Project design document form
(Version 11)

Complete this form in accordance with the instructions attached at the end of this form.

BASIC INFORMATION	
Title of the project activity	Candelaria Hydroelectric Project
Scale of the project activity	☐ Large-scale ☒ Small-scale
Version number of the PDD	13.1
Completion date of the PDD	30/07/2020
Project participants	Hidroeléctrica Candelaria S.A. (private entity)
Host Party	Guatemala
Applied methodologies and standardized baselines	Methodology AMS-I.D. “Grid connected renewable electricity generation” (version 18)
Sectoral scopes	Sectoral Scope 01: Energy industries (renewable / non-renewable sources)
Estimated amount of annual average GHG emission reductions	10,618 tCO2

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

Background

The Candelaria Hydroelectric Project is a small scale, run-of river, hydroelectric project owned and operated by Hidroeléctrica Candelaria S.A. As per CDM project standard for project activities, it is classified as a small-scale project Type I (Renewable energy projects < 15 MW).

Project Description

The objective of the project activity is to generate renewable electricity using hydroelectric resources and to sell the generated output to the national grid.

The project activity involves a run-of-river hydroelectric plant with an installed capacity of 4.3 MW that utilizes the water of the Trece Aguas River. This watercourse is also used for electricity generation by the Secacao 16.5 MW hydropower plant located upstream of Candelaria. The Secacao plant was developed prior to Candelaria in 1998, and is owned and operated by Candelaria's sponsors.

The total differential altitude (head) between the head pond and the turbine/generator of Candelaria plant is approximately 130 meters. The project involved the installation of a Francis type turbine and the construction of a 430 meter long tunnel and a 770 meter long penstock. Once the water has gone through the Candelaria plant, it is returned to the original river basin downstream.

The Candelaria plant delivers electricity to the Guatemalan Interconnected National System (*Sistema Nacional Interconectado*, SNI) through a 69 kilovolt transmission line that was built to connect the previously existing 16 MW Secacao plant. The Candelaria plant is also connected to a previously existing 13.8 kilovolt distribution line owned by a utility serving the local rural area, thus giving access to electricity to several local communities. The project has delivered an average of 25,586 MWh/year of net electricity during the period 2007-2018.

According to the version 18.0 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[1] that the CDM project power plant is connected to."

It is estimated that Guatemala has a hydroelectric potential of at least 4,000 MW. However, due to political and social instability and the lack of long-term planning and incentives, fossil fuel based power plants have been installed in the country. This is the current practice in the country and it represents the scenario existing prior to the implementation of the project and the baseline scenario. 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. Thus, the electricity delivered to the grid by Candelaria plant would have otherwise been generated by the operation of grid-connected power plants (including fossil fuel power plants) and by the addition of new generation sources into the grid.

As a consequence, the project has the capacity to reduce CO_2 emissions by avoiding electricity generation by the fossil fuel-fired power plants connected to the grid. The project is expected to reduce an average of 10,618 tCO_2/year, totalling 74,326 tCO_2 during the third crediting period.

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

The project participants consider that the benefits generated by the project activity significantly favour sustainable development. Hydroelectric plants and other renewable technologies would allow Guatemala, in the medium to long-term, to achieve a more sustainable energy matrix.

Specifically, the project provides the following sustainable development benefits:

- **Economic benefits:** on a national scale, the project provides clean electricity to the power market, thus reducing its dependence on imported fossil fuel.

- **Environmental benefits:** hydroelectricity is a clean generation technology and a renewable energy source. By displacing fossil fuel consumption, Candelaria not only reduces CO_2 emissions, but also mitigates other pollutants, such as SO_2, NO_x, and particulates associated with power generation. In addition, the project developers of the Candelaria, Secacao and Choloma hydroelectric plants have carried out an afforestation and reforestation plan in the areas surrounding the projects, and, with this objective, they have founded Reforestadora Polochic S. A. Moreover, in the long-term, because of its size and general characteristics (i.e., very rural area, local electricity needs), this project has a high probability of being replicated in other parts of Guatemala. This fact magnifies any global and local environmental benefits generated by the project.

- **Social benefits:** the region where the project is located has a serious chronic deficiency in electricity and work opportunities: most inhabitants have no access to either. Petén, Guatemala's largest department (administrative district), is located north of Alta Verapaz, where the project is located. The two departments lack appropriate electricity distribution networks, and large portions of the population have no access to electricity. The project delivered some of its electricity to local inhabitants, improving their quality of life. In addition, the afforestation project established by the Candelaria developers has provided hundreds of jobs for the communities surrounding the project site, and will continue to do so in the long-term.

Additionally, Candelaria directs 10% of the funds generated through the sale of CERs to an organization established by the Candelaria developers (Fundación Trece Aguas) aimed at investing in the local communities to support and strengthen schools, education, health services and infrastructure needs. The long-term aim is to structure it so that it can raise and manage funds from local and/or international aid sources, in order to continue with its mission and extend its local impact.

Revenues from the CERs sales have financed the development of several local support activities, as:

- The "Rural Electrification Project", a Public-Private Partnership carried out by Fundación Trece Aguas and the National Electricity Utility, giving access to electricity for the first time to nine communities with over 400 families, including schools, churches, community centres and small business.

- The construction and continuous operation and maintenance of the first Health Center, benefiting 11 communities and more than 4,000 people. The Health Center has a general clinic area, birthing room, sterilization area, housing for attending personnel and a training center. There are 2 nurses and a doctor working at the clinic, as well as 2 ambulance drivers, hired by Fundación Trece Aguas.

- Opening of access roads, recovery and rehabilitation of existing roads, slope stabilization and storm water management to protect schools, housing and roads from landslides danger, rehabilitation of school-buildings.

A.2. Location of project activity

A.2.1. Host Party(ies)

Guatemala

A.2.2. Region/State/Province etc.

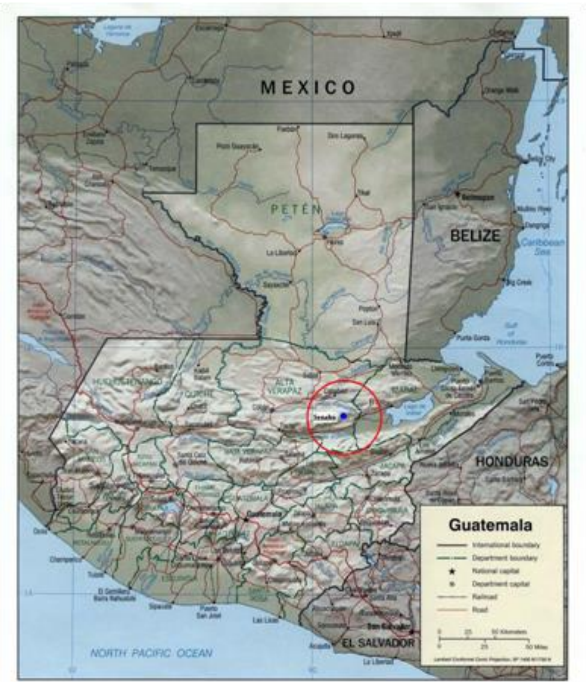
Alta Verapaz Department

A.2.3. City/Town/Community etc.

Senahú (closest town)

A.2.4. Physical/Geographical location

The project is located in the north-central area of Guatemala, on the mountain range called Sierra de Santa Cruz, in the northern area of the Polochic River Valley. The region is an agricultural area and contains large but decreasing areas of rainforest. The following figure shows a map identifying the general location of the project.



Guatemala, Alta Verapaz Department

The geographical coordinates of the power house of Candelaria plant are the following:

Latitude: 15.38695 N
Longitude: -89.75510 W

A.3. Technologies/measures

The purpose of the project activity is to generate renewable energy from a hydrological resource. The electricity generated by the project is delivered to the SNI, reducing power generation by thermal plants connected to the grid.

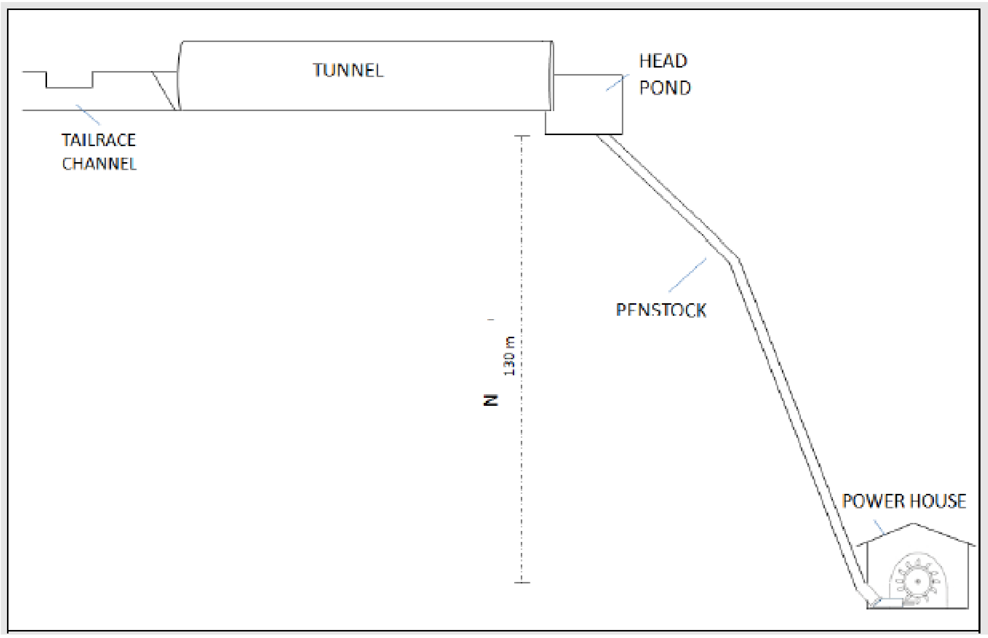
Scenario existing prior to the implementation of the project

No power plant was installed at the project site prior to the implementation of the project activity. The energy generated by the project was previously dispatched by other power plants connected to the national grid, including fossil fuel power plants. This is the scenario existing prior to the implementation of the project and it also represents the scenario that would exist in the absence of the project (i.e.: the baseline scenario). Therefore, the hydropower plant contributes to reducing emissions from those thermal power plants.

Scope of activities implemented within the project activity

Candelaria plant has an installed capacity of 4.3 MW and utilizes water from the Trece Aguas River. The total differential altitude (head) between the head pond and the turbine/generator of Candelaria plant is approximately 130 meters.

As shown in the following figure, the water flows through a tailrace channel into a 430 meter long tunnel. The water then runs through a head pond and into a 770 meters long penstock, and finally propels in a Francis type turbine located at Candelaria power house. The used water is returned to the original river basin downstream.



Candelaria's outline

The plant delivers electricity to the SNI and is connected to a 69-kilovolt transmission line. Also, the plant was enabled with electrical equipment to deliver part of its output locally, when required, through an existing 13.8 kilovolt distribution line owned by a distribution utility serving this rural area, thus giving access to electricity to several local communities.

The Candelaria plant delivers an average of 25,586 MWh of net electricity per year[2].

The project also involves technology and know-how transfer to the host Party, as follows:

- The turbine installed in the project plant is from UK (Gilbert Gilkes & Gordon Ltd.).
- The generator installed in the project plant is from France (Leroy Sommer).
- The project developer has been supported by specialized consultants from USA (EES Consulting Inc.).

[2]Historical average of net electricity delivered from 2007 to 2018.

Thus, the Candelaria project involves the importation of environmentally sound technologies to rural Guatemala. Local workers were trained for the operation of these technologies.

Introduced technologies were first used at the operations start day, with an expected operational lifetime of 30 years.

Because of its small size (4.3 MW) and location (rural highlands), this project has a high probability of being copied in other parts of the country, thus multiplying the social and environmental benefits, contributing to environmentally safe technology transfer and capacity building.

A.4. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Guatemala (host)	Hidroelectrica Candelaria S.A. (private entity)	No

A.5. Public funding of project activity

The project does not receive any public funding.

A.6. History of project activity

The construction of Candelaria began in January of 2005. As of early November of 2005, the tunnel, intake structure and transmission line of Candelaria were finalized. From November 2005 through May 2006 the steel penstock of US manufacture was imported, transported and installed, and the remaining tasks required for plant start-up were concluded, including the powerhouse and tailrace channel construction, and the import, transport and installation of electromechanical equipment. Finally, during June 2006, plant testing and final commissioning was successfully accomplished. Candelaria officially began generating electricity for the electricity national market on 01/07/2006.

The project was registered as a CDM project activity on 09/11/2006 with the UNFCCC reference number 0604. The first 7-year renewable crediting period started on 01/01/2007 and ended on 31/12/2013. The second 7-year crediting comprises from 01/01/2014 to 31/12/2020.

The project proponent is applying for the renewal of the crediting period from 01/01/2021 to 31/12/2027. Thus, the registered PDD has been updated in accordance with the CDM Project Standard (version 02.0) as given in paragraphs 278 to 291. This PDD contains the necessary adjustments for the third crediting period.

A.7. Debundling

There is an existing 16.5 MW hydropower plant (Secacao) located upstream Candelaria, also using the water of the Trece Aguas River. The mentioned hydropower plant was developed from 1993 to 1998, began operations in 1998, and is owned and operated by Candelaria’s sponsors, but is not part of the project activity. Nor are any other CDM projects to be submitted by the project sponsor in the future on the same river and within the distance limitations of small-scale CDM project activities. Thus, the Candelaria Hydroelectric Project is not part of a larger, debundled CDM activity.

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

According to paragraph 279 of the Project Standard (version 2.0)[3], to support the request for renewal of the crediting period of this registered CDM project activity, the sections of the PDD relating to the baseline, estimated GHG emission reductions and the monitoring plan are updated using the latest approved version of the methodology applied in the original PDD.

Thus, this updated PDD is developed in accordance with the approved small-scale baseline and monitoring methodology AMS-I.D "Grid connected renewable electricity generation" (version 18.0)[4].

According to the methodology, the grid emission factor is calculated using the "Tool to calculate the emission factor for an electricity system" (version 07.0)[5].

Additionally, the Tool "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" (version 03.0.1)[6] is used to update the PDD according to the Project Standard.

B.2. Applicability of methodologies and standardized baselines

The project activity qualifies as Type I (renewable energy project activities with a maximum output capacity of 15 MW) and it is expected to qualify during every year of the crediting period.

The Candelaria Hydroelectric Project involves renewable energy generation by the installation of a new small hydropower plant with an output capacity of 4.3 MW that will supply electricity to the national grid, displacing fossil fuel fired generating units.

As indicated by the manufacturer of the turbine/generator of Candelaria plant (Gilbert Gilkes & Gordon Ltd.) the generator has an apparent power of 5,397 kVA and a power factor of 0.8. The maximum output capacity of the generator is the real power (in kW) and results from multiplying the apparent power (in kVA) by the power factor, as follows: 5,397 kVA × 0.8 = 4,318 kW = 4.3 MW.

As explained in section B.1, the project activity is developed in accordance with the approved small-scale baseline and monitoring methodology AMS-I.D "Grid connected renewable electricity generation" (version 18). The applicability conditions of the methodology are presented below together with an explanation on why each condition is met by the project activity.

1. *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.*

[3] https://cdm.unfccc.int/filestorage/e/x/t/extfile-20181221092046529-Reg_stan04v02.pdf/Reg_stan04v02.pdf?t=Q0l8cTlydnZlfDD8A0yxZQUZph3Js3s7_7cO

[4] https://cdm.unfccc.int/filestorage/2/P/7/2P7FS6ZQAR84LG3NMKYUH50WI9ODBC/EB81_repan24_AMS-I.D_ver18.pdf?t=ZjV8cTlydnl6fDA1aZgqbSRtcueoGZo3eiTW

[5] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v7.0.pdf

[6] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-11-v3.0.1.pdf

The project consists of a hydroelectric power plant that supplies electricity to the national grid in Guatemala. Thus, it complies with this criterion.

2. *Illustration of respective situations under which each of the methodology (i.e. AMS-I.D, AMS-I.F and AMS-I.A) applies is included in the following table.*

	Project type	***AMS-I.A***	***AMS-I.D***	***AMS-I.F***
1	*Project supplies electricity to a national/regional grid*		√	
2	*Project displaces grid electricity consumption (e.g. grid import) and/or captive fossil fuel electricity generation at the user end (excess electricity may be supplied to a grid)*			√
3	*Project supplies electricity to an identified consumer facility via national/regional grid (through a contractual arrangement such as wheeling)*		√	
4	*Project supplies electricity to a mini grid system where in the baseline all generators use exclusively fuel oil and/or diesel fuel*			√
5	*Project supplies electricity to household users (included in the project boundary) located in off grid areas*	√		

Since the project consists in a hydroelectric power plant that supplies electricity to the national grid, it is correct to apply AMS-I.D.

3. *This methodology is applicable to project activities that: (a) Install a Greenfield; (b) Involve a capacity addition in (an) existing plant(s); (c) Involve a retrofit of (an) existing plant(s); (d) Involve a rehabilitation of (an) existing plant(s)/unit(s); or (e) Involve a replacement of (an) existing plant(s).*

Before the implementation of the project activity, no power plant was installed at the project site. This is a Greenfield power plant and, therefore, complies with this criterion.

4. *Hydro power plants with reservoirs that satisfy at least one of the following conditions are eligible to apply this methodology:*

    a. *The project activity is implemented in an existing reservoir with no change in the volume of reservoir;*
    b. *The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the project emissions section, is greater than 4 W/m^2;*
    c. *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/m^2.*

The project consists of a run-of-river hydroelectric power plant without reservoir. Thus, this condition is not relevant.

5. *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 has no non-renewable components such as diesel units. Therefore, this condition is not relevant. In any case, the installed capacity of the project is 4.3 MW. Thus, it is below the small-scale limit of 15 MW.

6. *Combined heat and power (co-generation) systems are not eligible under this category.*

   The project is not a combined heat and power plant. Thus, this criterion is not relevant.

7. *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.*

   The project consists of a new installed power plant and does not involve the addition of renewable energy generation units at an existing renewable power generation facility. Thus, this criterion is not relevant.

8. *In the case of retrofit, rehabilitation or replacement, to qualify as a small-scale project, the total output of the retrofitted, rehabilitated or replacement power plant/unit shall not exceed the limit of 15 MW.*

   The project consists of a new installed power plant and does not involve any retrofit or replacement of existing units. Thus, this criterion is not relevant.

9. *In the case of landfill gas, waste gas, wastewater treatment and agro-industries projects, recovered methane emissions are eligible under a relevant Type III category. If the recovered methane is used for electricity generation for supply to a grid then the baseline for the electricity component shall be in accordance with procedure prescribed under this methodology. If the recovered methane is used for heat generation or cogeneration other applicable Type-I methodologies such as “AMS-I.C.: Thermal energy production with or without electricity” shall be explored.*

   The project consists of a hydroelectric power plant. Thus, this criterion is not relevant.

10. *In case biomass is sourced from dedicated plantations, the applicability criteria in the tool “Project emissions from cultivation of biomass” shall apply.*

    The project consists of a hydroelectric power plant. Thus, this criterion is not relevant.

Since the project activity complies with all relevant criteria, the methodology is applicable to the project activity.

The “Tool to calculate the emission factor for an electricity system” (version 07.0) is also applied to the project activity. The applicability conditions of the Tool are the following:

1. *This tool may be applied to estimate the OM, BM and/or CM when calculating baseline emissions for a project activity that substitutes grid electricity that is where a project activity supplies electricity to a grid or a project activity that results in savings of electricity that would have been provided by the grid (e.g. demand-side energy efficiency projects).*

   The project consists in a hydroelectric power plant that supplies electricity to the national grid in Guatemala. Thus, this criterion is met.

2. *Under this tool, the emission factor for the project electricity system can be calculated either for grid power plants only or, as an option, can include off-grid power plants. In the latter case, the conditions specified in “Appendix 2: Procedures related to off-grid power generation” should be met. Namely, the total capacity of off-grid power plants (in*

MW)should be at least 10 per cent of the total capacity of grid power plants in the electricity system; or the total electricity generation by off-grid power plants (in MWh) should be at least 10 per cent of the total electricity generation by grid power plants in the electricity system; and that factors which negatively affect the reliability and stability of the grid are primarily due to constraints in generation and not to other aspects such as transmission capacity.

In this case, the first option is selected, i.e.: the emission factor is calculated for grid power plants only, excluding off-grid power plants.

3. *In case of CDM projects the tool is not applicable if the project electricity system is located partially or totally in an Annex I country.*

   The SNI is located totally in Guatemala, which is not an Annex I country. Thus, this criterion is met.

4. *Under this tool, the value applied to the CO_2 emission factor of biofuels is zero.*

   No biofuels are currently consumed in the power plants connected to the SNI. Should this change during the third crediting period, the CO_2 emission factor of such biofuels would be set at zero.

In accordance with the applicable provisions on small-scale project type and eligibility in the CDM project standard for project activities, the project activity qualifies as Type I: Renewable energy project activities with a maximum output capacity of 15 MW, since its installed capacity is 4.3 MW.

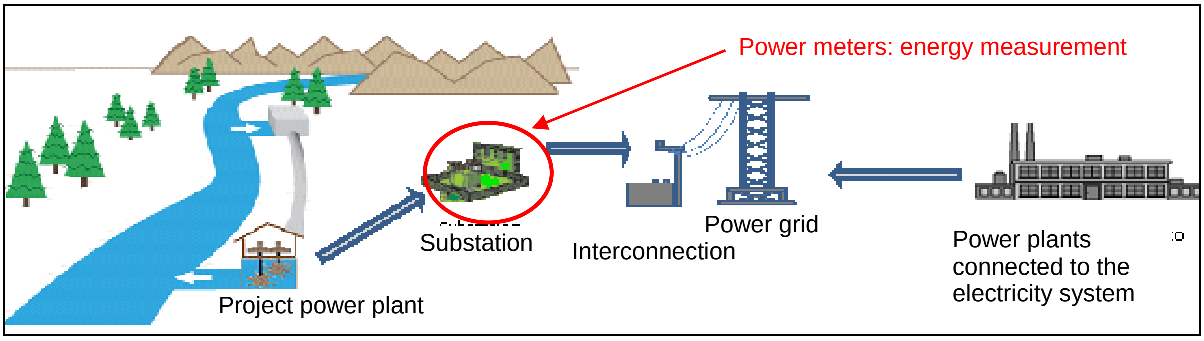
B.3. Project boundary, sources and greenhouse gases (GHGs)

According to the methodology, the spatial extent of the project boundary includes the project power plant and all power plants connected physically to the electricity system that the CDM project power plant is connected to.

Additionally, according to the Tool, a grid/project electricity system is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity and that can be dispatched without significant transmission constraints.

In this case, the project activity is connected to the Guatemalan Interconnected National System (*Sistema Nacional Interconectado*, SNI). Thus, the Candelaria power plant and all power plants connected to the SNI are included in the project boundary.

A simplified scheme of the project boundary is shown in the following figure:



Project boundary of the project activity

As shown in the table below, only carbon dioxide emissions from electricity generated by fossil fuel

fired power plants displaced by the project activity are taken into account in the baseline scenario. Other potential GHGs such as CH_4 and N_2O are excluded, which is conservative. The project activity, itself, does not produce significant GHG emissions.

Source		Gas	Included?	Justification/Explanation
Baseline	CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
	For hydro power plants, emissions of CH_4 from the reservoir	CO_2	No	The project activity is a hydroelectric power plant without reservoir.
		CH_4	No	
		N_2O	No	

B.4. Establishment and description of baseline scenario

According to paragraph 283 of the Project Standard, to demonstrate the validity of the original baseline or its update, project participants are not required to re-assess the baseline scenario. Instead, project participants shall assess the GHG emission reductions that would have resulted from that scenario.

The baseline scenario described in the registered PDD is consistent with the definition included in version 18 of the methodology. Thus, the baseline scenario is that the electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources into the grid.

In accordance with the Tool “Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period” (version 03.0.1), the following stepwise procedure should be used to support the request for renewal of the crediting period of the registered CDM project activity:

Step 1: Assess the validity of the current baseline for the next crediting period

Step 1.1: Assess compliance of the current baseline with relevant mandatory national and/or sectoral policies

The current baseline complies with all relevant mandatory national and/or sectoral policies.

There are no relevant mandatory policies that have come into effect after the submission of the project activity for validation. Thus, the mandatory policies applicable at the time of requesting the renewal of the crediting period are the same than those applicable at the time of the submission of the project for validation.

The legal framework governing the electric power subsector is based on the following policies:

- Constitution of the Republic of Guatemala
- General Electricity Law, Decree 93-96
- Regulations of the General Electricity Law, Government Agreement 256-97 and its modifications
- Regulations of the Wholesale Market Administrator, Government Agreement 299-98 and its modifications

- Regulations of Commercial and Operational Coordination pertaining to the Wholesale Market Administrator

With the passing of the General Electricity Law in 1996, the electricity wholesale market initiated operation administering the energy and power transactions between market agents under free market conditions. The electricity wholesale market allows energy transactions in the opportunity or spot market, and capacity and energy transactions in the contract market, according to mutually agreed contracts between market agents.

The General Electricity Law is the basic law in matters of electricity and is based on the following principles:

- The generation of electric power is free and does not require prior authorization or preconditions from the State, other than those acknowledged by the Political Constitution of the Republic of Guatemala and the national laws. Nonetheless, in order to use State assets for such purposes, the authorization of the Department will be required when the plant power exceeds 5 MW.
- Electric power transmission is free, when the use of public domain assets is not required.
- Electric power transmission implying the use of public domain assets and the final electric power distribution service shall be subject to authorization.
- Electric power buy/sell contracts are freely negotiated among the parties, except for transmission and distribution services, which are subject to authorization. The transfer of power among generators, marketers, importers and exporters resulting from wholesale market operations are subject to regulation as set out by law.

The Wholesale Market Administrator (*Administrador del Mercado Mayorista*, AMM) is the national entity in charge of regulating the commercialization of energy in the national grid. The AMM is responsible for the efficient operation of the wholesale market and manages the economic load dispatch, minimizing the total cost of the generation operation.

Additionally, there is a law that promotes renewable energy sources through fiscal incentives and import exemptions, the Decree 52-2003, regulated by Government Agreement 211-2005. Although this law provides a 10-year income tax and importation tax exemptions to renewable energy projects, which contributes positively to the projects' economics, the impact is relatively low since most projects have long term debt service periods that coincide with this exemption period thus reducing its financial contribution. Therefore, the law only partially contributes to overcome the investment barriers faced by projects like Candelaria, as shown below in Section B.5 of this PDD.

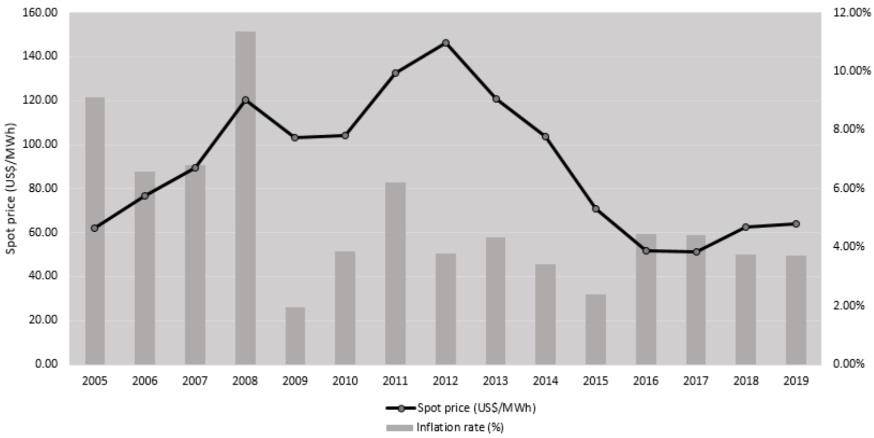
Step 1.2: Assess the impact of circumstances

The circumstances existing at the time of requesting the renewal of the crediting period are similar than those existing at the time of the submission of the project for validation.

The Guatemalan Spot Market continues being a cost-based system, and all generation, whether it is renewable resource based or fossil fuel based, must compete under equal terms. All generating plants declare their operating and fuel costs, and the Market Administrator dispatches the system to cover total demand plus reserves at the lowest declared variable cost (US$/MWh).

Actual electricity price and its marked fluctuations continue being a risk for the project activity. Continuous improvements in non-renewable technology combined with falling commodity prices have driven non-renewable power plants more competitive in the local energy matrix. Moreover, reforms and developments in neighbouring markets have opened up international competition. Candelaria is exposed to this continuous energy price risk of the spot market and hinders its possibilities of negotiating future contracts for fixed energy and capacity price to reduce market price risk.

The following figure shows the annual average spot prices during the last years, with a steady decline during the last 8 years.



Annual average spot price (Source: AMM website report and Guatemalan Bank)

As mentioned above, it is estimated that Guatemala has a hydroelectric potential of at least 4,000 MW. However, due to political and social instability and the lack of long-term planning and incentives, fossil fuel based power plants continue being installed in the country. This is the current practice in the country and it represents the scenario existing prior to the implementation of the project and the current baseline scenario. Thus, the electricity delivered to the grid by Candelaria plant would have otherwise been generated by the operation of grid-connected power plants (including fossil fuel power plants) and by the addition of new generation sources into the grid.
As a consequence, the project has the capacity to reduce CO_2 emissions by avoiding electricity generation by the fossil fuel-fired power plants connected to the grid. The baseline emissions are the product of quantity of electricity produced by Candelaria plant multiplied by the grid emission factor.

Step 1.3: Assess whether the continuation of use of current baseline equipment(s) or an investment is the most likely scenario for the crediting period for which renewal is requested.

According to the Tool, this sub-step should only be applied if the baseline scenario identified at the validation of the project activity was the continuation of use of the current equipment(s) without any investment and, the projects proponents or third party (or parties) would undertake an investment later due, for example, to the end of the technical lifetime of the equipment(s) before the end of the crediting period or the availability of a new technology.

Thus, this step does not apply to the project activity.

Step 1.4: Assessment of the validity of the data and parameters

There is only one parameter that was determined at the start of the crediting period and not monitored during the crediting period, the emission factor of the grid, which was determined as a combined margin emission factor, consisting of the combination of an operating margin and a build margin emission factor.

This parameter should be updated for the third crediting period in accordance with the latest version of the “Tool to calculate the emission factor for an electricity system”, as required by the latest version of the methodology AMS-I.D.

Step 2: Update the current baseline and the data and parameters

Step 2.1: Update the current baseline

As indicated previously, there are no national and/or sectoral policies or specific circumstances that require an update of the baseline scenario.

Step 2.2: Update the data and parameters

As explained above, the grid emission factor should be updated for the third crediting period. Thus, this PDD includes the calculation of the updated grid emission factor using version 7.0 of the “Tool to calculate the emission factor for an electricity system”.

B.5. Demonstration of additionality

Since the additionality of the project does not have to be reassessed for the renewal of the crediting period, the original text of the registered PDD is copied below:

Background information on Guatemalan power sector

During the 1980’s, the government of Guatemala, through the state-owned companies such as EEGSA (Empresa Eléctrica de Guatemala) and INDE (Instituto Nacional de Electrificación), controlled all generation, transmission, and distribution of electricity.

The state’s largest hydroelectric plant, Chixoy (300 MW), came on line in 1983 while other large government-sponsored hydro projects were also under development. However, after the inauguration of Chixoy, all other investments in the power sector were abandoned and a power crisis took place in the early 1990s. Blackouts were routine, and EEGSA as well as INDE became insolvent. By the end of the decade, there had been no new investment in the energy sector[7].

In an effort to control the power crisis, the Guatemalan government signed the first Power Purchase Agreement (PPA) with private companies that could install generating capacity quickly in the country. The first emergency-style operation was the 110 MW bunker fuel burning barges of Puerto Quetzal Power Company (partial Enron ownership) that began

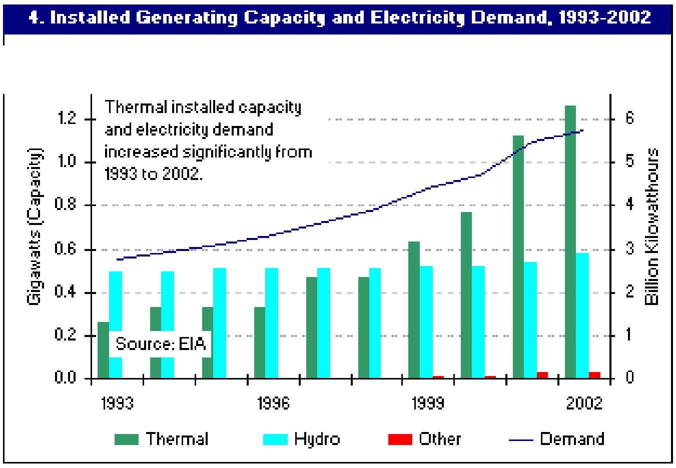
[7] Source: Energy Information Administration (EIA), *Country Analysis Brief*, US Dept. of Energy, 2004, http://www.eia.doe.gov/emeu/cabs/centam.html; IDC, 2001, *Guatemala’s Electricity Sector*, National Association of Private Electricity Generators, PowerPoint Presentation.

operating in 1993, followed by cogeneration plants installed by several Guatemalan sugar mills[8], and some small hydro projects, all private enterprises.

In 2000, Puerto Quetzal Power installed additional barge with capacity of 124 MW. In the same year, TECO (Tampa) began operating the 120 MW San José Power Station using low-grade South American coal.

A dramatic shift in the generation sources used in Guatemala's electricity grid over the past decade can be observed, mainly due to the fact that fossil fuel based plants are cheaper and faster to install when compared with hydropower plants.

From 1993 to 2002, thermal installed generation capacity grew nearly 400%. Along with increased fossil fuel generating capacity, Guatemala added two geothermal powered plants, the 5 MW Calderas in 1998, and the 24 MW Zunil 1 in 1999. During the same period, hydro installed electric generating capacity remained essentially static (see the following figure)[9].



Installed generating capacity and electricity demand (1993-2002)

In 1996 the Guatemalan government deregulated the electricity sector by establishing a new General Electricity Law. EEGSA and INDE distribution companies were sold to the private sector following the electricity sector's reform.

The Ministry of Energy and Mines is in charge of developing, implementing, and overseeing the country's energy strategy and the sector's legislation. The General Electricity Law (Decree 93-96, 1996) establishes a free and open market for all electricity activities (generation, distribution, and transmission) and aims to avoid state and private sector monopolies. The National Electricity Commission regulates the Guatemalan power sector, oversees the Spot Market, enforces the law, defines transmission and distribution rates, arbitrates any controversies among agents, and issues technical and operational dispatch rules.

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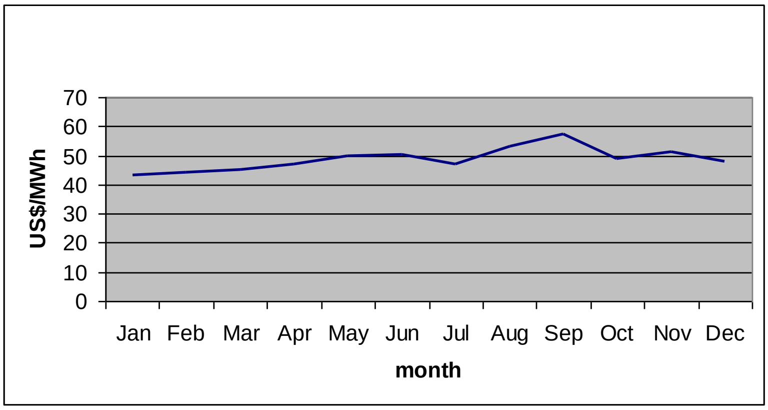
[8] In Guatemala, cogenerators burn sugarcane bagasse mixed with bunker fuel from November through April, depending on the harvest.

[9] Source: Energy Information Administration, *Country Analysis Brief*, US Department of Energy, 2001 http://www.eia.doe.gov/emeu/cabs/centam.html

The Spot Market Administrator (AMM) nets out daily (short-term) transactions, thus establishing short-term energy prices (on an hourly basis), and coordinates all power plant generation including international connections. The Guatemalan Spot Market is a cost-based system, and all generation, whether it is renewable resource based or fossil fuel based, must compete under equal terms (this places renewable resource generation at a serious cost disadvantage, especially during debt repayment). All generating plants declare their operating and fuel costs, and the Market Administrator dispatches the system to cover total demand plus reserves at the lowest declared variable cost (US$/MWh). In this manner, geothermal and hydro power plants with no fuel costs are dispatched first, followed by the next least-cost plant and so forth. The most up-to-date spot market prices are available at http://www.amm.org.gt/. The following figure shows the monthly average spot prices in 2004. The annual average was 48.81 US$/MWh, with a maximum of 57.24 US$/MWh registered in September.



Monthly average spot price (2004)

Under Guatemala's current market structure, energy is sold either via power purchase agreements or through the spot market. Capacity, on the other hand, is only sold through short, medium or long-term contracts. Under the Guatemalan Electricity Law, distribution companies must guarantee that they have enough energy and capacity to cover their demand plus a reserve, thus they must contractually purchase energy and capacity from generators.

As informed in the AMM website report, (as of December 2004), the effective installed capacity of Guatemala was 1,785.4 MW (see table below).

Installed capacity connected to the National Grid[10]

Generating Plant	Installed Capacity	
	Installed (MW)	%
Hydro	650.3	36.4
Steam	143.0	8.0
Gas Turbines	184.9	10.4

[10] Source: *Administrador del Mercado Mayorista*, http://www.amm.org.gt/pdfs/informes/2004/InfEst2004_01.pdf.

Generating Plant	Installed Capacity	
	Installed (MW)	%
Internal Combustion	593.0	33.2
Cogenerators	187.8	10.5
Geothermal	26.5	1.5
Total	**1,785.446**	**100**

Price expected for Candelaria's energy and capacity

The combined price to be received from the spot market and a capacity contract for Candelaria's energy and capacity is expected to be 0.0533 US$/kWh. Under this scenario Candelaria would be exposed to the energy price risk of the spot market as a "merchant plant". Although the project is being developed as a merchant plant under this scenario, the company will continuously evaluate possibilities of negotiating a contract for a fixed energy and capacity price to reduce the market price risk.

Construction of Candelaria began in January of 2005. As of early November of 2005, the tunnel, intake structure and transmission line of Candelaria were finalized. From November 2005 through May 2006 the steel penstock of US manufacture was imported, transported and installed, and the remaining tasks required for plant start-up were concluded, including the powerhouse and tailrace channel construction, and the import, transport and installation of electromechanical equipment. Finally, during June of 2006, plant testing and final commissioning was successfully accomplished. Candelaria officially began generating electricity for the Spot market on July 1, 2006.

Additionality considerations

Following the simplified modalities and procedures for CDM small scale project activities, evidence of barriers to investment is shown to justify the choice of option (a): "Investment Barrier"

Installation costs are lower and construction time is shorter for fossil fuel technologies when compared to renewable energy alternatives. The following table compares costs of the various technologies operating in Guatemala[11].

Cost comparison of various power generation technologies in Guatemala

Technology	Fuel	Installation (US$/kW)	Variable O&M (US$/kWh)	Fixed (US$/kW-mo)
Diesel engines	HFO	900	0.40	5
Gas turbines	Diesel	500	0.10	2.5
Steam turbines	Coal	1,200	0.15	4
Hydroelectric	NA	1,800	0.05	3
Geothermal	NA	2,830	0.06	

[11]Source: *Asociación Nacional de Generadores*, interviews, 2002

Cash Flow Analysis

In 1986, in order to promote private investment in renewable energy projects, the Guatemalan government passed law 20-1986, the “Law for the Development of New and Renewable Energy Sources,” which gave tax incentives to renewable energy projects and their investors and has been succeeded in promoting the development and construction of several plants. In 1999 this law was repealed and at present a new law (Decree 52-2003), regulated by Government Agreement 211-2005, is promoting renewable energy sources through fiscal incentives and import exemptions. Although this law provides a 10-year income tax and importation tax exemptions to renewable energy projects, which contributes positively to the projects’ economics, the impact is relatively low since most projects have long term debt service periods that coincide with this exemption period thus reducing its financial contribution. Therefore this incentives law does only partially contribute to overcome the investment barrier.

Financial analysis for the Candelaria project was performed with the following assumptions:

- 10 year income tax break
- 0.0533 US$/kWh for capacity and energy (estimated as an average price considering a capacity price of US$ 7 per kW-month, and energy price of 0.048 US$/kWh)
- Discount rate of 12% per year
- Expected life of the project: 30 years
- Debt: 10-year loan (2 year grace period) with an interest rate of 9%

The analysis resulted in a negative net present value of US$ –377,669 and an internal rate of return of 11.00%, without carbon credits. Taking into account income from emission reductions (at US$ 6 per tonne CO_2) the NPV of the project increases to US$ 232,238 and the IRR increases to 12.61%. CDM contributions (with a 21-year crediting period) increase the internal rate of return of the project by 1.61%.

The project cost is estimated at US$ 6.3 million (US$ 6,243,000), close to US$ 1.6 million per installed MW. Hidroeléctrica Candelaria S.A. will provide equity of US$ 375,000 and a local commercial bank will provide a loan of US$ 5.9 million (5,868,000).

A competitive price for energy and capacity for the Guatemalan Electricity Market for the coming 10 years is 0.05 to 0.055 US$/kWh. The price assumed for the Candelaria project is 0.0533US$/kWh, even though the price to make the project “stand on its own” would have needed to be at least 0.06 US$/kWh.

However, the project sponsors decided to develop Candelaria for the following two reasons:

- The long-term attractiveness of a small and efficient hydropower plant at a location already owned, a supplemental cash flow to come from the existing Secacao plant in order to resolve Candelaria’s cash flow shortfalls in the early years, and importantly,
- the potential of generating supplemental income from Certified Emission Reductions (CERs).

Candelaria's required price is high relative to the expected future spot market prices mainly due to the fact that a small 4.3 MW plant has difficulties in reducing the investment per MW, as its size does not allow for scale economies to be achieved easily. Due to the market's inability to level costs of renewable energies with fossil fuel burning plants, Candelaria is a marginal project and would not be carried out in the absence of CDM revenues. Income from emission reductions would help the project become more attractive to developers and lenders.

Thus, the project activity is clearly additional.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

Baseline emissions

As per version 18 of the methodology AMS-I.D, the baseline scenario is that the electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources into the grid.

The baseline emissions are the product of electrical energy baseline multiplied by the grid emission factor, as follows:

$$BE_y = EG_{PJ,y} \times EF_{grid,y}$$

Where:

BE_y	=	Baseline emissions in year *y* (tCO_2)
$EG_{PJ,y}$	=	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year *y* (MWh)
$EF_{grid,y}$	=	Combined margin CO_2 emission factor for grid connected power generation in year *y* calculated using the latest version of the "Tool to calculate the emission factor for an electricity system"(tCO_2/MWh)

According to the methodology, the emission factor can be calculated in a transparent and conservative manner as follows:

(a) A combined margin, consisting of the combination of operating margin and build margin according to the procedures prescribed in the "Tool to calculate the emission factor for an electricity system", or

(b) The weighted average emissions (in tCO_2/MWh) of the current generation mix. The data of the year in which project generation occurs must be used.

In this case, Option (a) is applied. Thus, the grid emission factor is calculated as a combined margin emission factor using version 07.0 of the "Tool to calculate the emission factor for an electricity system" and according to the following steps:

STEP 1: identify the relevant electricity systems
STEP 2: choose whether to include off-grid power plants in the project electricity system (optional)
STEP 3: select a method to determine the operating margin (OM)
STEP 4: calculate the OM emission factor according to the selected method
STEP 5: calculate the build margin (BM) emission factor
STEP 6: calculate the combined margin (CM) emission factor

Step 1: Identify the relevant electricity systems

For determining the electricity emission factors, a project electricity system is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity and that can be dispatched without significant transmission constraints. In this case, the project electricity system is the Guatemalan Interconnected National System (*Sistema Nacional Interconectado*, SNI), following Option 2 of the Tool.

For the purpose of determining the OM emission factor, the CO_2 emission factors for net electricity imports from the connected electricity systems are assumed as 0 tCO_2/MWh, according to option (a) given by the Tool. Electricity exports are not subtracted from electricity generation data used for calculating and monitoring the electricity emission factors.

Step 2: Choose whether to include off-grid power plants in the project electricity system

Either of the following two options can be used to calculate the OM and the BM emission factor:

- **Option I:** Only grid power plants are included in the calculation.
- **Option II:** Both grid power plants and off-grid power plants are included in the calculation.

In this case, Option I is chosen.

Step 3: Select a method to determine the OM

The calculation of the OM emission factor is based on one of the following methods:

(a) Simple OM
(b) Simple Adjusted OM
(c) Dispatch Data Analysis OM
(d) Average OM

The Tool states that the Simple OM method can only be used where low-cost/must run resources constitute less than 50% of total grid generation (excluding electricity generated by off-grid power plants) in: 1) average of the five most recent years, or 2) based on long-term averages for hydroelectricity production.

In Guatemala, low-cost/must-run resources constitute 65% of total grid generation in average of the five most recent years (2014 - 2018), which is above 50%. Therefore, the Simple Adjusted OM method is applied. See details in Appendix 4 of this PDD.

The Simple Adjusted OM emission factor is calculated using the ex ante option for data vintage. The emission factor is determined once at the validation stage and updated at the time of submission of the request for renewal of the crediting period to the DOE. No monitoring and recalculation of the emission factor during the third crediting period is required. A 3-year generation-weighted average is used (2016 – 2018), based on the most recent data available at the time of submission of the request for renewal of the crediting period to the DOE.

Power plants registered as CDM project activities are included in the sample group that is used to calculate the OM if the criteria for including the power source in the sample group apply.

Step 4: Calculate the OM emission factor according to the selected method

According to the Tool, the Simple Adjusted OM emission factor is a variation of the Simple OM, where the power plants/units (including imports) are separated in low-cost/must-run power sources (k) and other power sources (m). As under Option A of the Simple OM, it is calculated based on the net electricity generation of each power unit and an emission factor for each power unit, as follows:

$$EF_{grid,OM-adj,y} = (1-\lambda_y) \times \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} + \lambda_y \frac{\sum_k EG_{k,y} \times EF_{EL,k,y}}{\sum_k EG_{k,y}}$$

Where:

$EF_{grid,OM-adj,y}$	=	Simple Adjusted operating margin CO_2 emission factor in year y (tCO_2/MWh)
λ_y		Factor expressing the percentage of time when low-cost/must-run power units are on the margin in year y
$EG_{m,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EG_{k,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit k in year y (MWh)
$EF_{EL,m,y}$	=	CO_2 emission factor of power unit m in year y (tCO_2/MWh)
$EF_{EL,k,y}$	=	CO_2 emission factor of power unit k in year y (tCO_2/MWh)
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
y	=	The relevant year as per the data vintage chosen in Step 3

The CO_2 emission factor of each power unit m is determined according to Option A2 of the Tool, based on the CO_2 emission factor of the fuel type used in the power unit and the efficiency of the power unit.

In accordance with the Tool, where several fuel types are used in the power unit, the fuel type with the lowest CO_2 emission factor is used.

Since the efficiencies are not directly available for the power plants in the SNI, default values from the Appendix of the Tool "Determining the baseline efficiency of thermal or electric energy generation systems" (version 2.0) are applied, which is conservative.

The CO_2 emission factor of each power unit m is calculated as follows:

$$EF_{EL,m,y} = \frac{EF_{co2,m,i,y} \times 3.6}{\eta_{m,y}}$$

Where:

$EF_{EL,m,y}$	=	CO_2 emission factor of power unit m in year y (tCO_2/MWh)
$EF_{CO2,m,i,y}$	=	Average CO_2 emission factor of fuel type i used in power unit m in year y (tCO_2/GJ)
$\eta_{m,y}$	=	Average net energy conversion efficiency of power unit m in year y (ratio)
m	=	All power units serving the grid in year y except low-cost/must-run power units
y	=	The relevant year as per the data vintage chosen in Step 3
3.6	=	Conversion factor (GJ/MWh)

According to the Tool, net electricity imports must be considered low-cost/must-run units k.

The parameter λ_y (lambda) is defined as follows, using Approach 2:

$$\lambda_y = \frac{\text{number of hours low - cost/must - run are on the margin in year y}}{8760 \text{ hours per year}}$$

Lambda should be calculated as follows:

Step (i) - Plot a load duration curve. Collect chronological load data (typically in MW) for each hour of the year *y*, and sort the load data from the highest to the lowest MW level. Plot MW against 8760 hours in the year, in descending order.

Step (ii) - Collect electricity generation data from each power plant/unit. Calculate the total annual generation (in MWh) from low-cost/must-run power plants/units.

Step (iii) - Fill the load duration curve. Plot a horizontal line across the load duration curve such that the area under horizontal line and the curve right from the intersection point (MW times hours) equals the total generation (in MWh) from low-cost/must-run power plants/units.

Step (iv) - Determine the "Number of hours for which low-cost/must-run sources are on the margin in year *y*". First, locate the intersection of the horizontal line plotted in Step (iii) and the load duration curve plotted in Step (i). 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. If the lines do not intersect, then one may conclude that low-cost/must-run sources do not appear on the margin and lambda is equal to zero.

Step 5: Calculate the BM emission factor

According to the Tool, the BM used for the third crediting period is the same as the one calculated for the second crediting period, therefore calculations are not required.

The BM emission factor calculated for the second crediting period was 0.375 tCO2/MWh.

Step 6: Calculate the CM emission factor

According to the Tool, the calculation of the CM emission factor is based on one of the following methods:

(a) Weighted average CM
(b) Simplified CM

In this case, Option (a) is chosen as preferred option indicated by the tool. Thus, the CM emission factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$$

Where:

$EF_{grid,CM,y}$	=	Combined margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EF_{grid,OM,y}$	=	Operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
w_{OM}	=	Weighting of operating margin emissions factor (per cent)
w_{BM}	=	Weighting of build margin emissions factor (per cent)

According to the default valued indicated by the Tool, for hydroelectric power generation projects the weights applied for the third crediting period are: w_{OM} = 0.25 and w_{BM} = 0.75.

Thus, the resulting CM emission factor is the following:

$\boldsymbol{EF_{grid,CM,y}}$= 0.536 tCO_2/MWh × 0.25 + 0.375 tCO_2/MWh × 0.75 = **0.415 tCO_2/MWh**

Further data are included in Appendix 4.

Project emissions

As per the methodology, project emissions in year *y* (PE_y) for hydroelectric power projects without reservoir are null. Thus, $PE_y = 0$.

Leakage emissions

As per the methodology, as energy generating equipment was not transferred from another activity, the leakage emissions are null. Thus, $LE_y = 0$.

Emission reductions

Emission reductions are calculated according to version 18 of the AMS-I.D methodology, as follows:

$$ER_y = BE_y - PE_y - LE_y$$

Where:

ER_y	=	Emission reductions in year *y* (tCO_2)
BE_y	=	Baseline emissions in year *y* (tCO_2)
PE_y	=	Project emissions in year *y* (tCO_2)
LE_y	=	Leakage emissions in year *y* (tCO_2)

Thus, taking into account all the above explanations, emission reductions are obtained as follows:

$$ER_y = BE_y = EG_{PJ,y} \times EF_{grid,y}$$

Where:

ER_y	=	Emission reductions in year *y* (tCO_2)
BE_y	=	Baseline emissions in year *y* (tCO_2)
$EG_{PJ,}$	=	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year *y* (MWh)
$EF_{grid,y}$	=	Combined margin CO_2 emission factor for grid connected power generation in year *y* calculated using the latest version of the “Tool to calculate the emission factor for an electricity system”(tCO_2/MWh)

B.6.2. Data and parameters fixed ex ante

Data / Parameter	$EF_{grid,y}$ / $EF_{grid,CM,y}$
Data unit	tCO_2/MWh
Description	CO_2 emission factor of the grid electricity in year *y* / Combined Margin CO_2 emission factor of the grid electricity in year *y*
Source of data	Data provided by the Wholesale Market Administrator (official source).
Value(s) applied	0.415
Choice of data or Measurement methods and procedures	In accordance with paragraph 23 of the methodology, Option (a) has been selected: a combined margin, consisting of the combination of operating margin and build margin. Operating and build margins are calculated based on the procedures prescribed in version 07.0 of the “Tool to calculate the emission factor for an electricity system”.
Purpose of data	Data used to calculate baseline emissions.
Additional comment	Data updated at the time of submission of the request for renewal of the crediting period to the DOE. No monitoring and recalculation of the emission factor during the third crediting period is required.

Data / Parameter	$EF_{CO2,m/k,i,y}$ / $EF_{CO2,m,i,y}$
Data unit	tCO_2/GJ
Description	Average CO_2 emission factor of fuel type *i* used in power unit *m* or *k* in year *y*
Source of data	Data from the 2006 IPCC Guidelines on National GHG Inventories, Table 1.4, Chapter 1, Vol. 2 (Energy).
Value(s) applied	See Appendix 4 of this PDD and the attached spreadsheet named “EF Calculation – Candelaria 3th crediting period”.
Choice of data or Measurement methods and procedures	According to version 7.0 of the “Tool to calculate the emission factor for an electricity system”, if there is no data from fuel supplier of the power plants in invoices or local average default values, IPCC default values at the lower limit of the uncertainty at a 95 per cent confidence interval should be used. In accordance with the Tool, where several fuel types are used in the power unit, the fuel type with the lowest CO_2 emission factor is used.
Purpose of data	Data used to calculate baseline emissions.
Additional comment	For the simple adjusted OM emission factor calculation: data updated once for each crediting period using the most recent three historical years for which data is available at the time of submission of the CDM-PDD to the DOE for validation or request for renewal of the crediting period (ex ante option). For the BM emission factor calculation: the value calculated for the second period is used for the third crediting period.

Data / Parameter	$EG_{m,y}$ / $EG_{k,y}$
Data unit	MWh
Description	Net quantity of electricity generated and delivered to the grid by power unit *m* or *k* in year *y*
Source of data	Data provided by the Wholesale Market Administrator (official source).
Value(s) applied	See Appendix 4 of this PDD and the attached spreadsheet named “EF Calculation – Candelaria 3th crediting period”.
Choice of data or Measurement methods and procedures	According to version 7.0 of the “Tool to calculate the emission factor for an electricity system”, data from utility or government records or official publications should be used.
Purpose of data	Data used to calculate baseline emissions.
Additional comment	

Data / Parameter	$\eta_{m/k,y}$ / $\eta_{m,y}$
Data unit	-
Description	Average net energy conversion efficiency of power unit *m* or *k* in year *y*
Source of data	Data from the Appendix of the tool "Determining the baseline efficiency of thermal or electric energy generation systems" (version 2.0).
Value(s) applied	See Appendix 4 of this PDD and the attached spreadsheet named “EF Calculation – Candelaria 3th crediting period”.
Choice of data or Measurement methods and procedures	According to version 7.0 of the “Tool to calculate the emission factor for an electricity system”, if the efficiencies are not directly available for the power plants, default values from the Appendix of the Tool "Determining the baseline efficiency of thermal or electric energy generation systems" (version 2.0) should be used.
Purpose of data	Data used to calculate baseline emissions.
Additional comment	

B.6.3. Ex ante calculation of emission reductions

As explained above in Section B.6.1 of this PDD, baseline emissions are calculated as follows:

$$BE_y = EG_{PJ,y} \times EF_{grid,y}$$

Where:

BE_y =	Baseline emissions in year *y* (tCO_2)
$EG_{PJ,y}$ =	Quantity of net electricity supplied to the grid as a result of the implementation of the CDM project activity in year *y* (MWh)
$EF_{grid,y}$ =	Combined margin CO_2 emission factor for grid connected power generation in year *y* calculated using the latest version of the “Tool to calculate the emission factor for an electricity system”

For the ex ante calculation of emission reductions, the quantity of net electricity supplied to the grid is estimated based on historical data of real electricity delivered by Candelaria plant. The annual average net electricity delivered by the plant from 2007 to 2018 is 25,586 MWh. This is the value of electricity supplied to the grid considered in the ex ante estimation of emissions reductions. However, it is important to note that, since the electricity generation depends on water availability, the values of electricity delivered could be lower or higher than the average historical value. It is expected a fluctuation of about ± 5% of the values of electricity delivered related to the average value.

As shown above in Section B.6.1 of this PDD, the CM emission factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$$

Where:

$EF_{grid,CM,y}$	=	CM CO_2 emission factor in year *y* (tCO_2/MWh)
$EF_{grid,OM,y}$	=	OM CO_2 emission factor in year *y* (tCO_2/MWh)
$EF_{grid,BM,y}$	=	BM CO_2 emission factor in year *y* (tCO_2/MWh)
w_{OM}	=	Weighting of OM emissions factor
w_{BM}	=	Weighting of BM emissions factor

According to the Tool, for hydroelectric power generation projects the weights applied for the crediting period are: w_{OM} = 0.25 and w_{BM} = 0.75.

The OM emission factor is determined as a 3-year generation-weighted average, based on the most recent data available at the time of submission of the request for renewal of the crediting period to the DOE. Specifically, data from years 2016, 2017 and 2018 are used, and the resulting OM emission factor is 0.536 tCO_2/MWh.

The BM emission factor used is the value calculated for the second crediting period, which is 0.375 tCO_2/MWh.

Thus, the resulting CM emission factor is the following:

$\boldsymbol{EF_{grid,CM,y}}$= 0.536 tCO_2/MWh × 0.25 + 0.375 tCO_2/MWh × 0.75 = **0.415 $\mathbf{tCO_2/MWh}$**

As a consequence, the annual value of emission reductions estimated for the project activity is the following:

$\boldsymbol{ER_y}$ = 25,586 MWh × 0.415 tCO_2/MWh = 10,618 **$\mathbf{tCO_2}$**

See more details in Appendix 4 of this PDD and the attached spreadsheet named “EF Calculation – Candelaria 3th crediting period”.

As shown in the attached spreadsheet, the value of annual emission reductions estimated for the project activity is rounded down.

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (tCO_2e)	Project emissions (tCO_2e)	Leakage (tCO_2e)	Emission reductions (tCO_2e)
2021	10,618	0	0	10,618
2022	10,618	0	0	10,618
2023	10,618	0	0	10,618
2024	10,618	0	0	10,618
2025	10,618	0	0	10,618
2026	10,618	0	0	10,618
2027	10,618	0	0	10,618
Total	74,326	0	0	74,326
Total number of crediting years	**7**			
Annual average over the crediting period	**10,618**	**0**	**0**	**10,618**

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data/Parameter	$EG_{PJ,y}$
Data unit	MWh
Description	Quantity of net electricity supplied to the grid as a result of the implementation of the CDM project activity in year *y*
Source of data	Electricity meters onsite
Value(s) applied	25,586 MWh (historical average of net electricity delivered from 2007 to 2018)
Measurement methods and procedures	Data measured using the commercial electricity meters authorized by the Wholesales Market Administrator (Administrador del Mercado Mayorista, AMM) according to the AMM´s Commercial Coordination Norm No. 14.
Monitoring frequency	Data monitored continuously. Recorded hourly, daily, monthly and yearly.

QA/QC procedures	According to the Commercial Coordination Norm number 14 (NCC-14), clause 14.12, "Periodic Verifications", issued by the Wholesale Market Administrator (*Administrador del Mercado Mayorista*, AMM), meters and related equipment verifications/audits will be carried out annually at the expense of the AMM, to verify the equipment accuracy. In parallel, in order to satisfy the conditions set forth in the aforementioned norm and to guarantee the precision and quality required, both commercial meters are verified and calibrated once a year (regularly during the annual programmed maintenance) by a recognized calibration company at the expense of Candelaria Hydroelectric Project. Data measured by the meters will be cross checked with the monthly invoices or through the data displayed in the SCADA system, software utilized to control and monitor all the electricity delivered to the national grid.
Purpose of data	Data used to calculate baseline emissions.
Additional comment	All the data monitored will be archived for two years after the end of the crediting period or the last CERs issuance, whichever occurs later.

B.7.2. Sampling plan

There is no sampling involved in the monitoring of the project activity.

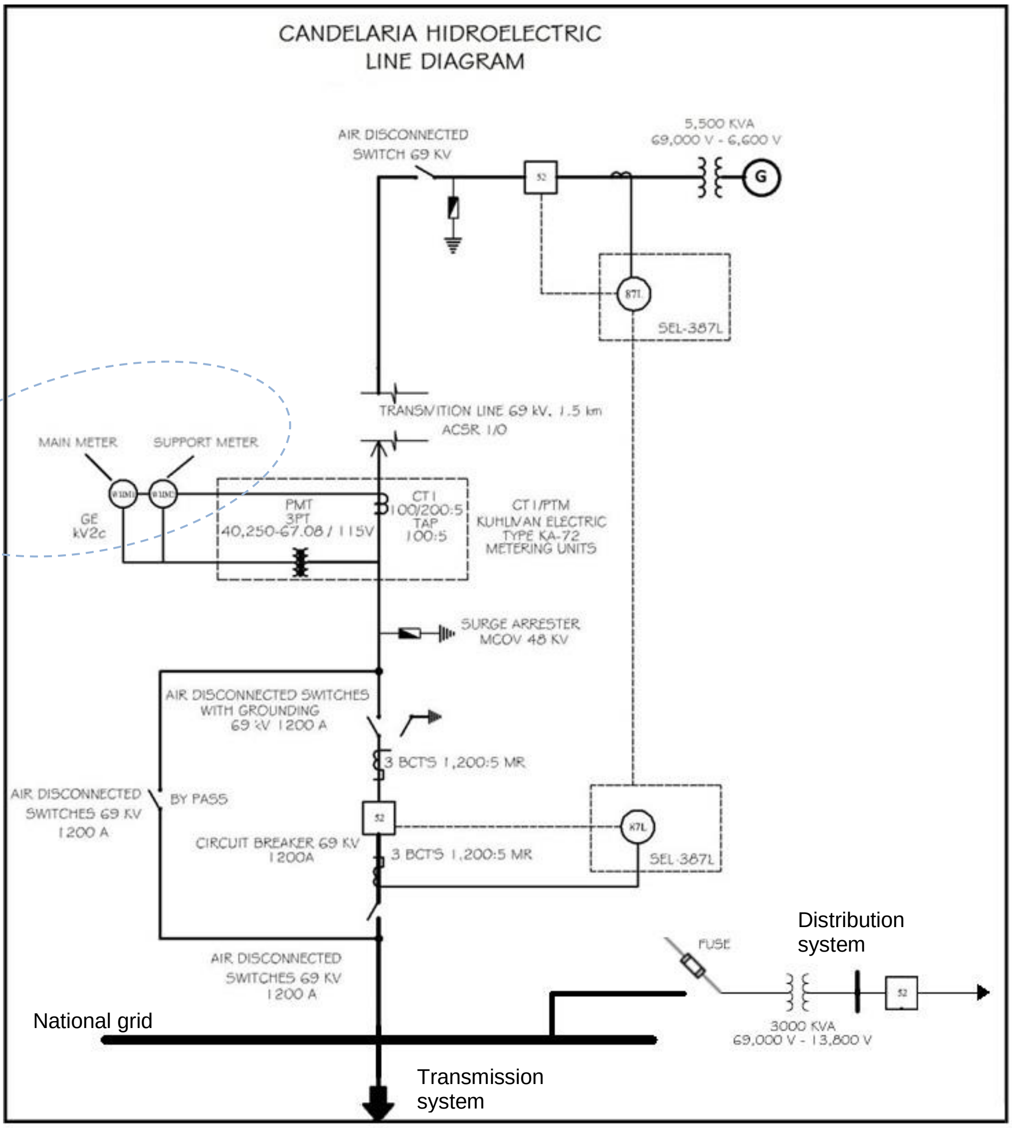
B.7.3. Other elements of monitoring plan

Equipment used for the commercial measuring

The equipment used to measure the energy produced by the Candelaria hydroelectric plant consists in a main and a support meter (electronic General Electric meters). This is in line with the stipulations described in the Commercial Coordination Norm, No. 14, (NCC-14) issued by the Wholesale Market Administrator (*Administrador del Mercado Mayorista*, AMM)[12].

The metering units are shown in the following diagram:

[12] The AMM is the entity in charge of dispatching and programming the operation and coordination of the National Power Grid.



Candelaria plant line diagram

Data quality obtained from the energy meters

According to the Commercial Coordination Norm number 14 (NCC-14), clause 14.12, "Periodic Verifications", issued by the AMM, meters and related equipment verifications/audits will be carried out annually at the expense of the AMM, to verify the equipment accuracy.

In parallel, in order to satisfy the conditions set forth in the aforementioned norm and to guarantee the precision and quality required, both commercial meters are verified and calibrated once a year (regularly during the annual programmed maintenance) by a recognized calibration company at the expense of Candelaria Hydroelectric Project.

Data collection procedures

The energy data of the Candelaria hydroelectric project are captured and recorded by the following procedures. Each procedure and the data collected are also verified by different persons to ensure the accuracy of the measured data. The procedures used to collect, monitor and register the data of the produced energy are described below:

1. **Hourly and daily readings procedure**

Source of data:	SCADA system / Main and Support commercial meters for a cross-check procedure
Responsible to collect data:	Operator
Responsible of quality data:	Operations Supervisor

Procedure:

The SCADA system reports hourly the instantaneous power and other generation conditions. This system works using a computer with SCADA (Supervisory Control and Data Acquisition) software, connected to a PLC (Programmable Logic Controller) device that automatically captures the information and converts it to data. This hourly generation data is available to the operator continuously, 24 hours a day, on the computer screen. The operator is responsible for transcribing the hourly data to the "Operation Control Sheets", which are kept in the Control Room of the plant.

Besides this, at 00:00 hrs, the Operator directly takes visual meter readings (from the main commercial meter). The difference from the previous day's reading and the current reading corresponds to the energy produced over that day (data read in kilowatts).

In addition, an internal daily report is generated by an automatic Data Monitoring System (*Sistema de Monitoreo de Información*, SIMON), which is fed by the Operator with the SCADA and the commercial meter data. This program allows the access to updated data and graphics of the daily, weekly, monthly and yearly power and energy produced by Candelaria hydroelectric plant.

2. Monthly readings procedure

Source of data:	Main and Support commercial meters
Responsible to collect data:	Operations Supervisor
Responsible of quality data:	Operations Manager

Procedure:

Once a month, for billing purposes, the Operations Manager gets the hourly reading monthly report, for his review and validation. This report allows the calculation of that month generated energy. The validated report is sent to the Financial Manager, General Manager Assistant, Candelaria's Client, and AMM's Measuring Coordinator, for their revision and reference.

Commercial invoice is issued by Candelaria Hydroelectric plant for the energy provided to the national grid, based on the monthly validated report.

3. Yearly data collection procedure

Source of data:	Monthly commercial invoice reports
Responsible to collect data:	CDM Coordinator
Responsible of quality data:	General Manager

Procedure:

In order to prepare the monitoring report to calculate the total energy produced by the Candelaria hydroelectric plant and estimate emission reductions, the CDM Division and Financial Division collect in a single report all the monthly reports used for billing purposes in an Excel spreadsheet, calculating the annual emission reductions. This report is reviewed and approved by the General Manager.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

01/01/2005

The start date of the project activity is determined as the construction start date of Candelaria plant.

C.2. Expected operational lifetime of project activity

30 years

C.3. Crediting period of project activity

C.3.1. Type of crediting period

Renewable crediting period (This PDD corresponds to the third crediting period.)

C.3.2. Start date of crediting period

01/01/2021

C.3.3. Duration of crediting period

7 years

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

The following documents have been developed:

- Plant Design Blueprints
- Environmental Impact Assessment (EIA)
- Water Quality Study
- Geological Study
- Topographical Study

No significant negative impacts are reported in any of the aforementioned documents.

The project does not have any significant impact on local bio systems or water supply to residents in the region. The EIA was performed for the project in connection with the EIA of the upstream power plant[13], and the EIA has been approved by the relevant Guatemalan authorities.

D.2. Environmental impact assessment

With the implementation of the Project Environmental Management Plan, no significant negative impacts are expected by the development and operation of the project activity.

The environmental impact assessment was updated on 2014, and it was approved by the Environment and Natural Resources Authority on 2015.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

Candelaria hydroelectric project conducted two stakeholders' consultation processes in order to obtain comments from all the stakeholders.

The first stakeholder consultation was carried out by means of a survey. The following questionnaire was sent to stakeholders in June 2003:

1. Do you think Candelaria hydroelectric project will contribute to the sustainable development of Guatemala?
2. Do you believe that the socio-economic situation of the region will improve due to the implementation of Candelaria hydroelectric project?
3. Could the implementation of project improve the environmental situation in the region?
4. How does the development of the project (positively or negatively) affect you and/or your environment?
5. Would you recommend that private companies or authorities develop projects of this nature?
6. Any additional comments you would like to make.

The questionnaire was sent to the following persons:

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[13] EIA: *"Estudio de Evaluación del Impacto Ambiental Significativo del Proyecto Hidroeléctrica Secacao –16 MW–, de Hidroeléctrica Secacao S.A., Municipio Senahú, Departamento de Alta Verapaz, Guatemala"* by Miguel Ángel Carballo Hernández (Geology, Oil and Environment advisor), April 1995. The Guatemalan authorities approved the study. Hidroeléctrica Secacao is linked with the Candelaria Project since both power plants share the water the same river and are operated by the same sponsors.

First Stakeholders Consultation

Name	Position	Company/Institution
Ing. Rudy Haroldo Najera Sagastume	General Director	General Direction of Energy – Ministry of Energy and Mines (*Dirección General de Energía – Ministerio de Energía y Minas*)
Ing. Jorge Juárez Pedroza	General Manager	National Institute of Electrification (*Instituto Nacional de Electrificación*)
Ing. Luis E. García Pinot	President	National Commission of Electric Energy (*Comisión Nacional de Energía Eléctrica*)
Lic. Carlos Roberto Morales Monzón	General Director	General Direction of Environmental Management and Natural Resources – Ministry of Environment and Natural Resources (*Dirección General de Gestión Ambiental y Recursos Naturales – Ministerio de Ambiente y Recursos Naturales*)
Mr. Roberto Barrera		AMM (*Administrador del Mercado Mayorista*)

The second stakeholder consultation intended to collect comments from local communities.

On 21/07/2006 Hidroeléctrica Candelaria S.A. presented the project at a meeting to which stakeholders from the local communities were invited.

In this event, 38 representatives (stakeholders) from four neighbouring communities participated, as documented in the attendance sheet. Ing. Raúl Castañeda from the local DNA Office (*Oficina Nacional de Desarrollo Limpio del Ministerio de Ambiente y Recursos Naturales*) also participated in the event as an observer.

The following table lists the stakeholder attendees:

Second Stakeholders Consultation

Name	Position	Company/Institution
Domingo Coy Cuz	Teacher	La Montanesa
Enrique Coal	Teacher	La Montanesa
Hermenegildo Xol Tul	Teacher	Santa Lucía
Elmer Chiqui Turcios	Teacher	Santa Lucía
Manuel Cucul Mo	Teacher	San Carlos
Juan Cucul Tox	Secretary	Santa Lucía
Mario Cac Coc	Secretary	San Carlos
Lorenzo Cac	Treasurer	San Carlos
David Che	Member I	San Carlos
Cesario Bac Chub	Auxiliary Mayor	San Carlos
Alfonso Cholon	Member III	San Carlos
Juan Rax	President	Santa Lucia Secacao
David Tox	Vicepresident	Santa Lucia Secacao
Santiago Coc	Treasurer	Santa Lucia Secacao
Vicente Cucul	Member I	Santa Lucia Secacao
Mateo Caal	Auxiliary Mayor	Santa Lucia Secacao
Santiago Maquin	Member II	Santa Lucia Secacao

Jose Choc	President	La Montañesa
Felipe Ich	Vicepresident	La Montañesa
Emilio Chic Jalal	Secretary	La Montañesa
Pedro Ich Choc	Treasurer	La Montañesa
Francisco Choc	Member I	La Montañesa
Alejandro Chub Col	Auxiliary Mayor	La Montañesa
Juan Daniel Caal	Member II	La Montañesa
Ramiro Choc Choc	Vicepresident	San Carlos
Martin Choc	President	San Carlos
Santiago Choc	Member II	San Carlos
Felipe Tzi Mo	Teacher	Santa Lucia
Javier Choc	Legal Representative	Las Margaritas Semococh
Fancisco Chub Choc	Secretary	Las Margaritas Semococh
Augusto Chub	Vicepresident	Las Margaritas Semococh
Adrian Sub	Treasurer	Las Margaritas Semococh
Jose Ba Coal	Under-Treasurer	Las Margaritas Semococh
Alberto Choc	Member I	Las Margaritas Semococh
Carlos Villela	Advisor	Las Margaritas Semococh
Rodrigo J. Tormo A.	Manager	Hidroelectrica Candelaria
Ricardo A. Vasquez	Operations Manager	Hidroelectrica Candelaria
Hugo R. Alvarado Chavez	Notary Public	Hidroelectrica Candelaria
Raul Castañeda	Observer	National Clean Development Department

The presentation was coordinated by Ing. Ricardo Vasquez, Operation Manager of Hidroeléctrica Candelaria S. A. at that time. The event included a presentation by Mr. Rodrigo Tormo, General Manager of Hidroeléctrica Candelaria and a tour visit to project installations. Mr. Mario Cruz Pop participated as a translator (many participants only speak a Mayan dialect) and Lic. Hugo Ricardo Alvarado (Notary Public) documented a transcript of the meeting.

After the meeting and the visit were concluded, local stakeholders had the opportunity to express their comments through the following questionnaire:

1. Based on the available information and your knowledge regarding Environment, Climate Change, Clean Development Mechanism (CDM) and Global Carbon Market related issues, briefly express your opinion about the Candelaria 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 contribution to the mitigation of climate change?
3. Do you believe that Candelaria hydroelectric project will contribute to the environmental, social and economic development (sustainable development) of the region and of Guatemala?
4. Express any additional comments

E.2. Summary of comments received

The following table shows a synthesis of the comments received during the first stakeholder consultation process:

Stakeholders comments received during the First Stakeholder Consultation

No	Ing. Rudy Haroldo Najera Sagastume	Ing. Jorge Juárez Pedroza	Ing. Luis E. García Pinot	Lic. Carlos Roberto Morales Monzón	Mr. Roberto Barrera
1	Yes. The project will contribute to reduce the electricity tariff dependency on international petroleum price and to reduce pollutant emissions due to fossil fuel combustion.	Yes. The project characteristics are compatible with the guidelines for sustainable development, e.g. private participation, internal development, clean energy utilization, and national energy sources development.	Yes. The project, using renewable resources to generate electricity, reduces the country vulnerability to changes in international fossil fuel price and contributes to tariff stabilization. It also contributes to balance the type of electricity generation in Guatemala.	Candelaria project would contribute to the regional development. However, we cannot give an opinion since we do not know EIA results for Candelaria project.	Yes. Definitely.
2	Project implementation will impact positively in rural development and the reduction of poverty, producing new jobs, agro industrial development and attracting investment.	Yes, the local community will be favoured by the electricity supply, but also in new jobs generation and improvement of the local electricity market.	Yes. The project contributes to create new jobs during the construction phase and introduces capacity and specialization in local people. During the project operation new technical and specialized jobs will be created.	The economic situation of the local inhabitants would improve considerably. The social situation could improve life quality for local people. This situation should be proven in the Candelaria EIA. Nevertheless, the opinion of the inhabitants who live close to the SECACAO hydro central (which is upstream from the Candelaria project), Mr. Von Quednow Cruz`s leagal appeal to the EIA in reference to regularization of the SECACAO reservoir, and the results of the social monitoring of environmental components through 30 surveys; should be considered as well.	Yes. There is an important percent of Guatemala inhabitants without electricity supply. Investment in power generation contributes to economic development since it represents production opportunities.

No	Ing. Rudy Haroldo Najera Sagastume	Ing. Jorge Juárez Pedroza	Ing. Luis E. García Pinot	Lic. Carlos Roberto Morales Monzón	Mr. Roberto Barrera
3	Yes. The environment will be favoured with construction of hydroelectric projects instead of conventional power plants, provided mitigation measures are included in the environmental impact assessment.	Yes, but very low. If we consider that more hydroelectric electricity will be used instead of another source consuming fossil fuels, local impact will be reduced.	Yes. The project sponsor will protect the river and its environment: fauna, flora, archaeology, etc., and today are careless. This improvement has positive effects at a regional and national level. In this point it is important to ensure that the environmental impact assessment recommendation will be enforced, taking into consideration the minimum water level that is ecologic.	In general, if renewable electricity supply increases, lower electricity consumption is expected from other electricity sources. But without the project EIA we cannot confirm that part of the electricity generated by the project will meet the energy demand of the local community. Candelaria EIA should consider the situation of project lifetime, and mitigation measures in the construction, operation and closure.	Yes. In 2002 the 64 % of the electricity generation was based on fossil fuel consumption (bunker fuel oil and coal) and this generates environmental pollution.
4	Project implementation is positive since the National Interconnected System will improve the offer of the power generation, making the electricity tariff more stable.	A better clime and atmosphere. The national economy will be improved since exports will be reduced. There will be new job opportunities. Enjoying a better environment through forest conservation.	Projects based in renewable electricity generation are very important for the National Committee of Electric Energy, since the electricity supply is increased, which is essential to the country development, reducing the country vulnerability and contributing to the electricity price stabilization.	I cannot give an opinion because I have not seen the EIA.	Hydroelectric projects are beneficial because they improve the electric inertia of the Interconnected System. I receive the benefits of the no environmental contamination.
5	Yes.	Yes, if more hydroelectric energy is used positive effects will occur in the environment, new jobs opportunities will appear and its contribution to increase social life quality and national and regional demand.	Yes. The National Committee of Electric Energy not only recommends this kind of projects but also has submitted to the National Congress a project of law named "Incentives for the Development of Renewable Energy Projects".	Yes, if project EIA can demonstrate that the construction and operation are compatible with the environment and mitigation measures are taken.	Yes. A balance of the generation system is needed. Most plants installed are thermal plants so the electricity price is dependent on the international price of fossil fuels and this is not an advantage for the country.

No	Ing. Rudy Haroldo Najera Sagastume	Ing. Jorge Juárez Pedroza	Ing. Luis E. García Pinot	Lic. Carlos Roberto Morales Monzón	Mr. Roberto Barrera
6	National policies are intended to encourage renewable resources development, which allow promoting investment in the renewable energy sector and benefit environmental quality in the energy sector. In this way the Ministry of Energy and Mines has created the Centre for Information and Promotion of Renewable Energy and has developed a project of law named “Incentives for the Development of Renewable Energy Projects”.		It is recommended the study of a third project located in the same river downstream due to the topographic conditions could permit the construction. Commercialization that benefits local communities should be legally and economically studied.	Project EIA should consider local community opinion in detail. SECACAO local inhabitant requirements should be solved because Candelaria is located downstream SECACAO. Project Sponsor could register the project as CDM to increase cash-flow benefits.	The development of electricity generation facilities using renewable sources has social and economic benefits for the country.

The comments received from local stakeholders during the consultation process on 21/07/2006 are mainly very positive. Local stakeholders expressed that Candelaria hydroelectric project will bring benefits to their communities, generating new jobs and increasing electricity generation from a non-polluting source. Provided the project activity is implemented, clean electricity will reach their houses and fossil fuels consumption will be reduced.

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

The transcription of the comments received is included in the following table:

Stakeholders comments received during the Second Stakeholder Consultation

Question	1	2	3	4
Hermenegildo Xal Tiul	Hidroeléctrica Candelaria is not contaminating our environment, as it is searching for techniques for reducing contamination.	Yes, because it does not generate contamination, by using renewable resources.	These projects are significantly important, since they provide a percentage of daily incomes.	Job opportunities for the young people in our community.

Question	1	2	3	4
Mario Cac Coc	Hidroeléctrica Candelaria represents a huge benefit for all, as it allows us to breathe clean air and does not contaminate the environment at all.	Of course, I recommend this project to the private companies so that stop damaging our lives.	Yes, it benefits us by providing us electric energy, employment and protection of the flora and fauna of our country.	I believe that more projects should be implemented and more employment should be generated for the community.
Martin Choc	I believe it is very good, because it does not contaminate and the water returns to its natural state.	I recommend the execution of projects involving renewable resources.	Now that the project is being developed, I believe that it will benefit us with a greater development.	It protects and preserves nature so that the rivers do not dry.
Lorenzo Cac	The project is excellent, as it helps to avoid an increase in the Earth's temperature.	Yes, the implementation of this type of projects helps to avoid contamination.	Yes, I believe it is a help regarding the financial development of the community.	Hidroeléctrica Candelaria is protecting our environment, unlike other companies that contaminate.
Manuel Cucul Mo	The project is not contaminating, everything is clean, and reforestation is being carried out in order to recover our natural wealth.	Yes, because it does not contaminate the environment at all.	Without the projects there are no incomes or employment. The implementation of the project in our country is worth it.	That employment opportunity should be provided to the community.
Alfonso Cholom	It is a very good work and helps us to preserve the environment.	I recommend them not to do it as it really affects nature.	Of course, because it can involve a better development for our community.	No
Cesario Bac Chub	Hidroeléctrica Candelaria does not contaminate because it involves a generation with no contamination.	This project is good for us, the construction of the Candelaria project must continue.	The projects involve improvements for the economy and social development of our community.	As Hidroeléctrica Candelaria is protecting the environment we expect more projects of this type to be developed.
David Che	I believe that the hydroelectric plant is working better with no type of contamination, everything is ok.	Yes, it is very good because this service is needed in our communities.	Yes, we need the employment sources that this company could generate.	Hidroeléctrica Candelaria works wells without contaminating. Besides, it is helping to the reforestation of the environment.
Ramiro Choc Choc	For us, Hidroeléctrica Candelaria does not involve any contamination and helps to improve the environment.	What we want is to continue with the same equipment of Candelaria, unlike of those that produce gases that contaminate.	A project like Hidroeléctrica Candelaria is very important, as they provide a percentage of daily incomes.	Job opportunities for our community.

Question	1	2	3	4
Santiago Choc	With the Hidroeléctrica Candelaria project there will not be diseases, it will bring development to our community.	Yes, because it does not contaminate the environment by using the same hydraulic technology.	It is contributing to the development of our community.	We would like to ask more projects like this in order to generate jobs.
Emilio Chub	It is very important because it protects the environment.	I agree because we want this project to benefit our community.	The reforestation of our community is necessary in order to protect water.	We would like the project to reach our community.
Pedro Ich	For us it is very important because it helps us with the environmental contamination problem.	It is very important for our community because it protects water.	I agree because it will help our community.	It is a help for us.
José Choc	It is very beneficial for the community, involving the planting of more trees so as to have enough natural resources.	To improve the condition of not contaminating the environment, to have a project like Candelaria	Yes, I agree.	We need the energy for our community.
Juan Daniel Caal	It is very important to know the rural situation.	Yes, I agree.	We would need this energy to reach the community.	I would like to thank everybody ad I hope you can continue working in this project.
Francisco Choc	It is very important how the project functions because it does not contaminate the environment.	Yes.	It is very useful for the community	We need to have energy in order to improve our situation.
Alejandro Chub	The project does not contaminate the environment; it benefits and helps us satisfy our needs.	I recommend the authorities of the project to keep on working.	Yes, I agree, and I hope the activities will continue in order to achieve a clean environment.	I would like our community to receive the energy produced.
Domingo Coy	It involves a benefit that will allow improving our situation and not contaminating the environment.	Yes, it is very important to not contaminate the environment.	It is a general benefit, because it benefits the whole community and satisfies its needs.	It is a pleasure to attend this lecture because it provides a lot of information.
Tiul Cal	For me, Hidroeléctrica Candelaria is very beneficial for the rural community.	It is very important because it covers the needs of the community.	I consider that Hidroeléctrica Secacao will help us with the reforestation in our community.	As teachers we need to be helped in the educative process, so as to have a better education.
Felipe Ich	This project will be a significant help for our community.	I recommend the project to help us in the reforestation of our environment.	I would like this project to be developed in our community.	I think the project will provide a help for us in the energy and drinkable water sector.

Question	1	2	3	4
Santiago Coc	I liked the Candelaria Hydroelectric Project because it is very clean.	I would like the authorities to develop more projects like Candelaria.	Yes, it generates jobs	Hidroeléctrica Secacao should continue generating a clean development.
Felix Tzi Mó	It is a project that economically contributes to the local and national community, as it avoids contamination.	In my opinion, it is advisable for other entities or companies to promote projects like the Candelaria project.	Of course, this project is a contribution to the social and environmental development.	It is necessary to promote the generation of electric energy of Candelaria in rural areas and thus the use of fuels will be avoided.
Juan Rax	Yes, I think it is convenient to carry out this kind of projects.	Yes, I recommend other companies to develop a project like this.	I consider that Hidroeléctrica Candelaria is contributing to the development of the country.	It is good for our development that the company keeps on generating electricity.
David Tox	I think that the electricity generation in Hidroeléctrica Candelaria is very good, because of the proper use of natural resources.	Yes, I recommend it because it does not involve the cutting down of trees or burning of fossil remains.	Of course. Hidroeléctrica Candelaria is contributing to the development of the country.	Besides the hydroelectric project, the area is also being afforested and this sets an example for other companies.
Mateo Caal	Hidroeléctrica Candelaria is a clean development project for it does not contaminate.	Yes because it constitutes a form of clean development without contamination.	Yes, it generates jobs	Hidroeléctrica Candelaria promotes the development of our community.
Santiago Maquín	HidroeléctricaSecacaco does not damage our environment.	Yes, because it does no contaminate the environment.	Yes, it generates jobs	No
Abner Chiquin	Hidroeléctrica Candelaria is beneficial for our development and does not damage the community because it does not contaminate.	Yes, because the generation of electricity from renewable resource does not generate contamination.	Yes, it generates jobs	Hidroeléctrica Candelaria helps the development of our region.
Juan Cucul	I like Hidroeléctrica Candelaria, because it involves clean development and benefit our environment as it does not generate contamination; I hope it will continue that way.	Yes, I recommend the companies to develop projects like this.	Yes, it generates jobs	Hidroeléctrica Candelaria implies development for our region.
Vicente Cucul	Hidroeléctrica Candelaria does not destroy our environment	Yes, because it does not contaminate the environment	Yes, because it generates employment and social development.	We would like to ask more projects like this in order to generate jobs.

Question	1	2	3	4
Juan Carlos Villela	I totally agree with the project implementation - The use of clean energy must be stimulated in order to avoid environmental contamination	Yes, I would recommend it, as it encourages the creation of laws for limiting the use of any type of contaminants.	Yes, I consider that the project involves a direct and indirect benefit for all.	I congratulate Hidroeléctrica Candelaria for participating in the development of Guatemala and for all the direct and indirect benefits it will generate.
José Bacaal	The projects that generate fumes is what there was before and it was bad, but this project is clean and protects the environment. I hope there are more projects like this.	Yes, I recommend it	Yes, I'm happy and I know that it will soon help the community.	I just want to thank for the invitation and for the project
Augusto Chub	The project is very good, since everything that generates fumes contaminates and it has to be removed. The project must continue.	Yes, I recommend it	Yes, I'm happy that the project is being developed and that it will involve more development for the community, you are doing a good job, keep on doing it.	I thank Hidroeléctrica Candelaria for giving us the opportunity to know the project that so much benefit will bring to the community.
Adrian Sub	The project is very good and it is an excellent thing for the environment.	Yes, I recommend it	Yes, the project brings hope of a better future, as it will involve the generation of energy, employment and improvement of health for the community.	Thanks!
Alberto Choc	I like the project because it protects the environment. Continue with the project so that contamination ends.	Yes, I recommend it	Yes, the entire project is good and it will benefit the community and the children living in it.	I thank for the invitation as it helped me to know the project and I'm sure it will help the development of the community.
Francisco Chub	I liked the explanation regarding the greenhouse effect and I hope more projects similar to this are developed.	Yes, I recommend it	Yes, because we want to see improvements, such as light, development and the social benefits that the project involves.	I thank you for the work you are doing.
Javier Choc	I'm glad to know that the project is good, continue with the project.	Yes, I recommend it.	Yes	Yes, and I believe it will involve benefits regarding development, light, education and health.

E.3. Consideration of comments received

Reforestation and afforestation projects

Hidroeléctrica Candelaria S.A. began implementing reforestation and afforestation projects in 2003, by starting with a development of 231 hectares. Later on, other projects involving 159 hectares and 53 hectares were carried out in 2005 and 2007, respectively. Finally, 417 hectares were developed during the 2008-2012 period.

For 2013, the project sponsors have planned the reforestation/afforestation of another 45 hectares.

It is estimated that about 3,500 employees are hired for the sowing/planting process involved in a project of 50 hectares, depending on the type of plantation.

Additionally, 13,000 workers are expected to be hired for the maintenance of the existing plantations up to 2013.

All workers come from the local communities and, during all this time, they have had the opportunity of being trained for the type of work they perform. An agricultural engineer is responsible for the management and maintenance of the plantations.

All of these activities yield significant benefits to the communities, not only by providing them with employment, but also through what they learn and put into practice in their own plantations, allowing them to achieve higher productivity in their personal crop plantation yields.

Mitigation Measures

The Environmental Impact Assessment of the project activity includes a list of mitigation measures that have to be implemented by the Candelaria project sponsors. In order to control the achievement of these commitments and to continue evaluating the project impacts, an environmental monitoring plan was implemented by Candelaria project sponsors since August 2006. Additionally, an environmental audits company is hired periodically by Candelaria project sponsors to bring support during the monitoring activities.

The results of the monitoring are presented periodically to the Environment and Natural Resources Ministry (*Ministerio de Ambiente y Recursos Naturales*, MARN) for its review and approval.

During the first years of operation of Candelaria plant, the reports showing the results of the monitoring were carried out every 6 months. However, due to the stability of the results, the reports started to be developed once a year.

SECTION F. Approval and authorization

The letters of approval from Guatemala (23/08/2006) and Switzerland (23/10/2009) are available and can be accessed at the UNFCCC website:

http://cdm.unfccc.int/Projects/DB/DNV-CUK1158743330.88/view

Appendix 1. Contact information of project participants

Organization name	Hidroeléctrica Candelaria S.A.
Country	Guatemala
Address	29 Avenida 2-85 Zona 15, Colonia San Lázaro, Guatemala, Guatemala
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Appendix 2. Affirmation regarding public funding

See Section A.5 of this PDD.

Appendix 3. Applicability of methodologies and standardized baselines

See Section B.2 of this PDD.

Appendix 4. Further background information on ex ante calculation of emission reductions

Candelaria Net Electricity Supplied to the Grid

Average net electricity delivered (MWh)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
January	2,141	1,600	1,416	1,601	1,565	1,912	1,690	1,999	2,068	2,045	1,651	2,115
February	1,514	1,266	1,372	1,243	1,219	1,698	1,284	1,599	1,671	1,624	1,289	1,719
March	1,560	1,133	1,204	1,186	1,234	1,427	1,223	1,724	1,690	1,535	1,425	1,500
April	1,451	863	999	863	1,130	775	783	1,220	838	1,265	967	1,074
May	1,199	932	462	1,635	1,062	1,374	1,116	1,721	1,978	787	1,105	1,406
June	1,609	2,020	1,219	1,845	1,760	2,000	2,457	3,066	2,700	1,722	2,427	2,340
July	2,432	2,995	2,779	2,524	2,868	2,697	3,051	3,174	2,939	2,757	2,966	2,841
August	2,852	3,045	3,109	2,869	2,596	3,076	3,155	3,199	2,740	2,814	3,200	2,934
September	3,031	2,980	2,968	2,844	2,911	3,031	3,052	3,117	2,775	3,013	3,030	3,059
October	3,122	3,094	3,090	2,901	2,924	3,076	3,067	3,145	2,493	2,743	3,081	3,014
November	2,451	2,648	2,558	2,305	2,730	2,398	3,091	3,042	2,641	2,148	2,940	2,495
December	2,052	2,161	1,962	1,893	2,103	1,930	2,556	2,582	2,478	1,981	2,369	2,032
Total	**25,414**	**24,737**	**23,138**	**23,709**	**24,102**	**25,394**	**26,526**	**29,589**	**27,010**	**24,434**	**26,451**	**26,530**
Average	**25,586**											

Grid OM Emission Factor

Average LC/MR generation

	2,014	2,015	2,016	2,017	2,018
LC/MR generation (MWh)	6,593,186	6,326,569	6,515,238	8,488,460	8,126,666
Total generation without imports (MWh)	9,780,657	10,301,959	10,877,904	11,489,899	12,522,391
Share of LC/MR generation	67%	61%	60%	74%	65%
Average share of LC/MR generation	**65%**				

Selection of set of power plants m for operating margin calculation

Power units *m* in 2016

Name of the power plant/unit (clasified by technology)	Starting year	EGm_{2016} Energy produced 2016 (MWh)	i Fuel Type	$EF_{CO2,m,i,y}$ Average emission factor of fuel type i ($t CO_2/TJ$)	Conversion factor TJ/MWh	η_m Default efficiency factors %	$EF_{EL,m,y}$ Emission factor of unit m ($t CO_2/MWh$)	CO_2 emissions 2016 t CO2
	AMM	AMM	AMM	Inventory Workbook (IPCC, 2006)	Conversion factor from the International System of	Meth tool 09, appendix	Calculated	Calculated
Coal		**2,484,764**						**2,099,349.08**
SAN JOSE	2000	1,042,421	Bituminous coal	89.50	3.6	37%	0.871	907,751.26
LA LIBERTAD	2008	80,903	Bituminous coal	89.50	3.6	39%	0.826	66,838.67
PALMAS 2	2012	298,342	Bituminous coal	89.50	3.6	39%	0.826	246,476.48
COSTA SUR	2013	171,708	Bituminous coal	89.50	3.6	39%	0.826	141,857.50
SANTA LUCÍA	2014	120,884	Bituminous coal / biomass	89.50	3.6	39%	0.826	99,868.81
JAGUAR	2015	575,226	Bituminous coal	89.50	3.6	39%	0.826	475,224.99
SAN ISIDRO	2016	195,280	Bituminous coal / biomass	89.50	3.6	39%	0.826	161,331.37
Combined cycle		**4,311**						**0.0**
ARIZONA VAPOR 1	2008	4,311	Waste Heat	0.0	3.6	0%	-	0
GAS TURBINES		**5,429**						**4,730.15**
TAMPA	1995	4,212	Diesel	72.6	3.6	30%	0.871	3,669.19
STEWART & STEVENSON	1995	299	Diesel	72.6	3.6	30%	0.871	260.76
ESC.GAS No.3	1976	-	Diesel	72.6	3.6	30%	0.000	-
ESC.GAS No.5	1985	918	Diesel	72.6	3.6	30%	0.871	800.19
LAGUNA GAS 2	1978	-	Diesel	72.6	3.6	30%	0.871	-
Internal combustion motors		**981,350**						**740,691.38**
ARIZONA	2003	341,550	Fuel Oil No.6	75.5	3.6	40%	0.680	232,083.47
LA ESPERANZA	2000	330,609	Fuel Oil No.6	75.5	3.6	33%	0.824	272,301.25
PQPLLC	1993	19,909	Fuel Oil No.6	75.5	3.6	33%	0.824	16,397.69
LAS PALMAS 1	1998	15,612	Fuel Oil No.6	75.5	3.6	33%	0.824	12,858.68
LAS PALMAS 2	1998	4,932	Fuel Oil No.6	75.5	3.6	33%	0.824	4,062.54
LAS PALMAS 3	1998	15,030	Fuel Oil No.6	75.5	3.6	33%	0.824	12,379.61
LAS PALMAS 4	1998	11,314	Fuel Oil No.6	75.5	3.6	33%	0.824	9,318.35
LAS PALMAS 5	1998	4,926	Fuel Oil No.6	75.5	3.6	33%	0.824	4,057.54
GENOR	1998	55,641	Fuel Oil No.6	75.5	3.6	33%	0.824	45,827.60
Sidegua	1995		Fuel Oil No.6	75.5	3.6	33%	0.824	-
TEXTILES B1	1996	58,390	Fuel Oil No.6	75.5	3.6	33%	0.824	48,092.06
TEXTILES B2	2003	31,528	Fuel Oil No.6	75.5	3.6	40%	0.680	21,423.05
TEXTILES B3	2008	52,821	Fuel Oil No.6	75.5	3.6	40%	0.680	35,891.63
ELECTROGENERACIÓN	2003	34,360	Fuel Oil No.6	75.5	3.6	40%	0.680	23,347.33
GENERADORA PROGRESO	1993	-	Fuel Oil No.6	75.5	3.6	33%	0.824	-
GECSA	2007	-	Fuel Oil No.6	75.5	3.6	40%	0.680	-
GECSA 2	2008	-	Fuel Oil No.6	75.5	3.6	40%	0.680	-
COENESA	2008	6	Diesel	75.5	3.6	40%	0.680	4.26
INTECSA	2016	-	Fuel Oil No.6	75.5	3.6	49%	0.560	-
GENOSA	2013	4,546	Fuel Oil No.6	75.5	3.6	49%	0.560	2,547.72
ACTUN CAN	2016	176	Fuel Oil No.6	75.5	3.6	49%	0.560	98.59
Cogenerators (fossil fuel)		**597,673**						**218,811.10**
CONCEPCION	1994	0	Fuel Oil No.6	75.5	3.6	83.5%	0.326	0
PANTALEON	1991	45,305	Bituminous coal	89.5	3.6	83.5%	0.386	17,482
SANTA ANA	1995	138,031	Bituminous coal	89.5	3.6	83.5%	0.386	53,262
MAGDALENA	1994	200,936	Fuel Oil No.6	75.5	3.6	83.5%	0.326	65,407
LA UNION	1995	6,403	Fuel Oil No.7	75.5	4.6	83.5%	0.416	2,663
MADRE TIERRA	1996	1,708	Fuel Oil No.8	75.5	5.6	83.5%	0.506	865
TULULA	2001	844	Fuel Oil No.6	75.5	3.6	83.5%	0.326	275
TRINIDAD	2011	109,878	Bituminous coal	89.5	3.6	83.5%	0.386	42,398
EL PILAR	2012	0	Fuel Oil No.6	75.5	3.6	83.5%	0.326	0
PALO GORDO	2014	94,058	Bituminous coal	89.5	3.6	83.5%	0.386	36,294
GENERADORA DEL ATLÁNTICO	2014	510	Bituminous coal	75.5	3.6	83.5%	0.326	166
	Σ	**4,073,528**					**Σ**	**3,063,582**

Power Units *m* in 2017

Name of the power plant/unit (clasified by technology)	Starting year	EGm_{2017} Energy produced 2017	i Fuel Type	$EF_{CO2,m,i,y}$ Average emission factor of fuel type i	Conversion factor	η_m Default efficiency factors	$EF_{EL,m,y}$ Emission factor of unit m	CO_2 emissions 2017
		(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	Meth tool 09, appendix	Calculated	Calculated
Coal		**######### #**						**1,989,137.02**
SAN JOSE	2000	890,196	Bituminous coal	89.50	3.6	37%	0.871	775,191.89
LAS PALMAS II	2012	222,686	Bituminous coal	89.50	3.6	39%	0.826	183,973.01
LA LIBERTAD	2008	33,723	Bituminous coal	89.50	3.6	39%	0.826	27,860.19
GENERADORA COSTA SUR	2013	115,995	Bituminous coal	89.50	3.6	39%	0.826	943,467.94
JAGUAR ENERGY	2015	1,142,000	Bituminous coal	89.50	3.6	39%	0.826	57,501.41
SAN ISIDRO	2016	69,601	Bituminous coal	89.50	3.6	39%	0.826	1,142.57
Combined cycle		**1,383**						**0.0**
ARIZONA	2008	1,383	Waste Heat	0.0	3.6	0%	-	0
GAS TURBINES		**4,948**						**4,310.65**
TAMPA	1995	2,901	Diesel	72.6	3.6	30%	0.871	2,527.11
STEWART & STEVENSON	1995	733	Diesel	72.6	3.6	30%	0.871	638.22
ESCUINTLA GAS 3	1985	-	Diesel	72.6	3.6	30%	0.871	-
ESCUINTLA GAS 5	1985	1,315	Diesel	72.6	3.6	30%	0.871	1,145.33
Internal combustion motors		**393,682**						**283,851.39**
ARIZONA	2003	200,117	Fuel Oil No.6	75.5	3.6	40%	0.680	135,979.43
LA ESPERANZA	2000	67,959	Fuel Oil No.6	75.5	3.6	33%	0.824	55,973.72
PQP	1993	3,961	Fuel Oil No.6	75.5	3.6	33%	0.824	3,262.06
LAS PALMAS	1998	11,692	Fuel Oil No.6	75.5	3.6	33%	0.824	9,630.37
GENOR	1998	5,262	Fuel Oil No.6	75.5	3.6	33%	0.824	4,334.31
TDL B1 (6,7,8,12)	1998	32,709	Fuel Oil No.6	75.5	3.6	33%	0.824	26,940.15
TDL B2 (3,4,9)	2003	17,264	Fuel Oil No.6	75.5	3.6	40%	0.680	11,730.63
TDL B3 (10,11,13)	2008	26,194	Fuel Oil No.6	75.5	3.6	40%	0.680	17,798.95
ELECTROGENERACIÓN	2003	18,615	Fuel Oil No.6	75.5	3.6	40%	0.680	12,648.88
GENOSA	2013	1,801	Fuel Oil No.6	75.5	3.6	49%	0.560	1,009.18
TERMICA B + TERMICA B2	2017	5,733	Fuel Oil No.6	75.5	3.6	49%	0.560	3,212.71
ELECTRO CRISTAL BUNKER	2016	2,375	Fuel Oil No.6	75.5	3.6	49%	0.560	1,331.00
COENESA	2008	-	Diesel	72.6	3.6	40%	0.653	-
Cogenerators (fossil fuel)		**109,568**						**39,836.97**
CONCEPCION	1994	15	Fuel Oil No.6	75.5	3.6	83.5%	0.326	5
PANTALEON B1	1991	18	Fuel Oil No.6	75.5	3.6	83.5%	0.326	6
PANTALEON B3	2016	1,242	Bituminous coal	89.50	3.6	83.5%	0.386	479
SANTA ANA	1995	5	Fuel Oil No.6	75.5	3.6	83.5%	0.326	2
SANTA ANA B2	2015	15,456	Fuel Oil No.6	75.5	4.6	83.5%	0.416	6,429
MAGDALENA	1994	47,860	Fuel Oil No.6	75.5	3.6	83.5%	0.326	15,579
LA UNION B1	1995	0	Fuel Oil No.6	75.5	3.6	83.5%	0.326	0
MADRE TIERRA	1996	36	Fuel Oil No.6	75.5	3.6	83.5%	0.326	12
GENERADORA SANTA LUCÍA	2014	6,095	Bituminous coal	89.50	3.6	83.5%	0.386	2,352
TULULA B1	2001	32	Fuel Oil No.6	75.5	3.6	83.5%	0.326	10
TULULA B4	2013	0	Bituminous coal	89.50	3.6	83.5%	0.386	0
TRINIDAD B3	2001	186	Fuel Oil No.6	75.5	3.6	83.5%	0.326	61
TRINIDAD B4	2015	0	Bituminous coal	89.50	3.6	83.5%	0.386	0
TRINIDAD B5	2016	24,155	Bituminous coal	89.50	3.6	83.5%	0.386	9,321
EL PILAR B3	2012	0	Fuel Oil No.6	75.5	3.6	83.5%	0.326	0
PALO GORDO B2	2014	14,263	Bituminous coal	89.50	3.6	83.5%	0.386	5,503
GENERADORA DEL ATLÁNTICO (GDR)	2014	206	Bituminous coal	89.50	3.6	83.5%	0.386	79
	Σ	**2,983,782**					**Σ**	**2,317,136**

Power Units *m* in 2018

Name of the power plant/unit (clasified by technology)	Starting year	EGm_{2018} Energy produced 2018 (MWh)	i Fuel Type	$EF_{CO2,m,i,y}$ Average emission factor of fuel type i ($t\ CO_2/TJ$)	Conversion factor TJ/MWh	η_m Default efficiency factors %	$EF_{EL,m,y}$ Emission factor of unit m ($t\ CO_2/MWh$)	CO_2 emissions 2018 t CO2
	AMM	AMM	AMM	Inventory Workbook (IPCC, 2006)	Conversion factor from the International System of	Meth tool 09, appendix	Calculated	Calculated
Coal		######### #						**2,705,794.14**
SAN JOSE	2000	911,775	Bituminous coal	89.50	3.6	37%	0.871	793,983.51
LAS PALMAS II	2012	99,291	Bituminous coal	89.50	3.6	39%	0.826	82,029.45
LA LIBERTAD	2008	94,668	Bituminous coal	89.50	3.6	39%	0.826	78,210.46
GENERADORA COSTA SUR	2013	156,349	Bituminous coal	89.50	3.6	39%	0.826	813,273.80
JAGUAR ENERGY 1	2015	984,410	Bituminous coal	89.50	3.6	39%	0.826	806,983.86
JAGUAR ENERGY 2	2015	976,796	Bituminous coal	89.50	3.6	39%	0.826	130,354.19
SAN ISIDRO	2016	157,784	Bituminous coal	89.50	3.6	39%	0.826	958.88
Combined cycle		**1,161**						**0.0**
ARIZONA VAPOR	2008	1,161	Waste Heat	0.0	3.6	0%	-	0
GAS TURBINES		**1,855**						**1,616.13**
TAMPA	1995	1,403	Diesel	72.6	3.6	30%	0.871	1,222.60
STEWART & STEVENSON	1995	292	Diesel	72.6	3.6	30%	0.871	254.26
ESCUINTLA GAS 5	1985	160	Diesel	72.6	3.6	30%	0.871	139.27
Internal combustion motors		**377,816**						**271,922.92**
ARIZONA	2003	228,320	Fuel Oil No.6	75.5	3.6	40%	0.680	155,143.60
PQP	1993	3,490	Fuel Oil No.6	75.5	3.6	33%	0.824	2,874.48
LAS PALMAS	1998	27,563	Fuel Oil No.6	75.5	3.6	33%	0.824	22,701.53
GENOR	1998	11,252	Fuel Oil No.6	75.5	3.6	33%	0.824	9,267.25
TDL B1 (6,7,8,12)	1998	33,569	Fuel Oil No.6	75.5	3.6	33%	0.824	27,648.59
TDL B2 (3,4,9)	1998	17,835	Fuel Oil No.6	75.5	3.6	33%	0.824	14,689.97
TDL B3 (10,11,13)	1998	23,046	Fuel Oil No.6	75.5	3.6	33%	0.824	18,981.88
ELECTROGENERACIÓN	2003	18,982	Fuel Oil No.6	75.5	3.6	40%	0.680	12,898.37
GENOSA	2013	2,704	Fuel Oil No.6	75.5	3.6	49%	0.560	1,515.53
TERMICA	2017	2,229	Fuel Oil No.6	75.5	3.6	49%	0.560	1,249.10
TERMICA B2	2017	6,693	Fuel Oil No.6	75.5	3.6	49%	0.560	3,751.08
ELECTRO CRISTAL BUNKER	2016	2,058	Fuel Oil No.6	75.5	3.6	49%	0.560	1,153.52
COENESA	2008	73	Diesel	72.6	3.6	40%	0.653	48.02
Cogenerators (fossil fuel)		**607,493**						**223,158.92**
CONCEPCION	1994	26	Fuel Oil No.6	75.5	3.6	83.5%	0.326	9
PANTALEON B1	1991	38	Fuel Oil No.6	75.5	3.6	83.5%	0.326	12
PANTALEON B3	2016	62,205	Bituminous coal	89.50	3.6	83.5%	0.386	24,003
SANTA ANA	1995	11	Fuel Oil No.6	75.5	3.6	83.5%	0.326	3
SANTA ANA B2	2015	88,682	Fuel Oil No.6	75.5	4.6	83.5%	0.416	36,885
MAGDALENA	1994	226,772	Fuel Oil No.6	75.5	3.6	83.5%	0.326	73,816
LA UNION B1	1995	3,599	Fuel Oil No.6	75.5	3.6	83.5%	0.326	1,172
MADRE TIERRA	1996	125	Fuel Oil No.6	75.5	3.6	83.5%	0.326	41
GENERADORA SANTA LUCÍA	2014	59,486	Bituminous coal	89.50	3.6	83.5%	0.386	22,954
TULULA B1	2001	36	Fuel Oil No.6	75.5	3.6	83.5%	0.326	12
TULULA B4	2013	73	Bituminous coal	89.50	3.6	83.5%	0.386	28
TRINIDAD B3	2011	-	Fuel Oil No.6	75.5	3.6	83.5%	0.326	-
TRINIDAD B4	2015	36,645	Bituminous coal	89.50	3.6	83.5%	0.386	14,140
TRINIDAD B5	2016	57,999	Bituminous coal	89.50	3.6	83.5%	0.386	22,380
EL PILAR B3	2012	0	Fuel Oil No.6	75.5	3.6	83.5%	0.326	0
PALO GORDO B2	2014	71,169	Bituminous coal	89.50	3.6	83.5%	0.386	27,462
GENERADORA DEL ATLÁNTICO (GDR)	2014	628	Bituminous coal	89.50	3.6	83.5%	0.386	242
	Σ	**4,369,398**					**Σ**	**3,202,492**

Selection of set of power plants k for operating margin calculation

Power Units *k* in 2016

Name of the power plant/unit (clasified by technology)	Starting year	Energy produced 2016	Fuel Type	Average emission factor of fuel type i	Conversion factor	Default efficiency factors	Emission factor of unit k	CO_2 emissions 2016
		$EG_{k,2016}$	i	$EF_{CO2,k,i,y}$		η_k	$EF_{EL,k,y}$	
		(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	Meth tool 09, appendix	Calculated	Calculated
Geothermal		**289,139**						0
ORZUNIL	1999	125,153	Geothermal steam	0	-	0	0	0
ORTITLÁN	2007	163,986	Geothermal steam	0	-	0	0	0
Hydroelectrics		**3,724,240**						0
CHIXOY	1983	980,005	Water	0	0	0	0	0
AGUACAPA	1982	259,420	Water	0	0	0	0	0
JURUN	1970	255,799	Water	0	0	0	0	0
ESCLAVOS	1966	41,696	Water	0	0	0	0	0
PEQUEÑAS HIDRO	1938-1926	44,687	Water	0	0	0	0	0
RIO BOBOS	1995	38,496	Water	0	0	0	0	0
SECACAO	1998	95,883	Water	0	0	0	0	0
PASABIEN	2000	38,691	Water	0	0	0	0	0
POZA VERDE	2000	35,960	Water	0	0	0	0	0
LAS VACAS	2002	86,953	Water	0	0	0	0	0
EL CANADÁ	2003	160,419	Water	0	0	0	0	0
MATANZAS + SAN ISIDRO	2002	54,224	Water	0	0	0	0	0
RENACE	2004	260,459	Water	0	0	0	0	0
PALIN II	2005	13,307	Water	0	0	0	0	0
MONTECRISTO	2006	44,053	Water	0	0	0	0	0
CANDELARIA	2006	24,434	Water	0	0	0	0	0
EL RECREO	2007	104,232	Water	0	0	0	0	0
HIDROXACBAL	2010	302,268	Water	0	0	0	0	0
PANAN	2010	19,944	Water	0	0	0	0	0
SANTA TERESA	2011	59,366	Water	0	0	0	0	0
CHOLOMA	2011	25,165	Water	0	0	0	0	0
PALO VIEJO	2012	110,365	Water	0	0	0	0	0
VISIÓN DE AGUILA	2013	7,710	Water	0	0	0	0	0
EL MANANTIAL	42036	46,934	Water	0	0	0	0	0
EL CÓBANO	42036	29,131	Water	0	0	0	0	0
OXEC	nov.2015	58,582	Water	0	0	0	0	0
RENACE 2	Ab.2016	374,515	Water	0	0	0	0	0
LAS FUENTES II	May.2016	23,025	Water	0	0	0	0	0
EL CAFETAL	May.2016	29,392	Water	0	0	0	0	0
RAAXHA	May.2016	15,972	Water	0	0	0	0	0
FINCA LORENA	Aug.2016	10,554	Water	0	0	0	0	0
RENACE 3	Nov.2106	58,060	Water	0	0	0	0	0
RECREO 2	Oct.2016	14,542	Water	0	0	0	0	0
Distribuited generation		**248,045**						0
SANTA ELENA	2008	2,209	Water	0	0	0	0	0
KAPLAN CHAPINA	2009	1,384	Water	0	0	0	0	0
CUEVAMARÍA	2009	20,708	Water	0	0	0	0	0
LOS CERROS	2010	4,322	Water	0	0	0	0	0
COVADONGA	2010	5,303	Water	0	0	0	0	0
JESBON MARAVILLAS	2010	-	Water	0	0	0	0	0
EL PRADO	2010	2,009	Water	0	0	0	0	0
OSCANA	2010	3,089	Water	0	0	0	0	0
HIDRO HDMM	2011	13,327	Water	0	0	0	0	0
LA PERLA	2011	9,517	Water	0	0	0	0	0
SAC-JA	2011	13,797	Water	0	0	0	0	0
SAN JOAQUIN 2	Jan 2012	4,738	Water	0	0	0	0	0
LUARCA	jun-12	490	Water	0	0	0	0	0
CERRO VIVO	2012	7,919	Water	0	0	0	0	0
LAS VICTORIAS	2013	2,646	Water	0	0	0	0	0
EL LIBERTADOR	2013	2,160	Water	0	0	0	0	0
EL IXTAL	2014	6,004	Water	0	0	0	0	0
CORALITO	2013	8,591	Water	0	0	0	0	0
EL ZAMBO	2013	3,324	Water	0	0	0	0	0
MONTE MARÍA	2014	2,323	Water	0	0	0	0	0
AGUNA	2014	9,417	Water	0	0	0	0	0
FOTOVOLTAICA SIBO	2014	12,371	Water	0	0	0	0	0
GDR LA PAZ	2014	5,232	Water	0	0	0	0	0
GDR GUAYACÁN	2014	4,736	Water	0	0	0	0	0
PUNTA DEL CIELO	2014	3,598	Water	0	0	0	0	0
SANTA TERESA	Jan 2015	8,364	Water	0	0	0	0	0
PANAL	feb-15	4,500	Water	0	0	0	0	0
PACAYAS	March 2015	17,497	Water	0	0	0	0	0
VERTEDERO EL TREBOL	Ap 2015	4,931	Water	0	0	0	0	0
SAMUC	may-15	6,033	Water	0	0	0	0	0
HIDRO CONCEPCIÓN	jul-15	1,110	Water	0	0	0	0	0
HIDRO SAN JOSÉ	jul-15	1,029	Water	0	0	0	0	0
GAVIOSA	jul-15	3,692	Water	0	0	0	0	0
HIDROELÉCTRICA PEÑAFLOR	oct-15	999	Water	0	0	0	0	0
SANTA ANITA	dic-15	1,879	Water	0	0	0	0	0
GDR MAXANAL	Feb.2016	4,304	Water	0	0	0	0	0
HIDROELECTRICA LA LIBERTAD CINCO M	Feb.2016	23,528	Water	0	0	0	0	0
LAS UVITAS	Ap 2016	5,476	Water	0	0	0	0	0
EL CONACASTE	May.2016	11,511	Water	0	0	0	0	0
EL BROTE	Aug 2016	2,343	Water	0	0	0	0	0
MOPA	Nov.2016	465	Water	0	0	0	0	0
LOS PATOS	Nov.2016	1,170	Water	0	0	0	0	0
Wind and photovoltaic		**394,500**						0
FOTOVOLTAICA HORUS	Feb/Jul 2015	179,431	Solar	0	0	0	0	0
EOLICA SAN ANTONIO EL SITIO	Ab 2015	148,261	Wind	0	0	0	0	0
EOLICA VIENTO BLANCO	Dec 2015	66,809	Wind	0	0	0	0	0
Cogenerators (biomass)		**2,148,452**						0
CONCEPCION	1994	63,713	Biomass	0.0	0	0%	0	0
PANTALEON	1991	272,915	Biomass	0.0	0	0%	0	0
SANTA ANA	1995	306,869	Biomass	0.0	0	0%	0	0
MAGDALENA	1994	755,347	Biomass	0.0	0	0%	0	0
LA UNION	1995	169,005	Biomass	0.0	0	0%	0	0
MADRE TIERRA	1996	97,294	Biomass	0.0	0	0%	0	0
TULULA	2001	50,517	Biomass	0.0	0	0%	0	0
TRINIDAD	2011-2012	246,624	Biomass	0.0	0	0%	0	0
EL PILAR	2012-2013	31,996	Biomass	0.0	0	0%	0	0
PALO GORDO	2014	153,713	Biomass	0.0	0	0%	0	0
GENERADORA DEL ATLÁNTICO	2013	458	Biomass/biogas	0.0	0	0%	0	0
Imports		568,985		0				0
	Σ	**7,373,361**					**Σ**	**0**

Power Units k in 2017

Name of the power plant/unit (clasified by technology)	Starting year	$EG_{k,2017}$	i	$EF_{CO2,k,i,y}$		η_k	$EF_{EL,k,y}$	
		Energy produced 2017	Fuel Type	Average emission factor of fuel type i	Conversion factor	Default efficiency factors	Emission factor of unit k	CO_2 emissions 2017
	year	(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	Meth tool 09, appendix	Calculated	Calculated
Geothermal		**253,048**						**0**
ORZUNIL	1999	108,730	Geothermal steam	0	-	0	0	0
ORTITLAN	2007	144,317	Geothermal steam	0	-	0	0	0
Hydroelectrics		######### #						**0**
CHIXOY	1983	1,551,746	Hydro resource	0	0	0	0	0
AGUACAPA	1982	253,385	Hydro resource	0	0	0	0	0
JURÚN MARINALA	1970	246,820	Hydro resource	0	0	0	0	0
LOS ESCLAVOS	1966	41,336	Hydro resource	0	0	0	0	0
SANTA MARÍA	1927	36,867	Hydro resource	0	0	0	0	0
EL SALTO	1938	1,278	Hydro resource	0	0	0	0	0
PORVENIR	1968	-	Hydro resource	0	0	0	0	0
CHICHAIC	1979	3,052	Hydro resource	0	0	0	0	0
RÍO BOBOS	1995	52,153	Hydro resource	0	0	0	0	0
SECACAO	1998	102,140	Hydro resource	0	0	0	0	0
PASABIEN	2000	49,237	Hydro resource	0	0	0	0	0
POZA VERDE	2000	35,977	Hydro resource	0	0	0	0	0
LAS VACAS	2002	99,231	Hydro resource	0	0	0	0	0
MATANZAS + SAN ISIDRO	2002	70,362	Hydro resource	0	0	0	0	0
RENACE	2002	302,311	Hydro resource	0	0	0	0	0
RENACE 2	2016	546,954	Hydro resource	0	0	0	0	0
RENACE 3	2016	304,977	Hydro resource	0	0	0	0	0
PALIN II	2005	13,475	Hydro resource	0	0	0	0	0
CANADA	2003	180,900	Hydro resource	0	0	0	0	0
MONTECRISTO	2006	49,400	Hydro resource	0	0	0	0	0
CANDELARIA	2006	26,451	Hydro resource	0	0	0	0	0
RECREO	2007	121,000	Hydro resource	0	0	0	0	0
RECREO 2	2016	95,868	Hydro resource	0	0	0	0	0
HIDRO XACBAL	2010	403,559	Hydro resource	0	0	0	0	0
HIDRO XACBAL DELTA	jul-17	117,495	Hydro resource	0	0	0	0	0
PANAN	2011	33,229	Hydro resource	0	0	0	0	0
SANTA TERESA	2011	65,398	Hydro resource	0	0	0	0	0
CHOLOMA	2011	31,403	Hydro resource	0	0	0	0	0
PALO VIEJO	2012	307,338	Hydro resource	0	0	0	0	0
VISIÓN DE AGUILA	2013	8,045	Hydro resource	0	0	0	0	0
HIDROAGUNA	2014	10,545	Hydro resource	0	0	0	0	0
EL MANANTIAL 1 + EL MANANTIAL 2 + EL MANANTIAL 3	2015	59,799	Hydro resource	0	0	0	0	0
EL COBANO	2015	29,893	Hydro resource	0	0	0	0	0
OXEC	nov-15	64,587	Hydro resource	0	0	0	0	0
LA LIBERTAD	2015	33,707	Hydro resource	0	0	0	0	0
LAS FUENTES II	2016	34,684	Hydro resource	0	0	0	0	0
EL CAFETAL	2018	40,605	Hydro resource	0	0	0	0	0
RAAXHA	2016	21,479	Hydro resource	0	0	0	0	0
FINCA LORENA	2016	25,109	Hydro resource	0	0	0	0	0
Distribuited generation		**293,536**						**0**
HIDROELÉCTRICA LA PERLA	2011	11,238	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA HIDROPOWER SDMM	2011	13,303	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA EL LIBERTADOR	2013	2,789	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA IXTALITO + XOLHUITZ	2014	15,292	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA GUAYACAN	mar-17	5,661	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA CORALITO	2014	9,310	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA CERRO VIVO	2013	7,531	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA SANTA TERESA	2012	8,802	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA EL SALTO MARINALÁ	jun-15	19,532	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA LOS PATOS	jun-17	21,178	Hydro resource	0	0	0	0	0
SANTA ELENA	2016-2017	3,734	Hydro resource	0	0	0	0	0
KAPLAN CHAPINA	2009	3,974	Hydro resource	0	0	0	0	0
CUEVA MARÍA	2016	10,568	Hydro resource	0	0	0	0	0
CUEVA MARIA 2	2008	12,861	Hydro resource	0	0	0	0	0
LOS CERROS	2009	4,788	Hydro resource	0	0	0	0	0
COVADONGA	2009	8,714	Hydro resource	0	0	0	0	0
EL PRADO	2009	2,225	Hydro resource	0	0	0	0	0
LAS MARGARITAS 1 + LAS MARGARITAS 2	2010	4,554	Hydro resource	0	0	0	0	0
SAC-JA	2010	10,091	Hydro resource	0	0	0	0	0
SAN JOAQUIN	2010	5,002	Hydro resource	0	0	0	0	0
LUARCA	2010-2012	0	Hydro resource	0	0	0	0	0
LAS VICTORIAS	2011	2,243	Hydro resource	0	0	0	0	0
EL ZAMBO	2012	4,866	Hydro resource	0	0	0	0	0
MONTE MARÍA	2012	2,301	Hydro resource	0	0	0	0	0
LA PAZ	2013	5,850	Hydro resource	0	0	0	0	0
TUTO DOS	2013	5,411	Hydro resource	0	0	0	0	0
EL PANAL	2014	3,833	Hydro resource	0	0	0	0	0
PACAYAS	2014	16,186	Hydro resource	0	0	0	0	0
SAMUC	2014	5,101	Hydro resource	0	0	0	0	0
SAMUC 2	2015	4,966	Hydro resource	0	0	0	0	0
CONCEPCIÓN	may-15	1,160	Hydro resource	0	0	0	0	0
SAN JOSE	jul-15	1,075	Hydro resource	0	0	0	0	0
PEÑA FLOR	mar-17	1,301	Hydro resource	0	0	0	0	0
SANTA ANITA	Dec 2015	1,878	Hydro resource	0	0	0	0	0
MAXANAL	2015	6,310	Hydro resource	0	0	0	0	0
LAS UVITAS	2015	7,183	Hydro resource	0	0	0	0	0
CONACASTE	2015	17,482	Hydro resource	0	0	0	0	0
EL BROTE	2016	7,622	Hydro resource	0	0	0	0	0
MOPÁ	2016	4,222	Hydro resource	0	0	0	0	0
EL COROZO	2016	3,503	Hydro resource	0	0	0	0	0
MIRAFLORES	ene-17	3,375	Hydro resource	0	0	0	0	0
LA CEIBA 1	feb-17	2,049	Hydro resource	0	0	0	0	0
CARMEN AMALIA	feb-17	2,247	Hydro resource	0	0	0	0	0
NUEVA HIDROCON	mar-17	3	Hydro resource	0	0	0	0	0
EL TRIÁNGULO	may-17	2,117	Hydro resource	0	0	0	0	0
LA VIÑA	may-17	104	Hydro resource	0	0	0	0	0
CUTZÁN	jun-17	0	Hydro resource	0	0	0	0	0
Cogenerators (biomass)		######### #						0
CONCEPCION	1994	58,577	Biomass	0.0	0	0.0%	0	0
PANTALEON B1	1991	217,946	Biomass	0.0	0	0.0%	0	0
PANTALEON B3	2016	46,397	Biomass	0.0	0	0.0%	0	0
SANTA ANA	1995	77,799	Biomass	0.0	0	0.0%	0	0
SANTA ANA B2	2015	205,863	Biomass	0.0	0	0.0%	0	0
MAGDALENA	1994	658,505	Biomass	0.0	0	0.0%	0	0
LA UNION B1	1995	165,201	Biomass	0.0	0	0.0%	0	0
MADRE TIERRA	1996	83,713	Biomass	0.0	0	0.0%	0	0
GENERADORA SANTA LUCÍA	2014	28,546	Biomass	0.0	0	0.0%	0	0
TULULA B1	2001	10,609	Biomass	0.0	0	0.0%	0	0
TULULA B4	2013	33,589	Biomass	0.0	0	0.0%	0	0
TRINIDAD B3	2011-2012	19,935	Biomass	0.0	0	0.0%	0	0
TRINIDAD B4	2015	130,660	Biomass	0.0	0	0.0%	0	0
TRINIDAD B5	2016	142,171	Biomass	0.0	0	0.0%	0	0
EL PILAR B3	2012-2013	29,255	Biomass	0.0	0	0.0%	0	0
PALO GORDO B2	2014	144,914	Biomass	0.0	0	0.0%	0	0
GENERADORA DEL ATLÁNTICO (GDR)	2014	147	Biomass	0.0	0	0.0%	0	0
BIOMASA SANTA ANA (GDR)	dic-17	-	Biomass	0.0	0	0.0%	0	0
Wind Power Plants		**218,055**						0
SAN ANTONIO EL SITIO	2015	147,299	Wind	0.0	0	0.0%	0	0
VIENTO BLANCO	2015	70,756	Wind	0.0	0	0.0%	0	0
Solar Power Plants		**198,203**						0
HORUS I	2015	109,589	Solar radiation	0.0	0	0.0%	0	0
HORUS II	2015	68,668	Solar radiation	0.0	0	0.0%	0	0
FOTOVOLTAICA SIBO (GDR)	2014	12,253	Solar radiation	0.0	0	0.0%	0	0
GRANJA SOLAR AVELLANA (GDR)	mar-17	1,690	Solar radiation	0.0	0	0.0%	0	0
GRANJA SOLAR EL JOBO (GDR)	mar-17	1,260	Solar radiation	0.0	0	0.0%	0	0
GRANJA SOLAR PEDRO DE ALVARADO (GDR)	mar-17	1,624	Solar radiation	0.0	0	0.0%	0	0
GRANJA SOLAR TAXISCO (GDR)	mar-17	2,153	Solar radiation	0.0	0	0.0%	0	0
GRANJA SOLAR BUENA VISTA (GDR)	ago-17	966	Solar radiation	0.0	0	0.0%	0	0
Biogas		**17,558**						0
BIOGÁS DEL VERTEDERO EL TRÉBOL (GDR)	2015	6,260	Biogas	0.0	0	0.0%	0	0
BIOGÁS DEL VERTEDERO EL TRÉBOL 2 (GDR)	may-17	7,121	Biogas	0.0	0	0.0%	0	0
GABIOSA (GDR)	2015	4,177	Biogas	0.0	0	0.0%	0	0
Imports		773,037		0				0
	Σ	**9,279,055**					**Σ**	**0**

Power Units *k* in 2018

Name of the power plant/unit (clasified by technology)	Starting year	$EG_{k,2018}$ Energy produced 2018 (MWh)	i Fuel Type	$EF_{CO2,k,i,y}$ Average emission factor of fuel type i ($t CO_2/TJ$)	Conversion factor TJ/MWh	η_k Default efficiency factors %	$EF_{EL,k,y}$ Emission factor of unit k ($t CO_2/MWh$)	CO_2 emissions 2018 t CO2
	AMM	AMM	AMM	Inventory Workbook (IPCC, 2006)	Conversion factor from the International System of	Meth tool 09, appendix	Calculated	Calculated
Geothermal		**249,754**						**0.0**
ORZUNIL	1999	110,097	Geothermal steam	0	-	0	0	0
ORTITLAN	2007	139,657	Geothermal steam	0	-	0	0	0
Hydroelectrics		######### #						**0**
CHIXOY	1983	1,296,611	Hydro resource	0	0	0	0	0
AGUACAPA	1982	262,503	Hydro resource	0	0	0	0	0
JURÚN MARINALA	1970	254,435	Hydro resource	0	0	0	0	0
LOS ESCLAVOS	1966	40,120	Hydro resource	0	0	0	0	0
SANTA MARÍA	1927	35,526	Hydro resource	0	0	0	0	0
EL SALTO	1938	-	Hydro resource	0	0	0	0	0
PORVENIR	1968	-	Hydro resource	0	0	0	0	0
CHICHAIC	1979	2,903	Hydro resource	0	0	0	0	0
RÍO BOBOS	1995	40,571	Hydro resource	0	0	0	0	0
SECACAO	1998	102,412	Hydro resource	0	0	0	0	0
PASABIEN	2000	11,704	Hydro resource	0	0	0	0	0
POZA VERDE	2000	39,879	Hydro resource	0	0	0	0	0
LAS VACAS	2002	81,628	Hydro resource	0	0	0	0	0
MATANZAS + SAN ISIDRO	2002	61,193	Hydro resource	0	0	0	0	0
RENACE	2002	225,492	Hydro resource	0	0	0	0	0
RENACE 2	Ap 2016	429,550	Hydro resource	0	0	0	0	0
RENACE 3	nov-16	249,894	Hydro resource	0	0	0	0	0
PALIN II	2005	13,439	Hydro resource	0	0	0	0	0
CANADA	2003	163,797	Hydro resource	0	0	0	0	0
MONTECRISTO	2006	44,468	Hydro resource	0	0	0	0	0
CANDELARIA	2006	26,530	Hydro resource	0	0	0	0	0
RECREO	2007	105,926	Hydro resource	0	0	0	0	0
RECREO 2	2016	87,312	Hydro resource	0	0	0	0	0
HIDRO XACBAL	2010	356,807	Hydro resource	0	0	0	0	0
HIDRO XACBAL DELTA	jul-17	213,782	Hydro resource	0	0	0	0	0
PANAN	2011	25,004	Hydro resource	0	0	0	0	0
SANTA TERESA	2011	58,556	Hydro resource	0	0	0	0	0
CHOLOMA	2011	28,579	Hydro resource	0	0	0	0	0
PALO VIEJO	2012	298,114	Hydro resource	0	0	0	0	0
VISIÓN DE AGUILA	2013	5,485	Hydro resource	0	0	0	0	0
HIDROAGUNA	2014	10,527	Hydro resource	0	0	0	0	0
EL MANANTIAL 1	2015	8,033	Hydro resource	0	0	0	0	0
EL MANANTIAL 2	2015	37,697	Hydro resource	0	0	0	0	0
EL MANANTIAL 3	oct-17	1,392	Hydro resource	0	0	0	0	0
EL COBANO	2015	30,287	Hydro resource	0	0	0	0	0
OXEC	nov-15	56,993	Hydro resource	0	0	0	0	0
OXEC 2	2018	75,703	Hydro resource	0	0	0	0	0
LA LIBERTAD	2016	24,988	Hydro resource	0	0	0	0	0
LAS FUENTES II	2016	28,048	Hydro resource	0	0	0	0	0
EL CAFETAL	2016	40,339	Hydro resource	0	0	0	0	0
RAAXHA	2016	21,677	Hydro resource	0	0	0	0	0
FINCA LORENA	2016	21,484	Hydro resource	0	0	0	0	0
Distribuited generation		**271,599**						**0**
HIDROELÉCTRICA LA PERLA	2011	11,139	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA HIDROPOWER SDMM	2011	11,312	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA EL LIBERTADOR	2013	4,583	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA IXTALITO	2014	5,730	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA XOLHUITZ	mar-17	6,400	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA GUAYACAN	2014	5,943	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA CORALITO	2013	9,012	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA CERRO VIVO	2012	6,472	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA SANTA TERESA	oct-11	8,472	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA EL SALTO MARINALÁ	jun-17	23,107	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA LOS PATOS	2016-2017	18,936	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA MAXANAL	2016	5,304	Hydro resource	0	0	0	0	0
HIDROELÉCTRICA LAS UVITAS	2016	7,097	Hydro resource	0	0	0	0	0
SANTA ELENA	2008	3,892	Hydro resource	0	0	0	0	0
KAPLAN CHAPINA	2009	5,238	Hydro resource	0	0	0	0	0
CUEVA MARÍA	2009	8,663	Hydro resource	0	0	0	0	0
CUEVA MARIA 2	2009	11,606	Hydro resource	0	0	0	0	0
LOS CERROS	2010	2,404	Hydro resource	0	0	0	0	0
COVADONGA	2010	6,634	Hydro resource	0	0	0	0	0
EL PRADO	2010	2,171	Hydro resource	0	0	0	0	0
LAS MARGARITAS 1 + LAS MARGARITAS 2	2010-2012	3,385	Hydro resource	0	0	0	0	0
SAC-JA	2011	6,544	Hydro resource	0	0	0	0	0
SAN JOAQUIN	2012	5,398	Hydro resource	0	0	0	0	0
LUARCA	2012	788	Hydro resource	0	0	0	0	0
LAS VICTORIAS	2013	2,430	Hydro resource	0	0	0	0	0
EL ZAMBO	2013	3,598	Hydro resource	0	0	0	0	0
MONTE MARÍA	2014	2,075	Hydro resource	0	0	0	0	0
LA PAZ	2014	5,037	Hydro resource	0	0	0	0	0
TUTO DOS	2014	5,291	Hydro resource	0	0	0	0	0
EL PANAL	2015	979	Hydro resource	0	0	0	0	0
PACAYAS	2015	15,564	Hydro resource	0	0	0	0	0
SAMUC	2015	5,013	Hydro resource	0	0	0	0	0
SAMUC 2	mar-17	6,084	Hydro resource	0	0	0	0	0
CONCEPCIÓN	2015	1,072	Hydro resource	0	0	0	0	0
SAN JOSE	2015	1,729	Hydro resource	0	0	0	0	0
PEÑA FLOR	2015	992	Hydro resource	0	0	0	0	0
SANTA ANITA	Dec 2015	1,711	Hydro resource	0	0	0	0	0
CONACASTE	2016	15,455	Hydro resource	0	0	0	0	0
EL BROTE	2016	4,515	Hydro resource	0	0	0	0	0
MOPÁ	2016	3,385	Hydro resource	0	0	0	0	0
EL COROZO	ene-17	2,893	Hydro resource	0	0	0	0	0
MIRAFLORES	feb-17	2,671	Hydro resource	0	0	0	0	0
LA CEIBA 1	feb-17	2,093	Hydro resource	0	0	0	0	0
CARMEN AMALIA	mar-17	1,961	Hydro resource	0	0	0	0	0
NUEVA HIDROCON	may-17	2,235	Hydro resource	0	0	0	0	0
EL TRIÁNGULO	may-17	2,347	Hydro resource	0	0	0	0	0
LA VIÑA	jun-17	329	Hydro resource	0	0	0	0	0
CUTZÁN	jul-17	-	Hydro resource	0	0	0	0	0
CHOLIVA	2018	1,151	Hydro resource	0	0	0	0	0
HIDROXOCOBIL	2018	573	Hydro resource	0	0	0	0	0
GDR HIDROSAN	2018	182	Hydro resource	0	0	0	0	0
Cogenerators (biomass)		######### #		0	0	0	0	0
CONCEPCION	1994	50,819	Biomass	0	0	0	0	0
PANTALEON B1	1991	56,515	Biomass	0	0	0	0	0
PANTALEON B3	2016	200,738	Biomass	0	0	0	0	0
SANTA ANA	1995	74,943	Biomass	0	0	0	0	0
SANTA ANA B2	2015	219,298	Biomass	0	0	0	0	0
MAGDALENA	1994	641,970	Biomass	0.0	0	0.0%	0	0
LA UNION B1	1995	185,782	Biomass	0.0	0	0.0%	0	0
MADRE TIERRA	1996	102,238	Biomass	0.0	0	0.0%	0	0
GENERADORA SANTA LUCÍA	2014	29,173	Biomass	0.0	0	0.0%	0	0
TULULA B1	2001	10,819	Biomass	0.0	0	0.0%	0	0
TULULA B4	2013	32,553	Biomass	0.0	0	0.0%	0	0
TRINIDAD B3	2011-2012	22,671	Biomass	0.0	0	0.0%	0	0
TRINIDAD B4	2015	135,476	Biomass	0.0	0	0.0%	0	0
TRINIDAD B5	2016	192,307	Biomass	0.0	0	0.0%	0	0
EL PILAR B3	2012-2013	34,350	Biomass	0.0	0	0.0%	0	0
PALO GORDO B2	2014	167,639	Biomass	0.0	0	0.0%	0	0
GENERADORA DEL ATLÁNTICO (GDR)	2014	403	Biomass	0.0	0	0.0%	0	0
BIOMASA SANTA ANA (GDR)	dic-17	419	Biomass	0.0	0	0.0%	0	0
Wind Power Plants		**319,501**						0
SAN ANTONIO EL SITIO	2015	154,064	Wind	0.0	0	0.0%	0	0
VIENTO BLANCO	2015	81,154	Wind	0.0	0	0.0%	0	0
LAS CUMBRES	2018	84,282	Wind	0.0	0	0.0%	0	0
Solar Power Plants		**208,313**						0
HORUS I	2015	112,742	Solar radiation	0.0	0	0.0%	0	0
HORUS II	2015	69,940	Solar radiation	0.0	0	0.0%	0	0
FOTOVOLTAICA SIBO (GDR)	2014	13,588	Solar radiation	0.0	0	0.0%	0	0
GRANJA SOLAR AVELLANA (GDR)	mar-17	2,238	Solar radiation	0.0	0	0.0%	0	0
GRANJA SOLAR EL JOBO (GDR)	mar-17	1,695	Solar radiation	0.0	0	0.0%	0	0
GRANJA SOLAR PEDRO DE ALVARADO (GD	mar-17	2,134	Solar radiation	0.0	0	0.0%	0	0
GRANJA SOLAR TAXISCO (GDR)	mar-17	2,961	Solar radiation	0.0	0	0.0%	0	0
GRANJA SOLAR BUENA VISTA (GDR)	ago-17	3,016	Solar radiation	0.0	0	0.0%	0	0
Biogas		**26,327**						0
BIOGÁS DEL VERTEDERO EL TRÉBOL (GDR	2015	5,942	Biogas	0.0	0	0.0%	0	0
BIOGÁS DEL VERTEDERO EL TRÉBOL 2 (GD	may-17	17,952	Biogas	0.0	0	0.0%	0	0
GABIOSA (GDR)	2015	2,433	Biogas	0.0	0	0.0%	0	0
Imports		415,844		0	0	0	0	0
	Σ	**8,568,837**					**Σ**	**0**

OM Calculation

$$EF_{grid,OM\text{-}adj,y} = (1-\lambda_y)\cdot\frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} + \lambda_y \cdot \frac{\sum_k EG_{k,y} \times EF_{EL,k,y}}{\sum_k EG_{k,y}}$$

OM 2016

1-λ	0.873	
$\sum(EG_{m,2016} \times EF_{EL,m,2016})$	3,063,582	tCO2
$\sum EG_{m,2016}$	4,073,528	MWh
$EF_{j,OM,\ 2016}$	0.656	tCO2/MWh
λ	0.127	
$\sum(EG_{k,2016} \times EF_{EL,k,2016})$	0	tCO2
$\sum EG_{k,2016}$	7,373,361	MWh
$EF_{k,OM,\ 2016}$	0.000	tCO2/MWh
Therefore:		
$EF_{grid,OM\text{-}adj,\ 2016}$	**0.656**	**tCO2/MWh**

OM 2017

1-λ	0.545	
$\sum(EG_{m,2018} \times EF_{EL,m,2018})$	2,317,136	tCO2
$\sum EG_{m,2018}$	2,983,782	MWh
$EF_{j,OM,\ 2018}$	0.423	tCO2/MWh

λ	0.455	
$\sum(EG_{k,2017} \times EF_{EL,k,2017})$	0	tCO2
$\sum EG_{k,2017}$	9,279,055	MWh
$EF_{k,OM,\ 2017}$	0.000	tCO2/MWh

Therefore:

$EF_{grid,OM\text{-}adj,\ 2017}$	**0.423**	**tCO2/MWh**

OM 2018

1-λ	0.731	
$\sum(EG_{m,2018} X\ EF_{EL,m,2018})$	3,202,492	tCO2
$\sum EG_{m,2018}$	4,369,398	MWh
$EF_{j,OM,\ 2018}$	0.536	tCO2/MWh
λ	0.269	
$\sum(EG_{k,2018}\ X\ EF_{EL,k,2018})$	0	tCO2
$\sum EG_{k,2018}$	8,568,837	MWh
$EF_{k,OM,\ 2018}$	0.000	tCO2/MWh
Therefore:		
$EF_{grid,OM\text{-}adj,\ 2018}$	**0.536**	**tCO2/MWh**

Average OM emission factor

	2016	2017	2018
Total generation (MWh)	11,446,889	12,262,837	12,938,235
OM emission factor (tCO_2/MWh)	0.656	0.423	0.536
Average OM emission factor (tCO_2/MWh)	**0.536**		

Appendix 5. Further background information on monitoring plan

See Section B.7 of this PDD.

Appendix 6. Summary report of comments received from local stakeholders

See Section E.

Appendix 7. Summary of post-registration changes

a. As per approved PRC-0604-001 DOE assessment opinion, the project design in the project activity implementation was not conformed with the description contained in the registered PDD, as it was found a little difference between the power rating of the installed turbine, with 4.456 MW, and the value indicated in the registered PDD, with 4.3 MW. Nevertheless, this difference was considered not significant and the determination of the emission reductions of the project activity was not affected, as it did not cause any impact on the installed capacity of the project, because according to the criterion stated in the paragraph 82(a) of the “Clean development mechanism project standard”, the installed capacity of the project is determined by the power rating of the installed generator of 4,317.6 kW, which is equivalent to the installed capacity indicated in the registered PDD. Therefore, that change did not impact on the applicability of the methodology under which the project activity was registered, the compliance of the monitoring plan with the applied methodology.

b. Ecoinvest Carbon SA is no project participant any more.

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Document information

Version	*Date*	*Description*
10.1	28 June 2017	Revision to make editorial improvement.
10.0	7 June 2017	Revision to: • Improve consistency with the “CDM project standard for project activities” and with the PoA-DD and CPA-DD forms; • Make editorial improvement.
09.0	24 May 2017	Revision to: • Ensure consistency with the “CDM project standard for project activities” (CDM-EB93-A04-STAN) (version 01.0); • Incorporate the “Project design document form for small-scale CDM project activities” (CDM-SSC-PDD-FORM); • Make editorial improvement.
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the “Standard: Applicability of sectoral scopes” (CDM-EB88-A04-STAN) (version 01.0).
06.0	9 March 2015	Revision to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Make editorial improvement.
05.0	25 June 2014	Revision to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from F-CDM-PDD to CDM-PDD-FORM; • Make editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	13 March 2012	Revision required to ensure consistency with the “Guidelines for completing the project design document form for CDM project activities” (EB 66, Annex 8).

Version	*Date*	*Description*
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

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