CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

Title: Piabanha River Hydroelectric Plants
Version number of the document: 03
Date: 21/02/2008

Revision history
Version 01: initial document submitted for validation on October 1st, 2007
Version 02: revised document submitted for validation on February 15th, 2008
Version 03: revised document submitted for validation on February 21st, 2008

A.2. Description of the project activity:

The proposed project activity comprises three run-of-the-river hydroelectric plants with capacities of 15.8 MW (PCH[1] Posse), 18.6 MW (PCH Monte Alegre) and 17.2 MW (PCH São Sebastião), summing up to 51.6 MW[2] of installed capacity, on the Piabanha River, located in the State of Rio de Janeiro, Brasil. The Piabanha River is a tributary of the Paraiba do Sul River, the main water course in the southeastern region of Brazil that passes through four states: São Paulo, Rio de Janeiro, Minas Gerais and Espirito Santo States. Under the Brazilian legislation[3], all hydroelectric plants from 1 MW up to 30 MW of installed capacity and with a reservoir smaller than 3 square kilometres, are considered to be small hydroelectric plants. The hydroelectric plants are considered run-of-river given that they do not require accumulating water for operation. The reservoir is used solely to assure adequate water flow at the intake point. In this way, the hydropower systems use water at a rate no greater than that which runs down the river.

The main purpose of the project activity is the generation of electricity using the hydro potential available in the Piabanha River, delivering it to the south/southeast/midwest connected electricity system in order to help meet demand, mostly at regional level, through sustainable energy generation.

The details of each of these projects are described below.

[1] PCH (Pequena Central Hidroelétrica, in Brazilian Portuguese) means Small Hydroelectric Plant.

[2] 51.6 MW of installed capacity is licensed by ANEEL (Brazilian Electricity Regulatory Agency) according to Resolutions 748/2002, 709/2003, and 716/2003. Technical description for the SHPs is based on the basic engineering plan developed for each plant.

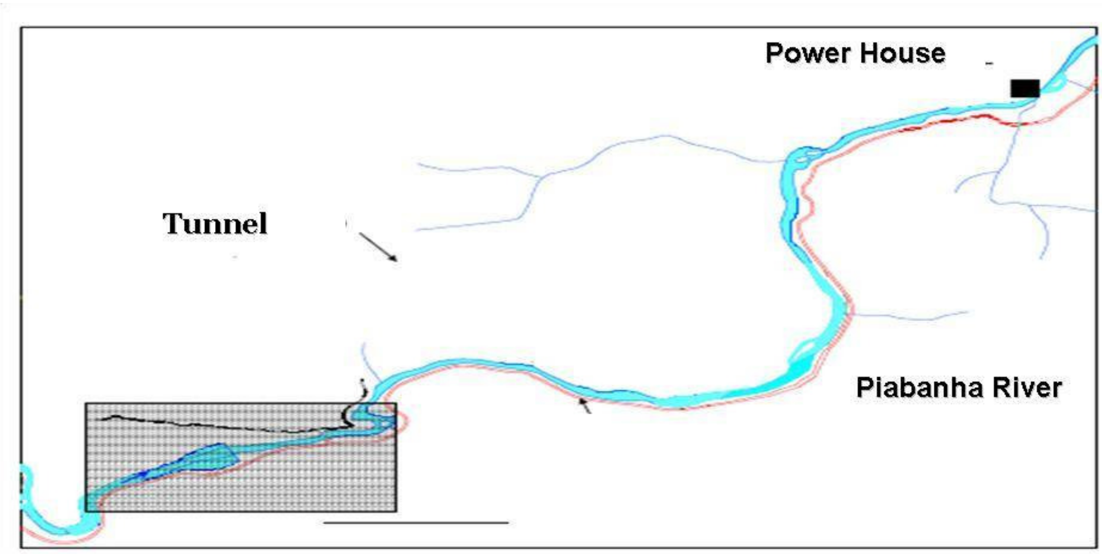
3 Article 26, Law 9.427, from 26/12/96, modified by article 4º, Law 9648, from 27/05/98; and, articles 2 and 3 of ANEEL Resolution nº 394, from 04/12/98.

15.8 MW PCH Posse

This plant will be built on the Piabanha River in the Petropolis Municipality, Rio de Janeiro State, at 43°06'39.6"W; 22°17'17.2"S. This location is 5.0 km upstream of the District of Posse and 33.5 km upstream from the Paraiba do Sul River.

The reservoir lake will comprise an area of 0.032 km^2 (power density: 494 W/m^2). This plant will operate with the water surface of the lake at a maximum normal operating level of 613.0 meters above sea level.

The turbines will be placed in a power house 3,300 meters downstream from the dam. The water will be conducted through a tunnel of approximately 11 square meters. This plant will receive 2 (two) Francis turbines coupled to generators of 8.8 MVA (8.0 MW) each. The electricity generated will be delivered to the national grid through a 6.9 kV transmission line at the Substation Piabanha, located 5 km from the power house. It is expected to start commissioning in October and November 2009.

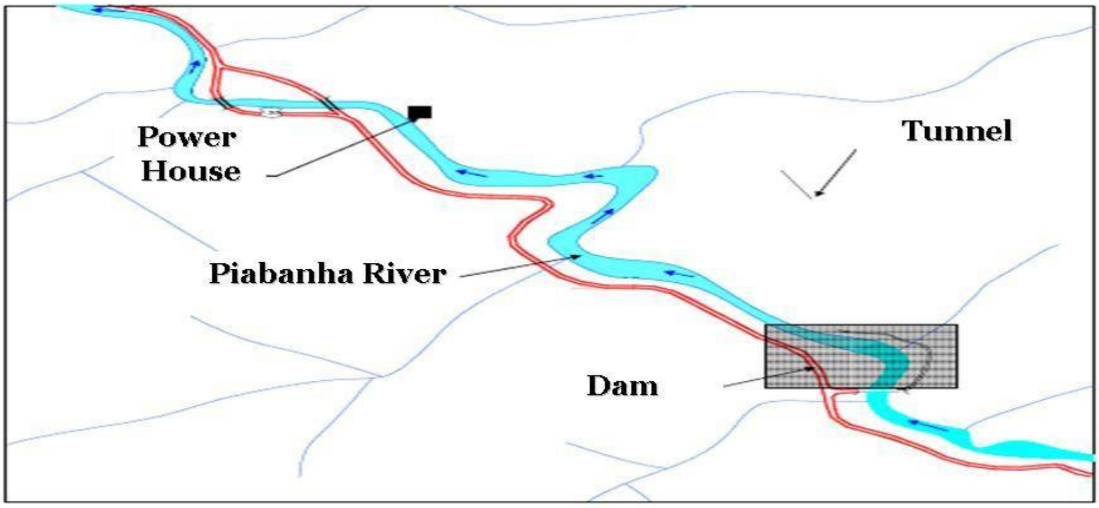


18.6 MW PCH Monte Alegre

This plant will be built on the Piabanha River in the municipality of Areal, Rio de Janeiro State at 43°07'2.2"W; 22°13'33.9"S. The location is 2.0 km downstream from the Areal Municipality and 20.9 km upstream from the Paraíba do Sul River.

The reservoir lake will comprise an area of 0.046 km^2 (power density: 404 W/m^2). This plant will operate with the water surface in the lake at a maximum normal operating level of 426.0 meters above the sea level.

The turbines will be placed in a power house 1,900 meters downstream from the dam. The water will be conducted through a tunnel of approximately 28 square meters. This plant will receive 2 (two) Francis turbines, positioned on a horizontal axis, and coupled to generators of 9.8 MVA (9.5 MW) each. The electricity generated will be delivered to the national grid through a 6.9 kV transmission line at the Substation Morro Grande, located 8 km from the power house. It is expected to start commissioning in December 2009.

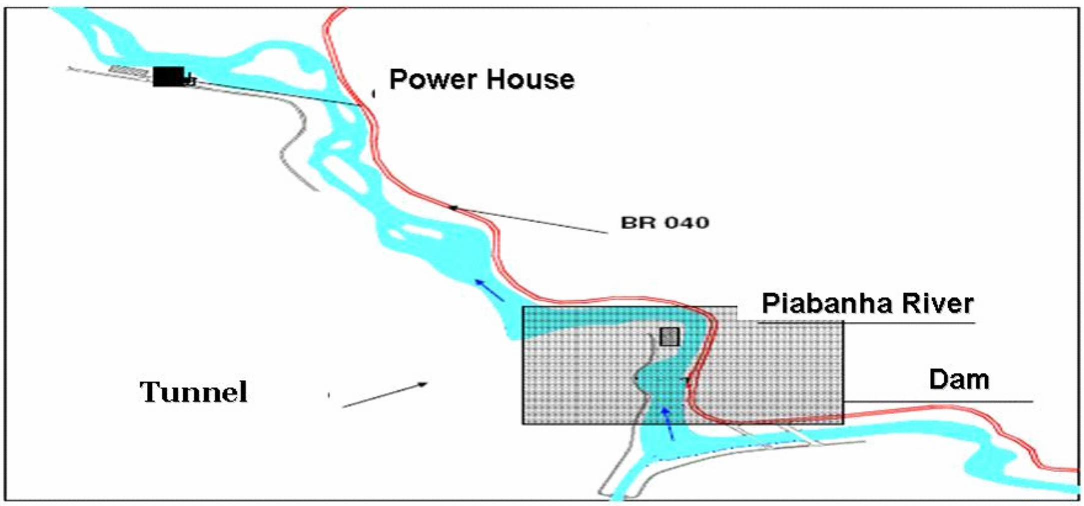


17.2 MW PCH São Sebastião

This plant will be built on the Piabanha River, on a site at the corner of three municipalities: Paraiba do Sul, Tres Rios and Areal. The location is defined by the coordinates 43°09'35.3"W; 22°11'50.8"S. This location is 13.2 Km upstream from the Paraíba do Sul River.

The reservoir lake will take an area of 0.049 km^2 (power density: 351 W/m^2) with a total volume of 0.0902 million cubic meter. This plant will operate with the water surface in the lake at a maximum normal operating level of 307.0 meters above the sea level.

The turbines will be placed in a power house 2,200 meters downstream from the dam. The water will be conducted through a tunnel of approximately 30 square meters. This plant will receive 2 (two) Francis turbines coupled to generators of 8.58 MVA (8.94 MW) each. The electricity generated will be delivered to the national grid, through a 6.9 kV transmission line at the substation Morro Grande, located 8 km from the power house. It is expected to start commissioning in October and November 2009.



The three run-of-the-river hydroelectric plants contribute to regional sustainable development by promoting renewable energy supply to meet current and future energy demands. Additional socio-economic benefits that are expected from project implementation include local employment generation, rural and urban infrastructure development, creation of local conservation areas and restoration programs, as well as promotion of recreational use of the reservoir lake (See Section D.1 for more detail.). The project will reduce greenhouse gas emissions by increasing the share of renewable energy in the south/southeast/midwest electricity system. The project is expected to achieve average emission reductions on the order of 71,006 tonnes of CO_2 e per year by displacing electricity from carbon intensive sources.

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)	AES Rio PCH Ltda.	No
Brazil	AES Infoenergy Ltda.	No
Netherlands	AES Carbon Exchange Limited	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 project activity

A.4.1. Location of the project activity:

The project activity will be located at the municipalities of Petrópolis, Areal, Paraíba do Sul and Três Rios, in the State of Rio de Janeiro, Southeastern Region of Brazil.

A.4.1.1. Host Party(ies):

Brazil

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

Southeastern region of Brazil, Rio de Janeiro State.

A.4.1.3. City/Town/Community etc:

Municipalities of: Petrópolis, Areal, Paraíba do Sul and Três Rios.

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

The proposed project activity comprises three hydropower plants in the Piabanha River, an easterly flowing river in the State of Rio de Janeiro, which is a tributary of the Paraiba do Sul River. The location of the three hydropower plants[4] is as follows:

43°06'39.6"W; 22°17'17.2"S – PCH Posse
43°07'2.2"W; 22°13'33.9"S – PCH Monte Alegre
43°09'35.3"W; 22°11'50.8"S – PCH São Sebastião

The locations are represented in the figure below:

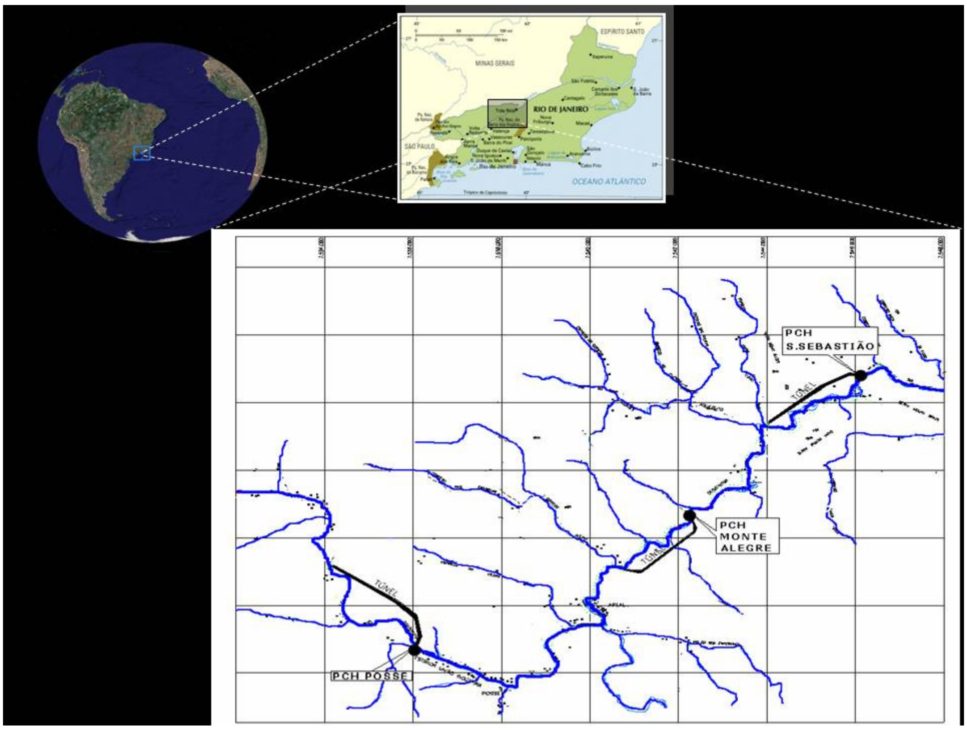


Figure 2 – Location of the Small Hydropower Plants

[4] These coordinates represent the water intake point for each small hydro plant.

A.4.2. Category(ies) of project activity:

Sectoral Scope 1: Energy Industries (renewable / non renewable sources)

A.4.3. Technology to be employed by the project activity:

The proposed project will use the potential energy by virtue of a height drop in a flowing river by diversion weirs for running Francis type hydro turbines to generate power. The three small hydro plants have the same configuration. Reservoirs will be built at sites along the river that favour the best relation between volume reserved and area taken by the reservoir. From the reservoir lake, the water will be diverted for power generation through intake channels, head race tunnels, penstock and surge shaft.

Francis type turbines are commonly used in applications where high flow rates are available at medium hydraulic head. Water enters the turbine though a volute casing and is directed onto the blades by wicket gates. The low momentum water then exits the turbine though a draft tube. In the model, water flow is supplied by variable speed centrifugal pump. A load is applied to the turbine by means of a magnetic brake, and torque is measured by observing the deflection of calibrated springs. The performance is calculated by comparing the output energy to the energy supplied.

The equipment and technology used in this project has been successfully applied to similar projects in Brazil and around the world. Technical description of the facilities is included in the table below.

	Monte Alegre	Posse	São Sebastião
Average flow rate (m3/s)	31.3	11.6	37.1
Reservoir area (km2)	0.04570	0.03190	0.04903
Reservoir volume(10^6 m^3)	0.14325	0.06784	0.09017
Head (m)	50.84	113.0	34.6
Load factor	57.49%	57.28%	53.56%
Installed capacity[5] (kW)	19,000	16,000	17,880
Turbine	2 Francis turbine, horizontal axis, 360 rpm	2 Francis turbine, horizontal axis, 720 rpm	2 Francis turbine, double horizontal axis, 360 rpm
Generator	9.8 MVA, 360 rpm, 6.9 kV	8.8 MVA, 720 rpm, 6.9 kV	8.58 MVA, 360 / 400 rpm, 6.9 kV
Nominal Turbine Flow rate (m3/s)	22.25	7.9	28.7

The small hydro plants will be operated remotely, by the COG Bauru (Centro de Operação da Geração) of AES Tietê S.A. The project time schedule includes the commissioning for the three small hydro plants by December 2009 as indicated by the timetable below.

[5] Installed capacity based on the basic engineering plan developed for each plant.

Timetable	jul/07	ago/07	set/07	out/07	nov/07	dez/07	jan/08	out/09	nov/09	dez/09
Engineering Design										
Site Investigations			X							
Hydrology Studies		X								
Engineering Studies				X						
Final Project Documentation				X	X					
EPC Contract										
Additional Information			X	X	X					
Proposals Submission					X					
Contract Negotiation						X				
Notice to Proceed							X			
Units Commissioning										
Posse 1								X		
Posse 2									X	
Monte Alegre 1								X		
Monte Alegre 2									X	
São Sebastião 1									X	
São Sebastião 2										X

Figure 4 – Project timetable

Based on completed discharge studies, the annual assured energy from the three small hydro plants is 251,066 MWh. For 2012 and 2016 this quantity increases to 251,744 MWh given that these are leap years.

Technical know-how will be transferred to local operation and maintenance teams by formal training programs and manuals. Plant operators will be responsible to follow corporate best practices identified for similar small hydro plants in Brazil and elsewhere. Project equipment will be mostly supplied by national manufacturers.

A.4.4 Estimated amount of emission reductions over the chosen crediting period:

Years	**Annual estimation of emission reduction in tonnes of CO_2 e**
2010*	70,951
2011	70,951
2012**	71,146*
2013	70,951
2014	70,951
2015	70,951
2016**	71,146*
Total Emission Reductions (tonnes of CO_2 e)	**497,047**
Total number of crediting years	**7**
Annual Average over the crediting period of estimated reductions (tonnes of CO_2 e)	**71,006**

* Every year of the crediting period includes all twelve months (i.e. from January to December).

** 2012 and 2016 are both leap years with one extra day available for energy generation.

A.4.5. Public funding of the project activity:

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

SECTION B. Application of a baseline and monitoring methodology

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

Title: "Consolidated Methodology for grid connected electricity generation from renewable sources"
Reference: ACM0002, Version 06, 19 May 2006
The methodology is used in conjunction with the "Tool for the demonstration and assessment of additionality (Version 4)".

B.2 Justification of the choice of the methodology and why it is applicable to the project activity:

The chosen methodology is applicable to new grid-connected hydro electric power projects, under the condition of electric capacity addition from run-of-river hydro power plants with reservoirs having power density greater then 4 W/m^2. This is the case of each of the plants comprising the Piabanha Hydroelectric Plants. The project does not include any fuel switching activities.

B.3. Description of the sources and gases included in the project boundary

The project boundary includes the physical sites as well as the reservoir area for the three plants. The spatial extent of the project boundary includes the project site and all power plants connected physically to the south/southeast/midwest electricity system. The north-northeastern system is not included given the model adopted by the Brazilian Ministry of Science and Technology (MCT), Brazilian Ministry of Energy and Mines (MME), and the National System Operator (ONS) to calculate emission factors since January 2006. The boundaries of the subsystems are defined by the transmission capacity. Given transmission constraints, the south/southeast/midwest electricity system is considered a boundary. The net imported electricity from countries such as Argentina and Uruguay was included in the project boundary.

The only greenhouse gas to include in the project boundary is the carbon dioxide released by the thermal power plants already installed and operating in the south/southeast/midwest electricity system.

	Source	Gas	Included?	Justification / Explanation
Baseline	Grid electricity production	CO_2	Yes	According to ACM0002
		CH_4	No	According to ACM0002
		N_2O	No	According to ACM0002
Project Activity	Hydro electricity production	CO_2	No	This emission source is not included given that the power density is greater than 10W/m^2 for each small hydro plant.
		CH_4	No	
		N_2O	No	

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

According to ACM0002, for project activities that do not modify or remodel an existing electricity generating plant, the baseline is as follows:

"The electricity delivered to the grid by the project would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin (CM) calculations in B.6.1".

In the absence of the project, electricity would continue to be generated by the existing generation mix, operating in the grid.

Two alternatives to the project scenario are considered:

Alternative 1*:* The proposed project activity: construction of new hydropower generation plant with a total installed capacity of 51.6 MW, connected to the local grid and implemented without considering CDM revenues. This alternative faces barriers outlined in section B.5, below. Therefore, the project is not considered feasible, in the absence of the CDM incentives (i.e. is not the baseline scenario).

Alternative 2: Continuation of the current situation: electricity would continue to be generated by the existing generation mix operating in the grid. This alternative does not face any technological or other barriers. Electricity would continue to be generated by the existing mix of power plants in the grid with an increasing share of fossil fuel based power plants. Most, if not all-medium and large hydro resources in the south and southeast of the country have been exploited, and most of the remaining reserves are located in the Amazon basin, far from the major industrial centers[6]. New additions to Brazil's electricity power sector are shifting from hydro to fossil-based plants[7].

To conclude, the conservative baseline scenario is identified as a continuation of the current situation in which electricity would continue to be generated by the existing mix of power plants in the grid.

Two additional alternatives to the project scenario were considered: (i) electricity generation through renewable energies other than hydro-power, and (ii) electricity generation through fossil fuels. The first additional alternative undergoes the same kind of barriers described for Alternative 1 as explained below. Other renewable energy technologies experience institutional and financial hurdles as small hydro plants do; the difference being the investment costs necessary to implement each technology. The second additional alternative is considered as part of Alternative 2, as the continuation of the current situation predicts an increase of fossil fuel based power plants in the existing generating mix operating in the grid. Therefore, both additional alternatives were not considered as separate baseline scenarios.

[6] Source: OECD, 2001
[7] Source: Schaeffer *et al.*, 2000

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 CDM project activity (assessment and demonstration of additionality):

Consistent with ACM0002, the additionality of the Piabanha River Hydroelectric Plants project shall be demonstrated and assessed using the latest version of the "Tool for the demonstration and assessment of additionality" agreed by the CDM Executive Board. The use of version 04 of the tool is described below.

Step 1. Identification of alternatives to the project activity consistent with mandatory laws and regulations

Sub Step 1a. Define alternatives to the project activity:

The realistic and credible alternatives to the project activity are:

- The installation of a new run-of-the-river hydropower plant with an installed capacity of 51.6 MW without being realized as a CDM project activity; and,
- Continuation of the current situation: electricity would continue to be generated by the existing generation mix operating in the grid.

Sub Step 1b. Consistency with mandatory laws and regulations:

- All the alternatives are consistent with mandatory applicable legal and regulatory requirements.

Step 2. Investment analysis.

Sub-step 2a . Determine appropriate analysis method

A benchmark analysis (Option III.) was selected as the most appropriate analysis method to consider.

Sub-step 2b . Option III. Benchmark analysis

The chosen financial indicator is the shareholder Internal Return Rate (IRR) calculated from the discounted cash flow spreadsheet prepared for the project analysis. The choice of an acceptable IRR is the most suitable for this decision context given that the project itself has the main purpose to complement the electricity delivered by AES Tietê S.A. to the southeastern electricity market. AES Rio PCH Ltda.[8] is a special purpose company (SPC) owned by AES Tietê S.A. (99%) and AES Minas PCH Ltda. (1%). The SPC was established to develop and manage the proposed run-of-the-river hydroelectric plants. The cash flow spreadsheet incorporates original assumptions for investment, revenues from sales of electricity, and operational and management costs for the scenario with CDM related revenues, that the AES Corporation adopts in order to comply with the shareholders expectations.

[8] 'Contrato social' or by-laws of AES Rio PCH Ltda. (30th of January, 2007).

AES Tietê S.A. began to evaluate the proposed project activity considering CDM related revenues in the first semester of 2006. In October 2006, a contractual agreement[9] between AES Tietê S.A. and the previous project owner (i.e. Guascor) was signed to buy the rights of all three plants. In January 29th 2007, AES Tietê S.A. board of directors approved the investment decision[10].

Sub-step 2c. Calculation and comparison of financial indicators

The benchmark selected for the IRR is the yield on a 21-year government bond – the Global BRL 2028 – that is traded in public markets, plus a conservative estimate of the risk premium for the project. The Global BRL 2028 bond was issued on February 7, 2007, just one week after the investment was approved by the AES Tiete S.A. board of directors, and its tenor matches the life of the project. The yield on the Global BRL 2028 bond was 10.68% at issuance on February 7, 2007.[11] Since a hydroelectric project is riskier than a government bond rate, it is appropriate to include a credit risk premium in the benchmark rate. BNDES, the National Development Bank of Brazil, estimates risk premiums in Brazil to be in the range of 0.46% to 3.57%.[12] Conservatively assuming the lower end of the BNDES range for credit risk premiums, the benchmark rate is equal to the Global BRL 2028 yield plus the risk premium: 11.14%. Excluding CER revenues, the project's financial model results in an IRR of 8.8%, much lower than the benchmark rate of 11.14%.

Sub-step 2d. Sensitivity analysis

A sensitivity analysis was performed in order to verify the robustness of the financial model with respect to the following project parameters: Engineering, Procurement, and Construction (EPC) costs, energy prices, and Operation and Maintenance (O&M) costs. These parameters fluctuated within a range of 10%, against the base case scenario. The results for the scenarios without CER revenues are shown in the figure below; the results indicate the project is unlikely to be considered financially attractive under a variety of scenarios.

Project Sensitivity Analysis	
Scenarios	IRR
Without CER revenues	8,8%
10% increase on EPC cost	7,7%
10% decrease on EPC cost	10,1%
10% increase in O&M cost	8,7%
10% decrease in O&M cost	8,9%
10% increase in energy price	9,8%
10% decrease in energy price	7,9%

Figure 5 - Sensitivity analysis

In sum, the Piabanha project explicitly considered possible revenues from the CDM before the decision was made to invest in the project. The financial benefit derived from CERs, would bring the project

[9] Purchase contract between AES Tietê S.A. and Guascor celebrated at 23rd of October, 2006.
[10] As evidenced by AES Tietê S.A. internal board memo forwarded to the validator.
[11] http://www.tesouro.fazenda.gov.br/english/public_debt/downloads/informes/Emissao_Global_BRL2028_eng.pdf
[12] http://www.bndes.gov.br/ambiente/meio_ambiente.asp

additional benefits due to the fact that they are generated in hard currencies (US Dollar or Euro). Hard currency revenue provides the Piabanha Hydroelectric Project a hedge against currency devaluation.

Step 3. Barrier analysis

Sub-step 3a. Identify barriers that would prevent the implementation of the proposed CDM project activity:

Institutional Barrier

Since 1995, when the privatization and the deregulation of the Brazilian Electricity market began, government policies have been continuously changing in Brazil. Many laws and regulations were created with the aim of providing incentives for new investments in the energy sector. At the same time, new entities were created, the Brazilian Electricity Regulatory Agency (Agência Nacional de Energia Elétrica, ANEEL) set up to develop the legislation and to regulate the market; the National Power System Operator (Operador Nacional do Sistema Elétrico, ONS) to supervise and control the generation, transmission, and operation; and the Wholesale Energy Market (Mercado Atacadista de Energia Elétrica, MAE) to define rules and commercial procedures of the short-term market.

The Brazilian government signaled that it was strategically important for the country to increase thermoelectric generation and consequently be less dependent of hydropower. With that in mind, the federal government launched in the beginning of the year 2000 the Thermoelectric Priority Plan (Plano Prioritário de Termelétricas, PPT) [13] originally planning the construction of thermal plants using mainly natural gas. In 2004, the newly elected government decided to completely review the institutional rules of the electricity market. The Congress approved a new model to the electric sector in March/2004, and new regulations for the electric sector have been created (OCDE, 2005). According to the model, the demand and supply of electricity is coordinated by a “pool demand” to be estimated by the distribution companies that have to contract 100% of its electricity projected demand during the next 3 to 5 years. These projections are evaluated by a new institution denominated Empresa de Planejamento Energético – EPE (Energetic Planning Company). EPE estimates the necessary expansion on supply capacity to be sold to the distribution companies through the pool. The negotiated electricity price is an average of all long-term contracted prices, and is the same for all distribution companies.

A “free market” was also established in parallel to the regulated long-term pool demand contracts. Large consumers (above 10 MW) have to inform the distribution companies with a 3-year notice that it wishes to change from the pool to the free market (or a 5-year notice vice-versa). These conditions are expected to become more flexible in the future. If real demand is higher than the projected supply, distribution companies will have to buy electricity at the free market. Otherwise, they will have to sell the surplus electricity at the free market. The distribution companies will be able to transfer to the final consumers the difference between the electricity purchased at the free market and through the demand pool, if the difference between the projected demand and the real demand stays below 5%. If it stays above this limit, the distribution companies will have to deal with these costs.

The Government made an option for a centralized institutional system, reinforcing the role of MME – Ministério das Minas e Energia (Mines and Energy Ministry) at long-term planning. EPE is responsible

[13] Federal Decree 3,371 of February 24th, 2000, and Ministry of Mines and Energy Directive 43 of February 25th, 2000.

for preparing for MME a portfolio of aimed technologies and a list of strategic and non-strategic projects. MME will present this portfolio to CNEP – Conselho Nacional de Política Energética (National Council of Energetic Policy) and, after approval by CNPE, the strategic projects will be auctioned, based on priorities through the pool. The companies may replace the non-strategic projects proposed by EPE, if the proposals would offer the same capacity for a lower tariff. Another institution created is the CMES - Comitê de Monitoramento do Setor Elétrico (Electric Sector Monitoring Committee), in charge of monitoring the tendencies of electricity demand and supply.

Although the new model was designed to reduce market risk, its capacity to provide incentives for private investment will depend on how these regulatory rules are actually played out. Risks faced by potential private investors include:

- Government failure (or non-market failure), due to the more significant role of the government on long term planning, and political interference on new institutions created;
- Lack of transparent and flexible rules for the transition phase between the regulated and free electricity markets;
- Price volatility in the near term given the sectoral dependency on hydroelectric power (and thus, on rainfall levels) and uncertainties regarding the natural gas business; and,
- Lack of definite rules on the separation of vertically integrated companies (generators and distributors).

These and other uncertainties constitute a real barrier for additional private investment within the Brazilian electricity, especially for renewable energy generation projects. Project developers need to balance these risks against alternative investment options (including high interest rates as explained above), as well as, the high level of guarantees required to finance small hydro or wind plants for example. This institutional barrier is exemplified by the various programs and incentive schemes previously organized by the federal government, but never successfully implemented.

A program called PCH-COM, for example, was structured at the beginning of 2001 by Eletrobras in partnership with BNDES. The main goal of PCH-COM was to support and encourage the construction of small hydro plants in Brazil. It included the financing of the project activity by BNDES and the commercialization of power by Eletrobras. In case the proposed project activity received approval by both agencies, there would be two contracts to be signed: (i) a financial agreement with BNDES, and (ii) a Power Purchase Agreement (PPA) with Eletrobras. The program was not successful because of the required guarantees 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).

In 2002, the federal government launched the PROINFA (Programa de Incentivo às Fontes Alternativas de Energia Elétrica) program to increase the share of renewable energy generation within the Brazilian energy matrix. The program planned to add 3,300 MW of installed capacity of small-hydro power plants, wind-power, and biomass, offering long-term contracts with special conditions, lower transmission costs, and lower interest rates from the local development banks. In 2005, the BNDES presented the last and 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 sufficiently attractive by potential entrepreneurs. The Project Participants, for example, did not apply to PROINFA, and therefore does not have access to the benefits of the program.

The main reason for the reduced number of renewable energy project activities enrolled within both PCH-COM and PROINFA was the financial burden. Both processes of negotiating a PPA with the utility (i.e. Eletrobras) and obtaining funding from BNDES have proven to be very cumbersome. The developers perceive BNDES as requiring excessive guarantees in order to provide financing. Although this might be the Bank's role as a financing institution to mitigate risk, it is understood as a market barrier. In spite of all government incentives for private investment in renewable energy, the share of small hydro power plants within the Brazilian electricity market is still insignificant. Based on data available on July 13th, 2007, there were[14]:

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

b) Small hydrpower plants in operation, generate less than 2% of the total electric power in the country, and generate less than 1% of the total electric power in the Rio de Janeiro State (RJ), where the project activity is located.

The recent trend does not anticipate changes from what has been observed in the last decade. In a recent 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, or 42%, will come from natural gas fired thermal power plants[15].

These numbers show that:

1) Common practice in Brazil has been the construction of large-scale hydroelectric plants and, more recently, natural gas-fired 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 beginning of 2007 might change this situation, but perspectives are not clear so far. In summary, renewable energy generation projects in Brazil, such as the Piabanha River Hydroelectric Plants project, face considerable institutional barriers. Despite governmental efforts to provide incentives and reduce market uncertainties, private entrepreneurs still lack the capacity to structure projects with reasonable returns, as to significantly increase the share of renewable plants within the Brazilian energy matrix. Those that manage to obtain costly financial guarantees have done so partially because of special incentive schemes such as PROINFA.

Sub-step 3b: Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity)

[14] Source: http://www.aneel.gov.br/area.cfm?idArea=15 (Capacidade Geração Brasil and Resumo Estadual)
[15] Source: Rosa, Luis Pinguelli. Brazilian. Newspaper "Folha de São Paulo", December 28, 2005.

According to the Brazilian Energy Balance or BEN (Balanço Energético Nacional), thermoelectric generation in 2004 increased 17% over 2003 while hydroelectric generation increased only 4,9%[16]. A recent study published by ANEEL (Agência Nacional de Energia Elétrica) or the Brazilian National Electric Energy Agency, estimated that Brazil will have to install an additional load of 28,000MW of new thermoelectric power plants in order to meet increasing electricity demand[17]. Both studies indicate that the continuation of current energy mix does not face the same level of institutional barrier or market uncertainties as renewable energy projects. It also confirms the feasibility of the construction of new thermoelectric units as compared to hydroelectric units, and demonstrates that increased thermal power generation is in fact a plausible scenario when considering new investments on the energy sector. Thus Alternative 2 (the continuation of the current situation) would not be prevented by the identified barriers.

Step 4. Common practice analysis

Sub-step 4a. Analyze other activities similar to the proposed project activity:

In Rio de Janeiro State, where the Piabanha Hydroelectric Plants are located, there are 08 small hydro power plants in operation, which correspond to approximately 0.4% of the total electricity generated in the State (as of August 13th, 2007).[18]. Another 15 small hydro power plants have been granted a license by ANEEL for the period 1998-2004, representing 6% of the total number of plants. Of these licensed plants, 6 have started construction representing 13% of the total number of plants under construction. All of the 6 small hydro plants under construction have been financed by the federal incentive program PROINFA[19]. The tables below summarize the generation capacity within the State of Rio de Janeiro.

Enterprises in Operation			
Type[20]	Quantity	Power (kW)	%
HPPC	5	2.304	0,03
SHP	*8*	*29.200*	*0,38*
HPP	10	1.230.779	16,04
TPP	31	4.403.704	57,39
TNPP	2	2.007.000	26,16
Total	56	7.672.987	100

Enterprises under Construction			
Type	Quantity	Power (kW)	%
SHP	*6*	*125.400*	*12,93*
HPP	1	333.700	34,40

[16] BEN 2005 -Balanço Energético Nacional (Chapter 1: "Análise Energética e Dados Agregados").

[17] PNE 2030 – Plano Nacional Energético para 2030", the Brazilian strategic energetic plan for 2030. The plan has not yet been concluded but several meetings have been done.

[18] Source: http://www.aneel.gov.br/area.cfm?idArea=15 (Capacidade Geração Brasil and Resumo Estadual)

[19] Source: http://www.mme.gov.br/download.do?attachmentId=11166&download and http://www.bndes.gov.br/english/news/not321_05.asp

[20] Type includes: HPPC for Hydro Power Plant Central Generation; WPP for Wind Power Plant; SHP for Small hydro Power Plant; HPP for Hydro Power Plant; TPP for Thermal Power Plant; and, TNPP for Thermonuclear Power Plant.

TPP	2	511.000	52,67
Total	9	970.100	100

Granted Enterprises between 1998 and 2004 (the construction hasn't started)			
Type	Quantity	Power (kW)	%
HPPC	2	1.900	0,07
WPP	6	277.250	10,88
SHP	*9*	*157.980*	*6,20*
HPP	1	195.000	7,65
TPP	10	1.915.354	75,19
Total	28	2.547.484	100

For the south-southeast-midwest grid[21], there are 269 small hydro power plants in operation, which correspond to approximately 1.69% of the total electricity generated for the grid (as of August 13th, 2007).[22]. Another 165 small hydro power plants have been granted a license by ANEEL for the period 1998-2004, representing 15% of the total number of plants. Of these licensed plants, 62 have started construction representing 16% of the total number of plants under construction. More than half of these plants (63%) have been financed by the federal incentive program PROINFA[23]. The tables below summarize the generation capacity within the south-southeast-midwest grid.

South-Southeast-Midwest Enterprises in Operation			
Type*	Quantity	Power (kW)	%
HPPC	200	106.282	0,11%
WPP	8	167.900	0,17%
SHP	269	1.651.405	1,69%
HPP	170	79.244.047	80,95%
TPP	581	14.718.989	15,04%
TNPP	2	2.007.000	2,05%
Total	1230	97.895.623	100

South-Southeast-Midwest Enterprises under Construction			
Type	Quantity	Power (kW)	%
HPPC	1	848	0,01%
SHP	62	1.098.450	15,57
HPP	17	4.949.000	70,16
TPP	14	1.005.922	14,26
Total	94	7.054.220	100

21 Includes the States of Distrito Federal, Espírito Santo, Goiás, Mato Grosso, Mato Grosso Do Sul, Minas Gerais, Paraná, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, São Paulo and Tocantins.
22 Source: http://www.aneel.gov.br/area.cfm?idArea=15 (Capacidade Geração Brasil and Resumo Estadual)
23 Source: http://www.mme.gov.br/download.do?attachmentId=11166&download and http://www.bndes.gov.br/english/news/not321_05.asp

South-Southeast-Midwest Granted Enterprises between 1998 and **2004** (the construction hasn't started)			
Type	Quantity	Power (kW)	%
HPPC	63	44.048	0,26%
WPP	45	1.758.063	10,26%
SHP	165	2.508.791	14,64%
HPP	24	4.332.400	25,28%
TPP	86	8.493.203	49,56%
Total	383	17.136.505	100%

Sub-step 4b. Discuss any similar options that are occurring:

The 08 small hydro plants in operation within the State of Rio de Janeiro belong to three private entities: Quanta Geração S/A (06 plants), Companhia de Eletricidade Nova Friburgo (02 plants), and Companhia Energética Paulista (01 plant). Except for the Comendador Venâncio plant owned by Companhia Energética Paulista, all other plants started operation more than 40 years ago. They were built during a different historical context, including a set of barriers not comparable to the ones faced by modern projects. For those 06 plants under construction, all of them applied to receive governmental subsidies from the PROINFA program. The table below summarizes the types of benefits received by plants under construction, and the start of operation date for the operating plants.

Enterprises in Operation		
	Start of operation	Incentive
Catete	1947	No
Xavier	1947	No
Chave do Vaz	1953	No
Euclidelândia	1949	No
Fagundes	1923	No
Franca Amaral	1961	No
Piabanha	1908	No
Comendador Venâncio	2005	CDM
Enterprises under Construction		
Bonfante	-	PROINFA
Monte Serrat	-	PROINFA
Santa Rosa II	-	PROINFA
Calheiros	-	PROINFA
Santa Fé I	-	PROINFA
Tudelândia	-	PROINFA

Additional small hydro projects in Brazil are still under development, and waiting for better financing opportunities. Most developers who funded their projects outside of PROINFA[24] have taken CDM as decisive factor for completing their projects. The Brazilian government has endorsed that the projects under the PROINFA program are also eligible to participate in the CDM process, in accordance with the decision of the UNFCCC about eligibility of projects derived from public policies. The legislation which

[24] The PROINFA program was instituted by Law nº 10.438/2002 and revised by Law nº10.762/2003. More information can be obtained by the following website: http://www.mme.gov.br/programs_display.do?prg=5

created PROINFA took into account possible revenues from the CDM in order to proceed with the program[25]. Therefore, similar activities (within or outside PROINFA) consider additional incentives provided by the CDM as a necessary condition to overcome financial hurdles.

The registration of the proposed project activity will help AES Rio PCH Ltda. 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:

The project activity comprises three run-of-the-river hydroelectric plants that will generate renewable energy to the south/southeast/midwest connected electricity system. ACM0002 (version 06) methodology is applicable to grid-connected renewable power generation project activities such as this one. ACM0002 uses derived margin parameters that were applied in the context of the project activity to determine appropriate emission factors.

According to ACM0002, version 06, the emission reduction ER_y by the project activity during a given year **y** is the difference between the baseline emissions (BE_y), project emissions (PE_y) and emissions due to leakage (L_y), as follows:

$$ERy = BEy - PEy - Ly \qquad (1)$$

The project emission (***PEy***) is zero given that the power density of the proposed project activity is greater than $10W/m^2$. There is no leakage (L_y) to be accounted for since the project activity is a run-of-river hydropower plant, and emissions arising due to activities such as power plant construction are negligible.

Thus the baseline emissions at each year ***y*** (BE_y in tCO_2) are the product of the baseline emissions factor (EF_y in tCO_2/MWh), times the electricity supplied by the project activity to the grid (EG_y in MWh) minus the baseline electricity supplied to the grid in case of modified or retrofit facilities (EG baseline in MWh), as follows:

$$BEy = (EGy - EGbaseline) \times EFy) \qquad (2)$$

The baseline emission factor (EF_y) is calculated through the Combined Margin (CM) method, that is a way to weight the contribution from the operation of existing thermal power plants and the contribution from the addition of new thermal power plants to the system, through the operating margin (OM) and the build margin (BM) factors respectively.

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

[25] Decree Number 5.025 (March 30th, 2004).

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}*)

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 data vintage adopted for this project is the **ex-ante**: the full generation weighted average for the most recent 3 years for which data are available at the time of PDD submission.

The simple adjusted operating margin emission factor (tCO_2e/MWh) is a variation of the simple operating margin emission factor[26], where the power sources (including imports) are separated in low-cost/must-run power sources (*k*) and other power sources (*j*), as follows:

$$EF_{OM,simple\_adjusted,y} = (1-\lambda_y).\frac{\sum_{i,j} F_{i,j,y}.COEF_{i,j}}{\sum_{j} GEN_{j,y}} + \lambda_y.\frac{\sum_{i,k} F_{i,k,y}.COEF_{i,k}}{\sum_{k} GENk_{k,y}} \quad (3)$$

where

Λ_y	Lambda factor: fraction of time during low-cost/must-run sources are on the margin
$F_{i,j,y}/F_{i,k,y}$	Amount of fuel *i* consumed by relevant power sources *j/k* (in mass or volume unit)
$GEN_{j,y}/GEN_{k,y}$	Electricity delivered to the grid by power sources *j/k* (MWh)
$COEF_{i,}$	CO_2 emission coefficient for fuel *i*. (tCO_2e/mass or volume unit)

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

$$COEF_i = NCV_i \cdot EF_{CO2,i} \cdot OXID_i \quad (4)$$

where

NCV_i	Net calorific value of fuel *i* (energy unit/mass or volume unit)
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:

[26] 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.

$$\lambda_y = \frac{number\ of\ hours\ per\ year\ for\ which\ low-cost/must-run\ sources\ are\ on\ margin}{8{,}760\ hours\ per\ year} \quad (5)$$

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.

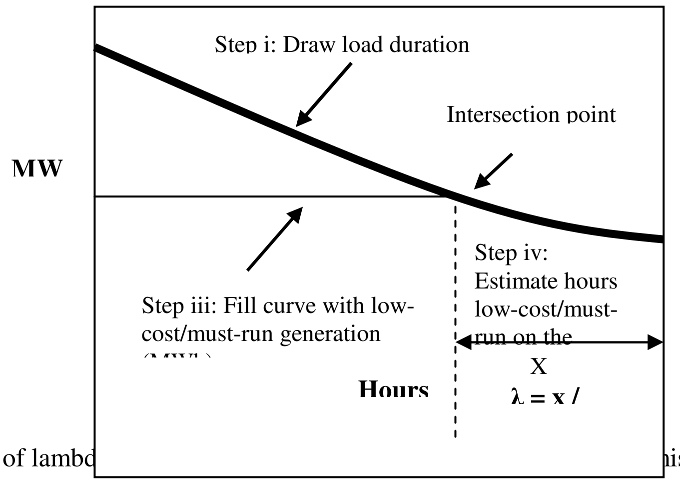


Figure 6: Illustration of lambd … ission factor

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

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

$$EF_{BM,y} = \frac{\sum_{i,m} F_{i,m,y} \cdot COEF_{i,m}}{\sum_{m} GEN_{m,y}} \qquad (6)$$

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. An *ex-ante* calculation of the build margin emission factor, based on the most recent information available on plants already built for sample group *m* at the time of PDD submission, has been selected for this project activity.

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:

$$EF_{grid} = \frac{(EF_{OM} + EF_{BM})}{2} \qquad (7)$$

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

The operating margin and build margin emission factors are calculated *ex-ante*, based on the most recent 3 years for which data are available, and on the most recent information available on plants already built at the time of this PDD, respectively.

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)
Value applied:	See Annex 3 below
Justification of the choice of data or description of	The national dispatch center supplies the raw dispatch data for the whole Brazilian interconnected grid. This data source is relevant for the

measurement methods and procedures actually applied :	calculation of the baseline.
Any comment:	These data are available in an excel spreadsheet presented to the DOE during the validation process.

Data / Parameter:	***Power Plants (Built Margin)***
Data unit:	N/A
Description:	New Electric Power Plants added to the Electric System
Source of data used:	National Agency of Electric Power (ANEEL) - Agência Nacional de Energia Elétrica. (http://www.aneel.gov.br/).
Value applied:	Data collected in December 2006
Justification of the choice of data or description of measurement methods and procedures actually applied :	ANEEL is a Federal Agency which is in charge to regulate and supervise the Electric Generation, Transmission, Distribution and the commercialization of Electric Energy
Any comment:	These data are available in an excel spreadsheet presented to the DOE during the validation process.

Data / Parameter:	***Load Duration Curve***
Data unit:	MW vs. hrs
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.6
Any comment:	These data are available in an excel spreadsheet presented to the DOE during the validation process.

Data / Parameter:	***Electricity Imports***
Data unit:	MWh
Description:	Net electricity imported by the South/Southeast/Midwest connected electricity System
Source of data used:	Data provided by ONS (the national dispatch center)
Value applied:	See annex 3

Justification of the choice of data or description of measurement methods and procedures actually applied:	These data are from an official source, and are made public available. The approved methodology ACM0002, version 6, specifies that an import from a connected electricity system should be considered as one power source j (delivering of electricity to the grid, not including low operating cost and must-run power plants).
Any comment:	These data are available in an excel spreadsheet presented to the DOE during the validation process.

Data / Parameter:	$EF_{OM,y}$
Data unit:	tCO_2/MWh
Description:	CO_2 Operating Margin emission factor of the grid in a year *y*
Source of data used:	Data for *EFOM,y* calculation were provided by ONS (National dispatch center). Calculated according to the approved methodology – ACM0002, version 6, 2006
Value applied:	0.4749
Justification of the choice of data or description of measurement methods and procedures actually applied:	According to ACM0002, version 6, May 19, 2006, the option chosen for the calculation of the emission factor in this project is option (b): simple adjusted operating margin factor. This choice is due to the fact that, in Brazil, even though most of the energy produced in the country comes from hydroelectric power, most of these low costs investments in hydro electrics are exhausted. Therefore, the possibility of investments in non-renewable sources arises, such as thermoelectric power plants. (See Annex 3)
Any comment:	These data are available in an excel spreadsheet presented to the DOE during the validation process.

Data / Parameter:	$EF_{BM,y}$
Data unit:	tCO_2/MWh
Description:	CO_2 Build Margin emission factor of the grid in a year *y*.
Source of data used:	Data for *EFBM,y* calculation were provided by ONS (National dispatch center).
Value applied:	0.0903
Justification of the choice of data or description of measurement methods and procedures actually applied:	Calculated according to the approved methodology – ACM0002, version 6, 2006. (See Annex 3).
Any comment:	These data are available in an excel spreadsheet presented to the DOE during the validation meeting.

Data / Parameter:	***Reservoir Area***
Data unit:	Square meter

Description:	Surface area at full reservoir level
Source of data used:	Satellite images
Value applied:	Posse – 0.032 km^2 Monte Alegre - 0.046 km^2 São Sebastião - 0.049 km^2
Justification of the choice of data or description of measurement methods and procedures actually applied:	Reservoir area was estimated by Guascor Empreendimentos Energéticos Ltda and included in the basic engineering plan for each small hydro plant. It was estimated based on complete energy and technical studies for the Piabanha river.
Any comment:	-

Data / Parameter:	*λ*
Data unit:	No unit
Description:	Fraction of time during which low-cost/must-run sources are on the margin.
Source of data used:	Data provided by ONS
Value applied:	λ*2004*=0,4937, λ*2005*=0,5275, λ*2006*=0,4185
Justification of the choice of data or description of measurement methods and procedures actually applied:	Calculated according to the approved methodology – ACM0002, version 6, 2006. (See Annex 3)
Any comment:	These data are available in an excel spreadsheet presented to the DOE during the validation process.

Data / Parameter:	***EFy***
Data unit:	tCO_2/MWh
Description:	Emission factor for the Brazilian South/Southeast/Midwest interconnected grid
Source of data used:	Data for EFy calculation were provided by ONS (the national dispatch center)
Value applied:	0.2826
Justification of the choice of data or description of measurement methods and procedures actually applied:	These data are from an official source, and are made public available. The calculation for this combined margin is based on the approved methodology ACM0002, version 6. (See Annex 3)
Any comment:	These data are available in an excel spreadsheet presented to the DOE during the validation process.

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
Justification of the choice of data or description of measurement methods and procedures actually applied:	See Section B.6
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
Justification of the choice of data or description of measurement methods and procedures actually applied:	See Section B.6
Any comment:	This is used to determine the grid emission factor.

Data / Parameter:	CEF_i
Data unit:	tCO2/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.

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 Piabanha River Hydroelectric project is expected to generate around **251,066** MWh of assured energy per year. Given that 2012 and 2016 are leap years, assured energy generated for these two years are estimated to be 251,754 MWh.

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 0.4749 tCO_2/MWh and the build margin emission factor 0.0903 tCO_2/MWh. Thus, the resulting grid emission factor is:

$$EF_{grid} = \frac{(EF_{OM} + EF_{BM})}{2} = \frac{(0.4749 + 0.0903)}{2}$$ tCO_2/MWh = **0.2826 tCO_2/MWh**

Thus, the annual emission reduction results to be:

ER = **251,066** MWh/year x 0.2826 tCO_2/MWh = **70,951 tCO_2/year (71,951 tCO_2/year for 2012 and 2016).**

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

***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)
2010	0	70,951	0	70,951
2011	0	70,951	0	70,951
2012	0	71,146*	0	71,146*
2013	0	70,951	0	70,951
2014	0	70,951	0	70,951
2015	0	70,951	0	70,951
2016	0	71,146*	0	71,146*
Total (tonnes of tCO_2e)	**0**	**497,047**	**0**	**497,047**

* 2012 and 2016 are both leap years with one extra day available for energy generation.

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

The methodology applicable to this project is the approved consolidated monitoring methodology ACM0002, version 6. It includes the use of metering equipment projected to register and verify bidirectionally[27] the energy generated by the facility. This energy measurement is fundamental to verify and monitor the GHG emission reductions. The Monitoring Plan permits the calculation of GHG emissions generated by the project activity, by applying the baseline emission factor.

There are no project activity emissions or leakage to be monitored. The only parameter that must be monitored is electricity supplied to the grid. The monitored amount of electricity supplied to the grid is multiplied by the *ex-ante* baseline emission factor to calculate GHG emission reductions.

B.7.1 Data and parameters monitored:

Data / Parameter:	EG_y
Data unit:	MWh
Description:	Electricity generated by the renewable technology delivered to grid in the year y
Source of data to be used:	Electronic records from the energy metering. The meter currently selected is model Q1000 supplied by Schumberger.
Value of data applied	251,066

[27] Bidirectionally means that the metering equipment will record energy exported from the small hydro plants, and imported from the grid (if necessary, but not the case for the Piabanha small hydro plants).

for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Net electricity supplied to the grid will be measured by the project (seller) and by the electricity buyer through an electricity meter connected to the grid and through sales receipt. Net electricity supplied to the grid will be measured every five minutes. This data will be hourly recorded by the seller and sent to the Electricity Trade Chamber (CCEE – Câmara de Comercialização de Energia Elétrica).
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.

Data / Parameter:	***Reservoir Area***
Data unit:	Square meter
Description:	Surface area at full reservoir level
Source of data to be used:	Satellite images
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable to the calculation of the emission reduction calculation
Description of measurement methods and procedures to be applied:	Measurement to be done at the start of the project in order to ensure there is no increase in the area occupied by the reservoir.
QA/QC procedures to be applied:	To be done only once at the start of operation for each small hydro plant.
Any comment:	

B.7.2 Description of the monitoring plan:

According to ACM0002, version 06, the monitoring of the following parameters is required:

• Electricity generation from the proposed project activity;
• Data needed to recalculate the operating margin emission factor, if needed, based on the choice of the method to determine the operating margin (OM), consistent with "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (ACM0002);
• Data needed to recalculate the build margin (BM) emission factor, if needed, consistent with "Consolidated baseline methodology for grid-connected electricity generation from renewable sources"(ACM0002);

Given that the emission factor is calculated *ex-ante*, the only parameter to be monitored is the electricity generated by the project. The project will proceed with the necessary measures for power control and monitoring. Together with the information produced by both ANEEL and ONS, it will be possible to monitor the grid power mix in order to recalculate the combined margin at any renewal of the crediting period.

Before the first crediting period, the Monitoring Plan 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 entity responsible for the monitoring process will be AES Tietê S.A. at the *Centro de Operação da Geração* (COG) located in the municipality of Bauru, in the State of São Paulo. AES Tietê will be responsible for data collection, management, and archive. The Monitoring Plan will be based on the internal corporate procedure entitled "Procedimentos para Estabelecimento de Fronteiras e Responsabilidades sobre o Sistema de Medição para Faturamento da AES Tietê S.A. (MED-001)". The procedure serves as a guideline for power control and monitoring according to procedures pre-defined by ONS[28] and approved by ANEEL.

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

Date of completion: 01/10/2007
Name of the responsible person/entity:

- Demóstenes Barbosa Silva, AES Tietê S.A. for AES Rio PCH Ltda.

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- João M. Franco, MGM International SRL (technical consultant) for AES Rio PCH Ltda.

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Both MGM International and AES Tietê S.A. are not project participants.

[28] ONS control and monitoring procedures may be viewed at http://www.ons.org.br/procedimentos/index.aspx. These include normative documents which define necessary requirements for electricity sector agents to operate within the national integrated electricity system.

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[29]:

29/01/2007

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

30 years and 0 months

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

Renewable crediting period

C.2.1. Renewable crediting period

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

01/01/2010

The crediting period will start on January 01, 2010, or on the date of registration of the CDM project activity, whichever is later.

C.2.1.2. Length of the first crediting period:

7 years and 0 months

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

NA

C.2.2.2. Length:

NA

SECTION D. Environmental impacts

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

Although small hydropower plants are supposed to receive quicker environment impact assessment, the Brazilian federal legislation establishes the following step process.

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[29] According to EB33, the starting date of a CDM project activity is the date at which the implementation or construction or real action of a project activity begins.

Prior to the EPC (Engineering Procurement and Construction) process, a hydro power plant should receive a previous environment assessment in order to receive a previous permit: LP (Licença Previa). With this previous permit in hand the project owner should detail the project and, having the detailed project, submit it to the same Environment Agency responsible for the previous permit. From this second round environmental assessment, the positive result is an installation permit: LI (Licença de Instalação) which establishes the requirements for the construction of the hydro power plant. These requirements refer, normally, to cares to be present during the construction phase as much as programs to be designed for specific purposes like fish stock preservation, riparian areas recuperations etc. The final necessary permit to be issued is the operating permit (Licença de Operação*:* LO).

An EIA (Environmental Impact Assessment) was conducted for each proposed small hydro power plant, and assessed by the State Environment Agency, FEEMA[30].

The power plants have the following LP and LI licenses issued by FEEMA:

- (LP): FE 2586 (valid until 08/01/2006)
- (LP): FE 2587 (valid until 08/01/2006)
- (LP): FE 2588 (valid until 08/01/2006)

- (LI): FE013396 (issued on 05/10/2007)
- (LI): FE013398 (issued on 05/10/2007)
- (LI): FE013397 (issued on 05/10/2007)

These (LI) licenses remain valid during a period of 03 years.

No transboundary environmental impacts are expected from this project activity.

Contribution from the project activity to sustainable local development

Several positive impacts for sustainable development are expected from the implementation of the project activity. Some of the environmental and socio-economic benefits that are expected due to implementation of the proposed small hydroelectric projects are:

a) Employment generation during construction of the three power plants for over 480 to 785 persons for a period of 18 to 24 months.
b) Generation of permanent employment during operation lifetime of the three projects. A minimum of 15 job positions are expected to be necessary to run these plants.
c) Rural infrastructure development such as creation or improvement of the existing roads, establishment of schools and other civic amenities such as medical facilities, regular bus transport lines etc.
d) Urban infrastructure development: investment in water treatment stations, wastewater collection and treatment facilities, final disposal sites for urban solid waste and river water quality monitoring system;

[30] FEEMA – Fundação Estadual de Engenharia do Meio Ambiente, www.feema.rj.gov.br, is the State agency in the Rio de Janeiro State, responsible for environmental permits.

e) Creation of local conservation areas – as parks or reserves – in order to promote the conservation of wildlife and threatened plants and animal species.

f) Implementation of a riparian areas restoration program, through the promotion of natural regeneration and reforestation where necessary, in order to create the conditions to improve the quality of the water along the Piabanha River and its tributaries.

g) Implementation of a greenhouse and seeds nursery in order to replicate native vegetation species buds, to be planted through the above referred program;

h) Implementation of a fish species monitoring program, in order to survey the local species, their genetic variability, their population and availability for sport fishing;

i) Implementation of fish species restoration program, through protection of breeding springs and, if necessary, artificial breeding and reproduction to release young fish specimens in the river;

j) Promotion of recreational uses of the reservoir lake, in order to generate local revenues from the economical use of the reservoir and its borders.

k) Meeting the power demands of the region through sustainable electricity generation.

l) Reduction of greenhouse gases and air pollutants (especially NOx, SO2, particulates) from combustion of fossil fuels.

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 projects are run-of-river small hydropower plants, therefore, the environmental impact is very small compared to other types of power generations alternatives. The licenses (LIs) for all three small hydro plants were granted by FEEMA based on an approved Environmental Program designed by FEEMA and the project proponent.

SECTION E. Stakeholders' comments

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

The Resolution number 1, issued by CIMG (Comissão Interministerial de Mudança Global do Clima) or the 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 by mail to participate in this process in September 12th, 2007 were the following:

- Prefeitura Municipal de Areal
- Secretaria de Obras, Serviço Público, Transporte, Agricultura e Meio Ambiente de Areal
- Câmara Municipal de Areal
- Associação Comercial e Industrial de Areal
- Prefeitura Municipal de Paraíba do Sul
- Secretaria Municipal de Infra-Estrutura e Meio Ambiente de Paraíba do Sul
- Câmara dos Dirigentes Lojistas de Paraíba do Sul
- Câmara Municipal de Paraíba do Sul
- Prefeitura Municipal de Petrópolis
- Secretaria Municipal de Meio Ambiente e Desenvolvimento Sustentável de Petrópolis
- Câmara Municipal de Petrópolis
- Casa da Cidadania - Petrópolis
- Associação Comercial e Empresarial de Petrópolis
- Prefeitura Municipal de Três Rios
- Secretaria Municipal de Meio Ambiente de Três Rios
- Câmara Municipal de Três Rios
- SICOMÉRCIO – Três Rios
- 6º Centro de Apoio Operacional de Defesa da Cidadania do Consumidor e Proteção ao Meio Ambiente e Patrimônio Cultural
- Centro Regional de Apoio Administrativo e Institucional de Petrópolis
- Ministério Público do Rio de Janeiro
- Fundação Estadual de Engenharia do Meio Ambiente - FEEMA
- Secretaria de Estado do Ambiente - SEA
- Associação de Usuários das Águas do Médio Paraíba do Sul – AMPAS
- Comitê de Bacia Hidrográfica do rio Piabanha e Sub-bacias Hidrográficas dos rios Paquequer e Preto
- Fórum Brasileiro de ONGs e Movimentos Sociais para o Meio Ambiente

The following documents were made publicly available at http://www.aestiete.com.br to all potential stakeholders:

- Executive Summary
- Project Design Document (PDD)
- Annex III (according to Resolution Nº 1 of the CIMGC)

E.2. Summary of the comments received:

>>

No comments were received until now. If any comment would appear during the validation process, due account will be taken.

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

>>

Since no comments were received until now, no adjustments in the project were necessary

Annex 1

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding will be used in this project activity.

Annex 3

BASELINE INFORMATION

The basic data and baseline calculation are presented on a spreadsheet made available to the DOE during the validation process. In this worksheet we can see all the formulas, data and results that compose the Emission Factor adopted in the present project.

The table bellow presents the conclusion of the spreadsheet:

Prepared by AgCert, EcoAdvance, Ecoinvest, Econergy, Ecosecurities and MGM

Source: Operador Nacional do Sistema Elétrico, Centro Nacional de Operação do Sistema, Acompanhamento Diário da Operação do SIN (daily reports from Jan. 1, 2006 to Dec. 31, 2006)

Emission factors for the Brazilian South-Southeast-Midwest interconnected grid

Baseline	EF_{OM} [tCO_2/MWh]	λ_y	Generation [MWh]
2006	0,8071	0,4185	315.192.117
2005	0,9653	0,5275	315.511.628
2004	0,9886	0,4937	301.422.617
	$EF_{OM, simple-adjusted}$ [tCO_2/MWh]	$EF_{BM,2006}$	Default EF_y [tCO_2/MWh]
	0,4749	0,0903	0,2826
	Alternative weights	Default weights	
	w_{OM} = 0,75	w_{OM} = 0,5	Alternative EF_y [tCO_2/MWh]
	w_{BM} = 0,25	w_{BM} = 0,5	0,379

		Imports (MWh)	
$EF_{OM,average}$ [tCO_2/MWh]		net int'l	net national
2006	0,0585	0	3.865.158
2005	0,0546	0	0
2004	0,0596	0	0

Annex 4

MONITORING INFORMATION

According to the consolidated monitoring methodology ACM0002 version 06, where project participants select to calculate emission factors on an *ex-ante* basis, at least EG_Y shall be monitored together with all parameters required to recalculate the combined margin at any renewal of a crediting period.

The methodology ACM0002 describes the procedure and equations for calculating emission reductions from monitored data. For this specific project, the methodology is applied through a spreadsheet model as part of the Monitoring Protocol. As specified on section B.7.2, the entity responsible for monitoring activities will be AES Tietê S.A.

AES Tietê staff 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 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 COG and AES Head Office in São Paulo, Brazil). These data will be archived for two years following the end of the crediting period.

Annex 5

REFERENCES

ACM0002 (2006). Metodologia de Linha de Base Consolidada Aprovada 0002 – Metodologia Consolidada para geração de eletricidade interligada à rede a partir de fontes renováveis. Versão 6, de 19 de maio de 2006. website: http://cdm.unfccc.int/.

ANEEL (2006), Resumo Geral dos Novos Empreendimento de Geração, Superintendência de Fiscalização dos Serviços de Geração –SFG, Agência Nacional de Energia Elétrica, 15 de novembro de 2006. web-site: http://www.aneel.gov.br/area.cfm?idArea=37 (Resumo Geral)

Banco Central do Brasil (Histórico das Taxas de Juros). web-site: http://www.bcb.gov.br/?COPOMJUROS

BNDES (2000). O setor elétrico – Desempenho 1993/1999. Banco Nacional de Desenvolvimento Econômico e Social. Informe Infra-estrutura, nº. 53. http://www.bndes.gov.br/.

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.

Ministério das Minas e Energia - Balanço Energético Nacional (BEN) web-site: http://www.mme.gov.br/site/menu/select_main_menu_item.do?channelId=1432

OCDE (2001). OCDE Economic Surveys: Brasil. Organization for Economic Co-Operation and Development, Paris, França.

ONS. Operador Nacional do Sistema Elétrico Brasileiro. website: http://www.ons.gov.br/.

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.