CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
VERSION 03 - IN EFFECT AS OF: 28 JULY 2006

CONTENTS

Annexes

SECTION A. General description of project activity

A.1. Title of the project activity:

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Use of waste gas at Namakwa Sands in South Africa
Version: 09
Date: 13/11/2012

A.2. Description of the project activity:

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(i) Purpose of the project

The purpose of the project is to reduce greenhouse gas emissions by utilising waste gas from a smelter operation. The waste gas will be used for the generation of electricity.

The *Exxaro Resources Ltd* owned *Exxaro TSA Sands (Pty) Ltd* smelter (referred to from this point on as Namakwa Sands) is a heavy minerals mining and beneficiation business located in South Africa. This business encompasses mining, mineral concentration, separation, and smelting operations. The smelting operation commenced in 1994 in the Western Cape Province, near the town of Saldanha Bay. The smelting operation consists of two closed, DC-arc furnaces: Furnace 1 (with an electrical capacity of 25 MW and a tapping capacity of 20 tonnes of slag every 2 hours and 30 tonnes of metal every 4 hours) and Furnace 2 (with an electrical capacity of 35 MW and a tapping capacity of 25 tonnes of slag every 1.5 hours, and 30 tonnes of metal every 2.5 hours). Inside these furnaces, the reduction of mined ilmenite to produce titania (TiO_2) slag and iron (Fe) occurs. The reduction of mined ilmenite requires the presence of a carbon-rich reductant. Typical reductants that are used by smelting operations are anthracite, char and/or coke.

The reduction of mined ilmenite is represented by reaction (1).

$$FeTiO_3 \rightarrow TiO_{2\,(slag)} + Fe_{(metal)} + CO_{(gas)} \qquad (1)$$

The carbon monoxide (CO) gas is formed as a result of the presence of the carbon in the reductant. If the reductant contains volatile hydrocarbons, as is the case at Namakwa Sands, hydrogen (H_2) gas is also formed. This CO and H_2 gas is referred to as furnace off-gas. Currently, the majority of the furnace off-gas is cleaned and then flared. The flaring of the cleaned gas is a safety measure, as carbon monoxide is extremely poisonous. Cleaning of the gas prior to flaring is required to reduce the particulate emissions from the flares. However, the flaring of the off-gas means that the energy inherent in the gas is not utilised.

The project will use this cleaned furnace off-gas, which was previously flared, to generate electricity using internal combustion engines. The actual quantity of gas available for the project depends on the furnace performance and availability.

The performance of the engines is still unknown as there is no reference plant running on gas with comparable hydrogen and carbon monoxide content. However, GE Jenbacher has guaranteed an electrical output of 1698 kW per engine for this project[1]. GE Jenbacher has been selected as the gas engine supplier for this project activity however; Exxaro Resources Ltd can only sign a contract with the supplier when a positive validation report is received.

Eight internal combustion engines will be installed in the project activity. At the completion of plant commissioning, the engines will displace a guaranteed 13.6 MW[2] of electricity, resulting in emission reductions of an average of 84,432 tCO_2e/ year. The electricity will be used by the Namakwa Sands smelting operation, thus resulting in a reduction of electricity purchased from Eskom (South Africa's national electricity provider).

The project timeline is as follows:

- The Exxaro Resources Ltd Board approved the capital expenditure for the project at a Board meeting on 17/08/2011. This Board approval was conditional to the project receiving a positive CDM validation report, as the project is not feasible in the absence of the CDM.
- Full capital approval for the project was granted on 12/01/2012, based on the draft CDM validation protocol that was received on the 15/12/2011. Exxaro Resources Limited placed the contract for project execution immediately thereafter. This represents the start date of the project activity.
- The full project schedule has not yet been finalised (as of 14/02/2012) but it is expected that the project will be commissioned on 01/01/2013.

(ii) Greenhouse gas reduction:

The electricity generated from the furnace off-gas will displace electricity from the project electricity system. According to the 'Tool to calculate the emission factor for an electricity system' (Version 02.2.1), a project electricity system is defined by the power plants that are physically connected through transmission and distribution lines to the project activity and that can be displaced without significant transmission constraints.

Namakwa Sands currently purchases its electricity from Eskom. Eskom is physically connected to the Southern African Power Pool[3]. Therefore, for this project activity, the project electricity system comprises of all power plants within the SAPP. Electricity from the SAPP is predominantly generated from sub-bituminous coal, with a low heat value and a high ash content (83% of the electricity is from

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[1] GE Jenbacher specifications for the JGS 620 GS-S.L spark ignited gas engine, with a guaranteed electrical output of 1698 kW.

[2] 13.58 MW rounded to one decimal place

[3] Eskom. (2010, October). Eskom and the Southern African Power Pool (SAPP). Retrieved from www.eskom.co.za/content/ES_0007SAfPowPoolRev5.pdf

coal fired power stations). Owing to the use of coal and, more specifically, low quality coal, the emission factor of the SAPP is 1.036 tonnes CO_2/MWh. This value was calculated using the 'Tool to calculate the emission factor for an electricity system' (Version 02.2.1), and these calculations were provided during validation.

(iii) Contribution to sustainable development:

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

Economic

There will be a transfer of technology from a developed country to a developing country. The internal combustion engines that are used to generate the electricity will be sourced from GE Jenbacher in Austria (Annex-1 country) and will be imported to South Africa.

Internal combustion engines are currently used in only five other South African registered CDM projects:

- The first of these projects is the 'PetroSA Biogas to Energy Project' (Project 0446), which was registered by the CDM EB on the 29/09/2006. In this project, the engines operate on biogas composed primarily of methane.

- In the second project, the engines run on landfill gas released from Durban's landfill sites. This project was registered as a CDM project by CDM EB on the 15/12/2006 and is titled 'Durban Landfill Gas-to-Electricity Project – Mariannhill and La Mercy' (Project 0545).

- The third project, titled 'Kanhym Farm manure to energy project' (registered under CDM on 18/07/2008 – project 1665), uses biogas from a piggery to generate electricity using an internal combustion engine.

- The fourth and fifth projects also use landfill gas to operate their internal combustion engines. These projects are titled 'Durban Landfill-Gas Bisaser Road' (registered under CDM on 26/03/2009 – project 1921), and 'Alton Landfill Gas to Energy Project' (registered under CDM on 24/08/2009 – project 2549).

These projects are all biogas projects, and differ fundamentally from the Namakwa Sands project. The main difference lies in the fact that the fuel gas of the proposed project does not contain any methane, but rather carbon monoxide and hydrogen. In addition, the projects mentioned above operate the engines on gas with a significantly higher calorific value than the furnace off-gas that this project will use.

There will be a transfer of knowledge as personnel responsible for the operation and maintenance of the engines will receive the necessary training.

Environmental

The proposed project activity will have a positive regional environmental impact. It will lower the environmental impacts of coal based power generation. This includes the amount of sulphur dioxide released due to the combustion of low grade coal, particulate emissions, water demand of coal based power generation, and the environmental impact of ash disposal.

The project will also have a positive local environmental impact. It will remove additional particulates from the furnace off gas. The gas, previously flared, will be filtered to minimise the particulate loading of the gas. The particulates trapped by the filters will be removed with water and be routed to the existing thickener. This will lead to improvements in the local air quality.

The proposed project will not change the current local water availability or access. Neither will the project have an impact on the current local water quality. The current soil condition at Namakwa Sands will not be affected by the project activity. The project will be located within an existing built up area at the Namakwa Sands Smelter, on already disturbed land. The project will, however, encourage more efficient use of natural resources and energy.

On a global scale, the project makes a contribution to greenhouse gas emission reduction.

Social

The project will create 11 jobs in the operations phase. The creation of jobs is important since the Namakwa Sands smelting operation is located in an area with very little established industries and, therefore, very few existing employment opportunities. The number of temporary jobs created in the construction phase has not been estimated, but similar projects estimate that the number of temporary jobs created is around 100 jobs. It is Exxaro Resources Ltd's policy to actively recruit labour from local communities wherever possible[4]. The creation of jobs is in line with the Saldanha Bay Municipality's Integrated Development Plan (IDP) for 2006-2011, which states that growing unemployment is one of the greatest challenges facing the municipality[5].

[4] Exxaro. (2009). Annual Report, page 122. Retrieved from http://www.exxaro.com/content/investor/finreport.asp
[5] Saldanha Bay Municipality Integrated Development Plan 2006-2011, pages 8 and 43. Retrieved from http://www.capegateway.gov.za/Text/2008/4/idp_wc_saldanha_bay_2007.pdf

A.3. Project participants:

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Name of Party involved (*) ((host) indicates a host Party)	**Private and/or public entity(ies) project participants (*) (as applicable)**	**Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)**
Republic of South Africa	Exxaro Resources Ltd	No

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

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The host party is the Republic of South Africa.

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

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The project is located in the Western Cape Province.

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

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The project is located approximately 15km from the town of Saldanha Bay.

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

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The project will be situated as near to the source of the furnace off-gas as possible in order to minimise the safety risks involved in transporting the off-gas. Therefore, the plant will be located at the Namakwa Sands' smelting operations in South Africa. The site is located within the Saldanha Bay Local Municipality, which is one of the municipalities encompassed under the West Coast District Municipality in the Western Cape. The site is 15 km from the towns of Vredenburg and Saldanha and is off the coastal road the R27.

The location of the proposed project activity is shown below:

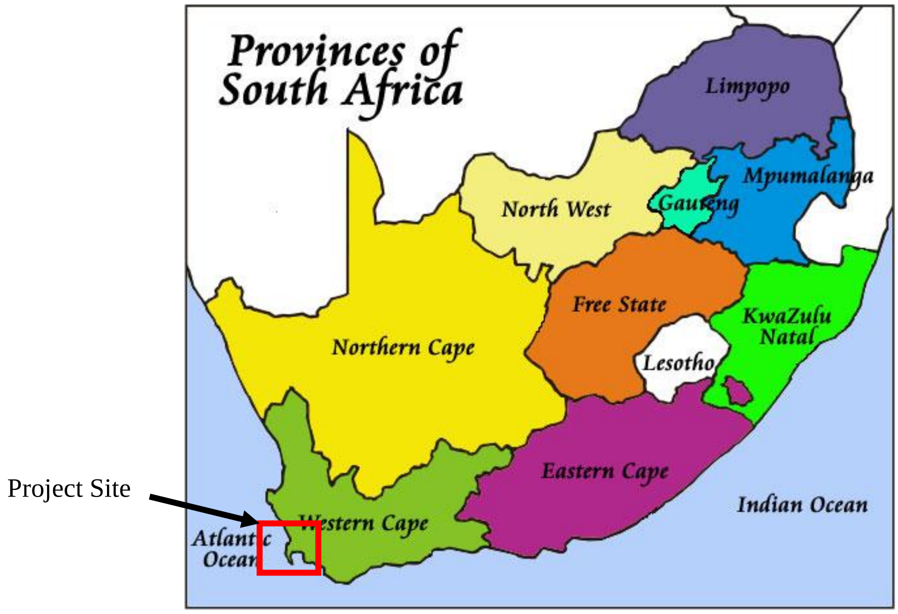

Figure 1: The provincial location of the project activity

Figure 2: The location of the project activity, which is at the Namakwa Sands smelting facility

The new project facility will be located at the following GPS coordinates:
Latitude: 32° 57' 43" S
Longitude: 18° 02' 39" E

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

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Sectoral scope 01: Energy industries (renewable-/non-renewable sources)
Sectoral scope 04: Manufacturing industries

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

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Furnaces

Namakwa Sands operates two closed, DC-arc furnaces that were built by Aesa Brown Boveri:

- Furnace 1
    - Electrical capacity: 25 MW.
    - Tapping capacity: 20 tonnes of slag every 2 hours and 30 tonnes of metal every 4 hours.
- Furnace 2
    - Electrical capacity: 35 MW.
    - Tapping capacity: 25 tonnes of slag every 1.5 hours and 30 tonnes of metal every 2.5 hours.

Inside these furnaces, ilmenite is reduced to produce titania slag and iron. Along with titania slag and iron, a gas (furnace off-gas) composed primarily of carbon monoxide and hydrogen is produced.

The composition of the furnace off-gas varies, but the table below presents the average composition of the gas based on information supplied by Namakwa Sands:

Furnace	Component	Composition (vol. %)
Furnace 1	CO	73.0
	H_2	14.5
Furnace 2	CO	75.5
	H_2	16.5

The remainder of the gas is predominantly nitrogen with a small amount of carbon dioxide. The oxygen content is negligible since the furnace is set to trip at an oxygen content of 0.5 vol. %.

The volume of the gas available per year for electricity generation varies between ± 82,000,000 Nm^3 and ± 90,000,000 Nm^3, with the average over the period 2011 – 2026 at 87,500,000 Nm^3. The average gas flow rate over the period 2011 – 2026 is 11,898 Nm^3/hr.

At present, the off-gas is collected from the furnaces and cleaned and conditioned in the gas cleaning plant. If the gas cleaning plant is down for planned or unplanned maintenance then the gas is flared in the

raw gas stack. However, under normal operation, the particulates in the gas are removed and the gas is cooled in the gas cleaning plant and the resulting clean gas is then routed to a gas buffer vessel. The clean gas is stored at 4.5kPa gauge in the gas buffer vessel. If the gas buffer vessel exceeds an upper limit of its maximum storage capacity, the clean gas is flared in the clean gas stack.

Currently, a small portion of the clean gas is extracted from the gas buffer vessel and used to dry anthracite. Anthracite is the reductant used in the furnaces to reduce ilmenite to titania slag and iron. This small portion of clean gas will still be used to dry the anthracite during the project activity. It is the rest of the gas, which was previously flared, that will be used in this project activity to generate electricity. The gas that is used to generate electricity will be extracted from the gas buffer vessel and further cleaned and conditioned. The gas must be further cleaned in order to meet the gas requirements as specified by the engine manufacturers.

Internal combustion engines

This project activity will be operated for power generation alone. The power will be generated using internal combustion engines. The internal combustion engines are spark ignition engines operating on the same principles as normal petrol engines. These engines have electrical outputs of between 1.5 MW and 2 MW. The project activity will use as much of the off-gas that is currently flared in the internal combustion engines as possible.

GE Jenbacher has been selected as the gas engine supplier for this project activity however; Exxaro Resources Ltd can only sign a contract with the supplier when a positive validation report is received.

The GE Jenbacher internal combustion engines used in the project will be imported from an Annex-1 country in Europe. Therefore, there will be a technology transfer from an industrialised country to a developing country. These engines have been used at five other registered CDM projects in South Africa. These projects are:

- PetroSA Biogas to Energy Project (project 0446)
- Durban Landfill Gas-to-Electricity Project – Mariannhill and La Mercy (project 0545)
- Kanhym Farm manure to energy project (project 1665)
- Durban Landfill-Gas Bisaser Road (project 1921)
- Alton Landfill Gas to Energy Project (project 2549)

These projects are all biogas projects and differ fundamentally from the Namakwa Sands project. The main difference lies in the fact that the fuel gas of this project does not contain any methane, but rather carbon monoxide and hydrogen.

This project also aims to be the first CDM registered project in South Africa to operate the engines on the low calorific value waste gas at a smelter. The average calorific value for waste gas in the three years prior to the start of the project activity was 10.92 MJ/Nm^3. For more details, refer to Annex 3 for the

energy balance of the relevant sections of the plant. Therefore, there will be knowledge innovation from this project. Knowledge transfer will also take place as the relevant personnel will be trained in the operation of the engines.

The actual performance of the engines is still unknown as there is no reference plant running on gas with comparable hydrogen and carbon monoxide content. This technological risk will be addressed by installing a conservative amount of engines at the beginning of the project. Their electrical output will be closely monitored during the first months of operation. If the engines reach/are close to their maximum electrical output, no further engines will be installed. However, if they do not operate near their maximum expected electrical output; additional engines will be installed when required.

Existing and proposed furnace off-gas system

Below is a schematic of the existing (currently done at Namakwa Sands) and new (proposed by the project activity) furnace off-gas system:

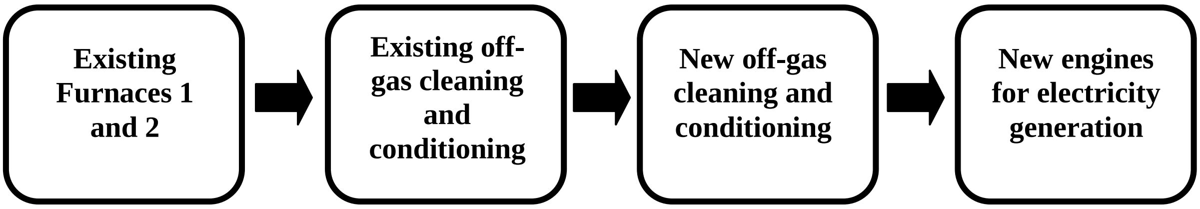

Figure 3: Schematic of furnace off gas system

Process flow diagram of the off gas system and project activity

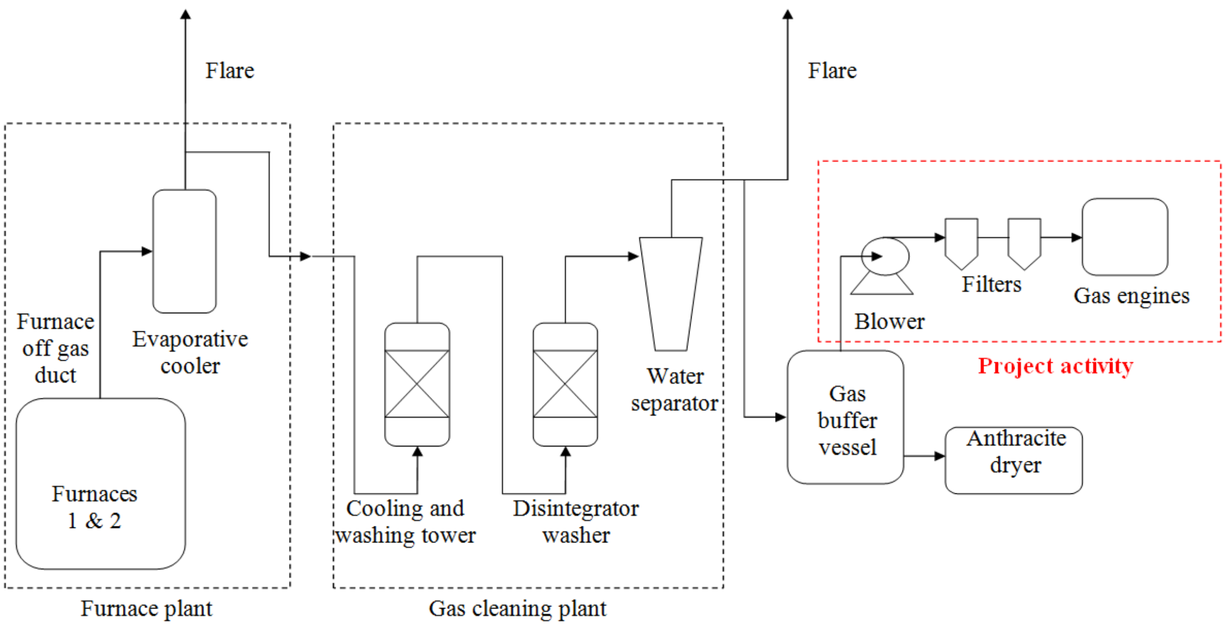

Figure 4: Process flow diagram of off gas system and the project activity

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

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Year	Annual estimation of emission reductions in tonnes of CO_2e
2013	85,392
2014	81,997
2015	82,809
2016	85,279
2017	85,392
2018	85,392
2019	85,392
2020	81,997
2021	85,392
2022	85,279
Total estimated reductions (tonnes of CO_2e)	844,320
Total number of crediting years	10
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	84,432

A.4.5. Public funding of the project activity:

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No public funding has been used in the development of this project and no public funding will be used in its implementation. Official Development Assistance (ODA) has not and will not be used in the development and implementation of this project.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

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The approved baseline and monitoring methodology is ACM0012: 'Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects', Version 04.0.0, Sectoral Scopes 01 and 04, EB 60.

The following methodological tools were used:

- 'Tool to calculate the emission factor for an electricity system' (Version 02.2.1)
- 'Tool for the demonstration and assessment of additionality' (Version 06.0.0)
- 'Tool to determine the remaining lifetime of equipment' (Version 01)

- 'Tool to calculate baseline, project and/or leakage emissions from electricity consumption' (Version 01)

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

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The following table summarises the main applicability criteria for project's applying ACM0012 (version 04.0.0). This project activity meets all of the criteria – this is justified in the table below.

Item	ACM0012 (version 04.0.0)	Project Activity
1	*The consolidated methodology is applicable to project activities implemented in an existing or Greenfield facility converting waste energy carried in identified WECM stream(s) into useful energy. The WECM stream may be an energy source for:* • *Generation of electricity;* • *Cogeneration;* • *Direct use as a process heat source;* • *Generation of heat in element processes;* • *Generation of mechanical energy; or* • *Supply of heat of reaction with or without process heating*	The waste energy will be used as an energy source for the generation of electricity at Namakwa Sands, an existing heavy minerals mining and beneficiation facility.
2	*In the absence of the project activity, the WECM stream:* *a) Would not be recovered and therefore would be flared, released to atmosphere, or remain unutilized in the absence of the project activity at the existing or Greenfield project facility; or* *b) Would be partially recovered, and the unrecovered portion of WECM stream would be flared, vented or remained unutilised at the existing or Greenfield project facility.*	Point (a) is applicable. In the absence of the project activity, Namakwa Sands would continue its current operation – the furnace off-gas (to be used in the project activity) would have been flared. The flaring of the waste gas prior to the project activity is demonstrated by an energy balance of the relevant sections of the plant. This is in accordance with Annex 2 of the applied methodology. Please refer to Annex 3 of this document for the energy balance.
3	*Project activities improving the WECM recovery may (i) capture and utilise a larger quantity of WECM stream as compared to the historical situation in existing facility, or capture and utilise a larger quantity of WECM stream as compared to a 'reference waste energy generating facility'; and/or*	This is not relevant. The furnace off-gas that is used in the project activity is not as a result of improving the WECM recovery.

	(ii) apply more energy efficient equipment to replace/modify/expand waste energy recovery equipment, or implement a more energy efficient equipment than the 'reference waste energy generating facility'.	
4	*The methodology is applicable under the following conditions:* *1. For project activities which recover waste pressure, the methodology is applicable where waste pressure is used to generate electricity only and the electricity generated from waste pressure is measurable;* *2. Regulations do not require the project facility to recover and/or utilize the waste energy prior to the implementation of the project activity;* *3. The methodology is applicable to both Greenfield and existing waste energy generation facilities. If the production capacity of the project facility is expanded as a result of the project activity, the added production capacity must be treated as a Greenfield facility;* *4. Waste energy that is released under abnormal operation (for example, emergencies, shut down) of the project facility shall not be included in the emission reduction calculations.*	1. Waste pressure will not be used to generate electricity at Namakwa Sands. 2. According to a document published by the National Energy Regulator of South Africa (NERSA), furnace off gases are normally flared into the atmosphere or burnt in an open flame without fully utilising the energy contained in them[6]. This shows that it is common practice in South Africa to flare the furnace off gas. This common practice is due to the fact that there is no legislation that requires facilities like Namakwa Sands to recover and/or utilise the waste energy. 3. This project activity is implemented at an existing waste energy generation facility. The production capacity of Namakwa Sands will not increase as a result of the project activity. 4. The waste gas released under abnormal operation of the plant will not be included in the emission reduction calculations.
5	*If multiple waste gas streams are available in the project facility and can be used interchangeably for various applications as part of the energy sources in the facility, the recovery of any waste gas stream, which would be totally or partially recovered in the absence of the project activity, shall not be reduced due to the implementation of CDM project activity.*	This is not relevant. The project facility does not have multiple waste gas streams that can be used interchangeably.

[6] National Energy Regulator of South Africa (2011). NERSA Consultation Paper: Cogeneration Regulatory Rules and Feed-In Tariffs, page 7 paragraph 3.

	For such situations, the guidance provided in Annex 3 shall be followed.	
6	*The methodology is not applicable to the cases where a WECM stream is partially recovered in the absence of the CDM project activity to supply the heat of reaction, and the recovery of this WECM stream is increased under the project activity to replace fossil fuels used for the purpose of supplying heat of reaction.*	This is not relevant. A WECM stream is not partially recovered in the absence of the CDM project activity to supply the heat of reaction.
7	*This methodology is also not applicable to project activities where the waste gas/heat recovery project is implemented in a single-cycle power plant (e.g. gas turbine or diesel generator) to generate power. However, the projects recovering waste energy from single cycle and/or combined cycle power plants for the purpose of generation of heat only can apply this methodology.*	The project activity is implemented in an ilmenite smelter (not a single-cycle power plant), and therefore this methodology is applicable.
8	*The emission reduction credits can be claimed up to the end of the lifetime of the waste energy generation equipment. The remaining lifetime of the equipment should be determined using the latest version of the 'Tool to determine the remaining lifetime of equipment'.*	The waste energy generation equipment in this project is two closed, DC-arc furnaces. In accordance with version 01 of the 'Tool to determine the remaining lifetime of equipment', option (b) was selected to determine the remaining lifetime of the furnaces. An independent expert, with relevant experience in evaluating the remaining lifetime equipment, assessed the furnaces at Namakwa Sands to have a remaining lifetime of 28 years[7], which far exceeds the end of the crediting period.
9	*The extent of use of waste energy from the waste energy generation facilities in the absence of the CDM project activity will be determined in accordance with the procedures provided in Annex 1 (for Greenfield project facilities) and in Annex 2 (for existing project facilities) to this methodology.*	The extent of use of waste energy in the absence of the CDM project activity was determined using an energy balance at Namakwa Sands, as per the guidance provided for existing facilities in Annex 2 of the methodology. The energy balance proves that the furnace off-gas that is recovered in the project activity was previously flared, and was not a source of

[7] According to a letter received on 06/03/2012 from an independent expert, regarding the Namakwa Sands furnaces life.

		energy before the implementation of the project activity.
10	*In addition, the applicability conditions included in the tools referred to above apply.*	All applicability conditions in the applied tools are satisfied.

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

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As per methodology ACM0012, the project boundary includes the relevant WECM stream(s), equipment and energy distribution system in the project and recipient facilities. In this project activity, the project facility is the same as the recipient facility.

The project boundary covers:

- The facility generating the furnace off-gas;
- The proposed electricity generation plant, which will generate electricity from the furnace off-gas;
- The facility using the electricity, which in this case is the same as the facility generating the furnace off-gas; and
- The electricity grid, to the extent of determining the grid emission factor.

The project boundary is illustrated in Figure 5 below:

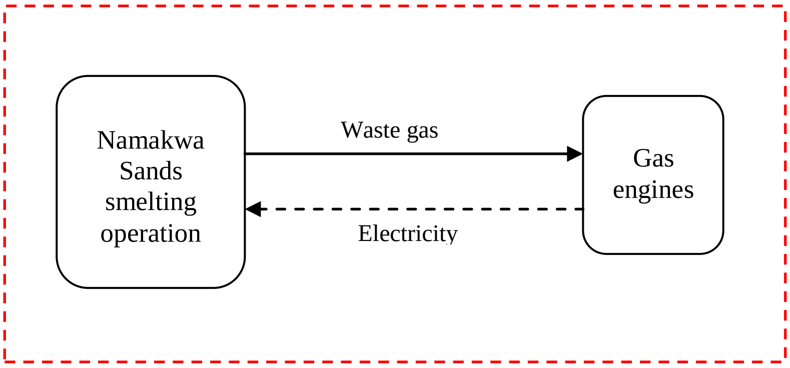

Figure 5: Project boundary of the project activity

Table 1: Summary of gases and sources included in the project boundary and justification explanation where gases and sources are not included

	Source	Gas	Included?	Justification / Explanation
Baseline	Electricity generation, grid	CO_2	Included	Main emission source.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.

	Fossil fuel in element process for thermal energy	CO_2	Excluded	Not applicable. The project activity does not involve the generation of thermal energy from waste gas.
		CH_4	Excluded	Not applicable. The project activity does not involve the generation of thermal energy from waste gas.
		N_2O	Excluded	Not applicable. The project activity does not involve the generation of thermal energy from waste gas.
	Fossil fuel consumption in cogeneration plant	CO_2	Excluded	Not applicable. The project activity does not involve cogeneration.
		CH_4	Excluded	Not applicable. The project activity does not involve cogeneration.
		N_2O	Excluded	Not applicable. The project activity does not involve cogeneration.
	Generation of steam used in the flaring process, if any	CO_2	Excluded	Not applicable. Steam is not used in the flaring process.
		CH_4	Excluded	Not applicable. Steam is not used in the flaring process.
		N_2O	Excluded	Not applicable. Steam is not used in the flaring process.
	Fossil fuel consumption for the supply of process heat and/or reaction heat	CO_2	Excluded	Not applicable. The project activity does not involve the supply of process heat and/or reaction heat.
		CH_4	Excluded	Not applicable. The project activity does not involve the supply of process heat and/or reaction heat.
		N_2O	Excluded	Not applicable. The project activity does not involve the supply of process heat and/or reaction heat.
Project Activity	Supplemental fossil fuel consumption at the project plant	CO_2	Included	Main emission source.
		CH_4	Excluded	Excluded for simplification.
		N_2O	Excluded	Excluded for simplification.
	Supplemental electricity consumption	CO_2	Included	Main emission source.
		CH_4	Excluded	Excluded for simplification.
		N_2O	Excluded	Excluded for simplification.
	Electricity import to replace captive electricity, which was generated using waste gas in absence of project activity	CO_2	Excluded	Not applicable. The baseline does not involve captive electricity.
		CH_4	Excluded	Not applicable. The baseline does not involve captive electricity.
		N_2O	Excluded	Not applicable. The baseline does not involve captive electricity.

	Energy consumption for gas cleaning	CO_2	Included	Main emission source.
		CH_4	Excluded	Excluded for simplification.
		N_2O	Excluded	Excluded for simplification.

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

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The baseline scenario was identified as the most plausible baseline scenario among all realistic and credible alternatives. A stepwise approach is used, as per methodology ACM0012.

It must be noted that in this project activity, the waste energy generation facility (where waste energy is generated) is the same as the recipient facility (where the energy is consumed). This facility is Namakwa Sands.

Step 1: Define the most plausible baseline scenario for the generation of heat, electricity and mechanical energy using the following baseline options and combinations

Realistic and credible alternatives were determined for:

- Waste energy use in the absence of the project activity; and
- Power generation in the absence of the project activity for the recipient facility

Heat and mechanical energy are not generated in the project activity and, therefore, realistic and credible alternatives for these need not be identified.

<u>The alternatives for the use of the waste energy in the absence of the project activity are:</u>

W1: WECM is directly vented to atmosphere without incineration

This is not a feasible option since the waste gas cannot be directly vented to the atmosphere, and must be flared so as to prevent the accumulation of hazardous gas (in accordance with South African regulations).

The Namakwa Sands facility is registered in terms of the South Africa Atmospheric Pollution Prevention Act, 1965 (Act No. 45 of 1965). This certificate was issued by the Air Pollution Control Directorate at the South African Department of Environmental affairs and Tourism.

The registration certificate was issued on the condition that Namakwa Sands:

- ‘Take all necessary measures to prevent the escape into the atmosphere of noxious or offensive gases’.
- ‘Furnace related emissions will be treated using proven technology for furnace gas cleaning. Final emissions will not exceed 30mg/Nm^3’.

– ‘All air pollution control plants and equipment (including flares) will have an availability of 96% of the time per calendar month at the stated efficiency’.

Namakwa Sands is in compliance with the Atmospheric Pollution Prevention Act (Act No. 45 of 1965) because the facility cleans and flares the furnace off gas. It therefore meets South African regulations.

If the facility did not clean and flare the furnace off gas, it would not be in compliance with its licence conditions under the Atmospheric Pollution Prevention Act (Act No. 45 of 1965), and therefore would not meet South African legislative requirements. This shows that the direct venting of WECM into the atmosphere without incineration (W1) is not a realistic and credible alternative.

W2: WECM is released to the atmosphere (for example after incineration) or waste heat is released to the atmosphere or waste pressure energy is not utilized

There are no barriers facing this alternative. The infrastructure and equipment necessary for flaring is already in place at Namakwa Sands for safety purposes, and therefore no additional capital expenditure would be required (no investment barrier). There are also no technological barriers to flaring the waste gas, as flares are available in South Africa. This is a realistic and credible alternative.

W3: Waste energy is sold as an energy source

The sale of the furnace off gas has been investigated, and preliminary negotiations were engaged with a potential buyer – a neighbouring steel mill. This is not a realistic and credible alternative due to the following:

- The potential buyer currently uses coal as a source of energy which is relatively cheap in South Africa.
- This company also generates its own waste gas of similar composition (carbon monoxide and hydrogen), which is currently flared and not used in their operation.
- The transport of waste gas to the buyer poses a significant safety risk. The gas would need to be piped over open land, thereby exposing members of the public to a potential safety hazard - the threshold limit value of carbon monoxide is 25ppm, and the explosion limits of carbon monoxide and hydrogen are 12% and 4% respectively.
- Namakwa Sands has also never had any other potential buyers for the furnace off-gas during the 15 years it has been in operation.

W3 also faces two prevailing practice barriers - it is not common practice to pipe gas of such hazardous composition, and it is also not common to use such a low calorific value waste gas in South Africa.

W4: Waste energy is used for meeting energy demand at the recipient facility

Using the waste gas to meet energy demand would require capital expenditure that would not be required if the waste gas was flared, as is currently the case at Namakwa Sands. The low calorific value of the

furnace off-gas makes it difficult to meet the energy demand of Namakwa Sands. The technology required for the use of low calorific gas (like furnace off-gas) for energy generation is not common at ilmenite smelters in South Africa. Two other similar projects are currently in the CDM validation phase - 'BioTherm Hernic Ferrochrome Cogeneration Project' and 'Cogeneration from Waste Smelter Gas at Richards Bay Minerals in South Africa'. This illustrates a lack of prevailing practice and, for this reason; it is not a realistic and credible alternative.

W5: A portion of the quantity or energy of WECM is recovered for generation of heat and/or electricity and/or mechanical energy, while the rest of the waste energy produced at the project facility is flared/released to the atmosphere/ unutilised

There are no barriers facing this alternative. The infrastructure and equipment necessary for flaring is already in place at Namakwa Sands for safety purposes, and therefore no additional capital expenditure would be required (no investment barrier). There are also no technological barriers to flaring the waste gas, as flares are available in South Africa. Namakwa Sands has the capacity to recover a portion of the WECM for heat application. This occurs currently, as a small portion of the clean gas is extracted from the gas buffer vessel and used to dry anthracite. For this reason, W5 is a realistic and credible alternative.

W6: All the waste gas produced at the industrial facility is captured and used for export electricity generation or steam

Due to the relatively cheap electricity price in South Africa, the price of producing electricity from the waste gas is higher than the price of the electricity supplied by Eskom. There is no existing steam generation equipment at Namakwa Sands, and therefore using the waste gas to generate steam would require a significant capital investment. Therefore, this is not a realistic and credible alternative.

<u>The alternatives for power generation in the absence of the project activity are:</u>

P1: Proposed project activity not undertaken as a CDM project activity

A large amount of furnace off-gas is required to generate a small amount of electricity, because the gas fluctuates in its supply and has a low calorific value. This, coupled with the significant capital investment of the project, makes the activity not feasible without the potential carbon credit revenue. Therefore, P1 is not a realistic and credible alternative.

P2: On-site or off-site existing fossil fuel fired cogeneration plant

There is no existing fossil fuel fired cogeneration plant at Namakwa Sands or in the surrounding area. This is because the availability of fossil fuel is limited. For example, natural gas[8] and coal[9] are not

[8] de Pontes, M., Ellman, M., & Germuishuys, K. (2009). The natural gas industry in South Africa: Availability, sustainability and reliability of gas supply. Energy Efficiency Made Simple Volume II, 59-60.

available in the vicinity of the proposed project activity (Western Cape Province). Importing other fuels through shipping requires a considerable capital investment, and securing a cost effective supply of fossil fuel would be difficult considering the location of Namakwa Sands and the distance to transport these fuels. Therefore, P2 is not a realistic and credible alternative.

P3: On-site or off-site Greenfield fossil fuel fired cogeneration plant

The installation of a new fossil fuel fired cogeneration plant, together with the purchase of fuel, would require a significant capital investment. This would not be the case if the waste gas is flared and electricity is purchased from Eskom (as is currently the case at Namakwa Sands). The availability of these fossil fuels is also limited, as mentioned above in P2. For example, natural gas and coal are not available in the vicinity of the proposed project activity (Western Cape Province). Importing other fuels through shipping would require a considerable capital investment. Securing a cost effective supply of fossil fuel would be difficult considering the location of Namakwa Sands and the distance to transport these fuels. Therefore, P3 is not a realistic and credible alternative.

P4: On-site or off-site existing renewable energy based cogeneration plant

There is no existing renewable energy based cogeneration plant at Namakwa Sands or in the surrounding area. This is because Namakwa Sands is located in an arid region (mean annual precipitation of between 350 and 500mm[10]), where biomass (which could be used for renewable energy based cogeneration) is not readily available[11]. The production of power from biomass would also be more expensive than purchasing electricity from Eskom. This is not a realistic and credible alternative.

P5: On-site or off-site Greenfield renewable energy based cogeneration plant

The cogeneration plant could involve a renewable energy such as biomass. As mentioned in P4 this, however, is unlikely as the Namakwa Sands smelter is located in an arid region (mean annual precipitation of between 350 and 500mm), which makes biomass not readily available in the vicinity of the proposed project activity. Purchasing and importing biomass to the site or surrounding areas would require a considerable capital investment, which is not required if the waste gas is flared and electricity is purchased from Eskom (as is currently the case at Namakwa Sands). Furthermore, the production of power from biomass would be more expensive than purchasing electricity from Eskom. This is not a realistic and credible alternative.

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[9] Jeffrey, L. (2005). Characterization of the coal reserves of South Africa. The Journal of The South African Institute of Mining and Metallurgy, 95-102.

[10] Department of Environmental Affairs and Tourisim. (2000, July). Environmental Potential Atlas for South Africa: Mean Annual Precipitation. Retrieved from http://www.environment.gov.za/enviro-info/nat/images/rain.jpg

[11] Damm, O., & Triebel, R. (2008). A Synthesis Report on Biomass Energy Consumption and Availability in South Africa. South Africa: LHA Management Consultants.

P6: On-site or off-site existing fossil fuel based existing identified captive power plant

There is no existing fossil fuel based captive power plant at Namakwa Sands or in the surrounding area. This is because, as in P2, the availability of fossil fuel is limited. For example, natural gas and coal are not available in the vicinity of the proposed project activity (Western Cape Province). Importing other fuels through shipping would require a considerable capital investment. There is also no identified captive power plant at Namakwa Sands or in the surrounding area. This is not a realistic and credible alternative.

P7: On-site or off-site existing identified renewable energy or other waste energy based captive power plant

There is no renewable energy based captive power plant at Namakwa Sands or in the surrounding area. This is because the production of electricity from these energies would be more expensive than purchasing it from Eskom[12]. This is not a realistic and credible alternative.

P8: On-site or off-site Greenfield fossil fuel based captive plant

As in P2, the availability of fossil fuel is limited. For example, natural gas and coal are not available in the vicinity of the proposed project activity (Western Cape Province). Importing other fuels through shipping would require a considerable capital investment. A new fossil fuel based captive or identified plant would require capital investment, which would not be required if the waste gas is flared and electricity is purchased from Eskom (as is currently the case at Namakwa Sands). This is not a realistic and credible alternative.

P9: On-site or off-site Greenfield renewable energy or other waste energy based captive plant

The renewable energies employed would probably be wind, solar, hydro or waste energy. The production of electricity from these energies would be more expensive than purchasing it from Eskom. A new hydro, wind, solar, or waste energy captive or identified plant would require capital investment, which is not required if the waste gas is flared and electricity is purchased from Eskom (as is currently the case at Namakwa Sands). This is not a realistic and credible alternative.

P10: Sourced from grid-connected power plants

Namakwa Sands has the capacity to obtain all of its required electricity from South Africa's national electricity provider, Eskom. This occurs currently, and is a realistic and credible alternative.

P11: Existing captive electricity generation using waste energy (if project activity is captive generation using waste energy, this scenario represents captive generation with lower efficiency or lower recovery than the project activity)

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[12] National Energy Regulator of South Africa. (2009, October 30). *Decision in the matter regarding Renewable Energy Feed-In Tariffs Phase II by the National Energy Regulator of South Africa*, pages 10 and 14.

In South Africa, most of the electricity generation capacity is Eskom (South Africa's national utility). The non-Eskom generation capacity is linked to four municipality-owned (local government) power stations – Kelvin A, Kelvin B, Pretoria West and Rooival. The only privately owned company generating electricity is Sasol, with Sasol SSF[13]. Sasol, however, was initially developed as a private company with only one shareholder – the South African government. This shows that is highly uncommon in South Africa for privately-owned companies to generate their own captive electricity. Furthermore, generating captive electricity with a lower efficiency or lower recovery does not make this alternative financially feasible. Therefore, P11 is not a realistic and credible alternative.

P12: Existing cogeneration using waste energy, but at a lower efficiency or lower recovery

Cogeneration with a lower efficiency or lower recovery than the project activity does not make this alternative financially feasible, and therefore it is not a realistic and credible alternative[14].

STEP 3: Step 2 and/or Step 3 of the latest approved version of the "Tool for the demonstration and assessment of additionality"

Step 3 of the 'Tool for the demonstration and assessment of additionality' (Version 06.0.0) was used to identify the most plausible baseline scenarios by eliminating non-feasible options. This has been done above. Three realistic and credible alternatives remain:

- W2: WECM is released to the atmosphere (for example after incineration) or waste heat is released to the atmosphere or waste pressure energy is not utilized.
- W5: A portion of the quantity or energy of WECM is recovered for generation of heat and/or electricity and/or mechanical energy, while the rest of the waste energy produced at the project facility is flared/ released to the atmosphere/ unutilised.
- P10: Sourced from grid-connected power plants.

An economic analysis was not required for the identification of the baseline scenario as:

1. The WECM *used by the project activity* was previously flared - it was not totally or partially recovered.
2. The CDM waste energy recovery project is not implemented in a Greenfield project facility – Namakwa Sands is an existing facility.
3. The CDM waste energy recovery project supplies the useful energy generated to an existing recipient – the Namakwa Sands smelting operation.

[13] Global Energy Decisions. (2008). *Stage 4 Report: Supply and Demand Side Resource Alternatives and Reference Case for Development of Third National Integrated Resource Plan for South Africa*. South Africa: Global Energy Decisions.
[14] Electricity study report (2009, August).

STEP 3: If more than one credible and plausible alternative scenario remain, the alternative with the lowest baseline emissions shall be considered as the most likely baseline scenario.

From step 2 above, it can be seen that the only alternatives that remain after an analysis of the investment, technological and common practice barriers, are W2, W5 and P10. As per methodology ACM0012, baseline scenario 1 situation 1 is therefore applicable:

Baseline Scenario	Combination of baseline scenarios				Description of project activity
	Waste energy	Power	Heat	Mechanical energy	
Project activity: Separate generation of electricity, mechanical energy or heat					
Baseline scenario-1 1. The total of waste energy of WECM recovered in the project is flared. 2. The electricity is obtained from the grid.	W2, W5	P10	N/A	N/A	Situation-1 • Independent generation of electricity at project facility.

National and Sectoral Policies and Regulations Relevant to the Project Activity

There are no policies that require Namakwa Sands to use the furnace off-gas that is currently being flared. Therefore, Namakwa Sands would continue to flare the gas if it were not for the proposed project activity. More relevant to the project activity is the Power Conservation Project (PCP), which, at the time of writing the PDD, is in the process of being developed by Eskom, in concert with Municipalities, Government, and customers.

The PCP is a demand side project aimed at stabilising the supply/demand balances in the system. According to Eskom, the details of the PCP are still being refined, but one of the criteria used in designing the PCP is to signal efficient use of electricity. Once the PCP is legislated, it will require Namakwa Sands to commit to reducing its grid electricity consumption. The relevance of the PCP, in the selection of the baseline scenario, is discussed below:

In EB 22 Annex 3, the Board differentiates between two types of national and/or sectoral policies that need to be taken into account when establishing the baseline scenario (paragraph 6). The second type is relevant to the PCP since it concerns energy efficiency:

Paragraph 6 (b): *National and/or sectoral policies or regulations that give comparative advantages to less emissions-intensive technologies over more emissions-intensive technologies (e.g. public subsidies to promote the diffusion of renewable energy or to finance energy efficiency programs). These policies are E- type policies that decrease GHG emissions.*

The Board then goes on to state that policies applicable under paragraph 6 (b) need not be taken into account when establishing the baseline scenario if they have been implemented since the adoption by the COP of the CDM M&P (decision 17/CP.7, 11 November 2001).

The PCP is still in development, but will, more than likely, be legislated before project implementation. However, this is after 11 November 2001 and, as such, the PCP need not be taken into account when establishing the baseline scenario for Namakwa Sands.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

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ACM0012 requires the project proponent to determine additionality based on ‘Tool for the demonstration and assessment of additionality’ (Version 06.0.0).

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

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

From B.4, three realistic and credible alternatives remain:

- W2: WECM is released to the atmosphere (for example after incineration) or waste heat is released to the atmosphere or waste pressure energy is not utilized;
- W5: A portion of the quantity or energy of WECM is recovered for generation of heat and/or electricity and/or mechanical energy, while the rest of the waste energy produced at the project facility is flared/ released to the atmosphere/ unutilised.
- P10: Sourced from grid-connected power plants.

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

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

An investment analysis was performed on the proposed project activity to determine if the project is financially viable.

Step 2: Investment analysis

Sub-step 2a: Determine appropriate analysis method

A benchmark analysis (Option III) is applied.

Sub-step 2b: Option III. Apply benchmark analysis

Financial/economic indicator

IRR has been identified as the most suitable financial/economic indicator for this project type. This is because it is Exxaro Resources Ltd's company policy to make investment decisions based on IRR.

Selection of an appropriate benchmark

According to the 'Guidelines on the Assessment of Investment Analysis' (Version 05, EB 62 Annex 5) paragraph 14, *an internal company benchmark should only be applied in cases where (a) there is only one possible project developer and (b) should be demonstrated to have been used for similar projects with similar risks, developed by the same company*.

(a) Exxaro Resources Ltd is the only possible project developer. This is because the project activity is located on its site, and forms an integral part of its gas system. The project activity also poses a potential health and safety risk, for which Exxaro Resources Ltd is legally liable for.

(b) Exxaro Resources Ltd has used the same internal benchmark for similar projects with similar risks. This is elaborated below:

Exxaro Resources Ltd's Board follows a strict procedure when approving similar projects with similar risks:

- The Board minutes agenda lists the project memoranda to be authorised. The memoranda, as well as the annexure, are available during and after the Board meeting. The Board thus review the Investment Review Committee (IRC) findings before authorising projects.
- The IRC memoranda reflect the Weighted Average Cost of Capital (WACC), risk premia (technical, financial, and project phase) and hurdle rate calculations. Proper review of risk premia thus takes place.
- Project memoranda always reflect the Internal Rate of Return (IRR) and the Net Present Value (NPV).
- Board minutes and IRC adhere to the stipulation of the following official Exxaro Resources Ltd documents:
  - Exxaro Resources Ltd Corporate Governance Guiding Principles for Property.
  - Exxaro Resources Ltd Delegation of Authority.
  - WACC and Hurdle rate.

In the period between January 2008 and December 2010, Exxaro Resources Ltd approved fourteen projects that exceeded the internal company benchmark.

Since the project fulfils both criteria (a) and (b), an internal benchmark can be applied.

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

According to paragraph 15 of the 'Guidelines on the assessment of investment analysis' (Version 05), *the values in the table in appendix A may also be used, as a simple default option, if a company internal benchmark is used*. This project activity falls under both project categories 'Group 1' and 'Group 2' as ACM0012 is written for sectoral scopes 1 (Energy Industries) and 4 (Manufacturing Industries). Because of this, the project participant has chosen to select an average benchmark between project categories 'Group 1' and 'Group 2'. Therefore, the real after tax expected return on equity in South Africa is 11.4%.

Furthermore, according to paragraph 7 of Appendix A of this guidance, if the investment analysis is carried out in nominal terms, project participants can convert the real term expected return on equity to nominal values by adding the inflation rate. Therefore, the nominal after tax expected return on equity in South Africa is calculated as 15.9%.

The nominal after-tax project IRR is -8.6%. This IRR is not limited to proposed crediting period, but rather reflects the period of expected operation of the project activity (16 years). The IRR calculation includes the cost of major maintenance and rehabilitation, as these costs are expected to be incurred during the period of expected operation.

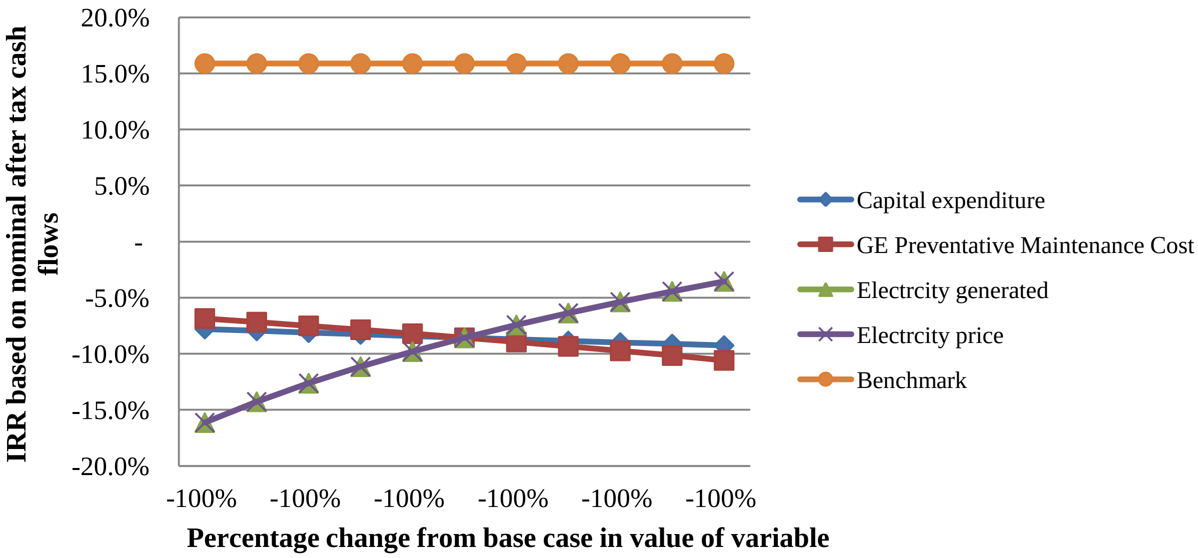
The CDM project activity has a less favourable IRR than the benchmark (-8.6% as opposed to 15.9%). For this reason, the project cannot be considered as financially attractive in the absence of the CDM.

Sub-step 2d: Sensitivity analysis

The aim of the sensitivity analysis it to determine the likelihood of the occurrence of a scenario other than the scenario presented. The individual variables, including the initial investment, that constitute more than 20% of the total project cost and project revenues are:

- Capital expenditure;
- GE Jenbacher engine preventative maintenance cost;
- Electricity generated;
- Electricity price.

The sensitivities on these parameters is represented graphically below.



None of the individual variables breach the benchmark IRR of 15.9% within the ±10% range. The results of the sensitivity analysis show that the conclusion regarding the financial/economic attractiveness (made in sub-set 2c above) is robust to reasonable variations in the critical assumptions.

Step 4: Common practice analysis

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

Common practice can be demonstrated in accordance with EB 63 Annex 12 'Guidelines on Common Practice' (Version 01.1). A stepwise approach is used:

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

The design capacity of the proposed project activity is 13.6 MW. Therefore, the applicable output range used for this analysis is 6.8 – 20.4 MW.

Step 2: Identify all plants that deliver the same output or capacity

In this analysis, the applicable geographical area is South Africa. According to the guidelines, a measure is a broad class of greenhouse gas emission reduction activities possessing common features. For this analysis, the measure is the use of ilmenite furnace off gas as a fuel to generate energy.

Ilmenite smelting is currently practised in only three locations in South Africa: Richards Bay Minerals, Namakwa Sands and KZN Sands[15]. For this reason, these three smelters are the only plants that are currently generating ilmenite furnace off gas in South Africa.

The Richards Bay Minerals project is currently in CDM validation[16] and has not started commercial operation yet. For this reason (and in accordance with the guidelines), it is excluded from N_{all}.

KZN Sands is owned by Exxaro Resources Ltd and currently flares its furnace off gas. This smelter is not implementing a waste energy recovery project. This project is therefore also excluded from N_{all}.

For this reason, $N_{all} = 0$.

Step 3: Identify plants that apply different technologies

Since N_{all} has been identified as being equal to zero, N_{diff} is also equal to zero.

Step 4: Calculate the factor F

The factor F is used to represent the share of plants using technology similar to the technology used in the proposed project activity. The equation to calculate F is given below:

$$F = 1 - \frac{N_{diff}}{N_{all}}$$

Since $N_{all} = N_{diff} = 0$, the factor F does not compute. For this reason, the analysis does not show a lack of common practice however; it has been proven that there are no ilmenite smelters in South Africa that are currently implementing a similar project in the absence of the Clean Development Mechanism.

Furthermore, the analysis cannot be used to prove a lack of common practice in this project activity as N_{all} is less than 3, and therefore, $N_{all} – N_{diff}$ can never be greater than 3.

Nevertheless, the proposed project activity has already been proven to additional through an investment analysis, as shown in Step 2.

Sub-step 4b: Discuss any similar Options that are occurring:

In South Africa, there are no ilmenite smelters that are currently implementing a similar project in the absence of the CDM. The project activity aims to be the first registered South African CDM project to

[15] Pistorius, P. (2008). Ilmenite smelting: the basics. *The Journal of The Southern African Institute of Mining and Metallurgy*, 35-43.
[16] http://cdm.unfccc.int/Projects/Validation/DB/AJ94B5TZMXOY273XYWBR0FF9BHNW2X/view.html

generate electricity from waste gas at an ilmenite smelter. As demonstrated in the investment analysis above, the project activity is additional.

Notice of prior consideration

The milestones in the project development are provided in the timeline below:

Date	Milestone
08/03/2006	Proposal for an evaluation study into the use of furnace off-gas at Namakwa Sands.
24/07/2006	Boiler quotation from Babcock Africa Services (Pty) Ltd.
07/08/2006	Engine quotation from GE Jenbacher.
31/08/2006	Promethium Carbon (Pty) Ltd completes prefeasibility study on proposed project activity.
19/01/2007	Exxaro Resources Ltd acquires the Namakwa Sands business
16/01/2008	Eskom Transmission feasibility quotation for connection of 9 x 2.097 MVA generators at Namakwa Sands Project.
04/03/2008	South African DNA letter of no objection for the Namakwa waste gas utilisation project.
11/04/2008	Memorandum of Understanding between Exxaro Coal (Pty) Ltd (a subsidiary of Exxaro Resources Ltd), Promethium Carbon (Pty) Ltd, and Group Five Energy (Pty) Ltd.
25/06/2008	Steering committee shows prior consideration of the CDM.
22/10/2008	Application notice for a basic assessment for an electricity plant at the Namakwa Sands Smelter, Saldanha Bay.
06/11/2008	A Background Information Document (BID) is released for a 30-day public comment period in order to provide interested and affected parties an opportunity to comment on the proposed project.
20/11/2008	An open day is held at the Skilpadsaal in Vredenburg, which provided the public with an opportunity to get more information regarding the proposed project.
11/06/2009	Request submitted to the Department of Environmental Affairs & Development Planning (DEA&DP) for an extension to the submission timeframe for the final basic assessment report.
03/03/2010	Request submitted to the Department of Environmental Affairs & Development Planning (DEA&DP) for a further six month extension to the submission timeframe for the final basic assessment report.
31/08/2010	Notice of prior consideration submitted to the UNFCCC and South African DNA.
11/11/2010	PDD completed by Promethium Carbon (Pty) Ltd.
18/11/2010	PDD published for Global Stakeholder Participation on UNFCCC website.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

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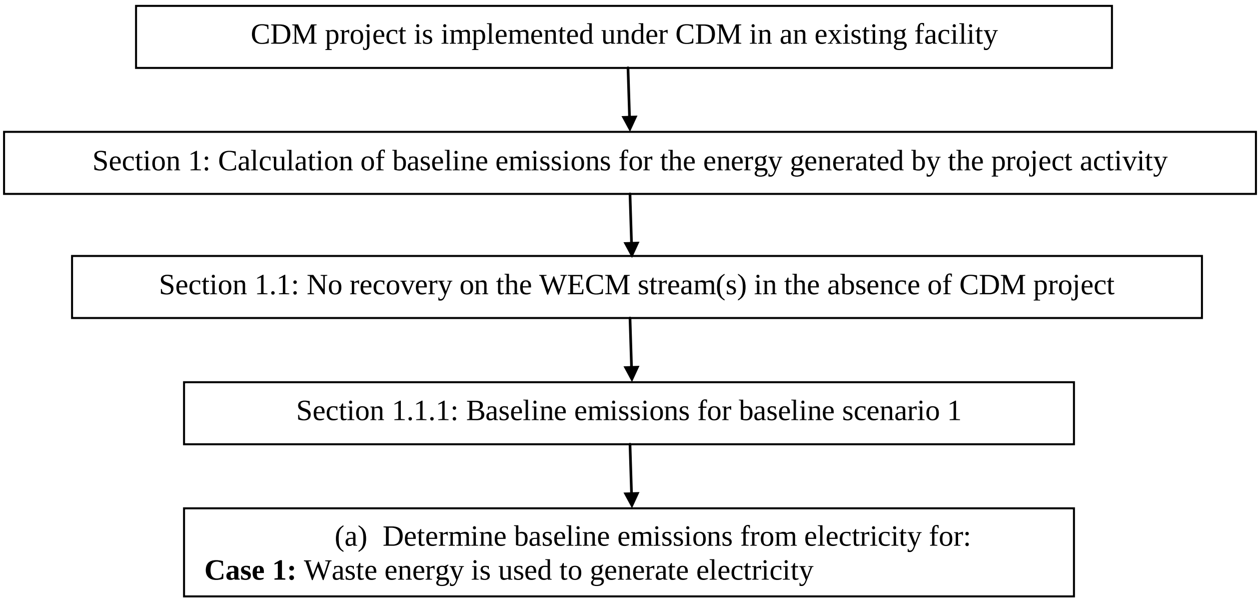
The emission reductions were calculated in accordance with ACM0012 version 04.0.0: ‘Consolidated baseline methodology for GHG emission reductions from waste energy projects’.

Baseline Emissions

In accordance with ACM0012, a flow chart was used for the determination of baseline emissions. This is shown below.



The method depicted in the flow chart above was used as the baseline emissions calculation method, as shown below.

The baseline emissions were determined using equation (1) of the applied methodology:

$$BE_y = BE_{EN,y} + BE_{flst,y} \qquad (1)$$

Where:

BE_y	The total baseline emissions during the year *y* in tons of CO_2
$BE_{EN,y}$	The baseline emissions from energy generated by project activity during the year *y* in tons of CO_2
$BE_{flst,y}$	Baseline emissions from fossil fuel combustion, if any, either directly for flaring of waste gas or for steam generation that would have been used for flaring the waste gas in the absence of the project activity (tCO_2e), calculated as per equation 26. This is relevant for those project activities where in the baseline steam is used to flare the waste gas

But, $BE_{flst,y} = 0$, since no additional fossil fuel is used in the baseline for waste furnace off-gas combustion because the gas is combustible. Therefore, equation (1) simplifies to:

$BE_y = BE_{EN,y}$

1. Baseline emissions from energy generated by the project activity ($BE_{EN,y}$)

The calculation of baseline emissions ($BE_{EN,y}$) depends on the type of project activity and the applicable baseline scenarios from Table 2 in ACM0012 version 04.0.0.

1.1. No recovery on the WECM stream(s) in the absence of the CDM project activity

1.1.1. Baseline emissions for baseline Scenarios 1 and 2

In section B.4, baseline scenario-1 was identified as being applicable to this project activity. Baseline scenario-1 represents the situation where the waste energy of the WECM stream used in the project activity is flared, and the electricity is obtained from the grid.

The baseline emissions from the energy generated by the project activity ($BE_{EN,y}$) were calculated using equation (2) of the applied methodology:

$$BE_{EN,y} = BE_{Elec,y} + BE_{Ther,y} \quad (2)$$

$BE_{Elec,y}$	Baseline emissions from electricity during the year *y* in tons of CO_2
$BE_{Ther,y}$	Baseline emissions from thermal energy (due to heat generation by element processes) during the year *y* (tCO_2)

However, $BE_{Ther,y} = 0$ as thermal energy does not form part of the project activity. Therefore, equation (2) simplifies to:

$$BE_{EN,y} = BE_{Elec,y}$$

(a) Baseline emissions from electricity ($BE_{Elec,y}$) generation

Case 1: Waste energy is used to generate electricity

The baseline emissions from electricity that is displaced by the project activity ($BE_{Elec,y}$) were calculated using equation (3) of the applied methodology:

$$BE_{Elec,y} = f_{cap} \times f_{wcm} \times \sum_j \sum_i (EG_{gr,y} \times EF_{Elec,gr,y}) \quad (3)$$

Where:

$BE_{Elec,y}$	Baseline emissions due to displacement of electricity during the year *y* (tCO_2)
$EG_{gr,y}$	The quantity of electricity supplied to Namakwa Sands, which in the absence of the project activity would have been sourced from the grid during the year *y* in MWh
$EF_{Elec,gr,y}$	The CO_2 emission factor for the grid electricity displaced due to the project activity, during the year *y* (tCO_2/MWh). The calculations for the CO_2 emission factor of the Southern African Power Pool are provided below.
f_{wcm}	Fraction of total electricity generated by the project activity using waste energy. This fraction is 1 if the electricity generation is purely from use of waste energy, as in the case of this project activity.
f_{cap}	Factor that determines the energy that would have been produced in project year *y* using waste energy generated at a historical level, expressed as a fraction of the total energy produced using waste source in year *y*. The ratio is 1 if the waste energy generated in project year *y* is same or less than that generated at a historical level. The calculations for this factor are provided below.

The calculation of $EF_{Elec,gr,y}$ *:*

The project activity will displace grid electricity. The emission factor for the grid electricity was calculated in accordance with the latest approved version of the 'Tool to calculate the emission factor for an electricity system' version 02.2.1. The steps applied to determine the emission factor for the grid were as follows:

Step 1: Identify the relevant electricity systems

This tool will serve project activities that prospect displace grid electricity in countries that form part of the Southern African Power pool.

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

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

None of the DNAs of Southern African countries have published delineations of their project electricity systems or connected electricity systems. There is however information available on the countries that is

part of the SAPP grid[17]; generated and exported electricity[18], as well as connected transmission lines between countries and the maximum ratings[19].

The countries that are *physically connected* in the SAPP are (excluding countries that are part of SAPP, but not connected) (connected utilities indicated in brackets):

- Namibia (NamPower);
- South Africa (Eskom and non-Eskom stations);
- Zimbabwe (ZESA);
- Zambia (ZESCO);
- Mozambique (EDM);
- Botswana (BPC);
- Democratic Republic of Congo (SNEL);
- Lesotho (LEC);
- Swaziland (SEB).

[17] The Southern African Power Pool, 2007, *SAPP Grid*, http://www.sapp.co.zw/viewinfo.cfm?id=7&linkid12&siteid=1
[18] The Southern African Power Pool, *Annual Reports*, http://www.sapp.co.zw/viewinfo.cfm?id=71&linkid=2&siteid=1
[19] The Southern African Power Pool, 2007, *Interconnector limits*, http://www.sapp.co.zw/viewinfo.cfm?id=74&linkid=12&siteid=1

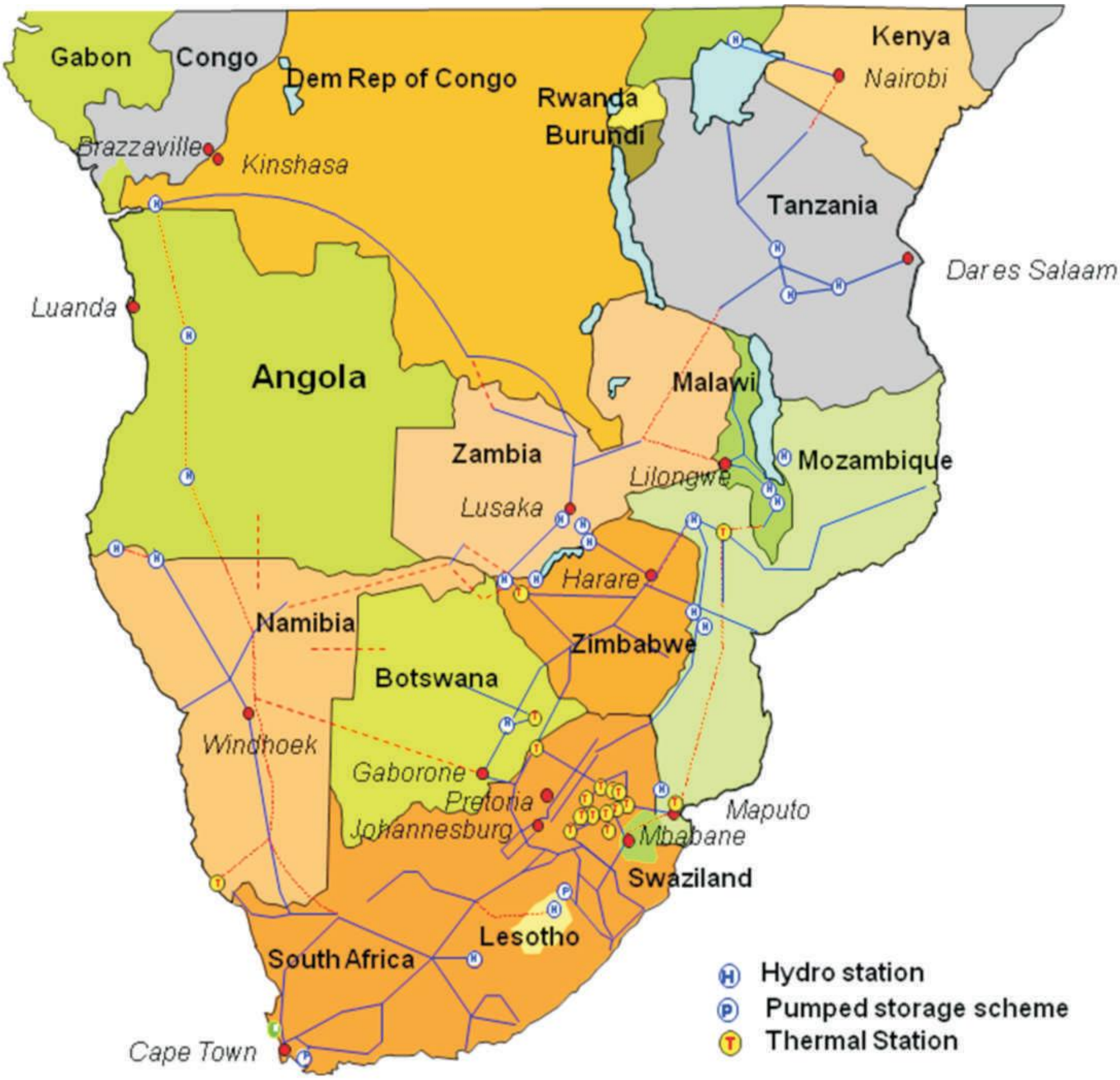


Figure 6: The SAPP grid

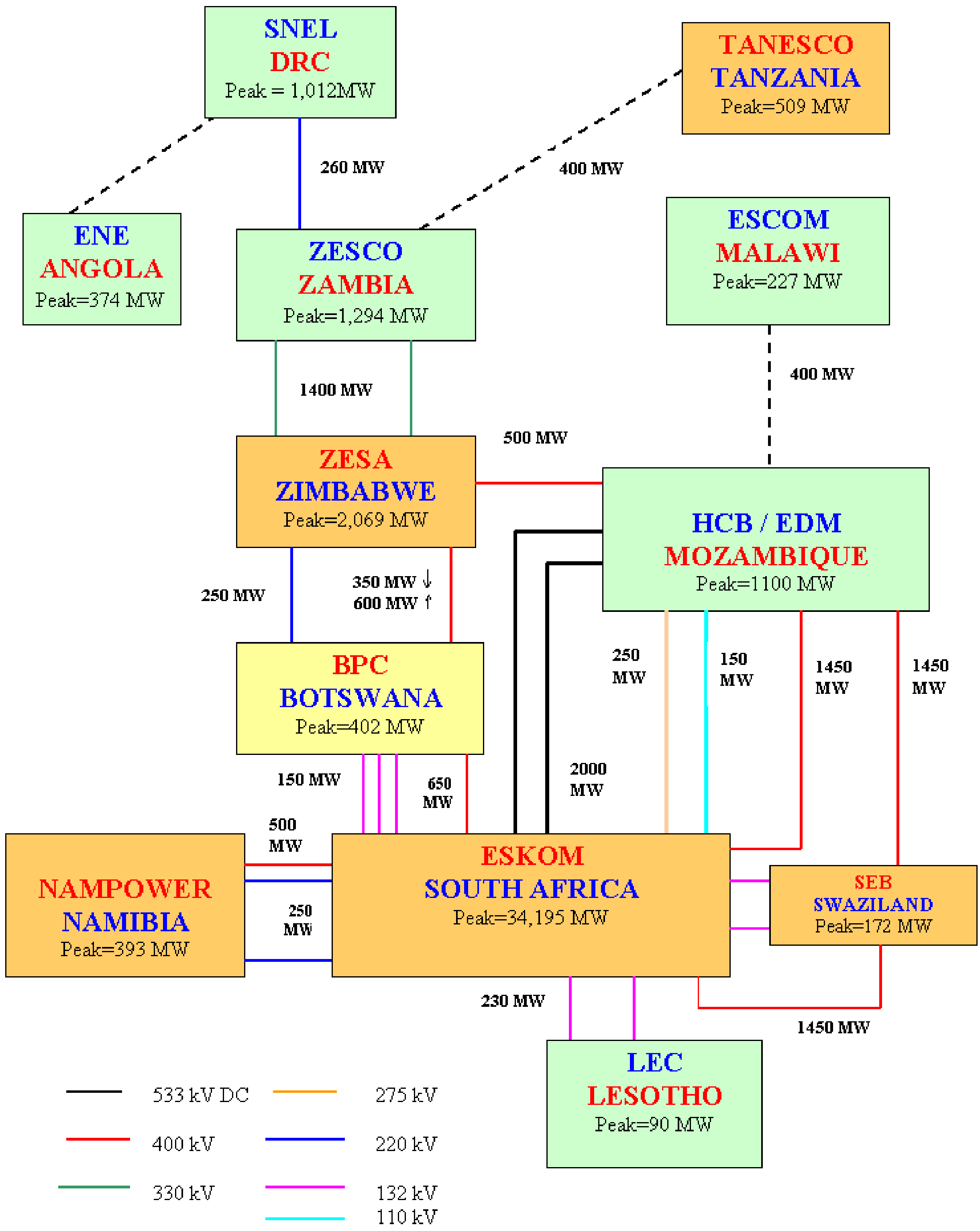


Figure 7: SAPP interconnector limits

The Caprivi link is an interconnector that is currently under construction between Zimbabwe and Namibia. It will supply 150 megawatts (MW) of electricity from Hwange power station to Namibia. The Caprivi Link is part of the ZIZABONA project and the power line from Hwange in Zimbabwe to Livingstone in Zambia is expected to be completed by December 2010[20]. This link will not be considered in calculations.

To determine which of the connected utilities are part of the project electricity system and which are connected electricity systems, the existence of significant transmission constraints between utilities has to be determined.

The existence of significant transmission constrains from the connected electricity system to the project electricity system are determined by the following criteria:

- In case of electricity systems with spot markets for electricity: there are differences in electricity prices (without transmission and distribution costs) of more than 5 percent between the systems during 60 percent or more of the hours of the year
- The transmission line operates at 90% or more of its rated capacity during 90% percent or more of the hours of the year.

Spot markets are not applicable for this electricity system. The SAPP does have a Short Term Energy Market (STEM). STEM is designed to be a day-ahead market and compliments the bilateral market through the provision of another technique for the pricing of electrical energy. A day-ahead market is a physical market where prices and amounts are based on supply and demand. SAPP said in 2004: "*The ambition of SAPP is to establish a regional spot market where electricity would be traded in real time and provide the necessary basis for the development of subsequent financial markets*"[21]. This has not been implemented to date as the STEM "Book of Rules" currently in use is still the 2003 version[22].

A 3-year average (2007 - 2009 financial years; 1 April – 31 March) for each utility's electricity combined imports and exports are obtained from the SAPP annual reports. This is used, together with 90% of the rated interconnector limits to calculate the percentage of hours in a year operated at 90% of rated capacity.

It was found that there is no significant transmission constrains between any of the connected SAPP countries, and thus no connected electricity systems. Therefore, all the suppliers listed comprise the project electricity system, from which the project activity sources electricity.

[20] Informante, *Simasiku on Caprivi link project and Hwange*, Administrator, 14 January 2010, http://www.informante.web.na/index.php?option=com_content&task=view&id=5570&Itemid=108&PHPSESSID=b4dcfee218fc205d8efdeb7968b06910

[21] Dr. L. Musaba, P. Naidoo, W. Balet and A. Chikova, Developing a competitive market for regional electricity cross border trading: The case for the Southern African Power Pool, http://www.sapp.co.zw/documents/P12%20-%20SAPP%20Publication%20for%20IEE%20-%20JAN%202004.pdf

[22] http://www.sapp.co.zw/docs/STEM%20Book%20of%20Rules%20-%20%20APRIL%202003.pdf as accessed on 2 June 2010

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

The grid emission factor is calculated from only grid power plants (Option I). Off-grid power plants are not included in the calculations.

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

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

The total generated electricity for the different utilities were obtained from the SAPP annual reports, but data for the electricity resources and generation capacities were not readily available in the public domain. The source and type of data that were used to establish the low-cost/must-run resources of each utility can be found in the table below.

Country (Utility)	Data description	Source
Namibia (NamPower)	General fractions for different electricity production resources	Developing Renewables, *Country Energy Information, Namibia*, 2006, http://www.energyrecipes.org/reports/genericData/Africa/061129%20RECIPES%20country%20info%20Namibia.pdf
South Africa (Eskom)	Actual generation (GWh) for 2006-2008.	Eskom Holdings Limited, 2009, *Eskom Annual Report 2009*, http://www.eskom.co.za/annreport09/
Zimbabwe (ZESA)	Generation capacity (MW) of different resources.	Stuart Doran, 2009, *Zimbabwe's economy*, http://www.thebrenthurstfoundation.org/Files/Brenthurst_Commisioned_Reports/BD0908-Zimbabwe.pdf
Zambia (ZESCO)	General fractions for different electricity production resources	ZESCO official website, http://www.zesco.co.zm/index.php?option=com_content&task=view&id=1&Itemid=
Mozambique (EDM)	Actual generation (GWh) for 2000-2004 (average taken).	*Brief analysis of energy sector in Mozambique*, EDM Annual Statistical Reports 2000-2004, http://www.mozergy.com/articles/MozambiqueEnergyOverview.pdf
Botswana (BPC)	General fractions for different electricity production resources	Nationmaster website, http://www.nationmaster.com/country/bc-botswana/ene-energy
Democratic Republic of Congo (SNEL)	General fractions for different electricity production resources	Geni website and SAPP, http://www.geni.org/globalenergy/library/national_energy_grid/democratic-republic-of-the-congo/demrepubliccongonationalelectricitygrid.shtml
Lesotho (LEC)	General fractions for different electricity production resources	The Southern African Power Pool, 2007, *SAPP Grid*, http://www.sapp.co.zw/viewinfo.cfm?id=7&linkid12&siteid=1

The average percentage of low-cost/must-run resources, for the entire SAPP grid, amount to 15.79% of the total grid generation. Therefore, Option (a) is applicable to the SAPP grid emission factor calculations.

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

The data used in OM calculations are for the 3 year period of 1 April 2006 – 31 March 2009 (SAPP financial year runs from 1 April – 31 March). This is the latest available data.

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

The simple OM emission factor ($EF_{grid,OMsimple,y}$) is calculated as the generation-weighted average 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. Hence, the hydro and nuclear power plants are excluded from the calculation of the OM.

Option B is used for calculating the simple OM. The calculations in this option are based on the total net electricity generation of all power plants serving the system and the fuel types and fuel consumption of the project electricity system. Option B is used seeing that:

a) The necessary data for Option A (electricity generation and emission factor for each power unit) 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 know; and
c) Off-grid power plants are not included in the calculation.

In addition to data and sources already provided in this report, the table below depicts data descriptions and sources that were used in the calculation of the simple OM.

Country (Utility)	Data description	Source
Namibia (NamPower)	Fuel efficiencies for Paratus and Van Eck power stations.	Republikein, *Namibia's power is in your hands; Use it wisely*, April 2008, www.republikein.com.na/fileadmin/pdf/2008/nampower.pdf
South Africa (Eskom)	Coal-fired stations fuel efficiency (average for all stations).	Eskom Holdings Limited, 2009, *Eskom Annual Report 2009*, http://www.eskom.co.za/annreport09/
South Africa (Eskom)	Gas turbine stations fuel efficiency (average for all stations).	Eskom Website (data used for 2005; latest available), http://www.eskom.co.za/live/content.php?Item_ID=4226&Revision=en%2F0
Zimbabwe (ZESA)	Fuel efficiency of Hwange coal-fired station.	UNFCCC website (data used from previous project), http://unfccc.int/kyoto_mechanisms/aij/activities_implemented_jointly/items/1886.php

Zimbabwe (ZESA)	Net calorific value (NCV) and emission factor (EF) for Zimbabwean coal.	UNFCCC website (data used from previous project), http://unfccc.int/kyoto_mechanisms/aij/activities_implemented_jointly/items/1886.php
General	NCV and EF for sub-bituminous coal and heavy fuel oil (HFO) (residual fuel oil values used from IPCC).	*2006 IPCC Guidelines for National Greenhouse Gas Inventories*

Equation 7 (in the methodological tool) is used to calculate the average OM:

$$EF_{grid,OMsimple,y} = \frac{\sum_i \left(FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y} \right)}{EG_y} \qquad (7)$$

Where:

$EF_{grid,\ OMsimple,y}$	Simple operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$FC_{i,y}$	Amount of fossil fuel type *i* consumed in the project electricity system in year *y* (mass or volume unit)
$NCV_{i,y}$	Net calorific value (energy content) fossil fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO2,i,y}$	CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)
EG_y	Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost/must-run power plants/units, in year *y* (MWh)
i	All fossil fuel types combusted in power sources in the project electricity system in year *y*
y	The relevant year as per data vintage chosen in Step 3

The constants used in calculations appear in the table below, while all the values and final calculated operating margin emission factor can be seen in the next table.

Constants		
$NCV_{\text{sub-bituminous coal}}$	18.9	GJ/T
$NCV_{\text{HFO (Residual Fuel Oil)}}$	40.4	GJ/T
NCV_{kerosene}	43.8	GJ/T
$EF_{\text{CO2, sub-bituminous coal}}$	0.0961	tCO_2/GJ
$EF_{\text{CO2,HFO (Residual Fuel Oil)}}$	0.0774	tCO_2/GJ
$EF_{\text{CO2,kerosene}}$	0.0719	tCO_2/GJ
$Density_{\text{HFO (Residual Fuel Oil)}}$	930	kg/m^3
$NCV_{\text{coal, Zimbabwean}}$	25.75	GJ/T
$EF_{\text{CO2,coal, Zimbabwean}}$	0.0946	tCO_2/GJ

Supplier	3 yr avg. (GWh)	Fuel Efficiency (T/GWh)	Fuel Consumed (T)	$EF_{grid,OMsimple}$ (tCO2/MWh)
Namibia (NamPower)	1,584.67	-	-	1.011
Hydro (Ruacana)	1,537.13	-	-	
Heavy Fuel Oil (Paratus)	47.54	260.40	12,379.42	
Coal (van Eck)	-	570.00	-	
South Africa (Eskom)	230,011.67	-	-	
Coal Fired	213,459.10	552.70	117,979,150.89	
Hydroelectric	1,361.91	-	-	
Pumped-storage	1,935.18	-	-	
Gas turbine (kerosene)	404.07	365.50	147,688.57	
Nuclear power	7,522.33	-	-	
Zimbabwe (ZESA)	7,781.00	-	-	
Coal (Hwange)	1,897.80	505.00	958,391.46	
Hydro (Kariba)	5,883.20	-	-	
Zambia (ZESCO)	9,771.00	-	-	
Hydro	9,761.23	-	-	
Diesel	9.77	No Data	No Data	
Mozambique (EDM)	261.67	-	-	
Hydro	223.90	-	-	
Diesel	37.77	No Data	No Data	
Botswana (BPC)	728.00	-	-	
Coal Fired	696.84	No Data	No Data	
Oil	31.16	No Data	No Data	
DRC (SNEL)	7,345.33	-	-	
Hydro	7,345.33	-	-	
Lesotho (LEC)	479.33	-	-	
Hydro	479.33	-	-	
Swaziland (SEB)	137.30	-	-	

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

The build margin must consist of either:

a) The set of five power plants most recently built; or
b) The set of power capacity additions in the electricity system that comprise 20% of the system generation and that have been most recently built.

The set of power plants that comprise the larger annual generation should be used.
Only data from NamPower, Eskom, and ZESA are available in the public domain, therefore Option (a) is used.

In order to determine the vintage of data, one of the following options must be selected:

Option 1: For the first crediting period, calculate the build margin emission factor *ex ante* based on the most recent information available at the time of CDM-PDD submission to the DOE for validation.

Option 2: For the first crediting period, the build margin emission factor shall be updated annually, *ex post*, including those units built up to the year of registration of the project activity.

Option 1 is used for this project due to the lack consistent data from the same vintage for the NamPower, Eskom, and ZESA power plants.

The commissioning dates for the Eskom and power plants appear in on the Eskom website[23]. NamPower and ZESA power plants are listed in the table below with their commissioning dates.

Power Plant	Commissioning Date	Reference
Ruacana	1977	NamPower, *http://www.nampower.com.na/pages/ruacana.asp*
Paratus	1976	NamPower, *http://www.nampower.com.na/pages/paratus.asp*
Van Eck	1979	NamPower, http://www.nampower.com.na/pages/van-eck.asp
Hwange	1984	Power plants around the world, *Coal-fired power plants in Africa*, November 2009, *http://www.industcards.com/st-coal-africa.htm*

The five most recently built power plants and their emission factors appear in the table below. Generation and fuel consumption data for Eskom power stations were obtained from the Eskom website (for the financial year ending 31 March 2010[24]). This is the latest available data.

[23] Eskom Holdings Limited, 2010, *CDM Calculations, General Information,* *http://www.eskom.co.za/live/content.php?Item_ID=4226&Revision=en/0* *[Accessed 1November 2010]*
[24] Eskom Holdings Limited, 2010, *CDM Calculations, General Information,* *http://www.eskom.co.za/live/content.php?Item_ID=4226&Revision=en/0 [Accessed 1 November 2010]*

Station	On-Line Year	Generation (MWh)	Fuel Consumption (Tons)	$EF_{EL,m,y}$
Kendal (Eskom)	1988	23,307,031.00	13,866,514.00	1.08
Lethabo (Eskom)	1985	25,522,698.00	18,170,227.00	1.29
Majuba (Eskom)	1996	22,340,081.00	12,261,833.00	1.00
Matimba (Eskom)	1987	27,964,141.00	14,637,481.00	0.95
Tuktuka (Eskom)	1985	19,847,894.00	10,602,839.00	0.97

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 as follows:

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

Where:

$EF_{grid,BM,y}$ Build margin 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 data is available.

The CO_2 emission factor of each power unit m ($EL_{EL,m,y}$) should be determined as per the guidance in Step 3 (a) for the simple OM, using option A1 using for *y* the most recent historical year for which power generation data is available, and using for *m* the power units included in the build margin.
If for a power unit *m* data on fuel consumption and electricity generation is available the emission factor ($EF_{EL,m,y}$) should be determined as follows:

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

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)

$EF_{CO2,i,y}$ 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 plants/units serving the grid in year y except low-cost/must-run power plants/units
i	All fossil fuel types combusted in power plant/unit m in year y
y	The relevant year as per data vintage chosen in Step 3

Using equation 13, the BM is calculated as **1.062** tCO_2e/MWh.

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

The combined margin factor is calculated as follows:

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

Where:

$EF_{grid,BM,y}$	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 emission factors for the operating margin, the build margin, and the final combined margin appear in the table below.

$EF_{grid,OM,y}$	1.011
$EF_{grid,BM,y}$	1.062
w_{OM}	0.500
w_{BM}	0.500
$EF_{grid,CM,y}$	**1.036**

The calculation of f_{cap} :

f_{cap} is calculated using the section 3.2 of ACM0012 version 04.0.0.

The methodology requires that the baseline emissions are capped irrespective of planned/unplanned or actual increase in output of plant, change in operational parameters and practices, change in fuel type and quantity resulting in an increase in generation of waste energy. According to page 29 of ACM0012 version 04, the capping factor can be estimated following this hierarchy:

(i) Method-1 (if the required data is available);
(ii) Method-2 (if the project activity is implemented in a Greenfields facility, or in an existing facility where the required data is unavailable);
(iii) Method-3 (if project proponents demonstrate the technical infeasibility in direct monitoring of waste heat/pressure).

ACM0012 states that the data required to use Method-1 is the 'historical data on energy released by the waste energy carrying medium'. Namakwa Sands did not historically measure quantity of waste gas released by the furnaces and therefore Method-1 is not applicable to the project activity.

Method-2 states that if Method-1 is not applicable, the manufacturer's data for the facility shall be used to estimate the amount of waste energy the facility generate per unit of "product". However, Namakwa Sands does not have this manufacturer's data.

Methodology ACM00012 further qualifies that if this manufacturer's data in not available, Method-2 can still be applied if an independent certified external process expert, such as a chartered engineer, can assess the conservative quantity of waste energy generated by the project facility per unit of product manufactured by the process generating waste energy. This option was selected in order to estimate f_{cap}, as is explained below.

Energy balance over the furnaces:

Namakwa Sands measured the following parameters for the three years prior to the start of the project activity: furnace feed-on utilisation; iron tapped; slag tapped; electrical energy consumption; anthracite consumption and electrode consumption. With this information it was possible to perform an energy balance over the furnaces to determine the quantity of waste gas released per unit of slag for the three years prior to the start of the project (refer to Annex 3).

Independent expert assessment:

A chemical engineer, registered with the Engineering Council of South Africa, working for an independent professional engineering firm, was contracted by Exxaro Resources Ltd to conduct an independent verification of the quantity of waste energy generated by the Namakwa Sands plant per unit of product (slag) manufactured based on the energy balance over the furnaces.

This independent, professionally-registered engineer verified that the energy balance performed over the furnaces was accurate, and that the calculation of waste energy per unit of product was correct. Therefore, all of the requirements of Method-2 have been fulfilled.

Equation (38) of the applied methodology is used to estimate f_{cap}:

$$f_{cap} = \frac{Q_{WCM,BL}}{Q_{WCM,y}} \quad (38)$$

And,

$$Q_{WCM,BL} = Q_{BL,product} \times q_{wcm,product} \quad (39)$$

Where:

$Q_{WCM,BL}$	Quantity of waste energy generated prior to the start of the project activity (Nm^3)
$Q_{WCM,y}$	Quantity of WECM used for energy generation during year *y* (Nm^3)
$Q_{BL,product}$	Production associated with the relevant waste energy generation as it occurs in the baseline scenario (ton slag)
$q_{WCM,product}$	Amount of waste energy per unit of product generated by the process (that generates waste energy) in the facility (Nm^3 waste energy/ton slag)

Project Emissions

Project emissions include emissions due to the combustion of auxiliary fuel and emissions due to the consumption of electricity. The project emissions are calculated using equation (41) of the applied methodology:

$$PE_y = PE_{AF,y} + PE_{EL,y} \quad (41)$$

Where:

PE_y	Project emissions due to the project activity (tCO_2)
$PE_{AF,y}$	Project activity emissions from on-site consumption of fossil fuels by the unit process(es) and/or cogeneration plant(s) if they are used as supplementary fuels due to non-availability of waste gas to the project activity or due to any other reason (tCO_2)
$PE_{EL,y}$	Project activity emissions from on-site consumption of electricity for gas cleaning equipment or other supplementary electricity consumption (tCO_2)

Fossil fuels will not be used as supplementary fuels due to non-availability of waste gas in the project activity. Therefore, equation (41) simplifies to:

$$PE_y = PE_{EL,y}$$

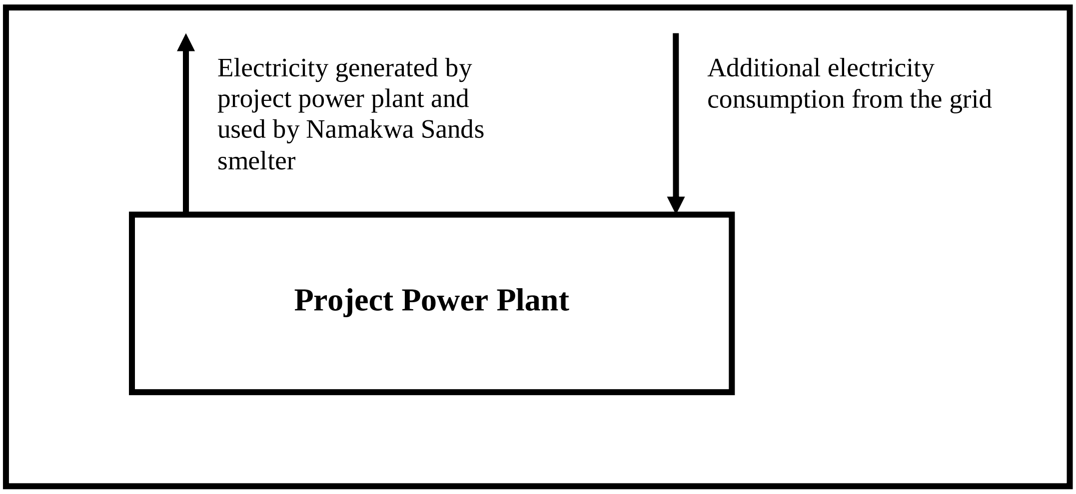
The project emissions from the consumption of electricity are calculated using version 01 of the 'Tool to calculate baseline, project and/or leakage emissions from electricity consumption'. The emissions are determined using equation (1) of the applied tool:

$$PE_{EL,y} = EC_{PJ,gr,y} \times EF_{EL,gr,y} \times \left(1 + TDL_{gr,y}\right) \quad (1)$$

Where:

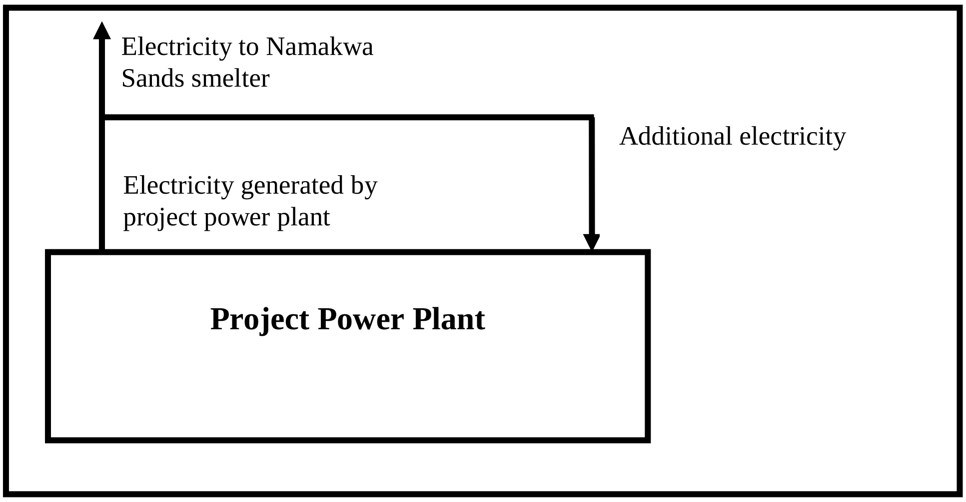
$PE_{EL,y}$	Project emissions from electricity consumption in year *y* (tCO_2/yr)
$EC_{PJ,gr,y}$	Quantity of electricity consumed by the project from the grid in year *y* (MWh/yr)
$EF_{Elec,gr,y}$	Emission factor of the grid in year *y* (tCO_2/MWh)
$TDL_{gr,y}$	Average technical transmission and distribution losses for providing electricity to the grid in year *y*

During plant maintenance, the source of electricity for the proposed project plant will be the grid.



Plant maintenance situation

During operation, the source of the electricity will be the proposed project plant. A small portion of the electricity produced by the project activity will be used to supply the equipment with electricity. This will decrease the amount of electricity supplied to the Namakwa Sands smelter.



Operation situation

In the case above, the baseline emissions change since the net amount of electricity supplied to Namakwa Sands smelter decreases. The project emissions also change as the electricity required is sourced from the electricity generated by the project activity and not from the grid.

The electricity is consumed from the grid and therefore the CO_2 emission factor for the electricity consumed is calculated using version 02.2.1 of the 'Tool to calculate the emission factor for an electricity system'. The calculations for this tool have been provided above.

Leakage

No leakage is applicable under this methodology.

Emission Reductions

Emission reductions due to the project activity during the year *y* were using equation (42):

$$ER_y = BE_y - PE_y \tag{42}$$

Where:

ER_y	Total emissions reductions during the year *y* in tons of CO_2
PE_y	Emissions from the project activity during the year *y* in tons of CO_2
BE_y	Baseline emissions for the project activity during the year *y* in tons of CO_2

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

Data / Parameter:	$EF_{Elec,gr,y}$
Data unit:	tCO_2 / MWh
Description:	CO_2 emission factor for grid electricity displaced by the project activity during year *y*
Source of data used:	The combined margin emission factor, determined according to version 02.2.1 of the 'Tool to calculate emission factor for an electricity system'
Value applied:	1.036
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per applied tool, this value will be calculated ex-ante. The calculations for the tool will be made available during validation.
Any comment:	The methodological choices made regarding the 'Tool to calculate the emission factor for an electricity system' (Version 02.2.1) are as follows: – In terms of data vintages, the ex ante option were chosen to calculate the simple OM. In this option a 3 year generation-weighted average are used for the grid power plants. Using this option also means that the emission factor is determined only once at the validation stage, thus no monitoring and recalculation is required during the crediting period. – The simple operating margin emission factor ($EF_{grid,OMsimple,y}$) is chosen for the calculation method, seeing as low-cost/must-run resources constitute less than 50% of total grid generation in average of the five most resent years. – For calculating of the combined margin emission factor: w_{OM} = 0.5 and w_{BM} = 0.5 (as specified by the applied tool – it is an 'other'-type project).

Data / Parameter:	$EF_{EL,gr,y}$
Data unit:	tCO_2 / MWh
Description:	CO_2 emission factor for electricity consumed by the project activity in year *y* (electricity is sourced from the grid).
Source of data used:	The combined margin emission factor, determined according to version 02.2.1 of the 'Tool to calculate emission factor for an electricity system'
Value applied:	1.036
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per applied tool, this value will be calculated ex-ante. The calculations for the tool will be made available during validation.
Any comment:	The methodological choices made regarding the 'Tool to calculate the emission factor for an electricity system' (Version 02.2.1) are as follows: – In terms of data vintages, the ex ante option were chosen to calculate the simple OM. In this option a 3 year generation-weighted average are used for the grid power plants. Using this option also means that the emission

	factor is determined only once at the validation stage, thus no monitoring and recalculation is required during the crediting period. – The simple operating margin emission factor ($EF_{grid,OMsimple,y}$) is chosen for the calculation method, seeing as low-cost/must-run resources constitute less than 50% of total grid generation in average of the five most resent years. – For calculating of the combined margin emission factor: w_{OM} = 0.5 and w_{BM} = 0.5 (as specified by the applied tool – it is an 'other'-type project).

Data / Parameter:	$Q_{BL,product}$
Data unit:	ton slag/year
Description:	Production associated with the relevant waste energy generation as it occurs in the baseline scenario
Source of data used:	Project participant
Value applied:	Average 2008 – 2010: 169,242
Justification of the choice of data or description of measurement methods and procedures actually applied :	The main product of the ilmenite smelter is titanium dioxide slag. The production of slag is calculated from the energy balance which was verified by an independent professionally-registered engineer. Refer to Annex 3.
Any comment:	

Data / Parameter:	$q_{wcm,product}$
Data unit:	Nm^3 waste energy/ton slag
Description:	Specific waste energy production per unit of product generated
Source of data used:	Project participant
Value applied:	Average 2008 – 2010: 542
Justification of the choice of data or description of measurement methods and procedures actually applied :	WECM is measured in Nm^3 and the main product of the ilmenite smelter is titanium dioxide slag. Calculated from energy balance which was verified by an independent professionally-registered engineer. Refer to Annex 3.
Any comment:	

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

The following assumptions were used to calculate the ex-ante emissions reductions:

- The start of the crediting period is 1 January 2013.
- Eight internal combustion engines are fully operational at the start of the crediting period (1 January 2013).

The baseline emissions (BE_y) were calculated using equation (1) of the applied methodology:

$$BE_y = BE_{EN,y} + BE_{flst,y} \quad (1)$$

Year	BE_y	$BE_{EN,y}$	$BE_{flst,y}$
	tCO_2/y	tCO_2/y	tCO_2/y
2013	85 588	85 588	0
2014	82 194	82 194	0
2015	83 006	83 006	0
2016	85 476	85 476	0
2017	85 588	85 588	0
2018	85 588	85 588	0
2019	85 588	85 588	0
2020	82 194	82 194	0
2021	85 588	85 588	0
2022	85 476	85 476	0

The baseline emissions from the energy generated by the project activity ($BE_{EN,y}$) were calculated using equation (2) of the applied methodology:

$$BE_{EN,y} = BE_{Elec,y} + BE_{Ther,y} \quad (2)$$

Year	$BE_{EN,y}$	$BE_{Elec,y}$	$BE_{Ther,y}$
	tCO_2/y	tCO_2/y	tCO_2/y
2013	85 588	85 588	0
2014	82 194	82 194	0
2015	83 006	83 006	0
2016	85 476	85 476	0
2017	85 588	85 588	0
2018	85 588	85 588	0
2019	85 588	85 588	0
2020	82 194	82 194	0
2021	85 588	85 588	0
2022	85 476	85 476	0

The baseline emissions from electricity that is displaced by the project activity ($BE_{Elec,y}$) were calculated using equation (3) of the applied methodology:

$$BE_{Elec,y} = f_{cap} \times f_{wcm} \times \sum_j \sum_i (EG_{gr,y} \times EF_{Elec,gr,y}) \quad (3)$$

Year	$BE_{Elec,y}$	$EG_{i,j,y}$	$EF_{Elec,i,j,y}$	f_{wcm}	f_{cap}
	tCO_2/y	MWh	tCO_2/MWh	-	-
2013	85 588	82 614	1.036	1	1.00
2014	82 194	82 614	1.036	1	0.96
2015	83 006	82 614	1.036	1	0.97
2016	85 476	82 614	1.036	1	1.00
2017	85 588	82 614	1.036	1	1.00
2018	85 588	82 614	1.036	1	1.00
2019	85 588	82 614	1.036	1	1.00
2020	82 194	82 614	1.036	1	0.96
2021	85 588	82 614	1.036	1	1.00
2022	85 476	82 614	1.036	1	1.00

f_{cap} is calculated using Method-2. Equation (38) of the applied methodology was used to estimate f_{cap}:

$$f_{cap} = \frac{Q_{WCM,BL}}{Q_{WCM,y}} \quad (38)$$

Year	f_{cap}	$Q_{WCM,BL}$	$Q_{WCM,y}$
	-	$Nm^3/year$	$Nm^3/year$
2013	1.00	91 688 951	91 433 808
2014	0.96	91 688 951	95 475 607
2015	0.97	91 688 951	94 541 846
2016	1.00	91 688 951	91 809 288
2017	1.00	91 688 951	89 811 598
2018	1.00	91 688 951	91 419 555
2019	1.00	91 688 951	87 767 489
2020	0.96	91 688 951	95 475 607
2021	1.00	91 688 951	89 811 598
2022	1.00	91 688 951	91 809 288

The quantity of waste energy generated prior to the start of the project activity is calculated using equation (39) of the applied methodology:

$$Q_{WCM,BL} = Q_{BL,product} \times q_{wcm,product} \quad (39)$$

Year	$Q_{WCM,BL}$	$Q_{BL,\ product}$	$q_{wcm,product}$
	Nm^3/year	ton slag/yr	Nm^3/t slag
2013	91 688 951	169 242	542
2014	91 688 951	169 242	542
2015	91 688 951	169 242	542
2016	91 688 951	169 242	542
2017	91 688 951	169 242	542
2018	91 688 951	169 242	542
2019	91 688 951	169 242	542
2020	91 688 951	169 242	542
2021	91 688 951	169 242	542
2022	91 688 951	169 242	542

The project emissions are calculated using equation (41) of the applied methodology:

$$PE_y = PE_{AF,y} + PE_{EL,y} \quad (41)$$

Year	PE_y	$PE_{AF,y}$	$PE_{EL,y}$
	tCO_2	tCO_2	tCO_2
2013	197	0	197
2014	197	0	197
2015	197	0	197
2016	197	0	197
2017	197	0	197
2018	197	0	197
2019	197	0	197
2020	197	0	197
2021	197	0	197
2022	197	0	197

The project emissions from the consumption of electricity are calculated using version 01 of the 'Tool to calculate baseline, project and/or leakage emissions from electricity consumption'. The emissions are determined using equation (1) of the applied tool:

$$PE_{EL,y} = EC_{PJ,gr,y} \times EF_{EL,gr,y} \times \left(1 + TDL_{gr,y}\right) \quad (1)$$

Year	$PE_{EL,y}$	$EC_{PJ,gr,y}$	$EF_{EL,gr,y}$	$TDL_{gr,y}$
	tCO_2	MWh	tCO_2/MWh	-
2013	197	178	1.036	0.067
2014	197	178	1.036	0.067
2015	197	178	1.036	0.067
2016	197	178	1.036	0.067
2017	197	178	1.036	0.067
2018	197	178	1.036	0.067
2019	197	178	1.036	0.067
2020	197	178	1.036	0.067
2021	197	178	1.036	0.067
2022	197	178	1.036	0.067

The emission reductions due to the project activity during the year *y* were using equation (42) of the applied methodology:

$$ER_y = BE_y - PE_y \quad (42)$$

Year	ER_y	PE_y	BE_y
	tCO_2	tCO_2	tCO_2
2013	85 392	197	85 588
2014	81 997	197	82 194
2015	82 809	197	83 006
2016	85 279	197	85 476
2017	85 392	197	85 588
2018	85 392	197	85 588
2019	85 392	197	85 588
2020	81 997	197	82 194
2021	85 392	197	85 588
2022	85 279	197	85 476
Total	844 320	1 969	846 288

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

>>

Year	Estimation of project activity emissions (tonnes of CO_2 e)	Estimation of baseline emissions (tonnes of CO_2 e)	Estimation of leakage (tonnes of CO_2 e)	Estimation of overall emission reductions (tonnes of CO_2 e)
2013	197	85,588	0	85,392
2014	197	82,194	0	81,997
2015	197	83,006	0	82,809
2016	197	85,476	0	85,279
2017	197	85,588	0	85,392
2018	197	85,588	0	85,392
2019	197	85,588	0	85,392
2020	197	82,194	0	81,997
2021	197	85,588	0	85,392
2022	197	85,476	0	85,279
Total (tonnes of CO_2 e)	1,969	846,288	0	844,320

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

B.7.1 Data and parameters monitored:

Data / Parameter:	$Q_{WCM,y}$
Data unit:	Nm^3/year
Description:	Quantity of waste gas used for energy generation during year *y*
Source of data to be used:	Plant measurements records.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2013: 45,716,904 2014: 95,475,607 2015: 94,541,846 2016: 91,809,288 2017: 89,811,598 2018: 91,419,555 2019: 87,767,489 2020: 95,475,607 2021: 89,811,598 2022: 91,809,288 2023: 47,270,923
Description of measurement methods and procedures to be applied:	The waste gas flow rate is measured continuously with differential pressure flow meters. These readings will be aggregated monthly for use in the monitoring plan.
QA/QC procedures to	The flow meters will be calibrated annually by a Namakwa Sands plant operator

be applied:	during the week that the gas holder (the holder which feeds the gas engines) is maintained. The calibration procedure will also follow the national regulations and CDM guidelines on calibration.
Any comment:	

Data / Parameter:	$EG_{gr,y}$
Data unit:	MWh
Description:	Quantity of electricity supplied to Namakwa Sands, which in the absence of the project activity would have sourced from the grid during the year *y*
Source of data to be used:	Recipient plant and generation plant measurement records
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2013: 82,614 2014: 82,614 2015: 82,614 2016: 82,614 2017: 82,614 2018: 82,614 2019: 82,614 2020: 82,614 2021: 82,614 2022: 82,614
Description of measurement methods and procedures to be applied:	The quantity of electricity supplied to the recipient plant will be measured continuously using an electricity meter. The meter readings will be aggregated monthly for use in the emission reduction report.
QA/QC procedures to be applied:	A set of meters will be installed on each feed from the plant. This set comprises of a main meter and a check meter. The check meter ensures accurate readings, and also serves as a backup meter. These meters are 4-quadrant billable class meters that are bi-directional. The electricity meters will be fitted with a telemetry system, and the data will be fed into the plant control system on a daily basis. The main and check meters will be reconciled daily to check if their readings are within a pre-defined accuracy band. If there are discrepancies, then a notification will be sent to the control room to advise the operator to attend to a problem with the meters. The electricity readings will be used for billing purposes and will be logged electronically for the purposes of calculating emission reductions. The information will be saved onto the Exxaro Resources Ltd Supervisory Control and Data Acquisition (SCADA) system, as well as Exxaro Resources Ltd on-site financial systems.
Any comment:	

Data / Parameter:	$EC_{PJ,gr,y}$
Data unit:	MWh
Description:	Quantity of electricity consumed by the project from the grid in year *y*

Source of data to be used:	Actual measurements, plant operational records
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2013: 76 2014: 178 2015: 178 2016: 178 2017: 178 2018: 178 2019: 178 2020: 178 2021: 178 2022: 178 2023: 89
Description of measurement methods and procedures to be applied:	The quantity of electricity consumed by the project from the grid will be measured continuously using an electricity meter. The meter readings will be aggregated monthly for use in the emission reduction report.
QA/QC procedures to be applied:	A set of meters will be installed on each feed from the plant. This set comprises of a main meter and a check meter. The check meter ensures accurate readings, and also serves as a backup meter. These meters are 4-quadrant billable class meters that are bi-directional – this means that they subtract any electricity used by the plant during start up, or when the plant is not producing electricity. These meters are also able to measure and record the quantity of electricity consumed by the project activity from the grid. The electricity meters will be fitted with a telemetry system, and the data will be fed into the plant control system on a daily basis. The main and check meters will be reconciled daily to check if their readings are within a pre-defined accuracy band. If there are discrepancies, then a notification will be sent to the control room to advise the operator to attend to a problem with the meters. The electricity readings will be used for billing purposes and will be logged electronically for the purposes of calculating emission reductions. The information will be saved onto the Exxaro Resources Ltd Supervisory Control and Data Acquisition (SCADA) system, as well as Exxaro Resources Ltd on-site financial systems.
Any comment:	

Data / Parameter:	$TDL_{gr,y}$
Data unit:	-
Description:	Average technical transmission and distribution losses for providing electricity to the grid in year *y*
Source of data to be used:	Eskom annual report
Value of data applied for the purpose of calculating expected emission reductions in	0.067

section B.5	
Description of measurement methods and procedures to be applied:	
QA/QC procedures to be applied:	Not applicable. The average technical transmission and distribution losses will be sourced from Eskom's annual report.
Any comment:	

Data / Parameter:	Abnormal operation of the project facility including emergencies and shutdown
Data unit:	Hours
Description:	The hours of abnormal operation of parts of project facility that have can have an impact on waste energy generation and recovery.
Source of data to be used:	Operation of project facility.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0
Description of measurement methods and procedures to be applied:	The hours of abnormal operation at Namakwa Sands will be recorded daily and aggregated annually.
QA/QC procedures to be applied:	The records will be cross-checked to ensure that the hours of abnormal operation are accurately recorded.
Any comment:	This parameter has to be monitored to demonstrate that no emission reduction is claimed for the hours during abnormal operation of the part of the project facility which has an impact on waste energy generation and recovery. This abnormality can be in terms of violation of operational parameters, poor quality product, emergencies or shutdown.

B.7.2. Description of the monitoring plan:

>>

The monitoring plan will ensure that emission reductions are accurately monitored, recorded, and reported.

(i) Parameters to be monitored in the project activity

The following parameters will be monitored in the project activity, as per the requirements in version 04.0.0 of methodology ACM0012:

Project emissions

1. Quantity of electricity consumed by the project operations.

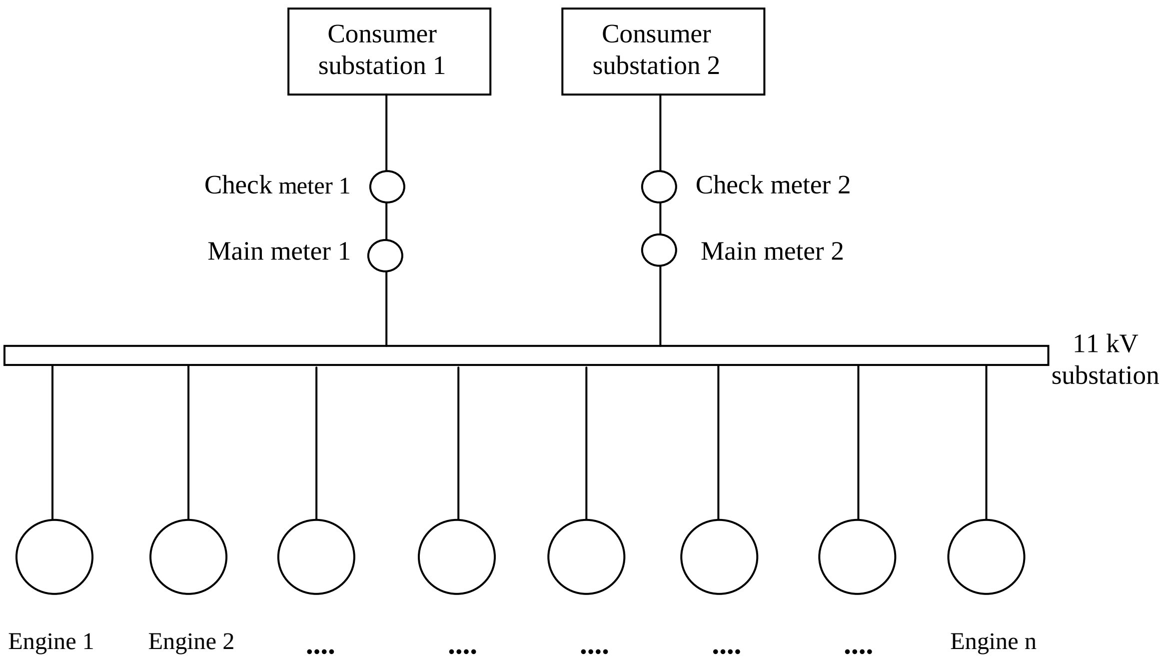
Baseline emissions

1. Quantity of electricity supplied to the recipient plant (Namakwa Sands).
2. Quantity of waste gas used for energy generation.

(ii) Monitoring equipment

Electricity meters will measure the quantity of electricity supplied to the recipient plant. These meters are 4-quadrant billable class meters that are bi-directional – this means that they subtract any electricity used by the plant during start up, or when the plant is not producing electricity. These meters are also able to measure and record the quantity of electricity consumed by the project activity from the grid.

Four electricity meters will be installed on the feeds to the recipient plant – two main meters and two check meters. The metering setup is illustrated in the diagram below.



(iii) Monitoring accuracy

The electricity meters will be fitted with a telemetry system, and the data will be fed into the plant control system on a daily basis. The main and check meters will be reconciled daily to check if their readings are within a pre-defined accuracy band. If there are discrepancies, then a notification will be sent to the control room to advise the operator to attend to a problem with the meters.

(iv) Data collection and storage

On a monthly basis, the Namakwa Sands plant manager (or other designated employee) and a representative from Namakwa Sands will read the two main electricity meters to determine the quantity of

electricity produced by the plant. This will be done by adding the readings from the two main meters. The electricity readings will be used for billing purposes and will be logged electronically for the purposes of calculating emission reductions.

The information will be saved onto the Exxaro Resources Ltd Supervisory Control and Data Acquisition (SCADA) system, as well as Exxaro Resources Ltd on-site financial systems. Backups will be kept both on- and off-site, and all of the data will be available for CDM verification.

As per methodology ACM0012, all data collected as part of the monitoring plan will be archived electronically, and will be kept for a minimum if two years at the end of the crediting period.

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

>>

Date of completion of application: 11/11/2010

Contact information for the entity responsible for the application of the baseline and monitoring information:

Promethium Carbon (Pty) Ltd
Coral House
20 Peter Place
Bryanston 2021
Johannesburg
Telephone: +27 11 706 8185

This entity is not a project participant.

SECTION C. Duration of the project activity / crediting period

C.1. Duration of the project activity:

C.1.1. Starting date of the project activity:

>>

As per version 05 page 28 of the Glossary of CDM Terms, ‘the start date shall be considered to be the date on which the project participant has committed to expenditures related to the implementation or related to the construction of the project activity’.

Exxaro Resources Limited granted full capital approval for the project on 12/01/2012. (This approval was based on the draft CDM validation protocol that was received on 15/12/2011.) Exxaro Resources Limited placed the contract for project execution immediately thereafter. 12/01/2012 therefore represents the start date of the project activity.

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

>>

The expected operational lifetime of the project activity exceeds ten years 0 months. The expected life of the furnaces and internal combustion engines exceeds the operational lifetime of the project activity. The service level agreement with the engine manufacturers is for 15 years.

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

C.2.1. Renewable crediting period:

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

>>

Not applicable

C.2.1.2. Length of the first crediting period:

>>

Not applicable

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>

The starting date of the fixed crediting period is 01/01/2013.

C.2.2.2. Length:

>>

10 years 0 months

SECTION D. Environmental impacts

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

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An initial environmental screening report for this project was undertaken by independent consultants; Strategic Environmental Focus (Pty) Ltd. This screening report identified the need to conduct a basic environmental assessment to comply with the National Environmental Management Act, 1998 (Act No. 107 of 1998) [NEMA], and the EIA Regulations of 2006 (Government Notice No's R385, 386 and 387 of 2006). A basic environmental assessment is a requirement for any project which generates over 10 MW of electricity, but under 20 MW of electricity.

The basic assessment is being conducted by Arcus Gibb (Pty) Ltd.

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

>>
An initial environmental screening report of the project activity and its associated environmental impacts was carried out by Strategic Environmental Focus (Pty) Ltd. They were required to make recommendations on the appropriate environmental authorisation processes for the project, to identify any potential environmental issues or sensitivities at the existing site and to highlight any environmental risks.

The process followed to compile the environmental screening report:

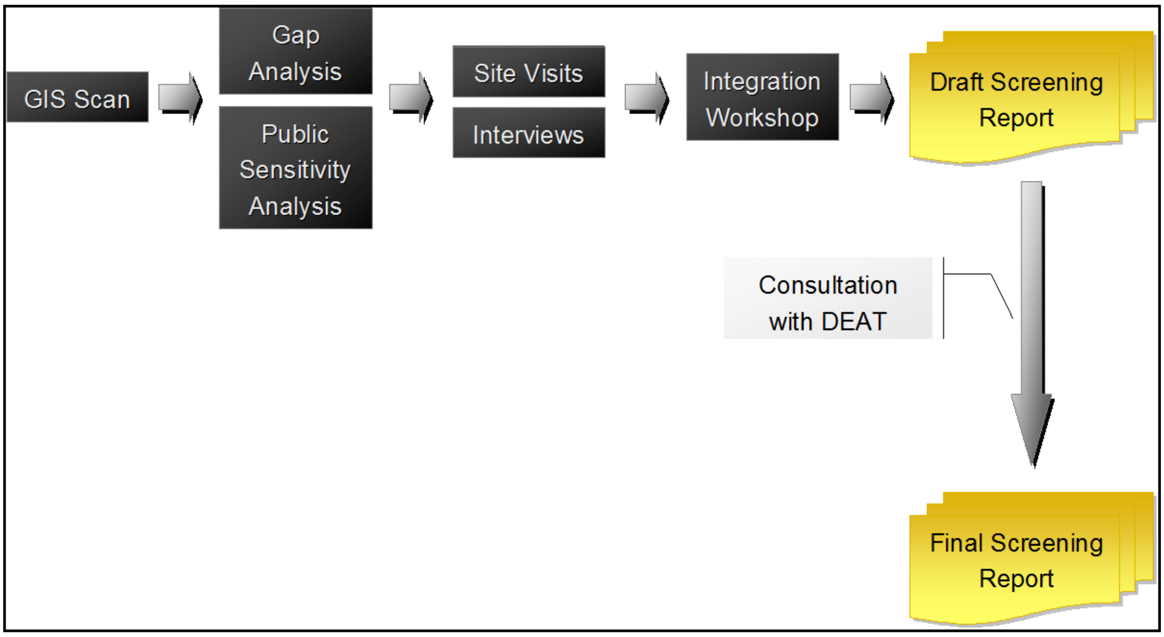

Figure 10: Screening report steps

The screening process determined that:

A basic assessment process will be required for the proposed plant to fulfil the requirements of South African environmental legislation. The proposed development involves 'listed activities', as defined by the National Environmental Management Act, 1998 (Act No. 107 of 1998) [NEMA], and the EIA Regulations of 2006 (Government Notice No's R385, 386 and 387 of 2006):

- Government Notice R386 of 2006:
  - *1 The construction of facilities or infrastructure including associated structures or infrastructure, for: (a) the generation of electricity where the electricity output is more than 10 megawatts but less than 20 megawatts.*

- *25 The expansion of or changes to existing facilities for any process or activity, which requires an amendment of an existing permit or license or new permit or license in terms of legislation governing the release of emissions, pollution, effluent.*

- No water use license is required for the proposed plant. This is because the water will be supplied by Namakwa Sands who has sufficient headroom available on the water use permit;
- The proposed plant will result in an improved particulate removal system, which will result in a decrease in particulate matter released into the atmosphere (30 mg/Nm3 to below 15 mg/Nm3);
- The proposed plant on site may have a resultant increase in noise pollution on the site, but this has been addressed by housing the engines (equipped with exhaust silencers) in an engine room;

The basic assessment will be conducted by Arcus Gibb (Pty) Ltd.

SECTION E. Stakeholders' comments

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

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Stakeholder consultation is required in South Africa. According to the National Environmental Management Act, 1998, Chapter 5, Section 24:

(7) Procedures for the investigation, assessment and communication of the potential impact of activities must, as a minimum, ensure the following:

(d) Public information and participation, independent review and conflict resolution in all phases of the investigation and assessment of impacts.

The following stakeholder consultation was conducted:

- A Background Information Document (BID) was released on 06/11/08 in order to provide interested and affected parties (I & AP) an opportunity to comment on the proposed project. In terms of the 'Regulations in terms of Chapter 5 of the National Environmental Management Act, 1998' (No. R. 385), an 'interested and affected party includes: any person, group of persons or organisation interested in or affected by an activity; and any organ of state that may have jurisdiction over any aspect of the activity'. In terms of this project activity, any person could register as an 'interested and affected party'. Once registered, these parties were given a 30-day public comment period in which to comment in writing about the proposed project activity.

- A regular Saldanha Bay Forum was held on 19/11/2008 at which the project was presented to the forum

- An open day was held at the Skilpadsaal in Vredenburg on 20/11/2008. The open day provided the public with an opportunity to get more information regarding the proposed project, and to provide inputs on the proposed project and basic assessment process. All I & AP were invited to attend the open day.

- Public participation notifications:
  - Newspaper advertisements: Weslander on 06/11/2008, and Coastal News on 14/11/2008
  - 6 on-site notices (3 in English, 3 in Afrikaans)
  - 68 email notifications/ invitations
  - 101 letters

E.2. Summary of the comments received:

>>

The table below gives a summary of the concerns and comments/suggestions raised by interested and/or affected parties during the 30 day public comment period.

Comment	Raised by	Response
1. *General environmental impacts*		
Degradation of the environment is a concern which should be addressed.	Donovan Cleophas (Principal: Steenberg's Cove Primary School)	The proposed development will take place on the same site as the existing smelter. As a result, the site is highly disturbed and the ground cover comprises of bare soil and concrete.
The initiative is supported by the CWCBR, subject to compliance with all the relevant procedures and legislation.	Nicole Loebenberg (Cape West Coast Biosphere Reserve)	We take note of your comment.
The Draft BAR is satisfactory.	Anna Swartz (Help Mekaar Diensentrum)	We take note of your comment.
2. *Water related impacts*		
The impact on underground water and drainage should be investigated, in the event that water should be used during the process.	Donovan Cleophas (Principal: Steenberg's Cove Primary School)	No groundwater will be abstracted for this development. Water will be sourced from the Municipality. The site is not located on a shallow water table or on seasonally wet soils, and as such issues surrounding drainage are not expected.

3. Noise impacts		
Will the proposed development result in noise impacts or reduction?	Donovan Cleophas (Principal: Steenberg's Cove Primary School)	It is anticipated that the noise generated by the proposed electricity generation plant will be negligible in comparison to that of the existing industrial operations. The installation of the electricity generation plant will adhere to all noise control regulations. The engines will be installed inside an enclosed building.
4. Air quality impacts		
The value of the proposed electricity generation plant is noted as it will reduce air pollution and generate electricity for the existing plant.	Joy Anne Joshua (Principal: Babbelbekkies Pre-Primary)	We take note of your comment.
Solid residues and emissions are areas of concern that should be investigated.	Donovan Cleophas (Principal: Steenberg's Cove Primary School)	Construction rubble will be disposed of via the municipal waste stream. Lubricating oil used in the engines will be recycled. Due to the nature of the project (re-routing the gas that is currently flared, through an engine) there will be no significant change to the air quality. A small amount of NO_x (nitrous oxides) and SO_x (sulphur oxides) will be emitted by the engine (these emissions are within European Standards. Emission values: NO_x < 500 mg/Nm³ (5% O_2) (from Jenbacher manual), but the CO emissions will be reduced from the current value of approximately 50mg/m^3 to less than 10mg/m^3. A small amount of CO will continue to be flared by the existing operations, but this will be reduced to approximately 10 to 15% of current volumes of flared gas.

		The overall environmental impact on air quality and climate will be positive, since it will reduce the volume of greenhouse gases emitted to the atmosphere.
5. *Employment opportunities and skills transfer*		
The construction phase and business opportunities should be outsourced to local SMME's.	Gert van Zyl (Chairman: Saldanhabaai Business Chamber)	Construction will make use of local contractors as far as possible.
Expansion of Namakwa Sands infrastructure which can secure new jobs for young people in the area is supported.	Joy Anne Joshua (Principal: Babbelbekkies Pre-Primary)	We take note of your comment.
Workers will be attracted to the area during the construction phase. What will happen to these workers after construction is completed?	Donovan Cleophas (Principal: Steenberg's Cove Primary School)	Construction will make use of local contractors as far as possible.
Who will be the beneficiaries of the process?	Donovan Cleophas (Principal: Steenberg's Cove Primary School)	Electricity generation projects have been identified an as opportunity to alleviate the growing capacity pressure on the electricity supply industry. As one of a number of electricity generation projects planned in South Africa, this project can potentially reduce the frequency of load shedding. Reliable power will be beneficial to the local community and businesses and to South Africa as a whole. Namakwa Sands will also benefit be being less reliant on Eskom for electricity.
6. *Safety and security*		
Issues surrounding safety on the work site should be addressed.	Donovan Cleophas (Principal: Steenberg's Cove Primary School)	All requirements in terms of the Occupational Health and Safety Act, 1993 (Act No.85 of 1993) and Namakwa Sands' occupational health and safety management system will be adhered to. Construction workers will be required to complete a site induction course before being allowed onto site.

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

>>

Although comments were received during the 30 day public comment period, the nature of the comments did not require any adjustments on the design, construction, or operation of the proposed project.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Exxaro Resources Ltd
Street/P.O.Box:	Roger Dyason Road
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E-Mail:	
URL:	
Represented by:	
Title:	Mr
Salutation:	
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Middle name:	
First name:	Thomas
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Direct tel:	+27 12 307 4034
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Not applicable. No public funding was used in the development or implementation of the project activity.

Annex 3

BASELINE INFORMATION

The energy balance of the relevant sections of the plant is provided below, to prove that the waste energy was not a source of energy before the implementation of the project activity.

GAS CALCULATIONS 2008

		Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08
		31	29	31	30	31	30	31	31	30	31	30	31
FURNACES													
Furnace 1													
Power setpoint	MW	25	25	25	25	25	25	25	25	25	25	25	25
Maintenance work	type	N	N	N	N	N	N	N	N	N	N	N	N
Feed on utilisation	%	78%	87%	82%	85%	88%	90%	87%	77%	52%	89%	87%	89%
Load factor	%	100%	88%	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Days off line for major maintenance	days	-	-	-	-	-	-	-	-	-	-	-	-
Iron tapped	tons	3 740	3 355	4 089	4 042	4 427	4 301	4 209	3 520	2 539	4 478	4 218	4 421
Electrical energy consumption	MWh	14 430	13 283	15 151	15 336	16 615	16 298	16 235	14 399	9 414	17 158	16 174	17 212
Anthracite consumption	tons	1 487	1 370	1 563	1 550	1 723	1 635	1 616	1 382	953	1 778	1 610	1 723
Electrode consumption	tons	49	47	61	58	58	64	62	57	37	60	52	54
Average power	MW	19	19	20	21	22	22	22	19	13	22	22	22
Furnace 2													
Power setpoint	MW	35	35	35	35	35	35	35	35	35	35	35	35
Maintenance work	type	N	N	N	N	N	N	N	N	N	N	N	N
Feed-on utilisation	%	84%	84%	80%	82%	85%	87%	72%	19%	78%	89%	88%	84%
Load factor	%	97%	90%	98%	99%	100%	100%	100%	100%	100%	100%	100%	100%
Days off line for major maintenance	days	-	-	-	-	-	-	-	-	-	-	-	-
Iron tapped	tons	5 541	4 814	5 509	5 435	5 618	5 844	5 117	1 164	5 346	6 209	6 101	5 805
Electrical energy consumption	MWh	21 212	18 322	20 503	20 446	22 316	22 032	19 010	5 376	19 789	23 295	22 583	21 893
Anthracite consumption	tons	2 218	1 915	2 035	2 088	2 290	2 242	1 923	505	2 073	2 406	2 310	2 215
Electrode consumption	tons	67	73	71	64	71	72	60	25	62	77	74	69
Average power	MW	29	26	28	28	30	30	25	7	27	31	31	29
GAS GENERATION													
Furnace 1													
Carbon in anthracite & electrodes	t	1 385	1 277	1 463	1 449	1 606	1 531	1 512	1 297	893	1 657	1 498	1 601
Carbon in tapped iron	t	86	77	94	93	102	99	97	81	58	103	97	102
Carbon in gas	t	1 299	1 200	1 369	1 356	1 504	1 432	1 415	1 216	834	1 554	1 401	1 500

CO in gas	t	3 029	2 799	3 193	3 163	3 508	3 340	3 299	2 836	1 946	3 624	3 267	3 498
CO in gas	Nm3	2 424 062	2 239 785	2 555 449	2 531 327	2 807 123	2 672 672	2 640 240	2 269 696	1 557 334	2 899 768	2 614 740	2 798 997
Gas produced	Nm3	3 320 634	3 068 199	3 500 615	3 467 571	3 845 375	3 661 195	3 616 766	3 109 172	2 133 334	3 972 285	3 581 836	3 834 242
Gas flow rate	Nm3/hr	5 724	5 746	5 747	5 624	5 757	5 588	5 542	5 371	5 637	5 759	5 509	5 541
Slag tapped		5 568	5 315	6 125	5 992	6 591	6 299	6 329	5 503	3 770	6 990	6 132	7 002
Furnace 2													
Carbon in anthracite & electrodes	t	2 059	1 792	1 898	1 940	2 127	2 085	1 788	478	1 924	2 238	2 148	2 059
Carbon in tapped iron	t	127	111	127	125	129	134	118	27	123	143	140	134
Carbon in gas	t	1 932	1 681	1 772	1 815	1 998	1 951	1 670	451	1 801	2 095	2 008	1 926
CO in gas	t	4 506	3 920	4 132	4 233	4 660	4 549	3 894	1 052	4 201	4 886	4 682	4 491
CO in gas	Nm3	3 605 518	3 136 924	3 306 464	3 387 579	3 728 932	3 640 363	3 116 464	841 932	3 361 957	3 910 266	3 746 753	3 593 631
Gas produced	Nm3	4 775 520	4 154 866	4 379 422	4 486 859	4 938 983	4 821 672	4 127 767	1 115 142	4 452 923	5 179 160	4 962 586	4 759 776
Gas flow rate	Nm3/hr	7 722	7 778	7 326	7 527	7 591	7 506	7 448	7 115	7 718	7 626	7 537	7 457
Slag tapped		8 522	7 308	7 963	8 190	9 003	8 708	7 456	1 816	8 063	9 695	8 780	9 126
Furnaces Combined													
Gas produced	Nm3	8 096 154	7 223 065	7 880 037	7 954 431	8 784 357	8 482 867	7 744 534	4 224 315	6 586 257	9 151 445	8 544 423	8 594 018
Gas flow rate	Nm3/hr	13 447	13 524	13 074	13 152	13 348	13 094	12 989	12 487	13 355	13 385	13 046	12 999
Gas Users													
Anthracite burner	Nm3	122 259	108 410	118 750	120 074	132 432	127 928	116 787	62 265	99 882	138 085	129 350	129 959
Proposed slag plant burner	Nm3	-	-	-	-	-	-	-	-	-	-	-	-
Available Gas													
Gas available for electricity generation	Nm3	7 973 894	7 114 655	7 761 287	7 834 356	8 651 925	8 354 939	7 627 746	4 162 049	6 486 375	9 013 360	8 415 073	8 464 059
Average Gas Flow Rate													
(F1 gas minus gas users)	Nm3	3 198 374	2 959 789	3 381 865	3 347 497	3 712 942	3 533 266	3 499 979	3 046 907	2 033 452	3 834 201	3 452 486	3 704 283
(F2 gas minus gas users)	Nm3	4 653 261	4 046 457	4 260 672	4 366 785	4 806 550	4 693 744	4 010 980	1 052 877	4 353 040	5 041 075	4 833 236	4 629 817
F1 gas flow rate	Nm3/hr	5 724	5 746	5 747	5 624	5 757	5 588	5 542	5 371	5 637	5 759	5 509	5 541
F2 gas flow rate	Nm3/hr	7 466	6 962	7 116	7 433	7 539	7 456	7 385	6 855	7 699	7 574	7 491	7 402
Average flow rate from both furnaces	Nm3/hr	13 190	12 708	12 863	13 057	13 296	13 044	12 926	12 226	13 336	13 333	13 000	12 943

F1 FOU	%	78%	87%	82%	85%	88%	90%	87%	77%	52%	89%	87%	89%
F2 FOU	%	84%	84%	80%	82%	85%	87%	72%	19%	78%	89%	88%	84%
Check - F1		3 310 185	3 488 371	3 508 567	3 447 412	3 782 488	3 616 987	3 567 754	3 059 652	2 108 623	3 825 254	3 432 209	3 676 087
Check - F2		4 653 261	4 046 457	4 260 672	4 366 785	4 778 897	4 675 310	3 966 581	968 761	4 316 447	4 987 964	4 753 767	4 603 739
Check - OVERALL		-10 448	420 172	7 953	-20 159	-90 540	-62 642	-93 412	-133 637	-61 305	-200 141	-229 096	-184 234
Gas Calorific Value													
Reduction in gas flow rate	%	0	0	0	0	0	0	0	0	0	0	0	0
Gas calorific value	GJ/hr	147	141	143	145	148	145	144	136	148	148	144	144
Energy content of gas	MJ/Nm3	11	10	11	11	11	11	11	11	11	11	11	11

GAS CALCULATIONS 2009

		Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09
		31	28	31	30	31	30	31	31	30	31	30	31

FURNACES

Furnace 1													
Power setpoint	MW	25	25	25	25	25	25	25	25	25	25	25	25
Maintenance work	type	N	N	N	N	N	N	N	N	N	N	N	N
Feed on utilisation	%	86%	83%	66%									
Load factor	%	100%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Days off line for major maintenance	days	-	-	-	-	-	-	-	-	-	-	-	-
Iron tapped	tons	4 297	3 658	3 155	-	-	-	-	-	-	-	-	-
Electrical energy consumption	MWh	16 771	14 548	12 883	-	-	-	-	-	-	-	-	-
Anthracite consumption	tons	1 653	1 448	1 294	-	-	-	-	-	-	-	-	-
Electrode consumption	tons	54	54	43	-	-	-	-	-	-	-	-	-
Average power	MW	22	21	17	-	-	-	-	-	-	-	-	-
Furnace 2													
Power setpoint	MW	35	35	35	35	35	35	35	35	35	35	35	35
Maintenance work	type	N	N	N	N	N	N	N	N	N	N	N	N
Feed-on utilisation	%	86%	84%	83%	83%	81%	87%	85%	87%	91%	85%	86%	82%
Load factor	%	100%	100%	100%	100%	100%	100%	100%	100%	100%	90%	96%	100%
Days off line for major maintenance	days	-	-	-	-	-	-	-	-	-	-	-	-
Iron tapped	tons	5 952	5 082	5 528	5 383	5 520	5 790	5 747	6 035	6 165	5 274	5 525	5 592

Electrical energy consumption	MWh	22 640	19 797	21 585	21 186	21 365	22 311	22 251	22 995	23 302	19 738	20 816	21 407
Anthracite consumption	tons	2 299	2 020	2 176	2 130	2 151	2 219	2 236	2 363	2 384	1 991	2 121	2 188
Electrode consumption	tons	71	65	72	75	72	76	83	90	81	77	66	66
Average power	MW	30	29	29	29	28	30	30	31	32	27	29	29

GAS GENERATION

Furnace 1													
Carbon in anthracite & electrodes	t	1 538	1 354	1 205	-	-	-	-	-	-	-	-	-
Carbon in tapped iron	t	99	84	73	-	-	-	-	-	-	-	-	-
Carbon in gas	t	1 439	1 270	1 132	-	-	-	-	-	-	-	-	-
CO in gas	t	3 357	2 961	2 641	-	-	-	-	-	-	-	-	-
CO in gas	Nm3	2 686 198	2 369 867	2 113 210	-	-	-	-	-	-	-	-	-
Gas produced	Nm3	3 679 723	3 246 394	2 894 808	-	-	-	-	-	-	-	-	-
Gas flow rate	Nm3/hr	5 458	5 551	5 589	-	-	-	-	-	-	-	-	-
Slag tapped		6 747	5 891	5 162	-	-	-	-	-	-	-	-	-
Furnace 2													
Carbon in anthracite & electrodes	t	2 136	1 879	2 026	1 988	2 004	2 069	2 090	2 211	2 222	1 864	1 971	2 031
Carbon in tapped iron	t	137	117	127	124	127	133	132	139	142	121	127	129
Carbon in gas	t	1 999	1 762	1 899	1 864	1 877	1 936	1 958	2 072	2 080	1 742	1 844	1 902
CO in gas	t	4 662	4 110	4 429	4 347	4 376	4 515	4 567	4 832	4 851	4 064	4 301	4 437
CO in gas	Nm3	3 730 763	3 289 297	3 544 028	3 478 531	3 502 181	3 613 073	3 654 489	3 867 009	3 881 702	3 251 985	3 442 114	3 550 553
Gas produced	Nm3	4 941 409	4 356 685	4 694 077	4 607 325	4 638 650	4 785 527	4 840 383	5 121 867	5 141 327	4 307 265	4 559 092	4 702 720
Gas flow rate	Nm3/hr	7 486	7 548	7 459	7 459	7 447	7 357	7 461	7 640	7 568	7 485	7 512	7 535
Slag tapped		9 343	8 174	8 910	8 622	9 027	9 227	9 333	9 502	9 520	8 506	8 763	9 079
Furnaces Combined													
Gas produced	Nm3	8 621 132	7 603 079	7 588 885	4 607 325	4 638 650	4 785 527	4 840 383	5 121 867	5 141 327	4 307 265	4 559 092	4 702 720
Gas flow rate	Nm3/hr	12 944	13 099	13 049	7 459	7 447	7 357	7 461	7 640	7 568	7 485	7 512	7 535
Gas Users													
Anthracite burner	Nm3	130 407	114 450	114 508	70 303	70 982	73 238	73 796	77 969	78 686	65 695	69 989	72 196
Proposed slag plant burner	Nm3	-	-	-	-	-	-	-	-	-	-	-	-
Available Gas													

Gas available for electricity generation	Nm3	8 490 725	7 488 629	7 474 377	4 537 022	4 567 668	4 712 288	4 766 587	5 043 898	5 062 641	4 241 569	4 489 103	4 630 524
Average Gas Flow Rate													
(F1 gas minus gas users)	Nm3	3 549 316	3 131 944	2 780 300	-70 303	-70 982	-73 238	-73 796	-77 969	-78 686	-65 695	-69 989	-72 196
(F2 gas minus gas users)	Nm3	4 811 001	4 242 235	4 579 569	4 537 022	4 567 668	4 712 288	4 766 587	5 043 898	5 062 641	4 241 569	4 489 103	4 630 524
F1 gas flow rate	Nm3/hr	5 458	5 551	5 589	-	-	-	-	-	-	-	-	-
F2 gas flow rate	Nm3/hr	7 437	7 484	7 426	7 495	7 483	7 392	7 498	7 677	7 604	6 734	7 232	7 571
Average flow rate from both furnaces	Nm3/hr	12 895	13 035	13 015	7 495	7 483	7 392	7 498	7 677	7 604	6 734	7 232	7 571
F1 FOU	%	86%	83%	66%	0%	0%	0%	0%	0%	0%	0%	0%	0%
F2 FOU	%	86%	84%	83%	83%	81%	87%	85%	87%	91%	85%	86%	82%
Check - F1		3 511 751	3 106 575	2 763 077	-	-	-	-	-	-	-	-	-
Check - F2		4 760 878	4 242 235	4 564 653	4 503 359	4 495 655	4 609 893	4 733 754	4 985 371	4 986 661	4 241 569	4 489 103	4 628 861
Check - OVERALL		-218 096	-139 819	-146 647	-33 663	-72 013	-102 395	-32 833	-58 527	-75 980	-	-	-1 663
Gas Calorific Value													
Reduction in gas flow rate	%	0	0	0	-0	-0	-0	-0	-0	-0	0	0	-0
Gas calorific value	GJ/hr	143	145	145	85	85	84	85	87	86	76	82	86
Energy content of gas	MJ/Nm3	11	11	11	11	11	11	11	11	11	10	11	11

GAS CALCULATIONS 2010

		Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10
		31	28	31	30	31	30	31	31	30	31	30	31

FURNACES

Furnace 1													
Power setpoint	MW	25	25	25	25	25	25	25	25	25	25	25	25
Maintenance work	type	N	N	N	N	N	N	N	N	N	N	N	N
Feed on utilisation	%					41%	85%	91%	91%	88%	90%	89%	79%
Load factor	%	0%	0%	0%	0%	97%	100%	100%	100%	100%	100%	100%	100%
Days off line for major maintenance	days	-	-	-	-	-	-	-	-	-	-	-	-
Iron tapped	tons	-	-	-	-	5 497	3 867	4 590	4 639	4 660	4 863	4 585	4 067

Electrical energy consumption	MWh					7 459	15 433	17 482	17 708	17 996	18 208	17 995	16 593
Anthracite consumption	tons	-	-	-	-	713	1 560	1 771	1 834	1 765	1 879	1 760	1 593
Electrode consumption	tons	-	-	-	-	32	56	58	54	53	55	58	55
Average power	MW	-	-	-	-	10	21	23	23	22	22	22	20
Furnace 2													
Power setpoint	MW	35	35	35	35	35	35	35	35	35	35	35	35
Maintenance work	type	N	N	N	N	N	N	N	N	N	N	N	N
Feed-on utilisation	%	88%	87%	86%	82%		52%	32%	90%	82%	88%	87%	80%
Load factor	%	100%	100%	98%	100%	0%	95%	94%	74%	84%	88%	89%	88%
Days off line for major maintenance	days	-	-	-	-	-	-	-	-	-	-	-	-
Iron tapped	tons	6 188	5 345	5 938	5 389	-	2 953	1 972	4 505	4 521	5 415	5 044	4 807
Electrical energy consumption	MWh	23 019	20 436	21 860	20 504	-	12 477	7 850	17 299	17 396	20 101	19 376	18 336
Anthracite consumption	tons	2 386	2 100	2 269	2 142	-	1 209	736	1 763	1 754	2 049	1 966	1 869
Electrode consumption	tons	70	62	68	71	-	54	31	53	55	62	58	56
Average power	MW	31	30	29	28	-	17	11	23	24	27	27	25

GAS GENERATION

Furnace 1													
Carbon in anthracite & electrodes	t	-	-	-	-	671	1 457	1 649	1 701	1 638	1 743	1 639	1 485
Carbon in tapped iron	t	-	-	-	-	126	89	106	107	107	112	105	94
Carbon in gas	t	-	-	-	-	544	1 368	1 543	1 595	1 531	1 631	1 533	1 392
CO in gas	t	-	-	-	-	1 269	3 190	3 600	3 719	3 571	3 803	3 576	3 246
CO in gas	Nm3	-	-	-	-	1 015 703	2 552 695	2 880 556	2 976 227	2 857 366	3 043 469	2 861 722	2 597 383
Gas produced	Nm3	-	-	-	-	1 391 373	3 496 842	3 945 967	4 077 023	3 914 200	4 169 136	3 920 167	3 558 059
Gas flow rate	Nm3/hr	-	-	-	-	4 640	5 636	5 615	5 727	5 410	5 696	5 419	5 334
Slag tapped		-	-	-	-	2 394	6 263	6 992	6 859	6 705	7 201	6 844	6 438
Furnace 2													
Carbon in anthracite & electrodes	t	2 214	1 949	2 106	1 995	-	1 138	691	1 636	1 630	1 903	1 824	1 735
Carbon in tapped iron	t	142	123	137	124	-	68	45	104	104	125	116	111
Carbon in gas	t	2 072	1 826	1 970	1 871	-	1 070	646	1 533	1 526	1 779	1 708	1 625
CO in gas	t	4 832	4 258	4 593	4 363	-	2 495	1 507	3 574	3 559	4 148	3 984	3 790
CO in gas	Nm3	3 866 887	3 407 453	3 675 657	3 491 233	-	1 996 915	1 205 600	2 860 287	2 848 355	3 319 481	3 188 206	3 032 587
Gas produced	Nm3	5 121 705	4 513 183	4 868 420	4 624 149	-	2 644 921	1 596 821	3 788 460	3 772 655	4 396 664	4 222 790	4 016 671

Gas flow rate	Nm3/hr	7 632	7 575	7 639	7 736	-	7 271	6 977	7 512	7 439	7 502	7 475	7 514
Slag tapped		9 513	8 466	9 153	8 583	-	4 706	2 874	6 820	6 748	8 084	7 920	7 555
Furnaces Combined													
Gas produced	Nm3	5 121 705	4 513 183	4 868 420	4 624 149	1 391 373	6 141 762	5 542 788	7 865 483	7 686 856	8 565 800	8 142 957	7 574 730
Gas flow rate	Nm3/hr	7 632	7 575	7 639	7 736	4 640	12 908	12 591	13 239	12 849	13 198	12 894	12 848
Gas Users													
Anthracite burner	Nm3	78 751	69 314	74 862	70 691	23 516	91 362	82 751	118 687	116 101	129 618	122 966	114 269
Proposed slag plant burner	Nm3	-	-	-	-	-	-	-	-	-	-	-	-
Available Gas													
Gas available for electricity generation	Nm3	5 042 954	4 443 869	4 793 558	4 553 458	1 367 857	6 050 401	5 460 036	7 746 796	7 570 755	8 436 182	8 019 991	7 460 461
Average Gas Flow Rate													
(F1 gas minus gas users)	Nm3	-78 751	-69 314	-74 862	-70 691	1 367 857	3 405 480	3 863 216	3 958 336	3 798 099	4 039 518	3 797 201	3 443 790
(F2 gas minus gas users)	Nm3	5 042 954	4 443 869	4 793 558	4 553 458	-23 516	2 553 559	1 514 069	3 669 773	3 656 554	4 267 046	4 099 824	3 902 403
F1 gas flow rate	Nm3/hr	-	-	-	-	4 640	5 636	5 615	5 727	5 410	5 696	5 419	5 334
F2 gas flow rate	Nm3/hr	7 668	7 611	7 531	7 754	-	6 828	6 361	5 482	6 167	6 535	6 571	6 556
Average flow rate from both furnaces	Nm3/hr	7 668	7 611	7 531	7 754	4 640	12 465	11 976	11 209	11 577	12 231	11 990	11 889
F1 FOU	%	0%	0%	0%	0%	41%	85%	91%	91%	88%	90%	89%	79%
F2 FOU	%	88%	87%	86%	82%	0%	52%	32%	90%	82%	88%	87%	80%
Check - F1		-	-	-	-	1 431 308	3 450 290	3 812 558	3 857 812	3 444 750	3 801 186	3 460 387	3 126 679
Check - F2		5 035 000	4 426 047	4 793 558	4 553 458	-	2 553 559	1 514 069	3 669 773	3 656 554	4 267 046	4 099 824	3 902 403
Check - OVERALL		-7 954	-17 823	-	-	63 451	-46 552	-133 409	-219 211	-469 450	-367 949	-459 780	-431 380
Gas Calorific Value													
Reduction in gas flow rate	%	-0	-0	0	-0	-	0	0	0	0	0	0	0
Gas calorific value	GJ/hr	87	86	85	88	50	138	133	124	129	136	133	132
Energy content of gas	MJ/Nm3	11	11	11	11	11	11	11	9	10	10	10	10

Annex 4

MONITORING INFORMATION

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