



**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:**

Karoo Renewable Energy Facility (Nobelsfontein Solar PV)

Version number of the document: 03

Date: 10/05/2012

A.2. Description of the project activity:

The Karoo Renewable Energy Facility (Nobelsfontein Solar PV) 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 the Northern and Western Cape provinces, approximately 34 km south of Victoria West. The majority of the site is located within the Ubuntu local municipality, with a smaller portion within the Beaufort West local municipality.

The objective of the project is to generate electricity from renewable energy resources (ie, solar PV) to provide power to the to the South African power grid. Construction and operation of a new renewable energy facility that uses solar energy to generate electricity and supply electricity to the grid (greenfield power plant).

The proposed facility will have a generating capacity of 50.4MW and based the local solar irradiation resource, the project activity is expected to deliver on annual average 94,527 MWh of electricity to the South African Power Grid annually; with an equivalent initial capacity factor of 21.9% : The capacity factor of a power plant is the ratio of the actual output of a power plant over a period of time and its potential net output if it had operated at full nameplate capacity the entire time. The electricity loss from generator end to substation is included as part of adjustments for calculating capacity factor The project will comprise the following infrastructure

- An array of photovoltaic (PV) panels (of up to 6m in height)
- Two (2) 132 kV substations with high-voltage (HV) yard footprints of approximately 100m x 100m
- Cabling between the project components, to be lain underground where practical
- Two (2) new overhead 132kV power lines:
 - From Substation 1:
 - Substation 1 Option 1: To turn-in directly to the existing Hutchinson/ Biesiespoort-1 132vV line (up to 1km length of power line) or alternatively
 - Substation 1 Option 2: To connect to Eskom’s existing Biesiespoort Substation (up to 2.5 km length of power line)
 - From Substation 2:
 - Substation 2 Option 1: To turn-in directly to the existing Droerivier/ Hydra-2 400kV line (up to 1.5 km length of power line) or alternatively
 - Substation 2 Option 2: To connect to Eskom’s existing Victoria Substation (up to 12 km length of power line)



- Internal access roads – 5m wide and 82.15 km long, linking the array with the other infrastructure on the site, as necessary. Existing farm roads will be used as far as possible.
- Small office and/ or workshop building – 40m x 20m for maintenance and storage purposes

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 CO₂ 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 91,785 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 pollution associated with coal-fired power plants such as sulphur dioxide, nitrogen oxides and particulates.

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 project assists in the process of stimulating a green economy in which new domestic industries are created to supply renewable energy facilities and related requirements, resulting in significant green jobs.

The project will contribute to socio-economic development in two ways. Firstly, 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 countries natural resources and increased energy security. Secondly, the project has the potential to create jobs, both in the construction and operations phases, which is a very important factor in an area of high unemployment. In addition to on-site job creation the project will source materials and equipment locally wherever possible.

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 project participant (Yes/No)

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



South Africa (host)	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 <u>project activity</u>:		

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.:

Northern Cape

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

Nobelsfontein (34k south of Victoria West)

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

The project site is located within the Northern and Western Cape provinces, approximately 34 km south of Victoria West. The majority of the site is located within the Ubuntu local municipality, with a smaller portion within the Beaufort West local municipality.

Coordinates: 31°43’16.27”S, 23°11’38.55”E

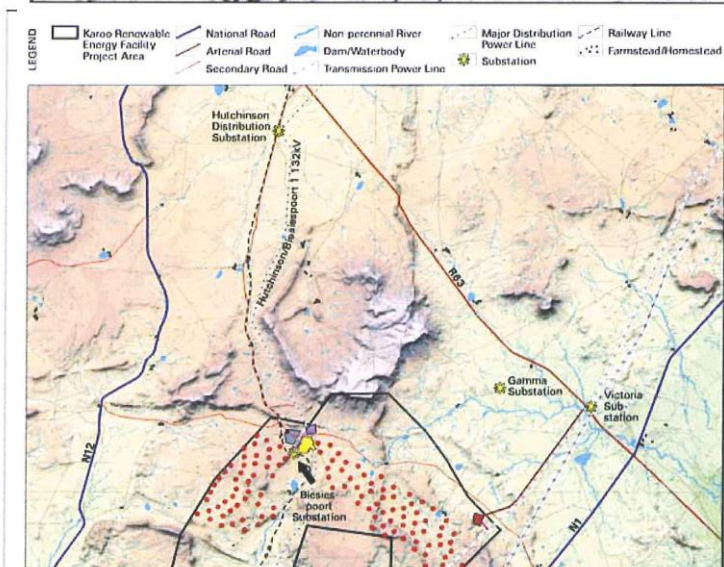
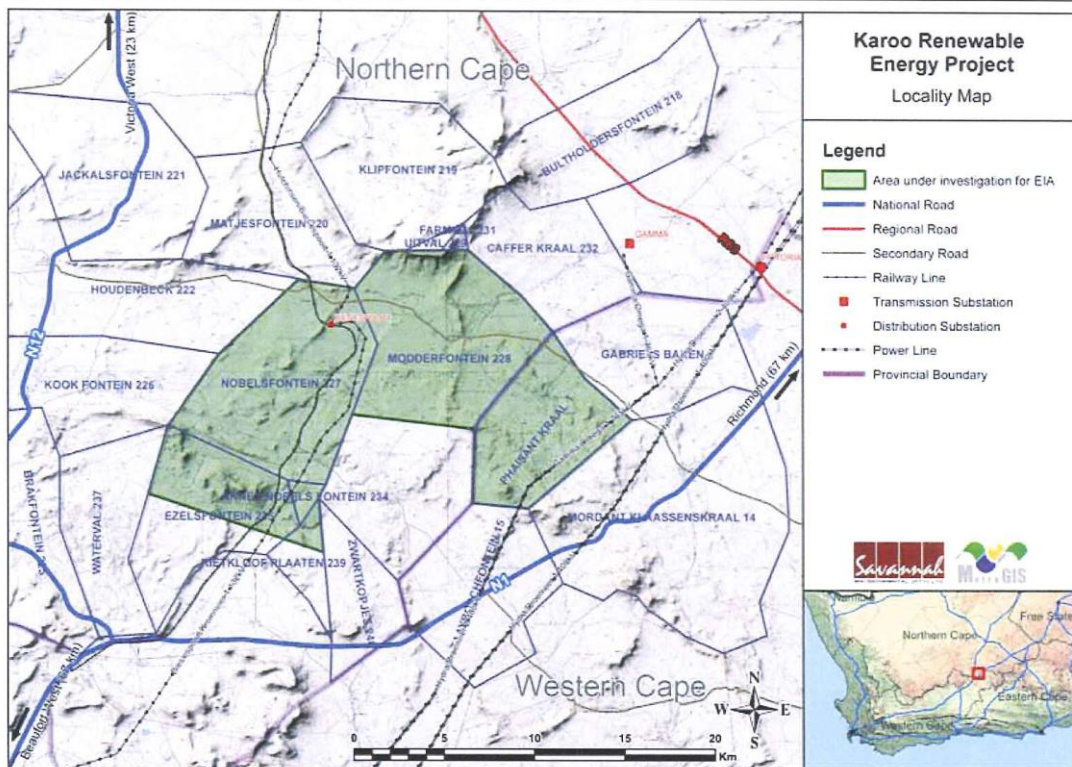
Town/ City: Nobelsfontein (34k south of Victoria West)

Province: Northern Cape

Country: South Africa



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



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

The large scale project objective is to utilize solar energy to generate electricity with no associated GHG emissions. This falls into Sectoral Scope 1: *Energy industries (renewable/non-renewable)* as per the published list of Sectoral Scopes.

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

The objective of the project is to generate electricity from renewable energy resources (ie, solar PV) to provide power to the to the national electricity grid. Construction and operation of a new renewable energy facility that uses solar energy and supplies electricity to the South African power grid (greenfield power plant), fulfils this objective. The project is a Greenfield power plant utilising an environmentally safe technology, which will include technology transfer to the Host Party.

The project has the installed capacity of 50.4MW over the project period. The project is equipped with 25 sub-fields of about 2.02 MW each. Every sub-field is made up of 8,400 polycrystalline type modules, divided into 420 strings made up of 20 modules each. Strings are made of PV modules connected in series, so that the maximum DC input of inverters is not reached. In each of the 25 sub-fields, strings are collected by string boxes. The connection to the South African power grid will be in HV at 132 kV. Phase 2 would follow the same setup.²

Item	Value
Nominal Power	50.4MWp
N ^o of modules (total)	210,000
N ^o of inverters	50
N ^o of modules per inverter	4,200

² Poyry Pre-Feasibility Report – Nov 2010



N° of strings per inverter	210
N° of PV modules per string	16
Radiant area (m ²)	343,728

Use of this technology is limited in South Africa. The technology has been tried and tested internationally. Internationally, solar PV is used in many countries, with the top five in terms of installed capacity being Germany (9.8GW), Spain (3.4GW), Japan (2.6GW), USA (1.7GW) and Italy (1.2GW). Table A-1 shows key technical parameters of solar cell modules adopted by the first phase of the Project, and table A-2 gives key technical parameters of 1000MV inverters used in the first phase.

Table A-1 crystalline silicon solar cell modules provided by Tina Solar TSM-240PC05³

Item	Value
Cell	Poly crystalline collar cells (156 X 156 mm)
N ^o of cells	60 series connected
Maximum system voltage	1,000 Vdc
Nominal power	240 Wp
Maximum power voltage (V _{mp})	30.04 V
Maximum current	7.89 A
Open Circuit voltage (V _{oc})	37.2 V
Short circuit current (I _{sc})	8.37 A
Efficiency (at STC – standard Test Conditions)	14.7% ± 3%
Temperature coefficient or power (P _{mpp})	-0.45% / °C
Dimensions (mm)	1,650 x 992 x 46
Weight	19.5 kg

Table A-2 Technical data of the 1000MV SMA Sunny Central inverter.⁴

Item	Value
Suggested DC power	1,018 kWp
MPPT DC voltage range	450 – 820 Vdc
Rated DC current	2,400 Adc
Rated AC power	1,000 kW
Rated AC current	28.8 A
Nominal AC voltage	20 kV
Nominal AC frequency	50 – 60 Hz
Number of units	2
Dimension (W x H x D) mm	5,400 x 3,620 x 3,000
Weight of concrete cabin, inverters and transformer – each single unit (t)	35

Electricity delivered to the South African power grid by the project activity will be monitored with electricity meters installed at the 132 kV Substation. The monitoring system should be web based to allow remote monitoring and supervision. The output of a power plant is 37% of the maximum output.

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-connected Eskom power plants and by the addition of new generation sources.

³ Poyry Pre-Feasibility Report – Nov 2010

⁴ Poyry Pre-Feasibility Report – Nov 2010

**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 91,785 tonnes of CO₂e per year over the crediting period. The total emissions reductions of the project will be 917,855 tonnes of CO₂e.

Annual expected emission reductions (tonnes CO₂ equivalent) are provided in the table below:

Year	Emission Reductions* (tones CO₂e/a)
2014	93,870
2015	93,400
2016	92,933
2017	92,469
2018	92,006
2019	91,546
2020	91,088
2021	90,633
2022	90,180
2023	89,729
Total Estimated Emission Reductions (tCO₂e)	917,855
Number of Crediting Years	10
Average Estimated Emission Reductions over the crediting period (tCO₂e)	91,785

A.4.5. Public funding of the project activity:

There is no public funding from Annex I Parties for 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:**

"Consolidated baseline methodology for grid-connected electricity generation from renewable sources", (version 12.1.0). ACM0002 is the approved baseline and monitoring methodology used for the project activity.

In concurrence with the methodology, the project makes use of the:

"Tool to calculate the emission factor for an electricity system" (Version 02.2.0),

"Tool for the demonstration and assessment of additionality" (Version 05.2) and the

"Combined tool to identify the baseline scenario and demonstrate additionality" (Version 0.03.0)

These are the latest approved versions of the above tools. For more information regarding the methodology please refer to <http://cdm.unfccc.int/methodologies/approved>.

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

Methodology ACM0002, approved by CDM EB, is applicable under the following conditions:

Applicability of ACM0002	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 installs a new grid-connected solar PV power plant at a site where no renewable power plants were previously operated
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 EGPI,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: <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 is not a hydro power plant.



<ul style="list-style-type: none"> • 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 • 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 	
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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 Solar PV 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/m ² .	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.

According to the consolidated baseline and monitoring methodology, ACM0002, the emission factor of the electricity system is determined using the “*Tool to calculate the emission factor for an electricity system*” and the additionality of the Project is demonstrated and assessed using the “*Tool for the Demonstration and Assessment of Additionality*” both of which were approved by CDM EB.

Methodology ACM0002 is therefore applicable to the project activity.

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

The project boundary includes the project power plant and all power plants physically connected to the South African power grid.

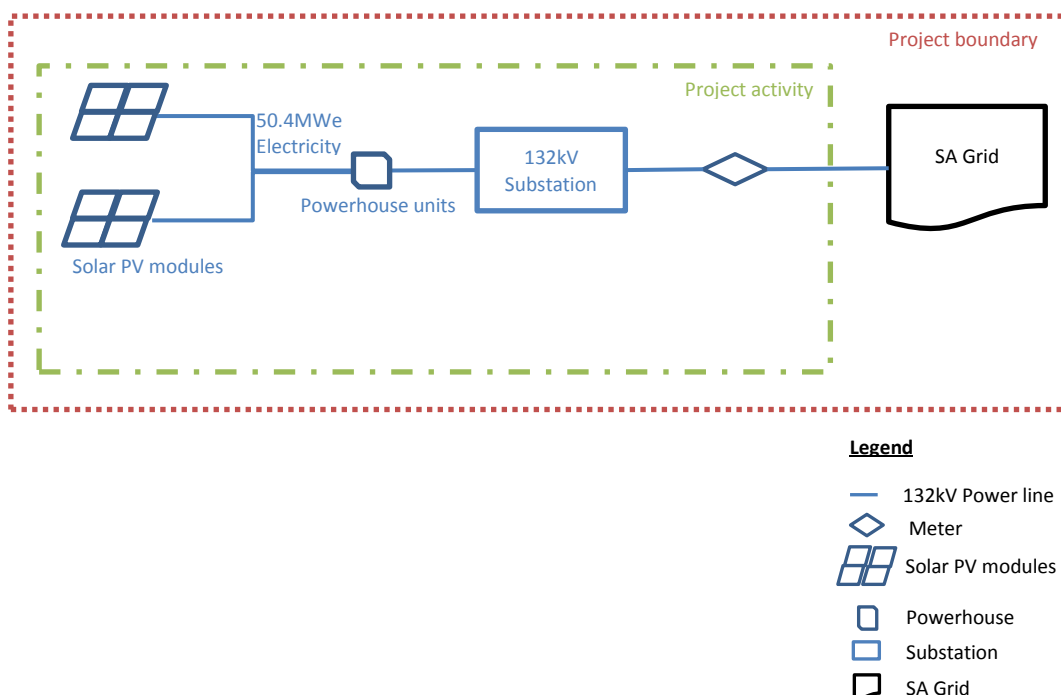


Figure B.3-1: Process flow diagram delineating the project activity and project boundary

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 below.

GHG emissions included in the project boundary as followed:

	Source	Gas	Included?	Justification/Explanation
Baseline	Electricity generation of the South African Power Grid.	CO ₂	Yes	Main emission sources.
		CH ₄	No	Excluded - According to ACM0002 Version 12.1.0.
		N ₂ O	No	Excluded - According to ACM0002 Version 12.1.0.
Project activity	CO ₂ emissions from combustion of fossil fuels for electricity generation in solar thermal power plants	CO ₂	No	The Project installs a new photovoltaic power plant and does not consume fossil fuels, therefore the emissions are excluded according to ACM0002 Version 12.1.0
		CH ₄	No	
		N ₂ O	No	



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

The project activity is the installation of a new grid-connected solar PV power plant. As per the methodology ACM0002 the baseline scenario is the following:

Electricity delivered to the grid by the project activity would have otherwise been generated by the operation of the grid-connected 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”.

The Project is the installation of a new grid-connected solar PV power plant that connects with and delivers electricity to the South African Power Grid. According to the “Tool to calculate the emission factor for an electricity system”, the delineation of grid boundaries of the Project is the South African Power Grid.

According to the consolidated baseline methodology ACM0002, the baseline scenario of the Project can be identified as: “an equivalent amount of annual power output generated by the operation of grid-connected power plants and by the addition of new generation sources within the South African Power Grid which the Project is connected to”.

A detailed analysis can be found in Section B.5.

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
April 2008	SARGE established
April 2008 to Mar 2009	Participated in and lobbied the Government on the need for a regulatory framework for renewables (eg Renewable Energy Feed-in Tariff)
Mar 09 to June 10	Identifying potential solar sites, financing partners and technical consultants
10 Nov 2010	Technical FSR Finished
1 Feb 2011	SARGE Board Resolution to negotiate purchase of CERs with Standard Bank



19 May 2011	Final EIA document submitted to Department of Environmental Affairs
3 June 2011	Execution of Carbon Letter of Intent and Term Sheet with Standard Bank
20 June 2011	Camco engaged for CDM qualification
02 July 2011	Board meeting decision to proceed with the project as a CDM project
23 July 2011	Signed Emission Reduction Purchase Agreement with Standard Bank on developing CDM project
31 Aug 2011	Submission of Prior Consideration of the CDM Form
13 Oct 2011	EIA Record of Decision received
14 Oct 2011	SARGE Board Meeting to agree on investment decision to proceed with the project investment and the carbon finance component
Mar 2012	Submission of tender under the Renewable Energy IPP Procurement Programme
Dec 2012	Expected financial closure
Mar 2013	Expected date for purchasing equipment
Jan 2014	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 activity 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:

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 connected Solar PV plant with an installed capacity of 50MW. The electricity produced would be supplied to the Eskom electricity network.
- The investment expenditure for a large scale Solar PV project is very high and return on equity is very low. To date there are no large scale Solar PV plants in South Africa. There are only small and micro installations.

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 realistic 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 Mpumalanga 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 Mozambique⁵
- 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 realistic and credible for the following reasons:

- Biomass: Biomass volumes are not sufficient to meet the fuel requirements of a renewable energy power plant capable of generating an equivalent amount of electricity as the project.

⁵ Sasol Pipeline Map available from:

http://www.sasol.com/sasol_internet/frontend/navigation.jsp;jsessionid=AXWRCXF1TBRGXG5N4EZFSEQ?navid=15700002&rootid=600000 (accessed 28 August 2011)



The project is located in one of the driest and arid parts of the country with very low agricultural productivity levels^{6 and 7}

- Hydro: There is very little potential to generate hydroelectricity in the region. The Vanderkloof 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.
- Wind: wind is a potential technology that can be used at this site, however site conditions and topography are such that wind cannot generate an equivalent amount of electricity as the proposed project.

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

Electricity delivered to the grid by the Solar PV 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.

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;

⁶⁶ <http://www.environment.gov.za/enviro-info/nat/rain.htm>

⁷ <http://www.environment.gov.za/enviro-info/nat/bioprod.htm>



- National Environmental Management: Protected Areas Act 57 Of 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 financially 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 benchmark 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)⁸ 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.

⁸ http://cdm.unfccc.int/Reference/Guidclarif/reg/reg_guid03.pdf



- 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%.⁹

Therefore, a 17% benchmark for the equity IRR is assumed for solar PV 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 South Africa will seek to procure the first 3,725 MW of capacity by 2016. Participation in the (IPP) Programme is based on a competitive tender process, where 70% of the selection criterion is based on pricing and 30% is based on local economic development. 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 2011 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. Solar PV projects have been capped at 285c/kWh; thus the maximum income that can be gained from the sale of electricity would be no greater than 285c/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	1,540	Million ZAR	Technology Provider, Subject to change
Annual operating and maintenance costs	35	Million ZAR/year	Based on operating and maintenance schedule

⁹



Average annual electricity production	94,527	MWh/year	Calculated from solar PV data collected on site and modelling
Electricity price	2,708	ZAR/MWh	Renewable Energy IPP Procurement Programme (under price cap for solar)
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 9.94%, which is below the financial benchmark. Therefore the project is not financially acceptable. Taking into account the CER revenue, the equity IRR increases to 10.96%, which is closer to the financial benchmark.

Table B.5-3 Comparison of IRR with and without the income from CERs sale

Item	Without CDM	Benchmark	With CDM
IRR	9.94%	17%	10.96%

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

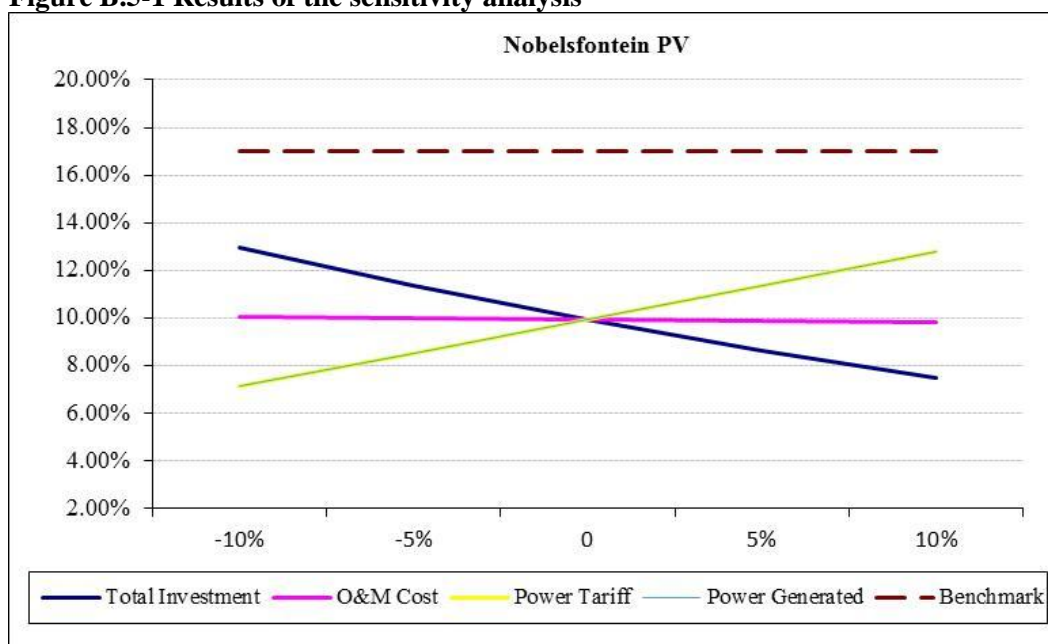
The results of the sensitivity are shown in Table B.5-4 and Figure B 5.1.

Table B.5-4 Results of the sensitivity analysis

Variable	-10%	-5%	0%	5%	10%
Total Investment	12.99%	11.37%	9.94%	8.65%	7.48%

O&M Cost	10.05%	9.99%	9.94%	9.88%	9.82%
Power Tariff	7.15%	8.54%	9.94%	11.35%	12.78%
Power Generated	7.16%	8.54%	9.94%	11.34%	12.77%
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.

Outcome 2d: Sensitivity analysis

The proposed CDM project activity is not financially or economically attractive. The revenue from the sale of CERs improves the financial attractiveness.

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	-20%
Power Tariff	+24%
Power Generated	+24%



Table B.5-5 shows, in any single condition if the total investment decreases by 20% or the tariff or power generated increases by 24%, 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:

The project will be a newly-built 50.4MW solar PV power plant in South Africa, therefore, activities similar to the Project should be solar PV power plants located in South Africa with an installed capacity in the applicable output range as calculated below.

However, a list of all power plants servicing the South African power grid is presented in Annex 3-2. No solar PV plants are producing electricity that is supplied to the South African power grid. At this stage solar PV plants are limited to personal and micro installations due to the high investment cost.

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 25.2MW (-50%) to 75.2MW (+50%).

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, there are no similar power plants, $N_{diff} = 0$.



Step 4: The factor is calculated as:

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

Where:

$$N_{\text{diff}} = 0;$$

$$N_{\text{all}} = 0$$

Thus, $F = 1 - 0/0 = 1$ which is greater than 0.2. Also, $N_{\text{all}} - N_{\text{diff}} = 0 - 0 = 0$, which is less than 3. As such, the project activity is not common practice and satisfies Sub-step 4a and Sub-step 4b.

Thus the project is additional as demonstrated above.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

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

- calculate the project GHG emissions;
- calculate the baseline GHG emissions;
- calculate the project leakage;
- calculate the emission reductions.

Calculation of the project GHG emissions

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

$$PE_y = 0 \text{ tCO}_2\text{e.}$$

Equation 1

Calculation of the baseline GHG emissions

Baseline emissions are the CO₂ emissions from electricity generation in fossil fuel-fired power plants that are 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:

$$BE_y = EG_{\text{pj, y}} \times EF_{\text{grid, CM, y}}$$

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 CO₂ 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 or 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 ($EF_{\text{grid, OM, } y}$) 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 CO₂ 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 (tCO₂/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:

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

Equation 4

Where:

$EF_{\text{grid, simple OM, y}}$	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
$EF_{\text{CO}_2, i, y}$	CO ₂ 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:

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \times NCV_{i,y} \times EF_{CO_2,i,y}}{EG_{m,y}}$$

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
$EF_{CO_2,i,y}$	CO ₂ 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 ($AEG_{SET_{5\text{-units}}}$, 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 ($AEG_{SET_{\geq 20\%}}$, 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 ($SET_{sample-CDM}$) the annual electricity generation ($AEG_{SET_{sample-CDM}}$, 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. $AEG_{SET_{sample-CDM}} \geq 0.2 \times AEG_{total}$), then use the sample group $SET_{sample-CDM}$ to calculate the build margin. Ignore steps (e) and (f).

Otherwise:

- (e) Include in the sample group $SET_{sample-CDM}$ 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 ($SET_{\text{sample-CDM->10yrs}}$).

The power plants/units in $SET_{\text{sample-CDM->10yrs}}$ 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:

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

Equation 6

Where:

$EF_{\text{grid,BM},y}$	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
$EF_{\text{EL},m,y}$	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 CO₂ emission factor of each power unit m ($EF_{\text{EL},m,y}$) 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 $SET_{\text{sample-CDM->10 years}}$, as a conservative approach only Option A2 from Step 4 can be used to calculate $EF_{\text{EL},m,y}$ and is determined as follows:

$$EF_{\text{EL},m,y} = \frac{EF_{\text{CO}_2,m,i,y} \times 3.6}{\eta_{m,y}}$$

Equation 7

$FE_{\text{EL},m,y}$	Simple operating margin CO ₂ emission factor in year y	tCO ₂ /MWh
$EF_{\text{CO}_2,i,y}$	CO ₂ emission factor of fuel type i in year y	tCO ₂ /GJ



$\hat{\eta}_{m,y}$	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:

$$EF_{\text{grid,CM},y} = EF_{\text{grid,OM},y} \times W_{\text{OM}} + EF_{\text{grid,BM},y} \times W_{\text{BM}} \quad \text{Equation 8}$$

Where:

$EF_{\text{grid,CM},y}$	Combined margin CO ₂ emission factor in year y	tCO ₂ /MWh
$EF_{\text{grid,OM},y}$	Operating margin CO ₂ emission factor in year y	tCO ₂ /MWh
$EF_{\text{grid,BM},y}$	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:

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

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

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.

$$L_y = 0 \text{ tCO}_2\text{e}$$

Calculation of the emission reductions

The project activity will produce GHG emission reductions by avoiding CO₂ emissions from electricity generation by fossil fuel power plants. The emission reduction for year y is calculated as follows:



$$ER_y = BE_y - PE_y - L_y$$

Equation 9

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 <i>m</i> 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:	FC_{i,m,y}
Data unit:	Mass or volume unit
Description:	amount of fossil fuel type <i>i</i> consumed by power unit <i>m</i> 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 :	Publicly 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 CO ₂ emission factor in year y
Source of data used:	Calculated
Value applied:	0.986
Justification of the choice of data or description of	Calculated according to the "Tool to calculate the emission factor for an electricity system" (version 02.2.0)



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

Data / Parameter:	EF_{grid,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

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

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 is shown in Table B 6-1 below:

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

Year	EG _{facility, y} (MWh)	ER _y (tCO ₂ e)
2014	96,673	93,870
2015	96,190	93,400
2016	95,709	92,933
2017	95,230	92,469
2018	94,754	92,006
2019	94,280	91,546
2020	93,809	91,088



	2021	93,340	90,633
	2022	92,873	90,180
	2023	92,409	89,729

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

Year	Estimation of baseline emissions (tCO ₂ e)	Estimation of project activity emissions (tCO ₂ e)	Estimation of leakage (tCO ₂ e)	Estimation of overall emissions reductions (tCO ₂ e)
2014	93,870	0	0	93,870
2015	93,400	0	0	93,400
2016	92,933	0	0	92,933
2017	92,469	0	0	92,469
2018	92,006	0	0	92,006
2019	91,546	0	0	91,546
2020	91,088	0	0	91,088
2021	90,633	0	0	90,633
2022	90,180	0	0	90,180
2023	89,729	0	0	89,729
Total (tCO₂e)	917,855	0	0	917,855

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	Year	EG_{facility, v} (MWh)
	2014	96,673



calculating expected emission reductions in section B.5	2015	96,190
	2016	95,709
	2017	95,230
	2018	94,754
	2019	94,280
	2020	93,809
	2021	93,340
	2022	92,873
	2023	92,409
	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 the Chief Engineer's computer and archived on a separate computer.
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 layout

It is clear from the figure below that the metering system will be installed between the 132kV substation and the connection to the National grid.

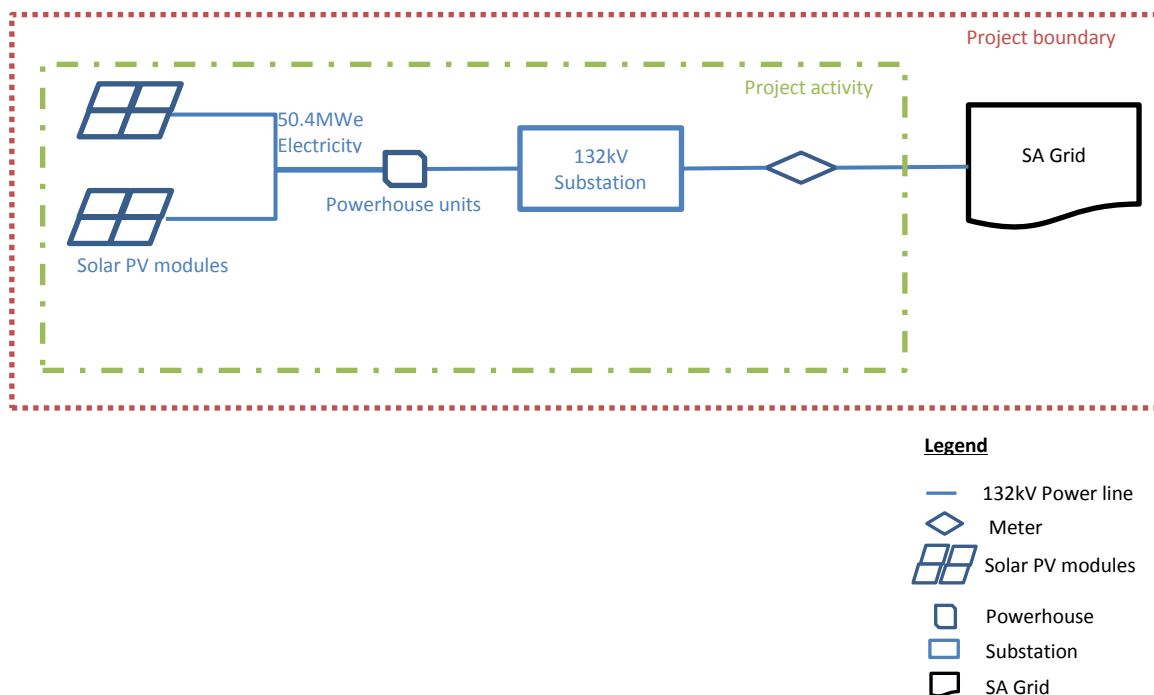


Figure B.7-1: Process flow diagram delineating the project activity, project boundary as well as the meter layout

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 meter readings, as well as the relevant information and data source(s) will be archived

All the relative staff will be trained before operation of the power plants. The training will consist 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 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.

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 are 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 Postal address: P.O Box 70, Woodlands Office Park, Woodmead 2080, South Africa Physical address: Building 18 Woodlands Office Park Western Service Road Woodmead Johannesburg 2080 South Africa Tel: +27 11 353 3400 Fax: +27 11 804 1038 Email: jonathan.curren@camcoglobal.com	No

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:

01/03/2013

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:

01/01/2014

C.2.2.2. Length:

10 years

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

Savannah Environmental (Pty) Ltd had prepared the EIA report together with the specialist studies to provide a detailed assessment of the environmental impacts on the social and biophysical environment of the proposed project. This provides a summary of the conclusions of the assessment of the proposed site for the renewable energy facility, including two on site- substations and the associated 132 kV power lines, and all other associated infrastructure. In so doing, it draws on the information gathered as part of the EIA process and the knowledge gained by the environmental consultants during the course of the EIA and presents an informed opinion of the environmental impacts associated with the proposed project. In summary, the following conclusions were drawn from each of the specialist studies undertaken:

Impacts on **Individuals of threatened animal species** (The Riverine Rabbit) are of **low** significance prior to mitigation due to the fact that potentially suitable habitat is present in the north-eastern part of the site. No individuals of the species were found on site and landowners on site have indicated that no previous sittings have taken place on site. It is, nevertheless, possible for the species to occur. The proposed facility is likely to have a **high to low** local and regional negative impact on the **flora / vegetation and (ecology)** on the site prior to mitigation (including impacts on indigenous natural vegetation, individuals of threatened animal species, establishment and spread of declared weeds and alien invader plants and impacts on wetlands). The impact can be reduced to **moderate to low** after the implementation of recommended mitigation measures. The primary negative impacts are the results of direct impacts; including loss of habitat within indigenous natural vegetation in development footprints, and direct, long-term loss of natural vegetation in areas that will be disturbed by heavy construction machinery, lay down areas, etc. during the construction phase.

The proposed facility could have a significant, long-term impact of **moderate to high** significance on selected **avifauna** species resident to the surrounding area. The taxa likely to be most affected include large raptors (Verreaux's and Martial Eagles) nesting on existing transmission power line towers on the Karoo flats, or else on the cliffs of Gys Roosberg, the Horseshoe and some outlying ridge lines, and using these topographic features for slope soaring. Another possible impact of the facility will be displacement effects on, and (in particular) collision mortality of Ludwig's Bustards and Blue Cranes. These priority species may be disturbed by the construction of the renewable energy facility, and/or losing foraging habitat (in terms of the area covered by the construction footprint and by the displacement from areas with operating turbines and PV panels), and/or sustain mortalities in collisions with the turbine blades, or by collision with, or electrocution on the new power infrastructure. These effects may be reduced to **acceptable and sustainable levels** by adherence to a proposed mitigation scheme. A comprehensive programme to fully monitor the actual impacts of the facility on the broader avifauna of the area is recommended and outlined, from pre-construction into the operational phase of the project. Full clarity on the likely environmental impact of this facility can only be reached once the pre-construction monitoring has been completed.

The findings of the **geology, soils and erosion potential** study have indicated that the proposed development will have an impact of **moderate to low** significance on the geological environment and



these impacts can be largely reduced to an adequately low level with the implementation of appropriate mitigation.

Both the Phase 1 Archaeological Impact Assessment and the Palaeontological Desktop study concluded that the study area is of **moderate** cultural and palaeontological sensitivity. The possible impacts can be reduced to an **adequately low** level with the implementation of appropriate mitigation.

The placement of the facility and its associated infrastructure will have a **visual impact** on the natural scenic resources and rural character of this region. Potential visual impacts are of **high significance** in terms of the potential visual impact on users of arterial and secondary roads in close proximity (~5km radius) of the proposed facility. The impact on sensitive visual receptors in the vicinity of the development will be of **moderate to low significance**. The visual impact of the core facility (mainly the wind turbines) is not really mitigated due to the size of the structures in the landscape. Within the greater region, the potential visual impact on sensitive visual receptors, and on the sense of place of tourist routes and destinations, will be of **moderate to low** significance. The various ancillary infrastructures are expected to result in visual impacts of **low** significance. This anticipated visual impact is not, however, considered to be a fatal flaw from a visual perspective, considering the relatively low incidence of visual receptors in the region and the contained area of potential high visual exposure.

The **noise impact** on specific receptors in the area, during both the construction and operational phases is potentially of **moderate to low significance** on two of the identified noise receptors (PSR6 and PSR 7-refer to figure 6.11 for the location of these receptors). With the implementation of recommended mitigation measures this can be reduced to a **low significance**.

The findings of the **social impact** assessment undertaken indicate that the development will create limited employment and business opportunities for locals during both the construction and operational phase of the project. The proposed development also represents an investment in clean, renewable energy infrastructure, which, given the challenges created by climate change, represents a **positive social benefit** for society as a whole. However, the visual impacts associated with a facility of this nature will impact on the current sense of place and landscape character. This impact will be for the entire operational lifespan (approximately 25 years) of the facility. All of the potential negative impacts can be effectively mitigated through the recommended mitigation measures.

From the result of the facility layout determination, it is apparent that the permanently affected/utilised areas within the site/farm boundaries are only approximately 1.436km² in extent. This amount to 0.8% of the total 202km² originally earmarked for development, and is broken down in the table below.

A cumulative impact in relation to an activity refers to the impact of an activity that in itself may not be significant, but may become significant when added to the existing and potential impacts eventuating from similar or diverse undertaking in the area.

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 environmental impacts of the proposed project are not considered to be significant.

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

In order to obtain comments by local stakeholders, the draft EIA report was made available for review and a public feedback meeting was held.

The draft EIA report was made available from 1 April 2011 to 5 May 2011 at the following public places:

- Victoria West Library
- Beaufort West Library
- Karoo Vliesboere Corporation
- www.savannahSA.com

Focus group meetings were held with the Central Karoo District Municipality on the 22nd March 2011 and a public meeting was held on 23 March 2011 at the Victoria West City Hall.

FGM - Central Karoo District Municipality Attendees

Attendees

Ms. I. Snyman	Batho Earth: Social Consultant
Mr. G. Cronje	Savannah Environmental: Environmental Consultant
Ms. T Kruger	Savannah Environmental: Environmental Consultant
Ms. B. Brown	DEA: Central Karoo District Municipality: Environmental Manager
Mr. P. Nakani	Central Karoo District Municipality: Environmental Health Practitioner
Ms. T. Twani	Central Karoo District Municipality: IDP Manager

Public Meeting – Victoria West City Hall

Attendees

Ms. I. Snyman	Batho Earth: Social Consultant
Mr. G. Cronje	Savannah Environmental: Environmental Consultant
Ms. T Kruger	Savannah Environmental: Environmental Consultant
Ms. N. Feni	Department of Water Affairs: Environmental Officer
Mr. T. Rantekane	Department of Water Affairs: Senior Water Control Officer
Mr. R. Villacian	Gestaup Solar: Corporate Development
Mr. F. Roux	SARGE
Mr. J.H. van der Merwe	Elandsfontein (Swartkopjes): Property owner
Ms. M. January	ERM: Consultant
Ms. M. van Heerden	Rooikrans Retreat: Property owner / Highlands Representative
Mr. M. Kivedo	Ubuntu Local Municipality: Infrastructure
Mr. S. Mlahlwa	Dept. of Agriculture: A.D.T

E.2. Summary of the comments received:

Comments and questions included the following issues:

- Potential job opportunities
- Noise from the turbines
- Road access
- Whether the wind resource was sufficient



- Waste issues on site
- Impacts on water usage
- Disturbance and removal of vegetation
- Surface area of the PV plant
- Access roads
- Oil leakages
- Visibility from N1 Road
- Heritage impacts
- Timeframes
- Rezoning

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

All of the above comments were taken into account in the preparation of the final EIA and corrective action requirements were noted in the Record of Decision.

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

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State/Region:	Western Cape Province
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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
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Middle name:	Francois
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Represented by:	Geoff Sinclair
Title:	Head of Carbon Sales and Trading
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding from Annex I parties are involved in this project activity.

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.

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

Where:

$EF_{\text{grid,OMsimple},y}$	= 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 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 the data vintage chosen in Step 3

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

Since data on data on fuel consumption and electricity generation is available, Option A1 is utilised to determine the emission factor ($EF_{EL,m,y}$), 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:

$EF_{EL,m,y}$	= 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) of fossil fuel type i in year y (GJ/mass or volume unit)
$EF_{CO2,i,y}$	= CO2 emission factor of fossil fuel type i in year y (tCO2/GJ)
$EG_{m,y}$	= 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



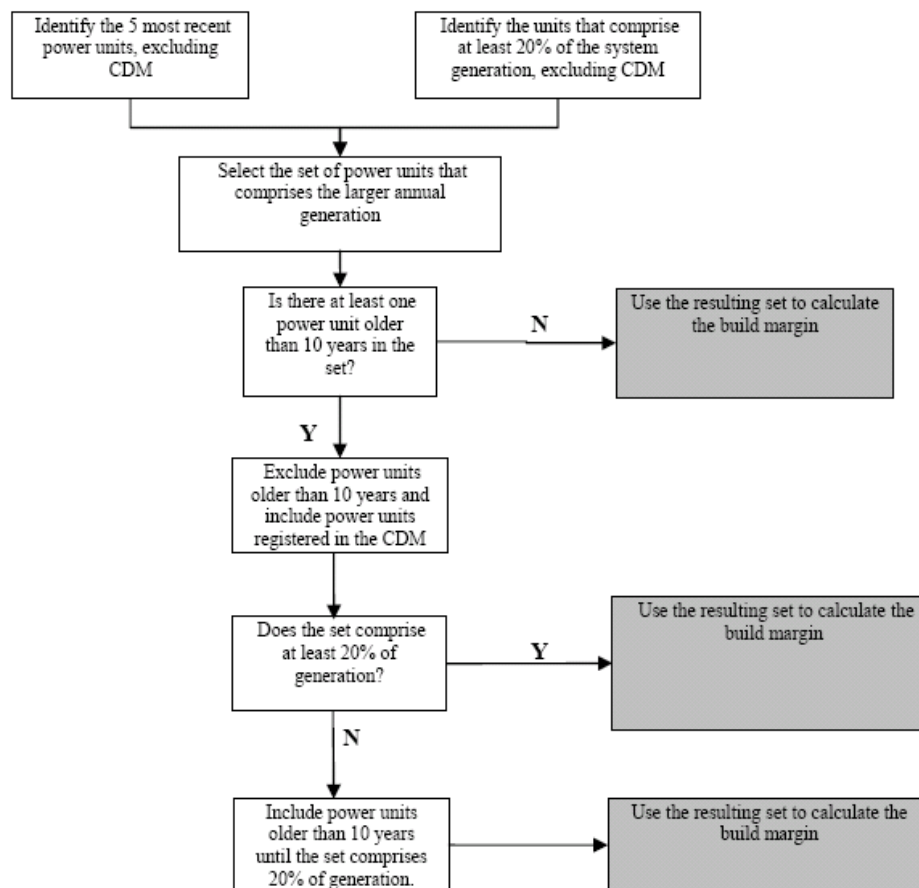
Plant no.	Power Station / Plant name (m)	Installed capacity (MW)	Generation technology	Energy Source / Fuel Type (t)	Net Calorific Value (NCV _v ,y) (GJ/t)	Fuel CO2 Emission Factor (EFCO ₂ ,y) (tCO ₂ /GJ)	Efficiency	2007/08			2008/09			2009/10			
								Fuel Consumption (FCI,m,y) (t)	Electricity Generation (EGm,y) (MWh)	Emission Factor of Power unit m (EFEL,m,y) (tCO ₂ /MWh)	Fuel Consumption (FCI,m,y) (t)	Electricity Generation (EGm,y) (MWh)	Emission Factor of Power unit m (EFEL,m,y) (tCO ₂ /MWh)	Fuel Consumption (FCI,m,y) (t)	Electricity Generation (EGm,y) (MWh)	Emission Factor of Power unit m (EFEL,m,y) (tCO ₂ /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	-	
								<i>Emission Factor of grid (EFEL, grid, 2007/08)</i>			<i>Emission Factor of grid (EFEL, grid, 2008/09)</i>			<i>Emission Factor of grid (EFEL, grid, 2009/10)</i>			
								0.955			0.971			0.973			
								<i>EFgrid,OMsimple,2009/10</i>									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:

$EF_{grid,BM,y}$ = 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/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	Emission Factor of Power unit m (EFEL,m,y) (tCO2/MWh)
					Electricity Generation (EGm,y) (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, $EF_{grid,BM,y} =$

0.986



Step 6: Calculate the combined margin emissions factor

The combined margin (CM) emissions factor (EF_{grid,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:

- 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 (%)

Therefore:

<i>EF_{grid,OM,y}</i>	<i>w_{OM}</i>	<i>EF_{grid,BM,y}</i>	<i>w_{BM}</i>	<i>EF_{grid,CM,y}</i>
0.966	0.75	0.986	0.25	0.971



Annex 4

MONITORING INFORMATION

No supplementary information.
