CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-SSC-PDD)
Version 03 - in effect as of: 22 December 2006

CONTENTS

Annexes

Revision history of this document

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

SECTION A. General description of small-scale project activity

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

La Cascada 2.3 MW Hydroelectric Project

Version 05, completed on 01/10/2007

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

La Cascada is a run of river renewable small hydroelectric generating plant, with a capacity of 2.3 MW of energy generation that will be located in San Roque Jurisdiction, Antioquia Department, Colombia Republic utilizing water from the Guacas River.

The project activity contemplates the production of clean hydroelectric power that will be supplied to the national interconnection grid. The project will help to reduce Colombian CO_2 emissions from petroleum and carbon consumption for electricity generation, which would have occurred otherwise in the absence of the project activity.

The project will have a total head of 100 m and a design flow rate of 3.0 m^3/s. The hydroelectric power station will have a power house with a horizontal axis Francis type turbine connected to a generator with capacity to generate up to 2.57 MVA at 4.16 kV. The substation, used to connect the power plant to the national grid, will have a power transformer of 2.6 MVA (4.16 KV/44kV), a connection module and 44 kV transmission line of approximately 560 m long. The diversion will be done by wall dam on the main stream. A lateral intake over the left bank will take the water to be turbinated. After this, an open water channel of about 80 m long, will conduct the water to the compensation tank. A sand trap will be used in order to retain sand grains over 1 mm. After moving through the compensation tank, water will move through the pressure conduit, a 58 m initial concrete box culvert, at low pressure, which will be connected to a 307 m penstock, leading to the power house. The power house will sit on the left bank of the Guacas stream and will be safe from flooding as it will be located about 150 m from the stream channel and it will be above the inundation levels of the stream. The discharge will be conducted to the stream by a stone lined open channel. A dissipation structure to return the water to the stream channel will be constructed as well.

La Cascada Hydroelectric Project will produce clean electricity to be placed into the Colombian National Interconnected Grid System following local existing electricity market regulations and required environmental and operational permits. The project is consistent with the Sustainable Development Criteria established by the Colombian DNA. Local host country sustainable development criteria include:

Compliance with local law and relevant norms

The project has all the required licenses, permits, concessions, and authorizations granted by the regional environmental authority (Corporación Autonoma Regional Rionegro-Nare, CORNARE). An environmental license was not required because the project is less than 10 MW. The Concession for Water Use, which is necessary for the plant to generate electricity, has been obtained and the final permit needed to proceed has been granted.

Coherence and contribution to government policies

La Cascada Hydroelectric Plant, a small-scale hydroelectric facility, complies with the framework of the energy sector policies of Colombia in aspects related to renewable energy electricity generation and technological innovation. The project is also consistent with the objectives established by the national government for participation in the CDM as a small-scale energy generation project based on renewable energy.

Contribution to the economic and social welfare of communities in the long run

La Cascada Hydroelectric Plant will provide job opportunities for skilled and non-skilled labor during the construction phase of the project, which spans over 7 months. An average of 15 construction labourers will be maintained (and will require more than 30 labourers during high construction periods). Most of the labor will be from nearby communities. Additionally, the operation of the project will create long-term employment for 1 chief engineer, 3 operating technicians, 2 security guards, and supporting office and clerical personnel.

A.3. Project participants:

Table 1: Project participants

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Colombia (host)	Prestadora de Servicios Públicos La Cascada S.A. E.S.P. (private)	No
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party (ies) involved is required.		
Note: When the PDD is filled in support of a proposed new methodology at least the host Party(ies) and any known project participant (e.g. those proposing a new methodology) shall be identified.		

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

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

A.4.1.1. Host Party(ies):

Colombia Republic

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

Antioquia Department

A.4.1.3. City/Town/Community etc:

San Roque Town, Community of Providencia

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

As mentioned above, the project activity will take advantage of the Guacas River. The river basin of the Guacas stream is located in the northeast of Antioquia Department, on the eastern slope of the central mountain range covering the territory of San Roque Jurisdiction; with a utility area of 63 km² before its opening to the Nus River (Figure 1).
The project geographical localization is 6°30'37.5" N and 74° 55'3.2" W at 700 m of the small town Providencia. The other nearest towns are San José del Nus at 15 km, Cisneros at 22 km and San Roque at 22 km.

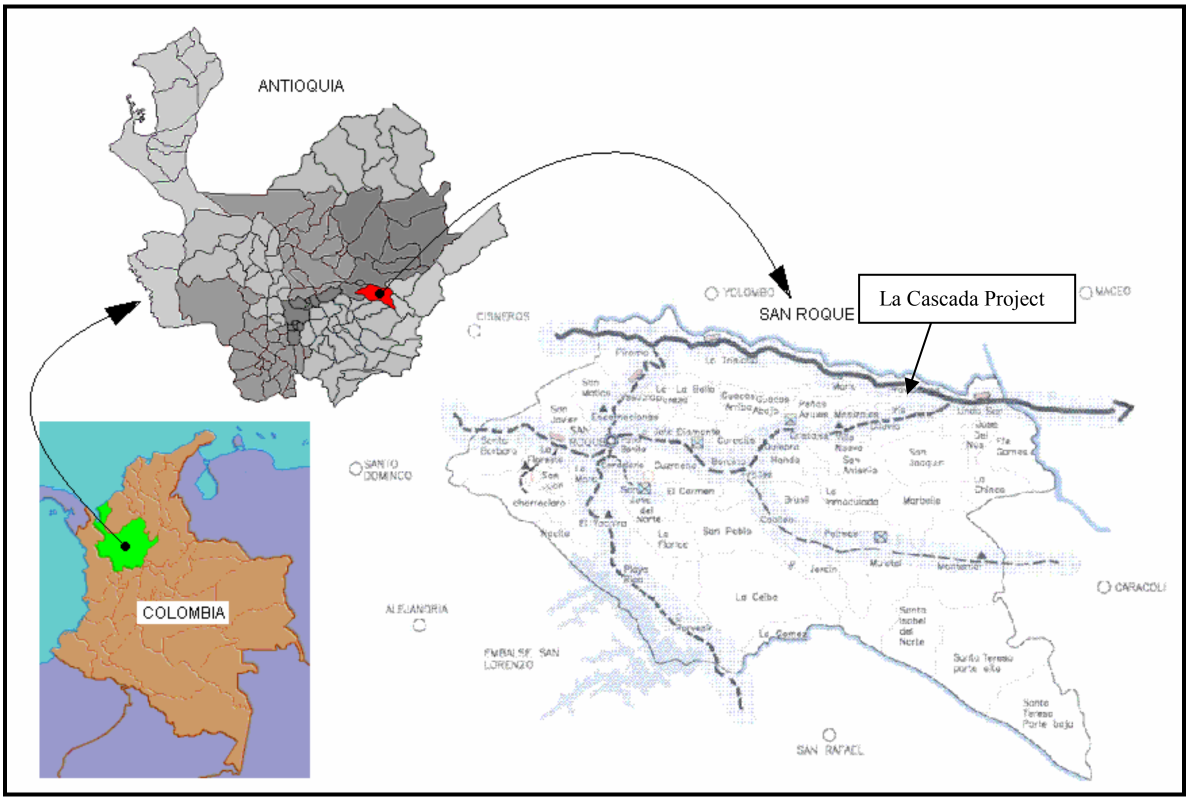

Figure 1: Project location

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

According to the list of the small-scale CDM project activity categories contained in Appendix B of the Simplified M&P for the Small-Scale CDM Project Activities, La Cascada Hydroelectric Plant corresponds to:

Type I: Renewable Energy Projects
Category D: Electricity Generation for a System

La Cascada Hydroelectric Plant relies on commercial, environmentally safe, and sounds technological packages as well as the required know-how for implementation, transferred to the host party through the appropriate commercial guarantees and support service packages established for the implementation of the project activity, and which are standard in hydro power development.

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

Table 2: Estimated emission reductions through the 10-year crediting period

Years	Estimation of annual emission reductions in tonnes of CO_2e
2008	5,139
2009	5,139
2010	5,139
2011	5,139
2012	5,139
2013	5,139
2014	5,139
2015	5,139
2016	5,139
2017	5,139
Total estimated reductions (tonnes of CO_2e)	**51,390**
Total number of crediting years	**10**
Annual average of the estimated reductions over the crediting period (tCO_2e)	**5,139**

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

No public funding has been involved in financing this project activity.

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

In accordance with Appendix C of the Simplified M&P for the Small-Scale CDM Project Activities, La Cascada Hydroelectric Plant is not a de-bundled component of a larger CDM project activity. The project activity is an independent hydro power plant generating electricity and supplying the grid. It is unrelated to any other CDM project activity in the region existing or planned. The project proponent has not registered another small-scale CDM project activity or applied to register another small-scale CDM project activity:

- in the same project category;

- registered within the previous 2 years; or
- whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point.

SECTION B. Application of a baseline and monitoring methodology

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

As mentioned above, according to the list of the small-scale CDM project activity categories contained in Appendix B of the Simplified M&P for the Small-Scale CDM Project Activities, La Cascada Hydroelectric Plant corresponds to:

Type I: Renewable Energy Projects
Category D: Electricity Generation for a System

Thus, the methodology used in this project activity is AMS-I.D: Grid Connected Renewable Electricity Generation (Version 10).

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

La Cascada Hydroelectric Plant qualifies under this project category since:

- The project activity is a run of river hydroelectric power plant.
- The project activity supplies electricity to the Colombian National Interconnected Grid System that is or would have been supplied by at least one fossil fuel fired generating unit, as stated in AMS I.D.

La Cascada Hydroelectric Plant has a plate power capacity of 2.3 MW, which is lower than 15 MW, and thus, the project activity qualifies as a small-scale project activity and will remain under the limits of small-scale project activity during every year of the crediting period.

B.3. Description of the project boundary:

The project boundary encompasses the physical, geographical site of the hydropower generation source. However, for calculation of the grid emission factor, all power sources connected to the National Interconnected Grid are also included in the spatial extent of the project boundary.

B.4. Description of baseline and its development:

According to the project category and corresponding methodology, the baseline is the energy produced by the renewable generating unit (MWh) multiplied by an emission coefficient (tCO_2e/MWh) calculated in a transparent and conservative manner as:

a) A combined margin (CM) emission factor, consisting of the combination of operating margin (OM) and build margin (BM) emission factors according to the procedures prescribed in the approved methodology ACM0002. Any of the four procedures to calculate the operating margin can be chosen, but the restrictions to use the Simple OM and the Average OM calculations must be considered, or

b) The weighted average emissions (in tCO_2e/MWh) of the current generation mix. The data of the year in which project generation occurs must be used.

For this project activity, the first option (option a) is selected due to the consideration of both an operating margin and a build margin is more representative of the trends of market/regulatory behaviour in Colombia (that affect dispatch over time), as well as investment signals, that result in the installation of capacity additions in highly dynamic operations of wholesale electricity markets.

ACM0002 indicates that the emission factor of the grid is determined by the following three steps:

1. Calculate the operating margin emission factor
2. Calculate the build margin emission factor
3. Calculate the combined margin emission factor by working out the weighted average of the operating margin emission factor and the build margin emission factor

Step 1. Calculate the operating margin emission factor (EF_{OM})
The operating margin refers to actual generation mix of the national grid.

Four different procedures are suggested by the methodology for determining the operating margin emission factor. These are:

(a) Simple Operating Margin
(b) Simple Adjusted Operating Margin
(c) Dispatch Data Analysis Operating Margin
(d) Average Operating Margin.

For this project activity, the Simple Adjusted Operating Margin method (b) has been selected from the four options proposed in the methodology since the low-cost/must-run resources constitute more than 50% of total grid generation.

According to the methodology, the simple adjusted operating margin emission factor can be calculated using one of the following data vintages:

- The full generation-weighted average for the most recent 3 years for which data are available at the time of PDD submission (*ex-ante*).
- The year in which project generation occurs, if the operating margin emission factor is updated based on data monitored (*ex-post*).

In this particular case, the *ex-post* vintage is selected among the two options proposed by the methodology.

Step 2. Calculate the build margin emission factor (EF_{BM})
According to the methodology, the build margin emission factor can be calculated using one of the following options:

- Option 1: calculation *ex-ante* based on the most recent information available on plants already built for sample group *m* at the time of PDD submission.

- Option 2: for the first crediting period, *ex-post* annual update for the year in which actual project generation and associated emission reductions occur, and for the subsequent crediting periods, calculation *ex-ante* as described in Option 1.

In this particular case, Option 2 is selected among the two options proposed by the methodology.

Step 3. Calculate the combined margin emission factor (EF_{grid})
The baseline emission factor is calculated as the weighted average of operating margin emission factor and the build margin emission factor.

In this case, for weighting these two factors, the default value of 50% will be considered for both the operating margin and the build margin emission factors.

Thus, according to the methodology, the key data used to determine *ex-post* the baseline scenario is given in the following table.

Table 3: Key data

Data	Source
Electricity generation	Prestadora de Servicios Públicos La Cascada S.A. E.S.P.
Combined margin emission factor	Calculated according to the methodology ACM0002

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered small-scale CDM project activity:

In accordance with Attachment A of Appendix B of the Simplified M&P for the Small-Scale CDM Project Activities, a barrier analysis is carried out in order to demonstrate project additionallity.

Sectoral circumstances

In Latin America, renewable energy projects, especially hydro projects, normally face long lead times and multiple uncertainties and barriers from the inception of pre-feasibility studies through the development of technical final specifications, securing of permits (both operational and environmental), often extending the length of time required for the project developer to reach financial closure before construction and implementation can take place. During the multi-year periods of pre-investment activity, different types of initial assumptions used in assessing a project (electricity market price trends, demand and supply behaviour, regulatory context, etc.) are prone to suffer changes. Therefore, project developers have to continuously adjust their project evaluation models for the purpose of determining the economic/financial viability of their projects as initial assumptions undergo changes.

As a result, most projects that initiate this cycle do not survive and are not implemented. The reality of hydro project development indicates that from initial concept to financial execution cycles, many hydro developers are not able to sustain their activity, therefore resulting in a low percentage of completion of investment cycles associated to hydro development due to rapidly changing electricity sector conditions in most of the Latin American countries.

La Cascada Hydroelectric Plant has not been exempted from such a dynamic framework of occurrences during its project development cycle, which has been typical of renewable energy projects in developing countries. Several changes in the sector as well as changes to the tax laws have already affected the financial outlook during the development stage of the project. For example, the recent adoption of the fiscal reform of 2007 eliminated inflation accounting, which provided a tax shield for the project in later years since the equity portion of the balance sheet was adjusted for inflation. Previously, this tax treatment created a non-operating expense, which offset the operating income of the project, thereby improving the IRR. Additionally, there are now uncertainties regarding the exemption of import taxes for clean energy projects that export carbon emission reductions as a result of the fiscal reform of 2007. The project will now have to bear these expenses and seek a refund of the taxes, which is not assured.

Technological barriers

- Due to the climatologic/meteorological cycles that influence the hydrological conditions encountered in the country, water availability can be a problem for the required hydraulic flows to the new plant turbine. This variation can reduce the expected water flow rate to the turbine and the amount of electricity generation that this water flow would produce, reducing the supplying capacity of the hydroelectric plant. Less risk is taken with thermal units that lead to higher GHG emissions.
- From a technical point of view, the project has required a significant learning effort for Prestadora de Servicios Públicos La Cascada S.A. E.S.P. This project is its first venture into hydro electricity generation. Moreover, project participants do not have any experience in the energy sector.
  Even though the project adopts a well-known technology, which has been implemented around the world, due to the lack of experience in the generation sector, from operation and maintenance to accommodation to different local/national regulations, and the lack of skilled or properly trained labour to operate and maintain the technology, the project participants foresees that it may incur additional costs.

Investment barriers

- As is widely known, small-scale hydroelectric projects are not least-cost options for grid electricity production in terms of capex per Megawatt of capacity, especially in reformed wholesale markets such as the one established in Colombia in the late 1990s.
  Additionally, taking into account the characteristics of the reformed electricity market in Colombia, which drives dispatch towards the lowest cost producers (and the relative composition of current electricity generation characterized by the mix in operation, investment trends, and overall utilization factor of the available and predicted plants to come on line in the future), if the project were not implemented, the energy that had been generated from La Cascada would have been produced with current or added power plants connected to the grid, mostly thermal plants, which would have lead to an increase of GHG emissions in Colombia. This would have been the most probable scenario without the proposed project activity, especially given recent regulations, which provide incentives to thermal operators, who can provide reliable capacity to the energy system in order to reduce the country's high dependence upon hydro generation, decreasing periodic energy supply problems due to shortages of water availability as a result of weather cycles. These regulations that incentive thermal investment, are discouraging investment in hydroelectric generation.

This project is not and has never been part of the national electricity expansion plan and has not been part of the baseline scenario of energy sector planning in Colombia.

- Primary factors influencing the project's financial viability were the expected sale price of electricity and availability of hydraulic flows to the new plant turbine. These estimates were based on the assumptions related to the expected electricity price used to incorporate the revenue from electricity sales into the financial analysis. They were based on the expected behaviour of electricity prices in the Colombian Electricity Market before major electricity sector reforms took place. In addition, the Internal Rate of Return (IRR) evaluation was linked to the projected electricity generation from the proposed project, which in turn was directly related to the expected water flow rate to the turbine and the amount of electricity generation that this water flow would produce.
  Small projects such as La Cascada hydropower plant face significant barriers to obtain funding for their implementation. Lenders generally are seeking larger projects and more experienced shareholders and project developers in the hydro sector. Since this is the first project to be developed by Empresa de Servicios Públicos La Cascada S.A. E.S.P., lenders may be willing to take risk only after a time in operation. Because of that, the project capital structure was 100% equity financed leading to an IRR of 13 %, which was much lower than the one that would have been, had project participants been able to leverage the project through typical project finance terms (70% debt). However, with the inclusion of CER, the IRR improved to 14%. Although project participants require a rate of return for unleveraged projects of 15%, the inclusion of the CDM benefits brought them close enough to this threshold to move forward on the project.
  The improvement from the CER to the operating cash flows over time was also seen as essential to provide some cushion to any unforeseen costs or risks involved in the operation of the project during the first ten years (where lack of experience could cause a reduction in the estimated return on investment).

The project developer also took into account the local and global environmental benefits of the clean energy project and the learning-by-doing in the areas of energy generation and in the application of the CDM. The possibility of applying CDM was promoted by the Ministry of the Environment as an alternative to address the financial barriers to implementation, and to assist in addressing the plant annual operating costs.

Taking into account national circumstances of the prices and dispatch of electricity in Colombia, in the absence of La Cascada Hydroelectric Plant, the associated electricity generation that would not be generated through a renewable project such as the proposed project activity would indeed be generated by an increased usage factor of the operation of grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin calculations. La Cascada Hydroelectric Plant is now expected to generate around 14.35 GWh per year, which represents around 0.03 % of total current electricity generation in Colombia. In the absence of this proposed small-scale renewable energy project, the viable alternative would be for the Colombian Grid to generate the equivalent of the electricity generated by La Cascada mostly with thermal generation plants, which would generate more greenhouse gas emissions.

Thus, the proposed project activity is additional.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

According to the project category and the corresponding methodology, project emissions are zero and leakage is to be considered only when the energy generating equipment is transferred from another activity. This is not the case of La Cascada Hydroelectric Plant. The energy conversion equipment for the project was manufactured new for specific site conditions. Therefore, there is no leakage associated to the project activity.

Then, emission reductions obtained during the year y (ER_y, in tCO_2e/year) are equal to baseline emissions calculated by multiplying the combined margin emission factor ($EF_{grid\ y}$, in tCO_2e/MWh) by the electricity generated by the proposed project activity during the year y (EG_y, in MWh), as follows:

$$ER_y = EG_y \times EF_{grid;y} \qquad (1)$$

The combined margin (CM) emission factor consists of the combination of operating margin (OM) and build margin (BM) emission factors according to the procedures prescribed in the approved methodology ACM0002.

ACM0002 indicates that the emission factor of the grid is determined by the following three steps:

1. Calculate the operating margin emission factor
2. Calculate the build margin emission factor
3. Calculate the combined margin emission factor by working out the weighted average of the operating margin emission factor and the build margin emission factor

Step 1. Calculate the operating margin emission factor (EF_{OM})

As mentioned above, in order to determine the combined margin emission factor, the Simple Adjusted Operating Margin method has been selected from the four options proposed in the methodology since the low-cost/must-run resources constitute more than 50% of total grid generation.

The simple adjusted operating margin emission factor (tCO_2e/MWh) is a variation of the simple operating margin emission factor[1], where the power sources (including imports) are separated in low-cost/must-run power sources (k) and other power sources (j), as follows:

$$EF_{OM} = (1-\lambda)\frac{\sum_{i,j} F_{i,j} \times COEF_i}{\sum_j GEN_j} + \lambda \frac{\sum_{i,k} F_{i,k} \times COEF_i}{\sum_k GEN_k} \qquad (2)$$

[1] The simple operating margin emission factor is calculated as the generation-weighted average emissions per electricity unit (tCO_2e/MWh) of all generating sources serving the system, not including low-operating cost and must-run power plants.

Where

λ	Lambda factor: fraction of time during low-cost/must-run sources are on the margin
$F_{i,j}/F_{i,k}$	Amount of fuel *i* consumed by relevant power sources *j*/*k* (in energy unit)
GEN_j/GEN_k	Electricity delivered to the grid by power sources *j*/*k* (MWh)
$COEF_i$	CO_2 emission coefficient for fuel *i* (tCO_2e/energy unit)

The CO_2 emission coefficient $COEF_i$ is obtained as follows:

$$COEF_i = CEF_i \times OXID_i \qquad (3)$$

Where

CEF_i	CO_2 emission factor per unit of energy of the fuel *i* (tCO_2e/energy unit)
$OXID_i$	Oxidation factor of fuel *i* (%)

On the other hand, the lambda factor (λ) is the determined as:

$$\lambda = \frac{number\ of\ hours\ per\ year\ for\ which\ low-\cos t/must-run\ sources\ are\ on\ m\arg in}{8{,}760\ hours\ per\ year} \qquad (4)$$

According to the methodology, the number of hours during low-cost/must-run sources are on the margin is obtained through the following procedure (see Figure 2 below):

Step i) Plot a Load Duration Curve

Collect chronological load data (typically in MW) for each hour of a year, and sort load data from highest to lowest MW level. Plot MW against 8,760 hours in the year, in descending order.

Step ii) Organize Data by Generating Sources

Collect data for, and calculate total annual generation (in MWh) from low-cost/must-run resources.

Step iii) Fill Load Duration Curve

Plot a horizontal line across load duration curve such that the area under the curve (MW times hours) equals the total generation (in MWh) from low-cost/must-run resources.

Step iv) Determine the "Number of hours per year for which low-cost/must-run sources are on the margin"

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 8,760 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. Lambda is the calculated number of hours divided by 8,760.

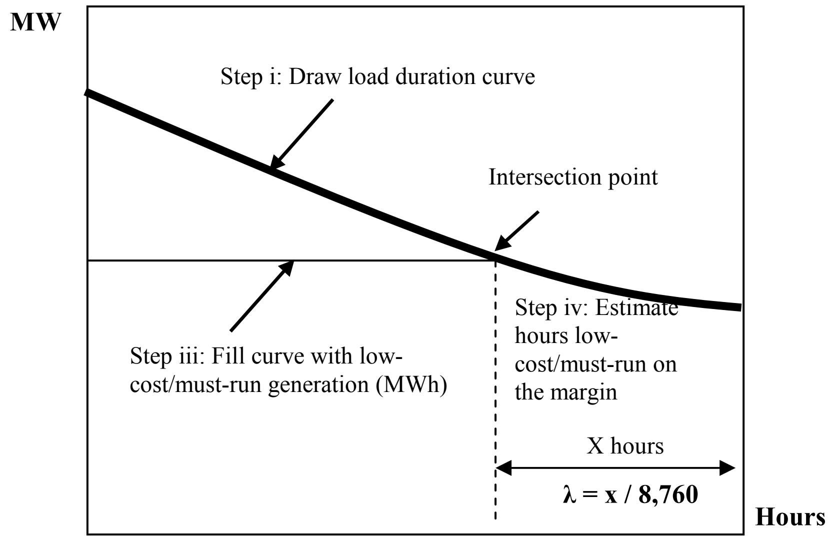

Figure 2: Illustration of lambda calculation for simple adjusted operating margin emission factor

Step 2. Calculate the build margin emission factor (*EF_{BM}*)
The build margin emission factor of each crediting period is calculated as follows:

$$EF_{BM} = \frac{\sum_{i,m} F_{i,m} \times COEF_i}{\sum_m GEN_m} \tag{5}$$

Where $F_{i,m}$, $COEF_i$ and GEN_m are analogous to the variables described above for the operating margin emission factor determination.

The sample group *m* consists of either:

- The five power plants that have been built most recently, or
- The power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

According to the methodology, from these two options, the sample group that comprises the larger annual generation should be used.

Step 3. Calculate the combined margin emission factor (*EF_{grid}*)
The baseline emission factor is calculated as the weighted average of operating margin emission factor and the build margin emission factor. For weighting these two factors applying the default value of 50% for both, the operating margin and the build margin emission factors, the combined margin emission factor is obtained as follows:

$$EF_{grid} = \frac{(EF_{OM} + EF_{BM})}{2} \qquad (6)$$

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

Table 4: Data available at validation

Data / Parameter:	***EF_{grid}***
Data unit:	tCO_2e/MWh
Description:	Grid emission factor
Source of data used:	XM Compañía de Expertos en Mercados S.A. E.S.P. [2] "Unidad de Planeación Minero Energética" (UPME) of the Ministry of Mines and Energy
Value applied:	0.3581
Justification of the choice of data or description of measurement methods and procedures actually applied:	The grid emission factor is determined *ex-ante*, according to the methodology ACM0002, using reliable local data provided by UPME and XM,
Any comment:	This value is used to calculate ex-ante baseline emissions. This emission factor will be yearly updated to calculate ex-post baseline emissions.

Data / Parameter:	***CEF_i***
Data unit:	tCO_2e/energy unit
Description:	Carbon dioxide emission factor per unit of energy of fuel *i*
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	Natural Gas: 56.10 t CO_2/TJ Bituminous coal: 94.6 tCO_2/TJ
Justification of the choice of data or description of measurement methods and procedures actually applied:	According to the methodology ACM0002, if local values are not available, country-specific values are preferable to IPCC world-wide default values. In this case, there is not a reliable local/national factor, thus, the IPCC default values are considered.
Any comment:	This value is used to calculate the operating and build margin emission factors.

Data / Parameter:	***$OXID_i$***
Data unit:	-
Description:	Oxidation factor of fuel *i*

[2] XM Compañía de Expertos en Mercados S.A. E.S.P. is private company that compiles official data of the Colombian energy sector.

Source of data used:	IPCC 1996 Guidelines for National Greenhouse Gas Inventories
Value applied:	Natural Gas: 0.995 Bituminous coal: 0.98
Justification of the choice of data or description of measurement methods and procedures actually applied:	The methodology states that the oxidation factor of a fuel should be taken from the IPCC 1996 guidelines.
Any comment:	This value is used to calculate operating and build margin emission factors.

B.6.3 Ex-ante calculation of emission reductions:

As mentioned above, since project emissions and leakage emissions are zero, emission reductions are the same as baseline emissions, as follows:

$$ER_y = EG_y \times EF_{grid;y}$$

La Cascada Hydroelectric Power plant is expected to generate around 14,350 MWh per year. This estimation was based on the daily average water flows, efficiency of equipments supplied by the manufacturer, and the typical availability for run of river plants. The daily average water flows were estimated from water flows of Caramanta plant, located downstream from the intake. This plant has a 28 years data series.

As mentioned above, the emission factor of the grid is determined using the methodology ACM0002/Version06 as a combined margin emission factor, consisting of the combination of the operating margin and the build margin factors.

As is shown in Annex 3 below, the operating margin emission factor results to be 0.4446 tCO_2/MWh and the build margin emission factor 0.2715 tCO_2/MWh. Thus, the resulting grid emission factor is:

$$EF_{CM} = \frac{(EF_{OM} + EF_{BM})}{2} = \frac{(0.4446 + 0.2715)}{2} = \mathbf{0.3581\ tCO_2/MWh}$$

Thus, the annual emission reductions result to be:

$$ER_y = 14{,}350 \text{ MWh/year} \times 0.3581 \text{ tCO}_2\text{/MWh} = \mathbf{5{,}139\ tCO_2/year}$$

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

Table 5: *Ex-ante* estimation of emission reductions (tCO_2e)

Year	Estimation of project activity emissions (tCO_2e)	Estimation of baseline emissions (tCO_2e)	Estimation of leakage (tCO_2e)	Estimation of overall emission reductions (tCO_2e)
2008	0	5,139	0	5,139
2009	0	5,139	0	5,139
2010	0	5,139	0	5,139
2011	0	5,139	0	5,139
2012	0	5,139	0	5,139
2013	0	5,139	0	5,139
2014	0	5,139	0	5,139
2015	0	5,139	0	5,139
2016	0	5,139	0	5,139
2017	0	5,139	0	5,139
Total (tonnes of CO_2e)	**0**	**51,390**	**0**	**51,390**

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

B.7.1 Data and parameters monitored:

Table 6: Data to be monitored

Data / Parameter:	***$EG_{;y}$***
Data unit:	MWh
Description:	Electricity generated by the renewable technology in the year *y*
Source of data to be used:	Prestadora de Servicios Públicos La Cascada S.A. E.S.P
Value of data	14,350
Description of measurement methods and procedures to be applied:	Data measured continuously, daily checked and registered electronically.
QA/QC procedures to be applied:	Production records will be crosschecked with sales records to the grid.
Any comment:	

Data / Parameter:	***$GEN_{j;y}$***
Data unit:	MWh
Description:	Electricity generated in Colombia by no LC/MR power plants *j* in the year *y*
Source of data to be used:	XM Compañía de Expertos en Mercados S.A. E.S.P.
Value of data	See spreadsheet with EF calculation
Description of measurement methods and procedures to be applied:	
QA/QC procedures to be applied:	Official data
Any comment:	Data used for operating margin EF calculation

Data / Parameter:	***$GEN_{k;y}$***
Data unit:	MWh
Description:	Electricity generated in Colombia by LC/MR power plants *k* in the year *y*
Source of data to be used:	XM Compañía de Expertos en Mercados S.A. E.S.P.
Value of data	See spreadsheet with EF calculation
Description of measurement methods and procedures to be	

applied:	
QA/QC procedures to be applied:	Official data
Any comment:	Data used for operating margin EF calculation

Data / Parameter:	***F** $_{i;j;y}$*
Data unit:	Energy unit
Description:	Fuel *i* consumed in energy unit by no LC/MR power plants *j*
Source of data to be used:	XM Compañía de Expertos en Mercados S.A. E.S.P. "Unidad de Planeación Minero Energética" (UPME) of the Ministry of Mines and Energy
Value of data	See spreadsheet with EF calculation
Description of measurement methods and procedures to be applied:	This value is obtained from heat rates (energy unit/MWh) of each power plant provided by XM multiplied by the electricity generation of the power plant (MWh). When heat rates are not available, power plant emission factor (tCO_2/MWh), provided by UPME, are used to calculate direct emissions from the power plant.
QA/QC procedures to be applied:	Official data
Any comment:	Data used for operating margin EF calculation

Data / Parameter:	***F** $_{i;k;y}$*
Data unit:	Energy unit
Description:	Fuel *i* consumed in energy unit by LC/MR power plants *k*
Source of data to be used:	XM Compañía de Expertos en Mercados S.A. E.S.P. "Unidad de Planeación Minero Energética" (UPME) of the Ministry of Mines and Energy
Value of data	See spreadsheet with EF calculation
Description of measurement methods and procedures to be applied:	This value is obtained from heat rates (energy unit/MWh) of each power plant provided by XM multiplied by the electricity generation of the power plant (MWh). When heat rates are not available, power plant emission factor (tCO_2/MWh), provided by UPME, are used to calculate direct emissions from the power plant.
QA/QC procedures to be applied:	Official data
Any comment:	Data used for operating margin EF calculation

Data / Parameter:	*Load Duration Curve*
Data unit:	MW vs. hs
Description:	Chronological load data for each hour of a year
Source of data to be used:	XM Compañía de Expertos en Mercados S.A. E.S.P.

Value of data	See spreadsheet with EF calculation
Description of measurement methods and procedures to be applied:	
QA/QC procedures to be applied:	Official data
Any comment:	Data used for operating margin EF calculation

Data / Parameter:	***$GEN_{m;y}$***
Data unit:	MWh
Description:	Electricity generated in Colombia by either the power plants comprising 20% of total generation that have been built most recently or the five power plants that have been built most recently *m* in the year *y*
Source of data to be used:	XM Compañía de Expertos en Mercados S.A. E.S.P.
Value of data	See spreadsheet with EF calculation
Description of measurement methods and procedures to be applied:	
QA/QC procedures to be applied:	Official data
Any comment:	Data used for build margin EF calculation

Data / Parameter:	***$F_{i;m;y}$***
Data unit:	Energy unit
Description:	Fuel *i* consumed in energy unit by either the power plants comprising 20% of total generation that have been built most recently or the five power plants that have been built most recently *m* in the year *y*
Source of data to be used:	XM Compañía de Expertos en Mercados S.A. E.S.P. “Unidad de Planeación Minero Energética” (UPME) of the Ministry of Mines and Energy
Value of data	See spreadsheet with EF calculation
Description of measurement methods and procedures to be applied:	This value is obtained from heat rates (energy unit/MWh) of each power plant provided by XM multiplied by the electricity generation of the power plant (MWh). When heat rates are not available, power plant emission factor (tCO_2/MWh), provided by UPME, are used to calculate direct emissions from the power plant.
QA/QC procedures to be applied:	Official data
Any comment:	Data used for build margin EF calculation

Data will be archived until two years after finishing the crediting period.

B.7.2 Description of the monitoring plan:

Energy measurement will be carried out through two energy meters manufactured by Power Measurement, reference ION 8600B (main) and ION 8600C (backup), of 0.2 accuracy, which comply with standards ANSI C12.20-1998 "American national standard for electrical meters, 0.2 and 0.5 accuracy classes for current classes 2 and 20" and IEC 60687 "Alternating current static watt-hour meters for active energy (classes 0.2 S and 0.5 S)".

Both meters will be connected to an Automatic Control System through a communication network, which allows its access for visualization of energy measures, and by modem, to the Electrical Distributing Company (Utility Company of Medellín). The internal memory in the acquired meters is able to record the history of measured values during an average period of six months. Data will be backed-up every five months in DVD and stored for verification.

Energy meters will be mounted on a self-supported panel with sealed door and cover to avoid possible connections access by non-authorized personnel.

Energy meters will be connected to current and voltage transformers with the following characteristics:

- Voltage transformer manufactured by Arteche, reference VRU-52, with measurement core class 0.2 and in agreement with Standard IEC 60044-2.
- Current transformer manufactured by Areva, reference SDF-52 with measurement core class 0.2 and in agreement with Standard IEC 60044-1.

Before their on-site installation, energy meters and instrumentation transformers will be taken to the laboratory of measures of the Public Electrical Distributing Company in Medellín, where the following tests will be carried out in order to verify and guarantee that these equipment were manufactured complying with the International Electro-technical Commission – IEC Standards:

- Calibration and programming of the energy meters.
- Accuracy verification of the current and voltage transformers measurement cores.

Once all the system is installed in site, an inspector of the measuring laboratory of the Utility Company of Medellín will verify that all the system is correctly installed and will seal the secondary terminals boxes of the instruments transformers and the energy meters panel.

The personnel in charge of the monitoring plan, calibration and maintenance are not even defined. Nevertheless, they will be properly trained people for these workings tasks.

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

Date of completion: 28/03/2007

Name of the responsible person/entity:

Diego Ezcurra, Marisa Zaragozi, and Fabián Gaioli, MGM International SRL.

Junín 1655, 1º B

C1113AAQ, Buenos Aires, Argentina

Tel./Fax: (54 11) 5219-1230/32

e-mail: dezcurra@mgminter.com

Diego Ezcurra, Marisa Zaragozi, and Fabián Gaioli are not project participants.

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

01/08/2006

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

50 years

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

C.2.1. Renewable crediting period

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

Not applicable

C.2.1.2. Length of the first crediting period:

Not applicable

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

02/01/2008

C.2.2.2. Length:

10 years

SECTION D. Environmental impacts

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

The project is minor of 10MW. In agreement with the Colombian procedure, the project does not need environmental license; therefore, it is not necessary to do a study of environmental impact (Decree 1,220 of April 2005, MAVDT).

However, it is necessary to obtain different permissions with the local environmental authorities:

- Water collecting permission.
- Riverbed occupation permission.
- Forest utilization permission.
- Waste water discharge permission.

All these permissions were preceded in CORNARE who is the environmental local authority. Nowadays the project has all the permissions required.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

To attend the impacts considered by project participants and to obtain the permissions required, a plan of environmental management was designed.

The programs of this plan are:

- Erosion control.
- Waste Management.
- Waste Water Management.
- Labourers Contracting.
- Environmental education.
- Employment health and industrial security.

The principal identified impacts, which need the plan of environmental management, are the following:

- **Wastes generation**: during the construction and operation, biodegradable and recyclable wastes, trees wastes and excavation's wastes will be generated. They were included in the plan of environmental management.
- **Forest affectation**: it is necessary to fall 27 trees, which will be replaced by other new trees that will be sown during the construction.
- **Alterations of the water quality by discharges**: during the construction and the operation, the discharges of residual water, can affect the quality of the water. A system of water treatment will be built so that the water poured has the characteristics of quality required by local norms.
- **Soil erosion**: this impact will be presented during the construction and will be attended by the measures of erosion control.

- **Community expectations**: anxieties and expectations by the construction of the project can be generated in the community. This situation will be handled with the community programs.
- **Fauna affectation**: the section affected is a waterfall where there are no fishes. Since the water is unloaded again at the foot of the waterfall, the fauna downstream itself will not be affected.
- **Landscape affectation**: the waterfall has value as natural scene. This impact is more notorious in epochs of summer. In order to obtain the permission of water collection, it was necessary to keep a permanent remnant volume so that the waterfalls remain pleasant in sight.

SECTION E. Stakeholders' comments

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

La Cascada Hydroelectric Project conducted two meetings in order to present the project activity and explain the characteristics and requirements of the CDM to all the invited stakeholders.

The first part of the stakeholder consultation intended to collect comments from local authorities. On March 23rd, Prestadora de Servicios Públicos La Cascada S.A. E.S.P. carried out the first meeting, where Dr. Foción Barrientos, mayor of San Roque, and eleven San Roque mayoralty employees were present.

The second part of the stakeholder consultation intended to collect comments from local communities. Also on March 23rd, Prestadora de Servicios Públicos La Cascada S.A. E.S.P. presented the project in the second meeting, where stakeholders from the local communities were invited through Mr Alberto Henao Barrientos, president of "Acción Comunal Corregimiento de Providencia". In this event, eighteen representatives of nearby communities participated and were documented in an attendance sheet.

The stakeholder comment process was completed through a survey, where the local stakeholders had the opportunity to express their opinions.

The following set of questions was asked to stakeholders through the survey:

1. Do you believe that the socio-economic situation of the region will improve due to the implementation of La Cascada Hydroelectric Project?
2. How does the development of the project affect you (positively or negatively) or on your environment?
3. Would you recommend private companies or authorities to develop projects of this nature?
4. Do you think La Cascada hydroelectric Project will contribute to the Sustainable Development of Colombia? (Sustainable Development is understood as "that development that satisfies the necessities with the present generations without jeopardizing the possibilities of the future generations to take care of its own necessities")
5. Any additional comments you would like to make.

Additionally, during the meetings, all comments and doubts from the stakeholders were received and clarified.

E.2. Summary of the comments received:

Local authorities expressed their interest and support to the project.

The comments received from representatives of the local communities are summarized in the following table, expressing general opinions:

Table 7: Stakeholders comments

Question	Comment
1. Do you believe that the socio-economic situation of the region will improve due to the implementation of La Cascada Hydroelectric Project?	Yes, because project will provide job opportunities.
2. How does the development of the project affect you (positively or negatively) or on your environment?	Positively
3. Would you recommend private companies or authorities to develop projects of this nature?	Yes, because they contribute with environment protection and create employment.
4. Do you think La Cascada hydroelectric Project will contribute to the Sustainable Development of Colombia? (Sustainable Development is understood as "that development that satisfies the necessities with the present generations without jeopardizing the possibilities of the future generations to take care of its own necessities")	Yes
5. Any additional comments you would like to make.	It is important to implement social programs involving communities. If energy is produced locally, prices should decrease.

The complete answers of each stakeholder will be provided to the DOE during the validation process.

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

Comments received by local stakeholders were highly positive about the implementation of the project activity.

The comments were in line with main social and environmental concerns of local community. Doubts were clarified during the meeting.

Main issues and needs for corrective actions were already taken into consideration by Prestadora de Servicios Públicos La Cascada S.A. E.S.P. in order to comply with the Environmental Management Plan.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	**Prestadora de Servicios Públicos La Cascada S.A. E.S.P.**
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding has been involved in financing this project activity.

Annex 3

BASELINE INFORMATION

As mentioned above, the grid emission factor is determined according to the methodology ACM0002, as a combined margin emission factor, consisting of the combination of the operating margin and the build margin emission factors.

The detailed calculation, as well as all the information used for it, is shown in the spreadsheet "EF Colombia Simple Adjusted.xls" attached to this PDD.

The following table summarizes the grid emission factor calculation for ex ante estimation:

Table 9: Grid emission factor

Operating Margin Emission Factor			
	2004	**2005**	**2006**
Electricity generation – low cost/must run (MWh)	39,948,786	40,890,533	42,442,113
CO_2 emissions – low cost/must run (tCO_2)	68,258	64,675	53,641
Electricity generation – no low cost/must run (MWh)	8,591,165	9,324,548	9,653,206
CO_2 emissions – no low cost/must run (tCO_2)	4,830,596	5,352,588	5,846,039
Lambda factor	0.2620	0.2303	0.2178
Operating Margin Emission factor (tCO_2/MWh)	0.4154	0.4422	0.4740
Full generation-weighted average Operating Margin Emission factor (tCO_2/MWh)	**0.4446**		
Build Margin Emission Factor			
Electricity generation in 2006 (MWh)	52,067,226		
20% of electricity generation in 2006 (MWh)	10,413,445		
Electricity generation of the power plant capacity additions that comprises 20% of the system generation in 2006 (MWh)	11,836,670		
CO_2 emissions of the power plant capacity additions that comprises 20% of the system generation in 2006 (tCO_2)	3,214,146		
Build Margin Emission factor (tCO_2/MWh)	**0.2715**		
Combined Margin Emission Factor – weighted 50% (tCO_2/MWh)	**0.3581**		

Annex 4

MONITORING INFORMATION

As mentioned above, the methodology requires the monitoring of electricity generation from the proposed project activity and all data required for emission factor calculation according to ACM0002.

In each vintage year, the amount of emission reductions obtained by the project activity will vary in relation to the total measured power generation. Thus, accurate measurement of the generated electricity will constitute an important aspect in claiming emission reduction once this project is implemented.

The methodology describes the procedure and equations for calculating emission reduction from monitored data. For this specific project, the methodology is applied through a spreadsheet model. The staff responsible for project monitoring must complete the electronic worksheets on a monthly basis. The spreadsheet automatically provides annual totals in terms of GHG reductions achieved by the project.

The model contains a series of worksheets with different functions:

- Data entry sheets (*Electricity Generation* and *Grid Emission Factor*)
- Result sheet (*Emission Reductions*)

There are cells where the user is allowed to enter data. All other cells contain computed values that cannot be modified by the staff.

A color-coded key is used to facilitate data input. The key for the code is as follows***:***

- ***Input Fields:*** Pale yellow fields indicate cells where project operators are required to supply data input, as is needed to run the model;
- ***Result Fields:*** Green fields display result lines as calculated by the model.

All the monitoring data will be archived for two years following the end of the crediting period.

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