	Water	0	-	0		0
Los Cerros	1.25	2010	2,794	Water	0	-	0		0
Covadonga	1.60	2010	1,268	Water	0	-	0		0
Jesbon Maravillas	0.75	2010	950	Water	0	-	0		0
El Prado	0.50	2010	55	Water	0	-	0		0
Oscana	DG**	2010	5	Water	0	-	0		0
Kaplan Chapina	2.00	2009	569	Water	0	-	0		0
Cuevamaría	1.50	2009	8,703	Water	0	-	0		0.0
Santa Elena	0.16	2008	768	Water	0	-	0		0
El Recreo	26.00	2007	140,819	Water	0	-	0		0
Generadora Montecristo	13.50	2006	57,306	Water	0	-	0		0
Hidroelectrica Candelaria	4.60	2006	23,708	Water	0	-	0		0
Palin II	5.80	2005	-	Water	0	-	0		0
Renace	68.10	2004	310,536	Water	0	-	0		0
Hidroelectrica El Canada	48.10	2003	233,372	Water	0	-	0		0
Las Vacas	46.00	2002	42,324	Water	0	-	0		0
Matanzas + San Isidro	15.93	2002	63,734	Water	0	-	0		0.0
Pasabien	12.75	2000	53,805	Water	0	-	0		0
Poza Verde	12.51	2000	35,213	Water	0	-	0		0
Secacao	16.50	1998	94,400	Water	0	-	0		0
Rio Bobos (Fabrigas)	10.00	1995	52,018	Water	0	-	0		0
Chixoy	300.00	1983	1,691,832	Water	0	-	0		0
Aguacapa	90.00	1982	317,023	Water	0	-	0		0
Jurun	60.00	1970	276,289	Water	0	-	0		0
Esclavos	15.00	1966	44,337	Water	0	-	0		0
Santa María	6.00	1927	31,985	Water	0	-	0		0
*Small plants	6.70	1938-1926	23,635	Water	0	-	0		0.0
Imports	11.15		354,021		0				0

Tables A3.3 Group of power plants for build margin

a. Identification of the set of five power units, excluding CDM project activities, which started to supply electricity to the grid most recently

Build Margin		$EG_{m,2010}$		i	$EF_{CO2,m,i,y}$		η_m	$EF_{EL,m,2010}$	
	Starting year	Energy produced 2010	Accumulative energy producction	Fuel Type	Average emission factor of fuel type i	Conversion factor	Default efficiency factors	Emission factor of unit m	CO2 emissions 2010
		(MWh)	(MWh)		(t CO_2/TJ)	TJ/MWh	%	t CO_2/MWh	t CO2
	AMM	AMM		AMM	Inventory Workbook (IPCC, 2006)	Conversion factor from the International System of Units	Meth tool, annex I	Calculated	Calculated
Option 1. Five most recent plants									
Panan	2010	34	34	Water	0.0	3.6	0	0	0.0
Los Cerros	2010	2,794	2,827	Water	0.0	3.6	0	0	0.0
Covadonga	2010	1,268	4,096	Water	0.0	3.6	0	0	0.0
Jesbon Maravillas	2010	950	5,046	Water	0.0	3.6	0	0	0.0
El Prado	2010	55	5,101	Water	0.0	3.6	0	0	0.0
TOTAL		**5,101.06**							**0.0**

b. Calculation of the total annual generation of the project electricity system, excluding CDM project activities. AEGtotal = 7,645,420 and 20% AEGtotal = 1,529,084 MWh.

c. Identification of the set of the power units, excluding CDM project activities, that started to supply electricity to the grid most recently

Build Margin		$EG_{m,2010}$		i	$EF_{CO2,m,i,y}$		η_m	$EF_{EL,m,2010}$	
	Starting year	Energy produced 2010	Accumulative energy producction	Fuel Type	Average emission factor of fuel type i	Conversion factor	Default efficiency factors	Emission factor of unit m	CO2 emissions 2010
		(MWh)	(MWh)		(t CO_2/TJ)	TJ/MWh	%	t CO_2/MWh	t CO2
	AMM	AMM		AMM	Inventory Workbook (IPCC, 2006)	Conversion factor from the International System of Units	Meth tool, annex I	Calculated	Calculated
Panan	2010	34	34	Water	0.0	-	0.0%	0.000	-
Los Cerros	2010	2,794	2,827	Water	0.0	-	0.0%	0.000	-
Covadonga	2010	1,268	4,096	Water	0.0	-	0.0%	0.000	-
Jesbon Maravillas	2010	950	5,046	Water	0.0	-	0.0%	0.000	-
El Prado	2010	55	5,101	Water	0.0	-	0.0%	0.000	-
Oscana	2010	5	5,106	Water	0.0	-	0.0%	0.000	-
Electrocristal bunker	2009	25,984	31,090	Fuel Oil No. 6	75.5	3.6	39.5%	0.688	17,879.44
Kaplan Chapina	2009	569	31,659	Water	0.0	-	-	0.000	-
Cuevamaría	2009	8,703	40,361	Water	0.0	-	-	0.000	-
La Unión 2 (biomass)	2009	1,784	42,145	Bagasse	0.0	-	-	0.000	-
Amatex 3	2008	42,800	84,945	Fuel Oil No. 6	75.5	3.6	39.5%	0.688	29,450.59
GECSA 2	2008	48,847	133,793	Fuel Oil No. 6	75.5	3.6	39.5%	0.688	33,612.01
COENESA	2008	136	133,928	Diesel	72.6	3.6	39.5%	0.662	89.76
Arizona Vapor 1	2008	7,797	141,726	Waste heat	0.0	-	-	0.000	-
Magdalena 5(biomass)	2008	168,448	310,174	Bagasse	0.0	3.6	-	0.000	-
La Libertad	2008	93,078	403,252	Coal	89.5	3.6	39.0%	0.826	76,897.02
Santa Elena	2008	768	404,020	Water	0.0	-	-	0.000	-
GECSA	2007	8,906	412,926	Fuel Oil No. 6	75.5	3.6	39.5%	0.688	6,128.57
El Recreo	2007	140,819	553,745	Water	0.0	-	-	0.000	-
Generadora Montecristo	2006	57,306	611,051	Water	0.0	-	-	0.000	-
Trinidad (biomass)	2006	38,299.42	649,351	Bagasse	0.0	-	-	0.000	-
San Diego (biomass)	2004	1,386	650,737	Bagasse	0.0	-	-	0.000	-
Palin II	2005	-	650,737	Water	0.0	-	-	0.000	-
Magdalena 4 (biomass)	2005	99,910	750,648	Bagasse	0.0	-	-	0.000	-
Pantaleon II (biomass)	2005	39,777	790,425	Bagasse	0.0	-	-	0.000	-
Renace	2004	310,536	1,100,961	Water	0.0	-	-	0.000	-
Arizona	2003	643,014	1,743,975	Fuel Oil No. 6	75.5	3.6	39.5%	0.688	442,458.58

Table A3.4 Calculation of the combined margin of the grid for the ex-ante estimation of the emission reductions

A	**Estimated operating margin emission rate**	tCO_2/MWh	0.688
B	**Estimated build margin emission rate**	tCO_2/MWh	0.348
C = A x 0.5 + B x 0.5	**Estimated baseline emission rate**	tCO_2/MWh	**0.518**

Calculation of lambda

Lambda is equal to the number of hours per year for which low cost and must-run plants are on the margin divided by the total hours per year.

- Lambda is calculated graphically as the intersection of the load duration curve and the horizontal line, and the area below represents the annual generation of low cost and must-run plants.
- Low cost and must-run plants are hydroelectric, geothermal power plants and imports. Additionally, the obligated dispatched components of cogenerators power units and coal based power plants.
- Data of the load duration curve are obtained directly from Wholesale Electricity Administrator´s web site (www.amm.org.gt, AMM en linea).

As per version 02.2.1 of the Tool to calculate the emission factor for an electricity system, Lambda (λ_{2010}) is calculated as follows:

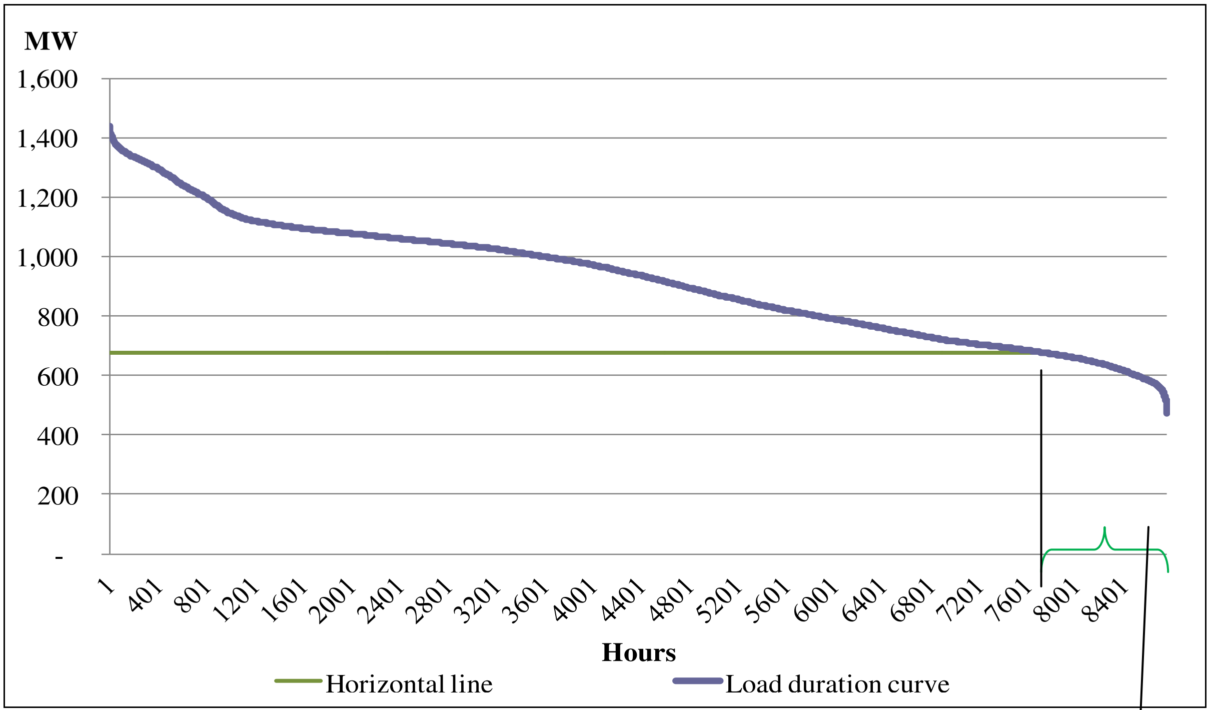
Step (1) Load duration curve is plotted. Chronological load data (in MW) for each hour of the year *y* are plotted in descending order.

Step (2) The total annual generation (in MWh) from low-cost/must-run power units and imports is calculated.

Step (3) A horizontal line across the load duration curve is plotted such that the area under the curve (MW times hours) equals the total generation (in MWh) from low- cost/must-run power plants/units (i.e. $\sum_k EG_{k,y}$).

Step (4) The "Number of hours for which low-cost/must-run sources are on the margin in year *y*" are calculated, locating the intersection of the horizontal line plotted in Step (3) and the load duration curve plotted in Step (1). The number of hours (out of the total of 8760 hours) to the right of the intersection is the number of hours for which low-cost/must-run sources are on the margin.

Step (5) Lambda is calculated as follow:
λ is equal to the number of hours low-cost/must-run sources are on the margin in 2010 divided by the hours per year (2010).



Lambda factor calculation for 2010

Number of hours that plants k are on the margin

Annex 4

MONITORING PLAN

See section B.7.