



**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: Caledon Wind Farm in South Africa

Version: 02

Date: 07/02/2012

A.2. Description of the project activity:

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Purpose of project activity:

Caledon Wind Energy Trading (Pty) Ltd is proposing to establish a commercial Wind Farm and associated infrastructure on a site near Caledon in the Theewaterskloof Municipality, Western Cape Province. The proposed 138.2MW Caledon wind farm will comprise up to 45 wind turbines. Associated infrastructure will include power lines connecting the turbines to the existing overhead transmission lines, a new substation, and access roads to the various turbines. The purpose of the proposed project activity is to generate zero emission wind power. The electricity will be sold either to Eskom, (the national electricity utility), or to an industrial customer.

Greenhouse gas reduction:

The implementation of the project activity will result in greenhouse gas emission reductions by replacing electricity generated from predominantly fossil fuel fired power plants run by Eskom.

Baseline scenario:

For the proposed project activity, the baseline scenario is Eskom providing the same electricity as the proposed project activity. The baseline scenario is the same as the scenario existing prior to the start of implementation of the project activity.

Contribution to Sustainable Development:

The project makes positive contributions to sustainable development. The South African Designated National Authority (DNA) evaluates sustainability in three categories: Economic, environmental and social. The contribution of the project towards sustainable development is discussed in terms of these three categories:

- **Economic:**

This large renewable energy project provides incremental energy security and financial resources to stimulate sustainable development within the Western Cape. The current electricity crisis in South Africa highlights the significant role that renewable energy can play in terms of supplementing the power available.

Local production of energy reduces transmission line losses associated with transmitting electricity over long distances, in this case from the coal fired power stations in the east of the country.

The development of renewable energy creates an opportunity to establish a new industry within the South African economy.



Wind farms are well suited to rural areas, such as Theewaterskloof, and have a reduced impact on agriculture compared to other electricity generating options, due to their small physical footprint. Wind turbines can also contribute to economic growth in these regions.

The project will contribute to foreign reserve earnings for South Africa via carbon credit sales revenue.

The project will provide encouragement to other independent power producers to invest in renewable energy sources.

- **Social:**

The establishment of the proposed wind farm will create local job opportunities during the construction and operational phases. During construction it is estimated that 74 workers with various skill levels will be required.¹ In addition, the community will benefit through both critical infrastructure and social upliftment through the creation of a dedicated community trust. The trust will directly hold a stake in the proposed wind-farm, the proceeds (dividends) derived from this stake will be channelled into pre-identified projects to enable sustainable job creation for the planned duration (20 years) of the wind-farm.

- **Environmental:**

Overall GHG emissions will be reduced.

The project will have a positive environmental impact by displacing electricity from the South African national grid. These positive impacts relate to a reduction in the generation of coal-based electricity and its associated environmental impacts. These impacts include: the impact of coal mining, the utilisation of scarce water resources, SO₂ emissions, particulate emissions, the environmental impacts associated with the mining and transportation of coal and the impacts associated with the disposal of coal ash.

The operation of wind energy farms does not require water as an input. This contrasts with conventional coal fired plants, which are a major consumer of water during their requisite cooling processes. As an already water stressed nation, it is critical that South Africa engages in a variety of water conservation measures, particularly as the detrimental effects of climate change on water availability are experienced in the future.²

Construction of the wind power plant will result in conserving depleting natural resources such as coal.

¹ Environmental Impact Assessment for the proposed Caledon Wind Farm, p59

² Environmental Impact Assessment for the proposed Caledon Wind Farm, p43

A.3. Project participants:

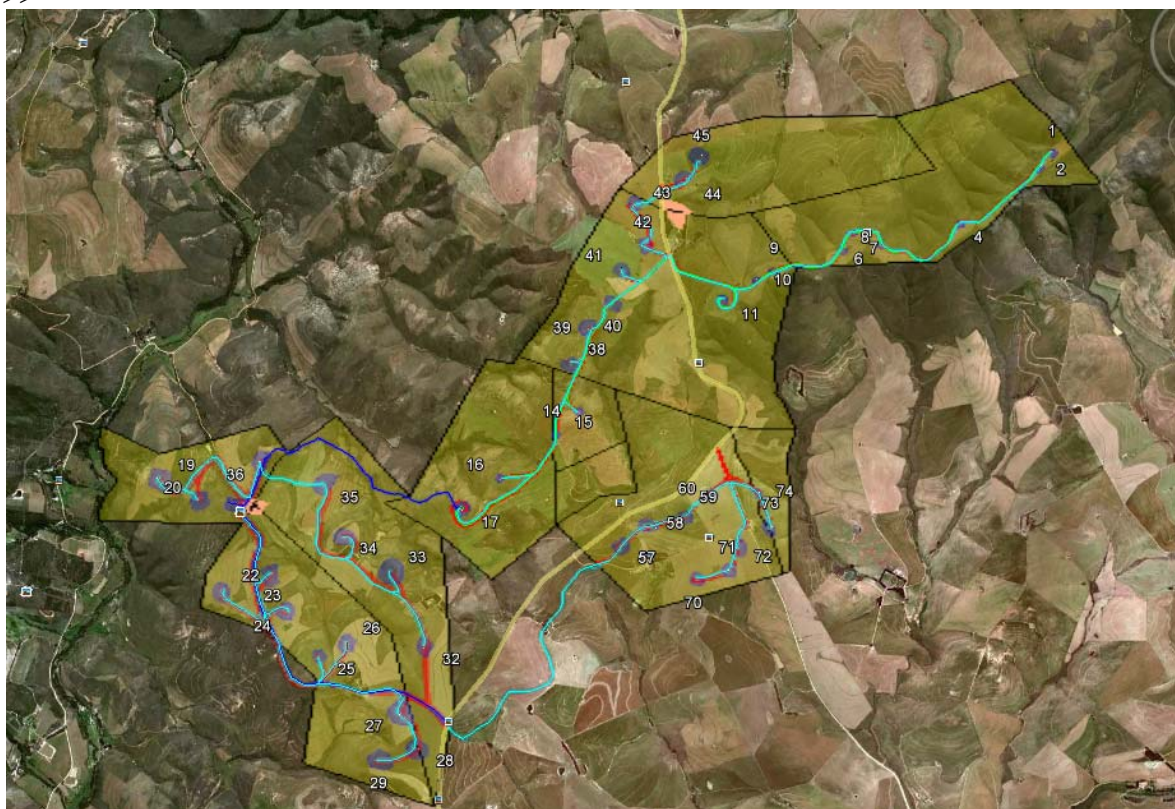
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Name of Party involved (*) ((host indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of South Africa (host)	Caledon Wind Energy Trading (Pty) Ltd (Private Entity)	No
Ireland	ESBI Contracting Ltd. (Private Entity)	No

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

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	Latitude	Longitude
T1	-34.132535°	19.341552°
T2	-34.133937°	19.339872°
T4	-34.139262°	19.330599°
T6	-34.141378°	19.321668°
T7	-34.140198°	19.318249°
T8	-34.141813°	19.317173°
T9	-34.143882°	19.309281°



T10	-34.144712°	19.307073°
T11	-34.146778°	19.303279°
T14	-34.157364°	19.286363°
T15	-34.159727°	19.283788°
T16	-34.163882°	19.277260°
T17	-34.166965°	19.272696°
T19	-34.163915°	19.236375°
T20	-34.166095°	19.241150°
T22	-34.174825°	19.244078°
T23	-34.173287°	19.249839°
T24	-34.177256°	19.251840°
T25	-34.181331°	19.255611°
T26	-34.179911°	19.258697°
T27	-34.186897°	19.265345°
T28	-34.190327°	19.267445°
T29	-34.191620°	19.262633°
T32	-34.180446°	19.268099°
T33	-34.172966°	19.264090°
T34	-34.169556°	19.258236°
T35	-34.164564°	19.255931°
T36	-34.162256°	19.248567°
T38	-34.152635°	19.285407°
T39	-34.149275°	19.287644°
T40	-34.146871°	19.290436°
T41	-34.143557°	19.291447°
T42	-34.141166°	19.293881°
T43	-34.137273°	19.293003°
T44	-34.134840°	19.299032°
T45	-34.132676°	19.300809°
T57	-34.170692°	19.291247°
T58	-34.168744°	19.295490°
T59	-34.167661°	19.298875°
T60	-34.165447°	19.302210°
T70	-34.173785°	19.300339°
T71	-34.172895°	19.304136°
T72	-34.170348°	19.305118°
T73	-34.165231°	19.307749°
T74	-34.168660°	19.309212°

A.4.1.1. Host Party(ies):

South Africa

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

Western Cape Province

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

Theewaterskloof Municipality



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

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The project site is located at the co-ordinates: S 34° 08'48" and E 19° 18'11". The project activity is situated within the Theewaterskloof Municipality, Western Cape Province. An area of approximately 2756 hectares, approximately 16 km west of Caledon and 7 km east of Botrivier, is being considered within which the proposed wind farm and associated infrastructure will be established.



Map No. 3788 Rev. 5 UNITED NATIONS January 2004

<http://www.ohchr.org/english/countries/maps/southafr.pdf>

Department of Peacekeeping Operations Cartographic Section

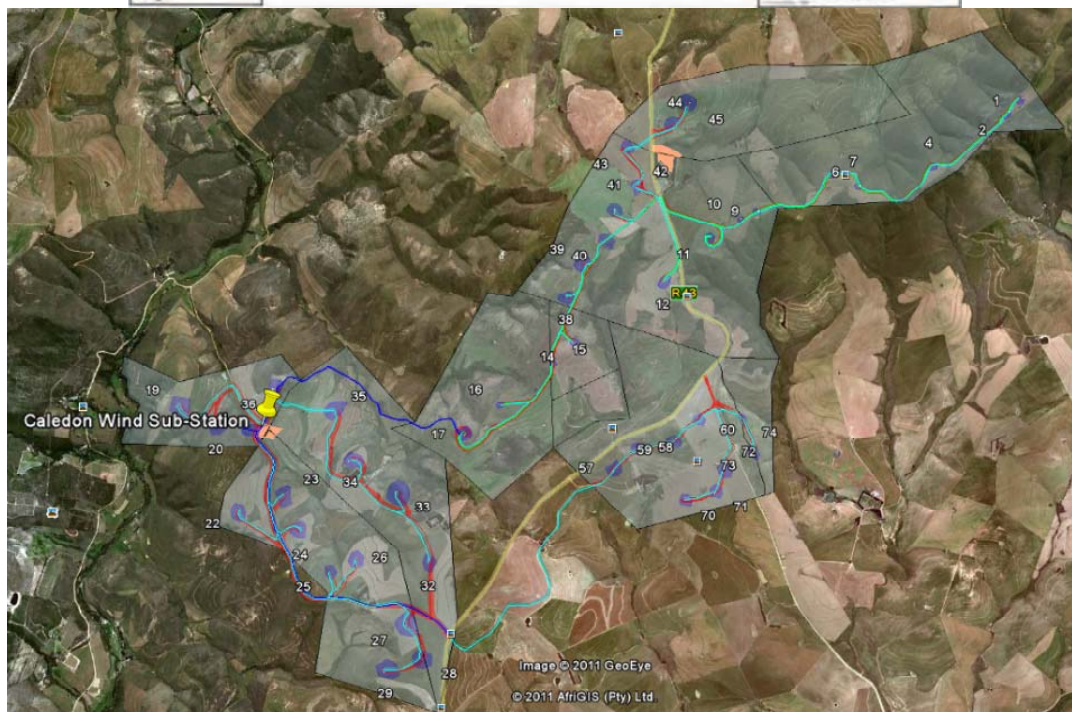
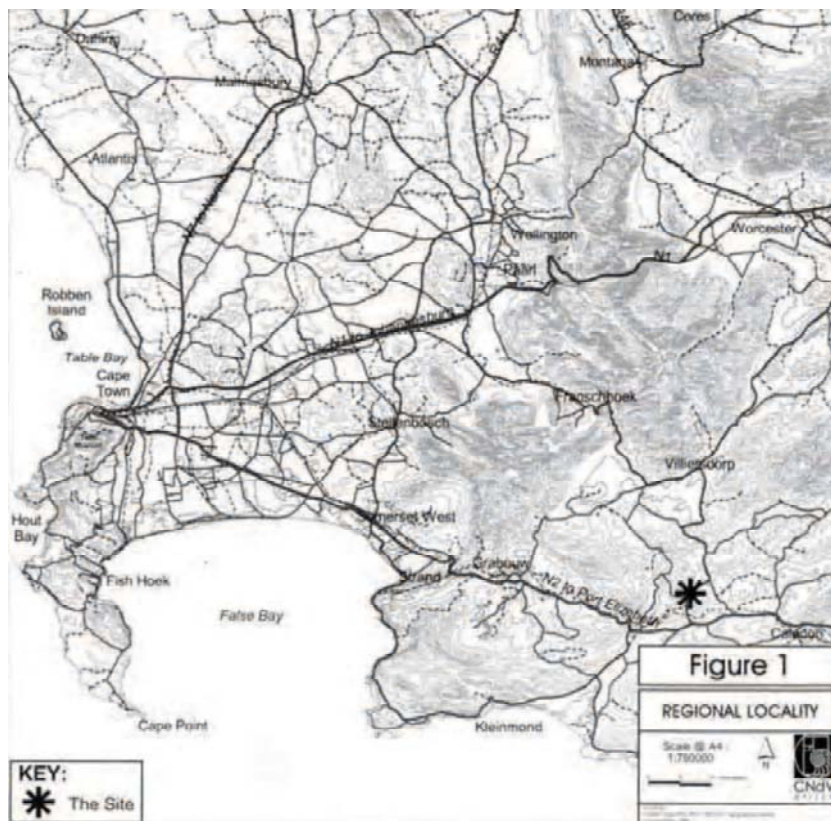


Figure 1: Location of the proposed project activity

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

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

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

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The wind farm is anticipated to produce electricity for approximately 20 years or more.

The proposed project activity is for the construction of a 138.2MW wind farm, comprising 45 wind turbines.

Internal access roads from the R43 to the operations area will be constructed. A transmission line from a point on the proposed wind farm connecting to the national grid through existing Eskom transmission lines must be installed. Turbine foundations, cables to carry electricity from the turbines to the existing overhead transmission lines and a substation at the connection point to the existing transmission lines must be created. A control centre compound will be established in an existing building in Caledon. The Eskom Houwhoek Substation needs to be upgraded to accommodate the additional capacity.

Wind turbines from an established manufacturer will be used at the site. The technical specifications are detailed in the table below.

Description	Specification	
Nominal power	3,000 kW	3,075kW
Hub height	84 m	84m
Number of blades	3	3
Number of turbines	2	43
Installed capacity		138.2MW
Mean park effect [%]		4.1
Gross production [MWh/a]		432'993
Mean capacity factor [%]		35.8
Mean full load hours [h]		3'133
Reduced availability [%]		3
Electrical losses [%]		3
Annual production AEP P50 [MWh/a]		407'014
Mean capacity factor [%]		33.6
Mean full load hours [h]		2'945
Annual production AEP P75 [MWh/a]		380'110
Mean capacity factor [%]		31.3
Mean full load hours [h]		2'743
Annual production AEP P90 [MWh/a]		355'896
Mean capacity factor [%]		29.4
Mean full load hours [h]		2'575



The project involves technology transfer, as no large wind turbines are produced in South Africa.

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

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Year	Annual estimation of emission reductions in tonnes of CO ₂ e*
1	413,491
2	413,491
3	413,491
4	413,491
5	413,491
6	413,491
7	413,491
8	413,491
9	413,491
10	413,491
Total estimated reductions (tonnes of CO₂e)	4,134,914
Total number of crediting years	10
Annual average over the crediting period of estimated reductions (tonnes of CO₂e)	413,491

A.4.5. Public funding of the project activity:

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No public funding has been used or will be used in the development and implementation of this 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:

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ACM0002: Consolidated baseline methodology for grid-connected electricity generation from renewable sources

Version 12.2.0, Sectoral Scope: 01, EB 58

Methodological tools used:

Methodological Tool: Tool for the demonstration and assessment of additionality
Version 06.0.0, EB 39 (Section B.5)

Methodological Tool: Tool to calculate the emission factor for an electricity system



Version 02.2.1, EB 63 (Section B.6.4)

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

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The project meets all the conditions set forth in the approved methodology ACM0002. The applicability conditions are described below. Hence, the selected methodology is appropriate for the project activity.

Applicability conditions as per ACM0002	Applicability to this project activity
This methodology is applicable to grid-connected renewable power generation project activities that (a) install a new power plant at a site where no renewable power plant was operated prior to the implementation of the project activity (greenfield plant); (b) involve a capacity addition; (c) involve a retrofit of (an) existing plant(s); or (d) involve a replacement of (an) existing plant(s).	The project activity is a grid-connected renewable power generation, greenfield plant. The project activity is the construction of a new wind power plant at a site where no renewable power plant was operated prior to the implementation of the project activity.
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 of a 138.2 MW wind power plant in the Theewaterskloof municipality.
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 10 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 activity is a greenfield wind power plant. It does not involve capacity additions, retrofits or replacements. Therefore this applicability criterion is not applicable.
In case of hydro power plants, one of the following conditions must apply: <ul style="list-style-type: none"> • The project activity is implemented in an existing reservoir, with no change in the volume of reservoir; or • 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 	This is not a hydro power project. Therefore this applicability criterion is not applicable.



Emissions section, is greater than 4 W/m ² ; or • The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the Project Emissions section, is greater than 4 W/m ² .	
The 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; • Biomass fired power plants; • 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/m ² .	This project does not involve switching from fossil fuels to renewable energy at the site of the project activity. The project activity is not a biomass fired power plant or a hydro power plant. Therefore these applicability criteria are not applicable.
In the case of retrofits, replacements, or capacity additions, this methodology is only applicable if the most plausible baseline scenario, as a result of the identification of baseline scenario, is “the continuation of the current situation, i.e. to use the power generation equipment that was already in use prior to the implementation of the project activity and undertaking business as usual maintenance”.	The project activity is a greenfield wind power plant. It does not involve retrofits, replacements or capacity additions. Therefore this applicability criterion is not applicable.

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

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The spatial extent of the project boundary includes the project power plant and all power plants connected physically to the electricity system that the CDM project power plant is connected to.

As per the approved methodology, ACM0002, the greenhouse gases and emission sources included in or excluded from the project boundary are shown in the Table below.

Source		Gas	Included?	Justification / Explanation
Baseline	CO ₂ emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity.	CO ₂	Yes	Main emission source.
		CH ₄	No	It is conservative. Minor emission source.
		N ₂ O	No	It is conservative. Minor emission source.
Project activity	Proposed activity – greenfield wind power plant	CO ₂	Yes	Excluded as per the methodology
		CH ₄	No	Excluded as per the methodology
		N ₂ O	No	

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

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The proposed project activity is the construction of a greenfield wind power plant. According to ACM0002, if the project activity is the installation of a new grid-connected 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 grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin (CM) calculations described in the “Tool to calculate the emission factor for an electricity system”.

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):

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The Caledon Wind project owners considered CDM benefits as necessary in the decision to undertake the project. The chronology of events for the project activity appears in the table below.

Activity	Date
EIA Draft Environmental Scoping Report	10/12/2009
Stakeholder consultation in Botrivier	11/01/2010
Stakeholder consultation in Caledon	12/01/2010
CDM development meeting held	20/01/2010
Order placed with Promethium (carbon consultant) to develop PDD for Caledon Wind project	14/05/2010
Prior consideration submitted to UNFCCC and DNA	21/09/2010

Additionality is demonstrated using the Tool for the demonstration and assessment of additionality (Version 06.0.0).

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

According to the Validation and Verification Manual (version 01): “103. The PDD shall identify credible alternatives to the proposed project activity in order to determine the most realistic baseline scenario, unless the approved methodology that is selected by the proposed CDM project activity prescribes the baseline scenario and no further analysis is required. (e.g., methodology ACM0002)”.

According to ACM0002 / Version 12.2.0, if the project activity is the installation of a new grid-connected 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 grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin (CM) calculations described in the “Tool to calculate the emission factor for an electricity system”.



As such, there is no need to further analyse alternatives to the proposed project activity to assess and demonstrate the additionality, since the methodology ACM0002 / Version 12.2.0 prescribes the baseline scenario for the proposed project activity. The baseline accounts for construction of other power sources due to calculating of a Combined Margin for the grid emission factor. The project is evaluated on its own viability and does not exclude the expansion of grid with other options.

The project participant went through the exercise of identifying realistic and credible alternatives available to the project that provide outputs or services comparable to the project activity. Although not required (as mentioned above).

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

In conclusion, realistic and credible alternatives available to the project that provide outputs or services comparable to the project activity include:

Alternative 1- Proposed project activity not undertaken as a CDM project but as a commercial project; and

Alternative 2- Equivalent electricity output from the grid. This is the baseline scenario as described in ACM0002 / Version 12.2.0

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

The construction of a power plant is required to be in compliance with all mandatory laws and regulations.

The above alternatives meet all legal and regulatory requirements of the host country South Africa.

Additionality of the CDM project can be demonstrated through the existence of barriers.

Step 3: Barrier Analysis

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

The following barriers have been identified:

(a) Barriers due to prevailing practice, *inter alia*:

In accordance with “Guidelines on additionality of first-of-its-kind project activities”, Annex 11 EB 63, (Version 01.0), paragraph 5:

“A proposed project activity is the First-of-its-kind in the applicable geographical area if:



- a) *The project is the first in the applicable geographical area that applies a technology that is different from any other technologies able to deliver the same output and that have started commercial operation in the applicable geographical area before the start date of the project; and*
- b) *Project participants selected a crediting period for the project activity that is a maximum of 10 years with no option of renewal.”*

There are currently no commercially operational wind farms in South Africa that contribute to the South African Power Pool. The facilities in South Africa are demonstration wind farms and have a smaller capacity than the proposed wind farm.

The two demonstration wind farms are: Klipheuwel Wind Farm and Darling National Demonstration Wind Farm. The Klipheuwel wind farm is an Eskom demonstration which has a total capacity of 3.2 MW. The Darling National Demonstration Wind Farm has the installed capacity of 5.2 MW and is being developed with financial assistance from: the Danish government; loan from the Development Bank of Southern Africa; investment by the Central Energy Fund and the Darling Independent Power Producer³.

Other commercial wind projects under development also require CDM funding. A commercial wind project faces a barrier, due to prevailing practice being coal fired electricity generation.

This project has not yet started commercial operation yet. The first commercial wind project implemented in South Africa, applying for a fixed crediting period of 10 years, would be additional due to being first-of-its-kind.

Approximately 0.02% of electricity in South Africa is produced by wind farms .Therefore; manufacturers of commercial-scale wind turbines are not available in South Africa.

The continuation of current practices (Alternative 2) does not pose any prevailing practice barriers as it is the business as usual scenario.

Many renewable energy technologies remain expensive, on account of higher capital costs, compared to conventional energy supplies for bulk energy supply to urban areas or major industries .Implementation of renewable energy technologies needs significant initial investment and may need support for relatively long periods before reaching profitability⁴. (SHABANGU, 2002)

The CDM alleviates this barrier by making available international finance to enable the implementation of the project. This is one of the factors affecting the prospects for renewable energy implementation that is mentioned in draft of the White Paper on the promotion of Renewable Energy and Clean Energy Development published in 2002 by the government of South Africa. (SHABANGU, 2002). The CDM further increases consumer awareness on the benefits and opportunities of renewable energy.

(b) Technological barriers

³ http://www.energy.gov.za/files/esources/renewables/r_wind.html

⁴ SHABANGU, S. (2002) Draft White Paper on the promotion of Renewable Energy and Clean Energy Development. South African Government.



The upper limit of wind energy available to be captured in South Africa is estimated at 3 GW(Diab, 1988)⁵. This capacity is currently not being realised due to one of the main barriers being little local capacity to manufacture, operate and maintain wind farms in South Africa⁶.

There is a lack of non-discriminatory open access to key energy infrastructure such as the national electricity grid, that provides a barrier to project implementation. (SHABANGU, 2002)

Another technological barrier was the fact that there are no local suppliers of the specialist spares, and it affected the wind turbine availability during the start up period. Special agreements had to be negotiated for fast turnaround on providing spares from overseas. The demonstration project also experienced problems with various smaller components regarding the turbine availability.

An IPP related tender from the Department of Energy in South Africa (2011), highlights the need for increased localisation of manufacturing, which further proves the existence of a technological barrier.

The existence of a technical barrier is further linked to the required infrastructure for transportation and construction. Similar commercial wind projects are using CDM to leverage actual implementation of wind projects, lifting renewable energy above the marginal threshold.

The continuation of current practices (Alternative 2) does not pose any technological barriers as it does not require any additional technology (it is the business as usual scenario).

The CDM alleviates this barrier by making available international finance to enable the implementation of the project. This is one of the factors affecting the prospects for renewable energy implementation that is mentioned in draft of the White Paper on the promotion of Renewable Energy and Clean Energy Development published in 2002 by the government of South Africa. (SHABANGU, 2002)

(c) Other barriers: Resource uncertainty:

Uncertainty in the annual energy production of each wind farm complicates the evaluation of project economics. The evaluation of a wind resource and the subsequent estimation of the annual energy production (AEP) were measured for a 24 month period for bankable feasibility studies, however no long term, (e.g. 10 years) reliable records are available. The graph below shows the fluctuation of the wind resource over the 24 month period.

⁵ SHABANGU, S. (2002) Draft White Paper on the promotion of Renewable Energy and Clean Energy Development. Pg 5. South African Government.

⁶ IDC 2010, Presentation on Green Industries & Technology. Available at <http://www.pmg.org.za/files/docs/100824idc-edit.pdf>

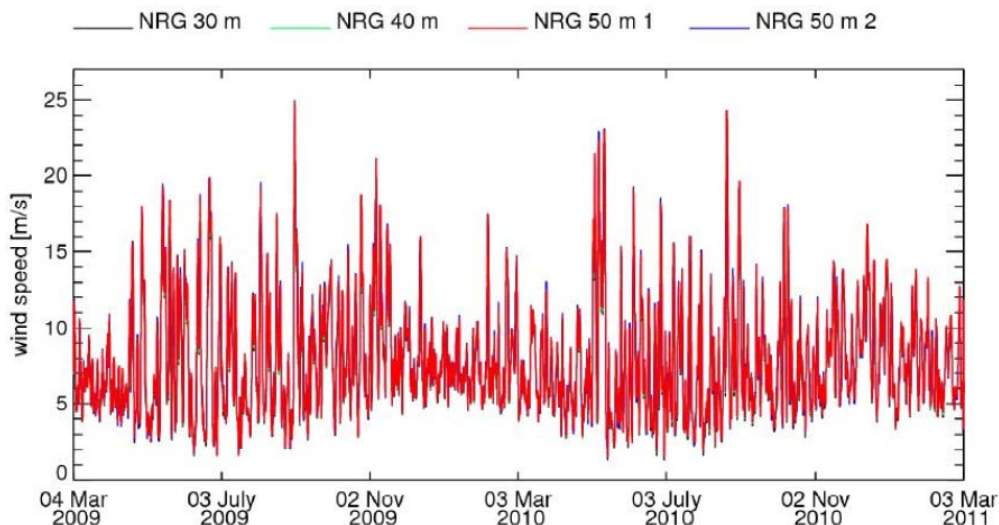


Figure 2: Processed Wind Data 2 Years

Compared to fossil fuel forms of energy, wind energy provides much higher uncertainty risks. The estimated output is based on wind measuring data and the assumptions made. There are no commercially operational wind farms and projects are therefore designed on generic and test data.

For the above uncertainty barriers, CDM income is expected to offset, to some extent, the risk concurrent with wind availability. CDM revenues help to overcome the risk associated with the barrier of resource uncertainty.

Proof: Here it is demonstrated that the expected revenues from the CDM are significant when put into relation with the risk caused by this barrier;

:

Thus ~13% is the revenue that will be lost if the production drop from P50 to P90.



Therefore the carbon revenue alleviates the resource uncertainty barrier of 15%.

Outcome of step 3a:

The combination of the above mentioned barriers may prevent Alternative 1 from occurring.

Sub-step 3b:

The continuation of current practices (Alternative 2) does not pose any barriers as it is the business as usual scenario.

Step 4: Common practice analysis:**Sub-step 4a - Other activities similar to the Caledon Wind Farm in South Africa;**

At 22 June 2011 there were 34 wind projects in South Africa which had submitted Prior Consideration of the CDM forms to the UNFCCC, but none of these projects are registered. Wind power generation in South Africa is still in its infancy. Installed wind capacity in the Rest of Africa and the Middle East (which includes South Africa) was 91MW in 2009.

Currently there are only two demonstration wind energy facilities in operation in South Africa as mentioned in the barrier analysis above. The current installed capacity of wind energy in South Africa is extremely low and includes the Darling Demonstration Wind Farm (5.2MW) and the Klipheuwel Wind Energy Demonstration Facility (3.2MW), which are the only grid connected wind farms in the country.

Sub-step 4b – Discussion of similar options that occur**The Darling Demonstration Wind Farm (5.2MW)**

One of the two demonstration wind farms in operation in South Africa is the Darling Demonstration Wind Farm. The required capital has come from a group of companies including Darling IPP (Darlipp), the nationally-run Central Energy Fund Ltd. (CEF) and the Development Bank of Southern Africa (DBSA). Danish donor money provided an additional grant for the project. Operation started in May 2008 after two years of construction. The four 1.3 MW turbines are estimated to have a total output of 13.2 GWh per year.

Klipheuwel Wind Energy Demonstration Facility (3.2MW)

The Klipheuwel Wind Energy Demonstration Facility was developed by Eskom as a demonstration project in 2002/03 as part of the South African Bulk Renewable Energy Generation programme. The facility is located in the Western Cape of South Africa. Klipheuwel's three turbines were commissioned from August 2002 to February 2003 and have a combined total capacity of 3.2 MW. The turbines include a Danish Vestas V47 with 0.66 MW, a V66 with 1.75 MW, and a French Jeumont J48 with 0.75 MW. The Klipheuwel Wind Energy Demonstration Facility is connected to the grid via 2.6km of 11kV overhead lines and cabling to the Klipheuwel substation.



No similar activities have proceeded without CDM financing.

Given a total installed capacity of less than 10 MW of wind energy in South Africa, the development of wind farms in South Africa is clearly not business as usual.

Sub-steps 4a and 4b are satisfied, i.e.(i) similar activities cannot be observed or (ii) similar activities are observed, but essential distinctions between the project activity and similar activities can reasonably be explained, thus the proposed project activity is additional). As a result of the above analysis it can be concluded that the project activity is additional.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

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Project emissions

According to the chosen baseline methodology ACM0002 Version 12.2.0, for wind energy based renewable energy project activities, $PE_y = 0$.

Baseline emissions

Baseline emissions include only CO₂ emissions from electricity generation in fossil fuel fired power plants that are displaced 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 to be calculated as follows:

(1)

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 $EG_{PJ,y}$

(a) Greenfield plants

The project activity is the installation of a new grid-connected renewable power plant at a site where no renewable power plant was operated prior to the implementation of the project activity, so method (a) Greenfield renewable energy power plants is used.

(2)

Where:

$EG_{PJ,y}$	= Quantity of net electricity generation that is produced and fed into the grid as a result
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	of the implementation of the CDM project activity in year y (MWh/yr)
$EG_{\text{facility},y}$	= Quantity of net electricity generation supplied by the project plant/unit to the grid in year y MWh/yr)

Calculation of $EF_{\text{grid},CM,y}$

The project activity will displace grid electricity. The emission factor for the grid electricity was calculated in accordance with the latest approved version of the “Tool for calculation of emission factor for electricity systems,” Version 02.2.0. The steps applied to determine the emission factor for the grid can be seen in Annex 3.

Leakage

No leakage emissions are considered, according to ACM0002 (version 12.2.0). The main emissions potentially giving rise to leakage in the context of electric sector projects are emissions arising due to activities such as power plant construction and upstream emissions from fossil fuel use (e.g. extraction, processing and transport). These emissions sources are neglected.

Emission reductions

Emission reductions are calculated as follows:

(6)

Where:

ER_y	= Emission reductions in year y (t CO ₂ e/yr)
BE_y	= Baseline emissions in year y (t CO ₂ /yr)
PE_y	= Project emissions in year y (t CO ₂ e/yr)

Since there are no project emissions this becomes:

(7)

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

(Copy this table for each data and parameter)

Data / Parameter:	$EF_{\text{grid},CM,y}$
Data unit:	tCO ₂ /MWh
Description:	Combined margin CO ₂ emission factor for the SAPP
Source of data used:	The combined margin emission factor, determined according to the latest approved version of the “Tool to calculate emission factor for an electricity system”.
Value applied:	1.0159
Justification of the choice of data or description of measurement methods and procedures actually applied :	This figure is calculated using the “Tool to calculate emission factor for an electricity system” (Version 12.1.0) at the beginning of the project and kept constant for the life of the project.
Any comment:	

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

>>

As per the description in B.6.1 the emission reductions are calculated as follows:

And

For the proposed project activity $EF_{grid,CM,y}$ is 1.0159

Year	ER_y	$EG_{facility,y}$	$EF_{grid,CM,y}$
1	413,491	407,014	1.0159
2	413,491	407,014	1.0159
3	413,491	407,014	1.0159
4	413,491	407,014	1.0159
5	413,491	407,014	1.0159
6	413,491	407,014	1.0159
7	413,491	407,014	1.0159
8	413,491	407,014	1.0159
9	413,491	407,014	1.0159
10	413,491	407,014	1.0159

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

>>

Year	Estimation of project activity emissions (tonnes of CO ₂ e)	Estimation of baseline emissions (tonnes of CO ₂ e)	Estimation of leakage (tonnes of CO ₂ e)	Estimation of overall emission reductions (tonnes of CO ₂ e)
1	0	413,491	0	413,491
2	0	413,491	0	413,491
3	0	413,491	0	413,491
4	0	413,491	0	413,491
5	0	413,491	0	413,491
6	0	413,491	0	413,491
7	0	413,491	0	413,491
8	0	413,491	0	413,491
9	0	413,491	0	413,491
10	0	413,491	0	413,491
Total (tonnes of CO ₂ e)	0	4,134,914	0	4,134,914

**B.7. Application of the monitoring methodology and description of the monitoring plan:****B.7.1 Data and parameters monitored:**

Data / Parameter:	$EG_{\text{facility},y}$
Data unit:	MWh/yr
Description:	Quantity of net electricity generation supplied by the project plant to the grid in year y
Source of data to be used:	Measured by meters with an accuracy of 0.5%.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	407,014 MWh/yr
Description of measurement methods and procedures to be applied:	Electricity meter will be installed at the transformer station, to measure the exported electricity generated by the project and exported to the grid and imported electricity by the project from the grid. The net electricity generation supplied by the project to the grid can be calculated.
QA/QC procedures to be applied:	The data from the meters installed at the substation will be crosschecked with sales invoices. In the case of inconsistencies, the more conservative of the two values will be used.
Any comment:	

B.7.2. Description of the monitoring plan:

>>

Operational and Management Structure:

Caledon Wind is responsible for the effective implementation of the monitoring management plan. All elements of the monitoring plan will be supported by formal procedures and regular training of delegated personnel, as appropriate.

Caledon Wind will be operated by an experienced Wind-Park operator JUWI for the 1st 5 years, (renewable bi-annually thereafter), during which, local staff will be trained (on-site and at their European operations) as part of Employment Equity Program.

The responsibility for data collection and achieving will be that of technical management (provided by the onsite team). The following arrangements apply:

- Remote Monitoring:
 - Plant operation monitoring per remote monitoring system
 - Taking adequate initial actions in case of malfunction/ damages
 - Information/ order to maintenance service provider if required



- Soft shut down/ on of WTG per remote system in case of scheduled grid shut offs/on
- Monthly/ Annual technical reporting:
 - Generation of monthly/ annual reports, including all major defects/ malfunctions, availability and generated power of each WTG and in average of the wind farm,
 - Report of all services performed by maintenance contractor or other contractors
- Semi-annual plant inspection:
 - Technical inspection of the WTG in accordance to a detail check schedule, including foundation, tower, gear boxes, generator, rotor blades, nacelle transformer, cabling, switch panels, etc. to evaluate actual plant condition and to control performance of maintenance contractor
 - Extensive photo documentation
 - Detailed inspection report about the current plant condition and recommended measures generation of punch list

Data sources

The following data sources will be used for monitoring the necessary data and parameters:

- Eskom
- Caledon Wind.

Emission reduction data monitoring and management procedures will be put in place prior to the starting date of the crediting period.

Caledon Wind will be responsible for training of personnel, calibration and maintenance of equipment and physical reading, day-to-day handling and long-term storage of metered data. Operational data will be monitored 24 hours per day in the control centre which will be based in Caledon. Meters will be calibrated in accordance with the manufacturer's requirements. The results of each calibration will be recorded in a formal report and the report archived.

Metering

Electricity supplied by the project activity to the grid will be measured by the Caledon Wind Farm.

Metering will be conducted with calibrated measurement equipment according to relevant industry standards. A main metering system will be installed on site by the project proponent. A backup metering system will also be installed.

Meter data will be recorded and stored by onsite devices as well as remotely via a fibre optic communication network. Photographic facilities will also record the metered data as part of monthly onsite verification procedures. The metering equipment will be located at the delivery point of the wind power plant to the grid, namely between the step-up transformers and the transmission line busbars.

Recording



Meter data (kWh and kVArh) from the main and backup metering systems will be recorded on a continuous basis to quantify net electrical output. Such data will be measured locally by onsite devices as well as remotely via a fibre optic communication network linked to both the Caledon Wind Farm and Eskom control rooms. Photographic facilities will also record the metered data as part of monthly onsite verification procedures.

Data management

The data received, analysed and used for monitoring purposes will be stored for at least two years following the end of the project activity crediting period as per ACM0002 (version 12.2.0). The hourly dispatch data will be stored in a centralised database.

Quality Assurance and Quality Control

Caledon Wind Farm will have a certified quality system that meets the requirements of the ISO 9001 series of standard or equivalent. The main metering equipment and the backup metering equipment shall be to a mutually agreed international standard providing a measured accuracy of class 0.5%. Meters will have fixed seal that cannot to be tampered with.

If during testing, both the main and backup meters are within the permissible limit of error i.e. 0.5%, the energy consumption will be as per the main meter. If during testing, the main meter is found to be within the permissible limits of error but the corresponding backup meter is beyond the permissible limit; the energy consumption will be as per the main meter. Action will be taken to address the issue with the backup meter. If during testing, the backup meter is found to be within the permissible limits of error but the corresponding main meter is beyond the permissible limit; the energy consumption will be as per the backup meter. Action will be taken to address the issue with the main meter.

The data from the meters installed at the transformer station will be crosschecked with Eskom invoices. In the case of inconsistencies, the more conservative of the two values will be used.

In order to ensure conservativeness, Deemed Generated Energy (electrical energy generated but not delivered to the grid due to Eskom system interruption or Eskom dispatch instruction) will not be included in emission reduction calculations.

If problems occur that may affect the quality of data, corrective action will be taken. In the case where data quality problems result in uncertainty issues, the more conservative value from an energy generation or emission factor standpoint will be used to in the calculations and monitoring data for verification.

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

>>

Date: 04/11/2011

Entity: Promethium Carbon (Pty) Ltd

Promethium Carbon is not a project participant.

**SECTION C. Duration of the project activity / crediting period****C.1. Duration of the project activity:****C.1.1. Starting date of the project activity:**

>>

01/12/2012 (the date when the turbine orders are expected to be placed)

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

>>

Duration of the equipment, if maintained in accordance with manufacturer's instructions is 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:**

>>

01/10/2012 or the date of registration, whichever occurs later.

C.2.2.2. Length:

>>

Ten years.

SECTION D. Environmental impacts

>>

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

>>

There are policies that exist that support wind energy in South Africa, but these are not mandatory policies. South Africa is supportive of wind energy as mentioned in the Renewable Energy White Paper and the Energy Efficiency Strategy.

The construction of a power plant is required to be in compliance with all mandatory laws and regulations. The project must comply with the requirements of the REFIT guidelines which are governed



by the National Energy Regulator Act, 2004 (No. 40 of 2004), Electricity Regulation Act, 2006 (No. 4 of 2006) and all subsequent relevant Acts of Amendment. In addition, the project must comply with the Generation Licence application procedures and all applicable environmental legislation.

The project activity complies with national legislation regarding the environmental impacts and does not include transboundary impacts.

In terms of the EIA Regulations, an application of this nature has to undergo both Scoping and Environmental Impact Assessment (EIA). Arcus GIBB (Pty) Ltd (Arcus GIBB) were commissioned to undertake the EIA process. The EIA has been submitted to the Department of Environment Affairs (DEA).

It is anticipated that the activities associated with the proposed project described above may have both positive and negative potential impacts on the receiving environment and community, and these will be assessed within the EIA. The following points were highlighted:

- **Flora Impact Assessment**
- **Fauna Impact Assessment**
- **Avifauna Impact Assessment**
- **Agricultural Potential Impact Assessment**
- **Baseline Geotechnical Study**
- **Social Impact Assessment**
- **Heritage Impact Assessment**
- **Noise Impact Assessment**
- **Traffic Impact Assessment**
- **Visual Impact Assessment**

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

>>

The ROI was received. The application for the record of decision (ROD) has been submitted and is expected to be received in January 2012.

**SECTION E. Stakeholders' comments**

>>

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

>>

As part of the EIA process, a stakeholder workshop was held on 11 January 2010 in Caledon, the closest town. In addition, public meetings were held in Botrivier on 11 January 2010 and Caledon on 12 January 2010. Invitations to the public meetings were extended in letters, by telephone and in public notices. Advertisements were also placed in various newspapers:

Newspaper	Date	Language
The Argus	18 November 2009	English
Die Burger	18 November 2009	Afrikaans
Caledon Kontreinuus	19 November 2009	Afrikaans
Overberg Venster	19 November 2009	Afrikaans
Hermanus Times	19 November 2009	English

E.2. Summary of the comments received:

>>

Botrivier Public Meeting

An example of comments received is presented below. All the comments received can be seen in the Environmental Impact Assessment for the Proposed Caledon Wind Farm, Power Lines and Associated Infrastructure Botrivier Public Meeting minutes.

1. Anthony Appel wanted to know: Why is the control room proposed to be in Caledon as opposed to Botrivier?
2. Anthony Appel also asked: How many trucks will be required per 50MW?
3. Anthony Appel enquired: Hawston View Road will be utilised during the construction of the new substation. Will CaledonWind consider tarring this road as that road has a tendency to become corrugated when over utilised?

Caledon Public Meeting

An example of comments received is presented below. All the comments received can be seen in the Environmental Impact Assessment for the Proposed Caledon Wind Farm, Power Lines and Associated Infrastructure Caledon Public Meeting minutes.

1. Dr Stuart Shearer wanted to know: What are the height of the towers and the length of the blades for a 3.6MW wind turbine?
2. K. Bobantz asked: When will the final positions of the turbines be determined? Will this be after the Draft Impact Assessment has been issued? Will interested and affected parties (I&APs) be able to comment on the positioning of the turbines?
3. Dr Stuart Shearer also enquired: Considering that some studies have shown that birds are attracted to a constant red light placed on top of high structures such as wind turbines, could the proponent not make use of blinking lights? If Aviation Authorities have put in place legislation prohibiting developers to place blinking lights on top of such towers, could Caledon Wind not apply for an exemption?

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



>>

Botrivier Public Meeting

An example of how the comments received at this meeting were taken into account is presented below. All the comments received and the responses can be seen in the Environmental Impact Assessment for the Proposed Caledon Wind Farm, Power Lines and Associated Infrastructure Botrivier Public Meeting minutes.

1. The placement of the control centre in Caledon as opposed to on-site or Botrivier is for logistical and structural reasons. The control room will require access to telecommunications infrastructure, fire management infrastructure. Furthermore it is not necessary to be on site and as such will also reduce the need for the operators to travel to site daily.
2. There will be approximately 25 turbines delivered per 50MW. Each turbine will require approximately 5 trucks, and all in all approximately 175 trucks will be required per each 50MW.
3. It is not proposed at this stage to tar the Hawston View road as currently the soil conditions on that road are suitable (hard and compact) for transportation of the substation components. The road condition, however, will be improved prior to construction and returned to the same state once construction is complete.

Caledon Public Meeting

An example of how the comments received at this meeting were taken into account is presented below. All the comments received and the responses can be seen in the Environmental Impact Assessment for the Proposed Caledon Wind Farm, Power Lines and Associated Infrastructure Caledon Public Meeting minutes.

1. A 3.6MW Turbine, which is the maximum size considered, has a tower height of up to 100m and a blade length of up to 58.5m, dependant on the final technical analysis performed by our (Swiss) expertise. This information has been made available in the Draft Scoping Report currently out for public review.
2. Rebecca Thomas and Hans Boer replied that information will be made available in the Draft Environmental Assessment report. I&APs will have an opportunity to review the Draft Environmental Assessment report and comment on the positioning of the turbines. It should be noted that the wind farm falls within an area of 3700ha, providing enough flexibility to place the wind turbines in optimal positions, meeting both technical and environmental requirements.
3. Dion Wilmans said that according to legislation set out by the relevant national authorities, including the Civil aviation authorities, the masts must be topped with a constant red light, not a flickering one. This also applies to other masts such telecommunication towers. The proponent may not deviate from this legislation and also stated that a flickering light has a disruptive visual effect that is not well received by people living adjacent to wind farms. However, specialists have been appointed to assess the impact of the wind turbines on bird populations in the area and they will recommend mitigation measures which will have to be considered by the authorities.

**Annex 1****CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY**

Organization:	Caledon Wind Energy Trading (Pty) Ltd
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E-Mail:	-
URL:	www.caledonwind.com
Represented by:	-
Title:	Mr
Salutation:	Mr
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Represented by:	Edward Weinberg
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding has been used or will be used in the development and implementation of this project.



Annex 3

BASELINE INFORMATION

STEP 1: IDENTIFY THE RELEVANT ELECTRICITY SYSTEMS

This tool will serve project activities that prospect to displace grid electricity in South Africa.

The **project electricity system** is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity and that can be displaced without significant transmission constraints.

Similarly, a **connected electricity system**, e.g. national or international, is defined as an electricity system that is connected by transmission lines to the project electricity system. Power plants within the connected electricity system can be dispatched without significant transmission constraints, but transmission to the project electricity system has significant transmission constraints.

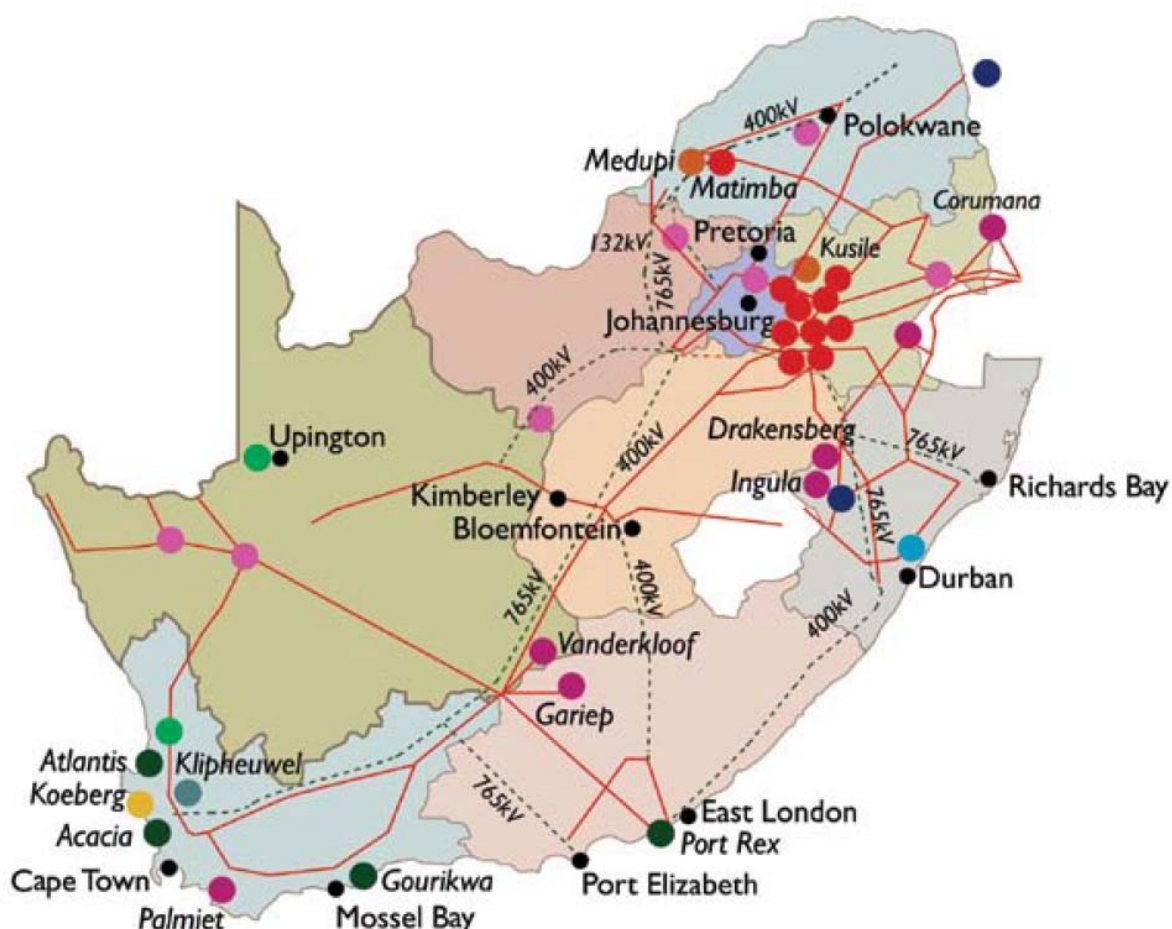
The DNA of South Africa has not published a delineation of the project electricity system and connected electricity systems. Also, the application of the criteria with regards to determining significant transmission constraints does not result in a clear grid boundary due to a lack of sufficient data. For these reasons the following was chosen for the reference system of this project:

- The **project electricity system** entails all the Eskom power plants in the South African electricity grid.
- Due to a lack of data available in the public domain (in order to evaluate significant transmission constraints), all other power stations (non-Eskom) and countries with power grids connected to South Africa, are treated as **connected electricity systems**, and emission factors for imports from these systems are conservatively assumed to be 0 tCO₂/MWh.

All electricity generated by the Eskom power stations is taken into consideration when calculating the grid emission factor; exports are not subtracted.

All the data for the Eskom power stations are obtained from the Eskom website, where they have a specific webpage dedicated to CDM grid emission factor related data (Eskom Holdings SOC Limited, 2011). This data includes commissioning dates, electricity generated, and fuel consumed.

Data for the imported electricity are obtained from the Eskom annual report, where “*Total purchased for the Eskom system (GWh)*” is shown in the “*Statistical overview*” table on pg. 324 of the report (Eskom Holdings SOC Limited, 2011).



STEP 2: CHOSE WHETHER TO INCLUDE OFF-GRID POWER PLANTS IN THE PROJECT ELECTRICITY SYSTEM

This step is optional according to the tool. The grid emission factor is calculated from only grid power plants (**Option I**). Off-grid power plants are not included in the calculations.

STEP 3: SELECT A METHOD TO DETERMINE THE OPERATING MARGIN (OM)

The OM is calculated using the **simple OM method (Option a)**. The simple OM method can be used provided that the low-cost/must-run resources constitute less than 50% of the total grid generation in average of the five most recent years.

The average percentage of low-cost/must-run resources amount to 0.00% of the total grid generation for this project electricity system. Therefore, Option (a) is applicable.

In terms of data vintages, the *ex ante* option were chosen to calculate the simple OM. In this option a 3 year generation-weighted average are used for the grid power plants. Using this option also means that the emission factor is determined only once at the validation stage, thus no monitoring and recalculation is required during the crediting period.



The data used in OM calculations are for the 3 year period of 1 April 2007 – 31 March 2010 (Eskom financial year runs from 1 April – 31 March). This is the latest available data.

STEP 4: CALCULATE THE OPERATING MARGIN EMISSION FACTOR ACCORDING TO THE SELECTED METHOD

The simple OM emission factor ($EF_{grid,OMsimple,y}$) is calculated as the generation-weighted average CO₂ emissions per unit net electricity generation (tCO₂/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units. Hence, the hydro and nuclear power plants are excluded from the calculation of the OM.

Option A is used for calculating the simple OM. The calculations in this option are based on the total net electricity generation and a CO₂ emission factor of each power plant.

Option A – Calculation based on average efficiency and electricity generation of each plant

Under this option, the simple OM emission factor is calculated based on the net electricity generation of each power plant and an emission factor of each power plant, as follows:

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

Where:

- $EF_{grid,OMsimple,y}$ = Simple operating margin CO₂ emission factor in year y (tCO₂/MWh)
- $EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m in the year y (MWh)
- $EF_{EL,m,y}$ = 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 data vintage chosen in Step 3

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

The emission factor for each power plant m were determined as follows (**Option A1**):

$$EF_{grid,OMsimple,y} = \frac{\sum_i (FC_{i,y} \times NCV_{i,y} \times EF_{CO_2,i,y})}{EG_y} \quad (6)$$

Where:

- $EF_{grid,OMsimple,y}$ = Simple operating margin CO₂ emission factor in year y (tCO₂/MWh)
- $FC_{i,y}$ = Amount of fossil fuel type i consumed in the project electricity system in year y (mass or volume unit)
- $NCV_{i,y}$ = Net calorific value (energy content) fossil fuel type i in year y (GJ/mass or volume unit)
- $EF_{CO_2,i,y}$ = CO₂ emission factor of fossil fuel type i in year y (tCO₂/GJ)
- EG_y = Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost/must-run power plants/units, in year y (MWh)
- i = All fossil fuel types combusted in power sources in the project electricity system in year y
- y = The relevant year as per data vintage chosen in Step 3.

Electricity imports are treated as one power plant, as per the tool guidance.



The constants used in calculations appear in Table 1.

Table 1: Constants used in calculations

Constants		
NCV _{other bituminous coal}	19.9	GJ/T
NCV _{other kerosene}	42.9	GJ/T
EF _{CO₂other bituminous coal}	0.0895	tCO ₂ /GJ
EF _{CO₂,other kerosene}	0.0708	tCO ₂ /GJ

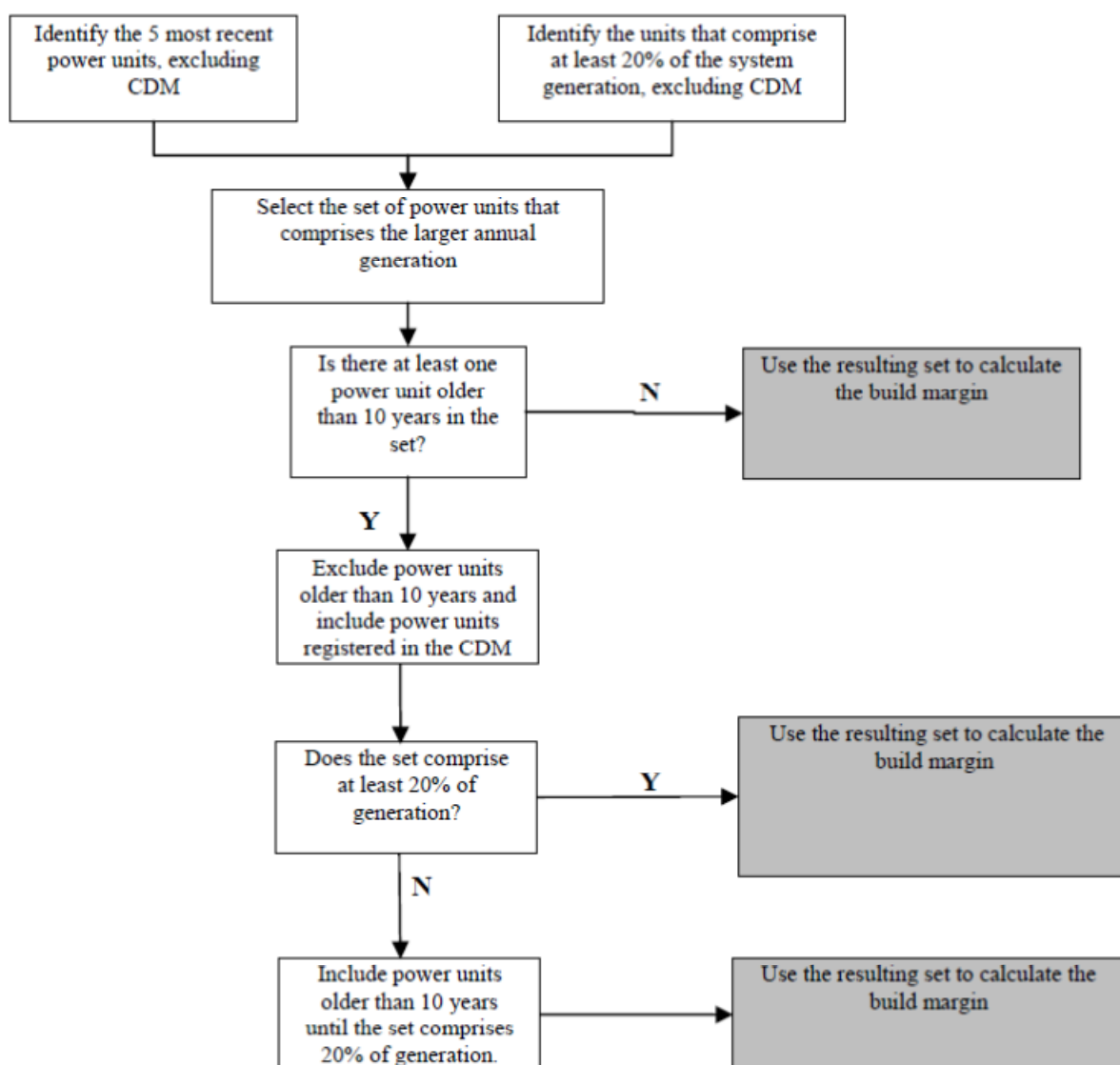
Using equation 6, the OM is calculated as **1.015** tCO₂e/MWh.

STEP 5: CALCULATE THE BUILD MARGIN (BM) EMISSION FACTOR

In terms of vintage of data, one **Option 1** was selected: 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.

The sample group of power units *m* used to calculate the build margin were determined as per the procedure delineated in the tool, consistent with the data vintages selected.

The following diagram summarizes the procedure of identifying the sample group:



The build margin emissions factor is the generation-weighted average emission factor (tCO₂/MWh) of all power units *m* during the most recent year *y* for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad (13)$$

Where:

- $EF_{grid,BM,y}$ = Build margin CO₂ emission factor in year *y* (tCO₂/MWh)
- $EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
- $EF_{EL,m,y}$ = CO₂ emission factor of power unit *m* in year *y* (tCO₂/GJ)
- m* = Power units included in the build margin

y = Most recent historical year for which power generation data is available.
 The CO₂ emission factor of each power unit m ($EF_{EL,m,y}$) should be determined as per the guidance in Step 4 (a) for the simple OM, using **Option A1** 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.
 If for a power unit m data on fuel consumption and electricity generation is available the emission factor ($EF_{EL,m,y}$) should be determined as follows:

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \times NCV_{i,y} \times EF_{CO_2,i,y}}{\sum_m EG_{m,y}} \quad (2)$$

Where:

- $EF_{EL,m,y}$ = CO₂ emission factor of power unit m in year y (tCO₂/MWh)
- $FC_{i,m,y}$ = Amount of fossil fuel type i consumed by power unit m in year y (mass or volume unit)
- $NCV_{i,y}$ = Net calorific value (energy content) fossil fuel type i in year y (GJ/mass or volume)
- $EF_{CO_2,i,y}$ = CO₂ emission factor of fossil fuel type i in year y (tCO₂/GJ)
- $EG_{m,y}$ = Net electricity generated and delivered to the grid by power 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 data vintage chosen in Step 3.

Using equation 13, the BM is calculated as **1.019** tCO₂e/MWh.

STEP 6: CALCULATE THE COMBINED MARGIN (CM) EMISSION FACTOR

The combined margin factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM} \quad (14)$$

Where:

- $EF_{grid,BM,y}$ = Build Margin CO₂ emission factor in year y (tCO₂/MWh)
- $EF_{grid,OM,y}$ = Operating margin CO₂ emission factor in year y (tCO₂/MWh)
- w_{OM} = Weighting of operating margin emissions factor (%)
- w_{BM} = Weighting of build margin emissions factor (%)

The emission factors for the operating margin, the build margin, and the final combined margin appear in Table 8.

Table 1: CM emission factor

$EF_{grid,OM,y}$	1.015
$EF_{grid,BM,y}$	1.019
w_{OM}	0.75
w_{BM}	0.25
$EF_{grid,CM,y}$	1.0159



Annex 4

MONITORING INFORMATION
