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

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## SECTION A. General description of project activity

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

Title: Olifantsrivier Wind
Version: 0.3
Date: 10/05/2012

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

The Olifantsrivier Wind Project (hereinafter referred to as 'the project') is developed by South African Renewable Green Energy ("hereinafter referred to as SARGE) Pty Ltd. The project site is located within Western Cape in South Africa, approximately 6km from the coast and 250km north of Cape Town. The site is located within the West Coast District Municipality. The nearest major town is the Lutzville. The primary objective of the project is to generate electricity from wind, a renewable energy source, and to provide power to the South African National Electricity Grid (hereinafter referred to as the "SA Grid").

The project will install 280 MW in total with up to 94 turbines, each of which has a rated output of 3MW. The project is expected to supply 741,096 MWh of electricity to the South African Power Grid annually; being the equivalent annual operation time of 2,628 hours with a capacity factor 30 %.The project will substitute the equivalent number of MWh of the electricity supplied by the public electricity utility.
The anticipated starting date for construction and installation works under this project is the 1 January 2013 with commissioning expected for January 2015.

Almost 90%[1] South Africa's electricity is generated in coal-fired power stations, thus the project will reduce the greenhouse gas (GHG) emissions and in particular $CO_2$ emissions, associated with coal-dominated power generation in South Africa. The GHG emissions from wind based electricity generation are zero and thus the project will result in estimated annual GHG emission reductions of 719,604 tCO2e.

The baseline scenario is similar to that existing prior to the implementation of the project and assumes that electricity delivered to the SA Grid would have otherwise been generated by the operation of the grid-connect Eskom power plants and by the addition of new generation sources.

In addition to supplying renewable electricity to the power grid, the project will contribute to the sustainable development of the immediate local community and the host country as a whole. The contribution to the sustainable development of South Africa is further discussed below:

**Environmental well-being:**
The project developers have conducted an Environmental Impact Assessment (EIA) for the project in accordance with the National Environmental Management Act (NEMA; Act No. 107 of 1988). The project will have dual environmental benefits of reducing GHG emissions arising from coal-dominated power generation as well as the reducing air pollutions associated with coal-fired power plants such as sulphur dioxide, nitrogen oxides and particulates.

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[1] http://www.energy.gov.za/files/electricity_frame.html

**Social - economic well-being:**
The project contributes to national economic development by increasing the energy supply capacity in the country. Specifically, renewable energy has significant medium and long term commercial potential and can increasingly contribute toward a long term sustainable energy future in South Africa. The Department of Energy noted in its macroeconomic study developed as part of the Capacity Building in Energy Efficiency and Renewable Energy Project, that the achievement of the renewable energy target of 4% of total electricity demand as set out in the White Paper on Renewable Energy (2003) will increase GDP by up to R1 billion per year. With the expansion of this the renewable energy target to 42% - by 2030 - set out in the Integrated Resource Plan (2010), the contribution to GDP will be far greater.

The project will assist in the process of stimulating a green economy in which new domestic industries are created to supply renewable energy facilities and related requirements. This will result in significant green job creation. The project will foster job creation within the Northern Cape both in the construction and operations phases, which is a very important factor in an area of high unemployment. Materials and equipment will be sourced locally as far as possible.

In addition, the creation of 'green' energy within the context of a green economy creates the potential for positive social spin-off effects, greater access to the benefits of the country's natural resources and increased energy security.

## A.3. Project participants:

| **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 a project participant (Yes/No)** |
|---|---|---|
| Republic of South Africa | South African Renewable Green Energy (Pty) Ltd ("hereafter referred to as SARGE) | No |
| United Kingdom | Standard Bank Plc | No |

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

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

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

Republic of South Africa

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

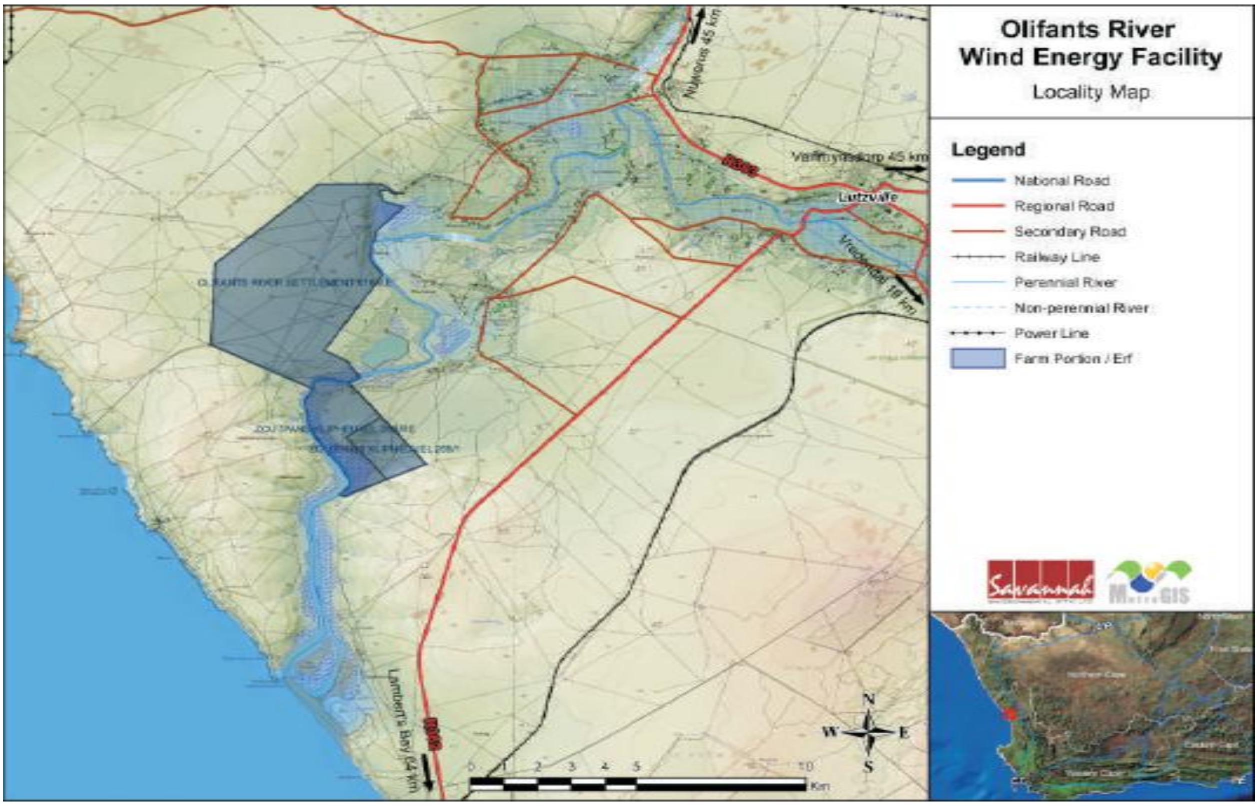
Western Cape Province

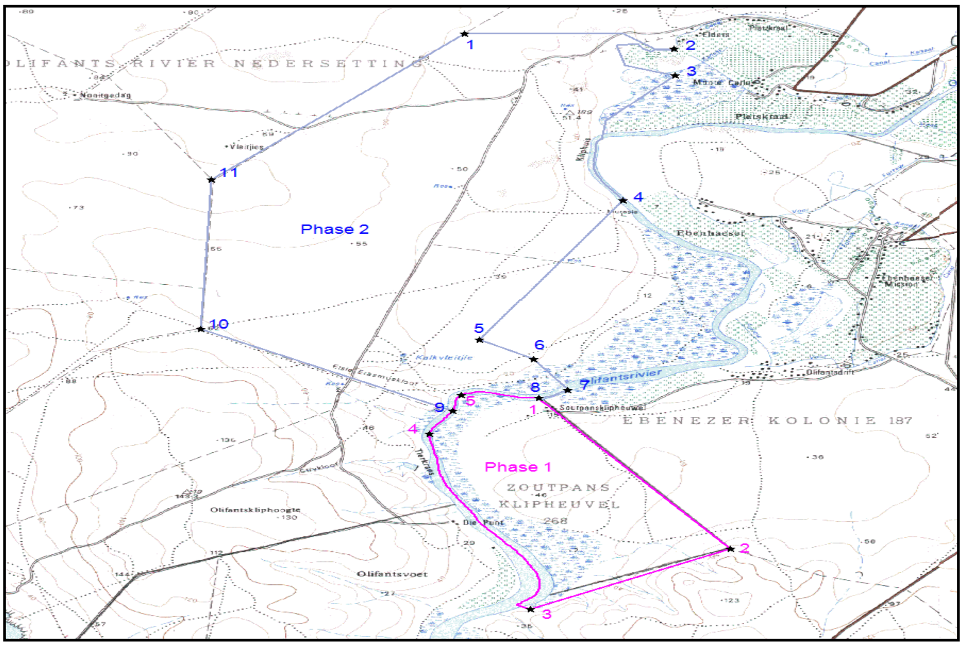
**A.4.1.3. City/Town/Community etc.:**

Town/ City: Olifantsrivier, (nearest major town is Lutzville)
Municipality: West Coast District Municipality

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

The project site located on the western coast of South Africa, approximately 6km from the coast and 250km north of Cape Town. The project site coordinates are 31°43'16.27" S, 23°11'38.55" E.


Olifants River
Wind Energy Facility
Locality Map
Legend
National Road
Regional Road
Secondary Road
Railway Line
Perennial River
Non-perennial River
Power Line
Farm Portion / Erf
Vanrhynsdorp 45 km
Lutzville
Nuwerus 45 km
Vredendal 18 km
Lambert's Bay 64 km
N
W
E
S
Km


Phase 2
Phase 1
1
2
3
4
5
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10
11
ZOUTPANS
KLIPHEUVEL
268
EBENEZER KOLONIE 187
Olifantsrivier
Olifantsvoet
Olifantskliphoogte

Figure A-1 The location of the project (A: South Africa, B: locality map of the project)

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

Project falls into Sectoral Scope 1: *Energy industries (renewable/non-renewable)*

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

The primary objective of the project is to generate electricity from wind, a renewable energy source, and to provide power to the South African National Electricity Grid. The project is a Greenfield power plant utilising an environmentally safe technology, which will include technology transfer to the Host Party.

The proposed facility will have a generating capacity of 280MW and will comprise the following infrastructure. This is presently indicative and will be finalised following completion of the wind assessment and full feasibility study.

| 109 wind turbines – Phase 2: Vestas V112-3.0 MW | | | |
|---|---|---|---|
| Item | Unit | Index | Data Source |
| Rated capacity | kW | 3,000 | http://www.vestas.com/en/wind-power-plants/procurement/turbine-overview/v112-3.0-mw.aspx#/vestas-univers |
| Rotor diameter | m | 112 | As above |
| Swept area | $m^2$ | 9,852 | As above |
| Rotational speed | rpm | 12.8 | As above |
| Rated frequency | HZ | 50Hz/ 60Hz | As above |
| Cut-in wind speed | m/s | 3 | As above |
| Rated wind speed | m/s | 12 | As above |
| Cut-out wind speed | m/s | 25 | As above |

| Main transformer: New substation | | | |
|---|---|---|---|
| Item | Unit | Index | Data Source |
| Rated Capacity under high voltage | kVA | tbc | REVIEW OF PROPOSED WIND FARM GRID CONNECTION STRATEGIES 25 May 2011 |
| Rated voltage | kV | 400kV | REVIEW OF PROPOSED WIND FARM |

| | | | |
|---|---|---|---|
| | | | GRID CONNECTION STRATEGIES 25 May 2011 |

- Up to 94 turbines with a generating capacity of up to 280MW (turbine footprints covering an area of 3.37 ha).
- No commitment to any turbine has thus been made, there are however several suppliers under consideration.
- Each turbine will be a steel tower – between 80m and 125m in height, a nacelle (gear box) and three rotor blades with a rotor diameter of between 90m and 100m (ie, each blade ranging from 45m to 55m in length)

The project adopts turbine-transformer units and all transformers will be linked to the plant substation. Grid connection will be via onsite 66kV line through to the upgraded Juno substation at Vredendal.

***Monitoring equipment***

Electricity delivered to the South African power grid by the project activity will be monitored with electricity meters installed at the Substation.

***Scenario existing prior to the project activity and baseline scenario***

The baseline scenario is similar to that existing prior to the implementation of the project and assumes that electricity delivered to the SA Grid would have otherwise been generated by the operation of the grid-connect Eskom power plants and by the addition of new generation sources.

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

The crediting period chosen for the project is a 10 year fixed crediting period. The annual emissions reductions of the project are estimated to be on average 719,604 tonnes of $CO_2$e per year over the crediting period. The total emissions reductions of the project will be 7,196,042 tonnes of $CO_2$e.

| Year | Annual Estimation of Emission Reductions in tonnes of $CO_2$e |
|---|---|
| 2015 | 719,604 |
| 2016 | 719,604 |
| 2017 | 719,604 |
| 2018 | 719,604 |
| 2019 | 719,604 |

| | |
|---|---|
| 2020 | 719,604 |
| 2021 | 719,604 |
| 2022 | 719,604 |
| 2023 | 719,604 |
| 2024 | 719,604 |
| **Total** | **7,196,042** |
| **Total number of crediting years** | **10** |
| **Annual average over crediting period** | **719,604** |

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

No public funds from Annex I countries is involved in the proposed project.

## 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 Version 12.1.0, the approved consolidated and monitoring methodology: **“Consolidated baseline technology for grid-connected electricity generation from renewable sources”**
http://cdm.unfccc.int/methodologies/DB/C505BVV9P8VSNNV3LTK1BP3OR24Y5L

Version 0.03.0 “**Combined tool to identify the baseline scenario and demonstrate additionality**”
http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v3.0.1.pdf

Version 05.2 **“Tool for the demonstration and assessment of additionality”**;
http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v5.2.pdf

Version 02.2.0 **“Tool to calculate the emission factor for an electricity system”;**
http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.pdf

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

The project meets all the qualifying criteria for ACM0002 applicability as follows:

| **Applicability of ACM0012** | **Justification on the applicability of ACM0002 to the project** |
|---|---|
| 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; | The project activity is the installation wind power plant with the total capacity of 280 MW. |
| In the case of capacity additions, retrofits or replacements (except for wind, solar, wave or tidal power capacity addition projects which use Option 2: on page 11 to calculate the parameter EGPJ,y): 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 expansion or retrofit of the plant has been undertaken between the start of this minimum historical reference period and the implementation of the project activity; | The project is a Greenfield plant. |
| In case of hydro power plants, one of the following conditions must apply: | The project is not a hydro power plant. |

| | |
|---|---|
| • The project activity is implemented in an existing reservoir, with no change in the volume of reservoir; or<br><br>• The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the Project Emissions section, is greater than 4 W/m2; or<br><br>• The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the Project Emissions section, is greater than 4 W/m2 | |

The methodology is not applicable to the following:

| | |
|---|---|
| Project activities that 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; | The project is a new build wind power project and does not involve switching from fossil fuels to renewable energy. |
| Biomass fired power plants; | The project is not a biomass fired power plant. |
| Hydro power plants that result in new reservoirs or in the increase in existing reservoirs where the power density of the power plant is less than 4 W/m2 . | The project is not a hydro power plant. |

The project is a Greenfield plant were no renewable power plant or fossil fuel power plant was operated prior to the implementation of the project activity at the project site. As such the project meets the applicability criteria of ACM0002 as described above.

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

As per ACM0002 and the tool, the spatial extent of the project boundary includes the project site and all the power plants connected physically to the electricity system. The project boundary includes the project power plant and all power plants physically connected to the SA Grid.

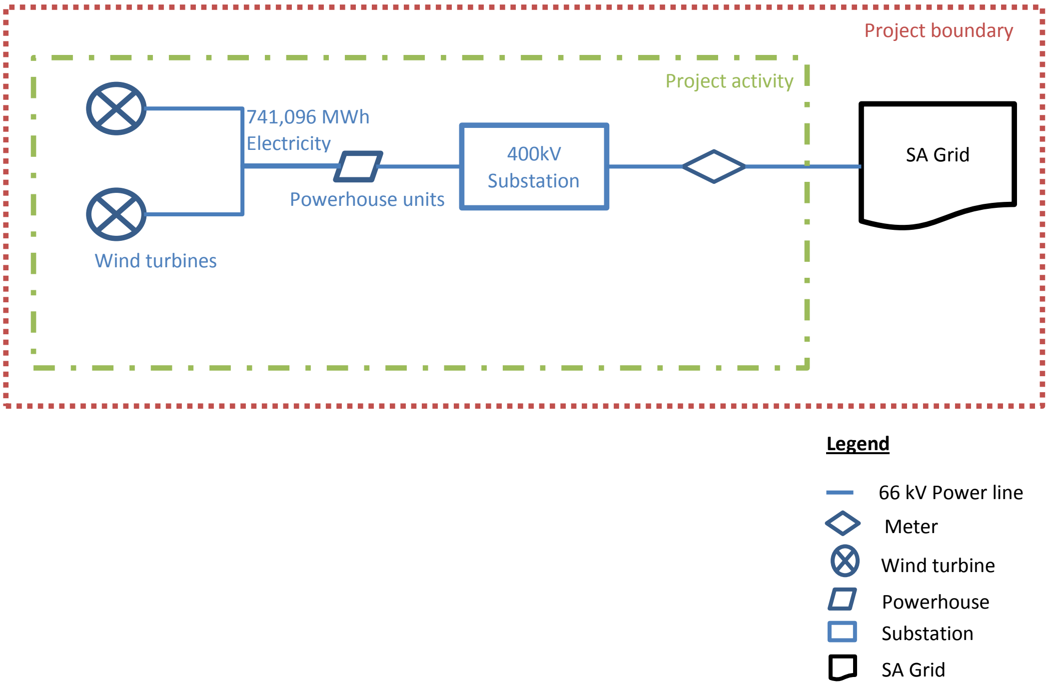


Figure B.3-1: Project process flow diagram delineating the project activity and project boundary

As per ACM0002 and For the purpose of calculating the project emissions and baselines emission sources and gases which are include in the project boundary are listed in the table B-1.

**Table B-1 The emission source and the category of GHG**

| | Source | Gas | Included? | Justification / Explanation |
|---|---|---|---|---|
| Baseline | $CO_2$ emissions from electricity generation n fossil fuel fired power plants that are displaced due to the project activity | $CO_2$ | Yes | Main emission source. |
| | | $CH_4$ | No | According to ACM0002 Version 12.1.0, this is excluded |
| | | $N_2O$ | No | According to ACM0002 Version 12.1.0, this is excluded. |
| Project Activity | The project | $CO_2$ | No | According to ACM0002 Version 12.1.0, project emission is excluded as a wind project |
| | | $CH_4$ | No | According to ACM0002 Version 12.1.0, project emission is excluded as a wind project |
| | | $N_2O$ | No | According to ACM0002 Version 12.1.0, project emission is excluded as a wind project |

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

According to the methodology ACM0002, if the project activity is the installation of new grid-connect renewable power plant/unit, the baseline scenario is the following:

Electricity delivered to the grid by the project activity would have otherwise been generated by the operation of the grid-connected plants and by the addition of new generation sources, as reflected in the combined margin (CM) calculations described in B.6.

The electricity generated from the project is delivered to the national grid, thus the baseline scenario is equivalent to the electricity service that would have been provided by the national grid.

**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):**

**Prior consideration of CDM before the construction of the project**

Table B.5-1 gives an indication of the project implementation and demonstrates that the potential for additional revenue through the sale of CERs was crucial from the beginning for deciding to proceed with the project.

**Table B.5-1 Overview of key events in the development of the project**

| Time | Activities |
|---|---|
| **19 Mar 2008** | SARGE releases proposal for investor participation in Wind Power Projects with reference to the need for carbon credit income |
| **26 July 2010** | Wind Prospect completes study on wind mast locations and specification |
| **1 Feb 2011** | SARGE Board Resolution to negotiate purchase of CERs with Standard Bank |
| **7 June 2011** | Execution of Carbon LOI and Term Sheet with Standard Bank |
| **23 July 2011** | SARGE and Standard Bank signed ERPA |
| **30 Aug 2011** | Prior Consideration submitted to UNFCCC and DNA |
| **Oct 2011** | EIA Background Document released |
| **14 Oct 2011** | SARGE Board Meeting to agree on investment decision to proceed with the project investment and the carbon finance component |
| **Aug 2012** | Submission of tender under the Renewable Energy IPP Procurement Programme |
| **Dec 2012** | Expected financial closure |
| **Mar 2013** | Expected date for purchasing turbines |
| **Jan 2015** | Estimated date for the start of the power production |

The events above demonstrate that access to carbon finance was a key determining factor to proceed with the proposed activity

The additionality of the project is demonstrated and assessed by using the '***Tool for the Demonstration and Assessment of Additionality'*** version 05.2. This tool provides for the following step-wise approach:

**Step 1:** Identification of the alternatives to the project activi5ty consistent with current laws and regulations
**Step 2:** Investment analysis (optional)
**Step 3:** Barrier analysis (optional)
**Step 4:** Common practice analysis

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

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

Realistic and credible alternatives available to the project that provide outputs or services comparable to the project activity include:

*Alternative 1:* The project itself not undertaken as a CDM project activity

*Alternative 2:* Construction of a coal/fossil fuel-fired power plant with the same annual electricity generation as the proposed project

*Alternative 3:* Construction of a power plant using other renewable sources with equivalent electricity service.

*Alternative 4:* Equivalent electricity service provided by the National Grid, a continuation of the current situation.

When considered the project outcomes, the alternatives are as follows:

*Alternative 1: The project itself not undertaken as a CDM project activity*

Alternative 1 has been excluded as realistic and credible for the following reason:

- This alternative envisages the construction and operation of a grid wind farm with an installed capacity of 330MW. The electricity produced would be supplied to the Eskom electricity network.
- The investment expenditure for a large scale wind farm project is very high and return on equity is very low. To date there are no large scale wind farms in South Africa. Two relatively new small pilot wind power projects are currently in operation: the Klipheuwel and Darling projects both in the Western Cape Province.

Thus the proposed project is not a credible alternative without being registered as a CDM project activity. This is further substantiated in the investment analysis below.

*Alternative 2: Construction of a coal/fossil fuel-fired power plant with the same annual electricity generation as the proposed project*

Alternative 2 has been excluded as realist and credible for the following reasons:

- Coal as a potential fuel for the plant: South Africa has significant coal reserves however these are concentrated in the north-eastern parts of the country thus the majority of South Africa's coal fired power stations are located here. The Northern Cape has no known coal deposits and transportation of coal from the Mpumulanga to the plant site to generate the equivalent amount of electricity would be prohibitively expensive and ultimately impractical.
- Natural gas as a potential fuel for the plant: There are currently no gas pipelines in the Northern Cape. Sasol, the largest supplier of natural gas in South Africa currently only has pipelines in Gauteng, KwaZulu-Natal and Mozambique[2]
- Other potential fossil fuels – diesel and heavy fuel oil: Fuel costs and transportation costs of the volumes required to generate the same amount of electricity as the plant are prohibitively expensive.

Thus Alternative 2 is not a credible alternative to the project activity.

*Alternative 3: Construction of a power plant using other renewable sources with equivalent electricity service.*

Alternative 3 has been excluded as realist and credible for the following reasons:

- Biomass: Biomass volumes are not sufficient to meet the fuel requirements of renewable energy power plant capable of generating an equivalent amount of electricity as the project. The project is located in one of the driest and arid parts of the country with very low productivity levels[3 and 4]
- Hydro: There is very little potential to generate hydroelectricity in the region. TheVanderkloof Dam occurs within the eastern extent of the Northern Cape, but it is over 500km away from the project site. The project site is in the most arid province in South Africa.
- Solar PV: Solar PV is a potential technology that can be used at this site, however site conditions and topography are such that solar PV cannot generate an equivalent amount of electricity as the project.

*Alternative 4: Equivalent electricity service provided by the National Grid, a continuation of the current situation.*

Electricity delivered to the grid by the wind power plant would have otherwise been generated by the operation of grid-connected Eskom's power plants and by the addition of new generation sources.
This alternative is a business as usual scenario corresponded to the baseline scenario.

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[2] Sasol Pipeline Map available from:
http://www.sasol.com/sasol_internet/frontend/navigation.jsp;jsessionid=AXWRCXF1TBRGXG5N4EZSFEQ?navid=15700002&rootid=600000 (accessed 28 August 2011)

[33] http://www.environment.gov.za/enviro-info/nat/rain.htm

[4] http://www.environment.gov.za/enviro-info/nat/bioprod.htm

**Outcome of sub-step 1a:**

In conclusion, realistic and credible alternatives to the project that provide outputs or services equivalent to those of the project activity include:

*Alternative 3:* Construction of a power plant using other renewable sources with equivalent electricity service

*Alternative 4:* Equivalent electricity service provided by the National Grid, a continuation of the current situation.

Both Alternative 3 and 4 are carried to Sub-step 1b

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

South Africa has two acts that direct the planning and development of the country's electricity sector:

i. The National Energy Act of 2008 (No. 34 of 2008)

ii. The Electricity Regulation Act (ERA) of 2006 (No. 4 of 2006).

Both alternatives are in compliance with mandatory legislation and regulations.

Additional laws and regulations relevant to the project include:

- Generation License issued by NERSA under the Electricity Regulation Act 2006;
- The South African Grid Code and South African Distribution/Transmission Grid Code regarding planning information, operational information and post-dispatch information;
- National Environmental Management: Protected Areas Act 57 0f 2003;
- National Water Act (Act No. 36 of 1998);
- National Environmental Management: Biodiversity Act (Act No. 10 of 2004);
- National Heritage Resources Act ( Act No. 25 of 1999);
- Aviation Act (Act No. 74 of 1962);
- Occupational Health and Safety Act (Act No. 85 of 1993);
- Noise Control Regulations, Environment Conservation Act (Act No. 73 of 1989).

**Step 2: Investment Analysis**

The purpose of this step is to determine whether the project activity is not:

a) The most economically feasible or financially attractive; or
b) Economically or finically feasible without the revenue from the sale of Certified Emission Reductions (CERs).

The investment analysis is composed of four steps:

- Sub-step 2a: Determine appropriate analysis method
- Sub-step 2b: Apply simple cost analysis (Option I), investment comparison analysis (Option II) or bench analysis (Option III)
- Sub-step 2c: Calculation and comparison of financial indicators (only applicable to Options II and III)
- Sub-step 2d: Sensitivity analysis (only applicable to Option II and III)

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

The tool provides for three potential methods that can be used to complete the investment analysis:

i. *Simple cost analysis:* A simple cost analysis can only be used if the project does not generate financial or economics benefits other than CDM related income.

The project will generate additional revenue from the sale of electricity and as such the simple cost analysis method cannot be used.

ii. Investment comparison analysis: Paragraph 19 of the "Guidelines on the assessment of investment analysis" (Version05)[5] states: *"If the alternative to the project activity is the supply of electricity from a grid this is not to be considered an investment and a benchmark approach is considered appropriate".*

In line with the abovementioned Guidelines, an investment comparison is not appropriate analysis method.

iii. *Benchmark analysis:* The guidelines further state (Paragraph 19) "*The benchmark approach is therefore suited to circumstances where the baseline does not require investment or is outside the direct control of the project developer, i.e. cases where the choice of the developer is to invest or not to invest".*

The benchmark analysis option was chosen as it matches the project best.

**Sub-step 2b Determine appropriate analysis method (Option III)**

The Internal Rate of Return (IRR) was used as the financial indicator for the project. The equity IRR was used to determine the project viability. In order to assess whether the project is economically feasible, the equity IRR was compared to a benchmark IRR.

The benchmark IRR chosen for the project is the 'Real Return on Equity ROE After Tax' as prescribed in the NERSA Consultation Paper, Review of the Feed-In Tariffs, March 2011 (Table 4: REFIT Financial Assumptions). This figure for 2011 is 17%.[6]

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[5] http://cdm.unfccc.int/Reference/Guidclarif/reg/reg_guid03.pdf

[6] http://www.nersa.org.za/Admin/Document/Editor/file/Electricity/Consultation/Documents/Review%20of%20Renewable%20Energy%20Feed-In%20Tariffs%20Consultation%20Paper.pdf

Therefore, a 17% benchmark for the equity IRR is assumed for wind projects in South Africa.

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

The project developers are planning on accessing the Renewable Energy Independent Power Producer (IPP) Programme under which under which South Africa will seek to procure the first 3,725 MW of capacity by 2016. Participation in the (IPP) Programme will based on a competitive tender process, where 70% of the selection criterion is weighted towards pricing. The IPP Procurement Programme was initiated to fulfil the renewable quota that the Minister of Energy determined. 3,725 MW of electricity was to be generated from renewable energy, in line with the Electricity Regulation Act. The formal invitation to bidders to submit their detailed Bid Responses for the supply of energy to Eskom was released on 3rd August 3011 through the Request for Qualification. ,

Prices per technology have been capped at levels below those promulgated in the 2009 Renewable Energy Feed-in Tariff (REFIT) approved by the National Energy Regulator of South Africa. Wind projects have been capped at 115c/kWh; thus the maximum income that can gained from the sale of electricity would be no greater than 115c/kWh.

The project developer's bid price to participate in the (IPP) Programme was used to calculate the equity IRR.

The information used in the investment analysis is presented in Table B.5-2

**Table B.5-2 Input data to calculate the project IRR**

| Parameter | Value | Unit | Source |
|---|---|---|---|
| Capital cost of plant | 4,994 | Million ZAR | Subject to change |
| Annual operating and maintenance costs | 185 | Million ZAR/year | Based on operating and maintenance schedule |
| Average annual electricity production | 741,096 | MWh/year | Calculated from wind data collected on site |
| Electricity price | 1,150 | ZAR/MWh | Renewable Energy IPP Procurement Programme (price cap for wind) |
| Inflation rate | 3 | % | http://www.resbank.co.za/MonetaryPolicy/DecisionMaking/Pages/InflationMeasures.aspx (low end of band) |
| Corporate tax rate | 28 | % | www.sars.gov.za/Tools/Documents/DocumentDownload.asp?FileID=42846 |

Table B.5-3 shows the equity IRR (after tax) with and without the income from CERs revenue. Without the CER revenue, the equity IRR is 8.21%, which is below the financial benchmark. Therefore the project is not financially acceptable. Taking into account the CER revenue, the equity IRR increases to 10.51%, which is closer to the financial benchmark.

**Table B.5-3 Comparison of IRR with and without CER revenue**

| Item | Without CDM | Benchmark | With CDM |
|---|---|---|---|
| IRR | 8.21% | 17% | 10.51% |

Outcome of Sub-step 2c:

The proposed project activity is not economically or financially feasible without the revenue from the sale of CERs.

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

A sensitivity analysis was conducted to show that the conclusion regarding the financial attractiveness is sufficiently robust to reasonable variations in the critical assumptions. The investment analysis provides a valid argument in favour of additionality as this analysis consistently supports the conclusion that the project activity is unlikely to be economically or financially attractive.

The sensitivity analysis should at least cover the range of +10% and – 10%. This project sensitivity analysis was done using this range.

The following variables were included in the sensitivity analysis:

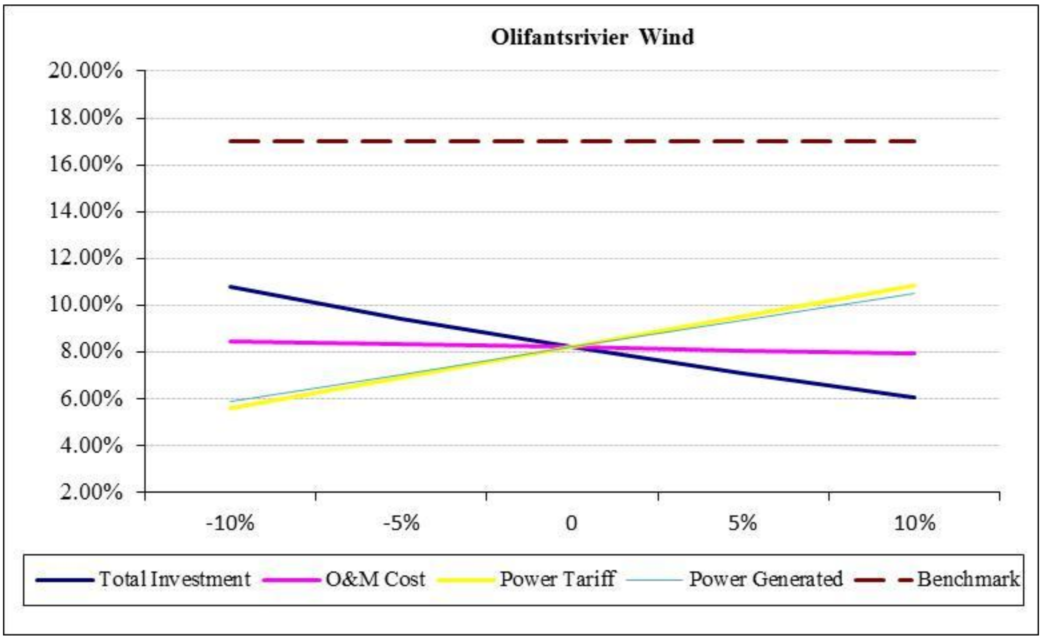
- Investment cost
- Operations and Maintenance (O&M) costs
- Power Tariff
- Power Generated

The results of the sensitivity are shown in Table B.5-4 and Figure B 5.1.

**Table B.5-4 Results of the sensitivity analysis**

| **Variable** | **-10%** | **-5%** | **0%** | **5%** | **10%** |
|---|---|---|---|---|---|
| Total Investment | 10.82% | 9.44% | 8.21% | 7.09% | 6.07% |
| O&M Cost | 8.44% | 8.32% | 8.21% | 8.09% | 7.98% |
| Power Tariff | 5.60% | 6.90% | 8.21% | 9.52% | 10.84% |
| Power Generated | 5.89% | 7.05% | 8.21% | 9.37% | 10.53% |
| Benchmark | 17% | 17% | 17% | 17% | 17% |

**Figure B.5-1 Results of the sensitivity analysis**




It can be observed that despite considerable variation in the key assumptions, the equity IRR remains below the benchmark the benchmark.

**Outcome 2d: Sensitivity analysis**

The proposed CDM project activity is unlikely to be financially or economically attractive without the revenue from the sale of CERs.

Table 5-5 shows the required variation of the materially significant financial parameters to make the equity IRR reach 17%

**Table B.5-5 Variation of financial parameters to make the project IRR reaching 17%**

| | |
|---|---|
| Total Investment | -27% |
| Power Tariff | +33% |
| Power Generated | +37% |

Table B.5-5 shows, in any single condition if the total investment decreases by 27%, the power tariff increases by 33%, or the power generated increases by 37%, the equity IRR of the project will reach the benchmark. However, these variations do not reflect a realistic range for the input parameters used in the financial analysis.

**Step 3: Barrier analysis**

The Barrier analysis is not applied.

**Step 4: Common practice analysis**

**Sub-step 4a: Analyze other activities similar to the proposed project activity:**
There are currently only two operational wind power plants in South Africa: the Darling and Klipheuwel farms:

i. The Klipheuwel wind farm is a government-owned wind facility intended as a demonstration project[7]. It has a total capacity of 3.2MW. The facility is not a commercial wind farm.

ii. The Darling Wind is a national demonstration wind facility with a capacity of 1.3MW. The Darling wind facility is the 1st grid connected, independent wind energy power-generating facility developed in South Africa. Its development has received financial assistance from the Danish government, Development Bank of Southern Africa, the Central energy Fund and the Darling Independent Power Producer forming a public-private partnership[8] .

The project activity differs significantly from the abovementioned projects in the following way:

- The project is a commercial wind facility
- The project is privately-owned with no public funding
- The project is far larger in scale than the abovementioned demonstration projects installing up to 150 turbines in comparison to 3 (Klipheuwel) and 4 (Darling) wind turbines

**Sub-step 4b: Discuss any similar Options that are occurring:**
In line with version 6.0.0 of the '***Tool for the Demonstration and Assessment of Additionality***', the following steps have been carried out in order to evaluate any similar options that are occurring:

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

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 activities undergoing validation shall not be included in this step;

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 $N_{diff}$ .

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.

*Step 1:* The applicable output range of the project activity is 140MW (-50%) to 420MW (+50%).

---

[7] http://www.energy.gov.za/files/esources/renewables/r_wind.html

[8] http://www.energy.gov.za/files/esources/renewables/r_wind.html

*Step 2:* As can be seen in Sub-step 4a above, there are currently no plants that deliver the same output or capacity in the applicable geographic area within the applicable output range calculated in Step 1. Therefore, $N_{all}$. = 0.

*Step 3:* Since, as identified in Sub-step 4a above, the only two plants in the applicable geographic area are Klipheuwel (with an installed capacity of 3.2MW) and Darling (with an installed capacity of 1.3MW) have different installed capacities, $N_{diff} = 2$.

Step 4: The factor is calculated as:

$F = 1\text{-}N_{diff} / N_{all}$

Where:

$N_{diff} = 2$;
$N_{all} = 0$

Thus, F = 1-2/0; = -1, which is less than 0.2. Also, Nall – Ndiff = 0 – 2 = -2, which is less than 3. As such, the project activity is not common practice and satisfies Sub-step 4a and Sub-step 4b.

**B.6. Emission Reductions:**

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

Methodology *ACM0002* equations are applied to calculate GHG Emission Reduction achieved by the Project in the following four steps:

1. Calculate the project GHG emissions;
2. Calculate the baseline GHG emissions;
3. Calculate the project leakage;
4. Calculate the emission reductions.

**1. Calculation of the project GHG emissions**

The project is a wind power plant project that does not consume fossil fuels. Therefore the project emissions should not be considered as per ACM0002:

$\mathbf{PE_y = 0\ tCO_2e.}$ (Equation 1)

**2. Calculation of the baseline GHG emissions**

Baseline emissions are the $CO_2$ emissions from electricity generation in fossil fuel-fired power plants that is displaced in the grid due to the project activity. The methodology assumes that all project electricity generation above baseline levels would have been generated by existing grid-connected power plants and the addition of new grid-connected power plants. The baseline emissions are therefore to be calculated as follows:

**$BE_y = EG_{pj,y}$ x $EF_{grid.CM.y}$** (Equation 2)

Where:

| | | |
|---|---|---|
| $BE_y$ | Baseline emissions in year y | $tCO_2$/yr |
| $EG_{pj,y}$ | 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/yr |
| $EF_{grid,CM,y}$ | 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 |

**Calculation of Electricity Generated ($EG_{pj,y}$)**

The calculation of $EG_{pj,y}$ is different for (a) greenfield plants, (b) retrofits and replacements, and (c) capacity additions. As the project activity is the 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, option (a) was chosen:

**$EG_{pj,y} = EG_{facility,y}$** (Equation 3)

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

**Calculation of Grid Emission Factor ($EF_{grid,CM,y}$)**

The baseline $CO_2$ emission factor of the grid ($EF_{grid,CM,y}$) is calculated as per the "*Tool to calculate the emission factor for an electricity system*":

- **Step 1**: Identify the relevant electric power system

The solar PV power plant will be connected to the South African national power grid. Eskom is responsible for the generation of 95% of the total electricity supplied to the South African power grid. The remaining 5% is attributed to private of municipal power generation. The simple conservative approach is to exclude the 5%, thereby assuming lower efficiencies and higher GHG emissions in the smaller older power generation plant.

The generation and consumption of Eskom's regional transmission grids are interlinked and there is no distinction between provincial and sectoral generation and consumption. The entire South African grid is viewed as a homogenous mix of electricity, even though supplied by different generators.

- **Step 2**: Choose whether to include off-grid power plants in the project activity system (optional)

According to the "*Tool to calculate the emission factor for an electricity system*", there are 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.

Option I will be used therefore only grid connected power plants in South Africa will be included in the grid emission factor calculations.

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

According to the "*Tool to calculate the emission factor for an electricity system*", 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

As per the "*Tool to calculate the emission factor for an electricity system*", the Simple OM method can be selected when low-cost / must-run resources constitute less than 50% of total grid generation. Given that the South African power grid has no wind, solar or geothermal power generation, and other low-cost/must-run resources such as hydro, nuclear contribute negligibly to the grid (5%), the Simple OM method can be used.

The Simple OM method was selected due to the fact that the data available from the Eskom included fuel consumption and net electricity generation of each power plant/unit which is best suited for this method. As per the "*Tool to calculate the emission factor for an electricity system*", for the simple OM the emissions factor can be calculated using either of the two following data vintages:

- *Ex ante* option: If the ex-ante option is chosen, the emission factor is determined once at the validation stage, thus no monitoring and recalculation of the emissions factor during the crediting period is required. For grid power plants, use a 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation. For off-grid power plants, use a single calendar year within the 5 most recent calendar years prior to the time of submission of the CDM-PDD for validation.

- *Ex post* option: If the ex post option is chosen, the emission factor is determined for the year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring. If the data required to calculate the emission factor for year y is usually only available later than six months after the end of year y, alternatively the emission factor of the previous year y-1 may be used. If the data is usually only available 18 months after the end of year y, the emission factor of the year preceding the previous year y-2 shall be used.

As per the Eskom website, the latest available data for fuel consumption and electricity generation is between 2007/2008 – 2009/2010 allowing for a 3-year average to be determined. The Simple OM was calculated *ex ante* and will be determined at the validation stage for the entire crediting period.

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

According to the "*Tool to calculate the emission factor for an electricity system*", there are two options to calculate the simple OM emission:

- **Option A:** Based on the net electricity generation and a CO2 emission factor of each power unit
- **Option B:** Based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system.

Option A was selected, based on available data on the net electricity generation and a $CO_2$ emission factor of each Eskom's power plants is available. The simple OM emission factor was calculated as a generation-weighted average of carbon dioxide emissions per unit net electricity generation ($tCO_2/MWh$) of all electricity generating power plants serving the South African power grid, not including low-cost/must-run power plants/units.

Therefore, the simple OM is calculated as follows:

$$EF_{grid,OMsimple,y} = \frac{\sum_{m} EG_{m,y} \times EF_{EL,m,y}}{\sum_{m} EG_{m,y}}$$

(Equation 4)

Where**:**

| | | |
|---|---|---|
| $EF_{grid, simple OM, y}$ | Simple operating margin $CO_2$ emission factor in year y | $tCO_2/MWh$ |
| $FC_{i,y}$ | amount of fuel type i consumed in the project electricity system in year y | m |
| $NVC_{i,y}$ | net calorific value (energy content) of fuel type i in year y | GJ/ mass or volume |
| $EF_{CO2. i. y}$ | CO2 emission factor of fuel type i in year y | $tCO_2/GJ$ |
| $EG_{m, y}$ | Net electricity generated and delivered to the grid by power plant unit m in year y | MWh |
| m | All power plants/units serving the grid in year y except low-cost/must-run power plants/units | |
| I | All fossil fuel types combusted in power plant/unit m in year y | |
| y | The relevant year as per the data vintage chosen in Step 3 | |

The emission factor of each power unit *m* should be determined as follows:

- **Option A1:** If for a power unit *m* data on fuel consumption and electricity generation is available
- **Option A2:** If for a power unit *m* only data on electricity generation and the fuel types used is available
- **Option A3:** If for a power unit *m* only data on electricity generation is available

Due to the fact that both fuel consumption and electricity generation data are available, Option A1 is selected and the emission factor of each power unit *m* is calculated as follows:

$$EF_{EL,m,y} = \frac{\sum_{i} FC_{i,m,y} \times NCV_{i,y} \times EF_{CO2,i,y}}{EG_{m,y}}$$

(Equation 5)

Where**:**

| | | |
|---|---|---|
| $FE_{EL,m,y}$ | Simple operating margin $CO_2$ emission factor in year y | $tCO_2/MWh$ |
| $FC_{i,m,y}$ | amount of fossil fuel type i consumed by power unit m in year y | M |
| $NCV_{i,y}$ | net calorific value (energy content) of fuel type i in year y | GJ/ mass or volume |
| $EF_{CO2.i.y}$ | CO2 emission factor of fuel type i in year y | $tCO_2/GJ$ |
| $EG_{m,y}$ | Net electricity generated and delivered to the grid by power plant unit m in year y | MWh |
| M | All power plants/units serving the grid in year y except low-cost/must-run power plants/units | |
| I | All fossil fuel types combusted in power plant/unit m in year y | |
| y | The relevant year as per the data vintage chosen in Step 3 | |

- **Step 5:** Calculate the build margin emission factor

According to the "*Tool to calculate the emission factor for an electricity system*", there are two options regarding data vintage:

- **Option 1:** For the first crediting period, calculate the build margin emission factor *ex ante* based on the most recent information available on units already built for sample group *m* at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the

DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

- **Option 2:** For the first crediting period, the build margin emission factor shall be updated annually, *ex post*, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emissions factor shall be calculated *ex ante*, as described in Option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.

Option (1) was selected regarding vintage of data, and therefore the build margin emission factor shall be calculated *ex ante* based on the most recent information available on units already built for sample group *m* at the time of CDM-PDD submission to the DOE for validation. The built margin will be updated after the first crediting period.
According to the "*Tool to calculate the emission factor for an electricity system*", the sample group of power units *m* used to calculate the build margin shall be determined as per the following procedure, consistent with the data vintage selected above:

- **(a) -** Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently ($SET_{5\text{-units}}$) and determine their annual electricity generation ($AEG_{SET\text{-}5\text{-units}}$, in MWh);
- **(b) -** Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities ($AEG_{total}$, in MWh). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of $AEG_{total}$ (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) ($SET_{\geq 20\%}$) and determine their annual electricity generation ($AEG_{SET\text{-}\geq 20\%}$, in MWh);
- **(c) -** From $SET_{5\text{-units}}$ and $SET_{\geq 20\%}$ select the set of power units that comprises the larger annual electricity generation ($SET_{sample}$); Identify the date when the power units in $SET_{sample}$ started to supply electricity to the grid. If none of the power units in $SET_{sample}$ started to supply electricity to the grid more than 10 years ago, then use $SET_{sample}$ to calculate the build margin. Ignore steps (d), (e) and (f).

Otherwise:

- **(d)** Exclude from $SET_{sample}$ the power units which started to supply electricity to the grid more than 10 years ago. Include in that set the power units registered as CDM project activity, starting with power units that started to supply electricity to the grid most recently, until the electricity generation of the new set comprises 20% of the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) to the extent is possible. Determine for the resulting set ($SET_{sample\text{-}CDM}$) the annual electricity generation ($AEG_{SET\text{-}sample\text{-}CDM}$, in MWh); If the annual electricity generation of that set is comprises at least 20% of the annual electricity generation of the project electricity system (i.e. $AEG_{SET\text{-}sample\text{-}CDM} \geq 0.2 \times AEG_{total}$), then use the sample group $SET_{sample\text{-}CDM}$ to calculate the build margin. Ignore steps (e) and (f).

Otherwise:

- **(e)** Include in the sample group $SET_{sample\text{-}CDM}$ the power units that started to supply electricity to the grid more than 10 years ago until the electricity generation of the new set comprises 20% of the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation);

- **(f)** The sample group of power units m used to calculate the build margin is the resulting set ($SET_{sample\text{-}CDM\text{->}10yrs}$).

The power plants/units in $SET_{sample\text{-}CDM\text{->}10yrs}$ were used to calculate the build margin.

The build margin is the generation-weighted average emission factor of all power units *m* during the most recent year *y* of which power generation data is available, calculated as follows:

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

(Equation 6)

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 power generation data is available | -- |

The $CO_2$ emission factor of each power unit *m* ($EF_{EL,\,m,\,y}$) shall be determined as per the guidance in step 4 (a) of the "*Tool to calculate the emission factor an electricity system*" for the simple OM, using options A1, A2 or A3, using for *y* the most recent historical year for which power generation data is available, and using for *m* the power units included in the build margin. The power units included in the built margin m correspond to the sample group SET $_{sample\text{-}CDM\text{-}>10\ years}$, as a conservative approach only Option A2 from Step 4 can be used to calculate $EF_{EL,\,m,\,y}$ and is determined as follows:

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} \times 3.6}{\eta_{m,y}}$$

(Equation 7)

| | | |
|---|---|---|
| $FE_{EL,\,m,\,y}$ | Simple operating margin $CO_2$ emission factor in year y | $tCO_2$/MWh |

| | | |
|---|---|---|
| $EF_{CO2. i. y}$ | CO2 emission factor of fuel type i in year y | $tCO_2/GJ$ |
| $ή_{m, y}$ | Average net energy conversion efficiency of power unit m in year y (ratio) | MWh |
| M | All power plants/units serving the grid in year y except low-cost/must-run power plants/units | |
| y | The relevant year as per the data vintage chosen in Step 3 | |

- **Step 6.** Calculate the combined margin emissions factor

According to the "*Tool to calculate the emission factor for an electricity system*", the combined margin is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$$ (Equation 8)

Where:

| | | |
|---|---|---|
| $EF_{grid, CM, y}$ | Combined margin CO2emission factor in year *y* | $tCO_2/MWh$ |
| $EF_{grid, OM, y}$ | Operating margin CO2emission factor in year *y* | $tCO_2/MWh$ |
| $EF_{grid, BM, y}$ | Build margin $CO_2$emission factor in year y | $tCO_2/MWh$ |
| $W_{OM}$ | Weight of operating margin emissions factor | % |
| $W_{BM}$ | Weight of build margin emissions factor | % |

In accordance with the "*Tool to calculate the emission factor for an electricity system*", for the first crediting period of wind and solar power generation project activities:

$W_{OM}$ = 0.75 and $W_{BM}$ = 0.25

The combined margin emission factor is determined *ex-ante* for the entire crediting period.

3. **Calculation of the project leakage GHG emissions**

According to methodology *ACM0002*, no leakage emissions are considered. The main emissions potentially giving rise to leakage in the context of electric sector projects are those arising due to activities such as power plant construction and upstream emissions from fossil fuel use (e.g. extraction, processing, and transport). These emissions sources are negligible.

**$L_y$ = 0 $tCO_2e$** (Equation 9)

4. **Calculation of the emission reductions**

The project activity will produce GHG emission reductions by avoiding $CO_2$ emissions from electricity generation by fossil fuel power plants. The emission reduction for year y is calculated as follows:

$$ER_y = BE_y - PE_y - L_y \quad \text{(Equation 10)}$$

Where:

| | | |
|---|---|---|
| $ER_y$ | Emissions reductions in year y | $tCO_2$/yr |
| $BE_y$ | Emissions in the baseline scenario in year y | $tCO_2$/yr |
| $PE_y$ | Emissions in the project scenario in year y | $tCO_2$e/yr |
| $L_y$ | Leakage Emissions in year y | $tCO_2$e/yr |

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

*(Copy this table for each data and parameter)*

| **Data / Parameter:** | **$EG_{m, y}$** |
|---|---|
| Data unit: | MWh |
| Description: | Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* |
| Source of data used: | Eskom Statistical data |
| Value applied: | Annex 3-3 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Publically available official data from a reliable data source. |
| Any comment: | The data provided represents that of the three most recent reporting years. |

| **Data / Parameter:** | **FCi,m, y** |
|---|---|
| Data unit: | Mass or volume unit |
| Description: | amount of fossil fuel type i consumed by power unit m in year y |
| Source of data used: | Eskom statistical data |
| Value applied: | Annex 3-3 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Publically available official data from a reliable data source. |
| Any comment: | The data provided represents that of the three most recent reporting years. |

| **Data / Parameter:** | **$NCV_{coal, y}$** |
|---|---|
| Data unit: | GJ/t |
| Description: | Net calorific value of Bituminous Coal |

| | |
|---|---|
| Source of data used: | 2006 IPCC Guidelines for National GHG Inventories, volume 2: Energy, Chapter 1, Table 1.2 |
| Value applied: | 19.9 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | The IPCC default value at the lower limit of the uncertainty at a 95% confidence interval was used as a conservative approach |
| Any comment: | This is used as a constant value |

| **Data / Parameter:** | **$EF_{CO2, coal, y}$** |
|---|---|
| Data unit: | $tCO_2/GJ$ |
| Description: | $CO_2$ emission factor of Other Bituminous Coal |
| Source of data used: | 2006 IPCC Guidelines for National GHG Inventories, volume 2: Energy, Chapter 1, Table 1.4 |
| Value applied: | 0.0895 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | The IPCC default value at the lower limit of the uncertainty at a 95% confidence interval was used as a conservative approach |
| Any comment: | This is used as a constant value |

| **Data / Parameter:** | **$FC_{i,m, y}$** |
|---|---|
| Data unit: | Mass or volume unit |
| Description: | amount of fossil fuel type i consumed by power unit m in year y |
| Source of data used: | Eskom's Statistical data |
| Value applied: | Annex 3.4 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Publically available official data from a reliable data source. |
| Any comment: | The data for 2010 reporting year was provided |

| **Data / Parameter:** | **$EF_{grid,BM,y}$** |
|---|---|
| Data unit: | $tCO_2/MWh$ |
| Description: | Build margin CO2 emission factor in year y |
| Source of data used: | Calculated |
| Value applied: | 0.986 |
| Justification of the choice of data or | Calculated according to the "Tool to calculate the emission factor for an electricity system" (version 02.2.0) |

| | |
|---|---|
| description of measurement methods and procedures actually applied : | |
| Any comment: | This is used as a constant value for the full crediting period |

| **Data / Parameter:** | **EFgrid,OM,y** |
|---|---|
| Data unit: | $tCO_2$/MWh |
| Description: | Build margin $CO_2$ emission factor in year y |
| Source of data used: | Calculated |
| Value applied: | 0.966 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Calculated according to the "Tool to calculate the emission factor for an electricity system" (version 02.2.0) |
| Any comment: | This is used as a constant value for the full crediting period |

| **Data / Parameter:** | **wOM** |
|---|---|
| Data unit: | Fraction |
| Description: | Weighting of operating margin emissions factor % |
| Source of data used: | Tool to calculate the emission factor for an electricity system |
| Value applied: | 0.75 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | As directed in the tool, a value of 0.75 is to be used for the entire crediting period |
| Any comment: | This is used as a constant value for the full crediting period |

| **Data / Parameter:** | **wBM** |
|---|---|
| Data unit: | Fraction |
| Description: | Weighting of build margin emissions factor |
| Source of data used: | Tool to calculate the emission factor for an electricity system |
| Value applied: | 0.25 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | As directed in the tool, a value of 0.25 is to be used for the entire crediting period |
| Any comment: | This is used as a constant value for the full crediting period |

| **Data / Parameter:** | **$EF_{grid, CM}$** |
|---|---|

| | |
|---|---|
| Data unit: | $tCO_2/MWh$ |
| Description: | Combined margin $CO_2$ emission factor for grid connected power generation calculated ex ante |
| Source of data used: | Calculated |
| Value applied: | 0.971 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Calculated according to the “Tool to calculate the emission factor for an electricity system” (version 02.2.0) |
| Any comment: | This is used as a constant value for the full crediting period |

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

The annual emission reductions can be calculated as follows

$$ER_y = EG_{facility,\, y} \times EF_{grid,\, CM}$$

Where:

| | | |
|---|---|---|
| $ER_y$ | Emission Reduction in year y | $tCO_2/yr$ |
| $EG_{facility,\, y}$ | Quantity of net electricity generation supplied by the project plant/unit to the grid in year y | MWh/yr |
| $EF_{grid,\, CM}$ | Combined margin $CO_2$ emission factor for grid connected power generation calculated ex ante | $tCO_2/MWh$ |

$EF_{grid,\, CM}$ = 0.971 - was calculated according to the “Tool to calculate the emission factor for an electricity system” (version 02.2.0) and was applied as a constant emission factor for the full crediting period.

The amount of electricity estimated to supply the South African power grid annually during the 10 year crediting period in shown in Table B.6-1 below:

**B.6-1-: Net electricity generation annually supplied to the South African Grid during the crediting period**

| Year | EGfacility, y (MWh) | ERy (tonnes of $CO_2$e) |
|---|---|---|
| 2015 | 741,096 | 719,604 |
| 2016 | 741,096 | 719,604 |
| 2017 | 741,096 | 719,604 |
| 2018 | 741,096 | 719,604 |
| 2019 | 741,096 | 719,604 |
| 2020 | 741,096 | 719,604 |

| | | |
|---|---|---|
| 2021 | 741,096 | 719,604 |
| 2022 | 741,096 | 719,604 |
| 2023 | 741,096 | 719,604 |
| 2024 | 741,096 | 719,604 |

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

>>

| Year | Estimation of baseline emissions (tonnes of $CO_2e$) | Estimation of project activity emissions (tonnes of $CO_2e$) | Estimation of leakage (tonnes of $CO_2e$) | Estimation of overall emissions reductions (tonnes of $CO_2e$) |
|---|---|---|---|---|
| 2015 | 719,604 | 0 | 0 | 719,604 |
| 2016 | 719,604 | 0 | 0 | 719,604 |
| 2017 | 719,604 | 0 | 0 | 719,604 |
| 2018 | 719,604 | 0 | 0 | 719,604 |
| 2019 | 719,604 | 0 | 0 | 719,604 |
| 2020 | 719,604 | 0 | 0 | 719,604 |
| 2021 | 719,604 | 0 | 0 | 719,604 |
| 2022 | 719,604 | 0 | 0 | 719,604 |
| 2023 | 719,604 | 0 | 0 | 719,604 |
| 2024 | 719,604 | 0 | 0 | 719,604 |
| **Total** | **7,196,042** | **0** | **0** | **7,196,042** |

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

### B.7.1 Data and parameters monitored:

*(Copy this table for each data and parameter)*

| | |
|---|---|
| **Data / Parameter:** | **$EG_{facility, y}$** |
| Data unit: | MWh/yr |
| Description: | Quantity of net electricity generation supplied by the power plant to the grid in year y |
| Source of data to be used: | On-site meter readings |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | (see table below) |

| Year | Power Generation (MWh/yr) |
|---|---|
| 2015 | 741,096 |
| 2016 | 741,096 |
| 2017 | 741,096 |
| 2018 | 741,096 |

| | | | |
|---|---|---|---|
| | | 2019 | 741,096 |
| | | 2020 | 741,096 |
| | | 2021 | 741,096 |
| | | 2022 | 741,096 |
| | | 2023 | 741,096 |
| | | 2024 | 741,096 |
| Description of measurement methods and procedures to be applied: | This will be determined on the basis of electricity meters installed at each site of the project activity. Data on electricity supply shall be regularly transferred to a server managed by the Chief Engineer's and archived on a separate server. | | |
| QA/QC procedures to be applied: | Annual calibration and quality checks on all instrumentation shall be carried out by specialized organisations that are licensed and contracted for this type of activity. This will be done in accordance with the requirements of the manufacturing company and to the schedule developed by the project owner. The quality assurance and quality control procedures for recording, maintaining and archiving data shall be improved as part of this CDM project activity according to CDM EB rules and practices in terms of the need for verification of the emission reductions according to this PDD. | | |
| Any comment: | Details provided in Section B.7.2 | | |

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

In accordance with the requirements of methodology, *ACM0002*, "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" the following monitoring will be undertaken:

1. **Monitoring period**

A 10 year fixed crediting period was chosen for this project. The monitoring period will run concurrently with the expected crediting period. At the end of each reporting year, monitored data shall be aggregated to a monitoring report.

2. **Data monitored and sources**

The primary parameter to be monitored by each power plant is the **quantity of net electricity generation** supplied to the South African power grid. This will be determined on the basis of electricity meters installed at each site of the project activity. These meters will continuously monitor the amount of electricity supplied to the grid, store the data in regular intervals, and will allow the project participants to access the readings remotely. The electricity meters shall be inspected annually and in case of inaccuracies will be recalibrated or replaced accordingly.

Electricity meter readings will be confirmed with the records of sold electricity. Data on electricity supply shall be regularly transferred to the Chief Engineer's computer and archived. The project owner's internal reports will be the source of data to calculate the GHG emission reductions during the monitoring period. The emission reductions shall be calculated using the Formula 2.

Should any instrument that is used in the monitoring process fail, this shall be fixed or replaced as soon as possible. In case of the breakdown of any of the solar panels, the net amount of electricity generation will decrease, and the total amount of electricity supplied to the grid will also decrease. All accidents that may occur at the solar park shall be recorded whereas only information on major accidents shall be included in the monitoring report.

It should be noted that the project activity is expected to be operational in 2013. As such, operation and maintenance procedures for each power plant will be developed, according to current best practices, to meet the plant's scheduled date of operations.

3. Monitoring lay out

It is clear from the figure below that the metering system will be installed between the 400kV substation and the connection to the National grid.

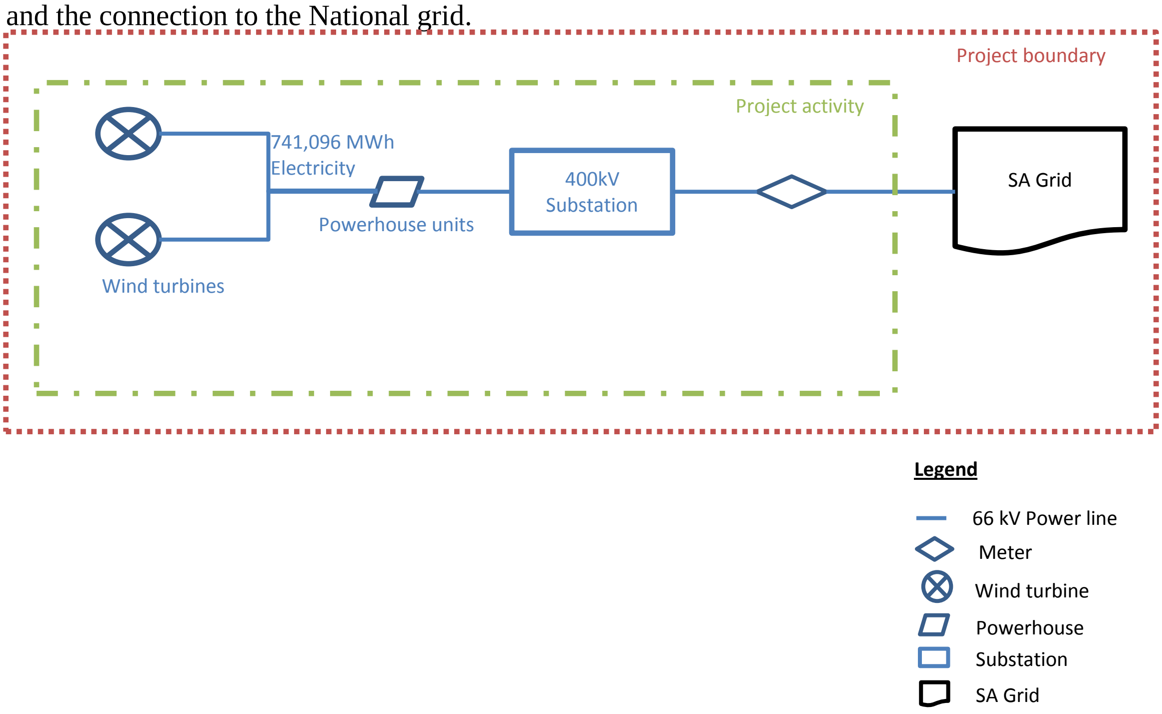



Figure B.7-1: Process flow diagram[9] delineating the project activity, project boundary as well as the meter layout

**4. Data Management**

All data collected as part of monitoring shall be archived electronically and kept at least for 2 years after the end of the crediting period. Data management systems shall be used to archive the monitoring data. The meters readings, as well as the relevant information and data source(s) will be archived

[9] a More detailed layout is available as part of the documents submitted.

All the relative staff will be trained before operation of the power plants. The training will consists of CDM knowledge, operational regulations, quality control (QC), data monitoring requirements and data management regulations, etc.

**5. Quality Assurance and Quality Control**

Annual calibration and quality checks on all instrumentation shall be carried out by specialized organisations that are licenced and contracted for this type of activity. This will be done in accordance with the requirements of the manufacturing company and to the schedule developed by the project owner. The quality assurance and quality control procedures for recording, maintaining and archiving data shall be improved as part of this CDM project activity according to CDM EB rules and practices in terms of the need for verification of the emission reductions according to this PDD.

**6. The monitoring team**

The identified project manager will supervise all the monitoring activities. A data handling and reporting manager is responsible for reading, recording, handling, reporting and archiving relevant data. The QA &QC manager is responsible for checking data and taking measures to ensure meters precision.

The power plant staff shall undergo the necessary training related to operation and maintenance of the solar park and all of the installed equipment. The training shall take place at the manufacturer's facility and on site at the power plant. The maintenance personnel of the power plant are responsible for daily control over the monitoring plan implementation.

The management of SARGE is fully responsible for the project implementation and overall control as well as collection of all data required for calculation of GHG emission reductions. All information regarding the accuracy of data falls under the responsibility of SARGE. The preliminary version of the monitoring report shall be submitted to the specialists of SARGE for review.

Specialists of Camco will calculate GHG emission reductions with data that will be provided by SARGE from the meter readings. In case any mistakes areii found in the calculations of GHG emission reductions by SARGE, the specialists of Camco shall correct these calculations accordingly. Specialists of Camco shall regularly (at least annually) carry out “test verifications” with a view to ensure that the monitoring plan followed by SARGE is applied correctly.

The designated on-site engineer(s) and/or other authorised individuals will be responsible for the maintenance and usage of the latest state-of-the-art monitoring equipment. The project will be required to perform additional detailed and independently-audited monitoring of performance, in order to satisfy regulatory and permitting requirements as well as its commercial contracts.

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

| Contact Information of the responsible person | Is organisation a Project Participant Yes/No |
|---|---|
| Carbon Asset Management Company Pty Ltd<br><br>Postal address:<br>P.O Box 70, Woodlands Office Park,<br>Woodmead 2080, South Africa<br><br>Physical address:<br>Building 18<br>Woodlands Office Park<br>Western Service Road<br>Woodmead Johannesburg<br>2080 South Africa<br><br>Tel: +27 11 353 3400<br>Fax: +27 11 804 1038<br><br>Email: jonathan.curren@camcoglobal.com | No |

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

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

20 years

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

01/03/2013

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

20 years

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

**C.2.1. Renewable crediting period:**

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

Not applicable

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

Not applicable

**C.2.2. Fixed crediting period:**

**C.2.2.1. Starting date:**

01/01/2015

**C.2.2.2. Length:**

10 years

## SECTION D. Environmental impacts

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

The EIA is underway and discusses all of the environmental and transboundary impacts. This will be completed prior to finalisation of validation

**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:**

## SECTION E. Stakeholders' comments

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

The Public Feedback Meeting was held on 21 November 2011 at the Lutzville Hotel from 17:30 - 19:00. Stakeholders were invited via posters displayed in the project area and an advert in the local newspaper.

This Public Feedback meeting was held as part of the Environmental Impact Assessment carried out by Savannah Environmental (pty) Ltd.

The results of the stakeholder attendance and comments are presently being compiled.

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

The results of the stakeholder attendance and comments are presently being compiled.

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

All of the comments will be taken into account in the final EIA report and the Record of Decision.

# Annex 1

## CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

| | |
|---|---|
| Organization: | South African Renewable Green Energy (SARGE) Pty Ltd |
| Street/P.O.Box: | Main Road |
| Building: | 1st Floor, ICR House |
| City: | Constantia, ape Town |
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| Telephone: | +27(0)21 794 3140 |
| FAX: | 27(0)21 794 3135 |
| E-Mail: | francois@sarge.co.za |
| URL: | www.sarge.co.za |
| Represented by: | Chief Executive Officer |
| Title: | Chief Executive Officer |
| Salutation: | Mr |
| Last name: | Roux |
| Middle name: | Francois |
| First name: | Pieter |
| Department: | |
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| Direct tel: | +27(0)21 794 3140 |
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| | |
|---|---|
| Organization: | Standard Bank Plc |
| Street/P.O.Box: | 20 Gresham Street |
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| City: | London |
| State/Region: | |
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| E-Mail: | CO2@standardbank.com |
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| Represented by: | Geoff Sinclair |
| Title: | Head of Carbon Sales and Trading |
| Salutation: | Mr |
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| | |
|---|---|
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| Direct tel: | |
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**Annex 2**

**INFORMATION REGARDING PUBLIC FUNDING**

Annex 3

## BASELINE INFORMATION

References:
http://www.eskom.co.za/c/article/236/cdm-calculations/
http://www.eskom.co.za/content/calculationTable.htm
V2.2.0 of the "Tool to calculate the emission factor for an electricity system". Annex 1: Default efficiency factors for power plants

The grid emissions factor (GEF) for the South African grid, is calculated utilising V2.2.0 of the "Tool to calculate the emission factor for an electricity system". The following six (6) steps of the baseline methodology procedure of the tool are utilised, namely:

*Step 1: Identify the relevant electricity systems*

The relevant electricity system is the South African National grid, which comprises the following plants and types:

| Plant no. | Power Station / Plant name | Commissioning date | Installed capacity (MW) | Generation technology / type | Fuel type /energy source |
|---|---|---|---|---|---|
| 1 | Arnot | 21/09/1971 | 1980 | Coal Subcritical | Other Bituminous Coal |
| 2 | Duvha | 18/01/1980 | 3450 | Coal Subcritical | Other Bituminous Coal |
| 3 | Hendrina | 12/05/1970 | 1895 | Coal Subcritical | Other Bituminous Coal |
| 4 | Kendal | 01/10/1988 | 3840 | Coal Subcritical | Other Bituminous Coal |
| 5 | Kriel | 06/05/1976 | 2850 | Coal Subcritical | Other Bituminous Coal |
| 6 | Lethabo | 22/12/1985 | 3558 | Coal Subcritical | Other Bituminous Coal |
| 7 | Matimba | 04/12/1987 | 3690 | Coal Subcritical | Other Bituminous Coal |
| 8 | Majuba | 01/04/1996 | 3843 | Coal Subcritical | Other Bituminous Coal |
| 9 | Matla | 29/09/1979 | 3450 | Coal Subcritical | Other Bituminous Coal |
| 10 | Tutuka | 01/06/1985 | 3510 | Coal Subcritical | Other Bituminous Coal |
| 11 | Koeberg | 21/07/1984 | 1800 | Nuclear | Nuclear |
| 12 | Camden | 21/12/1966 | 1600 | Coal Subcritical | Other Bituminous Coal |
| 13 | Grootvlei | 29/06/1969 | 1200 | Coal Subcritical | Other Bituminous Coal |
| 14 | Komati | 30/06/1969 | 1000 | Coal Subcritical | Other Bituminous Coal |
| 15 | Imports | N/a | N/a | N/a | N/a |

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

Although this step is optional, Option I: Only grid power plants are included in the calculation, is selected here.

*Step 3: Select a method to determine the operating margin (OM)*

| Plant no. | Power Station / Plant name | Generation technology | Low cost/must run (Yes / No) | Net electricity generation (EGm,y) (MWh) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 2007 | 2008 | 2009 | 2010 | 2011 |
| 1 | **Arnot** | Coal Subcritical | No | 11,495,036 | 15,938,102 | 11,905,060 | 11,987,281 | 13,227,864 |
| 2 | **Duvha** | Coal Subcritical | No | 24,479,488 | 31,550,562 | 23,622,732 | 21,769,489 | 22,581,228 |
| 3 | **Hendrina** | Coal Subcritical | No | 12,410,151 | 16,083,288 | 13,756,351 | 12,296,687 | 12,143,292 |
| 4 | **Kendal** | Coal Subcritical | No | 26,461,793 | 34,164,855 | 26,517,420 | 23,841,401 | 23,307,031 |
| 5 | **Kriel** | Coal Subcritical | No | 20,510,202 | 22,468,695 | 17,762,398 | 18,156,686 | 15,906,816 |
| 6 | **Lethabo** | Coal Subcritical | No | 22,498,940 | 32,052,833 | 25,701,723 | 23,580,232 | 25,522,698 |
| 7 | **Matimba** | Coal Subcritical | No | 28,401,085 | 34,983,880 | 29,021,742 | 26,256,068 | 27,964,141 |
| 8 | **Majuba** | Coal Subcritical | No | 17,620,119 | 22,828,565 | 23,680,971 | 22,676,924 | 22,340,081 |
| 9 | **Matla** | Coal Subcritical | No | 23,782,480 | 30,864,194 | 24,549,833 | 21,863,400 | 21,954,536 |
| 10 | **Tutuka** | Coal Subcritical | No | 16,500,638 | 23,389,829 | 20,980,242 | 21,504,122 | 19,847,894 |
| 11 | **Koeberg** | Nuclear | Yes | - | 11,293,000 | 11,780,000 | 11,317,000 | 13,004,000 |
| 12 | **Camden** | Coal Subcritical | No | 756,540 | 2,815,982 | 5,171,057 | 6,509,079 | 7,472,070 |
| 13 | **Grootvlei** | Coal Subcritical | No | - | - | 237,138 | 1,249,556 | 2,656,230 |
| 14 | **Komati** | Coal Subcritical | No | - | - | - | - | 1,016,023 |
| 15 | **Imports** | N/a | N/a | - | - | 10,624,000 | 10,998,000 | 9,162,000 |
| ***Total electricity generation*** | | | | ***204,916,472*** | ***278,433,785*** | ***245,310,667*** | ***234,005,925*** | ***238,105,904*** |
| ***Average annual generation*** | | | | | | | | ***240,154,551*** |
| ***Low cost/must run generation*** | | | | - | ***11,293,000*** | ***11,780,000*** | ***11,317,000*** | ***13,004,000*** |
| ***Average low cost/must run generation*** | | | | | | | | ***9,478,800*** |
| ***% of low cost/must run*** | | | | | | | | ***3.95*** |

Option (a) Simple OM is appropriate for use.

*Step 4: Calculate the operating margin emission factor according to the selected method*

Option A: Based on the net electricity generation and a CO2 emission factor of each power unit of the Simple OM method is utilised.

$$EF_{grid,OMsimple,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:

| | |
|---|---|
| EFgrid,OMsimple,y | = Simple operating margin CO2 emission factor in year y (tCO2/MWh) |
| EGm,y | = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh) |
| EFEL,m,y | = CO2 emission factor of power unit m in year y (tCO2/MWh) |
| m | = All power units serving the grid in year y except low-cost / must-run power units |
| y | = The relevant year as per the data vintage chosen in Step 3 |

*Determination of EFEL,m,y*

Since data on data on fuel consumption and electricity generation is available, Option A1 is utilised to determine the emission factor (EFEL,m,y), as follows:

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \times NCV_{i,y} \times EF_{CO2,i,y}}{EG_{m,y}}$$

Where:

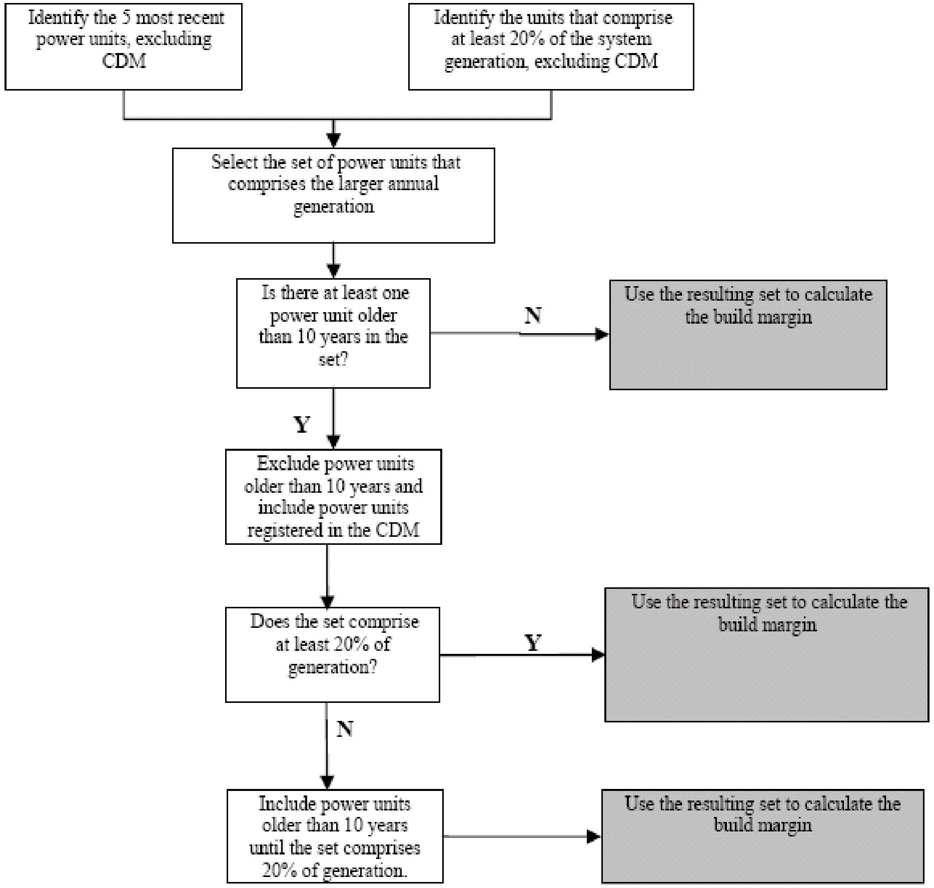
| | |
|---|---|
| EFEL,m,y | = CO2 emission factor of power unit m in year y (tCO2/MWh) |
| FCi,m,y | = Amount of fossil fuel type i consumed by power unit m in year y (Mass or volume unit) |
| NCVi,y | = Net calorific value (energy content) of fossil fuel type i in year y (GJ/mass or volume unit) |
| EFCO2,i,y | = CO2 emission factor of fossil fuel type i in year y (tCO2/GJ) |
| EGm,y | = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh) |
| m | = All power units serving the grid in year y except low-cost/must-run power units |
| i | = All fossil fuel types combusted in power unit m in year y |
| y | = The relevant year as per the data vintage chosen in Step 3 |

| | | | | | | | | 2007/08 | | | 2008/09 | | | 2009/10 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plant no. | Power Station / Plant name (m) | Installed capacity (MW) | Generation technology | Energy Source / Fuel Type (i) | Net Calorific Value (NCVi,y) (GJ/t) | Fuel CO2 Emission Factor (EFCO2,i,y) (tCO2/GJ) | Efficiency | Fuel Consumption (FCi,m,y) (t) | Electricity Generation (EGm,y ) (MWh) | Emission Factor of Power unit m (EFEL,m,y) (tCO2/MWh) | Fuel Consumption (FCi,m,y) (t) | Electricity Generation (EGm,y ) (MWh) | Emission Factor of Power unit m (EFEL,m,y) (tCO2/MWh) | Fuel Consumption (FCi,m,y) (t) | Electricity Generation (EGm,y ) (MWh) | Emission Factor of Power unit m (EFEL,m,y) (tCO2/MWh) |
| 1 | Arnot | 1980 | Coal Subcritical | Other Bituminous Coal | 19.90 | 0.090 | 0.370 | 6,210,700 | 11,905,060 | 0.929 | 6,395,805 | 11,987,281 | 0.950 | 6,794,134 | 13,227,864 | 0.915 |
| 2 | Duvha | 3450 | Coal Subcritical | Other Bituminous Coal | 19.90 | 0.090 | 0.370 | 12,425,531 | 23,622,732 | 0.937 | 11,393,553 | 21,769,489 | 0.932 | 11,744,606 | 22,581,228 | 0.926 |
| 3 | Hendrina | 1895 | Coal Subcritical | Other Bituminous Coal | 19.90 | 0.090 | 0.370 | 7,794,220 | 13,756,351 | 1.009 | 7,122,918 | 12,296,687 | 1.032 | 6,905,917 | 12,143,292 | 1.013 |
| 4 | Kendal | 3840 | Coal Subcritical | Other Bituminous Coal | 19.90 | 0.090 | 0.370 | 15,986,131 | 26,517,420 | 1.074 | 15,356,595 | 23,841,401 | 1.147 | 13,866,514 | 23,307,031 | 1.060 |
| 5 | Kriel | 2850 | Coal Subcritical | Other Bituminous Coal | 19.90 | 0.090 | 0.370 | 9,059,934 | 17,762,398 | 0.908 | 9,420,764 | 18,156,686 | 0.924 | 8,504,715 | 15,906,816 | 0.952 |
| 6 | Lethabo | 3558 | Coal Subcritical | Other Bituminous Coal | 19.90 | 0.090 | 0.370 | 18,314,572 | 25,701,723 | 1.269 | 16,715,323 | 23,580,232 | 1.263 | 18,170,227 | 25,522,698 | 1.268 |
| 7 | Matimba | 3690 | Coal Subcritical | Other Bituminous Coal | 19.90 | 0.090 | 0.370 | 14,862,323 | 29,021,742 | 0.912 | 13,991,453 | 26,256,068 | 0.949 | 14,637,481 | 27,964,141 | 0.932 |
| 8 | Majuba | 3843 | Coal Subcritical | Other Bituminous Coal | 19.90 | 0.090 | 0.370 | 12,853,342 | 23,680,971 | 0.967 | 12,554,406 | 22,676,924 | 0.986 | 12,261,833 | 22,340,081 | 0.978 |
| 9 | Matla | 3450 | Coal Subcritical | Other Bituminous Coal | 19.90 | 0.090 | 0.370 | 13,795,309 | 24,549,833 | 1.001 | 12,689,387 | 21,863,400 | 1.034 | 12,438,391 | 21,954,536 | 1.009 |
| 10 | Tutuka | 3510 | Coal Subcritical | Other Bituminous Coal | 19.90 | 0.090 | 0.370 | 10,627,575 | 20,980,242 | 0.902 | 11,231,583 | 21,504,122 | 0.930 | 10,602,839 | 19,847,894 | 0.951 |
| 11 | Koeberg | 1800 | Nuclear | Nuclear | N/a | N/a | N/a | N/a | N/a | N/a | N/a | N/a | N/a | N/a | N/a | N/a |
| 12 | Camden | 1600 | Coal Subcritical | Other Bituminous Coal | 19.90 | 0.090 | 0.370 | 3,218,873 | 5,171,057 | 1.109 | 3,876,211 | 6,509,079 | 1.061 | 4,732,163 | 7,472,070 | 1.128 |
| 13 | Grootvlei | 1200 | Coal Subcritical | Other Bituminous Coal | 19.90 | 0.090 | 0.370 | 130,748 | 237,138 | 0.982 | 674,538 | 1,249,556 | 0.961 | 1,637,371 | 2,656,230 | 1.098 |
| 14 | Komati | 1000 | Coal Subcritical | Other Bituminous Coal | 19.90 | 0.090 | 0.370 | - | - | 0.871 | - | - | 0.871 | 664,497 | 1,016,023 | 1.165 |
| 15 | Imports | N/a | N/a | 0 | | | | - | 10,624,000 | - | - | 10,998,000 | - | - | 9,162,000 | - |
| | | | | | | | | *Emission Factor of grid (EFEL, grid, 2007/08)* | | ***0.955*** | *Emission Factor of grid (EFEL, grid, 2008/09)* | | ***0.971*** | *Emission Factor of grid (EFEL, grid, 2009/10)* | | ***0.973*** |
| | | | | | | | | | | | *EFgrid,OMsimple,2009/10* | | | | | ***0.966*** |

***Therefore, EFgrid,OMsimple,2009/10 = 0.966***

*Step 5: Calculate the build margin (BM) emission factor*

In order to calculate the build margin (BM) of the grid, the tool provides the following procedure (see PDD for the procedure carried out step wise):



SET>20% including Majuba, Kendal and Matimba with 73,611,253MWh comprise the SETsample and SET>20% are used to calculate the build margin below utilising equation "13" of the tool.

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

Where:

EFgrid,BM,y = Build margin CO2 emission factor in year y (tCO2/MWh)

EGm,y = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)

EFEL,m,y = CO2 emission factor of power unit m in year y (tCO2/MWh)

m = power units included in the Build margin

y = Most recent historical year for which power generation data is available

| Plant no. | Power Station / Plant name (m) | Installed capacity (MW) | Generation technology | Energy Source / Fuel Type (i) | 2009/10 Electricity Generation (EGm,y ) (MWh) | Emission Factor of Power unit m (EFEL,m,y) (tCO2/MWh) |
|---|---|---|---|---|---|---|
| 8 | Majuba | 3843 | Coal Subcritical | Other Bituminous Coal | 22,340,081 | 0.978 |
| 4 | Kendal | 3840 | Coal Subcritical | Other Bituminous Coal | 23,307,031 | 1.060 |
| 7 | Matimba | 3690 | Coal Subcritical | Other Bituminous Coal | 27,964,141 | 0.932 |
| | | | | | *EFgrid,BM,y* | *0.986* |

***Therefore, EFgrid,BM,y = 0.986***

*Step 6: Calculate the combined margin emissions factor*

The combined margin (CM) emissions factor (EFgrid,CM,y) is calculated using the Weighted average CM method, Option A and equation "14" of the tool:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$$

Where:

| | |
|---|---|
| EFgrid,BM,y | = Build margin CO2 emission factor in year y (tCO2/MWh) |
| EFgrid,OM,y | = Operating margin CO2 emission factor in year y (tCO2/MWh) |
| wOM | = Weighting of operating margin emissions factor (%) |
| wBM | = Weighting of build margin emissions factor (%) |

***Therefore:***

| ***EFgrid,OM,y*** | ***wOM*** | ***EFgrid,BM,y*** | ***wBM*** | ***EFgrid,CM,y*** |
|---|---|---|---|---|
| ***0.966*** | ***0.75*** | ***0.986*** | ***0.25*** | ***0.971*** |

## Annex 4

## MONITORING INFORMATION

No supplementary information.