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:

Cristalino Small Hydroelectric Power Plant (hereafter referred to as "CristalSHP")

Version 03
30 October 2007

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

The CristalSHP project involves the implementation of a Small Hydroelectric Power Plant in the Barra Preta River. The Barra Preta River is located in the Manoel Ribas municipality at Paraná State, south region of Brazil. The CristalSHP is sited in the south part of Brazil, where the largest coal reserves are located as well as most of thermo power plants using this fuel.

The main objective of the project is to help meet Brazil's rising demand for energy due to economic growth and to contribute to the environmental, social, and economic sustainability by increasing renewable energy's share of the total Brazilian electricity consumption.

CristalSHP, with a power loading of 4.0 MW, uses the renewable hydro potential of the Barra Preta River to supply electricity to the Brazilian South/Southeast/Midwest interconnected grid. Since 2003 ANEEL (National Agency of Electric Energy) issued commercial exploration licenses for at least tree thermoelectric plants connected to that grid (UTE Rio Claro at Mato Grosso State, UTE Santa Terezinha at Paraná State and UTE Viralcool at São Paulo State) (Boletim Energia, número 97, 2003), contributing to increase the greenhouse gas (GHG) emission factor of Brazil's energy system. The project activity will reduce these emissions by avoiding electricity generation through fossil fuel combustion (and CO_2 emissions), which would generate (and release) CO_2 in the atmosphere.

Small-scale hydropower run-of-river plants such as CristalSHP provide local distributed generation, in contrast with the business as usual large hydropower and natural gas fired plants built in the last 5 years, and these small-scale projects provide site-benefits including:

- Increased reliability with shorter and less extensive outages;
- Lower reserve margin requirements;
- Improved power quality;
- Reduced lines losses;
- Reactive power control;
- Mitigation of transmission and distribution congestion; and
- Increased system capacity with reduced T&D investment.

A strong indication that CristalSHP contributes to the country's sustainable development goals is that the project is in accordance with the April 2002 law # 10,438 of Proinfa (*Programa de Incentivo as Fontes Alternativas de Energia Elétrica*). Proinfa is a Brazilian federal program that gives incentive to alternative sources of electricity (wind energy, biomass cogeneration, and hydropower plants with less than 30 MW). Among other factors, this initiative goal is to increase the renewable energy source share in the Brazilian electricity profile in order to contribute to a greater environmental sustainability through

giving these renewable energy sources better economic advantages. The Brazilian government has committed a large monetary fund in order to develop this plan.
Although CristalSHP is eligible for Proinfa, it had not applied to a Power Purchase Agreement (PPA) through Proinfa, and therefore, does not have access to the benefits of the program.

A.3. Project participants:

Name of the 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)
Brazil (host)	Cristalino Energia Ltda (private)	No
United Kingdom	MGM Carbon Portfolio, S.a.r.l (private)	No
(*) In accordance with CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a party involved may not have provided its approval. At the time of requesting registration, the approval by the party(ies) involved is required		

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

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

A.4.1.1. Host Party(ies):

Brazil

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

State of Paraná (South of Brazil).

A.4.1.3. City/Town/Community etc:

Municipality of Manoel Ribas

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

The CristalSHP is located in the south region of Brazil, State of Paraná, municipality of Manoel Ribas (latitude 24º34'29" South and longitude 51º33'31" West, Figure 3), and uses the hydro potential of the Barra Preta River. The Barra Preta River is part of the Ivaí River basin.

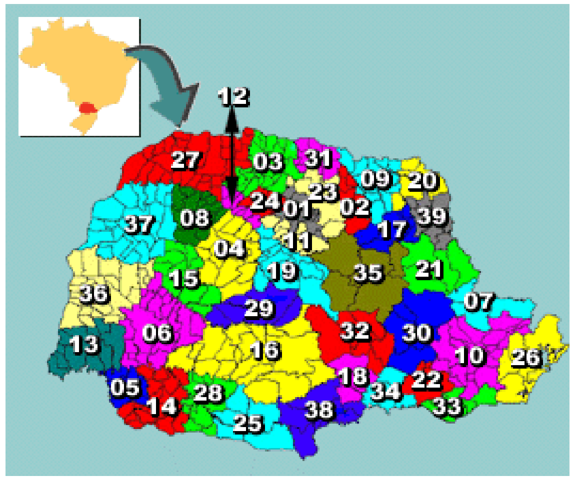


Figure 2 – Map of Paraná State divided by regions. The municipality of Manoel Ribas is sited in region 19 (Figure 3 below).

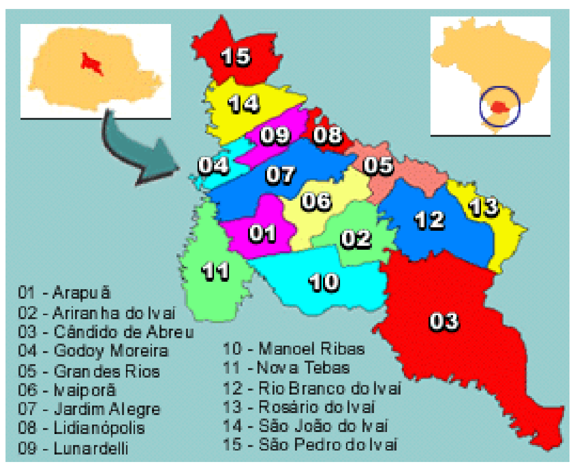


Figure 3 – Enlargement of region 19 in Figure 2. The municipality of Manoel Ribas comprehends area 10.

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, the CristalSHP project corresponds to:

Type I: Renewable Energy Projects

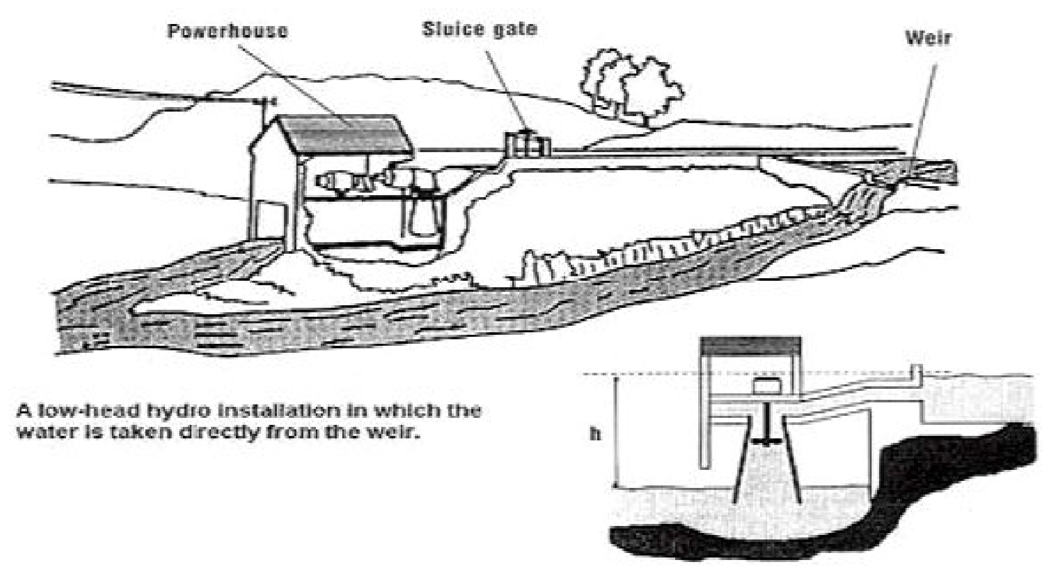
Category D: Energy Generation for a System.

The CristalSHP with a power loading of 4.0 MW, is introduced in the regional context as an low impact plant whose dam, designed to function as run of river, will flood 880 m^2, under regular operation conditions.
The CristalSHP project utilizes water from the Barra Preta River to generate electricity. The facility contains a small dam, which corresponds to the natural water body of the Barra Preta River, which stores water in order to generate electricity for short periods of time.

Run-of-river schemes do not include significant water storage, and must therefore make complete use of the water flow. A typical run-of-river scheme involves a low-level diversion dam and is usually located on swift flowing streams. According to Eletrobrás (1999), run-of-river projects are defined as "the projects where the river's dry season flow rate is the same or higher than the minimum required for the turbines". A low-level diversion dam raises the water level in the river sufficiently to enable an intake structure to be located on the side of the river. The intake consists of a trash screen and a submerged opening with an intake gate. Water from the intake is normally taken through a pipe (called a penstock) downhill to a power station constructed downstream of the intake and at as low a level as possible to gain the maximum head on the turbine.

The equipment and technology used in the CristalSHP project has been successfully applied to similar projects in Brazil and around the world. The equipment used in the project was developed and manufactured locally.

Figure 1. Schematic view of a run-of-river power plant



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

Table 2: Estimated emission reductions through the first 7-year crediting period

Year	Estimation of annual emission reductions in tonnes of CO_2e
2008 (March to December)	5,264
2009	6,317
2010	6,317
2011	6,317
2012	6,317
2013	6,317
2014	6,317
2015 (January and February)	1,053
Total estimated reductions (tonnes of CO_2e)	**44,219**
Total number of crediting years	**7**
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	6,317

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, the CristalSHP project is not a debundled component of a larger CDM project activity.

The project activity is an independent hydro power plant generating electricity and supplying to the grid, unrelated to any other CDM project activity in the region, existing or planned. The project proponent has not another registered small-scale CDM project activity, or an application 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, the CristalSHP project 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 11).

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

The CristalSHP qualifies under this project category since:

- The project activity is a hydroelectric power plant.
- The project activity supplies electricity to the Brazilian South/Southeast/Midwest interconnected grid.

The CristalSHP has a plate power capacity of 4.0 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 types 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, which is represented by the Ivaí river basin, close to the power plant facility and the interconnected grid.

Brazil is a large country and is divided in five macro-geographical regions, North, Northeast, Midwest, Southeast, and South. The majority of the population is concentrated in regions Northeast, Southeast, and South. Thus, the energy generation and the transmission are concentrated in these three subsystems. The energy expansion has mainly been designed for specifics areas:

1. Northeast: the electricity for this region is basically supplied by the São Francisco River. With a total of 10.5 GW installed capacity.
2. South/Southeast/Midwest: the majority of the electricity generation and consumption in the country is concentrated in this region. This region also concentrated 70% of the GDP generation in Brazil.
3. North: 80% of the Northern region is supplied by diesel.

The boundaries of the subsystems are defined by the electricity transmission capacities of the 3 sub systems listed above. The transmission lines between the sub systems have a limited capacity and the exchange of electricity between those sub systems is difficult. The lack of sufficient transmission lines forces the use of most of the electricity generated in each own sub systems. Thus the South/Southeast/Midwest interconnected sub system of the Brazilian grid, where the project activity is located, is included in the spatial extent of the project boundary.

Part of the electricity consumed in the country is imported from other countries. Argentina, Paraguay, and Uruguay supply about 10% of the electricity consumed in Brazil[1]. Brazil also exported, sometimes, energies to these countries.

B.4. Description of baseline and its development:

According to the project category, and the 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. Thus, Version 06 of the approved methodology ACM0002 is used to determine the grid emission factor. Historically, most generation in Brazil has been hydroelectric. However, the less expensive hydroelectric resources are exhausted. Gas-fired power plants require much lower capital cost, thus representing low financial risk for investment. Brazil also has thermal power plants using coal, fuel oil, and diesel. Since fossil fired power plants have higher operating cost compared to hydro, these are likely to be displaced by generation from any hydro added to the system. Thus, it is reasonable to choose the first option for calculating the grid emission factor.

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.

[1] Source: *Balanço Energético Nacional* - BEN, 2005

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 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 and the dispatching information is not publicly available in Brazil.

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-ante* vintage is selected among the two options proposed by the methodology. As a consequence, the operating margin emission factor is calculated *ex-ante* and it is considered fixed along the crediting period.

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 1 is selected among the two options proposed by the methodology. As a consequence, the build margin emission factor is calculated *ex-ante* and it is considered fixed along the crediting period.

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.

Baseline data sources

The national dispatch center supplied the raw dispatch data for the whole Brazilian interconnected grid.

The information on each generating source is not publicly available in Brazil. The National Power System Operator (*Operador Nacional do Sistema Elétrico*, ONS) argues that dispatching information is strategic to the power agents and therefore cannot be made available. On the other hand, ANEEL, the electricity agency, provides information on power capacity and other legal matters on the electricity sector, but no dispatch information can be got through this entity.

In that regard, project proponents looked for a plausible solution in order to be able to calculate the emission factor in Brazil in the most accurate way. Since real dispatch data is necessary after all, the ONS was contacted, in order to let participants know until which degree of detail information could be provided. After several months of talks, plants' daily dispatch information was made available for years 2003, 2004, and 2005.

Project proponents, discussing the feasibility of using such data, concluded it was the most proper information to be considered when determining the emission factor for the Brazilian grid. According to ANEEL, in fact, ONS centralized dispatched plants accounted for 75,547 MW of installed capacity by December 31st, 2004, out of the total 98,848 MW installed in Brazil by the same date[2]. Total capacity includes the amount available in neighboring countries to export to Brazil and emergency plants that are dispatched only during periods of electricity constraints in the system. Therefore, even though the emission factor calculation is carried out without considering all generating sources serving the system, about 76.4% of the installed capacity serving Brazil is taken into account, which is a fair amount if one looks at the difficulty in getting dispatch information in Brazil. Moreover, the remaining 23.6% are plants that do not have their dispatch coordinated by ONS, since either they operate based on power purchase agreements, which are not under control of the dispatch authority, or they are located in non-interconnected systems to which ONS has no access. In that way, this portion is not likely to be affected by the CDM projects, and this is another reason for not taking them into account when determining the emission factor.

The following table summarizes the key data necessary for the *ex-post* determination of baseline emissions:

[2] Source: http://www.aneel.gov.br/arquivos/PDF/Resumo_Gráficos_mai_2005.pdf

Table 3: Key data

Data	Source
Electricity generation of CristalSHP	Cristalino Energia Ltda
Electricity generation of the power plants serving the system	Operador Nacional do Sistema Elétrico, Centro Nacional de Operação do Sistema, Acompanhamento Diário da Operação do Sistema Interligado Nacional (daily reports)
Capacity additions to the system	Agência Nacional de Energia Elétrica, Banco de Informações da Geração
Fossil fuel conversion efficiencies	Bosi, M., A. Laurence, P. Maldonado, R. Schaeffer, A. F. Simoes, H. Winkler and J.-M. Lukamba. "Road testing baselines for greenhouse gas mitigation projects in the electric power sector." OECD and IEA information paper, October 2002. Where plant-specific efficiency data are not available, the following values are used: ▪ Combined cycle gas turbine power plants: 50% ▪ Open cycle gas turbine power plants: 32%, ▪ Sub-critical coal power plants: 33% ▪ Oil based power plant sub-critical oil boiler: 33%. Source: CDM-EB-2005.11.29-DOEs request for guidance on average plant efficiencies. Decision of the CDM EB responding to DNV "Request for guidance: Application of AM0015 (and AMS-I.D) in Brazil, dated 7 October 2005.
Emission factors and oxidation factors of fuels	IPCC Guidelines for National GHG Inventories

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 could be carried out in order to demonstrate project additionally, as described bellow (30 September 2005 edition):

"*Project participants shall provide an explanation to show that the project activity would not have occurred anyway due to at least one of the following barriers:*

(a) Investment barrier: a financially more viable alternative to the project activity would have led to higher emissions;

(b) Technological barrier: a less technologically advanced alternative to the project activity involves lower risks due to the performance uncertainty or low market share of the new technology adopted for the project activity and so would have led to higher emissions;

(c) Barrier due to prevailing practice: prevailing practice or existing regulatory or policy requirements would have led to implementation of a technology with higher emissions;

(d) Other barriers: without the project activity, for another specific reason identified by the project participant, such as institutional barriers or limited information, managerial resources, organizational capacity, financial resources, or capacity to absorb new technologies, emissions would have been higher."

The project activity had been initiated in April 22th, 2003, as stated in the decision nº 266 issued by ANEEL, which approves the CristalSHP basic project. However, the CristalSHP started supplying electricity to the grid by August 2005[3].
Nevertheless, the achievement of such target required efforts to remove several barriers.

To justify the additionality for this project, some previous internal analisys of the above alternatives were done and it was decided that this analysis will be focused on the alternative *c*) *Barrier due to prevailing practice:*

Prevailing Business Practice

The prevailing business practice in Brazil as far as obtaining financing and financial guarantees to project is a barrier to investment in renewable energy projects in the country. Given the various programs and incentives, which were considered along the last years, but never successfully implemented, it is possible to notice the difficulty and barriers to implement small hydro projects in the country. An indication of this barrier is exemplified by the Program called PCH-COM, structured by the end of 2000 and beginning of 2001. In 2001, Eletrobrás, in partnership with BNDES, launched the PCH-COM program, which had as its main goal to support and encourage the construction of small hydropower plants. This program consisted in the financing of the project by BNDES and the commercialization of the power by Eletrobrás. The operation of the program consisted on the analysis of the project by both BNDES and Eletrobrás. In case the project was approved, there would have been two contracts to be signed: the financing one with BNDES and the Power Purchase Agreement (PPA) with Eletrobrás. The program was not successful because of the guarantees needed and the clauses of the contracts (i.e., the project was not considered as a project finance basis and the lender demanded for direct guarantees from the developer, other than the project itself). After that, the government created, in 2002, the PROINFA program, which foresees raising the share of renewable energy power generation by adding 3,300 MW installed capacity of small-hydro power plants, wind-power, and biomass, offering long-term contracts with special conditions, lower transmission costs, and smaller interest rates from the local development banks. In 2005, the BNDES presented the last final version of its financing incentive line to PROINFA, which is different from the one first considered for the program and that was not considered sufficient attractive by potential entrepreneurs.

Aware of the difficulties mentioned above, CristalSHP decided not apply to PROINFA, and therefore, does not have access to the benefits of the program.

Another important aspect of prevailing business practice is related to the small participation of small hydro power plants in the Brazilian electric portfolio, which is commented in sequence:

[3] Aneel Resolution number 981, issued on 09 August 2005

Due to all what was exposed above, and in spite of all government incentives, an analysis based on data available at July 13th, 2007, shows that [4]:

a) there are 190 approved small hydropower plant projects in Brazil between 1998 and 2005, which have not started construction yet.

b) Small hydropower plants in operation, correspond to less than 2% of the total electric power generated in the country, and also correspond to less than 2% of the total electric power generated in the Paraná State (PR), where the CristalSHP is located

The recent trend does not anticipate changes from what has been observed in the last decade. . In an energy auction, which took place on December 16th, 2005, in Rio de Janeiro, 20 concessions for new power plants were granted, of which only two are for small hydropower plants (28 MW). From the total of 3,286 MW sold, 2,247 MW (68%) will come from thermal power plants, from which 1,391 MW come from natural gas fired thermal power plants, i.e., 42% of the total sold [5].

These numbers show that:

1) Common practice in Brazil has been the construction of large-scale hydroelectric plants and, more recently, of natural gas based thermal plants

2) incentives for the construction of thermal power plants have been more effective than those for small hydropower plants.

The recent nationalization of the natural gas industry by the Bolivian government which occurred at the begin of 2007 might change this situation, but perspectives are not clear so far

In summary, CristalSHP cannot be considered common practice and therefore does not fit in the business as usual scenario.

Conclusions

As defined by ANEEL[6], small hydro power plants are power plants with installed capacity greater than 1 MW and up to 30 MW, and with reservoir area lower than 3 km². Generally, it consists of a run-of-the-river hydro plant, which has a minimum environmental impact. This is not the business-as-usual scenario in a country where large hydro and thermal fossil fuel projects are preferable. CDM has made it possible for some investors to set up small hydro plants and sell electricity to the grid and this fact has motivated the implementation of CristalSHP. With the financial benefit derived from the CERs, it is anticipated that other project developers would benefit from this new source of revenues and would then decide to develop such projects.

[4] Source: http://www.aneel.gov.br/area.cfm?idArea=15 (Capacidade Geração Brasil and Resumo Estadual)
[5] Source: Rosa, Luis Pinguelli. Brazilian. Newspaper “Folha de São Paulo”, December 28, 2005.
[6] Resolution n. 394, December 4th, 1998.

The registration of the proposed project activity will help CristalSHP to improve its economic performance and may have a strong impact in paving the way for similar projects to be implemented in Brazil.

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 CristalSHP. 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_{gridy}, in tCO_2e/MWh) by the electricity generated by the proposed project activity during the year *y* (EG_y, in MWh), as follows:

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

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 and the dispatching information is not publicly available in Brazil.

The simple adjusted operating margin emission factor (tCO_2e/MWh) is a variation of the simple operating margin emission factor[7], where the power sources (including imports) are separated in low-cost/must-run power sources (*k*) and other power sources (*j*), as follows:

[7] 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.

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

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 are obtained through the following procedure (see Figure 5 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.

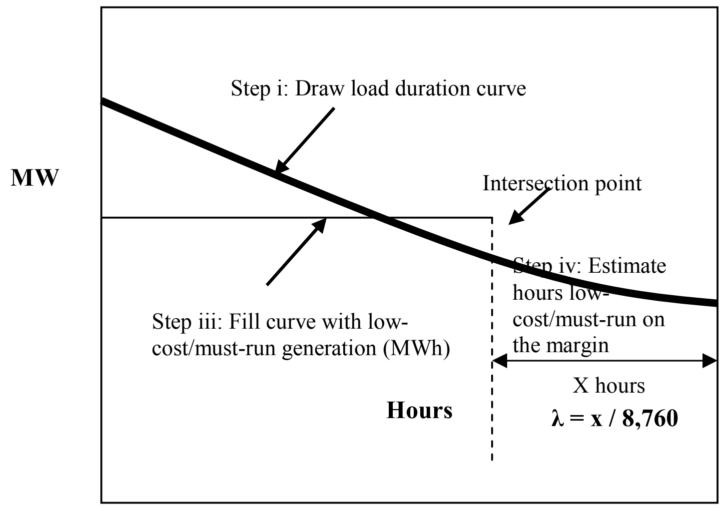


Figure 5: Illustration of lambda calculation for simple adjusted operating margin emission factor

Step 2. Calculate the build margin emission factor (*EF_{BM}*)

The build margin emission factor of each crediting period is calculated as follows:

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

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 5: Data available at validation

Data / Parameter:	GEN_j/GEN_k
Data unit:	MWh
Description:	Electricity delivered to the grid by power sources j/k
Source of data used:	ONS, the national dispatch center (daily reports): Operador Nacional do Sistema Elétrico, Centro Nacional de Operação do Sistema, Acompanhamento Diário da Operação do Sistema Interligado Nacional.
Value applied:	See Annex 3 below
Justification of the choice of data or description of measurement methods and procedures actually applied :	See Section B.4
Any comment:	This is used to determine the grid emission factor.

Data / Parameter:	GEN_m
Data unit:	MWh
Description:	Electricity delivered to the grid by the power sources *m*
Source of data used:	Operador Nacional do Sistema Elétrico, Centro Nacional de Operação do Sistema, Acompanhamento Diário da Operação do Sistema Interligado Nacional (daily reports) Capacity additions to the system are provided by Agência Nacional de Energia Elétrica, Banco de Informações da Geração.
Value applied:	See Annex 3 below

Justification of the choice of data or description of measurement methods and procedures actually applied:	See Section B.4
Any comment:	This is used to determine the grid emission factor.

Data / Parameter:	$F_{i,j}$ / $F_{i,k}$
Data unit:	Energy units
Description:	Amount of fuel *i* consumed by relevant power sources *j*/*k*
Source of data used:	Value determined using the fossil fuel conversion efficiencies from Bosi, M., A. Laurence, P. Maldonado, R. Schaeffer, A. F. Simoes, H. Winkler and J.-M. Lukamba. "Road testing baselines for greenhouse gas mitigation projects in the electric power sector." OECD and IEA information paper, October 2002. Where plant-specific efficiency data are not available, the following values are used: ▪ Combined cycle gas turbine power plants: 50% ▪ Open cycle gas turbine power plants: 32%, ▪ Sub-critical coal power plants: 33% ▪ Oil based power plant sub-critical oil boiler: 33%. Source: CDM-EB-2005.11.29-DOEs request for guidance on average plant efficiencies. Decision of the CDM EB responding to DNV "Request for guidance: Application of AM0015 (and AMS-I.D) in Brazil, dated 7 October 2005.
Value applied:	See Annex 3 below
Justification of the choice of data or description of measurement methods and procedures actually applied:	See Section B.4
Any comment:	This is used to determine the grid emission factor.

Data / Parameter:	$F_{i,m}$
Data unit:	Energy units
Description:	Amount of fuel *i* consumed by power sources *m*

Source of data used:	Value determined using the fossil fuel conversion efficiencies from Bosi, M., A. Laurence, P. Maldonado, R. Schaeffer, A. F. Simoes, H. Winkler and J.-M. Lukamba. "Road testing baselines for greenhouse gas mitigation projects in the electric power sector." OECD and IEA information paper, October 2002. Where plant-specific efficiency data are not available, the following values are used: ▪ Combined cycle gas turbine power plants: 50% ▪ Open cycle gas turbine power plants: 32%, ▪ Sub-critical coal power plants: 33% ▪ Oil based power plant sub-critical oil boiler: 33%. Source: CDM-EB-2005.11.29-DOEs request for guidance on average plant efficiencies. Decision of the CDM EB responding to DNV "Request for guidance: Application of AM0015 (and AMS-I.D) in Brazil, dated 7 October 2005.
Value applied:	See Annex 3 below
Justification of the choice of data or description of measurement methods and procedures actually applied:	See Section B.4
Any comment:	This is used to determine the grid emission factor.

Data / Parameter:	***CEF_i***
Data unit:	tCO_2/energy unit
Description:	Carbon dioxide emission factor per unit energy of fuel *i*
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 1, Table 1.4, Pages 1.23 and 1.24
Value applied:	Natural Gas: 56.10 Diesel: 74.10 Residual Fuel Oil: 77.40
Justification of the choice of data or description of measurement methods and procedures actually applied :	According to the methodology, 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 value is considered.
Any comment:	This is used to determine the grid emission factor.

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

Source of data used:	IPCC Guidelines for National Greenhouse Gas Inventories, Reference Manual, Volume 3 (1996), Table 1-6, Page 1.29.
Value applied:	Natural Gas: 0.995 Diesel: 0.99 Residual Fuel Oil: 0.99
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 1996 Revised IPCC Guidelines.
Any comment:	This is used to determine the grid emission factor.

Data / Parameter:	***Load Duration Curve***
Data unit:	MW vs. hs
Description:	Chronological load data for each hour of a year
Source of data used:	Operador Nacional do Sistema Elétrico, Centro Nacional de Operação do Sistema, Acompanhamento Diário da Operação do Sistema Interligado Nacional (daily reports)
Value applied:	See Annex 3 below
Justification of the choice of data or description of measurement methods and procedures actually applied:	See Section B.4
Any comment:	This is used to determine the grid emission factor.

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:

$$ER = EG \times EF_{grid}$$

The CristalSHP is expected to generate around 24,192 MWh per year, as shown in the following table:

Table 6: Expected annual electricity generation

Plant capacity **(A)**	4.0 MW
Annual hours **(B)**	8,760 hr/year

Capacity factor **(C)**	69.05%
Electricity generation (A) x **(B)** x **(C)**	24,192 MWh/year

As mentioned above, the emission factor of the grid is determined using the Version 06 of the methodology ACM0002 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 0.4349 tCO_2/MWh and the build margin emission factor 0.0872 tCO_2/MWh. Thus, the resulting grid emission factor is:

$$EF_{grid} = \frac{(EF_{OM} + EF_{BM})}{2} = \frac{(0.4349 + 0.0872)}{2} \ tCO_2/MWh = \mathbf{0.2611\ tCO_2/MWh}$$

Thus, the annual emission reduction results to be:

ER = 24,192 MWh/year x 0.2611 tCO_2/MWh = **6,317 tCO_2/year**

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

Table 7: *Ex-ante* estimation of emission reductions during the first 7-year crediting period

Year	Estimation of project activity emissions (tCO_2e)	Estimation of baseline emissions (tCO_2e)	Estimation of Leakage (tCO_2e)	Estimation of Overall reductions (tCO_2e)
2008 (March to December)	0	5,264	0	5,264
2009	0	6,317	0	6,317
2010	0	6,317	0	6,317
2011	0	6,317	0	6,317
2012	0	6,317	0	6,317
2013	0	6,317	0	6,317
2014	0	6,317	0	6,317
2015 (January and February)	0	1,053		1,053
Total (tonnes of tCO_2e)	**0**	**44,219**	**0**	**44,219**

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

B.7.1 Data and parameters monitored:

Table 8: 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:	Cristalino Energia Ltda
Value of data	24,192
Description of measurement methods and procedures to be applied:	Electricity delivered to the grid will be monitored by the project (seller) and by the electricity buyer through electricity meter connected to the grid and through sales receipt. This data will be measured each 15 minutes and recorded monthly.
QA/QC procedures to be applied:	The uncertainty level of the data is low, and the equipment will be regularly calibrated.
Any comment:	This data will be used to calculate the emission reductions obtained through the project activity. Data will be archived electronically until two years after finishing the crediting period.

B.7.2 Description of the monitoring plan:

According to Type I, Category D of small-scale project activity categories contained in appendix B of the Simplified M&P for CDM Small-Scale Project Activity, monitoring shall consist of metering the electricity generated by the renewable technology.

CristalSHP assigned a qualified person to compile the necessary data according to the approved methodology to accurately calculate emission reductions. These data will be compiled in a manner amenable to third party audit and deliverable to the DOE for validation and certification purposes. The daily generated energy is registered on paper and electronic by the operator.

For this project, the methodology is applied through a spreadsheet model. The 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.

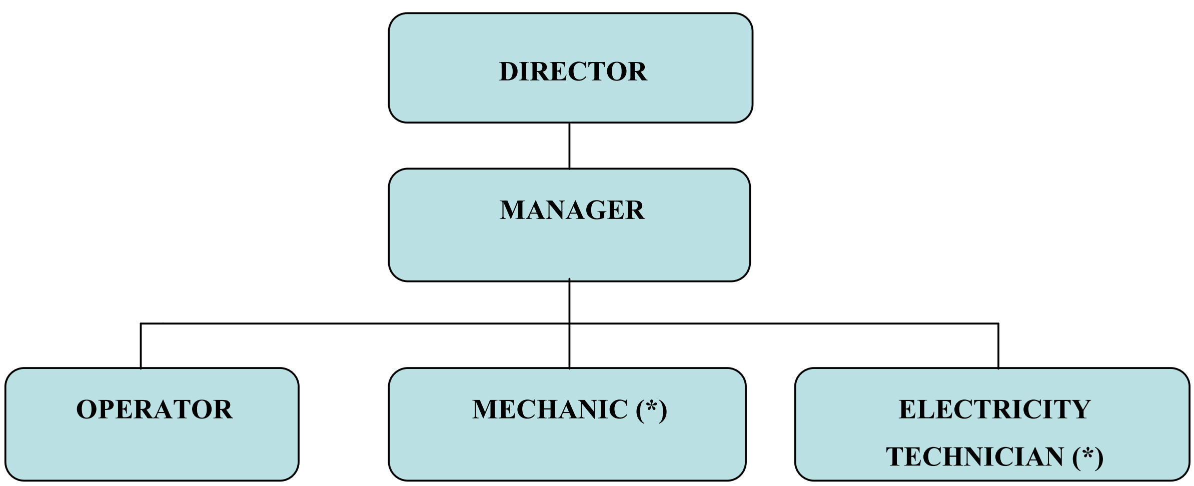
CristalSHP has a supervision system manufactured by GRAMEYER. The electrical parameters are measured, and the supplied energy is registered.

The generated energy is being transmitted to a substation belonging to the power utility COPEL, where the monitoring equipments (Saga 1000) were installed by the seller. The equipment will be calibrated each three years.This equipment is connected on line to the CCEE (Electrical Energy Commercialization Chamber), which is responsible for the accounting of the supplied energy. The monitoring of these measurements will be done under responsibility of COPEL. It will record the supplied energy in MWh through measurements made every fifteen minutes. The measurements will be archived electronically. The maintenance of these installations is foreseen to be done by COPEL.

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

During the period that precedes the first crediting period, an internal written procedure will be prepared, covering the aspects to warrant the quality and the reliability of the monitoring process, including essentially the following items:
-Procedures for training, periodical update and eventual substitution of operators and other personnel involved in the monitoring process;
-Procedures for quality assurance and calibration of measuring equipment;
-Procedures for archiving and back-up of monitored data;
-Procedures for recording activities related to above mentioned subjects;

The operational and management structure to be implemented is the following:



(*): Sub -Contracted

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: 01/12/2005 (revised on 09/03/2007)

Name of the responsible person/entity:

- Osvaldo Stella Martins PhD

- João M. Franco and Marisa Zaragozi, MGM International SRL
  Av. Luis Carlos Berrini , 1297 cj 121
  CEP 04571-010, São Paulo - Brazil
  Tel. (55 11) 5102 3844

Osvaldo Stella Martins and João M. Franco and Marisa Zaragozi 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:

The project activity had been initiated in March 22th, 2004, as stated in the decision nº 226 issued by ANEEL, which approves the CristalSHP basic project.

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

25 years

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

C.2.1. Renewable crediting period

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

01/03/2008

C.2.1.2. Length of the first crediting period:

7 years

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

N/A

C.2.2.2. Length:

N/A

SECTION D. Environmental impacts

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

As for the environmental permits, the proponent of any project that involves the construction, installation, expansion, and operation of any polluting or potentially polluting activity or any activity capable of causing environmental degradation is required to secure a series of permits from the respective state environmental agency. In addition, any such activity requires the preparation of an environmental assessment report, prior to obtaining construction and operation permits. Three types of permits are required. The first is the preliminary permit (*Licença Ambiental Prévia*, LP) issued during the planning phase of the project and which contains basic requirements to be complied with during the construction, and operating stages. The second is the construction permit (*Licença Ambiental de Instalação*, LI) and, the final one is the operating permit (*Licença Ambiental de Operação*, LO).

The process starts with a previous analysis (preliminary studies) by the local environmental department. After that, if the project was considered environmentally feasible, the sponsors have to prepare the Preliminary Environmental Assessment, which is basically composed by the following information:

- Reasons for project implementation;
- Project description, including information regarding the reservoir and the utility;
- Preliminary Environmental Diagnosis, mentioning main biotic, and anthropic aspects;
- Preliminary estimative of project impacts; and
- Possible mitigation measures and environmental programs.

The result of a successful submission of those assessments is the preliminary license, which reflects the environmental local agency positive understanding about the environmental project concepts.

To get the construction license, it will be necessary to present either: (a) additional information into previous assessment; or (b) a new more detailed simplified assessment; or (c) the PBA, according environmental local agency decision at the preliminary license issued. The operation license will be obtained as result of pre-operational tests during the construction phase, carried out to verify if all exigencies made by environmental local agency were satisfied.

Given the project is below the environmental legislation criteria of a small-scale size up to 15 MW, it has a fast-track environmental assessment process due to its reduced impact.

The state environmental agency responsible for the present project is the Environmental Institute of Paraná (*IAP*). IAP analyzed the EIA of CristalSHP, and issued all the required licenses to Cristalino Energia Ltda, allowing the construction and operation of CristalSHP. These licenses are mentioned bellow:

LP (Previous license), number: 3538 (which expires on 2005, february 2nd)

LI (Installation license), number: 2467 (which expires on 2008, December 20th)

LO (Operation license), number: 7536 (which expires on 2008, May 30th)

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:

The proposed project is a run-of-river hydropower plant, which involves no dam construction. Therefore, the environmental impact is very small compared to other types of power generations alternatives.

SECTION E. Stakeholders' comments

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

The Resolution number 1, issued by Brazilian DNA, established that the consultation must be performed by the project sponsor at least with the following entities:

- Municipality and Alderman Chamber
- State and Municipal Environmental Agencies
- Brazilian Forum of NGOs
- Community Associations
- Public Ministry

The stakeholders who were invited to participate in this process are the following:

- Municipality (Manoel Ribas)
- Alderman Chamber (Manoel Ribas)
- Alderman Chamber (Manoel Ribas)
- State Environmental Agency: (IAP)
- Municipal Environmental Agency (Manoel Ribas)
- Brazilian Forum of NGOs – Forum Brasileiro de ONGs e Movimentos Sociais para o Meio Ambiente e Desenvolvimento
- Commercial Association (Manoel Ribas)
- Rural Syndicate(Manoel Ribas)
- Public Ministry (Manoel Ribas)

The invitation letters were sent to the stakeholders listed above, during December 2006. The copies of the letters and the acknowledgement of receipt (called AR in Brazil) will be shown to the DOE during the validation process.

With the purpose to facilitate the comments of the invited persons, the following questionnaire was sent to the stakeholders:

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

The following documents were made available at a website available to all potential stakeholders: http://www.mgminter.com.br/dowload/projeto_pch_cristalino, as indicated in the letter inviting stakeholder comments.

- Presentation on the CristalSHP Project .
- Executive Summary of CristalSHP Project
- Project Design Document (PDD)
- Anexo III (regarding Resolution Nº 1 of the CIMGC)
- General Concepts on Greenhouse Effect and the Kyoto Protocol

E.2. Summary of the comments received:

Researches made with the local community demonstrated no opposition to the construction of the plant. This information was considerate in the decision to continue with the project, mainly by the fact that the displacement of households generates expectation of unquietness as well as voluptuous investment demands, making plants with low installation capacity not feasible.

Only the Chairman of Alderman Chamber (Mr.Gilvani Tonelli) commented the project :

The presented comments were positive, emphasizing the project will contribute to the sustainable development. Furthermore the project will benefit all the population of the Manoel Ribas Municipality.

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

Since all stakeholders consulted so far, support the project, no modifications to project design were necessary.

However, despite the acceptance of the project, we emphasize that the environmental aspects will be carefully observed with the objective to manage any eventual environmental impact.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Table 9: Non-Annex I project participant

Organization:	Cristalino Energia Ltda.
Street/P.O.Box:	Rua Capitão João A David, 230 - Centro - Prudentópolis
Building:	
City:	Manuel Ribas
State/Region:	Paraná
Postfix/ZIP:	89834-000
Country:	Brasil
Telephone:	*55 42 3446 2359*
FAX:	
E-Mail:	
URL:	
Represented by:	Walter Camargo
Title:	Director
Salutation:	
Last Name:	Camargo
Middle Name:	
First Name:	Walter
Department:	
Mobile:	
Direct FAX:	
Direct tel:	55 42 3446 2359
Personal E-Mail:	correcto@br10.com.br

Organization:	MGM Carbon Portfolio, S.a.r.l
Street/P.O.Box:	121, Avenue de la Faïencerie, L-15511
Building:	
City:	
State/Region:	Luxemburg
Postfix/ZIP:	
Country:	
Telephone:	
FAX:	
E-Mail:	
URL:	
Represented by:	Ivana Cepon
Title:	Business Developer Manager
Salutation:	Mrs.
Last Name:	Cepon
Middle Name:	
First Name:	Ivana
Department:	
Mobile:	54.9.11.5509.1592
Direct FAX:	+1.305.675.0968
Direct tel:	+ 54.11.5219.1230
Personal E-Mail:	icepon@mgminter.com

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

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

Annex 3

BASELINE INFORMATION

Calculation of the grid emission factor

The Brazilian electricity system has been historically divided into two subsystems: the North/Northeast (N/NE) and the South/Southeast/Midwest (S/SE/CO). This is due mainly to the historical evolution of the physical system, which was naturally developed nearby the biggest consuming centers of the country.

The natural evolution of both systems is increasingly showing that integration is to happen in the future. In 1998, the Brazilian government was announcing the first leg of the interconnection line between S/SE/CO and N/NE. With investments of around US$ 700 million, the connection had the main purpose, in the government's view, at least, to help solve energy imbalances in the country: the S/SE/CO region could supply the N/NE in case it was necessary and vice-versa.

Nevertheless, even after the interconnection had been established, technical papers, such as *Bosi* (2000) still divided the Brazilian system in two, since a very small fraction of electricity consumed in each of the regions can really be exchanged through the installed transmission line:

"… where the Brazilian Electricity System is divided into three separate subsystems:

(i) The South/Southeast/Midwest Interconnected System;
(ii) The North/Northeast Interconnected System; and
(iii) The Isolated Systems (which represent 300 locations that are electrically isolated from the interconnected systems)"

Moreover, Bosi (2000) gives a strong argumentation in favor of having so-called *multi-project baselines*:

"For large countries with different circumstances within their borders and different power grids based in these different regions, multi-project baselines in the electricity sector may need to be disaggregated below the country-level in order to provide a credible representation of 'what would have happened otherwise".

Finally, it is important to take into account that even though the systems today are connected, the energy flow between N/NE and S/SE/CO is heavily limited by the transmission lines capacity. Therefore, only a fraction of the total energy generated in both subsystems is sent one way or another. It is natural that this fraction may change its direction and magnitude (up to the transmission line's capacity) depending on the hydrological patterns, climate, and other uncontrolled factors. But it is not supposed to represent a significant amount of each subsystem's electricity demand. It has also to be considered that, only in 2004, the interconnection between SE and NE was concluded, i.e., if project proponents are to be coherent with the generation database they have available as of the time of the PDD submission for validation, a situation where the electricity flow between the subsystems was even more restricted is to be considered.

The Brazilian electricity system nowadays comprises of around 91.3 GW of installed capacity, in a total of 1,420 electricity generation plants. From those, nearly 70% are hydropower plants, around 10% are natural gas-fired power plants, 5.3% are diesel and fuel oil plants, 3.1% are biomass sources (sugarcane bagasse, black liquor, wood, rice straw, and biogas), 2% are nuclear plants, 1.4% are coal plants, and there are also 8.1 GW of installed capacity in neighboring countries (Argentina, Uruguay, Venezuela, and Paraguay) that may dispatch electricity to the Brazilian grid[8]. This latter capacity is in fact comprised by mainly 6.3 GW of the Paraguayan part of Itaipu Binacional, a hydropower plant operated by both Brazil and Paraguay, but whose energy almost entirely is sent to the Brazilian grid.

Thus, for the proposed project activity, the South/Southeast/Midwest interconnected sub system of the Brazilian grid, where the project activity is located, is included in the spatial extent of the project boundary.

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 simple adjusted operating margin emission factor (tCO_2e/MWh) is a variation of the simple operating margin emission factor[9], where the power sources (including imports) are separated in low-cost/must-run power sources (*k*) and other power sources (*j*), as follows:

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

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)

In the case of the South/Southeast/Midwest interconnected sub system of the Brazilian grid, all the low-cost/must-run plants produce zero net emissions, and thus:

---

8 Source: http://www.aneel.gov.br/aplicacoes/capacidadebrasil/OperacaoCapacidadeBrasil.asp

9 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.

$$\frac{\sum_{i,k} F_{i,k} \times COEF_i}{\sum_k GEN_k} = 0$$

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:

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

The dispatch data provided by the ONS[10] is treated as to allow calculation of the operating margin emission factor for the most three recent years with available information, which are 2003, 2004, and 2005.

The electricity generation and imports corresponding to each year are provided in the table below.

Table 10: Electricity generation and imports (MWh)

Year	Electricity load	Electricity generation by low-cost/must-run power sources	Imports
2003	288,933,290	274,670,644	459,586
2004	302,906,198	284,748,295	1,468,275
2005	314,533,592	296,690,687	3,535,252

[10] *Operador Nacional do Sistema Elétrico*, *Centro Nacional de Operação do Sistema*, *Acompanhamento Diário da Operação do Sistema Interligado Nacional* (daily reports from January 1st, 2003 to December 31st, 2005)

The lambda factors are calculated as explained above in Section B.6.1. The table below presents the values obtained:

Table 11: Lambda factors

Year	λ
2003	0.5312
2004	0.5055
2005	0.5130

Using the appropriate information for fossil fuel conversion efficiencies and CO_2 emission coefficients, the operation margin emission factors for each year is calculated and the mean average among the three years results to be 0.4349 tCO_2/MWh.

Step 2. Calculate the build margin emission factor (*EF_{BM}*)

The build margin emission factor of each crediting period is calculated as follows:

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

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.

Using the information related to the new electric power plants added to the system provided by ANEEL[11], data provided by the ONS corresponding to year 2005, and the appropriate information for fossil fuel conversion efficiencies and CO_2 emission coefficients, the build margin emission factor is calculated and results to be 0.0872 tCO_2/MWh.

[11] *Agência Nacional de Energia Elétrica*, *Banco de Informações da Geração*

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:

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

Thus, the resulting grid emission factor is:

$$EF_{grid} = \frac{(EF_{OM} + EF_{BM})}{2} = \frac{(0.4349 + 0.0872)}{2} \text{ tCO}_2\text{/MWh} = \mathbf{0.2611\ tCO_2/MWh}$$

The data and the spreadsheet with the calculation of the emission factor will be shown to the DOE during the validation process.

Annex 4

MONITORING INFORMATION

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 sheet (*Electricity Generation*)
- Result sheet (*Emission Reduction*)

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 electronic data will be backed up on a daily basis, and two electronic copies of each document will be kept in different locations (the project site and the Head Office). These data will be archived for two years following the end of the crediting period.

Annex 5

BIBLIOGRAPHY

Arida, P., E. L. Bacha, and A. Lara-Resende. *High Interest Rates in Brazil: Conjectures on the Jurisdictional Uncertainty*, 2004

Bosi, M. *An Initial View on Methodologies for Emission Baselines: Electricity Generation Case Study*. International Energy Agency, Paris, 2000.

Bosi, M., A. Laurence, P. Maldonado, R. Schaeffer, A. F. Simoes, H. Winkler and J.-M. Lukamba. Road testing baselines for greenhouse gas mitigation projects in the electric power sector. OECD and IEA information paper, October 2002.

Eletrobrás. *Diretrizes para estudos e projetos de pequenas centrais hidrelétricas.* Centrais Elétricas Brasileiras S.A. 1999.

Kartha, S., M. Lazarus and M. Bosi. *Practical baseline recommendations for greenhouse gas mitigation projects in the electric power sector.* OECD and IEA information Paper, 2002.

OECD. *OECD Economic Surveys: Brazil.* Organization for Economic Co-Operation and Development, Paris, France, 2001.

Schaeffer, R., J. Logan, A. S. Szklo, W. Chandler and J. C. de Souza. *Electric Power Options in Brazil.* Pew Center on Global Climate Change, 2000.