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

## CONTENTS



## Annexes

## SECTION A. General description of project activity

### A.1. Title of the project activity:

Serra das Agulhas Small Hydropower Plant Project Activity.

PDD version number: 4

Date (DD/MM/YYYY): 29/03/2012.

### A.2. Description of the project activity:

The primary objective of Serra das Agulhas 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[1], 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[2].

The privatization process of the 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 favored 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.

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[1] UNEP-LAC (2002). Final Report of the 7th Meeting of the Inter-Sessional Committee of the Forum of Ministers of Environment of Latin America and the Caribbean. United Nations Environment Programme, Regional Office for Latin America and the Caribbean. 15 to 17 May, 2002, São Paulo (Brazil).

[2] WSSD Plan of Implementation, Paragraph 19 (e): "*Diversify energy supply by developing advanced, cleaner, more efficient, affordable and cost-effective energy technologies, including fossil fuel technologies and renewable energy technologies, hydro included, and their transfer to developing countries on concessional terms as mutually agreed. With a sense of urgency, substantially increase the global share of renewable energy sources with the objective of increasing its contribution to total energy supply, recognizing the role of national and voluntary regional targets as well as initiatives, where they exist, and ensuring that energy policies are supportive to developing countries' efforts to eradicate poverty, and regularly evaluate available data to review progress to this end.*"

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.

The project consists of the construction of a small hydroelectric power plant ("PCH", from the Portuguese *Pequena Central Hidrelétrica*): Serra das Agulhas with 28 MW of installed capacity and 0.62 $km^2$ reservoir area. The plant is located in the Pardo Pequeno River, state of Minas Gerais, Southeastern region of Brazil. The project is expected to become fully operational in January 2014.

Serra das Agulhas is owned by Omega Energia Renovável S/A. Omega has its headquarters in Belo Horizonte, capital of Minas Gerais State.

Prior to the implementation of the project activity no small hydropower plant was operational in the location where the Serra das Agulhas project is being built. The project activity will reduce emissions of GHG 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 ACM0002, in the project activity scenario, there are emissions of methane ($CH_4$) from the water reservoir of hydropower plants. However, since the power density of Serra das Agulhas is greater than 10 $W/m^2$, there are no GHG emissions involved in the project activity.

Serra das Agulhas 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 Serra das Agulhas 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.

## A.3. Project participants:

**Table 1 – Party(ies) and private/public entities involved in the project activity**

| Name of Party involved (*) ((host) indicates a host Party) | Private and/or public entity(ies) Project participants (*) (as applicable) | Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No) |
|---|---|---|
| Brazil (host) | Omega Energia Renovável S/A (Private entity) | No |
| | Sigma Energia S/A (Private entity) | |
| | Ecopart Assessoria em Negócios Empresariais Ltda. (Private entity) | |
| (*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required. | | |

## A.4. Technical description of the project activity:

### A.4.1. Location of the project activity:

#### A.4.1.1. Host Party(ies):

Brazil.

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

Minas Gerais State (Southeastern region of Brazil).

#### A.4.1.3. City/Town/Community etc.:

Diamantina and Monjolos municipalities.

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

The project is located in the Southeastern region of Brazil, state of Minas Gerais, Diamantina and Monjolos municipalities (Figures 1 and 2), and uses the hydropower potential of Pardo Pequeno River under the following geographical coordinates:

**Table 2 – Serra das Agulhas geographical coordinates[3]**

| *Geographic Coordinates* | *Latitude (South)* | *Longitude* (*West)* |
|---|---|---|
| *Dam* | 18°21’43’’ | 43°57’31’’ |

[3] Source: ANEEL Ordinance nr. 937 dated March 21st, 2012. Information available at: <http://www.aneel.gov.br/cedoc/dsp2012937ti.pdf>.

| | | |
|---|---|---|
| *Power house* | 18° 20’ 51’’ | 44° 01’ 20’’ |

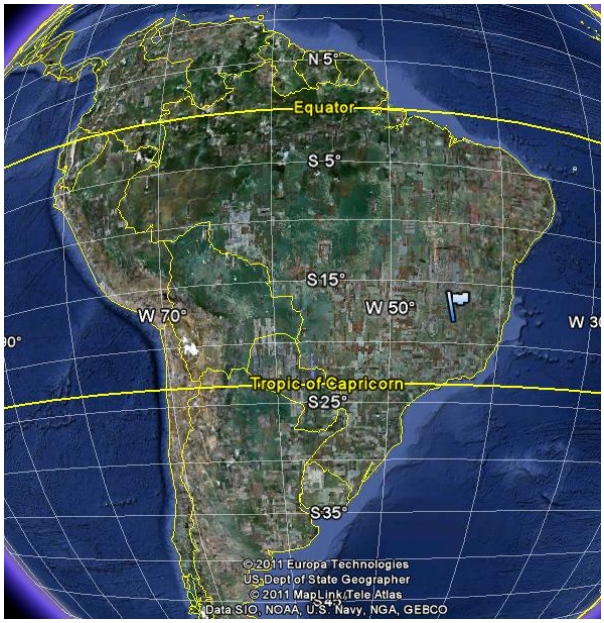


**Figure 1 – Map of Brazil presenting the project location**

**Source: GOOGLE EARTH (2011)[4]**


**Figure 2 – Map of Minas Gerais presenting the project location**

**Source: MAPAS-MG ([--])[5]**

Diamantina has 45,880 inhabitants, 3,891.654 km[26] and it is located 292 km far from Belo Horizonte[7], capital of Minas Gerais. Monjolos has 2,360 inhabitants, 650.910 km$^2$ and it is 247 km far from Belo Horizonte.

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

Sectoral Scope: 1 - Energy industries (renewable - / non-renewable sources).

Category: Renewable electricity generation for a grid.

[4] Available at: <http://earth.google.com/>. Accessed on July 7th, 2011.

[5] Available at: <http://www.mapas-mg.com/mapa-rodoviario.htm>. Accessed on July 7th, 2011.

[6] 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>.

[7] DER. Road map of Minas Gerais. Departamento de Estrada e Rodagem. Available at: <http://www.der.mg.gov.br/mapa-rodoviario>. Accessed on July 7th, 2011.

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

As mentioned earlier on section A.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 hydropower plant operational in the same location of Serra das Agulhas project. Therefore, the baseline scenario and the scenario without the project activity are the same, and the GHG ($CO_2$) emissions in the baseline scenario are represented by the emissions from the operational plants connected to the National grid.

In the project activity scenario, the following activities/measures will be taken for Serra das Agulhas implementation[8]:

→ Diversion of the river;

→ Construction of the diversion tunnel, dam, spillway, water intake, headrace/aqueduct, penstock, power house;

→ Installation of mechanical equipment (including turbines) and electrical equipment (including generators);

→ Construction of the substation/transmission line and connection of the power plant to the national grid.

The technology to be employed in the project activity is based on hydraulic turbines. There are many types of hydraulic turbines. The main types are Francis, Kaplan, Pelton and Bulbo. Each type of turbine is chosen and adapted based on waterfall and water flow of hydropower plants. In the case of Serra das Agulhas project, it will be used the Pelton turbines (Figure 3), which is appropriated for high waterfalls (between 200 m to 1,500 m)[9].

The Pelton wheel was invented by L. Allan Pelton in the 19th century and it is environmentally safe and sound technology, which has been implemented around the world[10]. Since Brazil has a large hydropower potential, the know-how to be used in the project activity have been transferred to the Host Party already. Therefore, the main equipment that will be used in Serra das Agulhas project (turbines and generators) will be produced in Brazil. This contributes for the energy sector development (resulting in more research) and for the capacity increase of the industrial sector within the Host Country.

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[8] Consolidated project design (from the Portuguese *Projeto Básico Consolidado*) dated May 2011 and prepared by VLB Engenharia.

[9] ANEEL. Chapter 4 – Hydraulic energy. "Atlas de Energia Elétrica". 2nd edition. 2005. Agência Nacional de Energia Elétrica. Available at: <http://www.aneel.gov.br/aplicacoes/Atlas/download.htm>. Accessed on July 7th, 2011.

[10] The Pelton Turbine (Pelton water wheel): The Past and Future of Hydroelectric Power. Available at: <http://www.energybeta.com/hydropower/pelton-turbine/>.

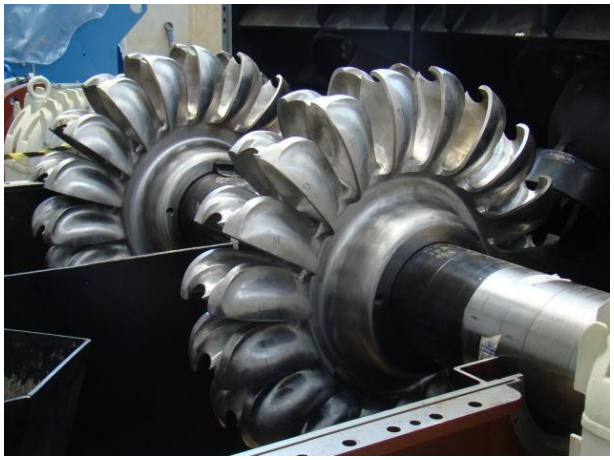

**Figure 3 – Example of a Pelton turbine**

**Source: HISA ([--])[11]**

Serra das Agulhas is estimated to have the following technical description[12]:

**Table 3 – Technical description of Serra das Agulhas project**

| | |
|---|---|
| ***General*** | |
| Plant load factor (PLF)[13] | 46.7% |
| ***Turbines*** | |
| Type | Pelton |
| Quantity | 2 |
| Nominal power (MW) | 14.45 |
| Average efficiency (%) | 92.0 |
| Average lifetime | 40 years |
| Manufacturer | To be defined |
| ***Generators*** | |
| Quantity | 2 |
| Nominal power (kVA) | 15,570 |
| Nominal power factor | 0.9 |
| Tension (kV) | 13.8 |

[11] Available at: <http://www.hisa.com.br/>. Accessed on July 7th, 2011.

[12] Source: ANEEL Ordinance nr. 937 dated March 21st, 2012. Information available at: <http://www.aneel.gov.br/cedoc/dsp2012937ti.pdf>. Since equipment of the project was not purchased and the manufacturer was not defined yet, the project participants considered the average lifetime of the main equipment (turbine and generator) based on the ANEEL's publication: "Manual de controle patrimonial do setor elétrico" 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>.

[13] The assured energy of Serra das Agulhas project is 13.08 MW-ave as presented in the Consolidated Project Design ("PBC" from the Portuguese Projeto Básico Consolidado) prepared by VLB Engenharia (third-party) in May 2011. Therefore, the PLF of the project is 46.7%.

| | |
|---|---|
| Average efficiency (%) | 97.0 |
| Average lifetime | 30 years |
| Manufacturer | To be defined |
| ***Transmission lines*** | |
| Location | Monjolos municipality |
| Extension (from the power plant to the existent line) | 7 km |
| Tension (kV) | 138 |

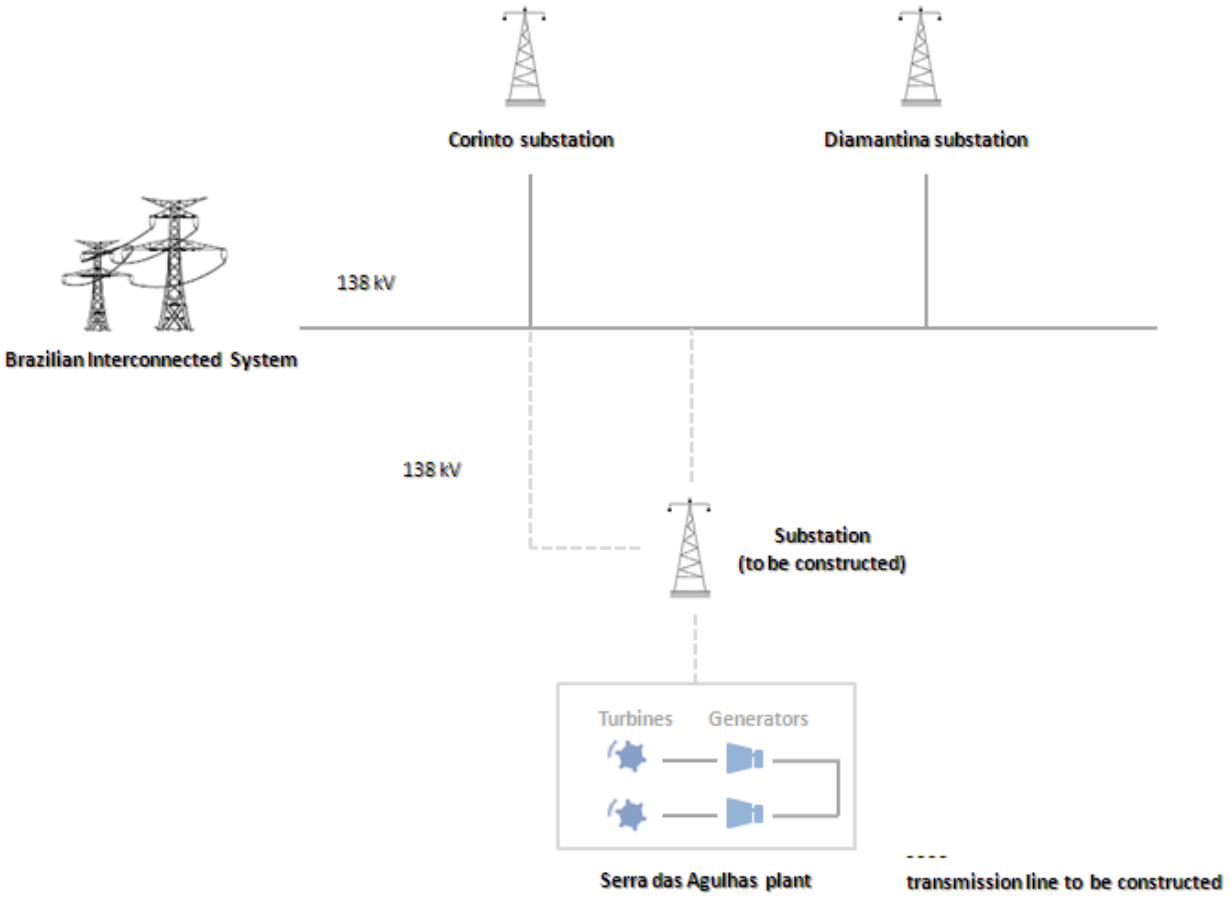


**Figure 4 – Simplified diagram of the project activity and its connection to the grid**

The monitoring equipment involved in the project activity is related to the electricity measurement (directly involved in the emission reductions generated by the project) and the water level in the project reservoir (as required by ACM0002). Furthermore, the installed capacity of the project and the $CO_2$ emission factor of the grid shall also be monitored as required by ACM0002, however, there is no need of monitoring equipment for these parameters.

There will be meters installed at the substation (connection point) to measure the net electricity. Regarding the water level, the monitoring can be made by using a metallic ruler or by the installation of an electronic device (monitoring made through dipsticks or floats). More information related to the monitoring parameters and equipment involved is presented in section B.7 of this PDD.

According to ACM0002, the main emission source of GHG from hydropower plants is related to the emission from water reservoirs. Since Serra das Agulhas project has a power density of 45.16 $W/m^2$, there are no GHG emissions involved in the project activity related to the water reservoir.

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

**Table 4 – Estimated emission reductions during the first crediting period of the project activity**

| Years | Annual estimation of emission reductions in tonnes of $CO_2e$ |
|---|---|
| Year 1 - (2014)* | 23,806 |
| Year 2 - (2015) | 35,467 |
| Year 3 - (2016) | 35,564 |
| Year 4 - (2017) | 35,467 |
| Year 5 - (2018) | 35,467 |
| Year 6 - (2019) | 35,467 |
| Year 7 - (2020) | 35,564 |
| Year 8 - (2021)** | 11,660 |
| **Total estimated reductions** (tonnes of $CO_2e$) | 248,460 |
| **Total number of crediting years** | 7 |
| **Annual average over the crediting period of estimated reductions** (tonnes of $CO_2e$) | 35,494 |

*Starting on May 1st
**Until April 30th

### A.4.5. Public funding of the project activity:

There is no recourse to any public funding by the Project Participants in the proposed project activity.

## SECTION B. Application of a baseline and monitoring methodology

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

ACM0002 - "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (Version 12.3.0)[14].

ACM0002 refers to the latest approved versions of the following tools:

- Tool to calculate the emission factor for an electricity system (Version 2.2.1);
- Tool for the demonstration and assessment of additionality (Version 6.0.0);
- Tool to calculate project or leakage $CO_2$ emissions from fossil fuel combustion (version 2.0.0).
- Combined tool to identify the baseline scenario and demonstrate additionality (version 4.0.0).

The *tool to calculate project or leakage $CO_2$ emission from fossil fuel combustion* and the *combined tool to identify the baseline scenario and demonstrate additionality* are not applicable to the project activity, and therefore are not used.

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

The methodology ACM0002 is applicable to grid-connected renewable power generation project activities that (a) install a new power plant at a site where no renewable power plant was operated 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).

> *Serra das Agulhas is a new grid-connected power plant at a site where no renewable power plant was operated prior to the implementation of the project activity (greenfield plant), i.e. option (a) above. Technical information of the project is presented in the consolidated project design (from the Portuguese Projeto Básico Consolidado – PBC) prepared by VLB Engenharia dated May 2011.*

Furthermore, the methodology is applicable under the following conditions:

- The project activity is the installation, capacity addition, retrofit or replacement of a power plant/unit of one of the following types: hydro power plant/unit (either with a run-of-river reservoir or an accumulation reservoir), wind power plant/unit, geothermal power plant/unit, solar power plant/unit, wave power plant/unit or tidal power plant/unit.

[14] Available at: <http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html>.

*Serra das Agulhas is a new small hydropower plant connected to the Brazilian Interconnected System (from the Portuguese Sistema Interligado Nacional – SIN).*

- In the case of capacity additions, retrofits or replacements (except for capacity addition projects for which the electricity generation of the existing power plant(s) or unit(s) is not affected)*:* the existing plant started commercial operation prior to the start of a minimum historical reference period of five years, used for the calculation of baseline emissions and defined in the baseline emission section, and no capacity addition or retrofit of the plant has been undertaken between the start of this minimum historical reference period and the implementation of the project activity;

  *Not applicable.*

- In case of hydropower plants, at least one of the following conditions must apply:

  - The project activity is implemented in an existing single or multiple reservoirs, with no change in the volume of any of the reservoirs; or
  - The project activity is implemented in an existing single or multiple reservoirs, where the volume of any of reservoirs is increased and the power density of each reservoir, as per definitions given in the project emissions section, is greater than 4 $W/m^2$ after the implementation of the project activity; or
  - The project activity results in new single or multiple reservoirs and the power density of each reservoir, as per definitions given in the Project Emissions section, is greater than 4 $W/m^2$ after the implementation of the project activity.

    *Serra das Agulhas project results in 45.16 $W/m^2$ power density, i.e. greater than 4 $W/m^2$. For the calculation of the power density of the project, 28 MW installed capacity and 0.62 $km^2$ reservoir area were considered based on the consolidated project design (PBC) prepared by VLB Engenharia dated May 2011.*

    *Detailed information of power density calculation is presented in section B.6.3.*

- In case of hydro power plants using multiple reservoirs where the power density of any of the reservoirs is lower than 4 $W/m^2$ after the implementation of the project activity all of the following conditions must apply:

  - The power density calculated for the entire project activity using equation 5 is greater than 4 $W/m^2$;
  - All reservoirs and hydropower plants are located at the same river and were designed together to function as an integrated project that collectively constitutes the generation capacity of the combined power plant;
  - The water flow between the multiple reservoirs is not used by any other hydropower unit which is not a part of the project activity;
  - The total installed capacity of the power units, which are driven using water from the reservoirs with a power density lower than 4 $W/m^2$, is lower than 15MW;

- The total installed capacity of the power units, which are driven using water from reservoirs with a power density lower than 4 W/m$^2$, is less than 10% of the total installed capacity of the project activity from multiple reservoirs.

  *Not applicable.*

Furthermore, the project activity does not involve:

- Switching from fossil fuels to renewable energy sources at the site of the project activity, since in this case the baseline may be the continued use of fossil fuels at the site;
- Biomass fired power plants;
- Hydropower plant that results in the creation of a new single reservoir or in the increase in existing single reservoir where the power density of the reservoir is less than 4 W/m$^2$;
- Retrofits, replacements, or capacity additions.

The project activity also complies with all the applicability conditions presented in the tools mentioned in section B.1. as can be checked and confirmed by analyzing the following sections.

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

According to ACM0002, "*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*".

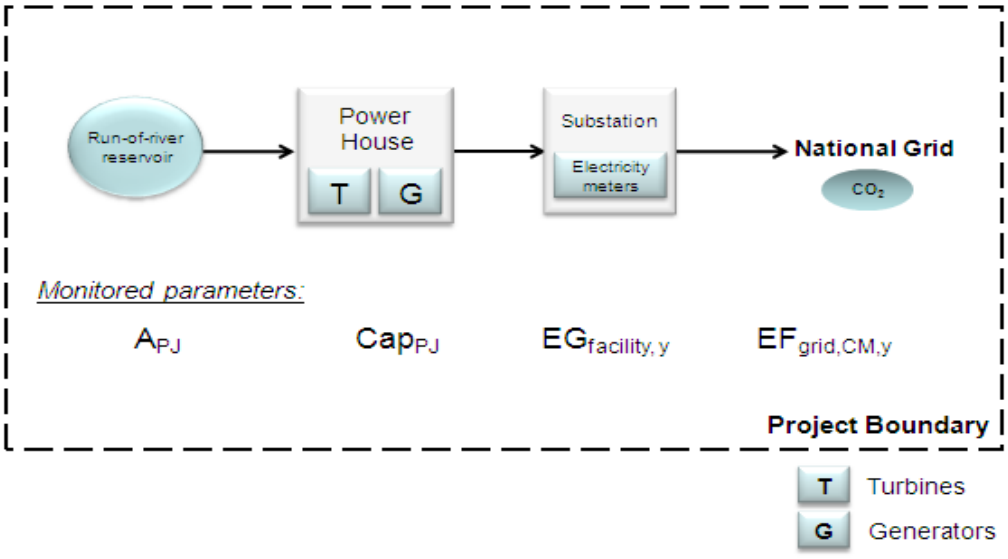


**Figure 5 - Project Boundary of the project activity**

The greenhouse gases and emission sources included in or excluded from the project boundary are shown in the below table.

**Table 5 – Greenhouse gases and emission sources included or excluded in the project boundary**

| | 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. |
| **Project Activity** | Emissions of $CH_4$ from the reservoir. | $CO_2$ | No | Minor emission source. |
| | | $CH_4$ | No | There are no emissions from the project reservoir considering its power density of 45.16 $W/m^2$, *i.e.*, greater than 10 $W/m^2$. However, project sponsor will monitor the reservoir area following ACM0002. |
| | | $N_2O$ | No | Minor emission source. |

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

There are no retrofits, replacements and/or capacity additions involved in the project activity. Serra das Agulhas project consists of a new grid-connected power plant. Hence, according to ACM0002, the baseline scenario is the following:

*"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, as reflected in the combined margin (CM) calculations as described in the "Tool to calculate the emission factor for an electricity system".*

In the absence of the project activity, all the energy would be supplied by other plants from the interconnected grid. The project activity reduces emissions of GHG by avoiding electricity generation by fossil fuel sources (and $CO_2$ emissions), which would be generated (and emitted) in the absence of the

project. According to ANEEL[15], 67.7 % of the Brazil's installed capacity is composed by large hydropower plants and 26.5 % by thermal power stations.

**B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):**

(i) Definition of the project starting date

The CDM glossary of terms defines the starting date of a non A/R project activity as "*the earliest date at which either the implementation or construction or real action of a project activity begins*". Considering this definition, the 41st CDM EB Meeting Report[16] clarified that:

> "*The start date shall be considered to be the date on which the project participant has committed to expenditures related to the implementation or related to the construction of the project activity. This, for example, can be the date on which contracts have been signed for equipment or construction/operation services required for the project activity. Minor pre-project expenses, e.g. the contracting of services /payment of fees for feasibility studies or preliminary surveys, should not be considered in the determination of the start date as they do not necessarily indicate the commencement of implementation of the project*".

The only expense incurred for the project implementation is related to the issuance of the Preliminary License ("LP" from the Portuguese *Licença Prévia*) nr. 066 issued on December 9th, 2010. However, this action cannot be considered as the project starting date since the LP issuance is classified as minor pre-project expenses. Undoubtedly, the project sponsor can sell Serra das Agulhas project if legal/regulatory aspects are not favourable for the project implementation and the CDM revenues are considered unfeasible. In reality, this is not uncommon and a project is purchased more than once.

Since the "real action" for Serra das Agulhas did not happen and, thus, the Project Participants considered the project starting date as the estimated date when the Engineering, Procurement and Construction (EPC) contract will be signed, *i.e.* July 16th, 2012.

(ii) Demonstration of the prior consideration of the CDM

The "Guidelines on the demonstration and assessment of prior consideration of the CDM" states:

> "*Proposed project activities with a starting date on or after 02 August 2008, the project participant must inform a Host Party DNA and the UNFCCC secretariat in writing of the*

[15] ANEEL (2011). Energy generation database (from the Portuguese *Banco de Informações de Geração – BIG*). Brazil's generation capacity. The Brazilian Power Regulatory Agency (in a free translation from the Portuguese *Agência Nacional de Energia Elétrica*). Available at: <http://www.aneel.gov.br/aplicacoes/capacidadebrasil/capacidadebrasil.asp>. Accessed in May 2011.

*commencement of the project activity and of their intention to seek CDM status. Such notification must be made within six months of the project activity start date and shall contain the precise geographical location and a brief description of the proposed project activity, using the standardized form F-CDM-Prior Consideration. Such notification is not necessary if a PDD has been published for global stakeholder consultation or a new methodology proposed to the Executive Board for the specific project before the project activity start date".*

The Global Stakeholder Process (GSP) of Serra das Agulhas occurred from October 12th to November 10th, 2011 (*i.e.* before the project starting date). Therefore, considering the statement of the "Guidelines on the demonstration and assessment of prior consideration of the CDM", the form F-CDM-Prior Consideration would not need to be sent. However, the Project Participants informed in writing the Brazilian DNA and the UNFCCC Secretariat on August 1st, 2011 for conservativeness reasons.

(iii) Fulfillment of the requirements presented in the "Tool for the demonstration and assessment of additionality"

For the demonstration of additionality, the proposed baseline methodology refers to the Additionality Tool approved by the Executive Board. The tool considers some important steps necessary to determine whether the project activity is additional and to demonstrate how the emission reductions would not occur in the absence of Serra das Agulhas project. The application of the above mentioned tool is described in the next paragraphs.

**Step 1. Identification of alternatives to the project activity consistent with current laws and regulation**

**Sub-step 1a. Define alternatives to the project activity:**

Scenario 1: The alternative to the project activity is the continuation of the current (previous) situation of electricity supplied by the existing power plants from the interconnected system.

Scenario 2: The proposed project activity undertaken without being registered as a CDM project activity.

**Sub-step 1b. Consistency with mandatory laws and regulations:**

Both alternatives, the project activity and the alternative scenario, are in compliance with all regulations according the following entities:

- The National Electric System Operator ("ONS" from the Portuguese *Operador Nacional do Sistema Elétrico*);
- The Electricity Regulatory Agency ("ANEEL" from the Portuguese *Agência Nacional de Energia Elétrica*);

[16] The 41st CDM EB Meeting Report was held on July 30th to August 2nd, 2008. See Meeting Report available at the UNFCCC's

- The Mines and Energy Ministry ("MME" from the Portuguese *Ministério de Minas e Energia*);
- The Chamber of Electrical Energy Commercialization ("CCEE" from the Portuguese *Câmara de Comercialização de Energia Elétrica*);
- The Minas Gerais Environmental Agency ("FEAM" from the Portuguese *Fundação Estadual do Meio Ambiente*);
- The CDM Executive Board.

***SATISFIED/PASS – Proceed to Step 2***

**Step 2. Investment analysis**

**Sub-step 2a. Determine appropriate analysis method**

The additionality of Serra das Agulhas project is demonstrated through an investment benchmark analysis (option III). Options I and II are not applicable since:

*Option I* – Both the project activity and the alternatives identified in Step 1 generate financial and economic benefits other than CDM related income.

*Option II* – The implementation of other project types of renewable energy generation - *i.e.* cogeneration or wind farm projects - is not potential alternatives in the site where the project is planned.

**Sub-step 2b. Option III – Apply benchmark analysis**

The financial indicator identified for the project is the project Internal Rate of Return (IRR). The IRR will be compared to the appropriate benchmark of the electric sector, which is the Weighted Average Cost of Capital (WACC).

*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

website: <http://cdm.unfccc.int/>.

risk profile of this particular project developer. The WACC shall be valid and applicable at the time of the investment decision (October 2011) calculated through the formula below:

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

Usually, for alternative energy generating project, BNDES finances up to 80% of the items eligible for financing[1]. Considering the total investment necessary to build a plant, it can be assumed that approximately 70% of the project is financed. Therefore, the 70% percentage corresponds to the Initial Debt/Equity ratio for the energy generation companies, which is the portion disbursed by the bank to the investor and paid on the beginning of the project.

Nevertheless, for the WACC calculation it should be considered the Long-term Debt/Equity structure, which considers not only the debt/equity ratio in the beginning of the project but also how this structure is expected to vary during the project. As a consequence of using the long term debt/equity structure, the 70% proportion decreases with the duration of the project.

In general, the investor has a grace period before starting to pay the amortization and, at the same time, receives all the financing from BNDES on the beginning of the project. For the remaining time, the investor does not receive additional financing (debt proportion decreases), while investor starts to pay the amortization from the financing with his equity capital (equity proportion increases), increasing the ratio between Equity/Debt until there is no Debt in the 16th year of the BNDES funding period. This rationale is illustrated using a hypothetical example in the below figure.

| | |
|---|---|
| Total Investment ($) | *500,000* |
| BNDES Tranche | *70%* |
| Amortization (years) | *16* |
| Inflation | *5%* |

| | Year 0 | Year 1 | Year 2 | Year 3 | ... | Year 17 | Year 18 | Year 19 | Year 20 |
|---|---|---|---|---|---|---|---|---|---|
| **Debt** | | 350,000 | 0 | 0 | ... | 0 | 0 | 0 | 0 |
| **Equity** | 150,000 | | 21,875 | 21,875 | ... | 21,875 | 0 | 0 | 0 |
| **Debt/Equity** | | 70% | 0% | 0% | ... | 0% | 0% | 0% | 0% |
| **Equity/Debt** | | 30% | 100% | 100% | ... | 100% | 0% | 0% | 0% |

| | |
|---|---|
| **Debt ($)** | 333,333 |
| **Equity ($)** | 387,076 |
| Debt/Equity ratio | *46%* |

**Figure 5 – Hypothetical example for the Long term Debt/Equity structure.**

Despite of the explanation provided above, this information is not readily available for similar project being developed in Brazil. Then, in accordance with the "Guidelines on the assessment of

investment analysis" (paragraph 18, Annex 5, EB62), 50% debt (**Wd**) and 50% (**We**) equity are assumed as a default value.

**Kd** and **Ke** are, respectively, the cost of debt and cost of equity. Detailed explanations related to both calculations are presented below.

→ *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 ($\pi$). 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 Serra das Agulhas project, **t** = 0%, since it is based on the Presumed Profit regime.

[1]

http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Institucional/Apoio_Financeiro/Produtos/FINEM/energias_alternativas.html

For the Presumed Profit eligibility, corporate entities revenues must be under Forty eight million Reais per year (Article #13, Law #9.718/1998)[17].

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)[18].

**Table 6 - – 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)[19]**

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 deductable 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 ($\pi$) for Brazil is reduced from the nominal figure achieved. The $\pi$ 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:

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

[17] Publicly available information in Portuguese at: <http://www.receita.fazenda.gov.br/legislacao/leis/Ant2001/lei971898.htm>.

[18] Publicly available information in Portuguese at: <http://www.receita.fazenda.gov.br/legislacao/leis/L2Parte3.htm>.

[19] 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 7 – Cost of Debt (Kd) calculation**

| **Cost of Debt (Kd)** | |
|---|---|
| (a) Financial cost[20] | 6.53% |
| (b) BNDES spread[21] | 0.90% |
| (c) Credit risk rate[22] | 2.00% |
| (a+b+c) Pre-Cost of Debt | 9.43% |
| (t) Marginal tax rate[23] | 0.00% |
| (d) Inflation forecast[24] | 4.50% |
| **After tax Cost of Debt** | 4.71% 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**);
- 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

[20] 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>.

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

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

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

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

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:

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

**Table 8 – Cost of Equity (Ke) calculation**

| **Cost of Equity** |
|---|

| | |
|---|---|
| (Rf) Risk-free rate[25] | 4.25% |
| US expected inflation[26] | 1.98% |
| (Rm) Equity Risk Premium[27] | 6.03% |
| (β) Sectorial risk[28] | 1.55 |
| (Rc) Estimated Country Risk Premium[29] | 2.45% |
| **Cost of Equity with Brazilian Country Risk** | 14.05% 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:

$$WACC = 50\% \times 4.71\% + 50\% \times 14.05\%$$

$$WACC = 9.38\%$$

*Internal Rate of Return (IRR)*

As mentioned above, the financial indicator identified for Serra das Agulhas project is the project Internal Rate of Return (IRR). Serra das Agulhas cash flow over its lifetime shows that the project IRR is 7.54%.

Project cash flow is available with the Project Participants and will be presented to the DOE.

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

Serra das Agulhas cash flow demonstrates that the IRR of the project (7.54%) is lower than WACC (9.38%). This demonstrates that the project activity is not financially attractive to investor.

**Sub-step 2d. Sensitivity analysis**

[25] 30-year US Treasury Yield. Available at Damodaran's website: <http://pages.stern.nyu.edu/~adamodar/>.

[26] 10-year T.Notes minus 10-year TIPS. Available at the Federal Reserve website: <http://www.federalreserve.gov/econresdata/researchdata.htm>.

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

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

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

As required by the Additionality Tool, a sensitivity analysis was conducted to demonstrate whether the conclusion regarding the financial/economic attractiveness is robust to reasonable variations in the critical assumptions. Therefore, the sensitivity analysis of the project was conducted by altering the following parameters:

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

According to the "Guidelines on the assessment of investment analysis" (version 5):

"*…only variables, including the initial investment cost, that constitute more than 20% of either total project costs or total project revenues should be subjected to reasonable variation*". In addition, it states that "*variations in the sensitivity analysis should at least cover a range of +10% and -10%*".

Therefore, financial analysis shall be performed based on the criteria established above.

**Table 9 – Sensitivity analysis**

| Scenario | % change | IRR (%) |
|---|---|---|
| Original | - | 7.54% |
| Increase in the energy price | 10% | 8.74% |
| Increase in the project plant load factor (PLF)/energy assured | | 8.70% |
| Reduction in operational costs | | 7.87% |
| Reduction in project investment | | 8.57% |

It is important to note that the average of the Brazilian inflation in 2010 was of 5.91% and in 2011 was equal to 6.5%[30]. The use of 10% of variation, around two times the 2010 and 2011 inflation rate, in the variation of costs and revenues of the project activity was chosen as a very conservative approach.

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 (9.38%) and analyzed the probability of the occurrence of these scenarios. Results of this sensitivity analysis are presented in the table below:

**Table 10 – Sensitivity analysis 2**

| Scenario | % change |
|---|---|

[30] The IPCA is used as a parameter for the inflation targeting system. In 2011 IPCA's accumulated growth was equal to 6.5%. This index is published by several institutions in the country. One of these institutions is the Institute for Applied Economic Research ("IPEA" from the Portuguese *Instituto de Pesquisa Econômica Aplicada*) available at < http://www.ipeadata.gov.br/>.

| | |
|---|---|
| (a) Increase in the energy price | 15% |
| (b) Increase in the project plant load factor (PLF)/energy assured | 16% |
| (c) Reduction in operational costs | 56% |
| (d) Reduction in project investment | 17% |

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 energy auctions held in August 2010 for new small hydropower plant projects (in a free translation from Portuguese *Leilão de Energia Nova*) adjusted to the Extended National Consumer Price Index ("IPCA" from the Portuguese *Índice Nacional de Preços ao Consumidor Amplo*) – BRL 151.62/MWh[31]. Considering an increase in the energy price of 15% to the IRR reaches the benchmark, the energy price would be 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 11 – Energy auction results for new projects for electricity supply from 2008 to 2012**

| | | Hydro | Biomass | Natural gas | Coal | Oil | Total |
|---|---|---|---|---|---|---|---|
| 2008 | MW-ave | 71 | 31 | 352 | 0 | 178 | 632 |
| | MWh | 622,358 | 271,734 | 3,085,491 | 0 | 1,560,277 | 5,539,859 |
| | BRL/MWh | 106.95 | 111.04 | 131.00 | 0.00 | 138.44 | 129.42 |
| 2009 | MW-ave | 1074 | 110 | 479 | 0 | 642 | 2305 |
| | MWh | 9,414,254 | 964,216 | 4,198,722 | 0 | 7,627,515 | 22,204,707 |
| | BRL/MWh | 124.38 | 133.80 | 127.25 | 0.00 | 134.77 | 128.32 |
| 2010 | MW-ave | 935 | 140 | 570 | 292 | 1304 | 3241 |
| | MWh | 8,195,836 | 1,227,184 | 4,996,392 | 2,559,555 | 11,430,342 | 28,409,309 |
| | BRL/MWh | 115.48 | 138.85 | 120.35 | 124.67 | 134.67 | 125.90 |
| 2011 | MW-ave | 569 | 61 | 400 | 0 | 74 | 1104 |
| | MWh | 4,987,626 | 534,702 | 3,506,240 | 0 | 648,654 | 9,677,222 |
| | BRL/MWh | 121.86 | 137.10 | 137.44 | 0.00 | 137.72 | 129.41 |
| 2012 | MW-ave | 715 | 0 | 351 | 930 | 316 | 2312 |
| | MWh | 6,267,404 | 0 | 3,076,726 | 8,152,008 | 2,769,930 | 20,266,067 |
| | BRL/MWh | 129.14 | 0.00 | 129.34 | 126.97 | 131.40 | 128.61 |
| Total | MW-ave | 3,364 | 342 | 2,152 | 1,222 | 2,514 | 9,594 |
| | MWh | 29,487,478 | 2,997,836 | 18,863,571 | 10,711,563 | 24,036,718 | 86,097,164 |

[31] The result of the energy auctions was BRL 141.93/MWh.

| | | | | | | |
|---|---|---|---|---|---|---|
| Share | 35.1% | 3.6% | 22.4% | 12.7% | 26.2% | 100.0% |
| BRL/MWh | 119.56 | 104.16 | 129.08 | 50.33 | 135.40 | 128.33 |

**Source: ESPARTA (2008)[32]**

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 129.14/MWh. And the current scenario demonstrates that the tendency is the decrease in the electricity price; in the next energy auction to be conducted in March 2012 by the Brazilian government, the ceiling price is BRL 112/MWh[33]. Since the Brazilian energy auctions are based on the lowest tariff criteria, the energy price negotiated in this auction will be lower than BLR 112/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 are an official reference for the energy prices analysis by energy players in Brazil. Official information regarding electric energy auctions are publicly available and can be obtained 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 hydropower plants is based on the installed capacity and assured energy of the project. The assured energy of Serra das Agulhas project is 13.08 MW-ave as presented in the Consolidated Project Design ("PBC" from the Portuguese *Projeto Básico Consolidado*) prepared by VLB Engenharia (third-party) in May 2011. Considering an increase of 16% in the assured energy to the IRR reaches the benchmark, the assured energy would be 15.16 MW-ave.

However, the installed capacity and assured energy 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[34]. Therefore, an increase of 16% 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

[32] ESPARTA, A. R. J. (2008). Greenhouse gases emission reductions in the Brazilian power sector: Kyoto Protocol's clean development mechanism experience and a future pathway (in a free translation from the Portuguese *Redução de emissões de gases de efeito estufa no setor elétrico brasileiro: a experiência do Mecanismo de Desenvolvimento Limpo do Protocolo de Quioto e uma visão futura*). PhD thesis – Energy Graduation Program. University of Sao Paulo, March 2008. Table 5, page 42 of the pdf document presented to DOE.

[33] Information available at: <http://www.epe.gov.br/leiloes/Paginas/Leil%C3%A3o%20de%20Energia%20A-3%202012/AneelaprovaeditaldoLeil%C3%A3odeEnergiaA-32012.aspx>.

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

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 tax, operational and maintenance costs (O&M costs), environmental/managerial 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>.

→ O&M costs, environmental/managerial costs and insurance were based on the project sponsor experience with other operational small hydropower plant of the group (PCH Pipoca).

→ Transmission costs ("TUSD" from the Portuguese *Tarifa de Uso do Sistema de Distribuição*) are based on the ANEEL Resolution nr. 1,127 dated April 5th, 2011. Available at: <http://www.aneel.gov.br/cedoc/atreh20111127.pdf>.

Considering the project cash flow, total operational costs result in BRL 4.4 MM/year (around 3.2% from total investment). A reduction in the project costs until the IRR reaches the benchmark would result in a decrease of 56% from the estimated operational costs, *i.e.* an O&M cost of BRL 1,9 MM/year (around 1.4% from total investment) .

However, ANEEL fee and transmission costs are based on the Brazilian legislation; the O&M, environmental/managerial and insurance costs are based on the project sponsor experience with other small hydropower plant in operation: Pipoca as can be evidenced through contracts, financial statements and insurance policy of this project[35]. Considering this information, the operational costs considered in the project cash flow are well substantiated since they are based on legislation and the project sponsor experience with a "real case". Therefore, a decrease of 56% is not a reasonable scenario in the context of the project activity and is not expected to occur.

It is important to mention that for the O&M 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"[36] suggests the use of 5% of total investment for annual O&M costs for small hydropower plants in Brazil (around ten times lower than the figure used by the project sponsor).

[35] All documented evidence was presented to DOE during validation.

[36] 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.

(d) Reduction in project investment

Investment presented in the project cash flow is based on the ANEEL's technical summary from the project design (PBC) which was presented to the Brazilian Power Regulatory Agency (ANEEL). The investment results in approximately BRL 138.7 MM. A reduction of 17% in the project investments to the IRR reaches the benchmark would result in BRL 115.5 MM.

However, 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)[37] 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"[38] 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 are reasonable considering that they are based on ANEEL's technical summary from the project design presented to ANEEL and, generally, actual investments are higher than estimated. Therefore, a 17% 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 IRR of Serra das Agulhas project without being registered as a CDM project is below the benchmark, evidencing that project activity is not financially attractive for the investor even when parameters change in favour of the project. The knowledge of the CDM registering benefits was the key points to decision-making to implement the project activity.

***SATISFIED/PASS – Proceed to Step 3***

[37] 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.

**Step 3. Barrier analysis**

Not applicable.

**Step 4. Common practice analysis**

According to the methodological tool "Demonstration and assessment of additionality":

*"Unless the proposed project type has demonstrated to be first-of-its kind (according to Sub-step 3a), and for measures different from those listed in paragraph 6 the above generic additionality tests shall be complemented with an analysis of the extent to which the proposed project type (e.g. technology or practice) has already diffused in the relevant sector and region (…)*

*§6 Measure (for emission reduction activities) is a broad class of greenhouse gas emission reduction activities possessing common features. Four types of measures are currently covered in the framework:*

*(a) Fuel and feedstock switch;*
*(b) Switch of technology with or without change of energy source (including energy efficiency improvement as well as use of renewable energies);*
*(c) Methane destruction;*
(d) *Methane formation avoidance*".

Considering the measures presented above, Serra das Agulhas project activity applies option (b) since the project consists of a switch from grid electricity generation to electricity generation from water source (hydropower plants)[39]. Therefore, only hydropower plants were considered in this common practice analysis and only the additionality test is applied.

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

Not applicable since the proposed project activity applies option (b) of the measures described in paragraph 6 of the methodological tool "Tool for the demonstration and assessment of additionality". Please refer to the additionality test below.

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

Not applicable since the proposed project activity applies option (b) of the measures described in paragraph 6 of the methodological tool "Tool for the demonstration and assessment of additionality". Please refer to the additionality test below.

[38]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.

[39] Analogously to the example presented in Annex 8 of the EB 62.

In accordance with paragraph 47 of the additionality tool, the following additionality test has to be applied:

**Step 1**: Calculate applicable output range as +/-50% of the design output or capacity of the proposed project activity.

Applying the output range of +/-50% in Serra das Agulhas project, only plants with installed capacity between 14 MW and 42 MW were considered.

**Step 2**: In the applicable geographical area, identify all plants that deliver the same output or capacity, within the applicable output range calculated in Step 1 as the proposed project activity and have started commercial operation before the start date of the project. Note their number $N_{all}$. Registered CDM project activities and projects undergoing validation shall not be included in this step.

In order to conduct the analysis of Step 2, the PPs considered the definitions of geographical area and output as presented in the methodological tool "Demonstration and assessment of additionality".

*(i) Output*

The additionality tool defines output as "*goods or services with comparable quality, properties, and application areas (e.g. clinker, lighting, residential cooking)*". Therefore, in the case of Serra das Agulhas project, the output considered is the renewable electricity generated by grid-connected hydropower power plants.

*(ii) Applicable geographical area*

The additionality tool states:

> "*Applicable geographical area covers the entire Host Country as a default; if the technology applied in the project is not country specific, then the applicable geographical area should be extended to other countries*".

The technology to be used in the project activity is not country specific. Nevertheless, some important aspects regarding the technology shall be considered. Brazil has an extension of 8,514,876.599 square kilometres[40] (with over 4,000 km distance in the North-South as well as in the East-West axis) and 6 distinct climate regions: sub-tropical, semi-arid, equatorial, tropical, highland-tropical and Atlantic-tropical (humid tropical). Considering the distinct climate conditions, precipitation varies from 500 to more than 3,000 mm/year[41]. These varieties of climate obviously have strong influence in the technical aspects related to a small hydropower plant implementation *since meteorological events have strong*

[40] Available at: http://www.ibge.gov.br/english/geociencias/cartografia/default_territ_area.shtm.

[41] Public information available at *Instituto Nacional de Metereologia – INMET*'s website. Gráfico de normais climatológicas (1961-1990): <http://www.inmet.gov.br/>.

*influence in hydrologic process*[42]*. "Climate affects all major aspects of the electric power sector from electricity generation, transmission and distribution system to consume demand for power"*[43].

Considering the State where Serra das Agulhas is located – Minas Gerais –, it has an extension of 586,520.368 square kilometres[44]. For reference, the average of European countries areas is 163,003 square kilometres[45]. This demonstrates that, Minas Gerais is considered large and physical and climatological differences can influence the implementation of small hydropower plants. However, the Project Participants decided to analyze projects located in the same state of the proposed project activity for conservativeness reasons.

An evidence of the climate regional distinctiveness can be noted by the spot price value division into sub-markets (South, Southeast/Midwest, Northeast, and North), known as Settlement Price for the Differences ("PLD" from the Portuguese *Preço de Liquidação das Diferenças*). PLD is used to price the purchase and the sale of electricity in the short term market.

Nevertheless, the climate conditions are not the only distinguishing feature among the several Brazilian regions. For the use of the transmission system, the Tariff for the Use of the Distribution System ("TUSD" from the Portuguese *Tarifa de Uso do Sistema de Distribuição*) or Tariff for the Use of the Transmission System ("TUST" from the Portuguese the *Tarifa de Uso do Sistema de Transmissão*) shall be applied. The TUSD/TUST tariff varies depending on the state where the power plant is connected to. TUSD/TUST is established under ANEEL regulation and has strong impact in the financial analysis of a project. Just for reference, from the first semester of 2010, TUSD in São Paulo state (located in the same region of Minas Gerais) was BRL 1.82/kW[46] and BRL 4.64/kW[47] in Minas Gerais state (more than two times higher than São Paulo).

Furthermore, each state has a specific environmental agency responsible for determining the technical standards required to obtain all environmental licenses, with regional regulations and distinct administrative process established by each state region.

Therefore, when evaluating the different climate conditions of each region, the specific environmental regulatory framework of each state, the energy price subdivision per markets and different values of TUSD/TUST applied at each Brazilian state, it's clear that the national territory does not consist of the same "comparable environments" as required by the methodological tool "Demonstration

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[42] PINTO, J. A. Climatic indicators study for long term prediction in the river flow of Alto São Francisco basin (in a free translation from the Portuguese *Estudo de indicadores climáticos para a previsão de longo termo de vazões na bacia do Alto São Francisco*). Universidade Federal de Minas Ferais: Belo Horizonte, 2005. Available at: <http://www.smarh.eng.ufmg.br/defesas/20D.PDF>.

[43] VESELKA, T. D. Balance power: A warming climate could affect electricity. Geotimes. Earth, energy and environment news. American Geological Institute: August, 2008. Available at: < http://www.agiweb.org/geotimes/aug08/article.html?id=feature_electricity.html>.

[44] Public information available at IBGE's website: <http://ibge.gov.br/>.

[45] Data collected from United Nations Economic Commission for Europe (UNECE) – UNECE member countries in figures: country overview y indicator, country and year. In this result, the Russian Federation area is not considered. Available at: <http://www.unece.org/>.

[46] ANEEL Resolution nr. 961 issued on April 6th, 2010. Available at: < http://www.aneel.gov.br/cedoc/atreh2010961.pdf >.

and assessment of additionality". Undoubtedly, these differences among the Brazilian states (climate, energy price, transmission/distribution costs and environmental legislation) have technical, financial and regulatory impacts for the implementation of hydropower plants. Therefore, it is reasonable to consider only projects located in Minas Gerais state as similar to the proposed project activity.

Considering the definitions presented above, only electricity generated by grid-connected hydropower plants located in Minas Gerais state and whose installed capacity are between the range of 14 MW and 42 MW (as calculated in the Step 1 above) were listed. Furthermore, CDM projects were excluded from this analysis.

**Table 12 – Grid-connected hydropower plants from 14MW to 42 MW installed capacity in Minas Gerais (without CDM incentives)**

| Project | Installed power (kW) | Type | PROINFA |
|---|---|---|---|
| Bonfante | 19,000 | small | X |
| Monte Serrat | 25,000 | small | X |
| Pai Joaquim | 23,000 | small | - |
| Funil | 22,500 | small | X |
| Nova Maurício | 29,232 | small | - |
| Carangola | 15,000 | small | X |
| Areia Branca | 19,800 | small | X |
| Santa Fé I | 30,000 | small | X |
| Antas II | 16,800 | large | - |
| João Camilo Penna (Ex-Cachoeira do Emboque) | 21,600 | large | - |
| Gafanhoto | 14,000 | large | - |
| Piau | 18,012 | large | - |

**Source: ANEEL (2011)[48], UNFCCC (2011)[49] and Eletrobrás (2011)[50]**

Considering the table above, $N_{all}$ = 12.

[47] ANEEL Resolution nr. 960 issued on April 6th, 2010. Available at: < http://www.aneel.gov.br/cedoc/atreh2010960.pdf >.

[48] ANEEL (2011). Banco de informações de Geração (BIG). Summary – Minas Gerais state. Agência Nacional de Energia Elétrica. Acessed on January 10th, 2012. Information available at: <http://www.aneel.gov.br/aplicacoes/ResumoEstadual/CapacidadeEstado.asp?cmbEstados=MG:MINAS GERAIS>.

[49] UNFCCC (2011). Project Activities. Validation. United Nations Framework Convention on Climate Change. Available at <http://cdm.unfccc.int/index.html>. Acessed on January 10th, 2012.

[50] ELETROBRÁS (2011). Centrais Elétricas Brasileiras S/A. Programs and setorial funds. Proinfa. Contracted projects and addendum signed (from the Portuguese *relação de empreendimentos contratados e extratos de contratos e termos aditivos celebrados*). Available at: <http://www.eletrobras.com/elb/data/Pages/LUMISABB61D26PTBRIE.htm>. Accessed on June 7th, 2011.

**Step 3**: Within plants identified in Step 2, identify those that apply technologies different that the technology applied in the proposed project activity. Note their number $N_{diff}$.

According to the additionality tool, different technologies are technologies that deliver the same output and differ by at least one of the following (as appropriate in the context of the measure applied in the proposed CDM project and applicable geographical area):

(a) Energy source/fuel;

(b) Feed stock;

(c) Size of installation (power capacity):

  (i) Micro (as defined in paragraph 24 of Decision 2/CMP.5 and paragraph 39 of Decision 3/CMP.6);

  (ii) Small (as defined in paragraph 28 of Decision 1/CMP.2);

  (iii) Large.

(d) Investment climate in the date of the investment decision, inter alia:

  (i) Access to technology;

  (ii) Subsidies or other financial flows;

  (iii) Promotional policies;

  (iv) Legal regulations;

(e) Other features, inter alia;

  (i) Unit cost of output (unit costs are considered different if they differ by at least 20%).

Considering the information above, the Project Participants identified the following types of technologies that differ from the proposed project activity:

(a) Size of installation (power capacity):

  − Micro (as defined in paragraph 24 of Decision 2/CMP.5 and paragraph 39 of Decision 3/CMP.6);

  − Small (as defined in paragraph 28 of Decision 1/CMP.2);

  − Large.

  According to the Brazilian regulation, small scale hydropower plants are defined as plants with installed capacities between 1MW and 30MW and reservoir areas smaller than 3km[251]. Since Serra das Agulhas project is inserted in the context of the Brazilian legislation, it is reasonable to compare the project activity with other small hydropower

[51] *ANEEL – Agência Nacional de Energia Elétrica. Resolution nr. 652, issued on December 9th, 2003.*

plants according to the Host Country definition of small scale power plants (and not to the CDM-EB definition of small scale).

Considering explanations above, no large scale hydropower plants (*i.e.* installed capacity over 30MW and reservoir areas greater than 3km$^2$) were considered in this common practice analysis. Therefore, the technology that delivers the same output of Serra das Agulhas project - in the context of the measure and applicable geographical area of the project - is the electricity generation by grid-connected small hydropower plants. Large scale hydropower plants shall be considered as having different technology to the proposed project activity.

**Table 13 – Small hydropower plants from 14MW to 30 MW installed capacity in Minas Gerais (without CDM incentives)**

| Project | Installed power (kW) | PROINFA |
|---|---|---|
| Bonfante | 19,000 | X |
| Monte Serrat | 25,000 | X |
| Pai Joaquim | 23,000 | - |
| Funil | 22,500 | X |
| Nova Maurício | 29,232 | - |
| Carangola | 15,000 | X |
| Areia Branca | 19,800 | X |
| Santa Fé I | 30,000 | X |

(b) Investment climate in the date of the investment decision, inter alia:

(i) Promotional policies

The Alternative Electricity Sources Incentive Program (in a free translation from the Portuguese *Programa de Incentivo às Fontes Alternativas de Energia Elétrica – PROINFA*) was created through the Law nr. 10,438 dated April 26$^{th}$, 2002. Among others, one of the initiative's goals is to increase the renewable energy sources share in the Brazilian electricity market, thus contributing to a greater environmental sustainability. In order to achieve such goals, the Brazilian government has designated the federal state-owned power utility Eletrobrás (Centrais Elétricas Brasileiras S/A) to act as the primary off-taker of electric energy generated by alternative energy facilities in Brazil, by entering into long-term Power Purchase Agreements with alternative energy power producers, at a guaranteed price of at least 80% of the average energy supply tariff charged to ultimate consumers. In addition, Brazilian Decree nr. 5,025 dated March 30$^{th}$, 2004, which regulates the Law nr. 10,438, states that PROINFA aims for the reduction of greenhouse gases as established by the United Nations Framework Convention on Climate Change (UNFCCC) under Kyoto Protocol, contributing to the sustainable development. Therefore, the program is clearly a "Type E-" policy.

Considering explanations above, projects which have been participating in PROINFA cannot be compared with projects which do not receive this type of incentive. Since Serra das Agulhas does not receive PROINFA incentive, PROINFA projects shall be considered as having different technology to the proposed project activity.

**Table 14 - Small hydropower plants from 14MW to 30 MW installed capacity in Minas Gerais (without CDM and/or PROINFA incentives)**

| Project | Installed power (kW) |
|---|---|
| Pai Joaquim | 23,000 |
| Nova Maurício | 29,232 |

(ii) Legal regulations

- Electricity sector framework

Until the beginning of the 1990's, the energy sector was composed almost exclusively of state-owned companies. From 1995 onwards, due to the increase in international interest rates and the lack of state investment capacity, the government initiated the privatization process. However, by the end of 2000 results were still modest. Although further initiatives, aiming to improve electric generation in the country, were taken between the 1990's and 2003, they did not attract new investment to the sector. In 2003, the recently elected government decided to fully review the electricity market institutional framework in order to boost investments in the electric energy sector. Market rules were changed and new institutions were created such as Energetic Research Company (in a free translation from the Portuguese *Empresa de Pesquisa Energética – EPE*) – an institution responsible for the long term planning of the electricity sector with the role of evaluating, on a perennial basis, the safety of the supply of electric power – and Chamber for the Commercialization of Electric Power (CCEE) – an institution responsible for the management of electric power commercialization within the interconnected system. This new structure was approved by the House of Representatives and published in March of 2004[52]. Given the new regulatory framework, the Project Participants considered only projects which started operation from April of 2004 onwards. Projects that started operations before the new electricity framework shall be considered as having different technology to the proposed project activity.

[52] http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2004/lei/l10.848.htm

In make an in-depth analysis, the Project Participants observed that Pai Joaquim and Nova Maurício small hydropower plants started operation in December 2003 and March 1956, respectively, *i.e.* before the new electricity sector framework[53].

Considering information above, $N_{diff} = 12$.

**Step 4**: Calculate factor $F=1- N_{diff} /N_{all}$ representing the share of plants using technology similar to the technology used in the proposed project activity in all plants that deliver the same output or capacity as the proposed project activity. The proposed project activity is a "common practice" within a sector in the applicable geographical area if the factor F is greater than 0.2 and $N_{all}-N_{diff}$ is greater than 3.

Since $N_{diff} = 12$ and $N_{all} = 12$:

$N_{all} - N_{diff} = 0 < 3$ and,

$F = 1- N_{diff} /N_{all} = 0 < 0.2$

Therefore, Serra das Agulhas project activity is not a common practice.

Spreadsheet with complete research of the common practice analysis is available with the Project Participants and was presented to DOE during validation.

**Outcome:** Considering research above, all projects that have started operation since April 2004 publicly receive some kind of incentive (CDM and/or PROINFA). This result demonstrates that risks related to this type of project are higher, as discussed in Step 2 – Investment Analysis, and that a strong incentive is required to promote the construction of renewable energy projects in Brazil, where it includes small hydropower plants.

It is worth mentioning that 67.7% of Brazil's generation is composed by large hydropower plants and 26.5 % of thermal power stations. Only 3 % of Brazil's installed capacity comes from small hydro power sources (3.5 GW out of a total of 114.3 GW).

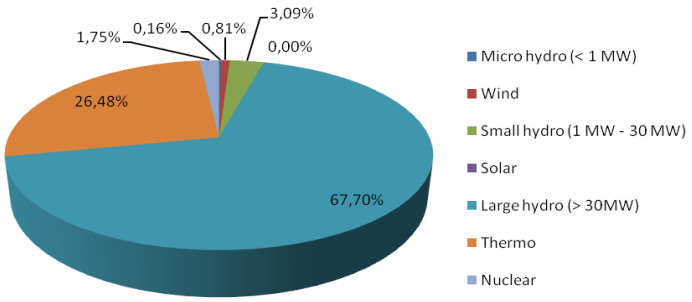


**Figure 6 – Operational power projects in Brazil**

[53] Pai Joaquim small hydropower plant started operation in December 2003. Information available at: <http://www.delp.com.br/port/detalhesite.asp?cat_nome=Arquivo%20Digital&site_nome=PCH%20de%20Pai%20Joaquim&site_id=34>.

**Source: ANEEL (2011)**[54]

In summary, this project activity is clearly not common practice, because no similar project started operation during the above mentioned period without some kind of incentive. With the financial benefit derived from the CERs, it is anticipated that other project developers will benefit from this new source of revenue and further will decide to develop such projects. CDM has made it possible for investors to set up their small hydro plants and sell their electricity to the grid.

***SATISFIED/PASS – Project is ADDITIONAL***

## B.6. Emission reductions:

### B.6.1. Explanation of methodological choices:

The ACM0002 - "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" was chosen. This methodology is applicable to grid-connected renewable power generation projects as is the case of Serra das Agulhas project.

***Emission reductions ($ER_y$) calculation***

According to the selected approved methodology ACM0002, emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \qquad \textbf{Equation 1}$$

Where:

$ER_y$ = Emission reductions in year $y$ ($tCO_2e$);

$BE_y$ = Baseline emissions in year $y$ ($tCO_2$);

$PE_y$ = Project emissions in year $y$ ($tCO_2e$).

***Baseline emissions ($BE_y$) calculation***

The baseline emissions ($BE_y$) during a given year $y$ are achieved through the equation below:

$$BE_y = EG_{PJ,y} \times EF_{grid,CM,y} \qquad \textbf{Equation 2}$$

[54] ANEEL (2011). Energy generation database (from the Portuguese *Banco de Informações de Geração – BIG*). Operational power projects in Brazil. The Brazilian Power Regulatory Agency (in a free translation from the Portuguese *Agência Nacional de Energia Elétrica*). Available at: <http://www.aneel.gov.br/aplicacoes/capacidadebrasil/capacidadebrasil.asp>. Accessed in May 2011.

Where:

$EG_{PJ,y}$ = Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year *y* (MWh);

$EF_{grid,CM,y}$ = Combined margin $CO_2$ emission factor for grid connected power generation in year *y* calculated using the latest version of the "Tool to calculate the emission factor for an electricity system" ($tCO_2$/MWh).

*Baseline emission factor ($EF_{grid,CM,y}$) calculation*

According to the selected approved methodology ACM0002, the baseline emission factor ($EF_y$) is calculated using the methodological tool "Tool to calculate the emission factor for an electricity system". According to this tool PPs shall apply the following six steps to the baseline calculation:

STEP 1 - Identify the relevant electricity systems;

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

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

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

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

STEP 6 - Calculate the combined margin (CM) 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*".

The Brazilian DNA published Resolution nr. 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).

Project participants may choose between the following two options to calculate the operating margin and build margin emission factor:

Option (i): only grid power plants are included in the calculation;

Option (ii): both grid power plants and off-grid power plants are included in the calculation.

The Brazilian DNA made available the emission factor calculation based on information of the grid power plants only – option (i) – following the "Tool to calculate the emission factor for an electricity system". More information of the methods applied can be obtained at the DNA's website (http://www.mct.gov.br/index.php/content/view/4016.html).

- **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.

Since there is no preferable method for the calculation of the OM emission factor, the Project Participants have chosen the method and calculation made available by the Brazilian DNA (*Comissão Interministerial de Mudança Global do Clima – CIMGC*), using option (c) Dispatch data analysis OM. More information of the OM emission factor can be obtained at the DNA's website (http://www.mct.gov.br/index.php/content/view/74689.html).

According to the "Tool to calculate the emission factor for an electricity system", in the "dispatch data analysis OM" method, it shall be considered the year in which the project activity displaces grid electricity and update the emission factor annually during monitoring. Therefore, Serra das Agulhas applies the *ex-post* data vintage.

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

The dispatch data analysis OM emission factor ($EF_{grid,OM-DD,y}$) is determined based on the grid power units that are actually dispatched at the margin during each hour *h* where the project is displacing grid electricity. It shall be calculated according to the formulae below:

$$EF_{grid,OM-DD,y} = \frac{\sum_h EG_{PJ,h} \times EF_{EL,DD,h}}{EG_{PJ,y}} \qquad \textbf{Equation 3}$$

Where:

$EF_{grid,OM-DD,y}$ = Dispatch data analysis operating margin $CO_2$ emission factor in year *y* ($tCO_2/MWh$);

$EG_{PJ,h}$ = Electricity displaced by the project activity in hour *h* of the year *y* (MWh);

$EF_{EL,DD,h}$ = $CO_2$ emission factor for power units in the top of the dispatch order in hour *h* in year *y* ($tCO_2/MWh$);

$EG_{PJ,y}$ = Total electricity displaced by the project activity in year *y* (MWh);

*h* = Hours in year *y* in which the project activity is displacing grid electricity;

*y* = Year in which the project activity is displacing grid electricity.

*Calculation of hourly $CO_2$ emission factor for grid power units ($EF_{EL,DD,h}$)*

The Brazilian DNA made available the calculation of the operating margin emission factor based on option (c) dispatch data analysis. Therefore, the project participants used this figure for Serra das Agulhas project activity.

However, the project participants neither have access to the decisions that the Brazilian DNA took in order to calculate the hourly $CO_2$ emission factor nor to the spreadsheet used. Only final values are available for public consultation. Hence, the project participants are not able to describe which method has been used to calculate the hourly emission factor.

*Calculation to determine the set of grid power units n in top of the dispatch*

The Brazilian DNA made available the calculation of the operating margin emission factor based on option (c) dispatch data analysis. Therefore, the project participants used this figure for Serra das Agulhas project activity.

However, the project participants neither have access to the decisions that the Brazilian DNA took in order to determine the set of power units *n* nor to the spreadsheet used. Only final values for the hourly emission factor ($\underline{EF_{EL,DD,h}}$) are available for public consultation. Hence, the project participants are not able to describe which method has been used to determine the set of power units *n*.

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

The build margin emissions factor is the generation-weighted average emission factor ($tCO_2$/MWh) of all power units m during the most recent year y for which electricity generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} \qquad \textbf{Equation 4}$$

Where:

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

$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m in year *y* (MWh);

$EF_{EL,m,y}$ = $CO_2$ emission factor of power unit m in year *y* ($tCO_2$/MWh);

*m* = Power units included in the build margin;

*y* = Most recent historical year for which electricity generation data is available.

*Calculation to determine the set of power units m included in the build margin*

The Brazilian DNA made available the calculation of the build margin emission. Therefore, the project participants used this figure for Serra das Agulhas project activity.

However, the project participants neither have access to the decisions that the Brazilian DNA took in order to determine the set of power units *m* nor to the spreadsheet used. Only final values are available for public consultation. Hence, the project participants are not able to describe which method has been used to determine the set of power units *m*.

*Calculation of the $CO_2$ emission factor for each power unit m ($EF_{EL,m,y}$)*

The Brazilian DNA made available the calculation of the build margin emission. Therefore, the project participants used this figure for Serra das Agulhas project activity.

However, the project participants neither have access to the decisions that the Brazilian DNA took in order to calculate the $CO_2$ emission factor for each power unit *m* nor to the spreadsheet used. Only final values are available for public consultation. Hence, the project participants are not able to describe which method has been used to calculate the $CO_2$ emission factor for each power unit *m*.

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

The calculation of the combined margin (CM) emission factor is based on one of the following methods:

(a) Weighted average CM; or

(b) Simplified CM.

The weighted average CM method (option A) should be used as the preferred option.

The simplified CM method (option b) can only be used if:

- The project activity is located in a Least Developed Country (LDC) or in a country with less than 10 registered CDM projects at the starting date of validation; and
- The data requirements for the application of step 5 above cannot be met.

*(a) Weighted average CM*

The combined margin emissions factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM} \quad \textbf{Equation 5}$$

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 (%).

The following default values should be used for $w_{OM}$ and $w_{BM}$:

- Wind and solar power generation project activities: $w_{OM}$ = 0.75 and $w_{BM}$ = 0.25 (owing to their intermittent and non-dispatchable nature) for the first crediting period and for subsequent crediting periods;
- All other projects: $w_{OM}$ = 0.5 and $w_{BM}$ = 0.5 for the first crediting period , and $w_{OM}$ = 0.25 and $w_{BM}$ = 0.75 for the second and third crediting period,6 unless otherwise specified in the approved methodology which refers to this tool.

Since Serra das Agulhas is a small hydropower plant project, the weights used for the operating and build margin are 0.50 for both.

*(b) Simplified CM*

The combined margin is calculated using equation 5 above with the following conditions:

- $w_{BM}$ = 0;
- $w_{OM}$ = 1.

Under the simplified CM, the operating margin emission factor ($EF_{grid,OM,y}$) must be calculated using the average OM (option (d) in step 3 of the "Tool to calculate the emission factor for an electricity system).

*Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity* ($EG_{PJ,y}$)

According to ACM0002, the calculation of $EG_{PJ,y}$ is different depending on the case of the project as follows:

(a) Greenfield plants (installation of a new grid-connected renewable power plant/unit at a site where no renewable power plant was operated prior to the implementation of the project activity);

(b) Retrofits and replacements of an existing renewable energy power plant;

(c) Capacity addition to an existing renewable energy power plant.

Since Serra das Agulhas project is a new small hydropower plant connected to the grid where no renewable power plant was operated prior to the project, Serra das Agulhas applies option (a). In this case, $EG_{PJ,y}$ is calculated as follows:

$$EG_{PJ,y} = EG_{facility,y} \qquad \textbf{Equation 6}$$

Where:

$EG_{facility,y}$ = Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y* (MWh)

Estimated quantity of net electricity generation supplied by the project plant/unit to the grid is presented in section B.6.3 below.

***Project emissions ($PE_y$) calculation***

The proposed project activity may involve project emissions that can be significant. In this sense, according to the selected CDM methodology these emissions shall be accounted for as project emissions by using the following equation:

$$PE_y = PE_{FF,y} + PE_{GP,y} + PE_{HP,y} \qquad \textbf{Equation 7}$$

Where:

$PE_y$ = Project emissions in year $y$ ($tCO_2e$);

$PE_{FF,y}$ = Project emissions from fossil fuel consumption in year $y$ ($tCO_2$);

$PE_{GP,y}$ = Project emissions from the operation of geothermal power plants due to the release of non-condensable gases in year $y$ ($tCO_2e$);

$PE_{HP,y}$ = Project emissions from reservoirs of hydro power plants in year $y$ ($tCO_2e$).

*Emissions from fossil fuel combustion ($PE_{FF,y}$)*

Considering that there is no fossil fuel combustion in the proposed project activity, $PE_{FF,y}$ = 0 $tCO_2$.

*Emissions from the operation of geothermal power plants due to the release of non-condensable gases ($PE_{GP,y}$)*

Considering that the proposed project activity consists on the construction of a small hydropower plant, there are no emissions of non-condensable gases from the operation of geothermal power plants. Therefore, $PE_{GP,y}$ = 0 $tCO_2$.

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

According to ACM0002, new hydropower projects that result in new single or multiple reservoirs, shall account for project emissions 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 $W/m^2$:

$$PE_{HP,y} = \frac{EF_{Res} \times TEG_y}{1000} \qquad \textbf{Equation 8}$$

Where:

$PE_{HP,y}$ = Project emissions from water reservoirs of hydropower plants in year $y$ ($tCO_2e$);

$EF_{Res}$ = Default emission factor for emissions from reservoirs, and the default value as per EB23 is 90 Kg $CO_2e$/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 power density (*PD*) of the project is greater than 10W/m$^2$, $PE_{HP,y}$ = 0 $tCO_2e$. The power density of the project activity is calculated as follows:

$$PD = \frac{Cap_{PJ} - Cap_{BL}}{A_{PJ} - A_{BL}} \qquad \textbf{Equation 9}$$

Where:

*PD* = Power density of the project activity, in 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.

***Leakage ($LE_y$) calculation***

The main emissions potentially giving rise to leakage in the context of electric sector projects are emissions arising due to activities such as power plant construction and upstream emissions from fossil fuel use (*e.g.* extraction, processing, transport). According to ACM0002, these emissions sources are neglected.

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

| **Data / Parameter:** | $Cap_{BL}$ |
|---|---|
| Data unit: | W |
| Description: | Installed capacity of the hydro power plant before the implementation of the project activity. For new hydropower plants, this value is zero. |
| Source of data: | Project site |
| Measurements procedures (if any): | Determine the installed capacity based on recognized standards. |
| Any comment: | - |

| **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 the project activity, when the reservoir is full |

| | |
|---|---|
| | ($m^2$). For new reservoirs, this value is zero. |
| Source of data: | Project site |
| Measurements procedures (if any): | Measured from topographical surveys, maps, satellite pictures, etc. |
| Any comment: | - |

### B.6.3. Ex-ante calculation of emission reductions:

***Emission reductions ($ER_y$) calculation***

According to the selected approved methodology ACM0002, emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \qquad \textbf{Equation 1}$$

***Baseline emissions ($BE_y$) calculation***

As described in section B.6.1, baseline calculation (*BE*) in this project are calculated directly from electricity supplied by the project to the grid (*EG*) multiplied by the emission factor (*EF*).

*Baseline emission factor ($EF_{grid,CM,y}$) calculation*

The methodology choices for 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*" and are presented below:

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

According to Resolution nr. 8 issued by the Brazilian DNA on May 26th, 2008, the Brazilian Interconnected Grid (from the Portuguese *Sistema Interligado Nacional – SIN*) 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.

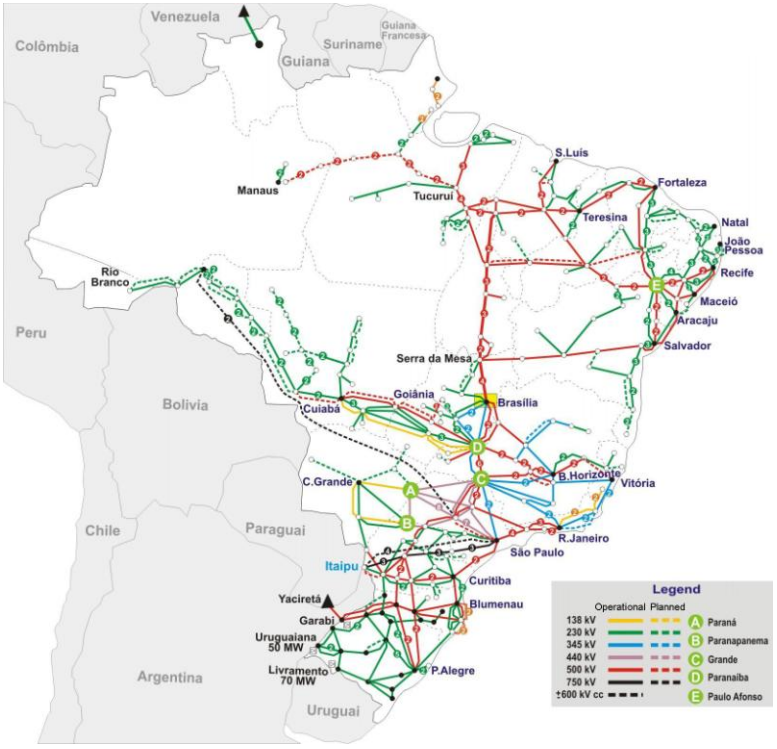


**Figure 7 – Brazilian Interconnected System**

**Source: ONS (2011)**[55]

- **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 is considered.

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

The Brazilian DNA made publicly available the OM through the dispatch data analysis OM (option c). Therefore, this method was used for the proposed project activity. Please refer to section B.6.1. for explanation of methodological choices.

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

The Brazilian DNA made publicly available the OM emission factor through the dispatch data analysis OM (option c). Therefore, data of 2010 was used (the most recent data available) as presented below.

[55] Electric System National Operator ("ONS" from the Portuguese *Operador Nacional do Sistema Elétrico*). Mapas do SIN. Information available at: <http://www.ons.org.br/>. Accessed on May 13th, 2011.

$$EF_{grid,OM\text{-}DD,y} = 0.4787\ tCO_2e/MWh$$

- **STEP 5** – Calculate the build margin emission factor ($EF_{BM,y}$)

The Brazilian DNA made publicly available the build margin emission factor. Therefore, data of 2010 was used (the most recent data available) as presented below.

$$EF_{grid,BM,y} = 0.1404\ tCO_2e/MWh$$

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

Applying the results presented above in STEPS 4 and 5 above to the Equation 5 presented in section B.6.1. and considering the weights $w_{OM} = 0.50$ and $w_{BM} = 0.50$, we obtain:

$$EF_{grid,CM,y} = 0.5 \times 0.4787 + 0.5 \times 0.1404\ tCO_2e/MWh$$

$$EF_{grid,CM,y} = 0.3095\ tCO_2e/MWh$$

*Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity* ($EG_{PJ,y}$)

As mentioned in section B.6.1, $EG_{PJ,y} = EG_{facility,y}$. Estimated quantity of net electricity generation supplied by the project plant/unit to the grid is calculated based on the assured energy 13.08 MW-ave (46.7% plant load factor) as presented in the studies of the consolidated project design (from the Portuguese *Projeto Básico Consolidado*) dated May 2011 and prepared by VLB Engenharia.

Considering the 8,760 hours of operation in the year, the energy delivered to the grid is 114,581 MWh/year. Therefore, Serra das Agulhas project applies option (b) of the "Guidelines for the reporting and validation of plant load factors", *i.e.* "*the plant load factor determined by a third party contracted by the project participants (e.g. an engineering company)*".

***Project emissions ($PE_y$) calculation***

*Emissions from fossil fuel combustion ($PE_{FF,y}$)*

Considering that there is no fossil fuel combustion in the proposed project activity, $PE_{FF,y} = 0$ $tCO_2$.

*Emissions from the operation of geothermal power plants due to the release of non-condensable gases ($PE_{GP,y}$)*

Considering that the proposed project activity consists on the construction of a small hydropower plant, there are no emissions of non-condensable gases from the operation of geothermal power plants. Therefore, $PE_{GP,y} = 0$ $tCO_2e$.

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

According to ACM0002, new hydropower projects that result in new single or multiple reservoirs, shall account for project emissions based on its power density (PD):

$$PD = \frac{Cap_{PJ} - Cap_{BL}}{A_{PJ} - A_{BL}} \qquad \textbf{Equation 9}$$

Considering Serra das Agulhas project data: $Cap_{PJ}$ = 28 MW; $Cap_{BL}$ = 0; $A_{PJ}$ = 0.62 $km^2$ and $A_{BL}$ = 0 $km^2$, the *PD* is 45.16 $MW/km^2$ or 45.16 $W/m^2$. As Serra das Agulhas power density (*PD*) is greater than 10 $W/m^2$, $PE_{HP,y}$ is = 0 $tCO_2e$.

***Leakage ($LE_y$) calculation***

As explained in section B.6.1 and according to ACM0002, emissions sources in the context of electricity generation can be neglected. Therefore, $LE_y$ = 0 $tCO_2$.

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

**Table 15 – Estimated project emissions, baseline emissions, leakage and emission reductions during the first crediting period of the project activity**

| **Years** | **Estimation of project activity emissions** (tonnes of $CO_2e$) | **Estimation of baseline emissions** (tonnes of $CO_2e$) | **Estimation of leakage** (tonnes of $CO_2e$) | **Estimation of overall emission reductions** (tonnes of $CO_2e$) |
|---|---|---|---|---|
| Year 1 - (2014)* | 0.00 | 23,806 | 0.0 | 23,806 |
| Year 2 - (2015) | 0.00 | 35,467 | 0.0 | 35,467 |
| Year 3 - (2016) | 0.00 | 35,564 | 0.0 | 35,564 |
| Year 4 - (2017) | 0.00 | 35,467 | 0.0 | 35,467 |
| Year 5 - (2018) | 0.00 | 35,467 | 0.0 | 35,467 |
| Year 6 - (2019) | 0.00 | 35,467 | 0.0 | 35,467 |
| Year 7 - (2020) | 0.00 | 35,564 | 0.0 | 35,564 |
| Year 8 - (2021)** | 0.00 | 11,660 | 0.0 | 11,660 |
| **Total** (tonnes of $CO_2e$) | **0.00** | **248,460** | **0.00** | **248,460** |

*Starting on May 1st
**Until April 30th

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

### B.7.1 Data and parameters monitored:

| **Data / Parameter:** | $EG_{facility,y}$ |
|---|---|
| Data unit: | MWh |
| Description: | Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y*. |
| Source of data: | Project activity site. |
| Measurements procedures (if any): | Electricity meters.<br><br>Data from sales receipt (records for sold electricity) or by documents from the Chamber of Electric Energy Commercialization (from the Portuguese *Câmara Comercializadora de Energia Elétrica – CCEE*).<br><br>114,581 MWh/year was considered for ex-ante estimative, Estimated energy dispatched to the grid based on 13.08 MW-ave assured energy. |
| Monitoring frequency: | Continuously measurement and monthly recording. |
| QA/QC procedures: | Cross check measurement results with sales receipt (records for sold electricity) or internal control (if available). If data from CCEE is made available to check the net electricity of the project and sales receipt can be used to verify the net electricity generated by the project, sales receipt will be used for cross-checking purposes. It may be available the project sponsor internal control at that time of the verification, which can also be used for cross-checking purposes. Electronically archived.<br>It is important to mention that equipments that will be used have by legal requirements extremely low level of uncertainty. |
| Any comment: | - |

| **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. |
| Measurements procedures (if any): | Installed capacity of the power plant will be checked by DOE during on-site visit (equipment tag[56]) at every verification. |

[56] It is important to mention that it may have differences between the sum of the nominal power of turbines/generators of the project and the environmental licenses/ANEEL authorizations. In Brazil, it is really common the equipment tag with a total

| | |
|---|---|
| | 28,000,000 W installed capacity was considered for ex-ante estimative. Determine the installed capacity based on recognized standards. |
| Monitoring frequency: | Yearly. |
| QA/QC procedures: | ANEEL resolution and/or licenses issued by the Environmental Agency of the State will be available at that time of the verification for cross-checking purposes. Electronically archived. |
| Any comment: | - |

| **Data / Parameter:** | $A_{PJ}$ |
|---|---|
| Data unit: | $m^2$ |
| Description: | 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. |
| Source of data: | Project site. |
| Measurements procedures (if any): | Measured from topographical surveys, maps, satellite pictures, etc. The reservoir area 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 monitored yearly by the project sponsor.<br>The water level to be compared with the topographical study will be based on the average water level that will be verified annually. Electronically archived.<br>620,000 $m^2$ reservoir area was considered for ex-ante estimative. |
| Monitoring frequency: | Yearly. |
| QA/QC procedures: | Engineering/environmental studies and/or licenses issued by the Environmental Agency of the State will be available at that time of the verification for cross-checking purposes. Electronically archived. |
| Any comment: | - |

| **Data / Parameter:** | $EF_{grid,CM,y}$ |
|---|---|
| Data unit: | $tCO_2/MWh$ |
| Description: | Combined margin $CO_2$ emission factor for grid connected power generation in year y calculated using the latest version of the "Tool to calculate the emission factor for an electricity system". |

power with slight difference than the one presented in the ANEEL authorization or the environmental licenses. Since turbine and generators of Serra das Agulhas project were not purchased, probably there will be a minor difference between equipment tag and official installed capacity. However, this slight difference is known by governmental entities and participants of the electric sector and it is deemed accepted, since this slight difference does not impact the assured energy of projects, and then, it does not impact the electricity commercialization or the capacity of energy supply. Therefore, this will not impact the additionality or the emission reductions of the project presented in this PDD.

| | |
|---|---|
| Source of data: | Calculated following the steps provided by the "Tool to calculate the emission factor for an electricity system" applying the numbers published by the Brazilian DNA (http://www.mct.gov.br/index.php/content/view/74689.html) |
| Measurements procedures (if any): | Once option c) dispatch data analysis OM was chosen by the Brazilian DNA, this value will be updated following the prescription of the tool. More information of the OM emission factor can be obtained at the DNA's website.<br><br>0.3095 $tCO_2$/MWh was considered for ex-ante estimative. |
| Monitoring frequency: | Hourly and yearly. |
| QA/QC procedures: | Official source of data. |
| Any comment: | For estimative purposes, data of 2010 year was used. |

| | |
|---|---|
| Data / Parameter: | $\boldsymbol{EF_{grid,OM,y}}$ |
| Data unit: | $tCO_2$/MWh |
| Description: | Operating margin $CO_2$ emission factor in year *y* |
| Source of data: | Brazilian DNA website (http://www.mct.gov.br/index.php/content/view/74689.html) |
| Measurements procedures (if any): | The selected option to calculate the operating margin is the dispatch analysis which does not permit the vintage of *ex-ante* calculation of the emission factor. Hence, this value will be calculated annually applying the numbers published by the Brazilian DNA and following the steps provided in the "*Tool to calculate the emission factor for an electricity system*".<br><br>The $EG_{PJ,h}$ parameter required for the calculation of the $EF_{grid,OM,y}$ parameter will be monitored as explained in $EG_{facility,y}$ as required by the "*Tool to calculate the emission factor for an electricity system*".<br><br>The $EF_{EL,DD,h}$ parameter will be provided by the Brazilian DNA in order to calculate the $EF_{grid,OM,y}$ as required by the "*Tool to calculate the emission factor for an electricity system*".<br><br>0.4787 $tCO_2$/MWh was considered for ex-ante estimative. |
| Monitoring frequency: | Hourly and yearly following the "Tool to calculate the emission factor for an electricity system". |
| QA/QC procedures: | Official source of data. |
| Any comment: | For estimative purposes, data of 2010 year was used. |

| | |
|---|---|
| Data / Parameter: | $\boldsymbol{EF_{grid,BM,y}}$ |
| Data unit: | $tCO_2$/MWh |
| Description: | Build margin $CO_2$ emission factor in year *y* |
| Source of data: | Brazilian DNA website (http://www.mct.gov.br/index.php/content/view/74689.html) |

| | |
|---|---|
| Measurements procedures (if any): | The selected option to calculate the operating margin was the dispatch analysis which does not permit the vintage of *ex-ante* calculation of the emission factor. Hence, this value will be calculated annually applying the numbers published by the Brazilian DNA and following the steps provided in the "*Tool to calculate the emission factor for an electricity system*".<br><br>0.1404 $tCO_2$/MWh was considered for ex-ante estimative. |
| Monitoring frequency: | Yearly following the "Tool to calculate the emission factor for an electricity system". |
| QA/QC procedures: | Official source of data. |
| Any comment: | For estimative purposes, data of 2010 year was used. |

### B.7.2. Description of the monitoring plan:

The monitoring of Serra das Agulhas project will follow ACM0002. As presented section B.7.1, and according to ACM0002, the parameters to be monitored for Serra das Agulhas project are as follows:

(i) Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y* ($EG_{facility,y}$);

(ii) Installed capacity of the hydro power plant after the implementation of the project activity ($Cap_{PJ}$);

(iii) 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 ($A_{PJ}$);

(iv) Combined margin $CO_2$ emission factor for grid connected power generation in year *y* calculated using the latest version of the "Tool to calculate the emission factor for an electricity system" ($EF_{grid,CM,y}$).

(i) Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y* ($EG_{facility,y}$)

The electricity monitoring will be conducted according to the "ACM0002 - "Consolidated baseline methodology for grid-connected electricity generation from renewable sources".

A substation will be constructed by the project sponsor in Monjolos municipality for the connection of Serra das Agulhas into the grid. There will be energy meters at this substation (principal and backup) that will measure the net electricity of Serra das Agulhas project. The net measurement will be used for emission reduction purposes.

All meters that will be used in Serra das Agulhas project shall have the necessary technical specifications as required by the National Operator System ("ONS" from the Portuguese *Operador do Sistema Nacional*). In Table 12 is presented the current meters which have the necessary specifications to be installed in the "connection point" of the grid as required by ONS. Therefore, Serra das Agulhas will apply one of the meters presented below.

**Table 16 – Meters with technical specifications as required by ONS**

| Manufacturer | Meter/model |
|---|---|
| Electro Industries | Nexus / 1270 |
| | Nexus / 1500 |
| Elo | ELO / 2180 |
| Itron | Q1000 |
| | SL7000 |
| Schneider Electric | ION / 7500 |
| | ION / 7550 |
| | ION / 7600 |
| | ION / 7650 |
| | ION / 8300 |
| | ION / 8400 |
| | ION / 8500 |
| | ION / 8600 |
| | ION / 8800 |
| Saga 1000 / 1681 | Landis & Gyr |
| ZIV | 5CTE-E5A-2F6402UC |
| Schweitzer Engineering Laboratories | SEL / 734 |

**Source: CCEE, [(--)][57]**

Calibration of meters located in the "connection point" of the grid will be made every 2 years as required by ONS[58]. The responsibility of calibration is not defined yet (project sponsor, power utility or the energy trader to be contracted by the project sponsor). However, the project sponsor will make sure that calibrations will follow the ONS requirements.

The project will proceed with the necessary measures for the power control and monitoring. Electricity dispatched to the grid of Serra das Agulhas project will be checked by sales receipt (records for sold electricity) or by documents from the Chamber of Electric Energy Commercialization ("CCEE" from the Portuguese *Câmara Comercializadora de Energia Elétrica*) and internal control (if available). CCEE makes feasible and regulates the electricity energy

[57] Information available at CCEE's website: <http://www.ccee.org.br/cceeinterdsm/v/index.jsp?vgnextoid=ca4da5c1de88a010VgnVCM100000aa01a8c0RCRD>

[58] Sub-módulo 12.3. Measurement system maintenance for invoicing, in a free translation from the Portuguese *Manutenção do Sistema de Medição para Faturamento*. Available at: <http://extranet.ons.org.br/operacao/prdocme.nsf/videntificadorlogico/5DA0C134065FB70F83257945005B1BDF/$file/Submodulo%2012.3_Rev_2.0.pdf?openelement>

commercialization. Hence, information related to electricity generation and supply of all grid-connected power plants is controlled by CCEE.

(ii) Installed capacity of the hydro power plant after the implementation of the project activity ($Cap_{PJ}$)

Installed capacity of the power plant will be checked by DOE during on-site visit[59] at every verification and cross-checked with official documents, *e.g.* ANEEL resolution and/or licenses issued by the environmental agency of Minas Gerais State.

(iii) Area of the reservoir measured in the surface of the water, after the implementation of the project activity, when the reservoir is full ($A_{PJ}$)

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 sponsors. 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.

(iv) Combined margin $CO_2$ emission factor for grid connected power generation in year *y* calculated using the latest version of the "Tool to calculate the emission factor for an electricity system" ($EF_{grid,CM,y}$)

The grid emission factor presented in this PDD was calculated by the Brazilian DNA (available at: http://www.mct.gov.br/index.php/content/view/307492.html), using the Dispatch Data Analysis for the Operating Margin. The Build Margin emission factor was determined using the generation-weighted average emission factor of all power units during the most recent year for which power generation data was available. Therefore, the emission factor of 0.3095 $tCO_2e/MWh$ was used just for estimating the expected emission reductions of the project activity during the crediting period. Hence, the emission factor calculation used in this PDD, for estimating purposes only, must be verified and updated accordantly using the most recent data available at the time of the verification process.

[59] It is important to mention that it may have differences between the sum of the nominal power of turbines/generators of the project and the environmental licenses/ANEEL authorizations. In Brazil, it is really common equipment tag with a total power with slight difference than the one presented in the ANEEL authorization or the environmental licenses. Since turbine and generators of Serra das Agulhas project were not purchased, probably there will be a minor difference between equipment tag and official installed capacity. However, this slight difference is known by governmental entities and participants of the electric sector and it is deemed accepted, since this slight difference does not impact the assured energy of projects, and then, it does not impact the electricity commercialization or the capacity of energy supply. Therefore, this will not impact the additionality or the emission reductions of the project presented in this PDD.

The responsibilities and institutional arrangements for data collection and archiving related to the proposed project activity are from Omega Energia. However, these responsibilities are not defined among its internal departments. This will be defined just before the project start operation. All data collected as part of monitoring will be archived electronically and be kept at least for 2 years after the end of the last crediting period.

It is important to mention that Serra das Agulhas will be inspected by the Brazilian Power Regulatory Agency (ANEEL), which it can visit the plant to inspect the operation and maintenance of the facility.

Until the preparation of this version of the PDD, Serra das Agulhas project is in a preliminary stage of construction and, therefore, the operational and management structure for the emission reductions under CDM is not defined yet. Currently, the project sponsor's priorities are to fulfill the requirements for the Construction License issuance (as the implementation of social/environmental programs), to obtain financing for the project implementation, to analyze price quotation for the equipment purchase and to make the necessary arrangements for the signature of the EPC contract. Therefore, the structure for the operational controlling of emission reductions will be developed when the issues mentioned above were solved[60].

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

Date of completion of the application of the methodology to the project activity study: 29/03/2012.

Name of person/entity determining the baseline and monitoring methodology:

| | |
|---|---|
| Company: | Ecopart Assessoria em Negócios Empresariais Ltda. |
| Address: | Rua Padre João Manoel, 222 |
| Zip code + city: | 01411-000 São Paulo, SP |
| Country: | Brazil |
| Telephone number: | +55 (11) 3063-9068 |
| Fax number: | +55 (11) 3063-9069 |
| E-mail: | info@eqao.com.br |

Ecopart Assessoria em Negócios Empresariais Ltda. is Project Advisor and Project Participant.

[60] Information included based on the DOE request of CL18 of the Validation Protocol.

## SECTION C. Duration of the project activity / crediting period

### C.1. Duration of the project activity:

#### C.1.1. Starting date of the project activity:

16/07/2012.

This date corresponds to the estimated date for the signature of the Engineering, Procurement and Construction (EPC) contract.

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

The project is expected to have an operational lifetime of 30 years according to authorizations granted for electricity generation from small hydropower plants in Brazil.

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

The project participants of Serra das Agulhas project chose the renewable crediting period (7 years which may be renewed at most two times).

#### C.2.1. Renewable crediting period:

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

01/05/2014.

##### C.2.1.2. Length of the first crediting period:

7 years -0 month.

#### C.2.2. Fixed crediting period:

##### C.2.2.1. Starting date:

Not applicable.

##### C.2.2.2. Length:

Not applicable.

## SECTION D. Environmental impacts

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

In Brazil, the sponsor of any activity that involves construction, installation, expansion or operation of any polluting or potentially polluting activity or any other capable to cause environmental degradation is obliged to secure a series of permits from the relevant environmental agency (federal and/or local, depending on the kind of project and location).

Although hydropower plants are considered as a renewable energy generation project, project sponsors have to obtain all licenses as required by the National Environmental Council (from the Portuguese *Conselho Nacional do Meio Ambiente – CONAMA*) Resolution nr. 237 dated December 19th, 1997:

- The Preliminary License (from the Portuguese *Licença Prévia* or *LP*);
- The Construction License (from the Portuguese *Licença de Instalação* or *LI*);
- The Operating License (from the Portuguese *Licença de Operação* or *LO*).

Serra das Agulhas possesses the LP nr. 066/10 issued on December 9th, 2010, valid until December 9th, 2014. Currently, the project sponsors are waiting for the LI issuance by the environmental agency, which request was made on May 17th, 2011.

Accordingly to article 3 of CONAMA Resolution nr. 237/97 and Complementary Law nr. 38 dated November 21st, 1995, 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. However, according to the article 12 of CONAMA Resolution nr. 237/97, the competent entity shall evaluate the significance of impact of the project implementation and the types of studies required for each project:

- EIA/RIMA (mentioned above) or;
- Simplified Environmental Report (from the Portuguese *Relatório Ambiental Simplificado – RAS*).

These reports shall be made public available to local stakeholders and public entities. Furthermore, according to the CONAMA Resolution nr. 1 dated January 23rd, 1986, the environmental agency is responsible to issue licenses and decide the necessity in making public consultations and forums for the project implementation.

In the case of Serra das Agulhas project, an EIA/RIMA was prepared by Poente Engenharia e Consultoria Ltda. in the end of 2003 and the public hearing was held on December 11th, 2006 in Monjolos municipality. Issues related to the project design, fishes monitoring treatment, land negotiation and tourism were raised and were clarified during the meeting. These issues were incorporated in the

Environmental Control Plan (from the Portuguese *Plano de Controle Ambiental – PCA*) dated May 2011 and presented to the environmental agency of Minas Gerais State for the Construction License request.

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

The project does not imply in significant negative transboundary environmental impacts, on the contrary the license would not be issued. All documents related to operational and environmental licensing are public and can be obtained at the state environmental agency (FEAM) and with the PPs.

## SECTION E. Stakeholders' comments

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

The Brazilian Designated National Authority "*Comissão Interministerial de Mudanças Globais do Clima*", requests comments from local stakeholders, and the validation report issued by an authorized DOE according to the Resolution nr. 7, issued on March 5th, 2008, in order to provide the Letter of Approval.

The Resolution determines that direct invitation for comments shall be sent by the project proponents at least 15 days before the Global Stakeholder Process (GSP) to the following agents:

- Municipal governments and City Councils;
- State and Municipal Environmental Agencies;
- Brazilian Forum of NGOs and Social Movements for Environment and Development;
- Community associations;
- State Attorney for the Public Interest (state and federal).

Considering the requirement mentioned above, invitation letters were sent to the following agents (copies of the letters and post office confirmation of receipt communication are available upon request and were supplied to the DOE during validation):

- *Prefeitura de Diamantina e Monjolos* (Diamantina and Monjolos City Hall)
- *Câmara Municipal de Diamantina e Monjolos*

  (Municipal Assembly of Diamantina and Monjolos)
- *Secretaria do Meio Ambiente de Diamantina e Monjolos*

  (Environmental Agency of Diamantina and Monjolos)
- *ONG Caminhos da Serra*

  (*Caminhos da Serra NGO* has influence in Diamantina and Monjolos municipalities)
- *FEAM – Fundação Estadual do Meio Ambiente de Minas Gerais*

  (Minas Gerais Environmental Agency)
- *Ministério Público de Minas Gerais*

  (State Attorney for the Public Interest of the State of Minas Gerais)
- *Ministério Público Federal*

  (Federal State Attorney for the Public Interest)
- *Fórum Brasileiro de ONGs e Movimentos Sociais para o Desenvolvimento e Meio Ambiente*

(Brazilian Forum of NGOs and Social Movements for the Development and Environment)

In the letter sent to the stakeholders mentioned above, the Project Participants informed the link where the Project Design Document and the "Anexo III" report were available in Portuguese for consultation and comments. "Anexo III" is a report containing information related to the contribution of the proposed project activity to sustainable development. In addition, the link where the project was public available for GSP and the contact information of the project participants were also included in the letter sent to local stakeholders.

Furthermore, the PDD of the project was made available for comments at the validation stage at the United Nations Framework Convention on Climate Change (UNFCCC) website: <http://cdm.unfccc.int/Projects/Validation/index.html>.

## E.2. Summary of the comments received:

As mentioned in section E.1, the Project Participants conducted the local stakeholder process mailing letters for the local entities where Serra das Agulhas will be located, informing the link where the PDD and "Anexo III" report (both in Portuguese) were available and the contact information which stakeholders could consult, send comments or make questions related to the proposed project activity, as required by the Brazilian DNA in order to issue the Letter of Approval.

Regarding this stakeholder process, only one comment was received. The project participants received an official letter nr. 61/2011 dated October 17th, 2011 and signed by Mr. José Mário Rosa da Silva, the President of the Municipal Assembly of Monjolos. In this letter, it is presented the minutes of meeting of the meeting held on October 7th, 2011 by the Municipal Assembly. Serra das Agulhas project was one of the issues discussed during this meeting.

The president of the Municipal Assembly has informed that he was not "against the project" construction and he has asked the opinion of the members of the Municipal Assembly. Many local councillors presented their own opinions, but no actions were defined in relation to the project activity. After the presentation of the personal opinions of the Municipal Assembly members related to the proposed project activity, other issues were discussed in relation to the relationship of the Municipal Assembly with other public entities (city hall, sanitation, and others), tourism, public security, and others.

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

Considering the official letter nr. 61/2011, the project participants sent a response on January 13th, 2012 thanking the Municipal Assembly of Monjolos for the comments received and informed that the PDD and the "Anexo III" report (both in Portuguese) are still available at the link: <http://sites.google.com/site/consultadcp/>.

## Annex 1

## CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

| | |
|---|---|
| Organization: | Omega Energia Renovável S/A |
| Street/P.O.Box: | Av. São Gabriel, 477, 2º andar – Itaim Bibi |
| Building: | |
| City: | São Paulo |
| State/Region: | São Paulo |
| Postcode/ZIP: | 01435-001 |
| Country: | Brazil |
| Telephone: | +55 (11) 3254-9810 |
| FAX: | +55 (11) 3254-9810 |
| E-Mail: | |
| URL: | http://www.omegaenergia.com.br/ |
| Represented by: | Mr. |
| Title: | |
| Salutation: | |
| Last name: | da Cunha |
| Middle name: | Antonio R. |
| First name: | João |
| Department: | |
| Mobile: | |
| Direct FAX: | |
| Direct tel: | +55 (11) 3254-9810 |
| Personal e-mail: | joao.cunha@omegaenergia.com.br |

| | |
|---|---|
| Organization: | Sigma Energia S/A |
| Street/P.O.Box: | Av. Getúlio Vargas, 874 – 1202 – Funcionários |
| Building: | |
| City: | Belo Horizonte |
| State/Region: | Minas Gerais |
| Postcode/ZIP: | 30112-020 |
| Country: | Brazil |
| Telephone: | |
| FAX: | |
| E-Mail: | |
| URL: | http://www.omegaenergia.com.br/ |
| Represented by: | Mr. |
| Title: | |
| Salutation: | |
| Last name: | da Cunha |
| Middle name: | Antonio R. |
| First name: | João |
| Department: | |

| | |
|---|---|
| Mobile: | |
| Direct FAX: | |
| Direct tel: | +55 (11) 3254-9810 |
| Personal e-mail: | joao.cunha@omegaenergia.com.br |

| | |
|---|---|
| Organization: | Ecopart Assessoria em Negócios Empresariais Ltda. |
| Street/P.O.Box: | Rua Padre João Manoel 222 |
| Building: | |
| City: | São Paulo |
| State/Region: | São Paulo |
| Postfix/ZIP: | 01411-000 |
| Country: | Brazil |
| Telephone: | +55 (11) 3063-9068 |
| FAX: | +55 (11) 3063-9069 |
| E-Mail: | info@eqao.com.br |
| URL: | http://www.eqao.com.br/ |
| Represented by: | Mrs. Melissa Sawaya Hirschheimer |
| Title: | |
| Salutation: | Mrs. |
| Last Name: | Hirschheimer |
| Middle Name: | Sawaya |
| First Name: | Melissa |
| Department: | |
| Mobile: | |
| Direct FAX: | +55 (11) 3063-9069 |
| Direct tel: | +55 (11) 3063-9068 |
| Personal E-Mail: | mailto:focalpoint@eqao.com.br |

## Annex 2

## INFORMATION REGARDING PUBLIC FUNDING

No public funding is involved in the present project.

This project is not a diversion of ODA from an Annex 1 country.

## Annex 3

## BASELINE INFORMATION

This section is intentionally left blank. For details please refer to sections B.2, B.6.1., B.6.2 and B.6.3. above.

## Annex 4

## MONITORING INFORMATION

This section is intentionally left blank. For details please refer to sections B.7.1 and B.7.2. above.

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