**CLEAN DEVELOPMENT MECHANISM**

**SIMPLIFIED PROJECT DESIGN DOCUMENT**

**FOR SMALL-SCALE PROJECT ACTIVITIES (SSC-CDM-PDD)**
**Version 02**

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**Annexes**

## SECTION A. General description of the small-scale project activity

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

*Rosa dos Ventos* wind energy project.

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

The project activity is a bundling of two small scale wind energy projects gathered under the name *Rosa dos Ventos*. The CDM bundling Project is composed of the *Lagoa do Mato* wind farm (10.40 MW) and *Canoa Quebrada* wind farm (3.20 MW). The Project owner and developer is a specific purpose vehicle (SPV), *Rosa dos Ventos Ltda*, an independent energy producer so labelled within the new Brazilian electricity market scenario.

During the last decade, several studies regarding the Brazilian wind energy potential were carried out with estimations ranking between 20,000 MW to 60,000 MW. The most successful study was based on numeric modeling of surface data using *MesoMap*[1], being suitable for macro estimations on wind energy assessment (20 to 30 $km^2$ resolution), but proving not sufficient for areas smaller than 1 $km^2$ and altitudes higher than 50 meters.

From 1995 onwards, the Brazilian government has approved the installation of new wind farms, amounting more than 5,000 MW and, despite the enormous potential of the wind energy in Brazil, the installed capacity remains irrelevant, with 28,550 kW so far implemented[2] or 0.03% of the total installed capacity in Brazil.

The purpose of the project activity is to generate energy from a renewable source by placing 17 Enercon wind turbines of 800 kW nominal capacity with a total installed power of 13.60 MW, generating around 50.89 GWh per year. The bundling project is foreseen to reduce green house gases (GHG) emissions of around 13,610 $tCO_2equ$ (tonnes of carbon dioxide equivalent) per annum between 2007 and 2014 on average.

Both wind projects are allocated under the *Proinfa* program, a governmental program created to promote the introduction of new sources of renewable energy, the development of environmentally-friendly technologies and to assist in achieving the stabilization of the anthropogenic GHG emission according to the United Nations Framework Convention on Climate Change (UNFCCC) and Kyoto Protocol.

Both wind farms will be located 170 km east of *Fortaleza*, the capital of the *Ceara* state. The project will positively reduce the energy imports to the Northeast geo-electric region from distant states, reducing the energy losses due to transportation and helping to reduce the GHG generated by the increasing thermal plants share at the current regional energy mix. Moreover the peak wind energy production occurs during the low hydro season and vice versa, complementing both sources on the regional energy scenario.

[1] *Specific software developed with the support of the New York State Energy Research and Development Authority (NYSERDA) and the US department of Energy (DoE).*

[2] *Installed capacity by sources, ANEEL.*

Besides, the project activity assists in the local sustainable development by reducing local air pollution, assisting on technical knowledge transfer and generating specialized and non-specialized employment during the construction and operation phase (at different levels such as wind measurement, energy services, topographic studies, geological and environmental analysis, civil works etc).

In the view of the local Stakeholders, the project activity will open up new access roads, reinforce the regional grid and decrease the need for water stock for energy use, therefore, allowing extra water supply in a region suffering from droughts and water scarcity.

**A.3. Project participants:**

| Name of the Party involved | Private entity(ies) project participants | Party involved whishes to be considered as project participant |
|---|---|---|
| UK | *Carbon Capital Markets* | No |
| Brazil (Host Country) | *Rosa dos Ventos Ltd.* | No |

The owner of the Rosa dos Ventos Wind Energy Project is *HLC Brasil*. The contact for the CDM project activity is *Ecologica Assessoria Ltda*. All contact details are included in Annex 1.

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

The project activity will optimize the use of trade winds (*aliseos)* rotating clockwise around low pressure areas coming from the Tropical Atlantic Ocean. For the project area, the measured average wind speed is around 8.47 m/s[3] with a relative distribution of the wind frequency East/Northeast at 35.33 %.

The local climatic conditions were horizontally and vertically extrapolated from the two years wind speed measurements based on local wind data and further feeding into the *WAsP*[4] software. In order to better describe local series of climatic conditions cause by the trade winds, the project developer used the *EWDA*[5] software.

In order to assess the power potential for the project activity a local Weibull distribution was modelled based on a three years measurement vintage. For the annual energy production, the turbine manufacture's power curve was used and crossed with the Weibull model.

The wind turbines used for the project activity are medium power wind turbine E-48 (three blades model with a standard rotational speed of 17.3 rpm) from ENERCON GmbH. The energy generated on each wind turbine is internally stepped up from 690 Volts through an internal transformer (Δ connection) to reach the local distribution voltage (power plant voltage) of 13.8 kV on (λ connection). A local sub-station constructed at the project premises will again steep up the voltage into the regional grid voltage (69 kV transmission line).

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3 *Measured value at 61 meters high.*

4 *Wind Atlas Analysis and application Program (WAsP).*

5 *Eolica wind data Analysis (EWDA), version 1.0, developed for the project by the Brazilian centre of wind energy.*

On table 1 to table 4, the power plant characteristics are shown.

| Wind energy plant name | *Lagoa do Mato* | *Canoa Quebrada* |
|---|---|---|
| Construction start date | 1/03/2006 | 1/03/2006 |
| Operation start date | 1/12/2006 | 1/12/2006 |
| Installed power | 3.20 MW | 10.40 MW |

***Table 1.Wind energy plants***

| Technical Description of the Project Bundling | | | | | |
|---|---|---|---|---|---|
| Plant specifications | Wind Turbine | Rotor diameter | Hub height | Rated power/ E48 | # turbines |
| *Lagoa do Mato* | Enercon E48 | 48 meters | 75 meters | 800 KW/ turbine | 4 |
| *Canoa Quebrada* | Enercon E48 | 48 meters | 75 meters | 800 KW/ turbine | 13 |

***Table 2.Technical description of the Project Bundling***

| Technical Description of the Wind Turbine | | | | |
|---|---|---|---|---|
| Plant specifications | Swept area | Cut-in/out wind speed | Rated wind speed | Installed capacity |
| *Lagoa do Mato* | 1,810 $m^2$ | 3/18-24 m/s | 13 m/s | 3.20 MW |
| *Canoa Quebrada* | 1,810 $m^2$ | 3/18-24 m/s | 13 m/s | 10.40 MW |

***Table 3. Technical description of the Wind Turbines***

| Energy production of the Project activity | | | | |
|---|---|---|---|---|
| Plant specifications | Ideal energy production | Total Losses | Capacity factor | Net energy production |
| *Lagoa do Mato* | 13.07 GWh/year | 5.60 % | 46.74 % | 13,047 GWh/year |
| *Canoa Quebrada* | 41.34 GWh/year | 5.60 % | 41.72 % | 37,847 GWh/year |

***Table 4. Energy production of the Project activity***

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

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

Brazil

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

*Ceará* state

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

Municipality of *Aracati.*

**A.4.1.4. Detail of physical location, including information allowing the unique identification of this small-scale project activity(ies):**

Both sites for the project activity are located at 5 km distant and 170 km from *Fortaleza*, the capital of the *Ceará* state. On Table 5 is shown the coordinates and surface allocated for the wind farms. More details on the physical location are provided on Annex 3.

| Wind farm site | *Canoa Quebrada* | *Lagoa do Mato* |
|---|---|---|
| **Surface** | 97 Ha | 196 Ha |
| **Location** | 04° 32' 02''**S** 37° 41' 28''**W** | 04° 35' 21'' **S** 37° 38' 15'' **W** |

*Table 5. Wind farm's physical details*

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

The Project proposed classifies on the Type I- Renewable Energy Projects, category I.D- "Grid Connected Renewable Electricity Generation". The Project conforms to the project category since the project comprises energy generation based on renewable energy sources connected to the electrical grid under a Power Purchase Agreement (PPA).

Since the nominal installed capacity is below of the 15 MW, the project activity is defined under the definition of Type I, Small Scale CDM project activities given by the Annex II of Decision 17/CP.7 "Simplified modalities and procedures for small–scale clean development mechanism project activities"[6].

The technology used for the technical studies carried out comprises data geo-processing (*Topocad 4.0*), geological studies, wind energy assessment based on local software tools (*WinPro, EWDA*) as well as international recognized tools for wind energy assessment as *WAsP*. The technology for the wind turbines is based on the E-48 ENERCON technology with construction facilities in Brazil.

**A.4.3. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed small-scale project activity, including why the emission reductions would not occur in the absence of the proposed small-scale project activity, taking into account national and/or sectoral policies and circumstances:**

The inclusion of the Project into the regional grid[7] will likely reduce the net imports from the national electric system at the project electrical system. Locally, the project activity will suppress partially the energy demand from a typical energy imports geo-electric area and therefore the project will affect the dispatch order of marginal sources (thermal power plants) within the project boundary.

The higher unit cost per MWh and the higher risk involved on the operation of the renewable energy systems (specially wind power and Photovoltaic energy[8]) has been the major barriers that kept the investors away from such technologies. The result of this is shown in the picture below, where wind energy projects accounts for a small participation in the Brazilian electric system, only 0.03% of the total installed power. Despite the great potential for such projects, at the beginning of the year 2004 only 9 small scale wind farms were in operation with an average installed power of 2.5 MW[9].

[6] http://cdm.unfccc.int/Reference/Documents/AnnexII
[7] *Referred as the Northeast geo-electric system. For further details on the project boundary, please refer to Section B.4*
[8] *Data source: Energy Ministry of Mines and Energy, decennial electric expansion plan, 2003-2012.*
[9] *Data source: Brazilian energy atlas, second edition.*

At the Northeast, the hydro power energy is mainly dispatch at the baseload due to the lower operation cost complemented by thermal generation, especially for the peak load. The increasing participation on the thermal share at the Northeast sub-system allows an optimization of the affluent natural energy available at the hydro plant that would be conservatively dispatch if no a secondary energy source (thermal generation) was in place. Moreover, the recent droughts, environmental restrictions, high transmissions losses and the incremental risk associated to the firm energy delivered by existing hydro power plants has result on an increase of thermal capacity, not only at the Northeast but in Brazil as a whole.

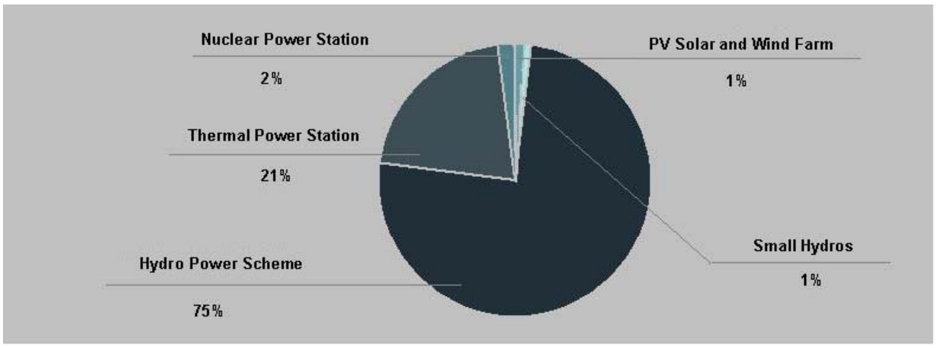


***Figure 1 . Installed capacity at the Brazilian electric system[10]***

Under a high risk power shortage scenario, the Brazilian government increased drastically the share of the thermal capacity, especially at the Northeast by means a national program to enhance the thermal energy. One of the most important issues of the thermal plan is that the distribution company has a *take-or-pay* contract with the thermal generation company. Currently up to the 23% of the thermal installed capacity at the Northeast is under this program. Additionally, in the year 2001 the Brazilian government defined a set of back up thermal units in order to cover the immediate peak energy demand to ensure a low risk operation profile for each sub-system. Actually there are around of 23 thermal generation units (709.2 MW) working at the Northeast under such conditions.

As shown at the table 6 below, the NOS (Brazilian grid operator entity) does not schedule large capacity additions on hydro power energy at the Northeast.

| Northeast sub-system (MW) | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|
| B. ESPERANÇA | 225 | 225 | 225 | 225 | 225 | 225 | 225 | 225 | 225 | 225 |
| BELEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| COMPL MOXOTO | 4,285 | 4,285 | 4,285 | 4,285 | 4,285 | 4,285 | 4,285 | 4,285 | 4,285 | 4,285 |
| GATOS 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ITAPARICA | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 |
| ITAPEBI | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 |
| P. CAVALO1 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 |
| PAO ACUCAR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PARATINGA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PEDRA BRANCA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SACOS | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 50 | 50 | 50 |
| SOBRADINHO | 1,050 | 1,050 | 1,050 | 1,050 | 1,050 | 1,050 | 1,050 | 1,050 | 1,050 | 1,050 |
| XINGO | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 |
| **TOTAL** | **10,695** | **10,695** | **10,695** | **10,695** | **10,695** | **10,695** | **10,745** | **10,745** | **10,745** | **10,745** |

***Table 6. Hydro power development plans.***

10 *Data source: ANEEL, installed power by generation type in Brazil.*

Under such scenario, the National electric energy agency (ANEEL) verified a low affluent hydro energy at the Northeast sub-system for the operation year 2004. In order to ensure a risk-free energy delivery at the Northeast sub-system, further thermal capacity test were carried out. The result was a lack on Natural gas for a full load operation scenario and a further decrease on 481 MW of the total thermal capacity installed.

The following thermal power plants were affected by Natural gas restrictions: *UTE Fafen, UTE Termobahia e UTE Camaçari, UTE Termoceará, UTE Fortaleza, UTE Termoacu,* and *UTE Termopernambuco.* On the table below the foresee operation for the affected thermal power plants during the period 2005/2006 (end of gas shortage) and further.

| Northeast sub-system | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|
| CAMACARI | 0 | 0 | 342 | 350 | 350 | 350 | 350 | 350 | 350 | 350 |
| TERMO BAHIA | 88 | 186 | 186 | 186 | 186 | 186 | 186 | 186 | 186 | 186 |
| FAFEN | 26 | 26 | 54 | 155 | 155 | 155 | 155 | 155 | 155 | 155 |
| TERMOPERNAMBUCO | 520 | 520 | 520 | 638 | 638 | 638 | 638 | 638 | 638 | 638 |
| TERMOACU | 0 | 0 | 0 | 316 | 316 | 316 | 316 | 316 | 316 | 316 |
| TERMOCEARA | 0 | 0 | 220 | 220 | 220 | 220 | 220 | 220 | 220 | 220 |
| TERMOFORTALEZA | 0 | 319 | 319 | 347 | 347 | 347 | 347 | 347 | 347 | 347 |
| **TOTAL** | **634** | **1,051** | **1,641** | **2,212** | **2,212** | **2,212** | **2,212** | **2,212** | **2,212** | **2,212** |

***Table 7. Operation scheduled for the affected thermal power plants.***

The future of the energy mix at the Northeast foresees the implementation of a gas pipeline from the South to the Northeast to be finished at the end of 2006. The *GASENE* gas pipeline will deliver more than 20 Millions $Nm^3$ of natural gas per day. Under such conditions is expected that the baseline generation at the Northeast will increase the thermal share in the near future.

Finally, with an annual average of energy of 50.89 GWh, the project bundling will displace around 95,273 $tCO_2$equ from the project boundary electric system, during the first crediting period.

### A.4.3.1 Estimated amount of emission reductions over the chosen crediting period:

| Year | Annual estimation of emission reductions in tonnes of $CO_2$equ |
|---|---|
| 2007 | 11,410 |
| 2008 | 13,610 |
| 2009 | 13,610 |
| 2010 | 13,610 |
| 2011 | 13,610 |
| 2012 | 13,610 |
| 2013 | 13,610 |
| 2014 | 2,200 |
| **Total estimated reductions** (tonnes of $CO_2$equ) | 95,273 |
| **Total number of crediting years** | ***7*** |
| **Annual average over the crediting period of estimated reductions** (tonnes of $CO_2$ equ) | 13,610 |

***Table 8. Estimation of emission reductions***

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

The Project will not receive any public funding from Parties included in Annex I.

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

A proposed project activity shall be deemed to be a debundled component of a large project activity if there is a registered small-scale CDM project activity or a request for registration by another small-scale project activity:

- By the same project participants;
- In the same project category and technology/measure;
- Registered within the previous 2 years; and
- Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point

The project activity is the only CDM project proposed by the project developer and therefore is not part of a larger project activity, according to the definitions established on Appendix C of the **“*Simplified Modalities and Procedures for Small-Scale CDM Project activities*”.**

## SECTION B. Application of a baseline methodology:

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

Project Type I. - Renewable energy project.

**The approved baseline methodology employed for the Project is:** AMS I.D. '*Grid connected renewable electricity generation'*, Version 09 (July 2006).
**Reference:** Appendix B of the simplified modalities & procedures for small-scale CDM-project activities.

### B.2 Project category applicable to the small-scale project activity:

**Category I.D** – "Grid Connected Renewable Electricity

| Project | Project Category |
|---|---|
| Rosa dos Ventos Wind Energy Project | Category I.D. "Grid Connected Renewable Electricity Generation |

As per the methodology, the project category I.D. comprises renewable energy generation units, such as photovoltaic, hydro, tidal/wave, wind, geothermal, and renewable biomass that supply electricity to and/or displace electricity from an electricity distribution system that is or would have been supplied by at least one fossil fuel fired generation unit.

The project uses renewable source of energy in form of wind to produce electricity. The total electricity production is 13.60 MW (800KW x 17) which is less than the eligibility limit of 15MW for a small-scale CDM project activity applying only to the renewable component as per the methodology.

### B.3. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered small-scale CDM project activity:

The project will reduce anthropogenic emissions of GHG by reducing the need of net energy import to the Northeast sub-system[11]. Furthermore, the Project activity will also reduce GHG emissions by delaying the dispatch of thermal plants on the margin.

Project additionality is explained according to attachment A of the appendix B of the simplified M&P for small-scale CDM project activities[12], in particular by demonstrating the existence of investment, technology and prevailing practice barriers. The existent national policy promoting the use of renewable energy (*Proinfa* Program) is also addressed as means of attesting additional contribution to climate change mitigation and sustainable development.

The Brazilian Alternative Energy Sources Program - *Proinfa*

The wind energy projects bundled are both registered under the Brazilian Alternative Energy Sources Program (*Proinfa*). The *Proinfa* was created in 2002 by Law 10.438 with the specific purpose of promoting the use of alternative renewable energy sources (wind, biomass and small-hydro plants) and diversifying the Brazilian energy matrix. In its first phase, the *Proinfa* foresees the implementation of 3.300 MW of installed capacity, with operations beginning at latest in December 2008. The PPA (power

[11] *The Northeast sub-system is a major energy importer.*
[12] http://cdm.unfccc.int/methodologies/SSCmethodologies/AppB_SSC_%20AttachmentA.pdf.

purchase agreement) will be secured by *Centrais Elétricas Brasileiras SA – Eletrobrás* – the utility company designated to assist the Brazilian Government in achieving the National Policy's objectives.

As stated by Decree 5.025/2004[13], the *Proinfa* was designed not only to increase the participation of alternative renewable energy sources in the Brazilian energy matrix, but also to boost projects in accordance with the legal regime established by the Kyoto Protocol and the United Nations Framework Convention on Climate Change (UNFCCC), strengthening the Country's engagement in contributing to GHG emission reductions.

The *Proinfa* program falls into national and sectorial policies Type E- as defined by the Executive Board during its 16th meeting: "national and/or sectorial policies or regulations that give positive comparative advantages to less emissions-intensive technologies over more emissions-intensive technologies"[14].

Moreover, the Executive Board also specified that Type E- national and sectorial policies "may not be taken into account in developing a baseline scenario" when such national and sectorial policies have been implemented after the adoption of the CDM M&P in decision 17/CP17 (November 11, 2001)[15]. Accordingly, the *Proinfa*, launched in April 2002, is not considered in the baseline scenario and therefore additional as a national emission reduction initiative.

<u>Attachment A of the appendix B of the simplified M&P for small-scale CDM project activities</u>

Notwithstanding, additionality of the project activity can also be demonstrated in accordance with the attachment A of the appendix B of the simplified M&P for small-scale CDM project activities, considering the following categories of barriers:

(a) Investment barrier;

(b) Technological barriers;

(c) Prevailing practice.

(a) <u>Investment Barrier</u>

Even with the existing public subsidies offered by *Proinfa*, the development of wind energy projects in Brazil still pose several investment obstacles that must be surpassed by project developers in order to secure economic viability.

The initial investment required for the implementation of wind farms is considerably higher than what it is required for thermal plants. In addition, given the relatively short construction time and the lower energy generation cost, thermal plants represent a more attractive option for entrepreneurs when compared to alternative renewable energy sources, such as wind power.

In January 2005 the average power plant implementation cost was around 850 US$/kW for hydroelectric and 660 US$/kW for thermal[16], while the implementation cost for the *Lagoa do Mato* and *Canoa Quebrada* wind power project is estimated in 4,000 US$/kW[17].

The energy generation cost between thermal and wind power also differs quite significantly, as showed in the tables below:

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[13] *Article 5 of Decre*e 5.025, from March 30, 2004.
[14] *http://cdm.unfccc.int/EB/Meetings/016/eb16repan3.pdf.*
[15] *http://cdm.unfccc.int/EB/Meetings/016/eb16repan3.pdf.*
[16] *Mercados de Energia/PSR Consultoria, March 2005.*
[17] *Financial data from the project developer is available under request.*

**Energy Generation Costs (USD/MWh) for Thermal Plants in the Northeast**

| *Energy Generation Costs (USD/MWh)* | |
|---|---|
| **Thermal Power Plants (NE)** | **2004** |
| FAFEN | 31 |
| TERMOBAHIA | 37.87 |
| CAMAÇARI | 57 |
| MPX | 36 |
| TERMOFORTALEZA | 25.3 |
| TERMOPERNAMBUCO | 17.3 |
| **Source: Energy Plan 2004, NOS.** | |

***Table 9. Energy generation costs***

There are two main aspects which affect the cost of electricity generated from wind, and therefore its final price:

- Technical factors, such as wind speed and the nature of the turbines.
- The financial perspective of those that commission the projects, (what rate of return is required on the capital, amortization and the length of time over which the capital has to be repaid).

For the *Rosa dos Ventos* wind energy project, the generation Costs (USD/MWh) will be directly related to the technical O&M cost and the financial cost associated to the project.

Regarding the technical factors, the measured capacity factor for the area (the *Ceará s*tate) where the project will be implemented is of 35%, which has become a standard value. Under such perspective is reasonable to present a financial plan for the project activity based on conservatory premises of capacity factor calculated upon standard values rather than the estimated values used on the Table 4.

At the table 10 below the costs are detailed.

| *Unit* | | Estimated *(RS/MWh)* | Estimated *(USD/MWh)* |
|---|---|---|---|
| Financial cost | Amortization + Financial Cost (interest) | 128.67 | 59 |
| Administration cost | Land (rental value) | 4.4 | 1.94 |
| | Administration staff | 13.86 | 6.44 |
| Delivery cost | Wheeling fee | 22.64 | 10.53 |
| Technical cost | O&M activities | 21.89 | 10.18 |
| **TOTAL** | | **190.8** | **88.73** |

***Table 10. Energy generation costs ( 1 USD = 2.15 RS).***

As shown at the table 10, the cost of generation is much higher when comparing with the generation cost from other energy sources, which in practice results in wind energy being far from competitive in the current Brazilian energy scenario.

<u>Other Investment Barriers.</u>

Also, the limitations of the existent surface model to define wind energy potential result in uncertainty about the energy density for the project site and therefore the annual energy output. The two to three years local measurement proved not to be sufficient for the project developers in Brazil. Consequently, there is a 50% probability on having a deviation on the energy output from the energy expected, resulting in a major barrier for commercial investments.

Equally troublesome to investors and project developers is that, according to the *Proinfa* regime and the PPA model established, *Eletrobrás* is only required to secure the payment of a monthly revenue corresponding to 70% of the contracted energy, leaving to the energy producer further uncertainties over its expected monthly turnover.

Wind energy projects often deal with extra financial hurdles that come with the need for technology transfer and specialized services, such as lack of local qualified personnel, foreign equipment acquisition and associated currency instability risks. Not rarely project developers need also to account for royalties due in relation to the technology or know-how employed.

The 220 MW total installed capacity ceiling established per State by the *Proinfa* program also curbs any scale economy for project developers. In that sense, States with a larger capacity of wind energy supply such as Ceará and Rio Grande do Norte are in significant disadvantage comparatively to other States in Brazil, which decreases the financial attractiveness of the Proinfa projects in such States, resulting on another financial barrier for the investor.

The additional finance from the CDM was therefore vital to the Project Developer's decision to undertake the project and invest in a more environmentally-friendly technology for energy generation. The revenues derived from the CERs of the project activity will serve the purpose of alleviating the investment risks highlighted above.

(b) Technological Barriers

For the development of wind based technologies in Brazil several technical barriers must be faced. For instance, technical limitations imposed to the electrical grid by a fluctuating feed drastically changes grid requirements and grid management. For the local electric network, additional new fluctuating sources to the grid also poses limitations on conducting several megawatts produced at high winds into the local weak electric infrastructure.

In addition, according to the *Proinfa* program, at least 60% of the services and equipment employed in the wind farms must be purchased domestically. This condition creates an additional obstacle since the internal market is currently composed by a small number of equipment/technology suppliers, circumstance that often compels project developers to purchase lower efficiency turbines, thereby, reducing project efficiency and profitability[18].

As a result, Project Investors are seeking for additional assurance for the technical and financial success of the project through the CDM.

(c) Prevailing Practice

In spite of the public subsidies given by *Proinfa*, usual practices in Brazil exclude wind power mainly due to associated technological risks, large initial capital investment and high energy generation costs.

The marginalization of wind power technology in the Brazilian overall energy scenario is conclusive. Until 2004 only 25MW of wind capacity had been installed in Brazil[19]. According to the National Energy Balance, wind energy accounted for only 0.017% (61 GWh) of the total energy generation in 2004 (349,593 GWh) [20].

[18] *The Rosa dos Ventos Wind Energy Project makes use of a 800kW/turbine, while in regular market conditions it could be applying a higher efficiency turbine, which would improve earning power, capacity and optimize equipment allocation.*
[19] *"Altas Brasileiro de Energia", 2nd Edition, 2004.*
[20] *National Energy Balance 2005, Ministry of Mines and Energy.*

As a primary energy source, wind energy is not significant enough to be considered in the internal energy offer for 2004[21], as showed in Figure 2:

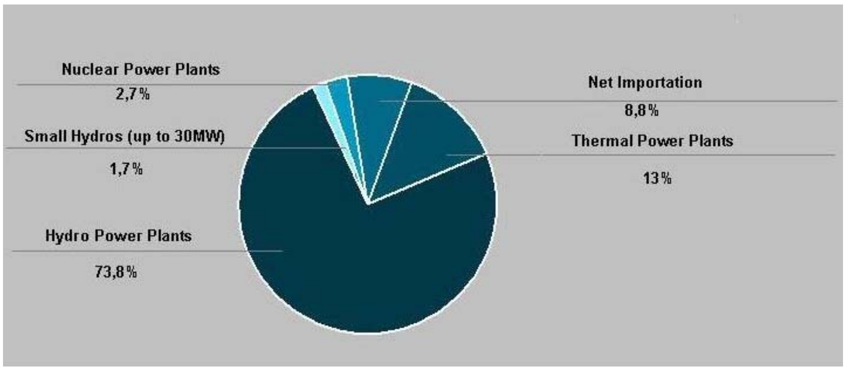


**Figure 2: Internal energy offer (Source: Ministry of Mines and Energy)**

In the Northeast region particularly, where hydro and biomass sources are not abundant, thermal plants are often the first option for investors. As discussed in the *Investment Barrier* section above, thermal power plants present lower implementation and energy related costs in comparison with wind power development costs. In that sense, the revenues (selling of CERs) arising from the CDM represent an additional form of financial viability to the proposed project.

Nevertheless, the *Rosa dos Ventos* wind energy project as stated previously is not the business-as-usual scenario in a country where large hydro power plant and thermal fossil fuel projects are preferable.

Despite the fact that the wind energy project is a clean source of energy generation it can be concluded that the CDM project is not financially attractive when comparing to other power generation sources presented at the Northeast.

Therefore the registration of the project as a CDM project will help to overcome the natural barriers presented here at the PDD; e.g. the decrease of the risk associated to the amount of energy delivered, to incentive the local industry for wind energy and develop a know-how on wind energy assessment.

Finally the registration of the proposed project activity will have a strong impact on the development of wind energy projects by encourage other project developers to implement similar projects based on the CERs as financial incentive for such project type.

**B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the small-scale project activity:**

As referred to in appendix B of the simplified M&P for small scale CDM project activities, the project boundary encompasses the physical and geographical site (described in section A.4.1.4) of the renewable generation source.

The Brazilian energy market is currently transforming into a wholesale electricity market in order to promote competition. The dispatch model is managed by the NOS, the National Operator System, and is based on the most economic dispatch order at any given time. Moreover, the transmissions lines between geo-electric areas will definitely regulate the dispatch order by allocating first the energy

[21] *National Energy Balance 2005, Ministry of Mines and Energy.*

within the geo-electric area where the energy was generated (the least costly option[22]) and then allocating the exceeding energy across others geo-electric areas (sub-markets).

Historically the Brazilian electric system has been divided into two areas, the North/Northeast and the South/Southeast/Central system. Since 1999 both systems are connected through heavy transmissions lines (500 kV) and as long as the installed power increases on each geo-electric system, new transmission lines will be implemented.

Nowadays, the dispatch model for each sub-market is managed by a regional office, comprising four operational and dispatch offices for the different geo-electric areas: Northeast, North, South and Southeast/Central. These electricity sub-markets must all be considered when defining grid operation and energy dispatch model on the grid operation margin.

Moreover, the CDM Executive Board, clearly states that "in large countries with layered dispatch systems, a regional grid definition should be used"[23]. The project boundary for the project activity is the Northeast sub-system that constitutes itself an energy market with its own dispatch order and reflects more realistically the integration of the project activity into the grid.

**B.5. Details of the baseline and its development:**

The baseline is defined by the project category I.D "Grid Connected Renewable Electricity Generation", within the project type "Renewable energy project". The baseline is calculated in a transparent and conservative manner and corresponds to an average of the "operating margin" and the "build margin".

The date of completion of the Baseline study: 18/08/2006.

| Name of person/Organization | Project Participant |
|---|---|
| Alejandro Bango<br>*Ecologica Assessoria Ltda*.<br>*São Paulo*, Brazil.<br>Tel: +55 11 5083 3252<br>Fax: +55 11 5083 8442<br>e-mail: alejandro@ecologica.ws<br>WWW: www.ecologica.ws | NO |
| Thiago Chagas<br>*Ecologica Assessoria Ltda*<br>*São Paulo*, Brazil.<br>Tel: +55 11 5083 3252<br>Fax: +55 11 5083 8442<br>e-mail: thiago@ecologica.ws<br>WWW: www.ecologica.ws | NO |

[22] *The NOS must establish a least-cost planning to determine the mix of loads that would comprise a hypothetical least-cost resource portfolio designed to serve the expected load at the project boundary.*
[23] *http://cdm.unfccc.int/UserManagement/FileStorage , definition of the project boundary.*

## SECTION C. Duration of the project activity / Crediting period:

### C.1. Duration of the small-scale project activity:

### C.1.1. Starting date of the small-scale project activity:

| Wind Energy Plant | *Lagoa do Mato* | *Canoa Quebrada* |
|---|---|---|
| Starting date of the CDM activity | 01/03/2007 | 01/03/2007 |

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

30y - 0m

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

The CDM project activity will use a renewable crediting period.

### C.2.1. Renewable crediting period:

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

| Wind energy plant name | *Lagoa do Mato* | *Canoa Quebrada* |
|---|---|---|
| Starting date | 01/03/2007 | 01/03/2007 |

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

7y – 0m

### C.2.2. Fixed crediting period:

Not Applicable.

### C.2.2.1. Starting date:

Not Applicable.

### C.2.2.2. Length:

Not Applicable.

## SECTION D. Application of a monitoring methodology and plan:

### D.1. Name and reference of approved monitoring methodology applied to the small-scale project activity:

Metering the electricity generated by the renewable energy as described in methodology I, category D of the Simplified Modalities and Procedures for Small Scale CDM project activities (CDM-SSC)[24].

### D.2. Justification of the choice of the methodology and why it is applicable to the small-scale project activity:

The project activity will supply electricity to an electricity distribution system. Therefore, the project activity is eligible to use the small scale methodology Type I.D. - "Grid Connected Renewable Electricity Generation"[25].

Under this methodology, the monitoring applies for the bundle of projects by *metering the annual energy generated* by the project activity. No sources of leakage were identified.

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[24] *As indicated on http://cdm.unfccc.int/Projects/pac/ssclistmeth.pdf, Version 09*

[25] *See on http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_88PZMJZZR5KRJ6L9V7AXGGWHG7W2HH*

## D.3 Data to be monitored:

| ID Number | Data Variable | Source of data | Data Unit | Measured (m), Calculated (c), Estimated (e), | Recording frequency | Proportion of data to be monitored | How will the data be archived? | Comments |
|---|---|---|---|---|---|---|---|---|
| D.3.1 | Net generation delivered to the grid by the *Lagoa do Mato* wind farm | Project developer | MWh | M | continuous | 100% | Electronic | Recorded by electricity meters (seller) and registered by the energy buyer. |
| D.3.2 | Net generation delivered to the grid by the *Canoa Quebrada* wind farm | Project developer | MWh | M | continuous | 100% | Electronic | Recorded by electricity meters (seller) and registered by the energy buyer. |

The Net generation by the project activity is the only indicator required by the monitoring methodology for the project activity. The indicators (identified as D.3.1 and D.3.2) represent the annual energy delivered to the grid by each one of the wind farms bundled. The data will be measured directly at the power station and kept on records electronically for the crediting period plus two years.

## D.4. Qualitative explanation of how quality control (QC) and quality assurance (QA) procedures are undertaken:

| **Data** | **Uncertainty level of data (High / Medium / Low)** | **Explain QA/QC procedures planned for this data, or why such procedures are not necessary** |
|---|---|---|
| Net electricity output from the bundled project | Low | Data required for all parameters specified in the D.3 will be collected from the NOS. All steps will be followed to get accurate and precise data. These procedures will be the responsibility of the designated manager(s) ( as specified in D.5) |

**D.5. Please describe briefly the operational and management structure that the project participant(s) will implement in order to monitor emission reductions and any leakage effects generated by the project activity:**

The party responsible for implementing the monitoring plan shall be the owner company, *Rosa dos Ventos Ltda*. The project developer will also be responsible for developing the forms and registration formats for data collection and further classification. For this purpose the authority for the registration, monitoring, measurement and reporting will be the Engineer *Armando Abreu.*

The operational structure will be based on a continuous monitoring of the *Net energy generation* delivered to the grid by means electronic and analogical meters from both on site and placed at the grid connection point. The further collection, data analysis and records' handling will be managed by the wind farm management staff and records kept on electronic format. Moreover, the procedures for internal review of reported results will be periodically (weekly) checked against the NOS (National Operator System) daily records on the metered energy for the wind farms. The procedure defined for an eventual failure on the metering equipment will follow the NOS own records for the D.3.1 and D.3.2 indicators.

The management structure will rely on the local technicians with a weekly defined operation schedule. The project operator will be responsible for the training of monitoring and operation personnel with the help of equipment manufactures. The technical team will manage the monitoring, the quality control and quality assessment procedures and the different auditory carried out at the project premises.

The maintenance structure will be based on the internal O&M (Operation and Maintenance) staff to guarantee the perfect working of the meters. The maintenance structure will also ensure that the monitoring equipment is perfectly equilibrated based on the INMETRO standards (Brazilian institute for metrology and calibration).

**D.6. Name of person/entity determining the monitoring methodology:**

| Name of person/Organization | Project Participant |
|---|---|
| Alejandro Bango<br>*Ecologica Assessoria Ltda.*<br>*São Paulo,* Brazil.<br>Tel: +55 11 5083 3252<br>Fax: +55 11 5083 8442<br>e-mail: alejandro@ecologica.ws<br>WWW: www.ecologica.ws | NO |

## SECTION E.: Estimation of GHG emissions by source.

### E.1. Formulae used:

### E.1.1 Selected formulae as provided in appendix B:

Appendix B from project category I.D "Grid Connected Renewable Electricity Generation" does not indicate a specific formula for the baseline.

### E.1.2 Description of formulae when not provided in appendix B:

#### E.1.2.1 Describe the formulae used to estimate anthropogenic emissions by sources of GHGs due to the project activity within the project boundary:

Not applicable since GHG emissions from the project activity are zero.

#### E.1.2.2 Describe the formulae used to estimate leakage due to the project activity, where required, for the applicable project category in appendix B of the simplified modalities and procedures for small-scale CDM project activities

Not applicable since GHG emissions from the project activity are zero. As a consequence, no formulae were used.

#### E.1.2.3 The sum of E.1.2.1 and E.1.2.2 represents the small-scale project activity emissions:

Not applicable since GHG emissions from the project activity are zero.

#### E.1.2.4 Describe the formulae used to estimate the anthropogenic emissions by sources of GHGs in the baseline using the baseline methodology for the applicable project category in appendix B of the simplified modalities and procedures for small-scale CDM project activities:

The methodology used to estimate anthropogenic emissions on the baseline for small scale CDM project activities follows the guidelines stated in appendix B for the project category I.D.

As defined at the baseline methodology, the emission coefficient (measured in kg $CO_2$equ/kWh) is calculated as the average of the "operating margin" and the "build margin". For the purpose of determining the build margin (BM) and operating margin (OM) emission factor, the Northeast geo-electric system is defined as the spatial extent of the power plants that can be dispatched without significant transmission constraints.

Therefore, the **annual baseline emissions ($BE_y$)** use the Combined Margin (CM) approach to calculate the baseline scenario emissions. The annual baseline emissions ($BE_y$) is the result of the annual net electricity generated from the Project ($EG_y$) times the yearly baseline emission factor ($EF_y$).

$$BE_y = EG_y * EF_y \quad \textit{Equation 1}$$

$EG_y$ *(MWh/year)*= The generation of the project activity.

$EF_y(tCO_2MWh)$= Weighted average emissions per electricity unit for the Northeast system.

The **baseline emission factor ($EF_y$)** is a weighted average of the $EF\_OM_y$ (operating margin carbon emissions factor) and the $EF\_BM_y$ (build margin carbon emissions factor):

| | |
|---|---|
| $EF_y = (\omega_{BM} * EF\_BM_y) + (\omega_{OM} * EF\_OM_y)$ | ***Equation 2*** |

Where:

$\omega_{OM} = 0.75$ and $\omega_{BM} = 0.25$ as defined at the baseline methodology for wind projects.

There are four methods to calculate the operating margin emission factor(s):

- Simple operating margin;
- Simple adjusted operating margin;
- Dispatch data analysis operating margin;
- Average operating margin

Dispatch data analysis should be the first methodological choice, however the required data are not available in Brazil.

For the project activity the simple adjusted OM method is used for the calculations. The simple adjusted operating margin emission factor ($EF_{OM,\ adjusted,y}$ in $tCO_2/MWh$) is a variation on the simple operating margin, where the power sources (including imports) are separated in low-cost/must-run power sources (*k*) and other power sources (*j*):

$$EF_{OM,\ Simple\ Adjusted,\ y} = (1-\lambda_y) \cdot \frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}}{\sum_j GEN_{j,y}} + \lambda_y \cdot \frac{\sum_{i,k} F_{i,k,y} \cdot COEF_{i.k}}{\sum_k GEN_{k,y}}$$ ***Equation 3***

Where:

- $\lambda_y$ is the share of hours in year *y,* for which low-cost/must-run sources are on the margin.
- $\sum_{i,j} F_{i,j,y}$ is the amount of fuel *i* (mass or volume unit) consumed by relevant power sources *j*
- $COEF_{i,j}$ is the $CO_2e$ coefficient of fuel *i* ($tCO_2e$/mass or volume unit of the fuel), taking into account the carbon dioxide equivalent emission potential of the fuels used by relevant power sources *j* (analogous for sources *k*) and the percent oxidation of the fuel in year(s); and
- $\sum_j GEN_{j,y}$ is the electricity (MWh) delivered to the grid by source *j* (analogous for sources *k*).

For the project activity, the low operating cost and must run resources typically include large hydro, geothermal, wind, low-cost biomass, nuclear and solar generation. Therefore the emission factor for low-cost/must-run resources can reasonably be: $EF\ OM_{,y} = 0$.

The non-low-cost/must run resources for the project activity are thermal power plants burning coal, fuel oil, natural gas and diesel oil. These plants result in non-balanced emissions of greenhouse gases calculated as follows:

The most recent numbers for the interconnected S-SE-CO system were obtained from the Brazilian national dispatch center (*NOS*) in the form of daily consolidated reports. The load duration curves and energy demand for the project boundary of the project activity are given in Annex 5.

In order to calculate the Operating Margin (OM) emission factor, the project boundary has to be modelled with electricity imports from other geo-electric systems to describe, as close as possible, the baseline situation. The Northeast subsystem is connected through transmission lines with the North and Southeast/Central west subsystems.

- Modelling the electricity imports: The project category I.D "Grid Connected Renewable Electricity Generation" does not indicate how to manage electricity imports from other grid systems. The ideal approach is to determine the impact of electricity imports on the "merit order" operation margin and therefore the energy dispatch for the Northeast system. This approach is true when dispatch merit of the external grid power sources are clearly known based on reliable data[26], if not the average emission rate of the exporting grid will be used otherwise.

For the project activity, the electricity imports from the North into the Northeast are given by a hydro power plant which constitutes a "low-cost/must-run" source. Moreover the impacts of droughts[27] and shortage of natural gas at the Northeast, clearly affect the operation of the power plants on the margin within the project boundary.

The previous means that the implementation of the project activity will not have any displacement effect on the energy provided by this must-run source that operates at the baseload.

The imports from the Southeast/Central west subsystem are composed by a mix of generation with a dispatch model based on bilateral contracts and/or energy bids. For this reason, it is not easy to identify the dispatch and therefore the imports are also treated as low-cost must run resources.

The operating margin for the project boundary is calculated *ex- ante* using the full generation-weighted average for the most recent 3 years. The amount of fuel consumption for thermal generation for the project boundary is available for 2003, 2004 and 2005 (last year availability of the data). The average *EF_OMy* for the project activity is 0.198 (kg $CO_2$equ/kWh). At the table 11 below the values are given.

| Data Vintage | EF_Omy (kg $CO_2$equ/kWh) |
|---|---|
| 2003 | 0.13 |
| 2004 | 0.28 |
| 2005 | 0.19 |

***Table 11. Values of EF_OMy***

26 The grid operator (NOS) must provide enough data to identify such marginal plant(s).

27 *Electricity imports seek to maximize either social economic surplus for water or the economic value of the available stock of water at the Northeast.*

The **Build Margin ($EF\_BM_y$)** represents the weighed average emissions (tCO2equ/MWh) occurred in 2005 and is calculated as follows:

| $EF\_BM_y = \Sigma (F_{i,m} * CEF)/TGEN$ | ***Equation 4*** |
|---|---|

Where:

*TGEN (MWh/year)* represents the total electricity supply by all recent capacity additions[28] to the system at the Northeast system, excluding zero or low operating sources and imports.

$F_{i,j}$ $(m^3)$ represents the total fuel consumption of fossil fuel sources classified by primary source and power generation type at the Northeast electric system.

*CEF* $(kgCO_2/m^3)$ represents the emission factor for the fuel type.

The build margin approach aims to make a "best guess" on the type of power generation facility that would have otherwise been built, in the absence of the GHG mitigation project.

As noted by *Kartha et al*.,[29] even in well-planned electricity systems, it is not easy to determine the timing and type of new electricity capacity additions. For the project activity the most recent data based on historical capacity additions are provided through the NOS.

The values for energy generation are defined through the wholesale electricity market operator (CCEE) and where data are not available, default values for the Brazilian grid system are defined[30].

The build margin is estimated *ex-ante,* based on the five most recently built plants, which comprise the larger annual generation compared to the recently built 20%, thus they represent the capacity additions to the system. The list of the power plants is given below (Table 12):

| OPERATION | # GENSET | Power Plant | Install Power | Annual Generated Energy (MWh) |
|---|---|---|---|---|
| Jan.03 | 1,2,3,4,5 | MPX TERMOCEARA | 220 MW | 151,576 |
| Feb.03 | 1,2,3 | TERMOFORTALEZA | 294 MW | 1,245,705 |
| 30/01/2004 | 1,2,3,4 | CHESF/CAMACARI | 280 MW | 37,098 |
| 09/02/2004 | 1 | TERMOBAHIA | 180 MW | 0 |
| 15/05/2004 | 1 | TERMOPERNAMBUCO | 532.74 MW | 909,393 |
| 15/05/2004 | 2 | FAFEN ENERGIA | 18.2 MW | 59,145 |

***Table 12. Power plants on the Build Margin. Data Source: NOS (Brazilian grid operator entity)***

Finally, the baseline emission factor *EFy* is calculated as the weighted average of the Operating Margin emission factor (*EF_OMy*) and the Build Margin emission factor *(EF_BMy):*

$$EF_y = (\omega_{BM} * EF\_BM_y) + (\omega_{OM} * EF\_OM_y)$$

[28] *Capacity additions are defined as the greater (in MWh) of most recent 20% of existing plants or the 5 most recent plants*

[29] *Martina Bosi: Road-Testing Baselines for Greenhouse Gas Mitigation Projects in the Electric Power Sector (OECD and IEA Information Paper COM/ENV/EPOC/IEA/SLT(2002)6). Outubro de 2002. Disponível em: http://www.oecd.org/dataoecd/45/54/2766208.pdf*

[30] *OECD and IEA Information Paper, Bossi et al (2002).*

In order to ensure conservativeness of the *BM* calculation a sensitivity analysis was conducted. There are two main detected sources of uncertainty, there are the quantity of natural gas consumed by power utility (Nm3/kWh) and the energy imports from external electrical subsystems (GWh/year).

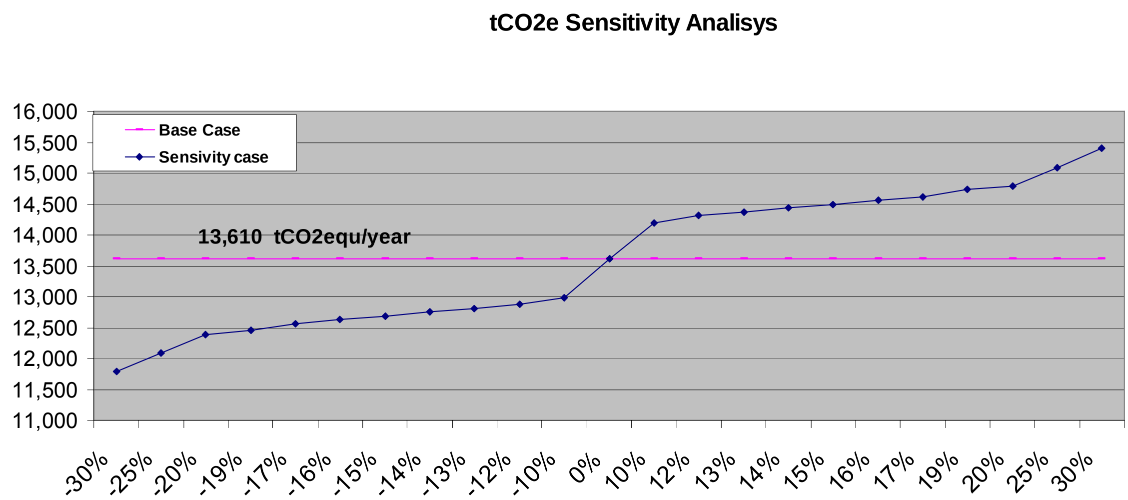
First, the consumption rate of the power plant was analysed. The consumption rate represents the average quantity of fuel consumed or expended to be consumed when generating a kWh of energy and expressed in quantities of Nm3/kWh. This parameter depends upon the technology of the power plant and economic factors through the capacity factor and the dispatch model of the power plant and therefore the uncertainty level is high.

For the project activity the consumption rate was tested for a range of +30% (decrease of the fuel consumption performance) and -30% (increase of the fuel consumption performance) based on the BM value calculated for the project activity. The goal is to analyse if a small change in the consumption rate results in relatively large changes in the outcome (emission reductions).

As shown at the graph below, the base case represents a total emission of 13,610 tCO2equ/year. If changes on the consumption rate applies, the BM will be affected on the way that the set of power plants defined at the build margin will have different values on the kg of CO2 emitted and therefore will directly affect to the BM value.

Changes of the consumption rate ranging between -30% were applied. The previous means a power plant scenario with an extremely high efficient consumption rate (up to 0.17 Nm3/kWh) based on a combined cycle and vapour turbines working for the cogeneration process. This is not the situation for the existing power plants where the real scenario represents a mix of open cycle power plants (based on Natural gas), such as *Camaçari* power plant with a higher consumption rate[31] (0.352 Nm3/kWh).

Nevertheless, the total deviation on the emission reduction regarding the extreme case (-30%) shows a reduction on 1,823 tCO2equ/year which is unlikely to happen as stated before. It seems reasonable to think that this extreme variation of the consumption rate may not affect substantially the outcome.




[31] *Eletrobrás; specific fuel consumption rate for the Camaçari and Termobahia power plants can be consulted under the following link: http://www.eletrobras.gov.br/mostra_arquivo.asp?id=http://www.eletrobras.gov.br/downloads/EM_Atuacao_CCC/consumo_especifico_2004.pdf&tipo=ccc)*

Taking on account the mix of thermal power plants (regarding the technology of generation) the consumption rate established for the project activity chosen is quite conservative (0.24 Nm3/kWh). Consumption rates below this value are not on consonance with the standard values for energy generation worldwide.

| Consumption rate (Nm3/kWh) | BM factor | ∆ base case |
|---|---|---|
| 0.24 | 0.470 | 0% |
| 0.22 | 0.430 | -10% |
| 0.21 | 0.420 | -12% |
| 0.21 | 0.410 | -13% |
| 0.20 | 0.400 | -15% |
| 0.20 | 0.390 | -17% |
| 0.19 | 0.380 | -20% |
| 0.18 | 0.350 | -25% |
| 0.17 | 0.330 | -30% |

***Table 13. Consumption rate and its impact on the BM factor.***

It can therefore be concluded from the sensitivity analysis that the *BM* value is as robust, stable and accurate to consider the calculated *BM* value conservative enough.

**E.1.2.5 Difference between E.1.2.4 and E.1.2.3 represents the emission reductions due to the project activity during a given period:**

The emission reduction ERy by the project activity during a given year y is the difference between baseline emissions ($BE_y$), project emissions ($PE_y$), as follows:

$$ER_y = BE_y - PE_y - 0 \qquad \textbf{Equation 5}$$

For the project activity, as the most of the energy project activities, the value of $PE_y = 0$.

Finally, the baseline emissions ($BE_y$ in $tCO_2$) are the product of the baseline emissions factor ($EF_y$ in $tCO_2/MWh$) times the electricity supplied by the project activity to the grid ($EG_y$ in MWh), as follows:

$$BE_y = EG_y * EF_y \qquad \textbf{Equation 6}$$

**E.2 Table providing values obtained when applying formulae above:**

| Calculated Results | Comments | Source |
|---|---|---|
| $EF\_OM_y = 0.198$ ($tCO_2equ/MWh$) | $EF\_OM_y$ was calculated for all the thermal plants within the project boundary | NOS, Operation and Energy Generation: (http://www.ons.org.br/historico/geracao_energia.aspx) . Fuel Energy Content: BEN (National Brazilian report on energy generation) Fuel Carbon Content: Revised IPCC Guidelines for National Greenhouse gas Inventories, Workbook page |

| | | |
|---|---|---|
| | | 1.6<br>Fuel Oxidation Factor: Revised IPCC Guidelines for National Greenhouse gas Inventories, Workbook page 1.8<br>Fuel consumed at the power generation: SIESE 2002, 2003, 2004. (National Energy statistics).<br>Installed capacity: ANEEL www.aneel.gov.br |
| $EF\_BM_y$ = 0.477 ($tCO_2$equ/MWh) | EF_BMy was calculated for a sample group *m* consists of the five power plants that have been built most recently and actually on operation. Please note that the TERMOBAHIA thermal plant is currently switch off due to the Natural Gas shortage, and therefore is not considered as a being part of the Build Margin. | Power Plant energy generation: CCEE (Monthly Energy Generation).<br>Power Plant capacity factors (default): OECD and IEA Information Paper, *Bossi et al* (2002).<br>Fuel Energy Content: BEN (National Brazilian report on energy generation)<br>Fuel Carbon Content: Revised IPCC Guidelines for National Greenhouse gas Inventories, Workbook page 1.6<br>Fuel Oxidation Factor: Revised IPCC Guidelines for National Greenhouse gas Inventories, Workbook page 1.8<br>Installed capacity: ANEEL www.aneel.gov.br |
| *EF* = 0.267 ($tCO_2$equ/MWh) | The baseline emission factor ($EF_y$) is calculated as the weighted average of the combination of operating margin (*OM*) and build margin (*BM*) factors | |

***Table 14. Values obtained when applying formulae above***

| TECHNICAL DESCRIPTION OF THE BUNDLING | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Name of the Project Bundle** | | ***Lagoa do Mato Wind energy project ($tCO_2equ$)*** | | | | | | | | |
| **Wind turbine #** | Gross Energy (MWh/year) | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **TOTAL** |
| ***T1*** | 3,233 | 725 | 865 | 865 | 865 | 865 | 865 | 865 | 140 | 6,052 |
| ***T2*** | 3,285 | 737 | 879 | 879 | 879 | 879 | 879 | 879 | 142 | 6,150 |
| ***T3*** | 3,232 | 725 | 864 | 864 | 864 | 864 | 864 | 864 | 140 | 6,050 |
| ***T4*** | 3,296 | 739 | 881 | 881 | 881 | 881 | 881 | 881 | 142 | 6,170 |
| ***TOTAL*** | 13,046 | 2,925 | 3,489 | 3,489 | 3,489 | 3,489 | 3,489 | 3,489 | 564 | 24,422 |
| **Name of the Project Bundle** | | ***Canoa Quebrada Wind energy project ($tCO_2equ$)*** | | | | | | | | |
| **Wind turbine #** | Gross Energy (MWh/year) | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **TOTAL** |
| ***T1*** | 2,557 | 573 | 684 | 684 | 684 | 684 | 684 | 684 | 111 | 4,787 |
| ***T2*** | 2,769 | 621 | 741 | 741 | 741 | 741 | 741 | 741 | 120 | 5,184 |
| ***T3*** | 2,813 | 631 | 752 | 752 | 752 | 752 | 752 | 752 | 122 | 5,266 |
| ***T4*** | 2,924 | 656 | 782 | 782 | 782 | 782 | 782 | 782 | 126 | 5,474 |
| ***T5*** | 3,163 | 709 | 846 | 846 | 846 | 846 | 846 | 846 | 137 | 5,921 |
| ***T6*** | 3,262 | 731 | 872 | 872 | 872 | 872 | 872 | 872 | 141 | 6,107 |
| ***T7*** | 3,132 | 702 | 838 | 838 | 838 | 838 | 838 | 838 | 135 | 5,863 |
| ***T8*** | 3,043 | 682 | 814 | 814 | 814 | 814 | 814 | 814 | 132 | 5,697 |
| ***T9*** | 2,805 | 629 | 750 | 750 | 750 | 750 | 750 | 750 | 121 | 5,251 |
| ***T10*** | 2,833 | 635 | 758 | 758 | 758 | 758 | 758 | 758 | 122 | 5,303 |
| ***T11*** | 2,700 | 605 | 722 | 722 | 722 | 722 | 722 | 722 | 117 | 5,054 |
| ***T12*** | 2,897 | 650 | 775 | 775 | 775 | 775 | 775 | 775 | 125 | 5,423 |
| ***T13*** | 2,949 | 661 | 789 | 789 | 789 | 789 | 789 | 789 | 127 | 5,521 |
| ***TOTAL*** | 37,847 | 8,485 | 10,121 | 10,121 | 10,121 | 10,121 | 10,121 | 10,121 | 1,636 | 70,850 |
| | | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **TOTAL** |
| ***Total Bundling*** | | 11,410 | 13,610 | 13,610 | 13,610 | 13,610 | 13,610 | 13,610 | 2,200 | 95,273 |

*Table 15. CERs description of the bundling.*

## SECTION F.: Environmental impacts:

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

Wind power is one of the cleanest sources of renewable energy, with no associated emissions and waste products. The *Rosa dos Ventos* Wind Energy Project will output an expected amount of 50.89 GWh per year, producing energy without pollution and leading to a reduction in the emission of carbon dioxide, nitrogen oxide and sulphur dioxide.

The Environmental Impact Assessment (EIA) foresees in total 154 environmental impacts, being 99 (64,3%) positive and 55 (35,7%) adverse impacts. The EIA endorses, in its conclusion, the prevalent favorable aspects of promoting the wind energy potential as a means of boosting local economic growth by creating new investment opportunities, securing energy supply stability and promoting the use of clean and renewable technology.

Some of the impacts are discussed below:

**a. Dust emissions and Noise**

Low intensity noise can be generated in the implementation phase by the use and carrying of heavy equipments and the presence of workers. On the other hand, the advanced technology of the wind turbines prevent from any significant noise impact.

**b. Vibrations**

Vibrations sources such as building machines and vehicles will be restricted to the working area.

**c. Visual impacts**

The wind farm will not interfere significantly in the landscape and can also become an additional factor for touristy attraction.

**d. Land issues**

The Project area is not current used or economically explored and the installation of a wind farm will not interfere in the daily use of the land. The Project also takes into account the land owner profitability in relation to the land appreciation.

No major topographic changes are expected, since most of the area is flat. Access to the surface of any surrounding dunes will be limited in order to minimize leveling and cuts.

**e. Flora and Fauna**

The Project will not interfere in the land fauna behavior and changes are expected only during land clearance for access roads and tower’s construction, being therefore restricted to a small and specific area. Environmental compensation measures will be taken to recover any natural losses and endeavor to enhance local biodiversity.

Moreover, the studies show that bird's migratory paths will not be affected by the Project.

**d. Social Impacts**

The social impacts of the Project will be mainly positive impacts. It is expected to generate new business and services in the region, attract other enterprises which demand steady energy supply, develop new infrastructure in the area, including access roads and communication, as well as provide employment during implementation and operation phases.

## SECTION G. Stakeholders' comments:

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

According to the Resolution number 1 of the Brazilian Inter-Ministerial Commission on Climate Change[32], invitations for comments by local stakeholders are required by the Brazilian Designated National Authority (DNA) as part of the procedures for analyzing CDM projects and issuing letters of approval.

The DNA required project participants to communicate with the public through letters, to be sent inviting for comments to:

- The Brazilian national NGO's forum.

- The local attorneys' and prosecutors' agency.

- The municipality's chamber (mayor and assembly men).

- State's and municipal's environmental authorities.

- Local communities' associations.

As defined by the Designated National Authority (DNA), the project developer sent information letters to the key institutions, describing the major aspects of the implementation and operation of the proposed project. The project participant should leave 30 days opened for comments. The letters were distributed by *Rosa dos Ventos Ltd*. to key institutions (see table 16, below).

During this time, a copy of the letter will be open for public comments in English and Portuguese versions. The letters were sent in the beginning of February 2006. No comment was received.

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

No comment was received.

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

Not applicable.

[32] Issued on December 2nd of the 2003, decree from July 7th 1999.

| Name of the Institution | Type of Entity | Address | Phone / Fax | Contact Point | E-mail |
|---|---|---|---|---|---|
| Instituto de Desenvolvimento Sustentável e Energias Renováveis-IDER | Non-Governmental Organisation | Júlio Siqueira St, 581 - Dionísio Torres CEP: 60.130-090 Fortaleza/CE | Fone: (85) 3247-6506 | Armando Abreu – Eng. Elet.– Dir. Fin. Jörgdieter Anhalt – Eng. Mec.- Dir. Exec. | ider@matrix.com.br |
| *Núcleo de Ensino e Pesquisa Aplicada – NEPA* | Non-Governmental Organisation | 2326, Monsenhor Furtado St. , Bela Vista CEP 60.441-750 Fortaleza/CE | (85) 3482-0621 (85) 3842-2377 (85) 9997-0321 | Sr. Moura | nepa-ce@terra.com.br |
| Brazilian Forum of NGOs | Association of NGOs | SCLN 210 Block C Room 102 CEP 70856-530 Brasília DF | (61) 3340-0741 | -- | forumbr@tba.com.br |
| Public Attorney's Office - State of Ceará. | Public | 1100, Assunção, José Bonifácio, CEP 60.050.011 Fortaleza – Ceará | (85) 3452-3763 | Raimundo Batista de Oliviera (Environment Office) | batista@mp.ce.gov.br |
| Public Attorney's Office - State of Ceará. | Public | 1100, Assunção, José Bonifácio, CEP 60.050.011 Fortaleza – Ceará | (85) 3452-3763 | Verônica Maria Martins Telles (Local Attorney) | vmartinstelles@bol.com.br |
| Environment Secretariat – State of Ceará (SEMACE). | Public | 1400, Jaime Benévolo, Bairro de Fátima, Fortaleza – Ceará | (85 )3101-5521 | Romeu Aldiguero de Arruda Coelho - Superintendente | romeuarruda@semace.ce.gov.br |
| Aracati City Hall | Public | 1146, Santos Dumont, CEP 62.800.000 Aracati – Ceará | (88) 3446-2400 | Expedito Ferreira da Costa (Maior) | aracati@aracati.ce.gov.br |
| Aracati City Council | Public | 448, Cel. Alexanzeto, Centro CEP 62.800.000 Aracati – CE | (88) 3421-1144 (88) 3421-2435 | Naselma Ferreira Porto | |
| Environment and Tourism Secretariat – Municipality of Aracati. | Public | 352, Santos Dumont St, CEP 62.800.000 Aracati – Ceará | (88) 3446-2451 | Waldelanda Ramos (Secretary General) | waldelanda@aracati.ce.gov.br |

***Table 16. Participants entities.***

**Annex 1**

## CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

| | |
|---|---|
| Organization: | Carbon Capital Markets |
| Street/P.O.Box: | Level 3, 15 Berkeley Street |
| City: | London |
| State/Region: | -- |
| Postfix/ZIP: | W1J 8DY |
| Country: | United Kingdom |
| Telephone: | +44 207 317 6200 |
| FAX: | +44 207 317 6201 |
| E-Mail: | info@carboncapitalmarkets.com |
| Title: | Head of Trading |
| Salutation: | Mr. |
| Last Name: | Maltby |
| First Name: | Reuben |
| Department: | Trading |
| Mobile: | +44 77 9563 0861 |
| Direct FAX: | +44 207 317 6201 |
| Direct tel: | +44 207 317 6200 |
| Personal E-Mail: | reuben.maltby@carboncapitalmarkets.com |

| | |
|---|---|
| Organization: | Rosa dos Ventos Ltd. |
| Street/P.O.Box: | Avenida Senador Virgílio Távora, 1701 sala 1305 |
| City: | Fortaleza |
| State/Region: | Ceará |
| Postfix/ZIP: | 60170-250 |
| Country: | Brazil |
| Telephone: | +55 (85) 3452 7331 / |
| FAX: | +55 (85) 3224 3850 |
| E-Mail: | aferreira@hlcbrasil.com.br |
| Title: | Director |
| Salutation: | Mr. |
| Last Name: | Ferreira |
| Middle Name: | Almeida |
| First Name: | Armando |
| Department: | Administration |
| Mobile: | +55 (85) 9991 8015 |
| Direct FAX: | +55 (85) 3224 3850 |
| Direct tel: | +55 (85) 3452 7331 / (11)32876277 / (21) 424 4098 |
| Personal E-Mail: | aferreira@hlcbrasil.com.br |

**Annex 2**

## INFORMATION REGARDING PUBLIC FUNDING

Not applicable

## Annex 3

## DETAIL OF PHYSICAL LOCATION, INCLUDING INFORMATION ALLOWING THE UNIQUE IDENTIFICATION OF THE PROJECT ACTIVITY


*Figure 3. Physical location of the CEARA state (Northeast Brazil) and detail of the bundling project*

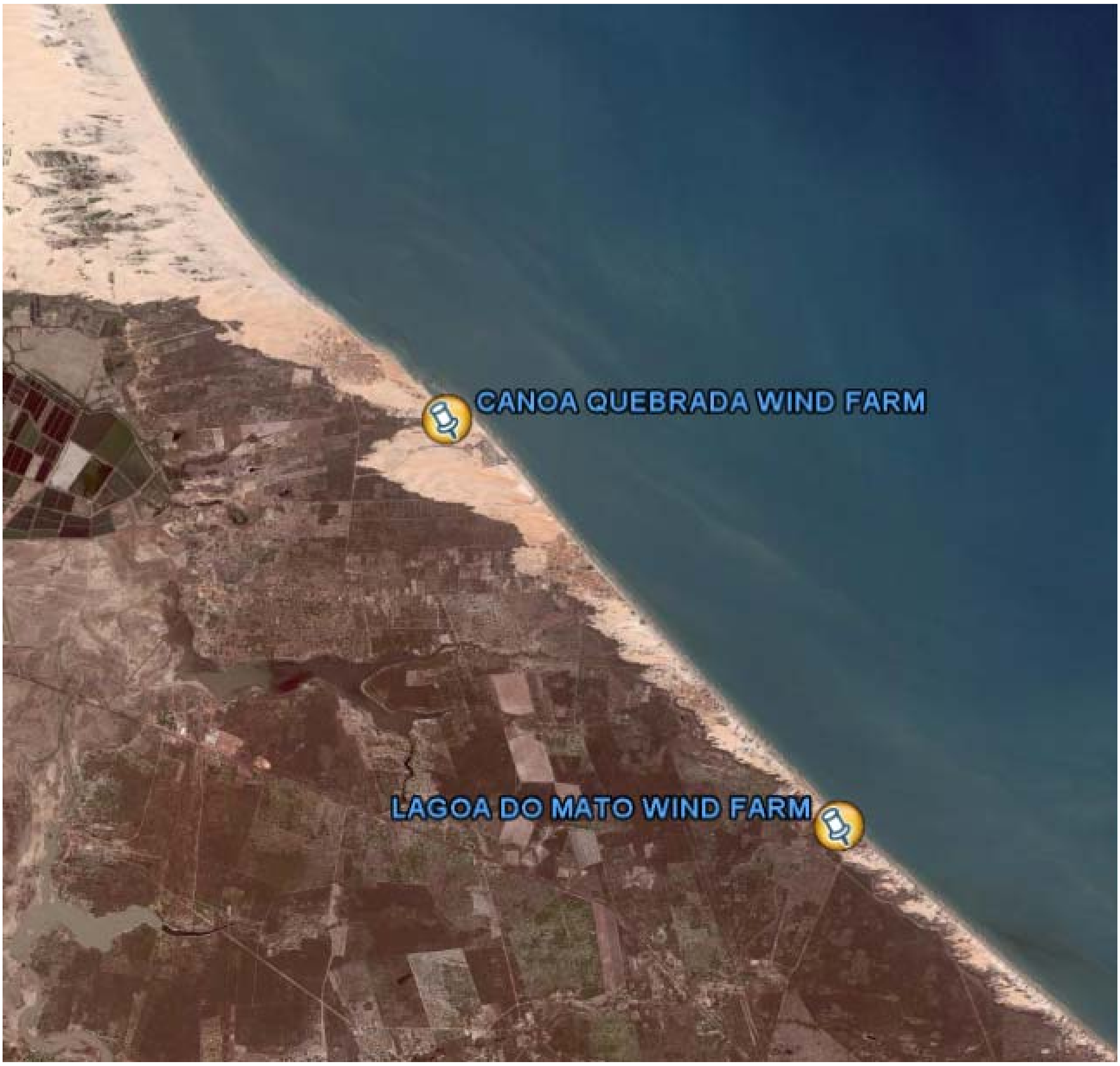



*Figure 4. Physical location of the Lagoa do Mato and Canoa Quebrada wind farm*

## Annex 4:

| GENERAL DESCRIPTION OF THE BUNDLING | | | | | | |
|---|---|---|---|---|---|---|
| **Name of the Project Bundle** | ***Rosa dos Ventos Wind energy project*** | | | | | |
| **Wind plant name** | Project type | Project category | Baseline methodology | Monitoring methodology | Part of sub-Bundling | QA/QC procedures |
| ***Lagoa do Mato*** | Type I | Category I.D | AMS-I.D | AMS-I.D | NO | Monitoring yearly Energy output (MWh/year) |
| ***Canoa Quebrada*** | Type I | Category I.D | AMS-I.D | AMS-I.D | NO | |

| TECHNICAL DESCRIPTION OF THE BUNDLING | | | | | |
|---|---|---|---|---|---|
| **Name of the Project Bundle** | ***Lagoa do Mato Wind energy project*** | | | | |
| **Wind turbine #** | Gross Energy (MWh/year) | Geographical Coordinates | Debundled component | Starting date for the crediting period (dd/mm/yy) | Closing date for the crediting period (dd/mm/yy) |
| ***T1*** | 3,233 | Lat: 649375.9 Long: 9493930.0 | No | 01/03/2007 | 28/02/2014 |
| ***T2*** | 3,285 | Lat: 649920.6 Long: 9493551.0 | No | 01/03/2007 | 28/02/2014 |
| ***T3*** | 3,232 | Lat: 650610.3 Long: 9493066.0 | No | 01/03/2007 | 28/02/2014 |
| ***T4*** | 3,296 | Lat: 650711.1 Long: 9492908.0 | No | 01/03/2007 | 28/02/2014 |
| ***TOTAL*** | ***13,047*** | | | | |
| **Name of the Project Bundle** | ***Canoa Quebrada Wind energy project*** | | | | |
| **Wind turbine #** | Gross Energy (MWh/year) | Geographical Coordinates | Debundled component | Starting date for the crediting period (dd/mm/yy) | Closing date for the crediting period (dd/mm/yy) |
| ***T1*** | 2,557 | Lat: 644400.9 Long: 9498869.0 | No | 01/03/2007 | 28/02/2014 |
| ***T2*** | 2,769 | Lat: 644403.2 Long: 9498433.0 | No | 01/03/2007 | 28/02/2014 |
| ***T3*** | 2,813 | Lat: 644269.0 Long: 9498276.0 | No | 01/03/2007 | 28/02/2014 |
| ***T4*** | 2,924 | Lat: 644666.0 Long: 9498825.0 | No | 01/03/2007 | 28/02/2014 |
| ***T5*** | 3,163 | Lat: 644674.9 Long: 9498678.0 | No | 01/03/2007 | 28/02/2014 |
| ***T6*** | 3,262 | Lat: 644686.7 Long: 9498531.0 | No | 01/03/2007 | 28/02/2014 |
| ***T7*** | 3,132 | Lat: 644698.5 Long: 9498385.0 | No | 01/03/2007 | 28/02/2014 |
| ***T8*** | 3,043 | Lat: 644800.6 Long: 9498939.0 | No | 01/03/2007 | 28/02/2014 |
| ***T9*** | 2,805 | Lat: 644913.3 Long: 9498771.0 | No | 01/03/2007 | 28/02/2014 |
| ***T10*** | 2,833 | Lat: 644925.3 Long: 9498624.0 | No | 01/03/2007 | 28/02/2014 |
| ***T11*** | 2,700 | Lat: 645174.4 Long: 9498749.0 | No | 01/03/2007 | 28/02/2014 |
| ***T12*** | 2,897 | Lat: 645405.2 Long: 9498707.0 | No | 01/03/2007 | 28/02/2014 |
| ***T13*** | 2,949 | Lat: 645623.5 Long: 9498605.0 | No | 01/03/2007 | 28/02/2014 |
| ***TOTAL*** | ***37,847*** | | | | |

***Table 17. Description of bundling activity***

**Annex 5**

Baseline information

Below, the graphs representing the duration load curve and the energy demand for 2003, 2004 and 2005. Data were sourced directly from the *NOS* (National operator system) for the project electrical system and project boundary (North/ Northeast system).

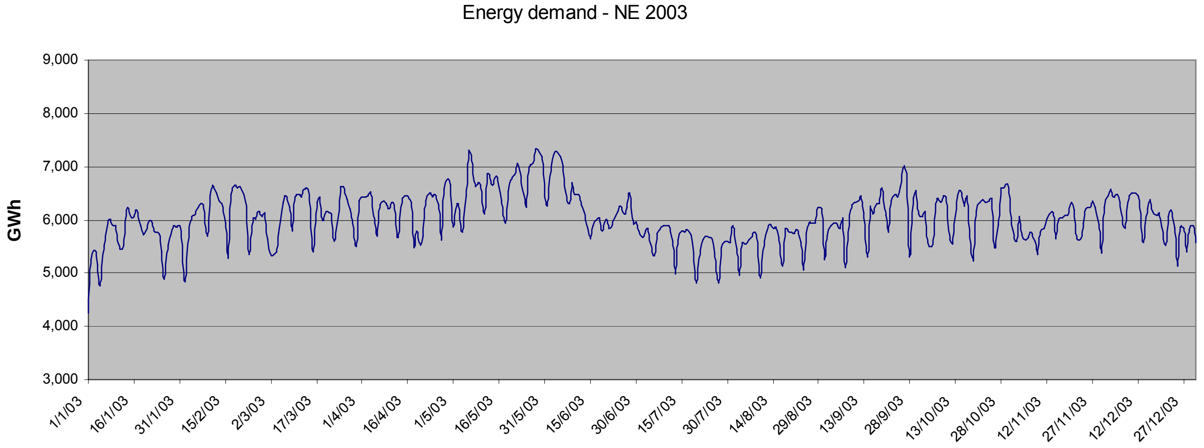



***Figure 5. Energy demand for the Northeast in 2003.***

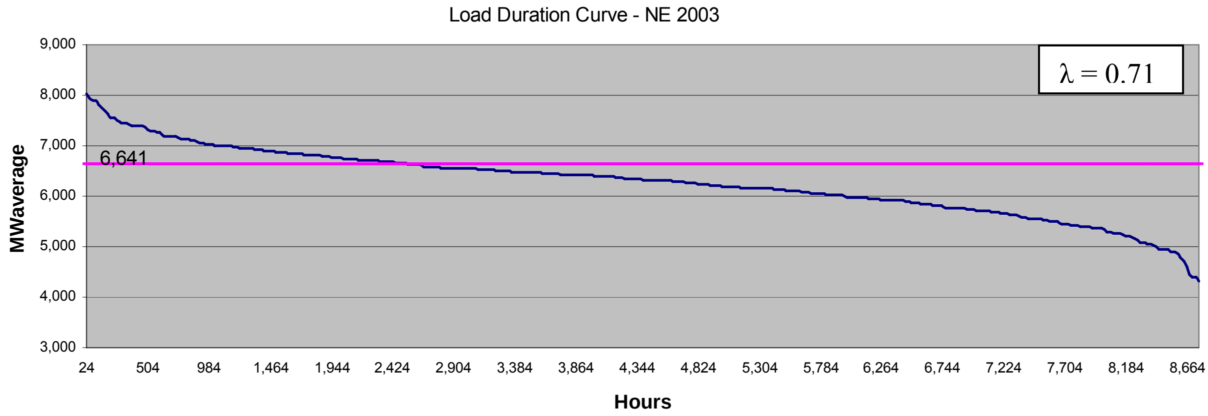



***Figure 6. Load duration curve for the Northeast in 2003.***

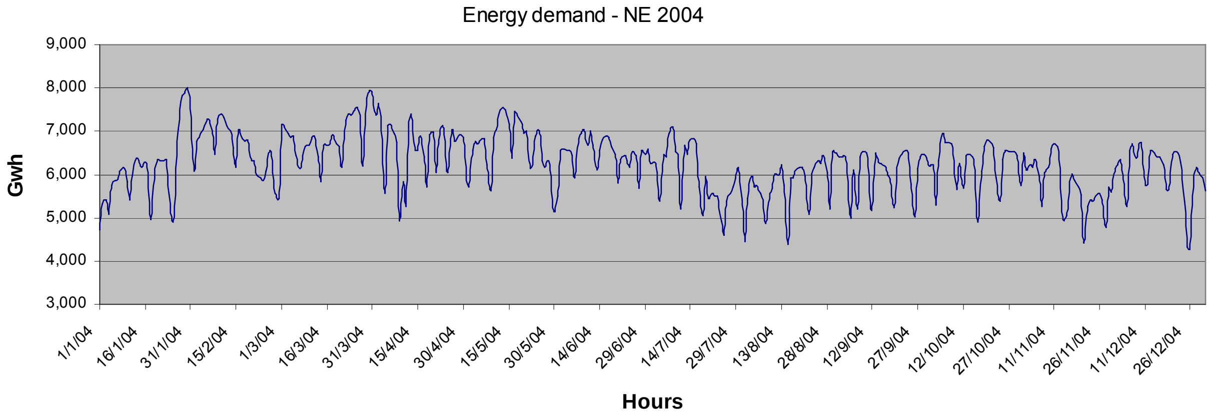



*Figure 7. Energy demand for the Northeast in 2004.*

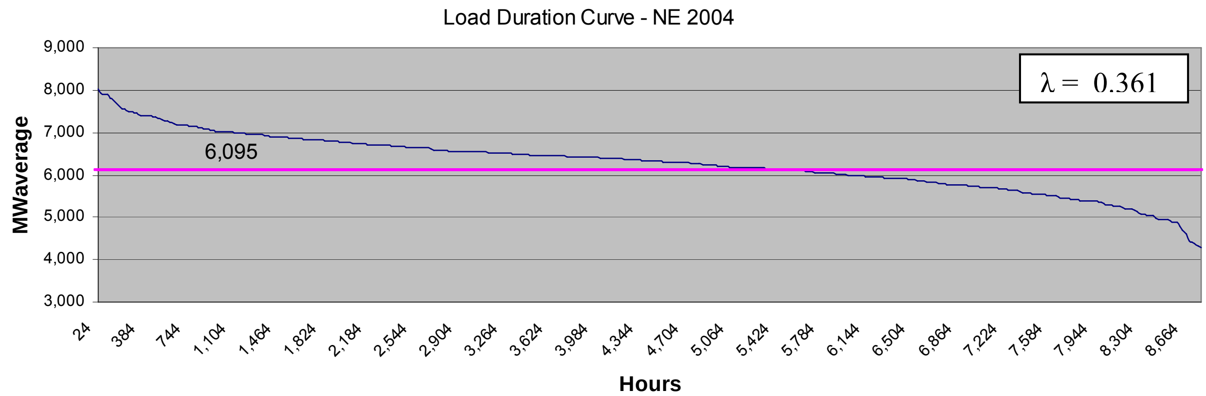



*Figure 8. Load duration curve for the Northeast in 2004.*

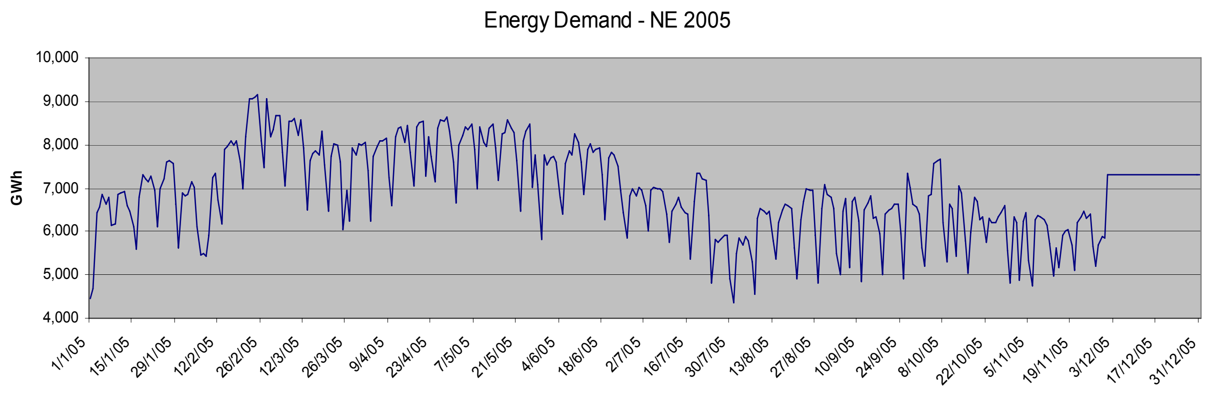



*Figure 9. Energy demand for the Northeast in 2005.*

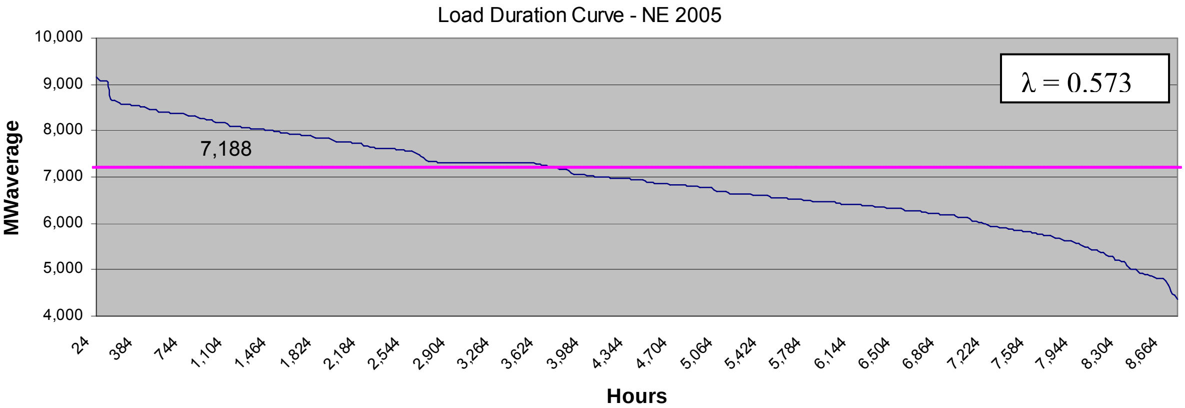



***Figure 10 Load duration curve for the Northeast in 2005.***

The table below represents the lead time values agreed for new capacity additions used at the baseline weighting values estimated. The assumptions are currently used in the US government's energy modelling. These are consistent with the coal and gas numbers from the OECD/IEA report, and include lead time estimates for other electric generating technologies. An assumption of three or four years would appear to be reasonable for many fossil and renewable generating technologies.

| Technology | Lead time (in years) |
|---|---|
| Coal | 4 |
| Natural Gas (CC) | 3 |
| Combustion | 2 |
| Nuclear | 6 |
| Wind | 3 |
| Biomass | 4 |

***Table 18. Lead time estimation for electric generating technologies.*** (*Source: OECD/IEA report: Projected Cost of Generating Electricity)*

At the definition of the baseline, the set of power plants (low cost/must run resources) are analysed as well those power plants non-low cost/must run power plants. The table below shows the installed capacity for the hydro power plants within the project boundary of the project activity.

| **Hydro Power Plant** | **Installed Power 2006 (kW)** | **Municipality** | **Installed Power 2003 (kW)** | **Installed Power 2004 (kW)** | **Installed Power 2005 (kW)** |
|---|---|---|---|---|---|
| Alto Fêmeas I | 10,649 | São Desidério - BA | 10,649 | 10,649 | 10,649 |
| Boa Esperança | 237,300 | Guadalupe - PI | 237,300 | 237,300 | 237,300 |
| Funil | 30,000 | Ubatã - BA | 30,000 | 30,000 | 30,000 |
| Luiz Gonzaga | 1,479,600 | Glória - BA | 1,479,600 | 1,479,600 | 1,479,600 |
| Moxotó | 400,000 | Delmiro Gouveia | 400,000 | 400,000 | 400,000 |
| Paulo Afonso I | 180,001 | Paulo Afonso - BA | 180,001 | 180,001 | 180,001 |
| Paulo Afonso II | 443,000 | Paulo Afonso - BA | 443,000 | 443,000 | 443,000 |
| Paulo Afonso III | 794,200 | Paulo Afonso - BA | 794,200 | 794,200 | 794,200 |

| | | | | | |
|---|---|---|---|---|---|
| Paulo Afonso IV | 2,462,400 | Paulo Afonso - BA | 2,462,400 | 2,462,400 | 2,462,400 |
| Pedra | 20,007 | Jequié - BA | 20,007 | 20,007 | 20,007 |
| Presidente Goulart | 8,000 | Correntina – BA | 8,000 | 8,000 | 8,000 |
| Sobradinho | 1,050,300 | Juazeiro – BA | 1,050,300 | 1,050,300 | 1,050,300 |
| Tucuruí I e II | 6.870.000 | Tucuruí – PA | 4,950,000 | 5,700,000 | 6,825,000 |
| Xingó | 3,162,000 | Piranhas – AL | 3,162,000 | 3,162,000 | 3,162,000 |
| Itapebi | 450,000 | Itapebi – BA | 450,000 | 450,000 | 450,000 |
| Pedra do Cavalo | 162,000 | Cachoeira – BA | 0 | 0 | 162,000 |
| **TOTAL (MW)** | | | **15,690 MW** | **16,440 MW** | **17,727 MW** |

***Table 19. Installed capacity of the hydro power plants.***

The table below shows the installed capacity for the ***thermal based power plants*** within the project boundary of the project activity.

| Thermal Power Plant | Fuel type | Installed Power 2003 (kW) | Installed Power 2004 (kW) | Installed Power 2005 (kW) | Installed Power 2006 (kW) |
|---|---|---|---|---|---|
| Altos | Diesel Oil | 13,120 | 13,120 | 13,120 | 13,120 |
| Aracati | Diesel Oil | 11,480 | 11,480 | 11,480 | 11,480 |
| Baturité | Diesel Oil | 11,480 | 11,480 | 11,480 | 11,480 |
| Camaçari | Natural Gas | 315,500 | 327,000 | 346,803 | 346,803 |
| Camaçari (I and II) | Natural Gas | 64,000 | 64,000 | 138,020 | 138,020 |
| Campo Maior | Diesel Oil | 13,120 | 13,120 | 13,120 | 13,120 |
| Carrapicho Gebra | Diesel Oil | 19,200 | 19,200 | 19,200 | 19,200 |
| Caucaia | Diesel Oil | 14,760 | 14,760 | 14,760 | 14,760 |
| Copene | Natural Gas | 250,400 | 250,400 | 250,400 | 250,400 |
| Crato | Diesel Oil | 13,120 | 13,120 | 13,120 | 13,120 |
| Kaiser Pacatuba | Natural Gas | 5,552 | 5,552 | 5,552 | 5,552 |
| Enguia Pecém | Diesel Oil | 14,760 | 14,760 | 14,760 | 14,760 |
| Iguatu | Diesel Oil | 14,760 | 14,760 | 14,760 | 14,760 |
| Juazeiro do Norte | Diesel Oil | 14,760 | 14,760 | 14,760 | 14,760 |
| Lagarto Gebra | Diesel Oil | 14,880 | 14,880 | 14,880 | 14,880 |
| Marambaia | Diesel Oil | 13,120 | 13,120 | 13,120 | 13,120 |
| Marituba Gebra | Diesel Oil | 16,000 | 16,000 | 16,000 | 16,000 |
| Nazária | Diesel Oil | 13,120 | 13,120 | 13,120 | 13,120 |
| Peri Peri Gebra | Diesel Oil | 16,000 | 16,000 | 16,000 | 16,000 |
| Cloroquímico Gebra | Diesel Oil | 16,000 | 16,000 | 16,000 | 16,000 |
| Potiguar | Diesel Oil | 52,800 | 52,800 | 52,800 | 52,800 |
| Rio Largo Brasympe | Diesel Oil | 177,120 | 177,120 | 177,120 | 177,120 |
| Termo Toalia | Natural Gas | 5,680 | 5,680 | 5,680 | 5,680 |
| Termocabo | Natural Gas | 48,000 | 48,000 | 48,000 | 48,000 |
| Termoceará | Natural Gas | 220,000 | 220,000 | 220,000 | 220,000 |
| Bahia I – Camaçari | Diesel Oil | 31,800 | 31,800 | 31,800 | 31,800 |

| | | | | | |
|---|---|---|---|---|---|
| Jardim Brasympe | Diesel Oil | 63,960 | 63,960 | 63,960 | 63,960 |
| Petrolina | Diesel Oil | 136,200 | 136,200 | 136,200 | 136,200 |
| Tambaqui | Diesel Oil | 162,338 | 162,338 | 83,280 | 83,280 |
| Fortaleza | Natural Gas | 0 | 319,000 | 319,000 | 346,630 |
| Termobahia Fase I | Natural Gas | 0 | 185,891 | 185,891 | 185,891 |
| Termopernambuco | Natural Gas | 0 | 532,756 | 532,756 | 532,755.70 |
| **TOTAL (MW)** | | | **15,690 MW** | **16,440 MW** | **17,727 MW** |

***Table 20. Installed capacity of the thermal power plants.***