CLEAN DEVELOPMENT MECHANISM
PROGRAM ACTIVITY DESIGN DOCUMENT FORM (CDM-CPA-DD)
Version 01

CONTENTS

Annexes

NOTE:

(i) This form is for the submission of CPAs that apply a large scale methodology using provisions of the proposed PoA.

(ii) The coordinating/managing entity shall prepare a CDM Programme Activity Design Document (CDM-CPA-DD)[1,2] that is specified to the proposed PoA by using the provisions stated in the PoA DD. At the time of requesting registration the PoA DD must be accompanied by a CDM-CPA-DD form that has been specified for the proposed PoA, as well as by one completed CDM-CPA-DD (using a real case). After the first CPA, every CPA that is added over time to the PoA must submit a completed CDM-CPA-DD.

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[1] The latest version of the template form CDM-CPA-DD is available on the UNFCCC CDM web site in the reference/document section.

[2] At the time of requesting validation/registration, the coordinating managing entity is required to submit a completed CDM-POA-DD, the PoA specific CDM-CPA-DD, as well as one of such CDM-CPA-DD completed (using a real case).

SECTION A. General description of CDM programme activity (CPA)

A.1. Title of the CPA:

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Southern African Renewable Energy (SARE) Programme – African Rainbow Energy PV CPA

A.2. Description of the CPA:

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This CPA consists of a system of solar photovoltaic panels of approximately 25MW installed capacity connected to the South African national grid. The use of solar energy displaces the baseline production of grid electricity. Grid electricity is primarily derived from the combustion of coal in South Africa and thus the project, using solar photovoltaic systems to generate electrical energy, has a significant effect on reducing GHG emissions related to electricity usage.

A.3. Entity/individual responsible for CPA:

>> *Here the information on the entity/individual responsible of the CPA shall be included, hence forth referred to as CPA implementer(s). CPA implementers can be project participants of the PoA, under which the CPA is submitted, provided the name is included in the registered PoA.*

African Rainbow Energy (Pty) Ltd

A.4. Technical description of the CPA:

A.4.1. Identification of the CPA:

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Southern African Renewable Energy (SARE) Programme – African Rainbow Energy PV CPA

A.4.1.1. Host Party:

>>

Republic of South Africa

A.4.1.2. Geographic reference of other means of identification allowing the unique identification of the CPA (maximum one page):

>> *Geographic reference or other means of identification[3], Name/contact details of the entity/individual responsible for the CPA , e.g. in case of stationary CPA geographic reference, in case of mobile CPAs means such as registration number, GPS devices.*

[3] E.g. in case of stationary CPA geographic reference, in case of mobile CPAs means such as registration number, GPS devices.

28º 23' 14" S
21º 22' 26" E

A.4.2. Duration of the CPA:

A.4.2.1. Starting date of the CPA:

>>

1 March 2012

A.4.2.2. Expected operational lifetime of the CPA:

>>

21 years

A.4.3. Choice of the crediting period and related information:

Renewable crediting period; Or

~~**Fixed Crediting period**~~

[Delete the one that is not applicable]

A.4.3.1. Starting date of the crediting period:

>>

1 March 2012

A.4.3.2. Length of the crediting period, first crediting period if the choice is renewable CP:

>>

7 years

NOTE: Please note that the duration of crediting period of any CPA shall be limited to the end date of the PoA regardless of when the CPA was added..

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

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Years	Annual estimation of emission reductions in tonnes of CO_2eq
Year 1 (2012)	41,044

Year 2 (2013)	54,283
Year 3 (2014)	53,840
Year 4 (2015)	53,398
Year 5 (2016)	52,956
Year 6 (2017)	52,514
Year 7 (2018)	52,072
Total estimated reductions (tonnes of CO_2e)	360,106
Total number of crediting years	7
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	51,444

A.4.5. Public funding of the CPA:

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The CPA will not require, nor make use of any public funding.

A.4.6. Confirmation that CPA is neither registered as an individual CDM project activity nor is part of another Registered PoA:

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The database maintained by the CME contains for each and every CPA, the following information:

Table 1: Database information for African Rainbow Energy PV CPA

Database information required:	**African Rainbow Energy PV CPA:**
Name of the CPA	Southern African Renewable Energy (SARE) Programme – Upington PV CPA
Name of the implementing entity of the CPA	African Rainbow Energy (Pty) Ltd
Contact details of the implementing entity including contact person, address, telephone and email address	Thierry Rault Via della Rotonda 36 Roma 00186 Italy Telephone number: +39 335 1696013 Email address: Thierry.rault@medenergygroup.com
Type of renewable energy	Solar (photovoltaic panels)
Installed capacity and other relevant technical specifications of each CPA	Installed capacity: 25MW
Location of the CPA	28º 23' 14" S 21º 22' 26" E
Verification status and monitoring reports of each CPA	Project currently in validation. No monitoring reports at this time.

The CPA project information has been tested against this database and no duplicate entries were identified.

At this time there are no other registered large scale renewable energy programmes within South Africa, nor large scale renewable energy projects within South Africa utilising photovoltaic technology.

SECTION B. Eligibility of CPA and Estimation of emissions reductions

B.1. Title and reference of the Registered PoA to which CPA is added:

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Southern Africa Renewable Energy Programme (SARE)

B.2. Justification of the why the CPA is eligible to be included in the Registered PoA :

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The methodology used in this CPA is:

- ACM0002 – Consolidated baseline methodology for grid-connected electricity generation from renewable sources – v12.1.0 - EB58

In addition to the methodology the following tools and guidelines are referred to in this CPA:

- Tool for the demonstration and assessment of additionality v5.2.1, EB39, Annex10;
- Tool to calculate the emission factor for an electricity system v2.2.0, EB61, Annex 12 ;
- Combined tool to identify the baseline scenario and demonstrate additionality v.3, EB60, Annex7;
- Tool to calculate project or leakage CO2emissions from fossil fuel combustion, v.2, EB41, Annex 11.
- Guidelines on the assessment on investment analysis, EB62 Annex 5

Table 2: PoA eligibility criteria and CPA eligibility

Eligibility criteria	CPA is eligible because:
1. Each CPA must meet the eligibility criteria of ACM0002 "*Consolidated baseline methodology for grid-connected electricity generation from renewable sources*" version 12.1.0. The methodology is applicable for project activities that (a) install a new power plant at a site where no renewable power plant was operated prior to the implementation of the project activity (greenfield plant); (b) involve a capacity addition; (c) involve a retrofit of (an) existing plant(s); or (d) involve a replacement of (an) existing plant(s).	The CPA is (a) the installation of a new power plant at a site where no renewable power plant was operated prior to the implementation of the project activity (greenfield plant)
i. 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	The CPA is the installation of: • Solar power plant/unit

• tidal power plant/unit.	
ii. 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 of ACM0002 "*Consolidated baseline methodology for grid-connected electricity generation from renewable sources*" version 12.1.0, to calculate the parameter EGPJ,y): • the existing plant started commercial operation prior to the start of a minimum historical reference period of five years (used for the calculation of baseline emissions and defined in the baseline emission section);and • no capacity expansion or retrofit of the plant has been undertaken between the start of this minimum historical reference period and the implementation of the project activity.	The CPA is not a capacity addition, retrofit or replacement, it is) the installation of a new power plant at a site where no renewable power plant was operated prior to the implementation of the project activity (greenfield plant).
iii. In the case of hydro power plants, one of the following conditions must apply: • the project activity is implemented in an existing reservoir, with no change in the volume of reservoir; or • the project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the Project 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/m^2.	The CPA is the installation of a solar power plant/unit so conditions do not apply.
iv. The project methodology is not applicable to the following: • project activities that involve switching from fossil fuels to renewable energy sources at the site of the project activity, since in this case the baseline may be the continued use of fossil fuels at the site; • biomass fired power plants; and • hydro power plants that result in new reservoirs or in the increase in existing reservoirs where the power density of the	The CPA is (a) the installation of a new solar power plant at a site where no renewable power plant was operated prior to the implementation of the project activity (greenfield plant).

power plant is less than 4 W/m^2.	
2. Each CPA must implement the baseline and monitoring methodology ACM0002 "*Consolidated baseline methodology for grid-connected electricity generation from renewable sources*"	The baseline and monitoring methodology ACM0002 "*Consolidated baseline methodology for grid-connected electricity generation from renewable sources*" is applied in the CPA.
3. Each CPA must demonstrate the additionality of the CPA according to section A.4.3 in the PoA-DD.	Section B.3. in the CPA-DD contains details of how the CPA meets all additionality criteria.
4. Each CPA must implement the operational and management plan as detailed in section A.4.4.1. in the PoA-DD.	The CPA has implemented an internal record keeping system (of which data is made available to the CME). The CPA will implement a system to avoid double counting on commissioning of the plant. The CPA has signed a Project Developer CDM Undertaking Agreement.
5. Each CPA must provide, monitor and collect data as specified by the parameters as listed in sections E.6.3 and.E.7.1 (related to the specific technology employed by the project).	The CPA will provide data where necessary and implement a monitoring plan to monitor and collect data as per E.6.3 and E.7.1.
6. The coordinating entity will ensure that all CPAs under its PoA are neither registered as an individual CDM project activity nor included in another registered PoA, and that the CPA is subscribed to the PoA	The CPA is not registered as an individual CDM project activity and is not included in another registered PoA as per section A.4.6. in this CPA-DD.
7. Each CPA shall be uniquely identified within a database of all CPAs maintained by the CME. Therefore the following data (as per section A.4.2.2. in the PoA-DD) must be provided to the CME prior to inclusion in the PoA: i. Name of the CPA; ii. Name of the implementing entity of the CPA; iii. Contact details of the implementing entity including contact person, address, telephone and email address; iv. Type of renewable energy (solar, wind, hydro etc.); v. Installed capacity and other relevant technical specifications of each CPA; vi. Location of the CPA (GPS coordinates of the power house for example); vii. Verification status and monitoring reports of each CPA.	The CPA has provided all required information to the CME (as per points i – vi. Information related to vii will be available in the future once registration has taken place).

8. Each CPA is developed at a location within the borders of the Countries and is connected to the national or regional electricity grid of that particular country.	The CPA is developed within the borders of South Africa (one of the Countries) and will be connected to the national/regional electricity grid of South Africa.

B.3. Assessment and demonstration of additionality of the CPA, as per eligibility criteria listed in the Registered PoA:

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The methodology ACM0002 stipulates the use of the "*Tool for the demonstration and assessment of additionality*". The tool follows a stepwise approach (outlined in the figure below) consisting of:

- Identification of alternatives to the project activity;
- Investment analysis;
- Barrier analysis; and
- Common practice analysis.

Additionality is demonstrated using this stepwise approach.

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

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

The CPA considers the following alternatives in the assessment of additionality:

Alternative 1: The CPA is undertaken without being registered as a CDM project activity (i.e. a CPA within a PoA).

Alternative 2: Continuation of the current situation – the proposed CPA is not developed and power continues to be supplied solely from the existing grid.

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

Alternative 1: This alternative, and likewise the project activity, is in compliance with South African laws and regulations.

Alternative 2: There is no mandatory requirement for the development of grid connected renewable power generation plants/units, therefore not undertaking the project activity would not be in contravention of any South African laws or regulations.

Step 2: Investment analysis

Sub-step 2a: Determine the appropriate investment analysis method

The appropriate analysis method for conducting the investment analysis is benchmark investment comparison analysis (Option III).

Sub-step 2b: Option III: Benchmark analysis

For the purpose of this analysis an equity IRR is calculated and compared to the expected general market return rate as a benchmark. The benchmark is determined using the Capital Asset Pricing Model (CAPM). This model takes into account the non-diversifiable risk of the asset, the expected return of the market and the expected return of a risk-free asset using the following formula:

$$E(R_i) = R_f + \beta_i(E(R_m)-R_f)$$

Where:

$E(R_i)$ = the expected return of the capital asset
R_f = the risk free rate of interest such as arising from government bonds
β_i = the sensitivity of the expected excess asset returns to the expected excess markets returns
$E(R_m)$ = the expected return of the market

Using this formula and the parameters in the table below, the benchmark [**$E(R_i)$**] is determined to be 20.25%.

Table 3: Determination of the benchmark $E(R_i)$

Parameter	Value	Reference
$E(R_i)$	**20.25%**	Calculated
R_f	8.66%	2yr ave, GSAB10yr Govt Bond, Bloomberg Finance, 31 May 2011
β_i	1.0	Assumed 1 as no data available for SA
$E(R_m)$	20.25%	JSE All Share Index, 12m return, Bloomberg Finance, 31 May 2011

In March 2011 the National Energy Regulator of South Africa stipulated that the real return that an investor in renewable energy generation should expect is 17%[4]. Given South Africa's inflation trajectory of 6%, the benchmark for returns in this industry is a nominal return of 23%. This is down from the 2009 stipulated return of 25%.

"Guidelines on the assessment on investment analysis" provides default values for the expected rate of return on equity (calculated after taxes). For the purpose of determining the adjustment factor to reflect the risk of projects in different sectoral scopes, three different project categories are distinguished according to the sectoral scopes under CDM. Group 1 includes:

- Energy industries (sectoral scope 1)
- Energy Distribution (sectoral scope 2)
- Energy Demand (sectoral scope 3)

[4] The required rate of return is stipulated in the NERSA Consultation Paper, Review of Renewable Feed-in Tariffs, March 2011, pg 22.

- Waste handling and disposal (sectoral scope 13)

The default value for group 1 projects in South Africa is 10.9%.

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

The CPA is the development of a system of solar photovoltaic panels of approximately 25MW total installed capacity connected to the South African national grid. At the time of writing the power purchase agreement is only defined by a template issued by the Department of Energy of South Africa. It is anticipated that the project will be awarded a Renewable Energy Independent Power Producer (IPP) Procurement Programme[5] tariff. This procurement programme is a competitive bidding processwith the aim of reducing GHG emissions related to electricity generation and this process imposes a compliance requirement with the aforementioned PPA template. The South African government originally put in place a REFIT (Renewable Energy Feed in Tariff) programme whose objective was to reduce the emissions of GHGs associated with electricity production by promoting the development of renewable energy sources. Whilst the project was originally conceived under a proposed REFIT programme the REFIT policy was abandoned by the South African government and replaced by the Renewable Energy IPP Procurement Program.

The South African Renewable Energy IPP Procurement programme is the procurement programme whereby bidders are required to bid on tariff and the identified socio-economic development objectives of the Department of Energy (DoE). The REFIT (Renewable Energy Feed In Tariff) tariffs (July 2011) are the stipulated maximum tariff that a bidder may propose - according to the IPP procurement programme request for proposal R2,850/MWh is the maximum for solar PV and CSP.

This tariff is ignored for the purpose of this analysis as it awarded to projects that reduce emissions in South Africa. Including the tariff here would induce a counter incentive contrary to the nature of the CDM and this was confirmed by the CDM Executive Board[6].

Nonetheless for the purposes of being conservative we use the Medium Term Power Purchase Program tariff of ZAR0.65/kWh as this is the only program to date that has resulted in electricity from an Independent Power Producer being purchased and supplied onto the grid[7]. This rate is significantly higher than the tariff at which electricity is sold, known as the Megaflex rate, at which electricity in low demand season costs ZAR/kWh 0.28 and in high demand season ZAR/kWh 0.32, and therefore by using the Medium Term Power Purchase Program tariff, a conservative approach is adopted with respect to the likely tariff.

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[5] The South African Renewable Energy IPP Procurement programme is tasked with promoting the renewable energy sector in order to reduce emissions in SA. The REFIT (Renewable Energy Feed In Tariff) tariffs (Nersa - July 2011) are essentially the maximum tariff that a bidder may bid.

[6] "As a general principle, national and/or sectoral policies and circumstances are to be taken into account on the establishment of a baseline scenario, without creating perverse incentives that may impact host Parties' contributions to the ultimate objective of the Convention" (EB 22, Annex 3, paragraph 5).

[7] Engineering Weekly (Source: http://www.engineeringnews.co.za/article/eskom-concludes-two-power-purchase-contracts-four-more-close-2010-05-19, accessed 24/05/11)

The table below provides details of tariffs used in CDM projects that are currently registered or in validation in SA.

Table 4: Tariffs used in CDM projects currently registered or in validation in SA

Project:	Tariff	Further details
Durban landfill gas to electricity – Marianhill and La Mercy landfills (registered 15/12/2006)	US $0.0422	Total generation cost
Kanhym farm manure to energy project (Registered 18/07/2008)	R246/MWh (increasing by 10% annually)	No further information in PDD
Durban landfill gas – Bisasar Road (Registered (26/03/2009)	US $0.0422/kWh	Total generation cost
Alton landfill gas to energy project (Registered 24/08/2009)	R320/MWh	Electricity base tariff + renewable energy tariff
Ekhurleni landfill gas recovery project – South Africa (Registered 26/10/2010)	R121.7/MWh	Megaflex weighted average cost
Cookhouse Windfarm in South Africa (validation 2011)	R0.66/kWh	NERSA revenue application decision (Feb 2010)
Grid connected wind power plant in Klawer , South Africa (validation 2011)	R52.30/MWh	"Price of electricity from the national grid"
Grid connected wind power plant in Witberg, South Africa (validation 2011)	R52.30/MWh	"Price of electricity from the national grid"
De Aar grid connected 100.5 wind farm, South Africa (validation 2011)	R0.6585/kWh	"NERSA's decision on Eskom's required revenue application - multi-year price determination 2010/11 to 2012/13 (MYPD 2) 24 February 2010, page 2, paragraph 1".
Prieska grid connected 20MW solar park (validation 2011)	R0.6585/kWh	"NERSA's decision on Eskom's required revenue application - multi-year price determination 2010/11 to 2012/13 (MYPD 2) 24 February 2010, page 2, paragraph 1".
Springbok grid connected 55.5MW wind farm, South Africa (validation 2011)	R0.6585/kWh	"NERSA's decision on Eskom's required revenue application - multi-year price determination 2010/11 to 2012/13 (MYPD 2) 24 February 2010, page 2, paragraph 1".

The table below provides the parameters used and results from the financial analysis:

Table 5: African Rainbow Energy PV CPA financial analysis

Parameter	UoM	Value
Energy Yield	kWh/yr	47,071,360
Tariff	ZAR/kWh	0.65
Average Revenue	ZAR/yr	11,912,936
Total Construction Cost	ZAR	-771,427,425
Average O&M Cost	ZAR/yr	-17,292,703
Average EBITDA	ZAR/yr	11,912,936
Debt:Equity Ratio	%	70:30
Interest Rate (Construction)	%	5.5
Interest Rate (Post-Cons)	%	5.5
Forex Rate	ZAR:EUR	9.140
Equity IRR (Leveraged & after tax)	**%**	**Not a Number (NAN)**
Project IRR	**%**	**-12.16**

Details of the cashflow model (2011-2033) are contained in Annex 3 of the CPA-DD.

The NPV for this project is negative and the Equity IRR is undefined (this means the project would require a negative discount rate to return the money invested in it). Similarly the project IRR, based on this analysis, is -12.82%. Once again this means the project is unable to return the capital invested in it and the project return is obviously significantly lower than the required return of 22.3[8]% or the "Guidelines on the assessment on investment analysis" default value for Group 1 in South Africa: 16.2[8]%.

[8] The comparative rates are stipulated in nominal terms and therefore the South African inflation rate of 5.3% has been added to the real return of 10.9% (source: https://www.fnb.co.za/rates/cRatesView.html?productGroup=Indicators&productName=SA%20Indicators)

Thus the project developer has a more financially attractive, and economically reasonable, alternative of investing in the equity market i.e. Alternative 2 is more financially viable than Alternative 1. Therefore the African Rainbow Energy PV CPA is additional and would not have occurred without registration as a CDM project (i.e. a CPA within this PoA).

Table 6: Comparison of IRR to benchmarks

Project indicator:		**Comparison:**		**Benchmark:**	
Upington PV CPA Equity IRR	**Upington PV CPA Project IRR**	**Nominal Required Return**	**Real Required Return**	**CAPM Required Return**	**EB62 Annex 5 Guidelines**
Source:	Source:	NERSA Stipulated		Bloomberg Data	Group 1 – SA[8]
NAN	-12.16%	22.3%	17.0%	20.25%	16.2%

Sub-step 2d: Sensitivity analysis

A sensitivity analysis was conducted over the main external parameters that drive the financial model. Each parameter listed has been increased by 10% and decreased by 10% and the effect on the equity IRR noted in the table below:

Table 7: Sensitiy analysis for African Rainbow Energy PV CPA

Parameter	**UoM**	**Baseline value**	**Value @ +10% / Project IRR @10%**	**Value @ -10% / Project IRR @10%**	**Higher / lower than benchmark?**
Energy yield	**kWh/yr**	47,071,360	51,778,500 / -9.92%	42,364,220 / -15.49%	Lower
Tariff	**ZAR/kWh**	0.65	0.72 / -9.92%	0.59 / -15.49%	Lower
Total construction cost	**ZAR**	-771,427,425	-848,570,168 / -12.82%	694,284,683 / -11.41%	Lower
Average O&M cost	**ZAR/yr**	-17,292,703	-19,021,973 / -12.16%	15,563,433 / -12.16%	Lower

Despite applying large increases and decreases to each of these parameters the stipulated benchmark of 22.3% was never exceeded nor the equity market benchmark of 20.25%. Indeed the Equity IRR was never able to be calculated, and the largest project IRR achieved was still not positive.

On the basis of these results it is clear that the financial analysis conducted is robust to even large changes in the underlying assumptions. This analysis provides further evidence that the project is additional and would not have happened in the absence of CDM activity.

Step 3: Barrier analysis

Barrier analysis is not applied in this CPA

Step 4: Common practice analysis

Sub-step 4a: Analyse other activities similar to the proposed project activity

Renewable Energy Market Transformation (REMT):

In April 2008 the Department of Energy (DOE), South Africa and the World Bank, acting as an implementing agency for the Global Environment Facility (GEF), entered into an agreement that established the REMT Project in South Africa. The project has two main components namely the Renewable Energy Power Generation (REPG) sub-component and the Commercial Solar Water Heating (CSWH) sub-component. The Development Bank of South Africa (DBSA) is the implementing agency for the REMT Project - the 4 year REMT Project commenced in November 2008. Both sub-components offer pre-investment matching grants (MG) in support of the identification, preparation, and financing of renewable energy projects. Technical assistance is offered in ‘Legal, Policy, Framework’ and in ‘Capacity Building’.

There are no projects under the REMT umbrella currently in development or completed that are ‘similar’ to this CPA i.e. projects that are in the same country/region and/or rely on a broadly similar technology, are of a similar scale, and take place in a comparable environment with respect to regulatory framework, investment climate, access to technology, access to financing, etc.

Cape Solar Plant – Aquila Private Game Reserve:

A 60 kilowatt solar plant powering a game reserve (Aquila Private Game Reserve) in the Western Cape was launched on 6 September 2010 by Germany’s Concentrix Solar.

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

Cape Solar Plant – Aquila Private Game Reserve[9]:

The 60 kW solar plant powering a game reserve (Aquila Private Game Reserve) in the Western Cape, launched on 6 September 2010, is a demonstration plant launched ahead of a planned 50 MW grid-connected solar facility in the area. The developer was “drawn to South Africa by the country’s renewable energy feed-in tariffs”. These tariffs have since been re-released (July 2011) as part of the Renewable Energy Independent Power Producer (IPP) Procurement Programme (originally called REFIT). The South African Renewable Energy IPP Procurement programme is the procurement programme whereby bidders are required to bid on tariff and the identified socio-economic development objectives of the department of Energy (DoE). The REFIT (Renewable Energy Feed In Tariff) tariffs

[9] (http://www.flyafrica.info/forums/showthread.php?30501-Solar-Company-makes-first-move-with-launch-of-Cape-solar-plant-http://ccgs.ru/en/projects/cdm/Mulilo/)

(July 2011) are essentially the maximum tariff that a bidder may bid - according to the IPP procurement programme request for proposal R2,850/MWh is the maximum for solar PV and CSP).

The date of commission for the 50MW plant is unknown.

Solar energy project – Copperton, Karoo[10]*:*

Mulilo Renewable Energy (MRE) and its Chinese Shareholder Yingli Green Energy have installed a 7kW PV facility in Copperton, Karoo. Power (10MWh/yr) has been flowing since April 2010. The project developers had plans to expand the project in phases, with the initial expansion being to 10MW over 12 months. An application was initially made for the inclusion of the extended facility into the Refit process in South Africa. As stated above the REFIT programme has be re-released as the Renewable Energy IPP Procurement Programme.

Although similar activities occur in terms of projects in the same country, relying on similar technology, in potentially comparable environment, the scale of such projects are not similar to the project activity described in this CPA-DD (i.e. 7kW and 60kW versus 25MW).

As such, sub-steps 4a and 4b are satisfied, and hence this reaffirms the additionality argument of this CPA project activity.

B.4. Description of the sources and gases included in the project boundary and proof that the CPA is located within the geographical boundary of the registered PoA.

>>

The GHG reduced through the CPAs under this PoA is CO_2. The reduction takes place through the displacement of fossil fuels (predominantly coal) used in the production of electricity in the absence of the CPA.

	Source	Gas	Included	Justification / Explanation
Baseline	Power plants servicing the South African national grid	CO_2	Yes	According to ACM0002 and the "*Tool to calculate the emission factor for an electricity system*", only CO_2 emissions from electricity generation should be accounted for.
		CH_4	No	Minor source of emissions
		N_20	No	Minor source of emissions
CPA Activity	Solar photovoltaic electrical system:	CO_2	No	Emissions are negligible

10 (http://www.engineeringnews.co.za/article/big-scale-up-plans-for-grid-connected-karoo-microsolar-plant-2010-05-28)

	generation of electrical energy supplied to the national grid	CH_4	No	Emissions are negligible
		N_20	No	Emissions are negligible

This CPA is located with the geographical boundary of South Africa, which is a host country to the PoA.

B.5. Emission reductions:

B.5.1. Data and parameters that are available at validation:

Data / Parameter:	$\mathbf{EF_{grid,CM,yy}}$
Data unit:	tCO_2/MWh
Description:	Combined margin CO2 emission factor for grid connected power generation in year y calculated using the "*Tool to calculate the emission factor for an electricity system*".
Source of data used:	Calculated
Value applied:	1.02
Justification of the choice of data or description of measurement methods and procedures actually applied :	The grid emission factor has been determined according to the "*Tool to calculate the emission factor for an electricity system*" for the South African national grid using the most appropriate local data sources.
Any comment:	This is determined ex ante. Detailed calculation follows below in section B.5.2.

B.5.2. Ex-ante calculation of emission reductions:

>>

1. Project Emissions

According to ACM0002, for most of the renewable power generation CPA project activities, $PE_y = 0$. However, some CPA project activities may involve project emissions that can be significant. These emissions shall be accounted for as project emissions by using the following equation:

$$\mathbf{PE_y = PE_{ff,y} + PE_{GP,y} + PE_{HP,y}} \qquad \mathbf{(1)}$$

Where:

$\mathbf{PE_y}$ = Project emissions in year *y* (tCO_2e/yr)

$\mathbf{PE_{ff,y}}$ = Project emissions from fossil fuel consumption in year *y* (tCO_2/yr)

$\mathbf{PE_{GP,y}}$ = Project emissions from the operation of geothermal power plants due to the release of non-condensable gases in year *y*

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

<u>Fossil fuel combustion ($PE_{FF,y}$)</u>

For this CPA project emission may result from the use of the backup power source in place (1 x fossil fuel (diesel) powered 3kW generator). These emissions are calculated as per the "Tool to calculate project or leakage CO_2emissions from fossil fuel combustion".

<u>Equations from the "Tool to calculate project or leakage CO_2emissions from fossil fuel combustion".</u>

CO_2 emissions from fossil fuel combustion are calculated based on the quantity of fuels combusted and the CO_2 emission coefficient of those fuels, as follows:

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y} \quad (1)$$

Where:

$PE_{FC,j,y}$	=	Are the CO_2 emissions from fossil fuel combustion in process *j* during the year *y* (tCO_2/yr)
$FC_{i,j,y}$	=	Is the quantity of fuel type *i* combusted in process *j* during the year *y* (mass of volume unit/yr)
$COEF_{i,y}$	=	Is the CO_2 emission coefficient of fuel type *i* in year *y* $(tCO_2$/mass or volume unit)
i		Are the fuel types combusted in process *j* during the year *y*

The CO_2 emission coefficient $COEF_{jy}$ can be calculated using one of two ways as per the tool. Option B is chosen here:

Option B:
The CO_2 emission coefficient $COEF_{i,y}$ is calculated based on net calorific value and CO_2 emission factor of the fuel type (diesel fuel), as follows:

$$COEF_{i,y} = NCV_{i,y} * EF_{CO2,I,y} \quad (4)$$

Where:

$COEF_{i,y}$	=	Is the CO_2 emission coefficient of fuel type *i* in year *y* $(tCO_2$/mass or volume unit)
$NCV_{i,y}$	=	Is the weighted average net calorific value of the fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO2,I,y}$	=	Is the weighted average CO_2 emission factor of fuel type *i* in year *y* (tCO_2/GJ)
i	=	Are the fuel types combusted in process *j* during the year *y*

Table 8: Calculation of $COEF_{J,y}$

$NCV_{i,y}$ (GJ/kg)	$EF_{CO2J,y}$ (tCO2/GJ)	$COEF_{J,y}$ (tCO_2/kg)	$COEF_{J,y}$ (tCO_2/L)
0.0433	0.0748	0.00324	0.00386

The net calorific value (NCV) of diesel is taken from IPCC vol. 2 Chapter 1 Table 1.2. (upper limit value).
The CO_2 emission factor (EF) is taken from IPCC vol. 2 Chapter 1 Table 1.4. (upper limit value).
The CO_2 emission coefficient (COEF) is calculated in tCO_2/kg and converted into tCO_2/L using a density of 0.84kg/L[11].

Table 9: Calculation of PE_{FCjy}

	$NCV_{i,y}$ (GJ/kg)	$EF_{CO2J,y}$ (tCO_2/GJ)	$COEF_{J,y}$ (tCO_2/L)	$FC_{I,J,y}$ (L)	PE_y / $PE_{FF,y}$ / $PE_{FC,j,y}$ (tCO_2)
2012	0.0433	0.0748	0.00386	54.6	0.21
2013	0.0433	0.0748	0.00386	54.6	0.21
2014	0.0433	0.0748	0.00386	54.6	0.21
2015	0.0433	0.0748	0.00386	54.6	0.21
2016	0.0433	0.0748	0.00386	54.6	0.21
2017	0.0433	0.0748	0.00386	54.6	0.21
2018	0.0433	0.0748	0.00386	54.6	0.21
Total	-	-	-	382	1.48

$FC_{I,J,y}$ (L) is estimated to be 54.6L per year. This is based on the fact that a 3kW diesel generator will be used as a backup power source – for this reason it is assumed that the generator will run for 1 hour per week per year (156kWh at 0.35L/kWh) for maintenance purposes[12].

2. Baseline Emissions

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

[11] World Resources Institute (2008). GHG Protocol for Stationary Combustion v4.0.

[12] http://www.cumminspower.com/www/common/templatehtml/technicaldocument/SpecSheets/Diesel/na/d-3425.pdf; http://www.dieselserviceandsupply.com/Diesel_Fuel_Consumption.aspx)

The baseline emissions will be calculated as follows:

$$\mathbf{BE_y = EG_{PJ,y} * EF_{grid,CM,y}} \quad (6)$$

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 "Tool to calculate the emission factor for an electricity system" (tCO_2/MWh)

Table 10: Calculation of BE_y

	$EG_{facility,y}$	$EG_{PJ,y}$	$EF_{grid,CM,y}$	BE_y
2012	40,239	40,239	1.02	41,044
2013	53,219	53,219	1.02	54,283
2014	52,785	52,785	1.02	53,841
2015	52,351	52,351	1.02	53,398
2016	51,918	51,918	1.02	52,956
2017	51,484	51,484	1.02	52,514
2018	51,051	51,051	1.02	52,072
Total	353,047	353,047	1.02	360,108

Calculation of $EG_{PJ,y}$

The calculation of $EG_{PJ,y}$ is different for (a) greenfield plants, (b) retrofits and replacements, and (c) capacity additions. The Upington PV CPA is a greenfield plant and hence the $EG_{PJ,y}$ is calculated as follows:

(a) Greenfield renewable energy power plants

$$\mathbf{EG_{PJ,y} = EG_{facility,y}} \quad (7)$$

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)

3. South African grid emission factor – combined margin ($EF_{grid,CM,y}$)

The methodological tool: "*Tool to calculate the emission factor for an electricity system*" (Version 02.2) determines the CO_2 emission factor for the displacement of electricity generated by power plants in an electricity system. It is applicable as the baseline emissions result from the consumption of grid electricity and the grid electricity system is located totally within South Africa and not in an Annex I country. The baseline emissions for a project activity that displaces electricity are calculated in terms of the "operating margin" (OM), "build margin" (BM) and "combined margin" (CM) CO_2 emission factors for the electricity system. The operating margin refers to existing power plants whose electricity generation would be affected by the proposed CDM project activity. The build margin refers to the power units built most recently and therefore their construction and operation would be affected by the proposed CDM project activity. The tool follows the following six steps:

Step 1: Identify the relevant electricity systems
Step 2: Choose whether to include off-grid power plants in the project electricity system (optional)
Step 3: Select a method to determine the operating margin (OM)
Step 4: Calculate the operating margin emission factor according to the selected method
Step 5: Calculate the build margin emission factor
Step 6: Calculate the combined margin (CM) emissions factor

Step 1: Identify the relevant electricity systems

In 2010, the South African national electricity grid consisted of 94.4%[13] of Eskom generated electricity. The 5.6% remainder was private, municipal or international power generation. Excluding the 5.6% is, apart from simplicity, a conservative approach, as lower efficiencies and higher GHG emissions are assumed in these smaller and older power generation plants.

Eskom generates, transmits, and distributes electricity to industrial, mining, commercial, agricultural, and residential customers, and also to redistributors[14]. Some assumptions have to be made to calculate the conservative electricity baseline: the regional generation and consumption of Eskom transmission grids are interlinked and no distinction can be made between provincial or sectoral generation and consumption. Therefore the whole SA transmission system is taken as a homogenous mix of electricity supply by all generators.

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

Under this step project participants may choose whether to include off-grid power plants to calculate the operating margin and build margin emission factor. It was decided to not include off-grid power plants since these play a very minor role in South Africa's overall power generation.

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

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[13] Eskom 2010 Annual Report, 1 April 2009 – 31 March 2010
[14] http://www.eskom.co.za/live/content.php?Item_ID=4226&Revision=en/3

In accordance with the tool, the calculation of the operating margin emission factor ($EF_{grid,OM,y}$) must be 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.

The simple OM method (a) can only be used if low-cost/must-run resources constitute less than 50 % of total grid generation. The Tool states that:

''Low-cost/must-run resources are defined as power plants with low marginal generation costs or power plants that are dispatched independently of the daily or seasonal load of the grid. They typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation. If coal is obviously used as must-run, it should also be included in this list, i.e. excluded from the set of plants."

The simple adjusted OM method (b) could be used, but the detailed data that is needed for this method is not publically available in South Africa.

The dispatch data analysis OM (c) method could be used, but the detailed dispatched data that is needed for this method is not publically available in South Africa.
The average OM (d) method should only be used if the data for simple OM is not available.

It is therefore decided to apply the Simple OM method to calculate the CM.

Hydro, Nuclear and Wind, classified as the low-cost and must-run power plants on the South African grid, constituted around 6% of the Eskom generation in 2010, and therefore the Simple OM method can be applied. The percentage of grid generation of low-cost/must run resources in the South African grid for the last five years is in the table below.

The weighting of low-cost/must run resources on the South African Electrical Grid for the last Five Years:

Table 11: Percentage of grid generation of low-cost/must run resources in the South African grid

Year	% Hydroelectric Generation	% Nuclear Generation	% Wind Generation	Average produced by these low cost/must run resources (%)
2010	0.55%	5.50%	0.0004%	6.05%
2009	0.47%	5.68%	0.0009%	6.15%
2008	0.31%	4.73%	0.0004%	5.05%
2007	1.05%	5.07%	0.0009%	6.12%
2006	0.51%	5.09%	0.0014%	5.60%
TOTAL	0.58%	5.21%	0.0008%	5.79%

In South Africa in 2010, coal-fired power stations constituted 93%[15] of the national generation capacity. Coal-fired power stations electricity generation amounted to 215,940GWh and Eskom's total electricity generation amounted to 232,812 GWh. Pumped storage, hydro-electric, nuclear, wind and liquid fuel OCGT[16] power stations constituted the remainder.

For the Simple OM the emission factor can be calculated using either of the two following data vintages:

- *Ex ante* option: 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, without requirement to monitor and recalculate the emissions factor during the crediting period, or
- *Ex post* option: 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 proceeding the previous year (*y*-2) may be used. The same data vintage (*y*, *y*-1, or *y*-2) should be used throughout all crediting periods.

The conservative electricity baseline was calculated using the method below based on the ex ante option: A 3-year average was used, based on the most recent data available at the time of submission which was the data available for 2007/8, 2008/9 and 2009/10 financial years.

Step 4: Calculation of the operating margin emission factor according to the selected method

(a) Simple OM

[15]Calculated from data made available to the public in the Eskom 2010 Annual Report

[16]Open cycle gas turbine equipment

The simple OM emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation (tCO_2/MWh) of all generating power plants serving the system, **not including low-cost/must-run power plants/units**.

The following data choice options are available:

Option A: *Based on the net electricity generation and a CO_2 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 is the preferred approach but option B can be chosen if:

a) *The necessary data for Option A is not available; and*
b) *Only nuclear and renewable power generation are considered as low-cost/must-run power sources and the quantity of electricity supplied to the grid by these sources is known; and*
c) *Off-grid power plants are not included in the calculation (i.e. if Option I has been chosen in Step 2)*

Data is available for option A, and therefore option A shall be used in the calculation of the Operating Margin emission factor.

Equation (1) from the Tool was used to calculate the simple operating margin CO_2 emission factor.

$$EF_{grid,OMsimple,y} = \frac{\sum_m EG_{m,y} * EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad \textbf{(1)}$$

Where:

$EF_{grid,OMsimple,y}$	Simple operating margin CO_2 emission factor in year *y*(tCO_2/MWh)
$EG_{m,y}$	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
m	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

If for a power unit *m* data on fuel consumption and electricity generation is available Option A1 should be used. As this is the case Option A 1 was used via the application of equation (2) to calculate the emission factor ($EF_{EL,m,y}$) as follows:

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{EG_{m,y}} \quad (2)$$

Where:

$EF_{EL,m,y}$	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
$FC_{i,m,y}$	Amount of fossil fuel type *i* consumed by power unit *m* in year *y* (mass or volume unit)
$NCV_{i,y}$	Net calorific value (energy content) fossil fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO2,i,y}$	CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)
$EG_{m,y}$	Net 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	Most recent historical year for which power generation data is available.

The data used in the calculation of the simple OM is found in the tables below:

Eskom Power Generation Data used in the Simple OM calculation:

Table 12: Eskom Power Generation Data used in the Simple OM calculation

Power Generation (MWh/yr)	2007/8	2008/9	2009/10	Average
Arnot	11 905 060	11 987 281	13 227 864	12 373 402
Camden	5 171 057	6 509 079	7 472 070	6 384 069
Duvha	23 622 732	21 769 489	22 581 228	22 657 816
Grootvlei	237 138	1 249 556	2 656 230	1 380 975
Hendrina	13 756 351	12 296 687	12 143 292	12 732 110
Kendal	26 517 420	23 841 401	23 307 031	24 555 284
Komati	0	-	1 016 023	338 674
Kriel	17 762 398	18 156 686	15 906 816	17 275 300
Lethabo	25 701 723	23 580 232	25 522 698	24 934 884
Matimba	29 021 742	26 256 068	27 964 141	27 747 317
Majuba	23 680 971	22 676 924	22 340 081	22 899 325
Matla	24 549 833	21 863 400	21 954 536	22 789 256
Tutuka	20 980 242	21 504 122	19 847 894	20 777 419

Eskom Coal Consumption Data used in the Simple OM calculation:

Table 13: Eskom Coal Consumption Data used in the Simple OM calculation

Coal Consumption (t/yr)	2007/8	2008/9	2009/10	Average
Arnot	6 210 700	6 395 805	6 794 134	6 466 880
Camden	3 218 873	3 876 211	4 732 163	3 942 416
Duvha	12 425 531	11 393 553	11 744 606	11 854 563
Grootvlei	130 748	674 538	1 637 371	814 219
Hendrina	7 794 220	7 122 918	6 905 917	7 274 352
Kendal	15 986 131	15 356 595	13 866 514	15 069 747
Komati	-	-	664 497	
Kriel	9 059 934	9 420 764	8 504 715	8 995 138
Lethabo	18 314 572	16 715 323	18 170 227	17 733 374
Matimba	14 862 323	13 991 453	14 637 481	14 497 086
Majuba	12 853 342	12 554 406	12 261 833	12 556 527
Matla	13 795 309	12 689 387	12 438 391	12 974 362
Tutuka	10 627 575	11 231 583	10 602 839	10 820 666

Komati was excluded from the operating margin emission factor calculations as there was not enough data for a three year average.

The average calorific values for 2008 – 2010 were taken from the Eskom 2010 annual report and are in the table below:

Table 14: Average coal calorific values for 2008 – 2010 taken from Eskom 2010 annual report

Coal fired stations	2009/10	2008/9	2007/8	Average
Calorific Value (MJ/kg)	19.22	19.10	18.51	18.94

The power plants not included in the calculation were low-cost/must-run which were identified as nuclear, wind and hydro-electric. Therefore the power plants included in the evaluation were coal-fired power stations. Pumped storage stations were excluded due to the nature of this type of electricity generation. The liquid fuel OCGT power stations constituted 0.02% of the total generation and were excluded as the data[17] on the Eskom website cites kerosene usage as zero for the last 4 years.

[17]http://www.eskom.co.za/live/content.php?Item_ID=4226, 27 October 2010

Calculation of simple operating margin emission factor:

Table 15: Calculation of simple operating margin emission factor

Power Station	$EF_{grid,OMsimple,y}$ (t CO2/MWh)	Weight	$EF_{EL,m,y}$ (t CO2/MWh)	$FC_{i,m,y}$ (ton)	$NCV_{i,y}$ (GJ/t)	$EF_{CO2,i,y}$ (t CO2/GJ)	$EG_{m,y}$ (MWH)
Arnot	0.05	5.7%	0.94	6 466 880	18.94	0.0946	12 373 402
Camden	0.03	2.9%	1.11	3 942 416	18.94	0.0946	6 384 069
Duvha	0.10	10.5%	0.94	11 854 563	18.94	0.0946	22 657 816
Grootvlei	0.01	0.6%	1.06	814 219	18.94	0.0946	1 380 975
Hendrina	0.06	5.9%	1.02	7 274 352	18.94	0.0946	12 732 110
Kendal	0.12	11.3%	1.10	15 069 747	18.94	0.0946	24 555 284
Kriel	0.07	8.0%	0.93	8 995 138	18.94	0.0946	17 275 300
Lethabo	0.15	11.5%	1.27	17 733 374	18.94	0.0946	24 934 884
Matimba	0.12	12.8%	0.94	14 497 086	18.94	0.0946	27 747 317
Majuba	0.10	10.6%	0.98	12 556 527	18.94	0.0946	22 899 325
Matla	0.11	10.5%	1.02	12 974 362	18.94	0.0946	22 789 256
Tutuka	0.09	9.6%	0.93	10 820 666	18.94	0.0946	20 777 419
Total	**1.02**	**100.0%**	**N/A**	**N/A**	**N/A**	**N/A**	**216 507 158**

Therefore the operating margin grid emission factor for the South African electricity grid is 1.02 t CO_2/MWh.

Step 5: Calculate the build margin emission factor

The data vintage chosen was that of Option 1 where the 2010**Error! Bookmark not defined.** Eskom financial year was used as the most recent available data on units already built at the time this CPA was submitted for inclusion in the PoA.

> **Option 1** - For the first crediting period, the build margin emission factor is calculated *ex ante* based on the most recent information available on units already built for sample group *m*. Most recent refers to the time at which the CPA is submitted for inclusion under the PoA. For the second crediting period, the build margin emission factor will 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.

The tool's guidance on selection of the group of power units *m* to be included in the build margin is determined in the steps outlined below using the data vintage as stipulated in the preceding section:

a) Identify the set of five power units that have started to supply electricity to the grid most recently ($SET_{5\text{-units}}$), excluding power units registered as CDM project activities. Determine their annual electricity generation ($AEG_{SET\text{-}5\text{-units}}$ in MWh)
The below table lists $SET_{5\text{-units}}$ and their Annual Electricity Generation:

Table 16: $SET_{5\text{-units}}$ and their Annual Electricity Generation

Power Unit	Year Commissioned	AEG 2010 (MWh)
Majuba	1996	22,340,081
Kendal	1988	23,307,031
Matimba	1987	27,964,141
Lethabo	1985	25,522,698
Tutuka	1985	19,847,894
Total $AEG_{SET\text{-}5\text{-units}}$	-	**118,981,845**

b) Determine the annual electricity generation of the CPA electricity system (excluding power units registered as CDM project activities). Identify the set of power units that stared to supply electricity to the grid most recently and that comprise 20% of the AEG_{total} (excluding power units registered as CDM project activities) Determine their annual electricity generation ($AEG_{SET\geq 20\%}$ in MWh).
The $SET_{\geq 20\%}$ comprises Majuba power station and Kendal power station as per the below table:

Table 17: Power stations that potentially make up $SET_{\geq 20\%}$

Power Units	AEG 2010 (MWh)	Date Commissioned	% of AEG_{total}
Arnot	13,227,864		6%
Camden	7,472,070		3%
Duvha	22,581,228		10%
Grootvlei	2,656,230		1%
Hendrina	12,143,292		6%
Kendal	23,307,031	1988	11%
Komati	1,016,023		0%
Kriel	15,906,816		7%
Lethabo	25,522,698	1985	12%

Matimba	27,964,141	1987	13%
Majuba	22,340,081	1996	10%
Matla	21,954,536		10%
Tutuka	19,847,894	1985	9%
Total AEG_{total}	**215,939,904**	-	100%
$AEG_{SET\geq20\%}$	45,647,112	-	21%

c) From the $SET_{5\text{-units}}$ and $SET_{\geq20\%}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample})
Therefore:

$AEG_{SET\text{-}5\text{-}units}$ = 118,981,845 MWh
$AEG_{SET\geq20\%}$ = 45,647,112 MWh

Therefore: **$AEG_{SET\text{-}5\text{-}units} \geq AEG_{SET\geq20\%}$ and** the SET_{sample} is the power units defined under Step (a)

As per step b, all of the power units in SET_{sample} started to supply electricity to the grid more than 10 years ago. Therefore SET_{sample} cannot be used to calculate the BM.

d) Exclude from the SET_{sample} the power units which started to supply electricity to the grid more than 10 years ago. Include that set the power units registered as CDM project activity (if any) starting with power units that started to supply electricity to the grid most recently, until the electricity generation set comprises 20% of the annual electricity generation of the project electricity system. Determine for the resulting set ($SET_{sample\text{-}CDM}$) the annual electricity generation ($AEG_{SET\text{-}sample\text{-}CDM}$ in MWh).

Therefore:

All of the power units in SET_{sample} will be excluded from SET_{sample} as they all started supplying electricity to the South African grid more than 10 years ago. There are no power units registered as CDM project activities in South Africa and therefore $SET_{sample\text{-}CDM}$ will have no power units included in it and an AEG of 0MWh. This does not comprise a minimum of 20% of the AEG_{total} of the electricity generation system and therefore $SET_{sample\text{-}CDM}$ cannot be used to calculate the BM.

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

Therefore:

The power units that started to supply electricity to the grid most recently but more than 10 years ago will be added to the $SET_{sample\text{-}CDM}$ until $AEG_{SET\text{-}sample\text{-}CDM} \geq 0.2 \times AEG_{total}$. The table below shows the power units and their AEG that will be included in the calculation of the BM.

Table 18: Power units and their AEG that will be included in the calculation of the BM

Power Units	AEG 2010 (MWh)	Date Commissioned	% of AEG_{total}
Majuba	22,340,081	1996	10%
Kendal	23,307,031	1988	11%
$AEG_{SET\text{-}sample\text{-}CDM}$	45,647,112	-	21%

f) Therefore:
The sample group of power units *m* used to calculate the BM is the resulting $SET_{sample\text{-}CDM>10yrs}$ as is illustrated in the above table under point e)..

The build margin emissions factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units *m* during the most recent year *y* for which power generation data is available, calculated with Equation 13 as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \cdot EF_{EL,m,y}}{\sum_m EG_{m,y}} \qquad \textbf{(13)}$$

Where:

$EF_{grid,BM,y}$	Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EG_{m,y}$	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
$EF_{EL,m,y}$	CO_2 emission factor of power unit *m* in year *y* (tCO_2/GJ)
m	Power units included in the build margin
y	Most recent historical year for which power generation is available

The CO_2 emission factor of each power unit m ($EL_{EL,m,y}$) should be determined as per Equation 2 in Step 4 for the simple OM, Option A1, using the most recent historical year for which power generation data is available (*y*), and using the power units included in the build margin (*m*).

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{\sum_m EG_{m,y}} \qquad \textbf{(2)}$$

Where:

$EF_{EL,m,y}$	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
$FC_{i,m,y}$	Amount of fossil fuel type *i* consumed by power unit *m* in year *y* (mass or volume unit)
$NCV_{i,y}$	Net calorific value (energy content) fossil fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO2,i,y}$	CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)
$EG_{m,y}$	Net 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	Most recent historical year for which power generation data is available.

Summary of calculation of the build margin:

Table 19: Calculation of the build margin

	$EF_{grid,BM,y}$	Weighting	$EF_{EL,m,y}$	$EG_{m,y}$
Power Station	t CO_2/MWh	%	t CO_2/MWh	MWh
Majuba	0.49	48.9%	1.00	22,340,081
Kendal	0.55	51.1%	1.08	23,307,031
Total	**1.04**	**100%**	**-**	**45,647,112**

Therefore the build margin emission factor for the 2010 South African Electricity Grid is 1.04 t CO_2/MWh.

Step 6: Calculate the combined margin (CM) emissions factor

The Gauteng CPA uses the preferred method Option A – Weighted Average CM to calculate the combined margin emission factor.

The CM emission factor is calculated as follows:

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

$EF_{grid,BM,y}$	Build Margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EF_{grid,OM,y}$	Operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
w_{OM}	Weighting of operating margin emissions factor (%)
w_{BM}	Weighting of build margin emissions factor (%)

The following default values should be used for w_{OM} and w_{BM} since the project activity is the generation of electricity from solar power:

- *Wind and solar power generation project activities: w_{OM} = 0.75 and w_{BM} = 0.25 (owing to their intermittent and non-dispatchable nature) for the first crediting period and for subsequent crediting periods;*

Calculation of the combined margin emission factor for the first crediting period:

Table 20: Calculation of the combined margin emission factor

	$EF_{grid,CM,y}$	$EF_{grid,OM,y}$	w_{OM}	$EF_{grid,BM,y}$	w_{BM}
Units	*t CO_2/MWh*	*t CO_2/MWh*	*%*	*t CO_2/MWh*	*%*
South African GEF	1.02	1.02	0.75	1.06	0.25

In conclusion, the combined margin emission factor for the South African grid for 2008 – 2010 was calculated to be **1.02 t CO_2/MWh.**

4. Leakage

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

5. Emission Reductions

$$ER_y = BE_y - PE_y \quad \textbf{(11)}$$

Where:

ER_y = Emission reductions in year *y* (t CO_2e/yr)

BE_y	=	Baseline emissions in year *y* (t CO_2/yr)
PE_y	=	Project emissions in year *y* (t CO_2e/yr)

Table 21: Calculation of ER_y

	BEy	PEy	**ERy**
2012	41,044	0.21	**41,044**
2013	54,283	0.21	**54,283**
2014	53,841	0.21	**53,840**
2015	53,398	0.21	**53,398**
2016	52,956	0.21	**52,956**
2017	52,514	0.21	**52,514**
2018	52,072	0.21	**52,072**
Total	360,108	1.48	**360,106**

Therefore the ex-ante estimate of emission reductions is, on average over the first crediting period, **51,444** tCO_{2e}/year.

B.5.3. Summary of the ex-ante estimation of emission reductions:

>>

Year	**Estimation of project activity emissions (tonnes of CO_2 e)**	**Estimation of baseline emissions (tonnes of CO_2 e)**	**Estimation of leakage (tonnes of CO_2 e)**	**Estimation of overall emission reductions (tonnes of CO_2 e)**
2012	0.21	41,044	0	41,044
2013	0.21	54,283	0	54,283
2014	0.21	53,841	0	53,840
2015	0.21	53,398	0	53,398
2016	0.21	52,956	0	52,956
2017	0.21	52,514	0	52,514
2018	0.21	52,072	0	52,072
Total (tonnes of CO_2 e)	1.48	360,108	0	360,106

B.6. Application of the monitoring methodology and description of the monitoring plan:

B.6.1. Description of the monitoring plan:

>>

The monitoring plan for Upington PV CPA is consistent with methodology ACM0002 and the requirements laid out in the PoA-DD.

1. Management structure and responsibilities

The CME will implement a monitoring protocol that allows the Designated Operational Entity (DOE) to verify all CPAs in the PoA. Monitoring of the parameters listed here in B.6.1. will be carried out by Upington PV CPA i.e. the net electricity supplied to the grid (and assuring the correct operation and maintenance of the measuring equipment).

Data collection:
The CME will establish and maintain an extensive database for each and every CPA. The database maintained by the CME contains for each and every CPA, the following information:

Table 22: Database information for African Rainbow Energy PV CPA

Database information required:	**African Rainbow Energy PV CPA:**
Name of the CPA	Southern Africa Renewable Energy (SARE) Programme – Upington PV CPA
Name of the implementing entity of the CPA	African Rainbow Energy (Pty) Ltd
Contact details of the implementing entity including contact person, address, telephone and email address	Thierry Rault Via della Rotonda 36 Roma 00186 Italy Telephone number: +39 3351696013 Email address: thierry.rault@medenergygroup.com
Type of renewable energy	Solar (photovoltaic panels)
Installed capacity and other relevant technical specifications of each CPA	Installed capacity: 25MW
Location of the CPA	28º 23’ 14” S 21º 22’ 26” E
Verification status and monitoring reports of each CPA	Project currently in validation. No monitoring reports at this time.

Upington PV CPA comprises a single project activity, and hence the net electricity supplied to the grid will be monitored directly at the Upington PV CPA project site, by the implementing entity. This data will be monitored and recorded using metering equipment (electricity meter).

Data recording:
At the Upington PV CPA project site, the net electricity supplied to the grid will be monitored directly using metering equipment (electricity meter). All data will be recorded electronically. Upington PV CPA will provide data on monitored parameters to the CME. The CME will document and store all data in an electronic database, while primary data will be stored by Upington PV CPA.

Data calibration:
This will be done by observing the calibration frequency as per the manufacturer’s requirements. Upington PV CPA will be responsible for calibration of all equipment used for monitoring, and will store all primary data on site. The CME will store all the data in an electronic database.

Data reporting:
The CME will in responsible for the preparation of the Monitoring Reports and communication with the DOE during verification activities. The Monitoring Report will compile all required monitoring information in order to allow the DOE to verify the emission reductions for each monitoring period of Upington PV CPA and all other individual CPAs. The Monitoring Report will unambiguously set out the data on emission reductions generation by each CPA during the monitoring period consistent with the requirements of the PoA-DD. Record keeping procedures undertaken by the CME will ensure that the data attributed to a monitoring period can be clearly attributed to Upington PV CPA and all other individual CPAs.

Data archiving:
Upington PV CPA will be responsible for the storage of all primary data and will store recorded data for a period of two years after the end of the relevant crediting period. The CME will be responsible for the management of records and data associated with all CPAs and all records will be stored for a period of two years after the end of the relevant crediting period including the back-up and storage of all hard copy documents.

2. Data quality control

The data and reports provided by Upington PV CPA to the CME will be checked internally by the CME to ensure the accuracy and completeness of data. In case of mistakes, corrective action will be applied to avoid future similar mistakes.

3. Training and monitoring personnel

Once the Upington PV CPA project has been constructed, all persons that participate in the monitoring process will be trained in the correct operation and application of the CDM monitoring plan and the CDM requirements of the project activity.

Leakage

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

The parameters to be monitored are:

Baseline emissions:

Greenfield renewable energy power plants:

(Copy this table for each data and parameter)	
Data / Parameter:	$EG_{facility,y}$
Data unit:	MWh/y
Description:	Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y*
Source of data to be used:	Direct, physical measurements as recorded by metering equipment (electricity meter) at CPA project site.

Value of data applied for the purpose of calculating expected emission reductions in section B.5	Direct, physical measurements as recorded by metering equipment (electricity meter) at CPA project site.
Description of measurement methods and procedures to be applied:	Direct, physical measurements as recorded by metering equipment (electricity meter). Continuous measurement and at least monthly recording.
QA/QC procedures to be applied:	Cross check measurement results with records for sold electricity. The calibration cycle stipulated by the manufacturer will be observed and calibration certificates archived.
Any comment:	-

Fossil fuel combustion ($PE_{FF,y}$):

(Copy this table for each data and parameter)	
Data / Parameter:	**$PE_{FF,y}$**
Data unit:	tCO2/yr
Description:	Project emissions from fossil fuel consumption in year *y*
Source of data to be used:	As per the “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.21/yr
Description of measurement methods and procedures to be applied:	Calculated
QA/QC procedures to be applied:	-
Any comment:	-

(Copy this table for each data and parameter)	
Data / Parameter:	**$FC_{i,j,y}$**
Data unit:	Volume per year (Litres)
Description:	Quantity of fuel type *i* combusted in process *j* during the year *y*
Source of data to be	Direct, physical measurements as recorded by metering equipment at CPA

used:	project site.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	54.6L/yr
Description of measurement methods and procedures to be applied:	• Use either mass or volume meters. In cases where fuel is supplied from small daily tanks, rulers can be used to determine mass or volume of the fuel consumed, with the following conditions: The ruler gauge must be part of the daily tank and calibrated at least once a year and have a book of control for recording the measurements (on a daily basis or per shift); • Accessories such as transducers, sonar and piezoelectronic devices are accepted if they are properly calibrated with the ruler gauge and receiving a reasonable maintenance; • In case of daily tanks with pre-heaters for heavy oil, the calibration will be made with the system at typical operational conditions. Monitoring frequency is at least daily.
QA/QC procedures to be applied:	Where the purchased fuel invoices can be identified specifically for the CDM project, the metered fuel consumption quantities should also be cross-checked with available purchase invoices from the financial records. The calibration cycle stipulated by the manufacturer of the metering equipment will be observed and calibration certificates archived.
Any comment:	-

(Copy this table for each data and parameter)	
Data / Parameter:	**$NCV_{i,y}$**
Data unit:	GJ per mass unit (GJ/kg)
Description:	Weighted average net calorific value of fuel type *i* in year *y*
Source of data to be used:	IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0433 GJ/kg
Description of measurement methods and procedures to be applied:	Any future revision of the 2006 IPCC Guidelines will be taken into account and the latest data used for this parameter.
QA/QC procedures to	-

be applied:	
Any comment:	-

(Copy this table for each data and parameter)	
Data / Parameter:	**$EF_{CO2,i,y}$**
Data unit:	tCO_2/GJ
Description:	Weighted average CO_2 emission factor of fuel type *i* in year *y*
Source of data to be used:	IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0748 tCO_2/GJ
Description of measurement methods and procedures to be applied:	Any future revision of the 2006 IPCC Guidelines will be taken into account and the latest data used for this parameter.
QA/QC procedures to be applied:	-
Any comment:	-

SECTION C. Environmental analysis

>>

C.1. Please indicate the level at which environmental analysis as per requirements of the CDM modalities and procedures is undertaken. Justify the choice of level at which the environmental analysis is undertaken:

☐ Please tick if this information is provided at the PoA level. In this case sections C.2. and C.3. need not be completed in this form.

C.2. Documentation on the analysis of the environmental impacts, including transboundary impacts:

>>

A full scoping phase and report has been carried out by Savannah Environmental (Pty) Ltd. The EIA phase of the project is currently underway. The following table provides an outline of potentially sensitive areas identified during the scoping phase.

Table 23: Analysis of environmental impcats

Construction/Decommissioning Impacts	**Positive/Negative Impact**	**Extent***
Disturbance or loss of indigenous vegetation	-	L
Disturbance or loss of threatened plant and/or animal species	-	L
Loss of protected trees	-	L
Damage to wetlands and drainage lines	-	L
Establishment and spread of declared weeds and alien invader plants	-	L
Inability to use arable land during construction of the facility	-	L
Soil loss/erosion/degradation	-	L
Loss of heritage resources	-	L
Temporary visual intrusions/disturbances to people	-	L
Job creation and skills development of local people during construction	+	L-R
Economic spin-offs to local community	+	L
Safety and security risks to site and surrounds	-	L
Temporary disruptions in the daily living and movement patterns to neighbouring landowners	-	L
Operational impacts	**Positive/Negative Impact**	**Extent***
Habitat transformation (limited to the footprint of the PV panels, access roads, and associated infrastructure)	-	L
Change in runoff and drainage patterns due to the presence of drainage lines on the site	-	L
Impact on surface water resources	-	L
Impact of the powerline on birds	-	L
Change in land-use for the footprint of the facility	-	L
Soil erosion	-	L

Visual impacts (intrusion, negative viewer perceptions, and visibility of the facility	-	R
Employment opportunities	+	L-R
Safety and security impacts on the site and neighbouring land	-	L
Positive/negative effect on the tourism industry	+/-	L
Contribution of clean energy	+	N-I
Health and safety impacts	-	L

*Note: L – Local, R – Regional, N – National, I – International

The Scoping Report comments that the majority of the potential impacts identified to be associated with the construction of the solar energy facility are anticipated to be localised and restricted to the proposed site itself (apart from social impacts – job creation, which could have more of a regional positive impact), while operational phase impacts range from local to regional and national (being the positive impact of contribution of clean energy as part of the energy mix in SA). No environmental fatal flaws or no go areas have been identified at this stage to be associated with the site. However, areas of potential environmental sensitivity were identified through the scoping phase.

The EIA phase will aim to provide an overall assessment of the social and biophysical environment affected by the proposed project, assess potentially significant impacts associated with the proposed solar energy facility and associated infrastructure, identify and recommend appropriate mitigation measures for potentially significant environmental impacts, and undertake a fully inclusive public involvement process to ensure that interested and affected parties are afforded the opportunity to participate, and that their issues and concerns and recorded.

C.3. Please state whether in accordance with the host Party laws/regulations, an environmental impact assessment is required for a typical CPA, included in the programme of activities (PoA),:

>>

The National Environmental Management Act (No. 107 of 1998 – NEMA) sets out the requirements for the environmental authorisation process. The Environmental Impact Assessment (EIA) regulations of June 2010 R543, R544, R545 and R546, published under NEMA stipulate the various activities that require a basic assessment or full scoping and EIA process. A full scoping phase and report has been carried out by Savannah Environmental (Pty) Ltd. For the full report (Savannah Environmental, 2011, Final Scoping Report: Proposed photovoltaic (PV) solar energy facility on a site north-east of Upington, Northern Cape Province) please go to www.savannahsa.com. The EIA phase of the project is currently underway.

SECTION D. Stakeholders' comments

>>

D.1. Please indicate the level at which local stakeholder comments are invited. Justify the choice:

☐ Please tick if this information is provided at the PoA level. In this case sections D.2. to D.4. need not be completed in this form.

D.2. Brief description how comments by local stakeholders have been invited and compiled:

>>

Stakeholder comments and queries were invited via 3 routes:

- Interested and Affected Parties, identified during the EIA process, were contacted directly and asked to provide their input;
- An advert was placed in the Business Day, on 22 July 2011, inviting input from members of the public;
- An advert was placed in Engineering Weekly, on 30 July 2011, inviting input from members of the public;
- An invitation to provide comments was also placed on the EcoMetrix Africa website, along with details of the project.

Input from local stakeholders was collated by EcoMetrix Africa and the project developer responded as described in D.3. below.

D.3. Summary of the comments received:

>>

Table 24; Summary of LSC comments received

No.	Date Received	Submission Route	Name	Comment	Reply
1	10/08/2011	email	Annette Stoltz	Could you please give me the detailed description of the property where this development will take place to enable me to track the applications?	The establishment of a commercial solar electricity generating facility and associated infrastructure near Upington, under the Southern Africa Renewable Energy Program is proposed to take place on Portion 0 of the Farm 418 which is located approximately 7km north-east of Upington in the Northern Cape Province.

D.4. Report on how due account was taken of any comments received:

>>

Responses are included in Section D.3. above.

Annex 1

CONTACT INFORMATION ON ENTITY/INDIVIDUAL RESPONSIBLE FOR THE CPA

Organization:	African Rainbow Energy (Pty) Ltd
Street/P.O.Box:	Via della Rotonda 36
Building:	
City:	Roma
State/Region:	
Postfix/ZIP:	00186
Country:	Italy
Telephone:	+39 335 1696013
FAX:	
E-Mail:	thierry.rault@medenergygroup.com
URL:	
Represented by:	EcoMetrix Africa
Title:	Project Manager
Salutation:	Mr
Last Name:	Buchanan
Middle Name:	
First Name:	Sean
Department:	Projects
Mobile:	
Direct FAX:	
Direct tel:	0114631009
Personal E-Mail:	sean.buchanan@ecometrix.co.za

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Refer to section A.4.5.

Annex 3

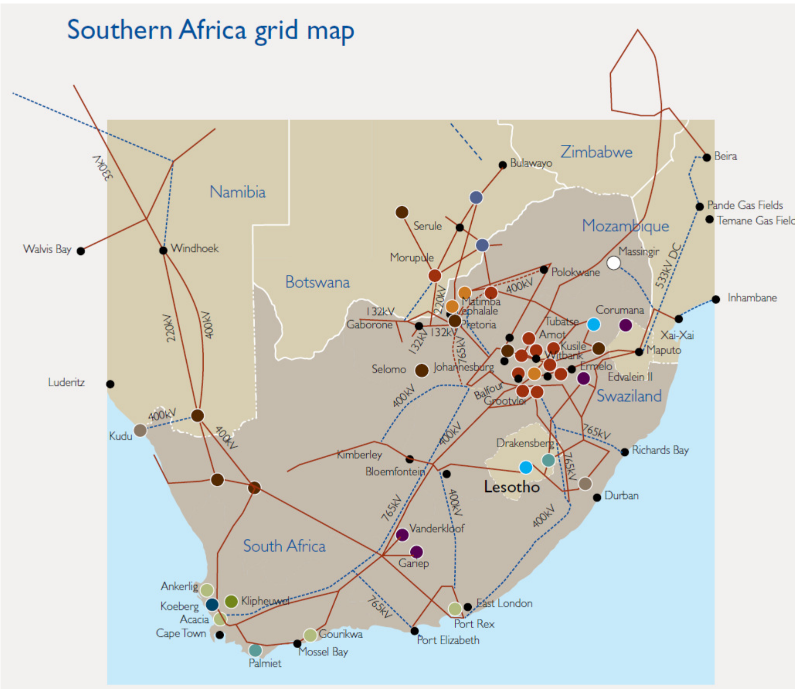
BASELINE INFORMATION

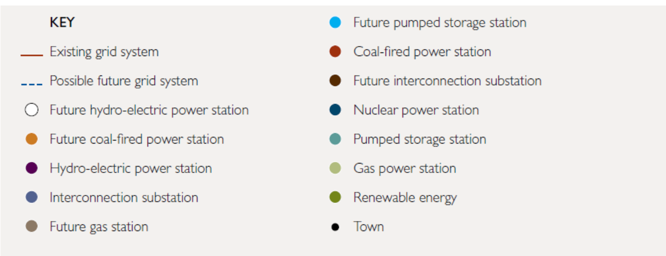
Grid Emission Factor:

All calculations regarding the grid emission factor are contained in the EcoMetrix South African GEF Tool.xls (Attached). Publically available data used in the calculation is included below and was obtained from the following sources:

- Eskom Production data - http://www.eskom.co.za/content/calculationTable.htm
- Default values stipulated by Eskom - http://www.eskom.co.za/c/article/236/cdm-calculations/
- Eskom Annual Report - http://www.eskom.co.za/c/article/257/annual-statements/

Step 1 - Data





The map indicates the South African power network and some interconnections with neighbouring countries.

Eskom is a net exporter (exports exceed imports) of electricity to the region:

- Exports = 6,30% of the total electricity available in South Africa
- Imports = 5,39% of the total electricity available in South Africa
- Net exports = 0,93%

Step 2 – Data

No additional data required for this step

Step 3 – Data

	2011	2010	2009	2008	2007	2006	2005 (15 - months)	2004	2003	2002	2001
Sales											
Total sold (GWh)[1, 2]	224 446	218 591	214 850	224 366	218 120	207 921	256 453	206 799	196 980	187 957	181 511
Growth/(reduction) in GWh sales (%)	2.7	1.7	(4.2)	2.9	4.9	(18.9)[3]	30.5	5.0	4.8	3.5	1.8
Electricity output											
Total produced by Eskom stations (GWh (net))	237 430	232 812	228 944	239 109	232 445	221 988	273 404	220 152	210 218	197 737	189 590
Coal-fired stations (GWh (net))	220 219	215 940	211 941	222 908	215 211	206 606	251 914	202 171	194 046	181 651	175 223
Hydro-electric stations (GWh (net))	1 960	1 274	1 082	751	2 443	1 141	903	720	777	2 357	2 061
Pumped storage stations (GWh (net))	2 953	2 742	2 772	2 979	2 947	2 867	3 675	2 981	2 732	1 738	1 587
Gas turbine stations (GWh (net))	197	49	143	1 153	62	78	–	–	–	–	–
Wind energy (GWh (net))	2	1	2	1	2	3	–	–	–	–	–
Nuclear power station (GWh (net))	12 099	12 806	13 004	11 317	11 780	11 293	16 912	14 280	12 663	11 991	10 719
Total purchased for Eskom system (GWh)	15 446	13 754	12 189	11 510	11 483	10 310	12 197	9 818	8 194	9 496	9 200
Total electricity for Eskom system (Eskom stations and purchased) (GWh)[4]	252 876	246 566	241 133	250 619	243 928	232 298	285 601	229 970	218 412	207 233	198 790
Total consumed by Eskom (GWh)[5]	3 962	3 695	3 816	4 136	3 937	3 814	5 043	4 040	3 664	2 354	2 177
Total available for distribution (GWh)[2]	248 914	242 871	237 317	246 483	239 991	228 484	280 558	225 930	214 748	204 879	196 613

Year	% Hydroelectric Generation	% Nuclear Generation	% Wind Generation	Average produced by these low cost/must run resources (%)
2010	0.55%	5.50%	0.0004%	6.05%
2009	0.47%	5.68%	0.0009%	6.15%
2008	0.31%	4.73%	0.0004%	5.05%
2007	1.05%	5.07%	0.0009%	6.12%
2006	0.51%	5.09%	0.0014%	5.60%
TOTAL	0.58%	5.21%	0.0008%	5.79%

Step 4 – Data

	Electricity Output (GWh (net))			
Year	**2010**	**2009**	**2008**	***AVERAGE***
Coal fired stations	215 940	211 941	222 908	*216 930*
	Coal Burnt (Mt)			
	2010	**2009**	**2008**	***AVERAGE***
	122.7	121.2	125.3	*123.1*
	Calorific Value (MJ/kg)			
	2010	**2009**	**2008**	***AVERAGE***
	19.22	19.10	18.51	*18.94*

	$EF_{grid,OMsimple,y}$	$FC_{i,y}$	$NCV_{i,y}$	$EF_{CO2,i,y}$	EG_y
Units	*t CO_2/MWh*	*t*	*GJ/t*	*t CO_2/GJ*	*MWh*
Coal fired stations	1.02	123 066 667	18.94	0.0946	216 929 667

Option A

$EF_{grid,OMsimple,y} = \sum_{i,m} FC_{i,m,y} * NCV_{i,y} * EF_{CO2,i,y} / EG_{m,y}$	
$EF_{grid,OMsimple,y}$	t CO_2/MWh
$FC_{i,m,y}$	mass
$NCV_{i,y}$	GJ/mass
$EF_{CO2,i,y}$	t CO_2/GJ
$EG_{m,y}$	MWh

Power Generation (MWh/yr)	2007/8	2008/9	2009/10	Average
Arnot	11 905 060	11 987 281	13 227 864	12 373 402
Camden	5 171 057	6 509 079	7 472 070	6 384 069
Duvha	23 622 732	21 769 489	22 581 228	22 657 816
Grootvlei	237 138	1 249 556	2 656 230	1 380 975
Hendrina	13 756 351	12 296 687	12 143 292	12 732 110
Kendal	26 517 420	23 841 401	23 307 031	24 555 284
Komati	0	-	1 016 023	338 674
Kriel	17 762 398	18 156 686	15 906 816	17 275 300
Lethabo	25 701 723	23 580 232	25 522 698	24 934 884
Matimba	29 021 742	26 256 068	27 964 141	27 747 317
Majuba	23 680 971	22 676 924	22 340 081	22 899 325
Matla	24 549 833	21 863 400	21 954 536	22 789 256
Tutuka	20 980 242	21 504 122	19 847 894	20 777 419

Coal Consumption (t/yr)	2007/8	2008/9	2009/10	Average
Arnot	6 210 700	6 395 805	6 794 134	6 466 880
Camden	3 218 873	3 876 211	4 732 163	3 942 416
Duvha	12 425 531	11 393 553	11 744 606	11 854 563
Grootvlei	130 748	674 538	1 637 371	814 219
Hendrina	7 794 220	7 122 918	6 905 917	7 274 352
Kendal	15 986 131	15 356 595	13 866 514	15 069 747
Komati	-	-	664 497	
Kriel	9 059 934	9 420 764	8 504 715	8 995 138
Lethabo	18 314 572	16 715 323	18 170 227	17 733 374
Matimba	14 862 323	13 991 453	14 637 481	14 497 086
Majuba	12 853 342	12 554 406	12 261 833	12 556 527
Matla	13 795 309	12 689 387	12 438 391	12 974 362
Tutuka	10 627 575	11 231 583	10 602 839	10 820 666

	2007/8	2008/9	2009/10	Average
Average Coal Calorific Value (MJ/kg)	18.51	19.10	19.22	18.94

Power Station	$EF_{grid,OMsimple,y}$ (t CO2/MWh)	Weight	$EF_{EL,m,y}$ (t CO2/MWh)	$FC_{i,m,y}$ (ton)	$NCV_{i,y}$ (GJ/t)	$EF_{CO2,i,y}$ (t CO2/GJ)	$EG_{m,y}$ (MWH)
Arnot	0.05	5.7%	0.94	6 466 880	18.94	0.0946	12 373 402
Camden	0.03	2.9%	1.11	3 942 416	18.94	0.0946	6 384 069
Duvha	0.10	10.5%	0.94	11 854 563	18.94	0.0946	22 657 816
Grootvlei	0.01	0.6%	1.06	814 219	18.94	0.0946	1 380 975
Hendrina	0.06	5.9%	1.02	7 274 352	18.94	0.0946	12 732 110
Kendal	0.12	11.3%	1.10	15 069 747	18.94	0.0946	24 555 284
Kriel	0.07	8.0%	0.93	8 995 138	18.94	0.0946	17 275 300
Lethabo	0.15	11.5%	1.27	17 733 374	18.94	0.0946	24 934 884
Matimba	0.12	12.8%	0.94	14 497 086	18.94	0.0946	27 747 317
Majuba	0.10	10.6%	0.98	12 556 527	18.94	0.0946	22 899 325
Matla	0.11	10.5%	1.02	12 974 362	18.94	0.0946	22 789 256
Tutuka	0.09	9.6%	0.93	10 820 666	18.94	0.0946	20 777 419
Total	**1.02**	**100.0%**	**N/A**	**N/A**	**N/A**	**N/A**	**216 507 158**

Step 5 - Data

Station	Year Commissioned	AEG 2010 (MWh)
Majuba	1996	22 340 081
Kendal	1988	23 307 031
Matimba	1987	27 964 141
Lethabo	1985	25 522 698
Tutuka	1985	19 847 894
Total $AEG_{SET\text{-}5\text{-}units}$	-	**118 981 845**

Power Units	AEG 2010 (MWh)	Date Commissioned	% of AEG_{total}
Arnot	13 227 864		6%
Camden	7 472 070		3%
Duvha	22 581 228		10%
Grootvlei	2 656 230		1%
Hendrina	12 143 292		6%
Kendal	23 307 031	1988	11%
Komati	1 016 023		0%
Kriel	15 906 816		7%
Lethabo	25 522 698	1985	12%
Matimba	27 964 141	1987	13%
Majuba	22 340 081	1996	10%
Matla	21 954 536		10%
Tutuka	19 847 894	1985	9%
Total AEG_{total}	**215 939 904**	-	100%
$AEG_{SET\geq 20\%}$	45 647 112	-	21%

Power Units	AEG 2010 (MWh)	Date Commissioned	% of AEG_{total}
Majuba	22 340 081	1996	10%
Kendal	23 307 031	1988	11%
$AEG_{SET\text{-sample-CDM}}$	45 647 112	-	21%

Power Units	AEG 2010 (MWh)	Date Commissioned	% of AEG_{total}
Majuba	22 340 081	1996	10%
Kendal	23 307 031	1988	11%
$AEG_{SET\text{-sample-CDM->10yrs}}$	45 647 112	-	21%

Cash Flow Model:

ASSUMPTIONS

Blue data = input

General Assumptions	
Location	Upington
Currency	Rand
Inflation Rate	3.31%
Corporate tax rate	28.00%
Local taxes	0.00%
m² per Ha Conversion	10 000
€/Rand	9.140

Power Generation	
Hectares (Ha)	98
Ha/MWp	3.91
Tot MWp Part I	25.00
Tot MWp Part II	0.00
De-Rate Factor	79%
Availability	98%
Increase factor for T0 technology	27%
Losses for grid connectios	0%
Panel Loss of Efficiency per Year	0.8%
(Mwh/m²):	2 200

Price Assumptions		
Energy Price (Zar/Mwh)		0.00
Refit I (Zar/Kwh)		0.65
Refit II (Zar/Kwh)		0.52
Refit I (Zar/Mwh)		650.00
Refit II (Zar/Mwh)		520.00
% Energy Price paid in same year		100%
% Conto Energy paid in same year		100%
% Opex paid in same year		100%
installed		3 376 050
Investment in Zar per MWp installed		30 857 097
Maint. Costs on Invest. in Zar for MWp	0.90%	277 714
Insurance Costs on Invest. in Zar FOR MWp	0.50%	154 285
Land Letting with contingency (Zar/ha/year)	2.00%	-
South Africa EPC Discount		0%
Refit II Discount		20%

Timing	
Final authorisation	Nov-11
Construction beginning	Nov-11
Time for construction (months)	4
Production beginning	Apr-12
Production 2012 (months)	9
Production 2013-2031 (months)	12
Production 2032 (months)	3

DEPRECIATION (YEARS)	
Total pre-operative	20
Land purchase	20
Development premium	20
EPC contract	20
Interest during construction	20
Commission Project Financing	20

VAT	
VAT Refund (months)	1
Interest on VAT facility (net)	0.00%
Months of interest during construction	4

CAPEX	
Pre-operative 2011	3 000 000
Pre-operative 2012	12 000 000
Total pre-operative	15 000 000
EPC contract	771 427 425
Land purchase	4 000 000
Development premium	82 260 000
Total operative	**857 687 425**
construction	23 765 089
Financing	9 005 718
Total investment	**905 458 232**

EQUITY VS DEBT	
Equity %	30%
Debt %	70%
Equity Millions	192 193 667
Debt Millions	743 271 301

PROJECT FINANCING	
Commission	1.50%
Tenor (years)	15
DSRA (Zar)	30 006 736
construction	5.5%
Interest (from 1 to 5 yr)	5.5%
Interest (from 6 to 10 yr)	5.5%
Interest (from 11 to 15 yr)	5.5%
Interest (margin)	4.0%
construction	4

SUBORDINATED LOAN	
Tenor	8
Interest (from 1 to 5 yr)	5.5%
Interest (from 6 to 10 yr)	5.5%
Interest (from 11 to 15 yr)	5.5%
Spread	9%
Equity equivalent	90 545 823

OPEX		
Maintenance Costs Refit I		6 942 847
Maintenance Costs Refit II		-
Insurance Costs		3 857 137
Land Letting		-
Administrative and Staff Costs		1 096 800
Land Registry Tax		0%
Contingency	10.0%	1 189 678
Total Opex (basis 2010)		**11 896 784**

DIVIDEND	
Legal reserve	0%

WACC CALCULATION	
B Unlevered	1.00
Interest free risk	1.50%
Interest market risk	4.00%
Kd	2.80%

All figures in ZAR	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Operating cash flow	(454 111)	15 704 462	20 625 988	19 882 462	19 123 671	18 349 112	17 558 262	16 750 583	15 925 519	15 082 495	14 220 917	13 340 172
Taxes Paid	0	0	0	0	0	0	0	0	0	0	0	0
Capex	(3 000 000)	(866 687 425)	0	0	0	0	0	0	0	0	0	0
Taxes Excluding Financing		0	0	0	0	0	0	0	0	0	0	0
Terminal value												
Free Cash Flow	(3 454 111)	(850 982 963)	20 625 988	19 882 462	19 123 671	18 349 112	17 558 262	16 750 583	15 925 519	15 082 495	14 220 917	13 340 172
Cumulative Cash Flow	(3 454 111)	(854 437 074)	(833 811 086)	(813 928 624)	(794 804 953)	(776 455 841)	(758 897 579)	(742 146 996)	(726 221 477)	(711 138 982)	(696 918 065)	(683 577 893)
Payback	No	No	No	No	No	No	No	No	No	No	No	No

All figures in ZAR	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Operating cash flow	12 439 626	11 518 625	10 576 492	9 612 529	8 626 013	7 616 200	6 582 320	5 523 575	4 439 146	(959 459)	0
Taxes Paid	0	0	0	0	0	0	0	0	0	0	0
Capex	0	0	0	0	0	0	0	0	0	0	0
Taxes Excluding Financing	0	0	0	0	0	0	0	0	0	0	0
Terminal value											
Free Cash Flow	12 439 626	11 518 625	10 576 492	9 612 529	8 626 013	7 616 200	6 582 320	5 523 575	4 439 146	(959 459)	0
Cumulative Cash Flow	(671 138 267)	(659 619 642)	(649 043 150)	(639 430 622)	(630 804 608)	(623 188 408)	(616 606 088)	(611 082 513)	(606 643 367)	(607 602 826)	(607 602 826)
Payback	No	No	No	No	No	No	No	No	No	No	No

IRR PROJECT	-12.16%
WACC PROJECT	7.00%
NPV PROJECT	(656 064 625)

IRR & DCF EQUITY

	0	1	2	3	4	5	6	7	8	9	10	11
All figures in ZAR	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
EBITDA	(454 111)	15 704 462	20 625 988	19 882 462	19 123 671	18 349 112	17 558 262	16 750 583	15 925 519	15 082 495	14 220 917	13 340 172
Capex	(3 000 000)	(899 458 232)	0	0	0	0	0	0	0	0	0	0
Debt	454 111	580 539 945	(116 454 495)	(111 858 233)	(107 695 600)	(103 509 516)	(99 296 580)	(95 052 898)	(90 774 013)	(86 454 819)	(65 119 882)	(61 118 984)
Tax	0	0	0	0	0	0	0	0	0	0	0	0
Free Cash Flow To Equity	(3 000 000)	(303 213 825)	(95 828 507)	(91 975 771)	(88 571 929)	(85 160 404)	(81 738 318)	(78 302 315)	(74 848 494)	(71 372 324)	(50 898 965)	(47 778 812)
Cumulative Cash Flow	(3 000 000)	(306 213 825)	(402 042 332)	(494 018 104)	(582 590 033)	(667 750 437)	(749 488 755)	(827 791 070)	(902 639 564)	(974 011 889)	(1 024 910 854)	(1 072 689 665)
Payback	No	No	No	No	No	No	No	No	No	No	No	No

	12	13	14	15	16	17	18	19	20	21	22
All figures in ZAR	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
EBITDA	12 439 626	11 518 625	10 576 492	9 612 529	8 626 013	7 616 200	6 582 320	5 523 575	4 439 146	(959 459)	0
Capex	0	0	0	0	0	0	0	0	0	0	0
Debt	(57 118 086)	(53 117 187)	(49 116 289)	(45 115 391)	(42 114 717)	(21 004 715)	0	0	0	0	0
Tax	0	0	0	0	0	0	0	0	0	0	0
Free Cash Flow To Equity	(44 678 459)	(41 598 563)	(38 539 797)	(35 502 862)	(33 488 704)	(13 388 515)	6 582 320	5 523 575	4 439 146	(959 459)	0
Cumulative Cash Flow	(1 117 368 125)	(1 158 966 687)	(1 197 506 485)	(1 233 009 347)	(1 266 498 051)	(1 279 886 566)	(1 273 304 247)	(1 267 780 671)	(1 263 341 526)	(1 264 300 985)	(1 264 300 985)
Payback	No	No	No	No	No	No	No	No	No	No	No

IRR	#NUM!
WACC PROJECT	7.00%
NPV	(883 739 221)

Annex 4

MONITORING INFORMATION

Refer to section B.6.

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