ZÉ TUNIN SMALL HYDROPOWER PLANT PROJECT ACTIVITY

Document Prepared By Ecopart Assessoria em Negócios Empresariais Ltda.

Contact Information

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PROJECT DETAILS

1.1 Summary Description of the Project

The primary objective of Zé Tunin Small Hydropower Plant Project Activity is to help meet Brazil's rising demand for energy due to economic growth and to improve the supply of electricity, while contributing to environmental, social and economic sustainability by increasing the share of renewable energy in total electricity consumption for Brazil (and for the region of Latin America and the Caribbean).

Countries in the Latin America and the Caribbean region have expressed their commitment towards achieving a target of 10% renewable energy of total energy use in the region. Through an initiative from the Ministers of the Environment in 2002, a preliminary meeting of the World Summit for Sustainable Development (WSSD) was held in Johannesburg in 2002. In the WSSD final Plan of Implementation no specific targets or timeframes were stated, however, their importance was recognized for achieving sustainability in accordance with the Millennium Development Goals.

The privatization process of the Brazilian electric sector, initiated in 1995 commenced with the expectation of adequate tariffs (fewer subsidies) and better prices for generators. It drew the attention of investors to possible alternatives not available in the centrally planned electricity market. Unfortunately, the Brazilian energy market lacked a consistent expansion plan; the current expansion plan contains major problems such as political and regulatory uncertainties. In the late 1990's a strong increase in demand contrasted with a less-than-average increase in installed capacity caused the outbreak of the supply crisis/rationing in 2001/2002. One of the solutions the government provided was flexible legislation, which favoured smaller independent energy producers. Furthermore, the possible eligibility under the Clean Development Mechanism of the Kyoto Protocol drew the attention of investors to small hydropower projects.

The project consists of the construction of a small hydroelectric power plant ("PCH", from the Portuguese Pequena Central Hidrelétrica): Zé Tunin with 8 MW of installed capacity and 0.367 km2 reservoir area. The plant is located in the Pomba River, state of Minas Gerais, Southeastern region of Brazil. The project is fully operational since January 2013. In addition, Zé Tunin Small Hydropower Plant Project Activity has a diesel generator to ensure operations in case of emergency.

Zé Tunin is owned by Pequena Central Hidrelétrica Zé Tunin S.A., which is a company controlled by Energisa S.A.

Prior to the implementation of the project activity no small hydropower plant was operational in the location where Zé Tunin project was built. The project activity reduces GHG emissions by avoiding electricity generation from fossil fuel sources, which would be generated (and emitted) in the absence of the project. In conclusion, the baseline scenario and the scenario without the project activity are the same.

According to the applicable methodology, in the project activity scenario, there are emissions of methane (CH4) from the water reservoir of hydropower plants. However, since the power density of Ze Tunin is greater than 10 W/m^2, there are no GHG emissions involved in the project activity.

Zé Tunin project can be seen as a solution by the private sector to the Brazilian electricity sector since it may help to avoid another electricity supply crisis, contributing to sustainable development and having a positive effect for the country beyond the evident reductions in GHG.

Although Zé Tunin does not have a relevant positive impact in the host country given its electric system size, it is without reasonable doubt part of a greater idea. The project contributes to sustainable development since it meets the present needs without compromising the ability of future generations to meet their own needs, as defined by the Brundtland Commission (1987). In other words, the implementation of small hydroelectric power plants ensures renewable energy generation, reduces the national electric system demand, avoids negative social and environmental impact caused by the construction of large hydropower plants with large reservoirs and fossil fuel thermo power plants, and drives regional economies, increasing quality of life in local communities.

Therefore, indisputably the project has reduced negative environmental impacts and has developed the regional economies, resulting, consequently, in better quality of life. In other words, environmental sustainability combined with social and economic justice, undeniably contribute to the host country's sustainable development.

1.2 Sectoral Scope and Project Type

Sectoral scope 1 - Energy (renewable/non-renewable).

The project consists of the construction of a single Small Hydro Power Plant, hence it does not correspond to a grouped project.

1.3 Project Proponent

Organization name	Pequena Central Hidrelétrica Zé Tunin S.A.
Contact person	Gustavo Nasser Moreira
Title	-
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1.4 Other Entities Involved in the Project

Organization name	Ecopart Assessoria em Negócios Empresariais Ltda.
Role in the project	Carbon Credits consultancy
Contact person	Melissa Sawaya Hirschheimer
Title	-
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1.5 Project Start Date

The proposed Small Hydro Power Plant became operational on December 27th, 2012[1], that was when the project began generating GHG emission reductions.

1.6 Project Crediting Period

The project crediting period starts on January 1st, 2013 and ends December 31st, 2022, totalizing 10 years of crediting period.

1.7 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	X
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
Year A (2013)	18,479
Year B (2014)	18,479
Year C (2015)	18,479
Year D (2016)	18,479
Year E (2017)	18,479
Year F (2018)	18,479
Year G (2019)	18,479
Year H (2020)	18,479
Year I (2021)	18,479
Year J (2022)	18,479
Total estimated ERs	**184,787**
Total number of crediting years	**10**
Average annual ERs	**18,479**

[1] ANEEL Ordinance nr. 4,126. Available at: <http://www.aneel.gov.br/cedoc/dsp20124126.pdf>.

1.8 Description of the Project Activity

Kaplan turbines are well suited to situations in which there is a low head and a large amount of discharge. The adjustable runner blades enable high efficiency during partial load periods, and there is a very small decrease in efficiency due to head variation or load. As a result of recent developments, the range of Kaplan turbine applications has been greatly increased. They are being applied, for example, in exploiting many hydro sources previously discarded for economic or environmental reasons. The adjustable runner blades add to the complexity of the construction of a Kaplan turbine. The runner blade operating mechanism consists of a pressure oil head, a runner servomotor, and the blade operating rod inside the shaft.

Figure 1 - Example of a Kaplan Turbine

Source: Hydrohrom (2013)[2]

In the absence of the project activity all the energy would be supplied by other plants of the interconnected grid. Hence, the baseline scenario is identified as the continuation of the current (previous) situation of electricity. Prior to the implementation of the project activity there was no hydro operational in the same location of the project activity. Thus, the baseline scenario and the scenario without the project activity are the same.

This cleaner source of electricity also provides an important contribution to environmental sustainability by reducing carbon dioxide emissions that otherwise would have occurred in the absence of the project. The project activity reduces emissions of greenhouse gas (GHG) by avoiding electricity generation from fossil fuel sources (and CO_2 emissions), which would be generated (and emitted) in the absence of the project.
In addition, Zé Tunin project has a diesel generator to ensure operations in case of emergency. The technical description is presented in the Table 1 below.

[2] Available at <http://www.hydrohrom.cz/Obr/photo/Sredno.jpg>. Accessed on May 3rd, 2013.

The equipment and technology used in the Project has been successfully applied to similar projects in Brazil and around the world. Technical description is as follows according to the equipment TAG.

Table 1 - Technical description of the project

Turbines	
Type	Kaplan S
Quantity	2
Nominal power (kW)	4,160
Rotation (r.p.m.)	327.3
Generators	
Quantity	2
Power (kVA)	4,345
Power factor (%)	92
Nominal tension (kV)	6.9
Diesel Generator	
Model	GTA 251 AI27
Motor nr.	G12G03767
Generator nr.	1016467917
Power (kVA)	200
Power factor	0.8
Frequency (Hz)	60
Voltage (V)	380
Rotation (rpm)	1,800
Manufacturer	WEG

The average lifetime of the main equipment (turbine and generator) used in the project is based on the ANEEL's publication "*Manual de controle patrimonial do setor elétrico*", which presents 30 years for the generators and 40 years for the turbines[3]. Therefore, the project lifetime is of 30 years, which is the same period authorized for the project proponent to explore the hydropower potential of PCH Zé Tunin as established by the Brazilian Power Regulatory Agency through ANEEL Resolution nr. 2,994 dated July 5th, 2011.

1.9 Project Location

The PCH Zé Tunin uses the hydropower potential of Pomba River and is located in the Southeastern region of Brazil, state of Minas Gerais, Astolfo Dutra and Guarani municipalities

[3] Available at the ANEEL's website: <http://www.aneel.gov.br/cedoc/aren2009367_2.pdf>. This publication was approved by ANEEL Resolution nr. 367 dated June 2nd, 2009, available at: <http://www.aneel.gov.br/cedoc/ren2009367.pdf>.

(Figure 2, Figure 3 and Figure 4), between the geographical coordinates[4] 21°18'54''S and 42°56'42''W.

Figure 2 - Map of Brazil presenting the project location. Source: GOOGLE EARTH (2011)[5]

Figure 3 - Municipality of Guarani[6]

Figure 4 - Municipality of Astolfo Dutra[7]

Astolfo Dutra municipality has 13,048 inhabitants, 158.891 km^2 and is located 288 km far from Belo Horizonte, capital of Minas Gerais state. Guarani municipality has 8,678 inhabitants, 264.194 km^2 and it is 280 km far from Belo Horizonte[8][9].

1.10 Conditions Prior to Project Initiation

Prior to the implementation of PCH Zé Tunin, there was no operational power plant in the project location, thus, the electricity was supplied by the existing power plants connected to the grid. Therefore, primary purpose of the project activity is the renewable electricity generation to the national interconnected system.

[4] ANEEL Ordinance nr. 2,994 dated July 05th, 2011. Information available at: <http://www.aneel.gov.br/cedoc/rea20112994.pdf>.
[5] Available at <http://earth.google.com/>. Accessed on January 10th, 2013
[6] Available a: <http://pt.wikipedia.org/wiki/Guarani_(Minas_Gerais)>. Accessed on January 10th, 2013
[7] Available at <http://pt.wikipedia.org/wiki/Astolfo_Dutra>. Accessed on January 10th, 2013
[8] IBGE (2011). Database – Cities. Brazilian Statistic and Geographic Institute (in a free translation from the Portuguese *Instituto Brasileiro de Geografia e Estatística - IBGE*). Available at <http://www.ibge.gov.br/cidadesat/topwindow.htm?1>.
[9] DER. Road map of Minas Gerais. Departamento de Estrada e Rodagem. Available at: <http://www.der.mg.gov.br/mapa_internet2/mapa-rodoviario.htm>. Accessed on January 10th, 2013

1.11 Compliance with Laws, Statutes and Other Regulatory Frameworks

The project has all relevant environmental licenses and permissions issued and in compliance with Brazilian Regulation. The Operation License nº 0677 ZM was issued on 26/11/2012 by the Minas Gerais Environmental Agency (from the Portuguese *Fundação Estadual do Meio Ambiente – FEAM*") and it is valid until 26/11/2018.

The authorization nr. 2,994 dated on 05/07/2011 issued by the National Agency of Electric Energy (ANEEL) is a proof that the project is in compliance with the Government requirements.

1.12 Ownership and Other Programs

1.12.1 Right of Use

According to ANEEL Resolution nr. 2,994 dated July 5th, 2011, Pequena Central Hidrelétrica Zé Tunin S.A. is authorized to explore the hydropower potential of PCH Zé Tunin. Therefore, the project proponent has the right of use of the proposed project activity and eventual credits generated by it.

1.12.2 Emissions Trading Programs and Other Binding Limits

Not applicable. The project will not be used for compliance with an emissions trading program or to meet binding limits on GHG emissions.

1.12.3 Other Forms of Environmental Credit

The project activity was or will not generate any other form of GHG related environmental credit for GHG emission reductions under the VCS Program. Any credit has been or will be cancelled from the VCS Program.

1.12.4 Participation under Other GHG Programs

The project activity is not registered or is seeking registration under any other GHG program.

1.12.5 Projects Rejected by Other GHG Programs

The project activity did nor does not participate in any other GHG program and, therefore, was not rejected by other GHG program.

1.13 Additional Information Relevant to the Project

Eligibility Criteria

Not applicable.

Leakage Management

Not applicable.

Commercially Sensitive Information

Not applicable.

Further Information

Not applicable.

2 APPLICATION OF METHODOLOGY

2.1 Title and Reference of Methodology

The project uses the Clean Development Mechanism (CDM) methodology: AMS-I.D - Grid connected renewable electricity generation (version 17.0)[10], also approved by the VCS Program.

The AMS-I.D also refers to the following tools:

- Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion (version 02);
- Tool to calculate the emission factor for an electricity system (version 03.0.0).

2.2 Applicability of Methodology

Category I.D – ***Grid connected renewable electricity generation***

From AMS-I.D:

"*1. This methodology comprises renewable energy generation units, such as photovoltaic, hydro, tidal/wave, wind, geothermal and renewable biomass:*

(a) Supplying electricity to a national or a regional grid; or

(b) Supplying electricity to an identified consumer facility via national/regional grid through a contractual arrangement such as wheeling.

The project activity consists of a small-hydro power plant connected to the grid (option a).

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

As described above, the Zé Tunin Small Hydropower Plant supplies electricity to Brazilian grid. Therefore, as described in Table 2 of the methodology, AMS-I.D. is suitable to the proposed project activity.

[10] Available at: <http://cdm.unfccc.int/methodologies/DB/RSCTZ8SKT4F7N1CFDXCSA7BDQ7FU1X>. Accessed on April 22nd, 2013.

3. This methodology is applicable to project activities that: (a) Install a new power plant at a site where there was no renewable energy power plant operating prior to the implementation of the project activity (Greenfield plant); (b) Involve a capacity addition; (c) Involve a retrofit of (an) existing plant(s); or (d) Involve a replacement of (an) existing plant(s).

The proposed project activity corresponds to option a) above, *i.e.* a Greenfield plant.

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

- *The project activity is implemented in an existing reservoir with no change in the volume of reservoir;*
- *The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the Project Emissions section, is greater than 4 W/m^2;*
- *The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the Project Emissions section, is greater than 4 W/m^2."*

The power density of the plant is 21.8 W/m^2 (as determined below in section 3.2). Therefore, the proposed project activity satisfies this applicability condition.

5. If the new unit has both renewable and non-renewable components (e.g. a wind/diesel unit), the eligibility limit of 15 MW for a small-scale CDM project activity applies only to the renewable component. If the new unit co-fires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15 MW.

The proposed project activity has not non-renewable components. Hence, it does not co-fire fossil fuels. The maximum output capacity of Zé Tunin Small Hydropower Plant is 8 MW and which will not increase beyond 15MW.

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

Not applicable. The proposed project activity does not correspond to a combined heat and power system.

7. In the case of project activities that involve the addition of renewable energy generation units at an existing renewable power generation facility, the added capacity of the units added by the project should be lower than 15 MW and should be physically distinct from the existing units.

Not applicable. As discussed above, the proposed project activity corresponds to a Greenfield plant.

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

Not applicable. As discussed above, the proposed project activity corresponds to a Greenfield plant.

2.3 Project Boundary

According to AMS-I.D, "*the spatial extent of the project boundary includes the project power plant and all power plants connected physically to the electricity system which the CDM project power plant is connected to*".

Source		Gas	Included?	Justification/Explanation
Baseline	CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
		Other	No	Minor emission source
Project	Source 1	CO_2	No	Minor emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
		Other	No	Minor emission source

In addition, a diagram of the project boundary is provided below:

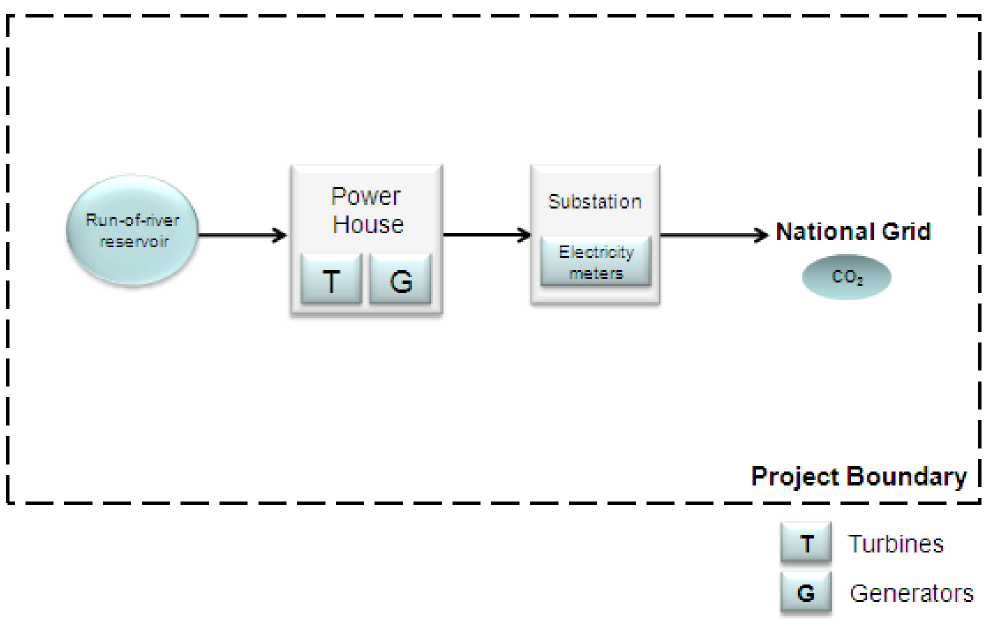

Figure 5 – Project Boundary of the project activity

2.4 Baseline Scenario

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

2.5 Additionality

Project Participants held a timeline of the project with dates of actions for the project implementation:

Table 2 – Project starting date

Date	Evidence
05/07/2011	Authorization to explore the hydropower potential – ANEEL Resolution nr. 2,994[11]
15/08/2011	EPC[12] contract signature, including the supply of main equipment's (turbines and generators)
01/09/2011	Construction License issuance
10/10/2012	PPA signature
26/11/2012	Operation License issuance
29/11/2012	O&M contract signature
26/12/2012	Financing contract signature
27/12/2012	Start of commercial operation[13]

Considering information above, the Project Participants considered the investment decision as the date in which project sponsors committed expenditures, *i.e.*, the date in which Zé Tunin project signed the EPC contract on August 15th, 2011. All documents related to the dates mentioned above are available with Project Participants and will be presented to DOE during validation.

The additionality of the proposed project activity follows the AMS-I.D methodology and the "Guidelines on the demonstration of additionality of small-scale project activities"[14].

According to the above mentioned documents, the additionality of the project shall be demonstrated by providing 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;

[11] Available at: <http://www.aneel.gov.br/cedoc/rea20112994.pdf>.
[12] Engineering, procurement and construction contract.
[13] ANEEL Ordinance nr. 4,126. Available at: <http://www.aneel.gov.br/cedoc/dsp20124126.pdf >.
[14] Available at: <https://cdm.unfccc.int/Reference/Guidclarif/meth/methSSC_guid05.pdf>.

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.

Considering the barriers presented above, the additionality of the proposed project will be conducted in the light of the investment barrier (item (a) above).

In order to demonstrate that the proposed project activity is not financially attractive, the project proponents calculated a financial indicator (the Internal Rate of Return – IRR) and compared to a benchmark of the electric sector (Weighted Average Cost of Capital – WACC) as described below.

→ ***Benchmark – Weighted Average Cost of Capital (WACC)***

The weighted-average cost of capital (WACC) is a rate used to discount business cash flows and takes into consideration the cost of debt and the cost of equity of a typical investor in the sector of the project activity. The benchmark can be applied to the cash flow of the project as a discount rate when calculating the net present value (NPV) of the same, or simply by comparing its value to the internal rate of return (IRR) of the project. The WACC considers that shareholders expect compensation towards the projected risk of investing resources in a specific sector or industry in a particular country.

The WACC calculation is based on parameters that are standard in the market, considers the specific characteristics of the project type, and is not linked to the subjective profitability expectation or risk profile of this particular project developer. Once a hydro power potential is discovered, any corporate entity is able to obtain the authorization from the government to build a small hydropower plant. In addition to that, even after the project proponent obtains such authorization, it can be negotiated/sold afterwards. Therefore, the use a sectorial benchmark is applicable as per the guidance provided in paragraph 13, Annex 5, EB 62.

The WACC of the sector presented here was calculated based on the year of 2011, which corresponds to the year when the EPC Contract signature occurred and also is considered the time of the investment decision. As per paragraph 6, Annex 5, EB 62 "*Input values used in all investment analysis should be valid and applicable at the time of the investment decision*". The WACC is equal to 10.83% and was calculated through the formula below:

WACC = Wd x Kd + We x Ke, where:

We and **Wd** are, respectively, the weights of equity and debt typically observed at the sector - **We** is of 31.03% and **Wd** is of 68.97%. These numbers are derived from the typical leverage of similar projects in this sector in Brazil, based on the rules for available long term loans from Brazilian Development Bank (BNDES - from the Portuguese *Banco Nacional de Desenvolvimento Econômico e Social*). BNDES is the major provider of long-term loans in the country; it supplies financing for small to large scale projects. Long-term loans are scarcely provided by commercial banks, and in general, these entities do not have competitive rates compared to the BNDES.

→ *Cost of Debt (Kd)*

Kd is the cost of debt, which is observed in the market related to the project activity, and which already accounts for the tax benefits of contracting debts. **Kd** also derives from long term loans applied to the sector in Brazil, and therefore is based on three variables, including the BNDES financing endeavour credit line's interest rates. Kd is calculated considering the sum of:

- Financial cost (**a**);
- BNDES remuneration (**b**);
- Credit risk rate (**c**).

The financial cost (**a**) is represented by the Long Term Interest Rate ("TJLP" from the Portuguese *Taxa de Juros a Longo Prazo*). TJLP is a variable market figure which assesses the rate of debt to apply to the average party borrowing from BNDES. This figure is the underlying majority found in the debt portion of borrowers from the BNDES. The TJLP is based on factors pertaining to market rates and spread of corporate rates over government risk.

The BNDES remuneration (**b**) and the credit risk rate (**c**) are two other factors compose the rate of debt companies in Brazil encounter via BNDES. The BNDES remuneration is the fee attached by BNDES for its administrative and operational costs, and for its remuneration. This rate varies according to BNDES policies and is non-negotiable and the least arguable rate in the equation. Regarding the credit risk rate, each year BNDES provides the lower and upper limits of the variation margin of that rate. It respects its perception of the risks, and the bank policies. For the purposes of our calculation and due to the fact that the industry as a whole is being considered, we estimate that rate by averaging the upper limit of the mar-gin with the rate established for loans to direct public administration of States and Cities, which is the lowest rate that could be provided to a private investor.

Two other components for the **Kd** calculation are the marginal tax rate (**t**) and inflation forecast (π). In the **Kd** calculation, the marginal tax rate (**t**) is multiplied by the Cost of debt and then by the debt to total cost of capital ratio to ascertain the debt portion of the WACC formula. In the case of Brazil, and specifically to energy projects, this tax factor could either be 34% or 0%. This is decided by the specific type of project and tax regime under which it sits. In the case of PCH Zé Tunin project, **t** = 0%, since it is based on the Presumed Profit regime.

For the Presumed Profit eligibility, corporate entities revenues must be under Forty eight million Reais per year (Article #13, Law #9.718/1998)[15].

For the Presumed Profit system, 8% of gross sales in addition to financial revenues/earnings is used as basis for the income tax calculation. To this figure a 25% rate is applied resulting in the final income tax value. For the social contribution calculation 12% of gross sales in addition to financial revenues/earnings is used as a basis for the calculation. To this figure a 9% rate is applied resulting in the final social contribution value (As per Article #518 of the Federal Decree #3000, dated 26 March 1999)[16].

Table 3 - Income Tax and Social Contribution (illustrative calculation)

Income Tax	**$**
Gross Sales	1.000
Presumed Profit for income tax (8%)	80
Financial revenue	500
Total Presumed for income tax	580
Income tax due (app. 25%)	145

Social contribution	**$**
Gross Sales	1.000
Presumed Profit for social contribution (12%)	120
Financial revenue	500
Total Presumed Profit for social contribution	620
Social contribution due (9%)	55.80

Source: KPMG. "Investment in Brazil: tax." (2008)[17]

Therefore, a corporate entity that opts for the presumed profit scheme pays the same rate of income tax and social contribution regardless of its costs, expenses, other cash items such as payable interest and non-cash items such as depreciation, because these elements are not deductible under this system.

The nominal rate achieved for debt is used to calculate nominal WACC, which is used to discount nominal cash flow projections. In order to achieve the real cash flow rate, the inflation targeting figure (π) for Brazil is reduced from the nominal figure achieved. The π is obtained from the Brazilian Central Bank (www.bcb.gov.br) and has experienced very little variance in the past 5 years.

Considering explanations above, **Kd** is calculated through the following equation:

$$\mathbf{Kd = [1 + (a + b + c) \times (1 - t)] / [(1 + \pi) - 1]}$$

[15] Publicly available information in Portuguese at: <http://www.receita.fazenda.gov.br/legislacao/leis/Ant2001/lei971898.htm>.
[16] Publicly available information in Portuguese at: <http://www.receita.fazenda.gov.br/legislacao/leis/L2Parte3.htm>.
[17] KPMG. Investment in Brazil: tax. São Paulo: Escrituras Editora, 2008. Publicly available in English at <http://www.kpmg.com.br/publicacoes/livros_tecnicos/Investment_in_Brazil10_out08.pdf>.

Table 4 – Cost of Debt (Kd) calculation

Cost of Debt (Kd)	
(a) Financial cost[18]	6.53%
(b) BNDES spread[19]	0.90%
(c) Credit risk rate[20]	4.18%
(a+b+c) Pre-Cost of Debt	11.61%
(t) Marginal tax rate[21]	0.00%
(d) Inflation forecast[22]	4.50%
After tax Cost of Debt	6.80% p.a.

Each data used to calculate **Kd** will be presented to the DOE. The spreadsheet used for WACC calculation will be available with the Project Participants and will be provided to the DOE.

→ *Cost of Equity (Ke)*

Ke represents the rate of return for equity investments, and is a summation of the following parameters:

- Risk-free rate (**Rf**);
- Equity risk premium (**Rm**);
- Estimated country risk premium (**Rc**);

[18] 5-year average of the Long term Interest Rate (from the Portuguese *Taxa de Juros de Longo Prazo – TJLP*). Available at BNDES' website: <http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Institucional/Apoio_Financeiro/Custos_Financeiros/Taxa_de_Juros_de_Longo_Prazo_TJLP/index.html>.

[19] BNDES' remuneration. BNDES' policies. Available at <http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Institucional/Apoio_Financeiro/Produtos/FINEM/meio_ambiente.html>.

[20] Credit risk rate. BNDES' policies. Available at <http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Institucional/Apoio_Financeiro/Produtos/FINEM/meio_ambiente.html>.

[21] Taxes calculated based on an assumed percentage over the gross revenue.

[22] Central Bank of Brazil. Brazilian inflation targeting. Available at: <http://www.bcb.gov.br/pec/metas/InflationTargetingTable.pdf>

- Sectorial risk (**β**).

Rf stands for the risk free rate. The risk-free rate used for **Ke** calculation was a long term bond rate. This bond was issued by the Brazilian government, denominated in US dollars. Therefore the rate includes the Brazilian country risk. There is a higher risk associated to investing in Brazil, or in Brazilian bonds, compared to investing in a mature market such as the United States. This risk is reflected in higher returns expected on Brazilian government bonds compared to the mature markets government bonds. In considering the Brazilian government bond, this premium for a higher risk is captured in our calculations.

In order to adjust the risk-free rate (**Rf**) to the inflation adjusted rate, the expected inflation rate (for the United States) (π**'**) is reduced. For its calculation is considered the 10 Year Treasury Note (^TNX), and the TIPS (Treasury Inflation Protected Securities), which are readily quoted in the US market. The ^TNX index carries inflation on their value while the TIPS is an index without inflation. The subtraction from the chosen period average values from the ^TNX and the TIPS results in the estimated inflation. There is no need to adjust for Brazil's expected inflation when dealing with a hurdle rate in real terms.

The sectorial risk (Beta or **β**), stands for the average sensitivity of comparable companies in that industry to movements in the underlying market. **β** derives from the correlation between returns of US companies from the sector and the performance of the returns of the US market. **β** has been adjusted to the leverage of Brazilian companies in the sector, reflecting both structural and financial risks. **β** adjusts the market premium to the sector.

Rm represents the market premium, or higher return, expected by market participants in light of historical spreads attained from investing in equities versus risk free assets such as government bond rates, investors require a higher return when investing in private companies. The market premium is estimated based on the historical difference between the S&P 500 returns and the long term US bonds returns. The spread over the risk-free rate is the average of the difference between those returns.

Note that in the formula above there is the factor EMBI+ (Emerging Markets Bond Index Plus), considers as the country risk premium, **Rc**. This factor accounts for the country or sovereign risk embedded in the debt of a country. Assuming that relative to the US risk-free debt market EMBI+ is 0, then Brazil's EMBI+ would calculate for the added or reduced risk relative of Brazils debt markets to the US.

Justification for the EMBI+ addition to the risk-free rate lies in the vast differences between the United States in such factors as credit risk, inflation history, politics, debt markets, and more. Ignoring these differences would result in the incorrect application of relevant environmental factors in the decision-making process of an investor in Brazil.

As mentioned in the **Kd** calculation, in order to achieve the real cash flow rate, the inflation targeting figure (π) for Brazil is reduced from the nominal figure achieved from the Brazilian Central Bank. This is also applied in **Ke** calculation.

Considering explanation above, Ke is calculated through the following equation:

$$Ke = [(1 + Rf) / (1 + \pi') - 1] + (\beta \times Rm) + Rc$$

Table 5 – Cost of Equity (Ke) calculation

Cost of Equity	
(Rf) Risk-free rate[23]	4.25%
US expected inflation[24]	1.98%
(Rm) Equity Risk Premium[25]	6.03%
(β) Sectorial risk[26]	2.50
(Rc) Estimated Country Risk Premium[27]	2.45%
Cost of Equity with Brazilian Country Risk	19.78% p.a.

Each data used to calculate **Ke** will be presented to the DOE. The spreadsheet used for WACC calculation will be available with the Project Participants and will be provided to the DOE.

Considering the values presented above, we have the following:

$$WACC = 68.97\% \times 6.80\% + 31.03\% \times 19.78\%$$

$$WACC = 10.83\%$$

→ **Financial indicator – Internal Rate of Return (IRR)**

As mentioned above, the financial indicator identified for PCH Zé Tunin project is the project Internal Rate of Return (IRR). PCH Zé Tunin cash flow over its lifetime shows that the project IRR is 9.42%.

The table presented below provides a list of the main input values considered for the IRR calculation as well as the source of the information used.

[23] 30-year US Treasury Yield. Available at Damodaran's website: <http://pages.stern.nyu.edu/~adamodar/>.

[24] 10-year T.Notes minus 10-year TIPS. Available at the Federal Reserve website: <http://www.federalreserve.gov/econresdata/researchdata.htm>.

[25] Historical S&P500 premium over 10-year US-Treasury Bond. Available at Damodaran's website: <http://pages.stern.nyu.edu/~adamodar/>.

[26] Market weighted average Beta US power Co. re-levered to Brazilian leverage. Available at Damodaran's website: <http://pages.stern.nyu.edu/~adamodar/>.

[27] Emerging Markets Bond Index Plus Brazil. Index calculated by JPMorgan. Available at: <http://www.cbonds.info/all/eng/index/index_detail/group_id/1/>.

Parameter	***Value***	**Justification/source of information used**
Installed Capacity	8 MW	ANEEL Ordinance #2.994, dated 05th, July 2011.
Plant Load Factor (PLF)	65.44%	The PLF was defined in the ANEEL technical record from the Consolidated Project Design ("PBC" from the Portuguese *Projeto Básico Consolidado)* of PCH Zé Tunin prepared by SPEC – Planejamento, Engenharia, Consultoria Ltda, dated on March 2011. Therefore, the project applies option (b) of the “Guidelines for the reporting and validation of plant load factors” (Annex 11, EB 48): *“(b) The plant load factor determined by a third party contracted by the project participants (e.g. an engineering company*)”.
Energy price	151.62 BRL /MWh	Results of the energy auctions conducted in 2010 by CCEE. Average of the energy price for small hydropower plants.
Operational costs	510,125 BRL /year (for 2012 year) 500,045 BRL/year (from 2013 year onwards)	The operational costs considered in the project cash flow are based on the following parameters: • ANEEL fee: ANEEL Dispatch nr. 360 dated February 4th, 2011. Available at: <http://www.aneel.gov.br/cedoc/dsp2011360.pdf> / Law nr. 9,427, December 12th, 1996, available at: <http://www.aneel.gov.br/cedoc/lei19969427.pdf> • O&M cost: Consolidated Project Design ("PBC" from the Portuguese Projeto Básico Consolidado) dated March 2011. • Insurance: Seguro Grupo Energisa, 2010. Percentage of CAPEX (operational) and Gross Income (civil responsability). • TUSD fee: source of information presented below.
100% TUST or TUSD fee	*1.71 BRL* /kW/month (from 18/06/2011 to 17/06/2012) *1.60 BRL/kW/month (from*	In each power project, the Tariff for the Use of the Transmission System (“TUST” from the Portuguese *Tarifa de Uso do Sistema de Transmissão*) or the Tariff for the Use of the Distribution System (“TUSD” from the Portuguese *Tarifa de Uso do Sistema de Distribuição*) fee must be applied in Brazil. The choice of TUSD or TUST fee depends if the power plant is directly or indirectly connected to the electricity

	18/06/2012 onwards)	connection network (in a free translation from the Portuguese *rede básica de conexão*). However, independently if the project is directly or indirectly connected to the electricity connection network, the fee shall be paid. Electricity producers using renewable sources receive a 50% discount in the TUST and TUSD fee. This discount aims at boosting investments in renewable energy projects and shall be considered as a Type E- policy as defined by Annex 3, EB 22. Additionally, according to this clarification, type E- policies[28] do not need to be considered in the development of the baseline scenario if implemented after 11 November 2001. The reduction in the TUST/TUSD fee was established by ANEEL Resolution nr. 77 dated 18/08/2004[29]. Therefore, the discount is not going to be taken into account. In the case of the proposed project activity, the average of the TUSDg values for Palestina and Triunfo SHPPs was taken into account: ANEEL Resolution nr. 1,155 dated June 14th, 2011[30]. Available at: <http://www.aneel.gov.br/cedoc/atreh20111155.pdf>.
Investment (BRL/MW)	6,720,958 BRL	Based on the EPC contract signed on August 15th. 2011.

The project cash flow is available with the Project Participants and was presented to the DOE.

→ **Comparison of Financial Indicators**

The calculation of the IRR of Zé Tunin project results in 9.42%, *i.e.* lower than the benchmark of 10.83%. This result demonstrates that the proposed project activity is not financially attractive to investor.

[28] From paragraph 6.b) of Annex 3, EB 22 Type E- policies are *National and/or sectoral policies or regulations that give comparative advantages to less emissions-intensive technologies over more emissions-intensive technologies (e.g. public subsidies to promote the diffusion of renewable energy or to finance energy efficiency programs).*

[29] Available in Portuguese at <http://www.aneel.gov.br/cedoc/ren2004077.pdf>. Accessed on 02/09/2011.

[30] According to ANEEL Resolution #1 dated 14 June 2011, there are two different values of TUSD tax for Palestina and Triunfo plants. The values R$1.63 per kW (Triunfo plant) and R$1.78 per kW (Palestina plant) should be applies from 18 June 2011 to 17 June 2012 and the values R$1.67 per kW (Palestina plant) and R$1.53 per kW (Triunfo plant) should be applied from 18 June 2012 onwards.

In order to confirm the project additionality, a sensitivity analysis was conducted by altering the project costs in +10% and revenues in -10% as presented below:

- Increase in project revenue (energy price and plant load factor/energy assured);
- Reduction in running costs (operational costs and investments).

The results of the sensitivity analysis are presented below.

Table 6 – Sensitivity analysis

Scenario	% change	IRR (%)
Original	-	9.42
Increase in the energy price	10%	10.53
Increase in the project plant load factor (PLF)/energy assured		10.48
Reduction in project investment		10.57
Reduction in operational costs		9.51

According to the "*Guidelines on the assessment of investment analysis*", whenever a scenario results in an IRR higher than the benchmark, an assessment on the probability of the respective occurrence shall be presented. Although none of the scenarios presented above the IRR reaches or surpasses the benchmark, the Project Participants also conducted the sensitivity analysis by altering each parameter until the IRR reaches the benchmark (10.83%) and analyzed the probability of the occurrence of these scenarios. Results of this sensitivity analysis are presented in the table below:

Table 7 – Sensitivity analysis

Scenario	% change
(a) Increase in the energy price	15.3%
(b) Increase in the project plant load factor (PLF)/energy assured	24.6%
(c) Reduction in operational costs	282.0%
(d) Reduction in project investment	20.5%

The probability of the occurrence of these scenarios is presented below:

(a) Increase in the energy price

The energy price considered in the project cash flow is based on the results of the energy auctions conducted in 2010 by CCEE. The average of the energy price for small hydropower plants results in approximately BRL 151.62/MWh. An increase of 15.3% in the energy price to the IRR reaches the benchmark would result in BRL 174.86/MWh. However, the results of the energy auctions for the electricity supply for the period from 2008 to 2012 demonstrates that the price of BRL 174.86/MWh would not be reasonable.

Table 8 – Energy auction results for new projects for electricity supply from 2008 to 2012

		Hydro	Biomass	Natural gas	Coal	Oil	Wind	Total
2008	MW-ave	121	35	968	276	2,801	0	4,201
	MWh	31,819,128	4,601,520	127,271,256	36,286,272	368,272,536	0	568,250,712
	BRL/MWh	98.98	145.00	141.51	140.00	140.57	0.00	139.59
2009	MW-ave	1	10	0	0	0	0	11
	MWh	262,992	1,314,960	0	0	0	0	1,577,952
	BRL/MWh	144.00	144.60	0.00	0.00	0.00	0.00	144.55
2010	MW-ave	1,295	0	0	0	0	0	1,295
	MWh	340,574,640	0	0	0	0	0	340,574,640
	BRL/MWh	75,43	0.00	0.00	0.00	0.00	0.00	75,43
2011	MW-ave	2,911	682	6,994	0	0	8,624	19,211
	MWh	76,255,370	13,705,446	149,443,278	0	0	150,614,998	390,019,092
	BRL/MWh	98.97	102.68	103.12	0.00	0.00	102.48	102.19
2012	MW-ave	1,506	0	0	0	0	1,516	3,022
	MWh	39,602,981	0	0	0	0	26,578,512	66,181,493
	BRL/MWh	93.46	0.00	0.00	0.00	0.00	87.94	90.69
Total	MW-ave	5,834	727	7,962	276	2,801	10,140	27,740
	MWh	488,515,111	19,621,926	276,714,534	36,286,272	368,272,536	177,193,510	1,366,603,889
	Share	21.0%	2.6%	28.7%	1.0%	10.1%	36.6%	100.0%
	BRL/MWh	108.85	130.76	122.32	140.00	140.57	95.21	105.37

Source: CCEE (2013)[31]

As per the average energy prices indicated above, it is very unlikely that energy prices for hydropower plants would surpass BRL 174.86/MWh – for an IRR above benchmark. The highest energy price for hydropower projects was BRL 144.00/MWh. Therefore, an increase in the energy price to around BRL 174.86/MWh (energy price required to meet the benchmark) is very unlikely to occur.

It is worth mentioning that energy auctions promoted by the government and results are publicly available at the Chamber of Electric Energy Commercialization's website: <http://www.ccee.org.br/>.

(b) Increase in the project plant load factor (PLF)/assured energy

The plant load factor (PLF) of Zé Tunin project is 65.44% as presented in the Consolidated Project Design ("PBC" from the Portuguese *Projeto Básico Consolidado*) prepared by SPEC Planejamento Engenharia Consultoria Ltda. (a third-party company) in March 2011. Considering an increase of 24.6% in the PLF to the IRR reaches the benchmark, the PLF would be 82%.

However, the installed capacity and PLF of a power plant are not freely determined by project sponsors; they shall be calculated according to the methodology established by the Mines and Energy Ministry ("MME" from the Portuguese *Ministério de Minas e Energia*), considering at least 30 years of historical data regarding the project's river and other rivers, such as river flow data, downstream and upstream levels[32]. Therefore, an increase of 24.6% in the energy generation is not reasonable in the project context and is not expected to occur.

It is important to mention that it is the project sponsor and Brazilian government interest that the project shall be designed based on the maximum installed power and energy generation of the power plant (the project cannot be inefficient, should be implemented as effectively as possible). Therefore, the figure used by the Project Participants is not underestimated.

(c) Reduction in project operational costs

Operational costs presented in the project cash flow are composed of ANEEL fee, operational and maintenance costs (O&M costs), insurance and transmission cost. Values considered in the project cash flow are based on the following source of information:

→ ANEEL fee ("TFSEE" from the Portuguese *Taxa de Fiscalização de Serviços de Energia Elétrica*) is based on ANEEL Dispatch nr. 360 dated February 4th, 2011. Available at: <http://www.aneel.gov.br/cedoc/dsp2011360.pdf> / Law nr. 9,427, December 12th, 1996, available at: <http://www.aneel.gov.br/cedoc/lei19969427.pdf>

[31] Chamber of Electric Energy Commercialization (from the Portuguese *Câmara de Comercialização de Energia Elétrica – CCEE*). Available at: <http://www.ccee.org.br/>.

[32] MME Ordinance nr. 463 dated December 3rd, 2009. Available at: <http://www.aneel.gov.br/cedoc/prt2009463mme.pdf>.

→ O&M costs: Consolidated Project Design ("PBC" from the Portuguese Projeto Básico Consolidado) dated March 2011.

→ Insurance: Seguro Grupo Energisa, 2010. Percentage of CAPEX (operational) and Gross Income (civil responsability).

→ Transmission costs ("TUSD" from the Portuguese *Tarifa de Uso do Sistema de Distribuição*) are based on the ANEEL Resolution nr. 1,155 dated June 14th, 2011. Available at: <http://www.aneel.gov.br/cedoc/atreh20111155.pdf>.

Considering the project cash flow, the total operational costs result in BRL 510 thousand per year (around 1% from total investment). A reduction in the project costs until the IRR reaches the benchmark would result in a decrease of 282.0% from the estimated operational costs, *i.e.* negative operational cost. Therefore, this scenario is not reasonable in the electricity generation sector and in the context of the proposed project activity and, thus, it is not expected to occur.

It is important to mention that for the O&M cost assumption considered by the project sponsor is very conservative, since the guidance from the Mines and Energy Ministry (MME)/Centrais Elétricas Brasileiras S/A – Eletrobrás) "Guidance for Small Hydropower Plants Studies and Projects"[33] suggests the use of 5% of total investment for annual O&M costs for small hydropower plants in Brazil (around five times higher than the figure used by the project sponsor).

(d) Reduction in project investment

Investment presented in the project cash flow is based on the EPC contract signed on August 15th. 2011, *i.e.* contract available at the time of the investment decision. The investment results in approximately BRL 53,768 MM. A reduction of 20.5% in the project investment to the IRR reaches the benchmark would result in BRL 42,767 MM.

However, the investment based on the EPC contract and considered in the project cash flow is very conservative for 2 (two) reasons:

- The cash flow does not consider monthly payment adjustment from the signature of the EPC contract up to the end of construction, as established in Clause 17 of the contract (for simplification purposes);

- According to Clause 15.5, the EPC contract does not cover costs related to:

  (i) Unforeseen costs due to physical risks (geological, geotechnical and hydrological);

  (ii) Changes in the technical configuration/project design required during the construction/installation and;

  (iii) Other supplementary services not covered in the contract.

[33] Mines and Energy Ministry ("MME" form the Portuguese Ministério de Minas e Energia and Eletrobrás - Centrais Eletricas Brasileiras S.A. (power utility controlled by Brazil federal government) (2000). "Diretrizes para projetos de Pequenas Centrais Elétricas". Page 31 of the pdf document presented to DOE.

In fact, real investments in developing countries are usually higher than the original estimative. This may be evidenced from the estimation of construction costs and schedules in developing countries. Using a sample of 125 projects (59 thermal and 66 hydropower) Bacon and Besant-Jones (1998)[34] indicates that although the ratio of actual to estimated cost can be smaller than one (indicating actual investment smaller than estimated), less than 10% of the analyzed projects had investments lower than those forecasted. One of the conclusions is that "*the estimated values were significantly biased below actual values*".

Further confirmation on that is provided by the Brazilian Association for the Small and Medium Electrical Energy Producers (in a free translation form Portuguese *Associação Brasileira dos Pequenos e Médios Produtores de Energia Elétrica - APMPE*), retained by PPs in order to attain an expert opinion. APMPE's work concludes that the likelihood of higher investments then those previously estimated is probable. In line with the statement of APMPE's president the "Guidance for Small Hydropower Plants Studies and Projects" [35] prepared MME/Eletrobrás recommends in its Annex 3 to add 5% on above estimated for unforeseen expenses. The Project Participants state that the estimated costs presented for the project activity do not include any cost for unforeseen expenses.

In summary, values used in the project cash flow very conservative since they are based on the EPC contract and, generally, actual investments are higher than estimated. Therefore, a 20.5% reduction in project investments is not expected to occur.

All information used in this sensitivity analysis is based on official data and was presented to DOE during the project validation.

Outcome: The results of the sensitivity analysis demonstrates that the IRR of the proposed project activity is below the benchmark, evidencing that project activity is not financially attractive for the investor even when parameters change in favor of the project.

2.6 Methodology Deviations

Not applicable.

3 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

3.1 Baseline Emissions

According to AMS-I.D, the baseline emissions are the product of electrical energy baseline $EG_{BL,y}$ expressed in MWh of electricity produced by the renewable generating unit multiplied by the grid emission factor as presented in the equation below.

[34] R. W. Bacon and J. E. Besant Jones (1998). Estimating construction costs and schedules – Experience with power generation projects in developing countries. Energy Policy, vol. 26, no 4, pp 317-333.

[35] Mines and Energy Ministry ("MME" form the Portuguese Ministério de Minas e Energia and Eletrobrás - Centrais Eletricas Brasileiras S.A. (power utility controlled by Brazil federal government) (2000). "Diretrizes para projetos de Pequenas Centrais Elétricas". Page 58 of the pdf document presented to DOE. Spreadhsheet of the Annex 3 is also attached.

Equation 1

$BE_y = EG_{BL,y} \times EF_{CO2,grid,y}$

Where:

BE_y = Baseline emissions in year y (tCO_2);

$EG_{BL,y}$ = Quantity of net electricity supplied to the grid as a result of the implementation of the CDM project activity in year y (MWh);

$EF_{CO2,grid\ y\ EF}$ = CO_2 emission factor of the grid in year y (tCO_2/MWh).

Regarding the CO_2 emission factor of the grid, AMS-I.D states that it can be calculated according to the following methods:

(a) A combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the "Tool to calculate the Emission Factor for an electricity system"; or

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

Option (a) above will be used. The "Tool for calculation of emission factor for electricity systems" presents the following steps to calculate the Emission Factor:

- **STEP 1** - Identify the relevant electricity systems

According to the tool, "*If the DNA of the host country has published a delineation of the project electricity system and connected electricity systems, these delineations should be used. If such delineations are not available, project participants should define the project electricity system and any connected electricity system and justify and document their assumptions in the CDM-PDD*".

Brazilian DNA published Resolution #8, issued on May 26th, 2008, defines the Brazilian Interconnected Grid as a single system that covers all the five macro-geographical regions of the country (North, Northeast, South, Southeast and Midwest). Hence this figure will be used to calculate the baseline emission factor of the grid.

- **STEP 2** – Choose whether to include off-grid power plants in the project electricity system (optional).

Option I of the tool is chosen, which is to include only grid power plants in the calculation.

- **STEP 3** - Select a method to determine the operating margin (OM).

The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods:

(a) Simple OM, or

(b) Simple adjusted OM, or

(c) Dispatch data analysis OM, or

(d) Average OM.

The simple operating margin can only be used where low-cost/must-run resources constitute less than 50% of total grid generation in: 1) average of 5 most recent years, or 2) based on long-term normalities for hydroelectricity production. Table 9 shows the share of hydroelectricity in the total electricity production for the Brazilian interconnected system. The results show the non-applicability of the simple operating margin to the proposed Project Activity.

Table 9 - Share of hydroelectricity generation in the Brazilian interconnected system, 2008 to 2012

Year	Share of hydroelectricity (%)
2008	88.62%
2009	93.27%
2010	88.77%
2011	91.18%
2012	85.86%

Source: ONS: Histórico de Geração, 2013. Available at: <http://www.ons.org.br/historico/geracao_energia.aspx>.

The fourth alternative, an average operating margin, is an oversimplification and does not reflect in any way the impact of the project activity on the operating margin. The use of the dispatch data analysis method is only applicable to the ex-post vintage for determining the emission factor, which is not the vintage chosen by the project participants. Therefore, the simple adjusted operating margin will be used to determine the grid emission factor.

Further, the ex-ante data vintage is the chosen to estimate the operating margin. Hence, in accordance with the methodology, the emission factor is determined once at the validation stage, thus no monitoring and recalculation of the emissions factor during the crediting period is required. For grid power plants, use a 3-year generation-weighted average, based on the most recent data available at the time of submission of the PD to the DOE for validation.

The PD was submitted to the DOE for validation in 2013. Therefore, data from 2010, 2011 and 2012 are to be used to determine this parameter. In accordance with the explanation provided above in STEP 2, off-grid power plants are not considered in the grid emission factor calculation.

- **STEP 4** - Calculate the operating margin emission factor according to the selected method

According to the tool "*the simple adjusted OM emission factor ($EF_{grid,OM\text{-}adj,y}$) is a variation of the simple OM, where the power plants / units (including imports) are separated in low-cost/must-run power sources (k) and other power sources (m)*."

The simple adjusted OM was calculated based on the net electricity generation and a CO_2 emission factor for each power unit – i.e. similarly to Option A of the simple OM method – as follows:

$$EF_{grid,OM\quad adj,y} = (1 \quad \lambda_y)\ \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} + \lambda_y\ \frac{\sum_k EG_{k,y} \times EF_{EL,k,y}}{\sum_k EG_{k,y}}$$ **Equation 2**

Where,

$EF_{grid,OM\text{-}adj,y}$	=	Simple adjusted operating margin CO_2 emission factor in year y (tCO_2/MWh)
λ_y	=	Factor expressing the percentage of time when low-cost/must-run power units are on the margin in year y
$EG_{m,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EG_{k,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit k in year y (MWh)
$EF_{EL,m,y}$	=	CO2 emission factor of power unit m in year y (tCO_2/MWh)
$EF_{EL,k,y}$	=	CO2 emission factor of power unit k in year y (tCO_2/MWh)
m	=	All grid power units serving the grid in year y except low-cost/must-run power units
k	=	All low-cost/must run grid power units serving the grid in year y
y	=	The relevant year as per the data vintage chosen in Step 3

Determination of $EF_{EL,m,y}$

Considering that only data on electricity generation and the fuel types used in each of the power units was available, the emission factor was be determined based on the CO_2 emission factor of the fuel type used and the efficiency of the power unit, as per Option A2 of the simple OM method. The following formula was used:

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} \quad 3.6}{\eta_{m,y}}$$ **Equation 3**

Where,

$EF_{EL,m,y}$	=	CO_2 emission factor of power unit m in year y (tCO2/MWh)
$EF_{CO2,m,i,y}$	=	Average CO_2 emission factor of fuel type i used in power unit m in year y (tCO2/GJ)

$\eta_{m,y}$ = Average net energy conversion efficiency of power unit m in year y (ratio)

m = All power units serving the grid in year y except low-cost/must-run power units

y = The relevant year as per the data vintage chosen in Step 3

Determination of $EG_{m,y}$

Information used to determine this parameter was supplied by ONS, which is an official source, as recommended by the tool. ONS is a non-profit corporate entity, founded on 26 August 1998, and is responsible for coordinating and controlling the operation of generation and transmission facilities in the Brazilian Interconnected System (SIN) under supervision and regulation of the ANEEL[36].

- **STEP 5** - Calculate the build margin (BM)emission factor

In terms of vintage, option 1 was chosen. In this sense, the build margin is to be calculated using the most recent information available on units already built for sample group *m* at the time of PD submission to the DOE, *i.e.* 2012.

The sample group of power units *m* used to calculate the build margin was determined following the guidance provided by the tool as further discussed in section 3.4 below. The build margin was calculated following the same approach described above in step 4.

- **STEP 6** – Calculate the combined margin (CM) emissions factor

The combined margin calculation is based on method a) provided by the tool, as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \quad w_{OM} + EF_{grid,BM,y} \quad w_{BM}$$ **Equation 4**

Where,

$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year y (tCO_2/MWh);

$EF_{grid,OM,y}$ = Operating margin CO_2 emission factor in year y (tCO_2/MWh);

w_{OM} = Weighting of operating margin emissions factor (%);

w_{BM} = Weighting of build margin emissions factor (%).

According with the Tool, values adopted for ϖ_{OM} and ϖ_{BM} were equal to 0.5 for each one during the 1st crediting period. As mentioned above, the *ex-ante* approach is used.

36 http://www.ons.org.br/institucional/modelo_setorial.aspx?lang=en

3.2 Project Emissions

According to AMS-I.D, for most renewable energy project activities, $PE_y = 0$. However, for the following categories of project activities, project emissions have to be considered following the procedure described in the most recent version of ACM0002:

- Emissions related to the operation of geothermal power plants (e.g. non-condensable gases, electricity/fossil fuel consumption);
- Emissions from water reservoir of hydro power plants.

CO_2 emissions from on-site consumption of fossil fuels due to the project activity shall be calculated using the latest version of the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”.

According to the most recent version available of ACM0002 - “Consolidated baseline methodology for grid-connected electricity generation from renewable sources” (version 13.0.0), emissions shall be accounted in the case of:

(a) Fossil fuel consumption;

(b) Geothermal power plants due to the release of non-condensable gases; and

(c) Water reservoir power plants.

Since, ACM0002 states that the use of fossil fuel for backup and emergency purposes (*e.g.* diesel generator) can be neglected, the only potential greenhouse gas emissions involved in PCH Zé Tunin is related to emissions from water reservoir.

Emissions from water reservoirs of hydro power plants ($PE_{HP,y}$)

For hydro power projects activities that result in new single or multiple reservoirs and hydro power project activities that result in the increase of single or multiple existing reservoirs, project proponents shall account for CH_4 and CO_2 emissions from the reservoirs, estimated as follows:

(a) If the power density of the single or multiple reservoirs (*PD*) is greater than 4 W/m^2 and less than or equal to 10 W/m^2

$$PE_{HP,y} = \frac{EF_{Res} * TEG_y}{1000}$$ **Equation 5**

Where:

$PE_{HP,y}$	=	Project emissions from water reservoirs (tCO_2e/yr);
EF_{Res}	=	Default emission factor for emissions from reservoirs of hydro power plants in year *y* ($kgCO_2e/MWh$);
TEG_y	=	Total electricity produced by the project activity, including the electricity

supplied to the grid and the electricity supplied to internal loads, in year *y* (MWh).

(b) If the power density of the project activity (*PD*) is greater than 10 W/m^2

$PE_{HP,y} = 0$

According to ACM0002, project emissions shall be accounted if power density (PD) of hydropower project is greater than 4W/m^2 and less than or equal to 10 W/m^2. The power density is calculated as follows:

$$PD = \frac{Cap_{PJ} - Cap_{BL}}{A_{PJ} - A_{BL}}$$ **Equation 6**

Where,

PD	=	Power density of the project activity (W/m^2);
Cap_{PJ}	=	Installed capacity of the hydro power plant after the implementation of the project activity (W);
Cap_{BL}	=	Installed capacity of the hydro power plant before the implementation of the project activity (W). For new hydro power plants, this value is zero;
A_{PJ}	=	Area of the single or multiple reservoirs measured in the surface of the water, after the implementation of the project activity, when the reservoir is full (m^2);
A_{BL}	=	Area of the single or multiple reservoirs measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m^2). For new reservoirs, this value is zero.

The power density of Zé Tunin project is 21.8 W/m^2. Therefore emissions from its reservoir must not be considered.

Emissions from fossil fuel combustion ($PE_{FC,j,y}$)

According to the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", CO_2 emissions from fossil fuel combustion in process *j* are calculated based on the quantity of fuels combusted and the CO2 emission coefficient of those fuels, as follows:

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y}$$ **Equation 7**

Where,

$PE_{FC,j,y}$	=	Are the CO_2 emissions from fossil fuel combustion in process *j* during the year *y*

(tCO_2/yr);

$FC_{i,j,y}$	=	Is the quantity of fuel type *i* combusted in process *j* during the year *y* (mass or volume unit/yr);
$COEF_{i,y}$	=	Is the CO_2 emission coefficient of fuel type *i* in year *y* (tCO_2/mass or volume unit);
i	=	Are the fuel types combusted in process *j* during the year *y.*

For the CO_2 emission coefficient of fuel type ($COEF_{i,y}$), option B is used:

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y}$$

Equation 8

Where,

$COEF_{j,y}$	=	Is the CO_2 emission coefficient of fuel type *i* in year *y* (tCO_2/mass or volume unit)
$NCV_{,j,y}$	=	Is the weighted average net calorific value of the fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO2,i,y}$	=	Is the weighted average CO2 emission factor of fuel type *i* in year *y* (tCO_2/GJ)
I	=	Are the fuel types combusted in process *j* during the year *y.*

For estimated purpose, the quantity of diesel oil used in Zé Tunin project since December 2012 (start of commercial operation) is used, *i.e.*, 3,975 liters[37]. Other data was based on IPCC Guidelines for National Greenhouse Gas Inventories for 2006[38] and EPE/MME[39].

Applying equations 7 and 8, estimated project emissions ($PE_{FC,j,y}$) are 1.96 tCO_2e, as presented in the table below:

Quantity of oil diesel (L)	**Oil diesel density (kg/L)**	**Net calorific value (TJ/kg)**	**Co2 emission factor of oil diesel (tCO_2/TJ)**	**Project Emissions (tCO_2e)**

[37] In accordance with Cummins and Stemac manuals, the diesel consumption of the engine at full load (100%) is 53 l/h and 39.5 l/h, respectively. For the calculation of quantity of diesel consumed was considered 53 l/h and 75 hours in operation (monitored by the Project Participant).
[38] The Intergovernmental Panel on Climate Change (IPCC), 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan. Vol 2 – Energy. Chapter 1 – Introduction.
[39] Empresa de Pesquisa Energética (EPE) and Ministry of Mines and Energy (MME). Brazilian Energy Balance 2013: Year 2012. Final Report.

3,975	0.84	42	0.0741	10.39

As demonstrated above, the emission reductions due diesel utilization correspond to 0.06%, *i.e.*, less than 1% of the annual emission reductions of the project.

3.3 Leakage

According to AMS-I.D, "*if the energy generating equipment is transferred from another activity, leakage is to be considered*". Considering that none of the energy equipment used in this project was transferred from another activity, leakage is not being considered.

3.4 Net GHG Emission Reductions and Removals

According to AMS-I.D, the baseline emissions are the product of electrical energy baseline $EG_{BL,y}$ expressed in MWh of electricity produced by the renewable generating unit multiplied by the grid emission factor, as per Equation 1, presented above in section 3.1.

The calculation of the combined margin CO_2 emission factor for grid connected power generation ($EF_{grid,CM,y}$) follows the steps established in the "*Tool to calculate the emission factor for an electricity system*". The results are presented below.

- **STEP 1** - Identify the relevant electricity systems

Following Resolution #8, issued by the Brazilian DNA on May 26th, 2008, the Brazilian Interconnected Grid corresponds to the system to be considered. It covers all the five macro-geographical regions of the country (North, Northeast, South, Southeast and Midwest) as presented in the figure below.

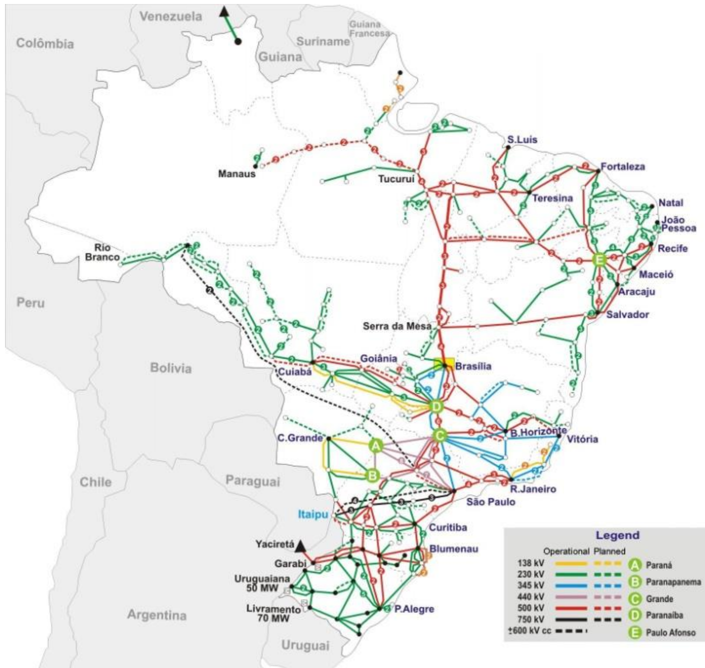

Figure 6: Brazilian Interconnected System. (*Source:* Electric System National Operator)

- **STEP 2** – *Choose whether to include off-grid power plants in the project electricity system (optional)*

Option I was chosen and only grid connected power plants are considered.

- **STEP 3** - *Select a method to determine the operating margin (OM)*

The simple adjusted operating margin and *ex-ante* data vintage were chosen for the calculation of this parameter. Data from 2010, 2011 and 2012 were used in the calculation. Please refer to section 3.1. for the proper justification.

- **STEP 4** - Calculate the operating margin emission factor according to the selected method

A spreadsheet containing all data used to determine the operation margin was supplied to the DOE. The result is presented below.

$$EF_{grid,OM\text{-}adj,y} = 0.6645\ tCO_2e/MWh$$

- **STEP 5** - Calculate the build margin (BM) emission factor

As described above in section 3.1., the *ex-ante* vintage was the option chosen to determine the build margin (option 1).

The sample group of power units *m* used to calculate the build margin was identified following the procedure provided by the tool. The result is discussed below and is presented in detail in the spreadsheet supplied to the DOE which is also attached to the PD.

(a) Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently ($SET_{5\text{-}units}$) and determine their annual electricity generation ($AEG_{SET\text{-}5\text{-}units}$, in MWh);

From the most recent consolidated information the $SET_{5\text{-}units}$ are: UTE Porto Pecem I - MPX, UTE Palmeiras de GO, UTE Ipaussu, UHE Foz do Chapecó and UTE Campina Grande. The electricity generated by these set of plants ($AED_{SET\text{-}5\text{-}units}$) in 2012 was 2,939,544 MWh.

(b) Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEG_{total}, in MWh). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of AEG_{total} (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) ($SET_{\geq 20\%}$) and determine their annual electricity generation ($AEG_{SET\text{-}\geq 20\%}$, in MWh);

Not considering the CDM project activities, in 2012, the Brazilian electricity System generated (AEG_{total}) 495,848,101 MWh. A large number of plants comprise 20% of AEG_{total}. This information ($SET_{\geq 20\%}$) can be checked in the calculation spreadsheet attached to this PD. The annual electricity generation of $SET_{\geq 20\%}$, corresponding to the parameter $AEG_{SET\text{-}\geq 20\%}$, is 99,169,620 MWh.

(c) From $SET_{5\text{-}units}$ and $SET_{\geq 20\%}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample}); Identify the date when the power units in SET_{sample} started to supply electricity to the grid. If none of the power units in SET_{sample} started to supply electricity to the grid more than 10 years ago, then use SET_{sample} to calculate the build margin. Ignore steps (d), (e) and (f).

From data presented in items (a) and (b), it can be observed that $SET_{\geq 20\%}$ is greater than $SET_{5\text{-}units}$. Therefore, SET_{sample} corresponds to $SET_{\geq 20\%}$. The oldest plant comprised in SET_{sample} started to supply electricity to the grid in January 2001. Hence, steps *(d), (e)* and *(f)* of the tool are applicable.

(d) Exclude from SET_{sample} the power units which started to supply electricity to the grid more than 10 years ago. Include in that set the power units registered as CDM project activity, starting with power units that started to supply electricity to the grid most recently, until the electricity generation of the new set comprises 20% of the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) to the extent is possible. Determine for the resulting set ($SET_{sample\text{-}CDM}$) the annual electricity generation ($AEG_{SET\text{-}sample\text{-}CDM}$, in MWh);

Plants which have started to supply electricity to the grid more than 10 years ago were excluded. Six registered CDM Projects were included in the SET_{smaple}. The electricity generation by resultant set of plants, corresponds to the parameter $AEG_{SET\text{-}sample\text{-}CDM}$, is 2,332,212 MWh.

If the annual electricity generation of that set is comprises at least 20% of the annual electricity generation of the project electricity system (i.e. $AEG_{SET\text{-}sample\text{-}CDM} \geq 0.2 \times AEG_{total}$), then use the sample group $SET_{sample\text{-}CDM}$ to calculate the build margin. Ignore steps (e) and (f).

From the results presented above, $AEG_{SET\text{-}sample\text{-}CDM}$ is lower than AEG_{total}. Then, steps (e) and (f) were applied.

(a) Include in the sample group $SET_{sample\text{-}CDM}$ the power units that started to supply electricity to the grid more than 10 years ago until the electricity generation of the new set comprises 20% of the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation);
(b) The sample group of power units m used to calculate the build margin is the resulting set ($SET_{sample\text{-}CDM\text{->}10yrs}$).

Power plants that started to supply electricity to the grid more than 10 years ago were included. The resultant set $SET_{sample\text{-}CDM\text{->}10yrs}$ is identified in the grid emission factor calculation spreadsheet.

The build margin was calculated following the same approach described above in Step 4, and considered the set of plants identified above. As mentioned previously, this parameter will be validated since the *ex-ante* option was chosen.

The result for the build margin emission factor is presented below.

$$\boxed{EF_{grid,BM,2012} = 0.2181\ tCO_2e/MWh}$$

- **STEP 6** – Calculate the combined margin (CM) emissions factor

Applying the results presented above in STEPS 4 and 5 above to Equation 4 presented in section 3.1. and considering the weights w_{OM} = 0.5 and w_{BM} = 0.5 (as per method ***a)*** of the tool) we obtain,

$$EF_y = w_{OM} \quad EF_{OM,y} + w_{BM} \quad EF_{BM,y}$$

$EF_y = 0.5 \times 0.6645 + 0.5 \times 0.2181$

$$\boxed{EF_{grid,CM,y} = 0.4413\ tCO_2e/MWh}$$

Following the explanation provided above in sections 3.2. and 3.3., neither project emissions nor leakage emissions are to be calculated. Therefore, the baseline emissions, project emissions and emission reductions provided by the project are presented in the table below.

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
2013	18,479	0	0	18,479
2014	18,479	0	0	18,479
2015	18,479	0	0	18,479

2016	18,479	0	0	18,479
2017	18,479	0	0	18,479
2018	18,479	0	0	18,479
2019	18,479	0	0	18,479
2020	18,479	0	0	18,479
2021	18,479	0	0	18,479
2022	18,479	0	0	18,479
Total	**184,787**	**0**	**0**	**184,787**

4 MONITORING

4.1 Data and Parameters Available at Validation

Data / Parameter	A_{BL}
Data unit	m^2
Description	Area of the single or multiple reservoirs measured in the surface of the water, before the implementation of project activity.
Source of data	Project site.
Value applied:	0
Justification of choice of data or description of measurement methods and procedures applied	Measured from topographical surveys, maps, satellite pictures, etc.
Purpose of Data	Calculation of project emissions.
Comments	According to the ACM0002 methodology for new hydro power plants, this value is zero.

Data / Parameter	Cap_{BL}
Data unit	W
Description	Installed capacity of the hydro power plant before the implementation of the project activity.
Source of data	Project site.
Value applied:	0
Justification of choice of data or description of measurement methods and procedures applied	Determination of installed capacity based on recognizes standards. The installed capacity of the plant can also be evidenced by the nameplates of the equipment installed at the SHPP.
Purpose of Data	Calculation of project emissions.

Comments	According to the ACM0002 methodology for new hydro power plants, this value is zero.

Data / Parameter	$EF_{CO2,m,i,y}$
Data unit	tCO_2/GJ
Description	CO_2 emission factor of fossil fuel type *i* used in power unit *m* in year *y*
Source of data	IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Value applied:	Large amount of data. Please refer to the emission factor calculation spreadsheet which is attached to the PDD.
Justification of choice of data or description of measurement methods and procedures applied	As per the recommendation of the *"Tool to calculate the emission factor for an electricity system"*. IPCC default values are being used since this information is neither provided by fuel suppliers nor regional and/or local default values are publicly available.
Purpose of Data	Calculation of baseline emissions.
Comments	-

Data / Parameter	$EG_{m,y}$ *and* $EG_{k,y}$
Data unit	MWh
Description	Net electricity generated by power plant/unit *m* or *k* in year *y*
Source of data	Official publications. Data from the Electric System National Operator was used.
Value applied:	Large amount of data. Please refer to the emission factor calculation spreadsheet which is attached to the PDD.
Justification of choice of data or description of measurement methods and procedures applied	Once for each crediting period using the most recent three historical years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (*ex-ante* option).
Purpose of Data	Calculation of baseline emissions.
Comments	-

Data / Parameter	$\eta_{m,y}$
Data unit	-

Description	Average net energy conversion efficiency of power unit *m* in year *y*
Source of data	Default values provided in Annex 1 of the *"Tool to calculate the emission factor for an electricity system"*
Value applied:	Large amount of data. Please refer to the emission factor calculation spreadsheet which is attached to the PDD.
Justification of choice of data or description of measurement methods and procedures applied	As per the recommendation of the *"Tool to calculate the emission factor for an electricity system"*.
Purpose of Data	Calculation of baseline emissions.
Comments	-

Data / Parameter	$EF_{grid,OM-adj,y}$
Data unit	tCO_2/MWh
Description	Simple adjusted operating margin CO_2 emission factor in year *y*
Source of data	Official publications (data from ONS), IPCC default values and default values provided by the *"Tool to calculate the emission factor for an electricity system"*
Value applied:	0.6645
Justification of choice of data or description of measurement methods and procedures applied	The *ex-ante* calculation vintage of this parameter was chosen as per the procedures of the *"Tool to calculate the emission factor for an electricity system"*.
Purpose of Data	Calculation of baseline emissions.
Comments	-

Data / Parameter	$EF_{BM,2012}$
Data unit	tCO_2/MWh
Description	Build Margin CO_2 emission factor in year *y*
Source of data	Official publications (data from ONS), IPCC default values and default values provided by the *"Tool to calculate the emission factor for an electricity system"*
Value applied:	0.2181
Justification of choice of data or description of measurement methods and procedures applied	The *ex-ante* calculation vintage of this parameter was chosen as per the procedures of the *"Tool to calculate the emission factor for an electricity system"*.

Purpose of Data	Calculation of baseline emissions.
Comments	-

4.2 Data and Parameters Monitored

Data / Parameter	$EG_{facility,y}$
Data unit	MWh/y
Description	Quantity of net electricity supplied to the grid in year y.
Source of data	Project activity site.
Description of measurement methods and procedures to be applied	The electricity delivered to the grid is monitored both by the project owner (seller) as well as by the energy buyer. A Brazilian government entity, CCEE – *Câmara Comercializadora de Energia Elétrica* - controls and monitors the electricity available on the national interconnected grid. The amount of electricity delivered to the grid by the project activity shall be cross-checked with the Reports issued by CCEE (records for sold electricity).
Frequency of monitoring/recording	Continuously measurement and monthly recording.
Value applied:	For estimative purposes 41,873 MWh/year was considered calculated based on 4.78 MW-ave assured power[40] and 8,760 hour of operation in the year.
Monitoring equipment	It consists in using meter equipment projected to registry and verifies bidirectionally the energy generated by the facility.
QA/QC procedures to be applied	The energy meters (main and backup) will be calibrated every 2 (two) years[41], in accordance with the Grid Procedures established by the Electric System National Operator (from the Portuguese *Operador Nacional do Sistema Elétrico* - ONS). All of the meters possess an accuracy class of 0.2%[42].
Purpose of data	Calculation of baseline emissions.
Calculation method	-
Comments	-

[40] MME Ordinance nr. 39 issued on June 13th, 2012. Available at: <http://www.aneel.gov.br/cedoc/prt2012039spde.pdf>.
[41] Sub-módulo 12.3. Metering System Maintenance for Invoicing, in a free translation from the Portuguese "*Manutenção do Sistema de Medição para Faturamento*".
[42] Sub-módulo 12.2. Metering System Installation for Invoicing, in a free translation from the Portuguese "*Instalação do Sistema de Medição para Faturamento*".

Data / Parameter	Cap_{PJ}
Data unit	W
Description	Installed capacity of the hydro power plant after the implementation of the project activity
Source of data	Project site
Description of measurement methods and procedures to be applied	This data is to be monitored yearly through the nameplate check of the generator. The installed capacity of the plant can also be evidenced by the Data Books of the equipment installed at the SHPP.
Frequency of monitoring/recording	-
Value applied:	8,000,000 W
Monitoring equipment	-
QA/QC procedures to be applied	If the equipment's suffer any kind of modification by the suppliers, it is provided a new nameplate for them. This modification should be informed to ANEEL and the resolution will be also reviewed and monitored.
Purpose of data	Calculation of project emissions.
Calculation method	-
Comments	The EB59 Annex 9, General Guidelines to SSC CDM methodologies version 16 determines that the rated/installed capacity for renewable electricity generating units that involve turbine-generator systems shall be based on the installed/rated capacity of generator.

Data / Parameter	A_{BL}
Data unit	m^2
Description	Area of the single or multiple reservoirs measured in the surface of the water, before the implementation of project activity.
Source of data	Project site
Description of measurement methods and procedures to be applied	The reservoir are will be monitored through topographical data in the location of the project activity (made once at the time of the project design) and the reservoir level, which will be monitored by project sponsor.

Frequency of monitoring/recording	Measurement will be done yearly.
Value applied:	For estimative purposes 367,000 m2 was considered based on the ANEEL Ordinance nr. 1,804, dated on April 27th, 2011[43].
Monitoring equipment	The monitoring of the reservoir level will be made through the rules installed at the dam.
QA/QC procedures to be applied	-
Purpose of data	Calculation of project emissions.
Calculation method	-
Comments	-

4.3 Monitoring Plan

The monitoring plan of the emission reductions by the project activity is in accordance with the procedures set by the methodology "*AMS-I.D - Grid connected renewable electricity generation*".

The Monitoring Plan will be based on amount of electricity delivered to the grid ($EG_{facility,y}$) by the project activity. The amount of electricity dispatched will be monitored by the project owner, as well as by the Chamber of Electrical Energy Commercialization (from the Portuguese *Câmara de Comercialização de Energia Elétrica - CCEE*) that controls all electricity provided to the grid and contractually assures, for the buyer, that the electricity sold will be properly delivered.

From what is established in the relevant regulation of the energy sector in Brazil, all the plants delivering electricity to the grid have to implement a Measurement System for Invoicing (from the Portuguese *Sistema de Medição e Faturamento - SMF*) in accordance with the specifications set by CCEE. Model and type of energy meters installed are in accordance with CCEE´s standards. Such configuration is in accordance with ONS´s grid procedures, "Module 12: Measurement for Invoicing".

There will be two energy meters (principal and back up) specified by CCEE, that will monitor the net electricity generation of the project activity ($EG_{facility,y}$), those meters will provide to CCEE the amount of electricity dispatched to the grid. A diagram with relevant monitoring points is presented below:

[43] Available at: <http://www.aneel.gov.br/cedoc/dsp20111804.pdf>.

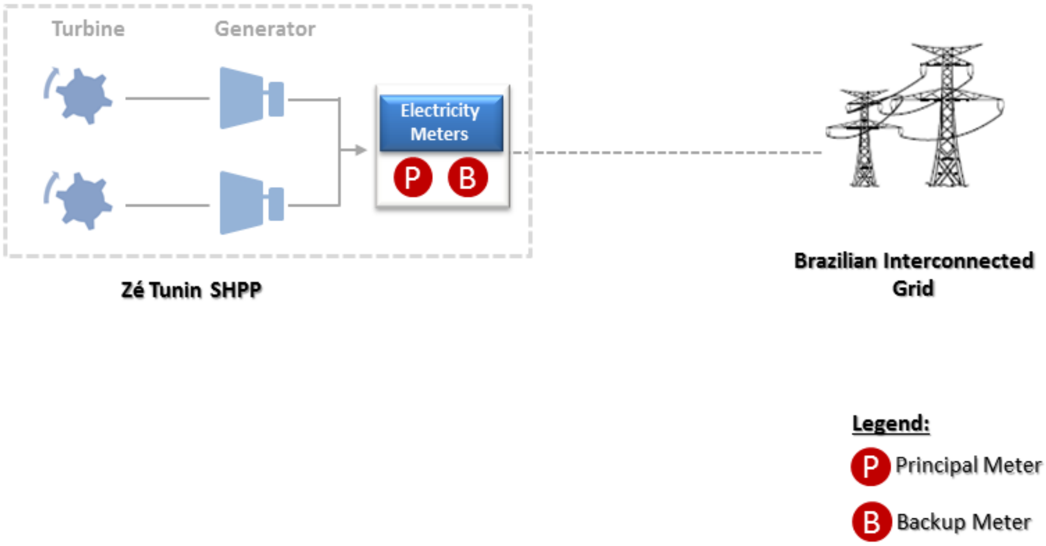

Figure 7 - Diagram of monitoring points

Although Zé Tunin Small Hydropower Plant isn't obliged to follow the Grid Procedures as established by the Electric System National Operator (from the Portuguese *Operador Nacional do Sistema Elétrico - ONS*) the plant operator is committed to follow the procedures of calibration established by ONS, *i.e.* calibration of energy meters every two years[44]. Electricity dispatched to the grid will be continuous monitored, hourly measured and at least monthly recorded. CCEE has remote access to energy information. The energy generated by the plants is informed by the project owner to CCEE in an hourly frequency. CCEE verifies the consistency of information and accounts for all the energy generated and dispatched to the system as well as consumed, CCEE issues an official report that presents a consolidated data indicating, per week, the dispatched energy during the specific month.

The installed capacity of the power plant will be checked by DOE during on-site visit every verification and cross-checked with official documents, *e.g.* ANEEL resolution or licenses issued by the environmental agency of Minas Gerais State. The reservoir area will be monitored through topographical studies (made at the time of the project design) and water reservoir levels, which will be yearly monitored by the project sponsor. The water level to be compared with the topographical study will be based on the average water level that will be verified annually. Data can be cross-checked with official documents, *e.g.* engineering/environmental studies and/or licenses issued by the Environmental Agency of the State and can be cross-checked with ANEEL's Geo-referenced Information Systems of the Electric Sector. This information will be available at the time of the project verification.

Pequena Central Hidrelétrica Zé Tunin S.A. is responsible for ensuring the meters' calibration (each two years), according to the procedures established by the ONS, and maintenance of the monitoring equipment of Zé Tunin. *Pequena Central Hidrelétrica Zé Tunin S.A.* is also responsible for the project management, as well as for organising and training the staff in the

[44] Sub-módulo 12.3. Metering System Maintenance for Invoincing, in a free translation from the Portuguese *Manutenção do Sistema de Medição para Faturamento*.

appropriate monitoring procedures. The plant is subject to ANEEL inspection in which the agency assesses the compliance with legal requirements as per official procedures and standards.

All data required for verification and issuance will be monitored and archived electronically and will be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later.

5 ENVIRONMENTAL IMPACT

The growing global concern on sustainable use of resources is driving a requirement for more sensitive environmental management practices. Increasingly this is being reflected in countries' policies and legislation. In Brazil the situation is not different. Environmental rules and licensing policies are very demanding in line with the best international practices.

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 Prévia* or L.P.) 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 de Instalação* or L.I.) and, the final one is the operating permit (*Licença de Operação* or L.O.).

The preparation of an Environmental Impact Assessment is compulsory to obtain the construction and the operation licenses. In the process a report containing an investigation of the following aspects was prepared:

- Impacts to climate and air quality;
- Geological and soil impacts;
- Hydrological impacts (surface and groundwater);
- Impacts to the flora and animal life;
- Socio-economical (necessary infra-structure, legal and institutional, etc.).

The project had the following approved specific environmental plan, which involves 8 different programs:

- Social Communication;
- Environmental Education;
- Terrestrial Fauna Conservation;

- Aquatic Fauna Monitoring;
- Water Quality Monitoring;
- Soil Conservation and Recovery;
- Forestry Program;
- Environmental Compensation.

The project has the necessary environmental licenses. The operating permit/license (LO nº 0677 ZM) was issued on November 26th, 2012 by the Environmental Agency of Minas Gerais State (*Secretaria de Estado de Meio Ambiente e Desenvolvimento Sustentável - SEMAD*). The operating license is valid until November 26th, 2018.

6 STAKEHOLDER COMMENTS

In order to issue licenses, the Environmental Impact Study (from the Portuguese *Estudo de Impacto Ambiental – EIA*) and the Environmental Impact Report (from the Portuguese *Relatório de Impacto Ambiental – RIMA*) are required for hydropower projects with installed capacity greater than 10 MW.

Both studies shall be made publicly available to local stakeholders and public entities. Furthermore, according to the CONAMA Resolution nr. 1 dated January 23rd, 1986, the environmental agency – State or National – is responsible to issue licenses and decide the necessity in making public consultations and forums for the project implementation. When public consultation is required, it usually happens in parallel with the Preliminary License issuance.

In the case of Zé Tunin project, the public forum was held by the environmental agency of Minas Gerais State (*Secretaria de Estado de Meio Ambiente e Desenvolvimento Sustentável - SEMAD*) on August 19th, 2008[45]. This process was performed by the project sponsor and concerns are registered in the Minutes of Meeting[46]. Some comments were made during the meeting, such as: necessity of the Environmental Impact Assessment (from the Portuguese "*Estudo de Impacto Ambiental – EIA*") instead of the Environmental Control Report (from the Portuguese "*Relatório de Controle Ambiental - RCA*"), pay a fair price to the relocated people and collect taxes to improve the municipality, creation of jobs to the local people, restoration of riparian forest, destination of the environmental compensation to the municipality impacted by the project and ichthyofauna monitoring,

Considering the comments mentioned above, the Project Sponsor clarified that during the licensing application, was requested the RCA study by the Environmental Agency due the characteristics of Zé Tunin project. However, the Project Sponsor also considered the EIA/RIMA developed for the others small hydropower plants installed at the same river (Ponte, Palestina

[45] SUPRAM-ZM Technical Opinion for the Installation License issued on April 15th, 2011.
[46] The Minutes of Meeting was provided to the DOE.

and Triunfo SHPPs) during the RCA development for Zé Tunin project. The Project Sponsor suggested the creation of a Basin Committee (from the Portuguese "*Comitê de Bacias*") to discuss and propose actions to restoration of riparian forest of Pomba River and also proposed a partnership with Brascan (owner of Ponte, Palestina and Triunfo SHPPs) for the ichthyofauna monitoring.

Project Sponsor also mentioned that the company will pay a fair price to the relocated people and also will collect withholding tax according to the national legislation. Regarding the environmental compensation, the company is discussing with the Environmental Agency for it to be for the region. Furthermore, it was highlighted the company's concern for the environment and local communities.

Considering the positive contribution of Zé Tunin implementation, the Preliminary License was issued on December 15th, 2008.