Verified Emissions Reduction
Project Design Document

Poza Verde Hydroelectric Project
Guatemala

April 2006

This document is based on the UNFCCC CDM Simplified Project Design Document For Small-Scale Project Activities (SSC-CDM-PDD) version 02.

Document History

Version	Author	Checked by	Date	Reason for Issue
0.1	Chris Pooley	Mike Sandford	April 2006	Initial draft
		Ed Everson	April 2006	GCC EF review
1.0	Chris Pooley	Mike Sandford	April 2006	Release

Contents

A General description of the project activity

A.1 Title of the project activity:

Poza Verde Hydroelectric Project.

A.2 Description of the project activity:

The objective of the Poza Verde Hydroelectric Project (hereafter, "the Project") is to provide clean and reliable renewable energy to Guatemala while addressing a variety of high priority local, national and international interests. The Project will reduce emissions of carbon dioxide by displacing demand for fossil-fuel generated electricity from the national grid, which is heavily dependent on heavy fuel oil, coal, and diesel. The Project is a small 8.2MW hydro plant owned by Papeles Elaborados S.A. in the municipality of Pueblo Nuevo Viñas of the Department of Santa Rosa.

The Project's positive sustainable development impacts include:

- Provision of renewable energy free of the CO_2, NO_x, SO_2, and particulate emissions usually associated with burning of fossil fuels;
- Strengthened energy security of the Guatemalan grid and reduced dependence on imports;
- Energy provision to approximately 5,000 people, and the extension of energy access to a rural area;
- Creation of 400 jobs during construction, 30 permanent jobs in the town of Pueblo Nuevo Viñas, and the technical training of 20 employees;
- Reduction of GHG emissions via displacement of thermal electricity generation; and
- Reforestation on the banks surrounding the Aguacapa River, with a resulting decrease in erosion and increase in CO_2 sequestration.

A.3 Project participants:

Papeles Elaborados S.A.

A.4 Technical description of the project activity:

Phase 1 of the Project consists of the operation of an 8.2MW small-scale, run-of-river hydroelectric power plant installed along the Aguacapa river. In Phase 2, the project will remain run-of-river, but a small diversion and reservoir will be built that will divert and hold water for short times during dry months in order to guarantee generation. The plant capacity will be increased to 12MW.

The Aguacapa river basin exceeds 240km^2 and ranges in elevation from 850 to 2,000 meters above mean sea level. According to daily measures taken at six different water flow and rainfall monitoring stations located along the river basin between 1971 and 1993, the Aguacapa river is a stable hydrologic system, registering an average water flow between 7.2m^3/s and 7.5m^3/s. Furthermore, annual rainfall records during the same analysis period show an average precipitation of 1,773mm, a minimum of 1,363mm, and a maximum of 2,213mm.

Once the water is diverted from the river, solids and sediments are removed using a series of open channels and screens where the sediments settle down and large solids are separated. The water then runs through a series of channels and tunnels alongside the riverbed for approximately 5km. From there, the water reaches an oscillation tank from which it flows down through a pressure piping system to the power house where two Francis turbines and two 4.16kV synchronic generators are located. The design flow of this project is set at 7m^3/s and the total height of the pressure pipe is 137m.

In Phase 2, the company will add water from another river, the Agua Tibia. This will improve the revenues of the project whilst keeping it as run-of-river. The Agua Tibia has a fall of 130 meters, which is achieved by diverting water through a 3.5km channel. At the start of the channel, a small dam will be constructed to direct the water to the channel then on to the power house. This will add approximately 1.35 cubic meters per second and an additional 13.85GWh of output, assuming an efficiency rate of 92%.

Further technical description can be found in the engineering report PV-GAR-20010920aV1.

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

A.4.1.1 Country:

Guatemala

A.4.1.2 Region/State/Province:

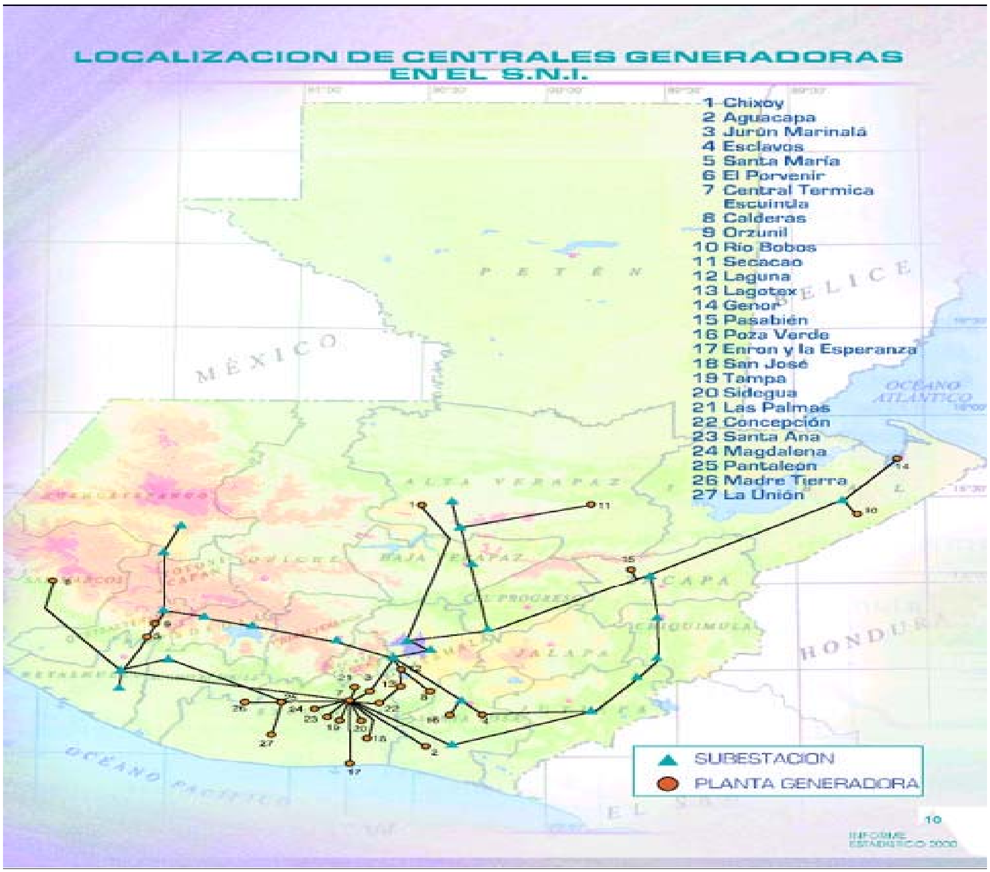
Santa Rosa State

A.4.1.3 City/Town/Community:

Pueblo Nuevo Viñas.

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

The Project activity will take place on the Aguacapa River, with the hydroelectric plant situated in the town of Pueblo Nuevo Viñas in the Guatemalan state of Santa Rosa. The coordinates of the engine room of the plant are: 14˚17'36.63"N 90˚29'56.58"W.



A.4.2 UNFCCC type, category and technology of the small-scale project activity:

This project activity falls under UNFCCC CDM Sector 1: Energy industries (renewable) – "Grid-connected electricity generation from renewable sources". Having an installed capacity of 12MW it would be eligible to use a type (I) small-scale methodology as it does not exceed the maximum 15MW. The technology employed for generation is the Francis turbine, which is a propeller type turbine that operates at heads of less than 10m and is completely immersed in the flow of the water.

A.4.3 Brief explanation of how the anthropogenic emissions of greenhouse gases by sources are to be reduced:

The proposed project activity will displace electricity generation from thermal facilities that use fossil fuels in the Guatemalan interconnected electricity grid. Although generation from the Project varies by season, it will provide a predictable source of electricity for the grid. Under a business as usual scenario, there would be continuing growth in thermal-based electricity generation capacity using fossil fuels.

Over the past several years, the Government of Guatemala has striven to attract energy investment. While investment in thermal generation has benefited from electricity sector privatisation under the Guatemalan Energy Law (1996), investment in non-thermal or renewable energy projects such as hydro has declined significantly. Guatemala's energy mix saw a substantial increase in thermal generation in the late 1990's, growing from 41% to about 55% thermal generation. Conversely, the Guatemalan grid has gone from being almost completely served by hydropower in the 1970's, to being only 34% hydro today. One of the primary reasons is the government's cessation of hydro investment in the 1980's followed by the privatisation policies.

A.4.4 Public funding of the project activity:

The Project has not received and is not seeking public funding.

A.4.5 Confirmation that the project activity is not an unbundled component of a larger project activity:

This Project is not an unbundled component of a larger project activity since the project participant has not registered or operated another project in the region surrounding the project boundary.

B Application of a Baseline Methodology

B.1 UNFCCC approved baseline methodology applied:

"AMS. I.D. – Grid-connected renewable electricity generation". Version 08 (March 03, 2006).

B.2 UNFCCC project category applicable to the project activity:

The baseline calculation for the Project follows the procedures as outlined in Appendix B (version 09) of the simplified modalities and procedures for small-scale CDM project activities for categories:

I.D. (AMS-III.D) - "Grid-connected renewable electricity generation" - for the methane recovery component of the project activity.

This selection is appropriate because the Project implements renewable generation within the requirements of the small scale methodology (less than 15 MW) and is connected to the grid. The alternative to the project activity would be to continue with the business as usual scenario, with electricity coming from the current operating generation mix and eventual generation plants being added with carbon intensities similar to recent additions.

B.3 Reduction of anthropogenic emissions of GHG by sources:

MARKET SITUATION & NATIONAL POLICIES

The addition of renewable electricity capacity to Guatemala's interconnected national grid was appropriate in view of Guatemala's rapid economic growth (4% pa) throughout the 1990's and the associated growth in electricity demand. During the period 1993-2003, Guatemala experienced an electricity demand growth rate of 8.1% pa. It is likely that under normal circumstances generation capacity additions would have been significantly more carbon-intensive than the project activity. Both the business-as-usual scenario and the project activity are in compliance with all applicable legal and regulatory requirements of Guatemala. The law governing the electricity sector is the "Ley General de Electricidad – Decreto Nº 93-96," which was enacted in 1996 and mandated the deregulation of the Guatemalan electricity sector. The Decreto Nº 93-96 also established the legal and regulatory requirements for electricity generation and transmission to the consumers.

The deregulation and privatisation of the Guatemalan electricity sector has had negative impacts on the ease of renewable energy development and the sustainability of the Guatemalan power grid, which has gone from being mainly hydro in the early 1970's to being only 34% hydro today. The government was the sole developer of electricity generation capacity in Guatemala before privatisation, but ceased almost all of its investment in renewable energy in the 1980's, causing the infrastructure to stagnate.

ADDITIONALITY

Additionality can be proven using an analysis of the barriers that the Project faces, including: (a) investment barriers, (b) technological barriers, and (c) prevailing practice barriers. The Project faced barriers in its development that were overcome by capitalizing on interest in the Project as a source of sustainable energy and climate change mitigation from the environmental finance community and the utility sector. Without its climate and sustainability benefits, the Project would not have found essential financing from the clean energy finance facilities, nor would it have been able to secure a bankable power purchase agreement.

INVESTMENT BARRIERS

The primary barrier to the implementation of hydro projects such as Poza Verde is the difficulty in obtaining finance. Several factors relevant to the Poza Verde project contribute to this difficulty.

- Access to finance in Guatemala

The domestic financial market in Guatemala during the period that the Project was under development was characterised by high interest rates and short loan terms. This forced project developers to look to international environmental finance facilities and regional development banks, which offered more attractive rates and longer terms, but are more difficult to access. However, the Project successfully secured financing based on its environmental and climate mitigation benefits. The Project sought and is receiving a portion of its debt from the Corporación Financeira Ambiental (CFA) and from E+Co, both are funds that exclusively finance projects that contribute to sustainable development. CFA's mission is to fund small to medium-sized private enterprises that undertake environmental projects in Central America. E+CO finances the Project as part of their strategy to "demonstrate to public and private sector investors that the establishment of local clean energy enterprises represents a win-win, market-based solution to the twin problems of meeting the increasing demand for energy services and protecting the environment."

- Perceived technology risk in hydro

As the Project is not based on conventional fossil technology, the risk perceived by prospective financers and consumers was greater. This was due to the low level of experience in financing such projects. The small-scale nature of the Project compounded the problem because the small, run-of-river hydro technology is less common than that of large hydro plant.

- Transaction costs for small projects

Project development and finance transaction costs are disproportionately high for a relatively small project such as Poza Verde. Furthermore, since small hydro projects are typically new to municipalities and local governments, the permitting process is often unclear which can lead to increased transaction costs.

- Host country investment environment

The Project faced substantial barriers due to political risk and an unstable electricity market. These were only overcome by co-operation with a utility that was interested in the environmental attributes of the Project. Following the cancellation of the power purchase agreement by the original off-taker, the state-owned INDE, the future of the Project was at risk. The Project eventually secured an alternative power buyer in COMEGSA by offering to share the commercialised environmental benefits it would generate with Iberdrola S.A., COMEGSA's parent company. The environmental benefits of the Project were thus key to its ability to overcome market instability and to proceed.

TECHNICAL BARRIERS

The lack of available knowledge and confidence in the technology involved in small, privately built hydroelectric projects made this type of development difficult to establish in Guatemala. This is reflected in the fact that very little of the current hydro capacity is small hydro plant. Indeed, the Poza Verde project has demonstrated that the risk-sensitive view is not altogether unfounded by the cost overruns that have plagued its development.

PREVAILING PRACTICE

At the time, Guatemala did not have many privately financed, built, and operated generation plant. The primary barriers within the institutional and regulatory framework were unclear process, sudden and unsubstantiated changes to the legal process, and long durations in the processes for obtaining licenses and permits. These problems were sufficient to deter many project developers from initiating small-scale energy projects and financial institutions from supporting projects that did. The time frame for the legal documentation required to develop small renewable energy projects has proven to be cumbersome. Generally, private utilities were reluctant to develop small hydro projects given their relatively less attractive short-term financial profiles compared to thermal generation projects.

B.4 Project boundary definition:

The project boundary is defined as the notional margin around a project within which the project's impact (in terms of carbon emission reductions) will be assessed. For the Project this includes emissions from activities that occur at the project location. The system boundary for the Project is defined as the national grid in Guatemala. The project boundary for the baseline therefore includes all the direct emissions from the electricity produced by the power plants displaced by the Project. This involves emissions from displaced fossil fuel use at power plants. Conforming to the UNFCCC guidance and rules for small scale project activities, the emissions related to production, transport and distribution of the fuel used for the power plants in the baseline are not included in the project boundary as these do not occur at the physical and geographical site of the Project.

B.5 Details of the baseline and its development:

The appropriate UNFCCC baseline for project category Type I.D (AMS-ID) is:

"the kWh produced by the renewable generating unit multiplied by an emission coefficient (measured in kg CO_2e/kWh) calculated in a transparent and conservative manner as:

a. A combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the approved methodology ACM0002.

OR

b. The weighted average emissions (in kg CO_2/kWh) of the current generation mix."

C Duration of the project activity

C.1 Duration of the small-scale project activity:

C.1.1 Starting date of the small-scale project activity:

1 March 2000.

C.1.2 Expected operational lifetime of the small-scale project activity:

The Project is expected to operate for approximately fifty years.

D Application of a monitoring methodology and plan:

D.1 Name and reference of approved monitoring methodology applied to the Project:

The monitoring methodology, as specified in UNFCCC CDM AMS.I.D. is defined such that "Monitoring shall consist of metering the electricity generated by the renewable technology."

D.2 Justification of the choice of the methodology:

The methodology was selected according to the UNFCCC Simplified Monitoring Methodologies for small-scale CDM projects because the project is a small-scale renewable energy project.

D.3 Data to be monitored:

Identifier	EG_y (see section E)
Data variable	Electricity supplied to the grid by the Project
Source of data	Project developer
Data unit	MWh
Measured, calculated, or estimated	measured
Recording frequency	Monthly
Proportion of data to be monitored	100%
How will the data be archived? (electronic/ paper)	Electronic
Comments	Every quarter a report is sent to the project developer by AMM. The readings are sent to The Green Certificate Company for recording and the certification

D.4 Quality control (QC) and quality assurance (QA) procedures:

The Project has been certified by Campbell Carr (see PV-GAR-20010920aV1). The Green Certificate Company will continue to verify the VERs annually. The electricity generation data is supplied by the Administracion del Mercado de Mayoristas (AMM), the Guatemalan electricity market administrator.

D.5 Operational and management structure for monitoring emission reductions and any leakage effects:

There are no anticipated leakage effects of the Project. Emissions reductions will be monitored based on independent data supplied to the project developer by the Administracion del Mercado de Mayoristas (AMM). The project developer will report this data to The Green Certificate Company.

E Estimation of GHG emissions:

E.1 Baseline emissions reduction:

The **baseline emissions reduction** (BE_y) resulting from the electricity supplied to the grid is calculated as follows, where EG_y is the annual electricity generated from the Project and EF_y is the emission factor.

$$BE_y = EG_y \text{ (MWh)} * EF_y \text{ (tCO}_2\text{/MWh) = VERs per year}$$

Country data sourced from AMM (unless otherwise stated) are provided in Annex 2 - Detailed Calculation of the Baseline Project Emissions.

E.1.1 Domestic emissions reduction factor:

The baseline is the kWh produced by the renewable generating unit multiplied by an emission coefficient (measured in tCO_2e/MWh) calculated in a transparent and conservative manner as the average of the 'approximate operating margin' and the 'build margin', where:

a. The 'approximate operating margin' (EF_OM_y) is the weighted average emissions (in tCO_2/MWh) of all generating sources serving the system, excluding hydro, geothermal, wind, low-cost biomass, nuclear and solar generation; and,

b. The 'build margin' (EF_BM_y) is the weighted average emissions (in tCO_2/MWh) of recent capacity additions to the system. The sample group consists of either the five power plants that have been most recently built, or the power plant capacity additions in the electricity system that comprise 20% of the system generation (in MWh).

E.1.1.1 Operating margin emission factor:

The Operating Margin emission factor (EF_OM_y) is calculated using the following equation:

$$EF\_OM_y (tCO_2 / MWh) = \frac{\sum_{i,j} F_{i,j,y} * COEF_{i,j}}{\sum_j GEN_{j,y}}$$

Where:

$F_{i,j,y}$ is the amount of fuel i (in GJ) consumed by power source j in year y;

j is the set of plant delivering electricity to the grid, not including low-cost or must-run plants and carbon financed plants;

$COEF_{i,j}$ is the carbon coefficient of fuel i (tCO_2/GJ);

$GEN_{j,y}$ is the electricity (MWh) delivered to the grid by source j.

For the Project EF_OM_y = 0.867 tCO_2/MWh.

E.1.1.2 Build margin emission factor:

The Build Margin emission factor (EF_BM_y) is the weighted average emission factor of a sample of power plants m. The equation for the build margin emission factor is:

$$EF\_BM_y(tCO_2/MWh) = \frac{[\sum_{i,m} F_{i,m,y} * COEF_{i,m}]}{[\sum_m GEN_{m.y}]}$$

Where:

$F_{i.m,y}$, $COEF_{i,m}$ and GEN_m are analogous to the OM calculation above.

For the Project EF_BM_y = 0.735 tCO_2/MWh.

E.1.1.3 Domestic emissions reduction factor calculation:

In this case, a weighting of ½ is adopted for both margin values.

Domestic EF_y = $0.50*EF\_OM_y + 0.50*EF\_BM_y$

For the Project the domestic emission factor is:

Domestic EF_y = 0.50*0.867 tCO_2/MWh + 0.50*0.735 tCO_2/MWh

= 0.801 tCO_2/MWh

E.1.2 Emissions reduction factor:

The domestic value is adjusted to account for imported and exported electricity to reach a final EF_y.

The adjustment is given by the following equation:

$$EF = EF + \frac{EL^{in}}{TGEN} * EF^{in} - \frac{EL^{out}}{TGEN} * EF^{out}$$

Where:

EL^{in} is imported energy

EL^{out} is exported energy

TGEN is total grid generation

EF emissions factor

The impact of the unknown import emissions factor (EF^{in}) is established using the range 0.001-0.999. The midpoint of the result range is then taken as the value.

EF_y = 0.700 tCO_2/MWh

E.2 Total emission reduction:

The **total emission reduction** ER_y of the project activity during any given year *y* is the difference between the baseline emissions (BE_y in tCO_2) and leakage:

$ER_y = BE_y$ – Leakage

For the Poza Verde project, leakage is expected to be zero.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Annex 2

DETAILED CALCULATION OF THE BASELINE PROJECT EMISSIONS

The emissions factor for the relevant period was calculated by Campbell Carr in 2006 and reviewed by The Green Certificate Company.

Operating Margin

Table 1 shows the operating plant on Guatemala's grid for 2000 that are used to calculate the operating margin.

Name	Technology	Fuel Type	Capacity (MW)	Generation (GWh)
La Esperanza	IC Motor	HFO	126	249.30
Genor	IC Motor	HFO	42.4	232.27
Las Palmas	IC Motor	HFO	66.8	478.09
Lagotex	IC Motor	HFO	20	25.46
Sidegua	IC Motor	HFO	44	130.25
Generadora Progreso	IC Motor	HFO	22	33.00
Puerto Quetzal Power	IC Motor	HFO	114	542.79
Escuintla Vapor 2	Steam Turbine	HFO	53	0.10*
Laguna Vapor 3	Steam Turbine	HFO	13	0§
Pantaleon	Cogen	HFO	38.5	2.49
Santa Ana	Cogen	HFO	33.8	9.33
La Union	Cogen	HFO	29.5	1.48
Concepcion	Cogen	HFO	27.5	28.0
Madre Tierra	Cogen	HFO	19	1.0
Magdalena	Cogen	HFO	15.4	3.4
Tampa	Gas Turbine	Diesel	80	99.57
Stewart & Stevenson	Gas Turbine	Diesel	51	41.57
Laguna Gas 1	Gas Turbine	Diesel	11	2.40
Laguna Gas 2	Gas Turbine	Diesel	23	#
Laguna Gas 4	Gas Turbine	Diesel	33	#
Escuintla Gas 2	Gas Turbine	Diesel	23	0*
Escuintla Gas 3	Gas Turbine	Diesel	25	20*
Escuintla Gas 4	Gas Turbine	Diesel	n/a	0*
Escuintla Gas 5	Gas Turbine	Diesel	15 (41)	10*
San José	Steam Turbine	Coal	142	558.42

* Campbell Carr estimate based on available data for 2001 and 2003

included within Stewart & Stevenson value

§ included within Las Palmas

This can be summarised by fuel type to:

Fuel Type	Generation (GWh)	Efficiency %	Consumption (TJ/year)	Carbon (tC/TJ)	Emissions (tCO_2/year)
HFO	1736.98	33	18948.85	21.1	1466010
Diesel	173.54	35	1784.98	20.2	132208
Coal	558.42	35	5743.75	25.8	543359
Total	2468.94				2141576

$$EF\_OM_y(tCO_2/MWh) = \frac{\sum_{i,j} F_{i,j,y} * COEF_{i,j}}{\sum_j GEN_{j.y}}$$

Operating Margin (EF_OM_y) = 2468938/2141576

= 0.867 tCO_2/MWh

Build Margin

The build margin is derived from the five most recently commissioned plant or 20% of generation capacity. The 20% criterion is used here, but the margin difference is minor.

Plant	Fuel Type	Commissioning	Generation (GWh)	Emissions (tCO_2/year)
San José	Coal	January 2000	558.42	543359
Genor	HFO	October 1998	232.27	196036
Las Palmas	HFO	September 1998	478.09	403508
Zunil	Geothermal	August 1998	*190.00	0
Secacao	Hydro	July 1998	*101.00	0
Lagotex	HFO	1996	25.46	21488
		Total	1585.24	1164391

* Campbell Carr estimate based on available data for 2001

$$EF\_BM_y(tCO_2/MWh) = \frac{[\sum_{i,m} F_{i,m,y} * COEF_{i,m}]}{[\sum_m GEN_{m.y}]}$$

Build Margin (EF_BM_y) = 1164391/1585240

= 0.735 tCO_2/MWh

Combined Margin (EF_y) = ½ x (Operating Margin + Build Margin)

= ½ x (0.867+0.735)

= 0.801 tCO_2/MWh

Import/Export Adjustment

The adjustment is given by the following equation:

$$EF = EF + \frac{EL^{in}}{TGEN} xEF^{in} - \frac{EL^{out}}{TGEN} xEF^{out}$$

where:

EL^{in} is imported energy

EL^{out} is exported energy

TGEN is total grid generation

EF emissions factor

Input data	Value	Unit
Combined Margin	0.801	tCO_2/MWh
EL in	122.95	GWh
EF in	Unknown	
TGEN	6070.23	GWh
EL out	840.87	GWh
EF out	0.801	tCO_2/MWh

The impact of the unknown import emissions factor is established using the range 0.001-0.999 giving:

	Adjusted Margin	Unit
Using a low EF^{in} (0.001)	0.690	tCO_2/MWh
Using a high EF^{in} (0.999)	0.710	tCO_2/MWh
Difference	0.020	tCO_2/MWh

Using a midpoint from the difference gives an adjusted emission factor of the grid (EF_y) for Poza Verde of 0.700 tCO_2/MWh.