PROJECT DESIGN DOCUMENT FORM
FOR CDM PROJECT ACTIVITIES (F-CDM-PDD)
Version 04.1

PROJECT DESIGN DOCUMENT (PDD)

Title of the project activity	Market Coke Waste Heat Recovery Project
Version number of the PDD	V01.3
Completion date of the PDD	25 January 2012 (V01) 19 July 2012 (V01.1) 30 November 2012 (V01.2) 26 June 2013 (V01.3)
Project participant(s)	Exxaro Resources Limited (Exxaro)
Host Party(ies)	Republic of South Africa
Sectoral scope and selected methodology(ies)	**Sectoral scope:** Sectoral Scope 01 Energy industries (renewable - / non-renewable sources) and Sectoral Scope 04 Manufacturing industries **Selected methodology:** ACM0012: Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects (ACM0012 / Version 04.0.0, Sectoral Scopes: 01 and 04, EB 60)
Estimated amount of annual average GHG emission reductions	414 032 tonnes of carbon dioxide equivalent (tCO_2e)

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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Exxaro Resources Limited (Exxaro) plans to construct the Market Coke Plant (the project facility) at their Grootegeluk Coal Mine (the recipient facility) in the Limpopo Province of South Africa. The Bankable Feasibility Study (BFS) for the project facility is underway and the potential to generate electricity from waste heat recovered in the Market Coke Waste Heat Recovery Plant (the project activity) is being investigated through the completion of a Pre-feasibility Study (PFS)[1]. The project activity and the project facility will independently seek approval from Exxaro's Board of Directors due to the need for carbon revenue for the project activity (see section B.5. below)[1].

The purpose of the project activity is to utilise waste heat recovered from the coke oven flue gas (waste gas, off-gas) after tertiary combustion, produced as part of the coking pyrolysis process in the project facility to produce electricity. During the coking pyrolysis process, coal from the Grootegeluk Coal Mine is heated in coke ovens in the absence of oxygen (air), driving off volatile matter in the coal to produce market coke. Large volumes of hot coke oven flue gases are produced in the coking pyrolysis process and these hot waste gases contain energy in the form of waste heat which can be recovered. In the project activity, steam is produced in waste heat recovery boilers (WHRB) using the waste heat recovered from the hot coke oven flue gas after tertiary combustion. The steam is expanded through turbines to produce mechanical energy used to drive alternators to produce electricity.

The project activity is expected to have a gross installed capacity of 60 MW and the objective of the project activity is to supply the majority of the electricity produced, 462 000 MWh/yr, to the internal grid of the Grootegeluk Coal Mine (with the potential to also export excess electricity to the South African grid) thereby displacing more carbon intensive electricity from the South African national grid operated by Eskom (the current situation and baseline – see section B.4. below) and therefore also lessening the burden on the national grid. Additionally, the project activity is expected to result in greenhouse gas (GHG) emissions reductions of approximately 414 032 tCO_2e/yr, with a total of approximately 4 140 321 tCO_2e over the ten year crediting period. The baseline or business as usual practice would be to combust the hot coke oven flue gases in flue gas ducts (tertiary combustion) and vent the waste heat to atmosphere and continue to source electricity from the Eskom grid (see section B.4. below).

The project facility and the project activity make important and noteworthy contributions to the sustainable development of South Africa[2], [3]. The project activity displaces the carbon intensive electricity of the national grid and is expected to result in GHG emissions reductions of approximately 414 032 tCO_2e/yr.

The project activity and project facility will be located at the existing Grootegeluk Coal Mine on the farm Daarby 458 LQ, approximately 25 km west of the town of Lephalale (formerly Ellisras), in the Limpopo Province of South Africa. Since the project activity will be located within the existing Grootegeluk Coal Mine, the project activity will not affect local or regional biodiversity. The proposed project activity site is located on an area currently utilised as a construction lay-down area within the mine, and as such will not affect "greenfields" sites on the mine further mitigating the disturbance of ecosystems and biodiversity.

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[1] Exxaro, 2012a.

[2] Department of Energy (DOE), 2011. Designated National Authority (DNA) Letter Of No Objection (LONO).

[3] DOE, 2012. DNA Letter of Approval.

Approximately 275 direct jobs will be created during the operational lifetime of the project facility and the project activity, with more jobs expected to be created during the construction phase[4].

Additionally, as described in sections D.1. and D.2. below, the scoping phase of the environmental impact assessment (EIA) process has identified potential environmental impacts and has outlined the approved plan of study for the EIA[5, 6]. Moreover, the project's environmental impacts will be assessed and appropriate mitigation measures will be identified and implemented in the project's design and operation[4].

A.2. Location of project activity
A.2.1. Host Party(ies)
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Country: Republic of South Africa.

A.2.2. Region/State/Province etc.
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Province: Limpopo Province.

A.2.3. City/Town/Community etc.
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Town/ City: Lephalale (formerly Ellisras).
Municipality: Lephalale Local Municipality, within the Waterberg District Municipality.

A.2.4. Physical/Geographical location
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The project activity will be located at the existing Grootegeluk Coal Mine on the farm Daarby 458 LQ, approximately 25 km west of the town of Lephalale (formerly Ellisras), in the Limpopo Province of South Africa.

Figure 1 below provides the location of the Grootegeluk Coal Mine, where the project activity will be located, while Figure 2 provides the location of the project activity within the boundaries of the Grootegeluk Coal Mine. The coordinates for the project are: 23.6453° Degrees South and 27.5544° Degrees East and refer to point R9 of Figure 3 below, the preliminary site layout diagram.

[4] Synergistics, 2012. Market Coke Plant and Co-generation Plant - Draft Environmental Scoping Report.
[5] Limpopo Department of Economic Development, Environment & Tourism (LEDET), 2011.
[6] LEDET, 2012.

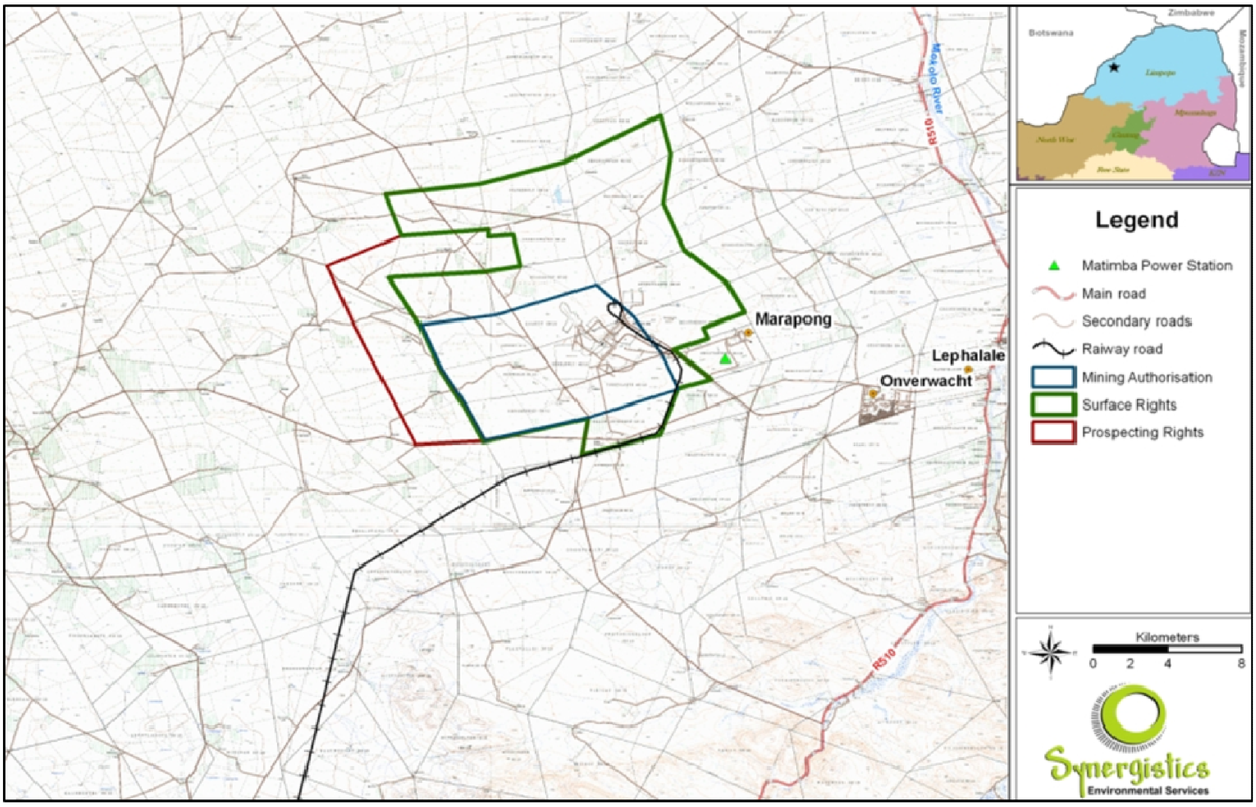

Figure 1: Location of the Grootegeluk Coal Mine in the Limpopo Province of South Africa (Source: Synergistics, 2012[4]).

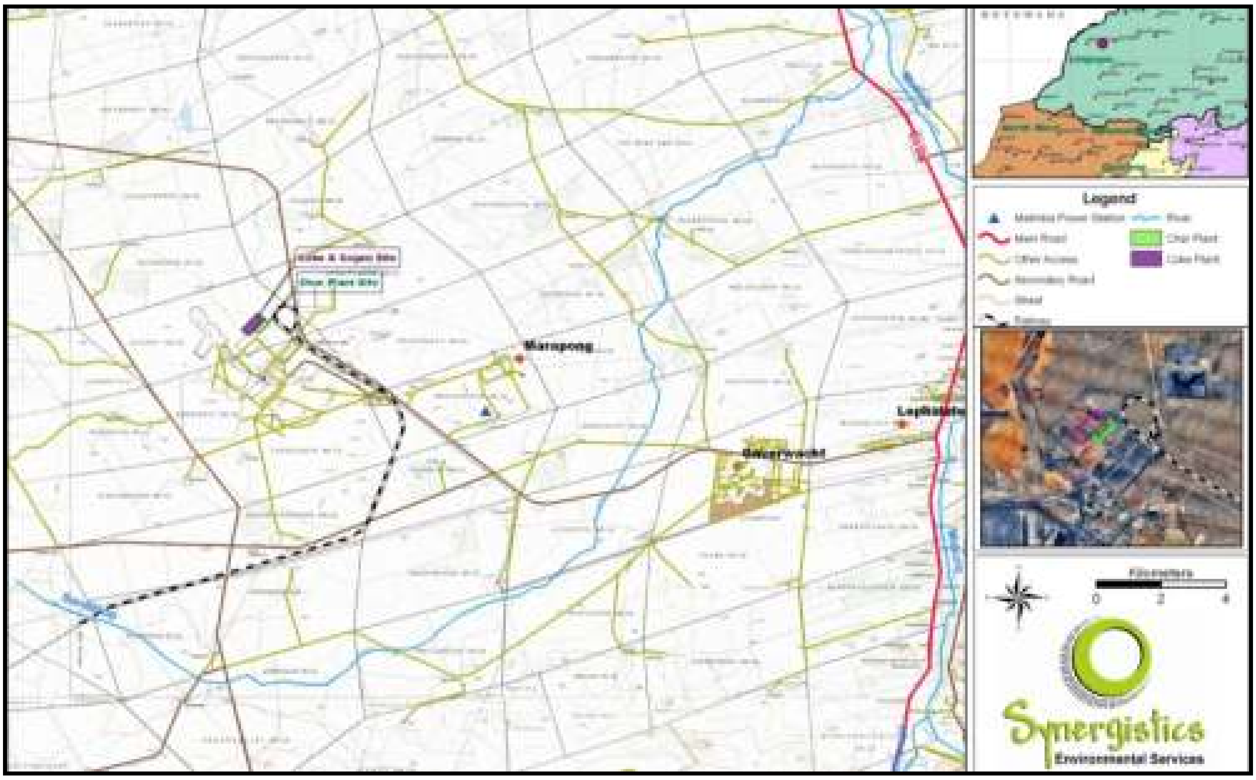

Figure 2: Location of the Market Coke Waste Heat Recovery Plant within the Grootegeluk Coal Mine (Source: Synergistics, 2012[4]).

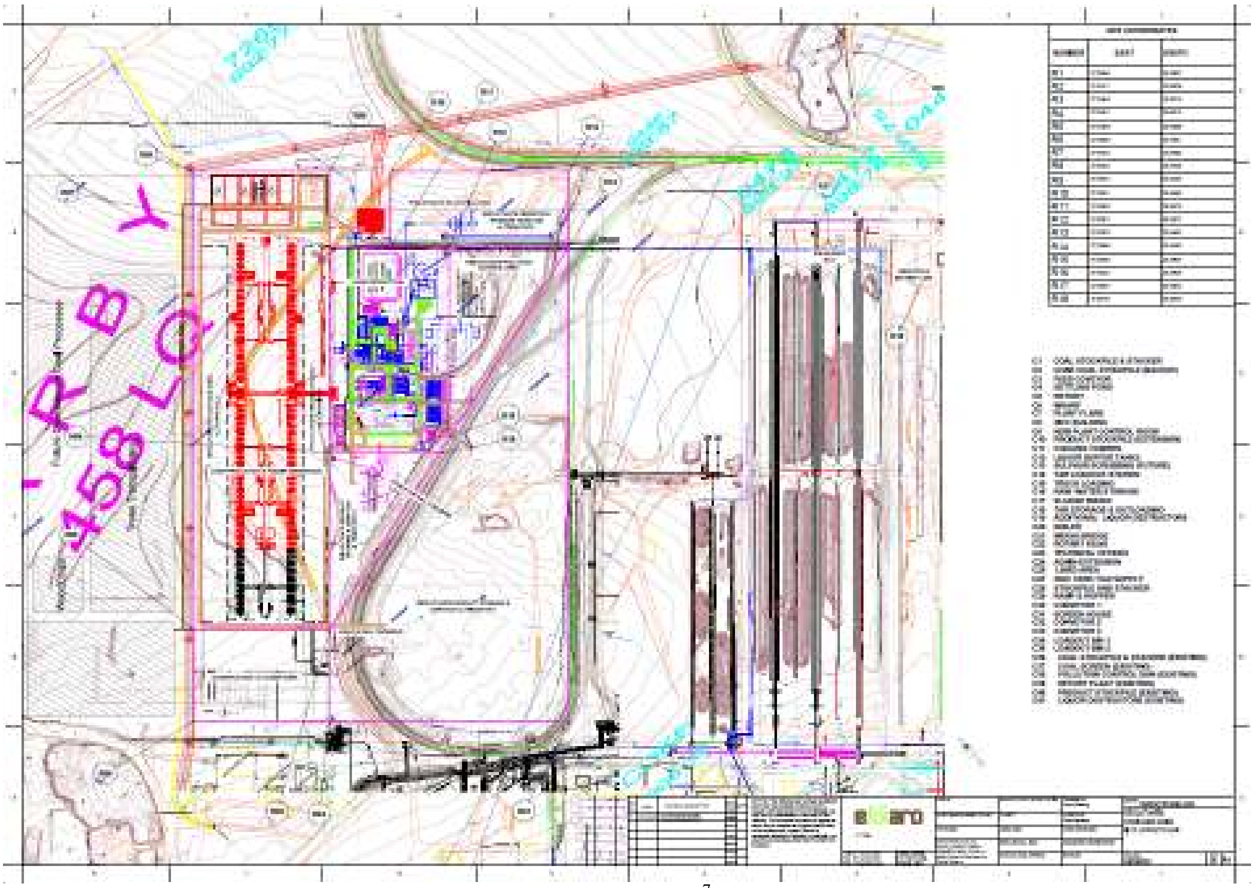

Figure 3: Preliminary site layout diagram (Source: Exxaro, 2012b[7]).

A.3. Technologies and/or measures

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The project activity will use standard technology and equipment to recover the waste heat from the hot coke oven flue gas after tertiary combustion, incorporating the gas system, WHRB, a standard steam system with turbines, generators, switchgear and control systems. A simplified process flow diagram for the project activity is provided in Figure 4 below.

[7] Exxaro, 2012b.

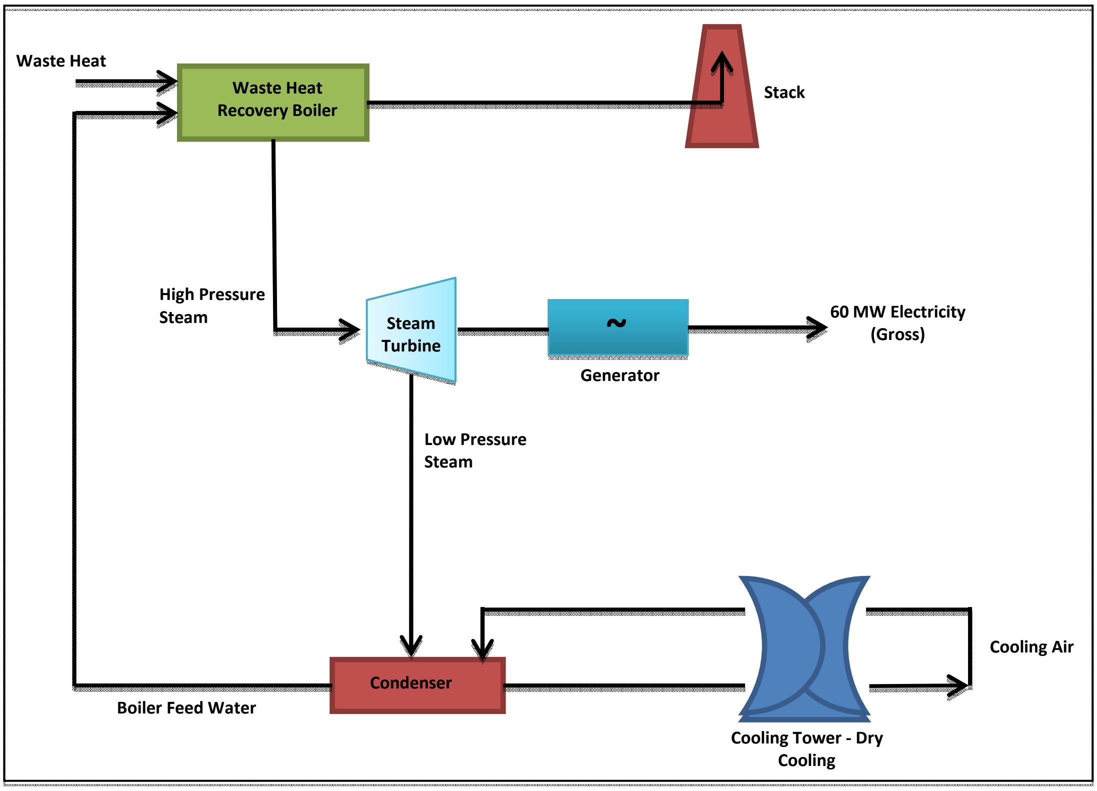

Figure 4: Simplified process flow diagram for the Market Coke Waste Heat Recovery Plant

As can be seen from Figure 4 above, waste heat from the tertiary combustion of the coke oven flue gas from the project facility enters the project activity at the WHRB where it is used to raise steam for use in the steam turbine. The steam is expanded through the turbine driving a shaft connected to the generator producing approximately 462 000 MWh/yr electricity. The project activity's expected plant load factor is 96%[8]. The plant load factor has been determined by an independent engineering company[8] and is in line with the "*Guidelines for the Reporting and Validation of Plant Load factors (Version 01, EB 48, Annex 11)*" specifically Paragraph 3b which states that "The plant load factor shall be defined ex-ante in the CDM-PDD according to one of the following three options: (b) The plant load factor determined by a third party contracted by the project participants (e.g. an engineering company);" as is the case with the proposed project activity.

The technology employed is mature and the equipment is available from a large number of manufacturers and is to a large extent interchangeable. The only deviation from the standard is that the project activity will utilize dry (air) cooling technology as opposed to a conventional wet cooling technology and system, as a result of the general water shortage in the region thereby enhancing its sustainable development and environmental benefits (even though the wet cooling technology and system would be cheaper and would also allow the generation of more power)[8, 9]. However, although the technology utilised is considered to be standard and mature technology, the use of this technology in the coke manufacturing process is considered to be first of its kind in South Africa, as demonstrated in section B.5. below.

The project boundary includes the proposed Market Coke Plant as the project facility, containing the coke ovens where the coke oven gas (COG) and coke oven flue gas (COFG) is generated after tertiary combustion of the COG and the associated and co-located Market Coke Waste Heat Recovery Plant (the

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[8] Engineering and Projects Company (E&PC), 2011.Exxaro Energy Coke Waste Heat Recovery Project: Process Design Criteria.

[9] E&PC, 2011. Exxaro Energy Coke Waste Heat Recovery Project: Process Concept Design.

project activity) containing the gas distribution system, WHRB, steam system with turbines, generators (alternators), switchgear, control systems and ancillary equipment[10].

The South African national electricity grid operated by Eskom which currently supplies electricity to the Grootegeluk Coal Mine prior to the project activity, shall also form part of the project boundary for the purposes of determining the baseline. The baseline (see section B.4 below) is the continuation of the status quo whereby the Grootegeluk Coal Mine's electricity is supplied from the South African national grid and the usual practice for the project facility would be to combust and vent the COG and COFG emitted from the coke ovens.

Emissions which fall outside of the project boundary, include the ongoing mining operations at the Grootegeluk Coal Mine as well as the operation of the project facility. The project activity will result in the displacement of GHG intensive electricity supplied from the South African national grid and will therefore target carbon dioxide (CO_2) reductions. Figure 5 and Figure 6 below provide a detailed process flow diagram delineating the project activity.

[10] E&PC, 2011. Exxaro Energy Coke Waste Heat Recovery Project: Equipment List.

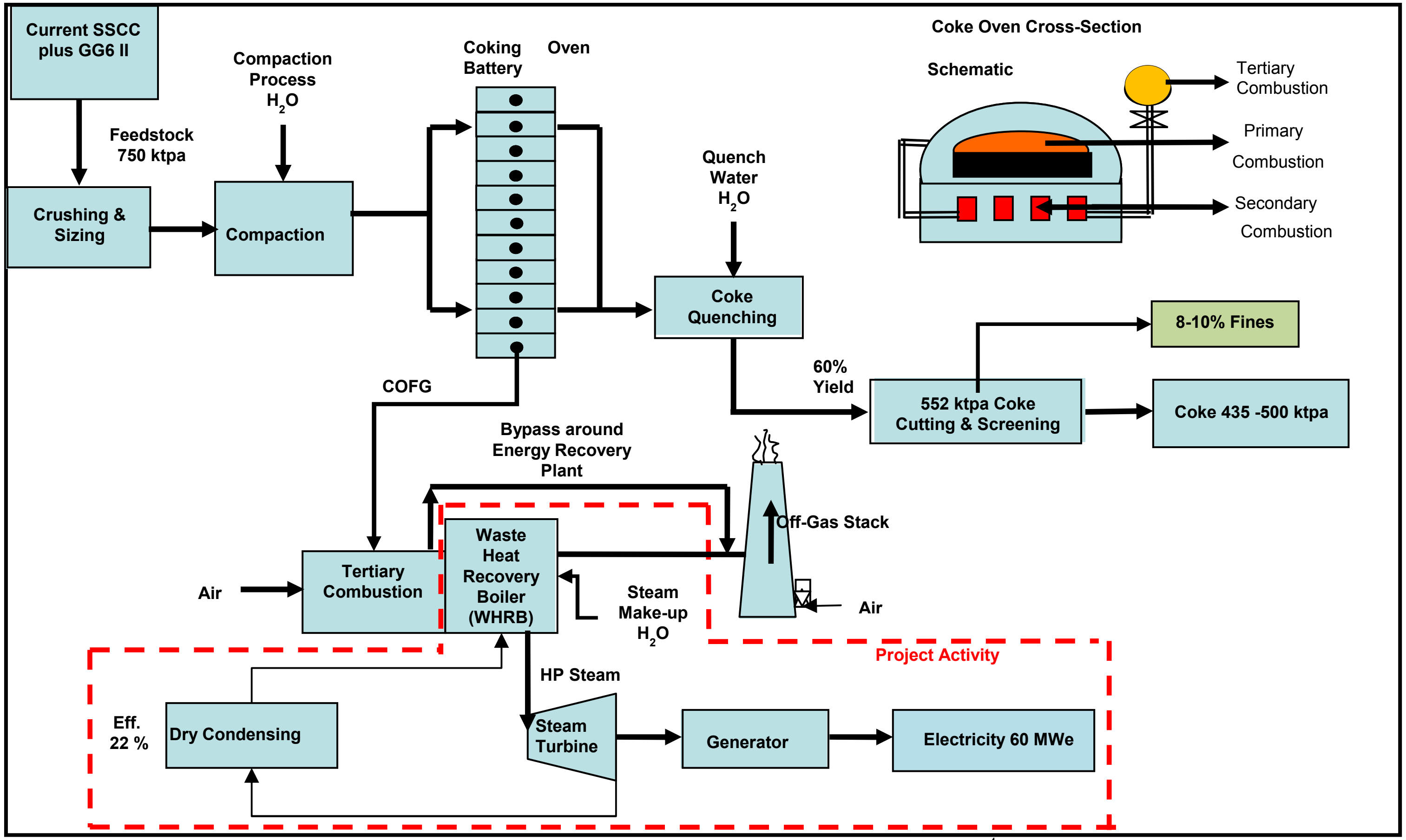

Figure 5: Detailed process flow diagram delineating the project activity (Source: Synergistics, 2012[4])

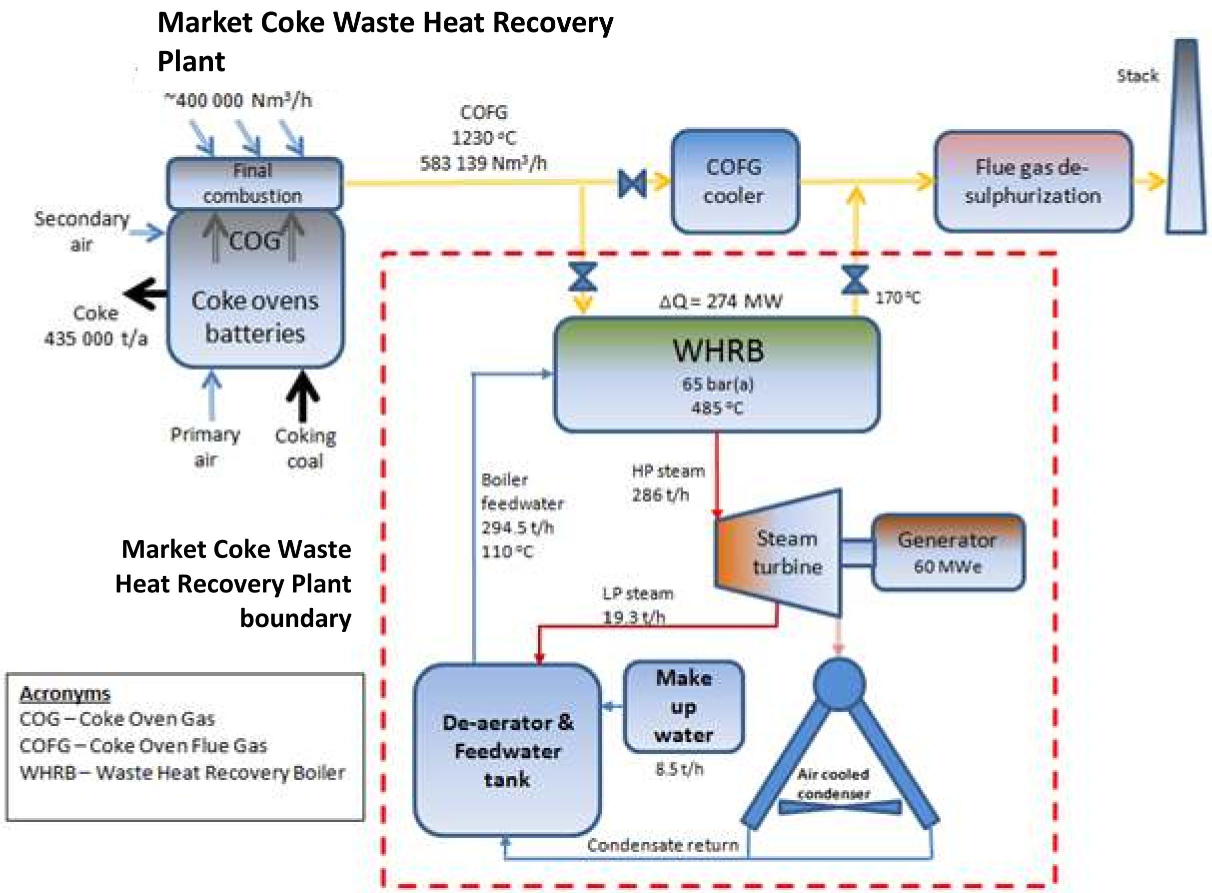

Figure 6: Detailed process flow diagram showing primary, secondary and tertiary combustion (Source: E&PC, 2011[11])

[11] E&PC, 2011. Exxaro Energy Coke Waste Heat Recovery Project: Energy and Material Balance.

Project facility process description
Semi-soft coking coal (SSCC) is conveyed from coal stockpiles within the existing Grootegeluk Coal Mine and stored in concrete silos and coal storage bins (hoppers). The SSCC is crushed and sized before compaction, where it is loaded from a hopper into a compacting box. Hydraulic compaction will be used which involves the compression of the SSCC layers from the top by a hydraulically activated compression plate. Water is added during compaction to increase the strength of the resulting coal cake[4].

The shaped and compacted coal cake is then loaded onto charging / pushing cars and is "charged" (fed) into the coke ovens. Once in the coke oven, the pyrolysis process begins through the combustion of the volatile gases which are released from the coal cake during heating. This is where the coke ovens make available the waste heat after tertiary combustion of the COG and COFG for utilisation in the project activity[4].

Primary air is introduced, mainly through ports in the coke oven doors, to initiate the partial combustion reaction that provides the heat to liberate the first volatiles from the coal (primary combustion). This partially combusted gas is drawn into channels in the oven floor where secondary combustion air is added which oxidizes most of the volatiles to provide sustained heat for the coking process (secondary combustion). The amount of secondary air added in controlled to regulate the oven temperature and is sub-stoichiometric to prevent overheating. The final flue gas leaving the coke oven via the overhead ducts, thus still contains combustible components (CO and H_2 gas) which is oxidized (for safety and environmental reasons) by the addition of tertiary combustion air, in excess of the stoichiometric requirement, outside the oven (tertiary combustion)[11].

As can be seen from the figure below, from the ducts below the coke oven floor, the hot coke oven gases are drawn into the flues that run across the length of the coke oven battery. Tertiary combustion of the hot coke oven flue gases takes place within the flues as air is fed in. The waste heat is transported along the flues, before the waste heat is recovered in the WHRB for use in the project activity.

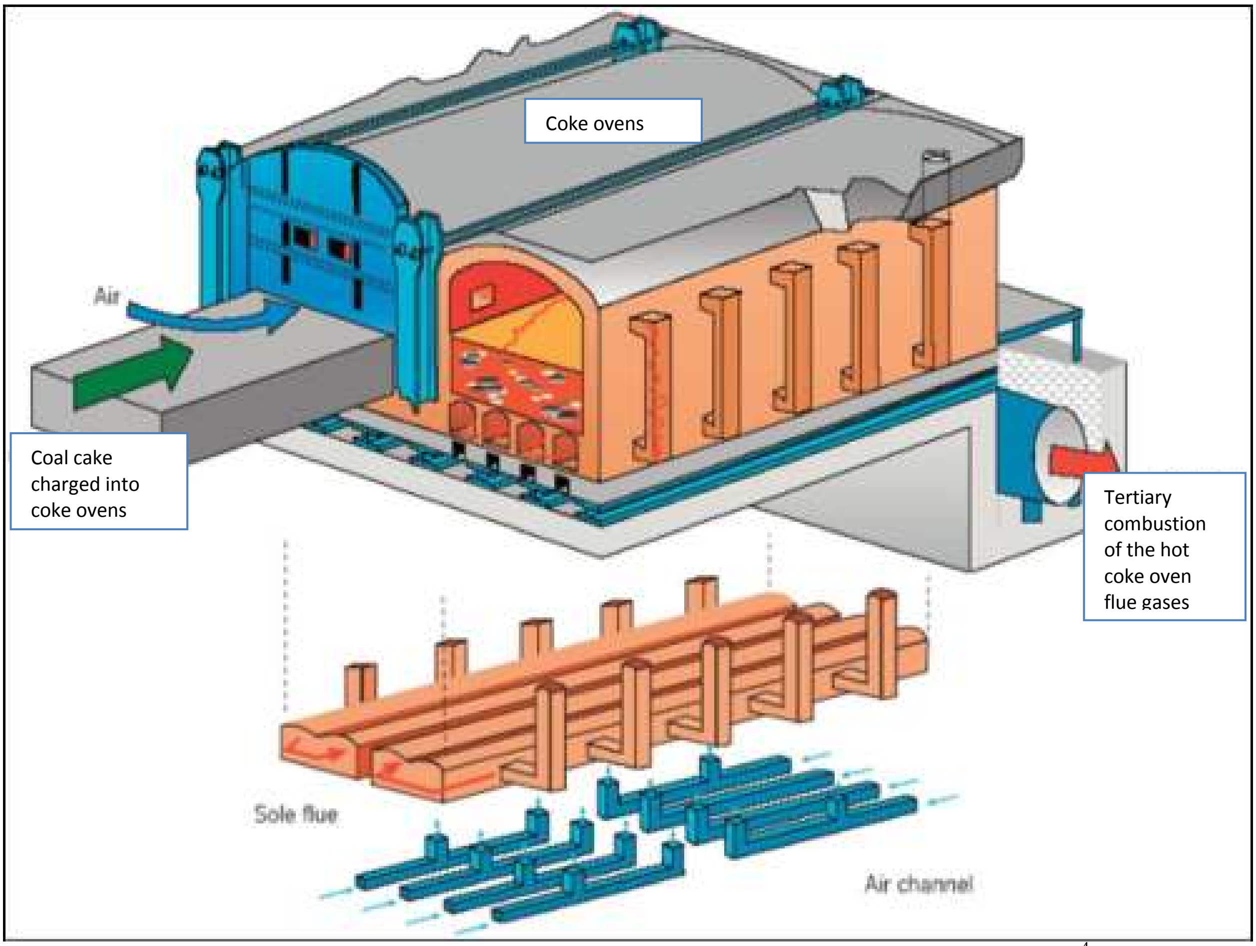

Figure 7: Schematic example of coke ovens and coking pyrolysis process (Source: Synergistics, 2012[4])

Project activity process description

As mentioned previously and as can be seen from Figure 5 and Figure 6 above, the battery limit between the project facility and the project activity is the point at which the hot COFG, after tertiary combustion, enters the WHRB. The expected thermodynamic conditions, including temperature and flow rate, of the waste heat is given in the table below.

Table 1: Waste heat conditions at WHRB inlet and outlet[11]

Description	**Value**	**Unit**
Inlet		
Flow rate	583 139	Nm^3/hr
Temperature	1 230	°C
Energy Available	274	MW
Outlet		
Flow rate	583 139	Nm^3/hr
Temperature	170	°C

The thermodynamic cycle for the project activity is the "Rankine cycle". The cycle is the basis for conventional power generating stations and consists of a steam source such as the WHRB which will utilise the waste heat from the tertiary combustion of the COFG at an approximate temperature of 1 230°C to convert water to high-pressure steam. In the steam cycle, water is first pumped into the WHRB at medium to high pressure. It is then heated utilising the waste heat to the boiling temperature in the range of 480°C to 540°C, depending on the pressure[11].

The pressurised steam is then expanded through a multi-stage turbine to a lower steam pressure and exhausted to a condenser at vacuum conditions. An extraction condensing turbine will be utilised. The rotational energy generated, is transferred by the turbine output shaft to the generator which generates electricity. The condensate from the condenser returns to the feed water pumps for further use and continuation of the cycle. The anticipated technical parameters for major equipment utilised in the project activity are provided in the table below.

Table 2: Anticipated technical parameters of major equipment[11]

Waste Heat Recovery Boilers (WHRBs)	**Turbine and generator units**
Units: 4	Units: 2
Boiler thermal efficiency (estimated): 85% (to be confirmed (tbc))	Steam temperature at turbine inlet (estimated): 480˚C (tbc)
Blowdown (estimated): 3% (tbc)	Steam pressure at turbine inlet (estimated): 65 Bar (tbc)
Steaming capacity per boiler (estimated): 286 t/hr (to be confirmed (tbc))	Specific steam consumption (overall) (estimated): 4.76kg/kW
Feedwater temperature (estimated): 110˚C (tbc)	Turbine capacity (estimated): 30MWe (tbc)
Feedwater Pressure (a) (estimated): 81 Bar(a) (tbc)	
Boiler outlet steam temperature (estimated): 485˚C (tbc)	

The steam system includes the WHRB and turbines, ducting, pumps, piping, cladding and civil work but also associated equipment like piping, valves, electrical equipment, automation, instrumentation, de-aerators, fans, stacks, condensers, cooling towers and the water treatment plants[10].

A.4. Parties and project participants

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

A.5. Public funding of project activity

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Official Development Assistance (ODA) or public funding has not and will not be used in the development and implementation of the project activity[12].

SECTION B. Application of selected approved baseline and monitoring methodology

B.1. Reference of methodology

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The approved baseline and monitoring methodology to be employed for the project activity is:

[12] Exxaro, 2012c.

- *"ACM0012: Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects (ACM0012 / Version 04.0.0, Sectoral Scopes: 01 and 04, EB 60)"*[13]

Relevant methodological tools utilised include:

- *"Tool to calculate the emission factor for an electricity system (Version 2.2.1, EB 63, Annex 19)"*[14];
- *"Tool for the demonstration and assessment of additionality (Version 6.1.0, EB 69), Annex 21)"*[14];

The relevant scope and applicability criteria of the tools are assessed and demonstrated for use in the tables below.

Table 3: Scope and applicability criteria analysis of the Tool to calculate the emission factor for an electricity system (Version 2.2.1, EB 63, Annex 19)

Tool scope and applicability criteria	Applicability of tool for use in the project activity
This methodological tool determines the CO_2 emission factor for the displacement of electricity generated by power plants in an electricity system, by calculating the "combined margin" emission factor (CM) of the electricity system. The CM is the result of a weighted average of two emission factors pertaining to the electricity system: the "operating margin" (OM) and the "build margin" (BM). The operating margin is the emission factor that refers to the group of existing power plants whose current electricity generation would be affected by the proposed CDM project activity. The build margin is the emission factor that refers to the group of prospective power plants whose construction and future operation would be affected by the proposed CDM project activity.	The project activity results in the displacement of electricity generated by power plants in the South African national grid (the electricity system) owned and operated by Eskom. As such, the tool is utilised to calculate the combined margin (CM) emissions factor of the grid. The project activity and the application of the tool thus complies with the criterion and is suitable for use.
This tool may be applied to estimate the OM, BM and/or CM when calculating baseline emissions for a project activity that substitutes grid electricity, i.e. where a project activity supplies electricity to a grid or a project activity that results in savings of electricity that would have been provided by the grid (e.g. demand-side energy efficiency projects).	The tool is utilised to estimate the OM, BM and CM of the grid for the purposes of determining the baseline emissions. The project activity substitutes grid electricity that would have otherwise supplied the recipient facility, the Grootegeluk Coal Mine. The criterion is satisfied and the tool is applicable for use.
Under this tool, the emission factor for the project electricity system can be calculated either for grid power plants only or, as an option, can include off-grid power plants. In the latter case, the conditions specified in "Annex 2 - Procedures related to off-grid power generation" should be met. Namely, the total capacity of off-grid power plants (in MW) should be at least 10% of the total capacity of grid power plants in the electricity system; or the total electricity generation by off-grid power plants (in MWh) should be at least 10% of the total electricity generation by grid power plants in the electricity system; and that factors which negatively affect the reliability and stability of the grid are primarily due to constraints in generation and not to other aspects	As can be seen from section B.6.1. below, although this step of the tool is optional, only grid power plants are included in the calculation. As such there is no requirement to meet the conditions specified in Annex 2 of the tool. The criterion is therefore satisfied and the use of the tool is applicable.

[13] Available online at: http://cdm.unfccc.int/methodologies/DB/L731WMCXLT0WE6ALG5AYAGLTJP7KW7
[14] Available online at: http://cdm.unfccc.int/Reference/tools/index.html

Tool scope and applicability criteria	Applicability of tool for use in the project activity
such as transmission capacity.	
Note that this tool is also referred to in the "Tool to calculate project emissions from electricity consumption" for the purpose of calculating project and leakage emissions in case where a project activity consumes electricity from the grid or results in increase of consumption of electricity from the grid outside the project boundary.	Project and leakage emissions are calculated according to ACM0012 as described in section B.6.1. below. The project activity does not consumer electricity from the grid and does not result in an increase of electricity from the grid outside of the project boundary. The criterion is fulfilled and the tool is applicable for use.
In case of CDM projects the tool is not applicable if the project electricity system is located partially or totally in an Annex I country.	The project electricity system comprises the South African national grid owned and operated by Eskom and is neither partially or totally located in an Annex I country. The tool is therefore applicable for use in the project activity.

Table 4: Scope and applicability criteria analysis of the Tool for the demonstration and assessment of additionality (Version 6.1.0, EB 69, Annex 20)

Tool scope and applicability criteria	Applicability of tool for use in the project activity
This tool provides for a step-wise approach to demonstrate and assess additionality. These Steps include: (a) Identification of alternatives to the project activity; (b) Investment analysis to determine that the proposed project activity is either: 1) not the most economically or financially attractive, or 2) not economically or financially feasible; (c) Barriers analysis; and (d) Common practice analysis.	The steps provided in the tool are applied and furthermore are considered to have been applied correctly, according to the requirements of the tool. The tool is therefore applicable for use since the criterion is satisfied.
Based on the information about activities similar to the proposed project activity, the common practice analysis is to complement and reinforce the investment and/or barriers analysis. The Steps are summarized in the flow-chart on page 2 of this document.	As can be seen in section B.5. below, the common practice analysis is utilised to complement the investment analysis. Furthermore the Steps are applied in accordance with the requirements of the tool and the criterion is satisfied, thereby the tool is applicable for use.
The document provides a general framework for demonstrating and assessing additionality and is applicable to a wide range of project types. Some project types may require adjustments to this general framework.	ACM0012 requires that the assessment and demonstration of additionality be carried out according to the latest version of the Tool for the demonstration and assessment of additionality, as such the tool is applied as is and no adjustments have been made to the general framework. The tool is therefore applicable for use.
This tool does not replace the need for the baseline methodology to provide a step-wise approach to identify the baseline scenario. Project participants that propose new baseline methodologies shall ensure consistency between the determination of additionality of a project activity and the determination of a baseline scenario. Project participants can also use the "Combined tool to identify the baseline scenario and demonstrate additionality", which provides a procedure for baseline scenario identification as well as additionality demonstration.	The baseline scenario has been determined in accordance with ACM0012, where realistic and credible alternatives have been identified in a step wise approach for the most plausible baseline scenario. The tool has therefore not replaced the need for the baseline methodology to provide a step-wise approach to identify the baseline scenario and is therefore applicable for use.

B.2. Applicability of methodology

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Provided in the table below is an applicability analysis of the project activity against the criteria set out in ACM0012:

Table 5: Applicability analysis of ACM0012 (Version 04.0.0, Sectoral Scopes: 01 and 04, EB 60) against the project activity

ACM0012 Applicability Criteria	Project Activity
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 process heat source; • Generation of heat in element process; • Generation of mechanical energy; or • Supply of heat of reaction with or without process heating.	The project activity is the construction and operation of the new (Greenfield) Market Coke Waste Heat Recovery Plant[8]. The project activity utilises waste heat carried in the COFG after tertiary combustion (the identified waste energy carrying medium (WECM)) produced in the greenfield Market Coke Plant (the project facility) as part of the coking pyrolysis process to generate 462 000 MWh/yr net electricity[8, 9]. The project activity subscribes to the criterion and ACM0012 is therefore suitable for use.
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. 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 (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".	In the absence of the project activity, the WECM would not be recovered and would be combusted and vented to atmosphere[15], [16]. Thus, the criterion is applicable to the project activity, and ACM0012 is suitable for use.
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.	Although the project activity produces electricity only, no waste pressure is recovered and therefore ACM0012 is applicable to the project activity[8, 9, 11].
Regulations do not require the project facility to recover and/or utilize the waste energy prior to the implementation of the project activity.	Current regulations require that the COG to be combusted before being vented to atmosphere in order to comply with environmental air quality regulations[17]. However, no South African regulations require the use of

[15] Exxaro, 2012d.
[16] Exxaro, 2012e.
[17] Department of Environmental Affairs (DEA), 2010. National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) (NEMAQA) – Government Notice No. 248 (GN 248 of 31 March 2010).

ACM0012 Applicability Criteria	Project Activity
	the waste energy[4]. The project activity subscribes to this criterion and ACM0012 is therefore suitable for use.
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.	Both the project activity and project facility are Greenfield facilities and will therefore be treated as such for further analysis in this document[1, 4, 5, 6, 8]. ACM0012 is therefore suitable for use.
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.	Under abnormal conditions (emergencies, plant shut down etc.) of either the project facility or project activity, waste energy released will not form part of the emissions reductions calculations and therefore ACM0012 is suitable for use.
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. For such situations, the guidance provided in Annex 3 shall be followed.	The only identified WECM for the project activity is the waste heat contained in the hot COFG after tertiary combustion produced as part of the coking pyrolysis process in the project facility[11]. Multiple waste gas streams are therefore not utilised in the project activity and therefore ACM0012 is suitable for use.
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.	In the absence of the project activity, the WECM would be combusted and vented in full, and would not be partially recovered[15, 16]. Additionally, the project activity utilises the WECM to generate electricity as the only output of the project activity and does not utilise the WECM for heat of reaction[11]. Thus, ACM0012 is suitable for use.
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 recovers waste heat contained in the COFG after tertiary combustion produced as part of the coking pyrolysis process in the project facility and does not recover waste energy from a single and or combined cycle power plant[8, 9, 11]. Furthermore, the project activity is a Greenfield plant producing power (electricity)[8, 9, 11] only and is not a cogeneration plant and is therefore applicable to ACM0012.
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 project activity is a Greenfield plant and will therefore employ a technical lifetime for equipment that is equal to the technically designed operational lifetime for equipment from its first commissioning. ACM0012 is thus suitable for use.
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 from the waste energy generation facility in the absence of the project activity is determined according to Annex 1 (since the project facility is a Greenfield plant) of the methodology below. As can be seen from section B.4. below as well as the analysis carried out hereunder, the identified baseline scenario is where waste energy would be combusted and

ACM0012 Applicability Criteria	Project Activity
	vented and power would be supplied from the national grid and ACM0012 is therefore suitable for use.
In addition, the applicability conditions included in the tools referred to above apply.	The project activity complies with the applicability conditions stated in the relevant tools as demonstrated in section B.1., thus ACM0012 is suitable for use.

Assessment of the extent of use of waste energy from the waste energy generation facility in the absence of the CDM project activity

The extent of use of waste energy from the waste energy generation facility in the absence of the project activity is determined according to Annex 1 of the methodology since the project facility is a Greenfield plant.

Annex 1: Assessment of extent of use of WECM and determination of baseline practice factor for CDM project activity implemented in Greenfield facilities using a reference waste energy generating facility (or "reference facility" for the purpose of this annex) and manufacturer's specifications.

Option 1: Assessment of other existing facilities

The following steps are carried out according to Option 1:

1. *The Greenfield (or new) facility generating the WECM used in the CDM project activity should be categorised based on following criteria applicable to project facility: (i) industry sector; (ii) product manufactured, its specifications and applications; (iii) production capacity; (iv) quality of raw material used; (v) process flow or technology type; (vi) configuration of the facility; (vii) facilities implemented in the previous 10 years.*

The Greenfield project facility has the following characteristics:

(i) industry sector - coke manufacturing sector;
(ii) product manufactured - coke for the ferroalloy industry in South Africa;
(iii) production capacity – 435 000-500 000tpa
(iv) quality of raw material used – SSCC from the Grootegeluk Coal Mine;
(v) process flow or technology type - coking pyrolysis process and non-recovery coke oven type as described in section A.3. above;
(vi) configuration of the facility – as described in section A.3. above
(vii) facilities implemented in the previous 10 years - as can be seen from section B.5. below there are no facilities implemented in the previous 10 years.

2. *Based on the literature from the recognised sources, or from surveys in the relevant industry sector, these facilities which follow the criteria mentioned above should be listed. The selected facilities can vary by +/-10% in terms of capacity of the facility as compared to the proposed facility under CDM.*

As can be seen from section B.5. below, there are currently only 3 coke manufacturing plants in South Africa located at:

- Vanderbijlpark – 6 coke batteries with gas cleaning and by-product recovery;
- Pretoria – 1 coke battery with gas cleaning and by-product recovery; and

- Newcastle – 3 coke batteries with gas cleaning and by-product recovery.

From the above mentioned coke manufacturing plants, there are no coke batteries either of the non-recovery type or the heat recovery type in operation in South Africa. ACM0012 requires that for the use of Option 1, it is necessary that at least five facilities are analysed to arrive at "reference facility" practice. However as shown above, it is not possible to analyse five facilities to arrive at "reference facility" practice, thus Option 2 of Annex 1 of ACM0012 is carried out below.

Option 2: Assessment of alternative design of the project facility

Based on the Pre-feasibility Study for the proposed project completed by Engineering and Projects Company (E&PC), an independent engineering consulting company, 2 alternative designs are possible:

- Scenario 1: project facility is constructed with no usage if WECM. WECM is combusted (flared) and vented to the atmosphere and power would be supplied from the national grid
- Scenario 2: project facility with usage of WECM i.e. WECM is recovered for power generation

The PFS was based on detailed proposals from international technology suppliers and engineering institutes including Beijing Sino-Steel Industry & Trade Corp. Group (SSIT), CITIC International Cooperation Co., Ltd, and Sinosteel MECC. A technical and commercial evaluation of the different proposals received was carried out a by the PFS authors.

Further, a combined process and financial model was developed by the PFS authors to determine the optimum steam conditions for the steam cycle and the number of waste gas heat generators and turbines for scenario 2 The Process Concept Design report documents the process and financial modelling to determine the optimum process solution for the project activity. A number of different configurations were considered including:

- Different steam conditions (32 bar(a) and 410 °C, 45 bar(a) and 445 °C, 65 bar(a) and 485 °C)
- Heat recovery boiler configuration (2 or 4 WHRSGs)
- Turbine configuration (this considered only 2 x 30MW steam turbines)

The maximum number of configurations based on the variables above is 6 and the optimisation model developed considered all 6 of these possible configurations. The study concluded that the optimum (most financially attractive) configuration is: four Waste Heat Steam Generators (WHSGs), and two Turbines at 65 bar(a) and 485 °C steam condition.

This scenario is the project activity without CDM and given that it is the most financially attractive of the 6 possible configurations, considering this configuration only in the analysis in Option 2 is conservative.

This list of scenarios for usage of WECM can therefore be considered complete.

A levelised cost analysis and IRR calculation are used for the 2 alternatives presented above to determine which one is the most attractive. For completeness a third scenario considering partial usage of WECM is also considered. Note that:

- The investment decision for the project facility is not the same as the investment decision for the project activity. The project facility and project activity are being developed as 2 distinct projects and will require separate board approval.
- Separate financial models are included in the PFS for the stand alone coke plant and for the WHR power plant
- According to the PFS, the design of the project facility is not expected to change whether the WECM is used or not

- The tendering and procurement process for the project activity and project facility is entirely separate.

Therefore the levelised cost analysis is carried out excluding the capital and operating costs of the project facility as these are expected to be the same in all scenarios.

For scenario 1, the tariff rate is the rate that the project owner currently purchases power from the South African grid. The operation period is 20 years, the discount rate is 11.9% and the income tax rate is 28%.

For scenario 2, the input values are based on those used in the IRR calculation (see section B5 of the PDD).

For scenario 3, it is assumed that 50% of WECM is captured, power generated is 50% less than in scenario 2 and capex and opex are 50% of those in scenario 2. These assumptions are reasonable as:

- Scenario 2 involves the installation of 4 WHRBs and 2 STs. For scenario 3, it is assumed that 2 WHRBs and 1 ST are installed. It is assumed that the operation hours for scenario 3 are the same as for the project (i.e. 8400hours per year, 96%) leaving just 360 hours for planned and unplanned maintenance. This is extremely conservative and it is not plausible to assume that operation hours could be higher in scenario 3. Therefore, it is assumed that power generated in scenario 3 is 50% of the amount that would be generated in scenario 2 as the installed capacity is 50% less and operation hours are the same.
- As the equipment installed in scenario 3 is simply half that in scenario 2, it is assumed that the capex is also halved. In fact, this is a conservative assumption as it is likely that some costs would be reduced for a larger project involving 4 WHRBs and 2 STs (e.g. manufacturers would likely offer a discount for purchasing more equipment)
- OPEX is a function of CAPEX and power generated (see response above). If CAPEX is halved through installation of only half the equipment as in the proposed project, then it is reasonable to assume that OPEX is also halved. In fact, this is a conservative assumption as some economies of scale are likely for a larger project.

Results of calculation:

Scenario	**Levelised cost (inc. tax) ZAR/MWh**	**Levelised cost (exc. tax) ZAR/MWh**	**Equity IRR after tax, no CERs**
1. No use of WECM, power purchased from the grid	407.74	566.3	No result
2. All WECM used for power generation	412.43	643.82	7.39%
3. 50% usage of WECM for power generation, 50% power purchased from the grid	410.09	605.06	7.39%

The analysis shows that scenario 1 is more attractive than scenarios 2 and 3 ie no usage of WECM and purchase of equivalent amount of power from the grid. This option also represents significantly less risk for the project owner as the proposed project is the first of its kind in South Africa.

The IRR calculation shows that for scenarios 2 and 3, the IRR is significantly less than the benchmark for the project (11.9%). For scenario 1, no investment is required for treatment of the WECM.

Therefore the project facility with venting of WECM (scenario 1) represents a financially more attractive investment option than the project facility plus project activity (scenario 2). In the absence of the project activity waste energy would be combusted and vented and power would be supplied from the national grid which represents the baseline scenario and corresponds moreover to the design and chosen technology for the project facility as the reference waste energy generating facilities. Since the procedure carried out above concludes that no waste energy would have been utilised in the project facility, the value of factor "$f_{practice}$", is $f_{practice} = 0$.
As can be seen from the above table, the project activity fulfils the required applicability criteria for ACM0012 and therefore ACM0012 is an appropriate methodology for the project activity.

B.3. Project boundary

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	Electricity generation, grid or captive source	CO_2	Included	Main emission source.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
Project scenario	Supplemental electricity consumption	CO_2	Included	Main emission source.
		CH_4	Excluded	Excluded for simplification.
		N_2O	Excluded	Excluded for simplification.

Provided in the table above are the emission sources and gases that are included in the project boundary for the purpose of calculating baseline emissions and project emissions.

The project boundary includes the proposed project facility, containing the coke ovens where the COG and COFG is generated and the associated and co-located project activity containing the gas system, WHRB, steam system with turbines, generators, switchgear, control systems and ancillary equipment (refer to Figure 4, Figure 5 and Figure 6 above for diagrams delineating the project boundary as well as Figure 8 below). This is in line with ACM0012 (Version 04.0.0, Sectoral Scopes: 01 and 04, EB 60) which requires that the project boundary includes the relevant WECM, equipment and energy distribution system in the project facility and the recipient.

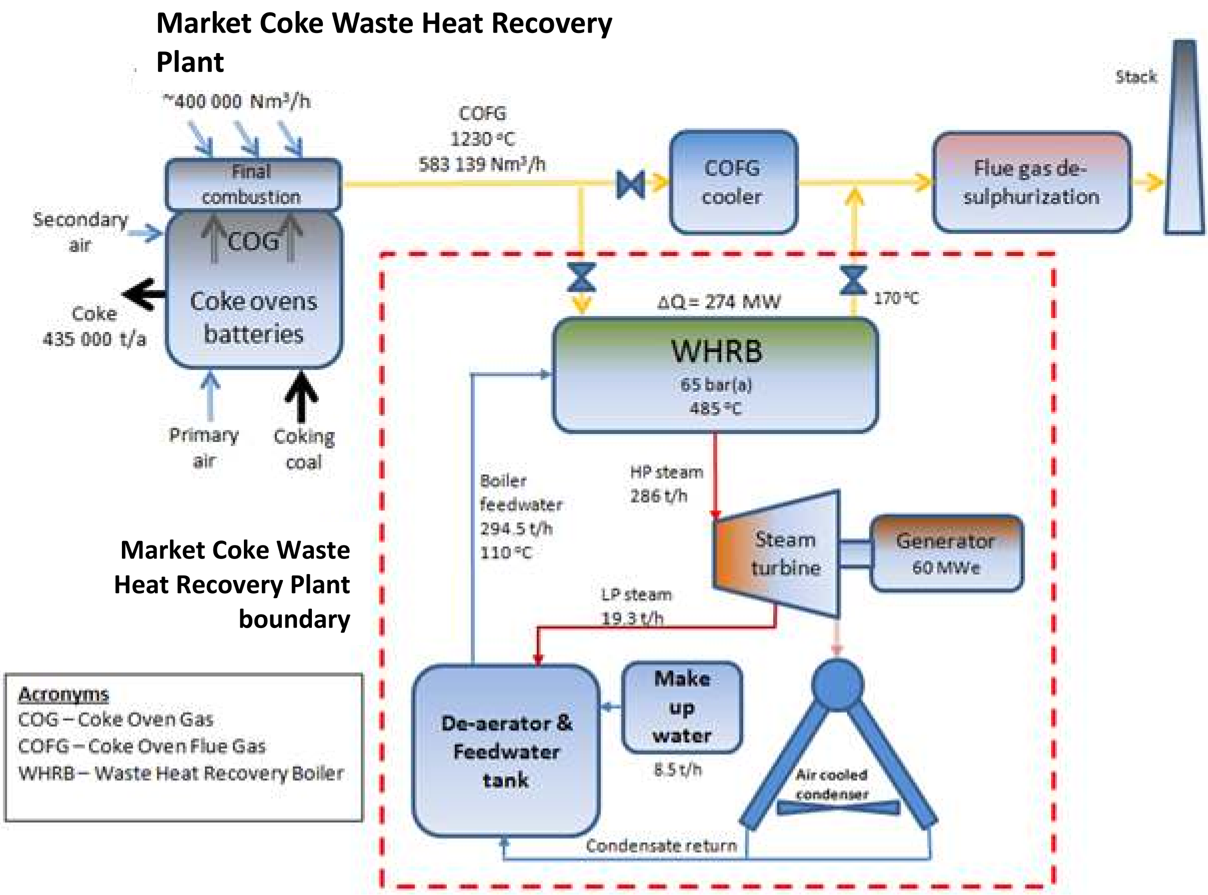

Figure 8: Detailed process flow diagram showing the project boundary (Source: E&PC, 2011[11])

The South African national electricity grid operated by Eskom which supplies the electricity to the Grootegeluk Coal Mine, shall also form part of the project boundary for the purposes of determining the baseline (see section B.4. below) and grid emissions factor (GEF) (see section B.6. below).

B.4. Establishment and description of baseline scenario

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As per ACM0012, "the baseline scenario is identified as the most plausible baseline scenario among all realistic and credible alternative(s).". As can be seen from section B.5. below, there are currently only 3 coke manufacturing plants in South Africa, however there are no coke batteries either of the non-recovery type or the heat recovery type in operation in South Africa.

In accordance with ACM0012 realistic and credible alternatives have been identified in a step wise approach for the most plausible baseline scenario. Realistic and credible alternatives have been 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.

Since the project activity does not generate heat (process heat and/or heat of reaction) or mechanical energy as outputs[8, 9, 11], realistic and credible alternatives have not been identified for these.

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

ACM0012 states that “therefore any alternative identified for the project activity should provide the same amount of heat, power or mechanical energy that is provided by the project activity…”.

As such, in line with ACM0012, the realistic and credible alternative(s) for the use of waste energy include the following:

- W1: WECM is directly vented to the atmosphere without incineration;
- W2: WECM is released to the atmosphere (for example after incineration) or waste heat is released (or vented) to the atmosphere or waste pressure energy is not utilized;
- W3: Waste energy is sold as an energy source;
- W4: Waste energy is used for meeting energy demand at the recipient facility(ies);
- 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 atmosphere/ unutilised;
- W6: All the waste energy produced at the facility is captured and used for export electricity generation or steam.

The table below provides an analysis of the realistic and credible alternatives for the use of waste energy in the absence of the project activity:

Table 6: Realistic and credible alternative analysis for waste energy

Alternative		Realistic and credible alternative? (Yes / No)	Justification / Explanation
W1	WECM is directly vented to the atmosphere without incineration	No	The WECM for the project activity is the waste heat contained in the COFG after tertiary combustion[8, 9, 11]. In terms of South African air quality regulations the project facility is required to comply with the relevant regulations and thus directly venting the WECM (the coke oven flue gas to the atmosphere without incineration) is not considered to be a realistic and credible alternative[4, 17]. W1 is therefore not a realistic and credible alternative.
W2	WECM is released to the atmosphere (for example after incineration) or waste heat is released (or vented) to the atmosphere or waste pressure energy is not utilized	Yes	As mentioned for W1 above, combustion (incineration) of the COFG is required in order for the project facility to comply with South African air quality regulations. As such, after tertiary combustion of the COFG, the waste heat would be released to the atmosphere[15, 16], W2 is therefore a realistic and credible

Alternative		Realistic and credible alternative? (Yes / No)	Justification / Explanation
			alternative.
W3	Waste energy is sold as an energy source	No	None of the existing operations at the Grootegeluk Coal Mine, regardless of their proximity to the project activity, have the potential to utilise the waste heat generated by the project facility[15, 16]. The waste energy (the waste heat) would remain utilised and therefore there does not exist the opportunity to sell the waste energy as an energy source. W3 is thus not considered to be a realistic and credible alternative.
W4	Waste energy is used for meeting energy demand at the recipient facility(ies)	No	As above for W3, none of the existing operations at the Grootegeluk Coal Mine (the recipient facility) have the potential to utilise the waste energy for meeting their energy demand, therefore W4 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 atmosphere/ unutilised	No	According to the Pre-feasibility Study (PFS), the total heat available from the coke oven flue gas produced in the project facility after tertiary combustion and ducting losses is 275MW[8, 9, 11]. As such this whole amount was utilised in the energy optimisation model developed to quantify the process design criteria for the project activity, in order for the project activity to produce the required level of power for use at the recipient facility. Therefore recovering only a portion of the energy of the WECM is not considered feasible since the power produced would not be sufficient to satisfy the needs of the recipient facility, W5 is thus excluded as a realistic and credible alternative.
W6	All the waste energy produced at the facility is captured and used for export electricity generation or steam	No	As above for W3 and W4, none of the existing operations at the Grootegeluk Coal Mine, regardless of their proximity to the project facility, have the potential to utilise the waste energy generated by the project facility[15, 16]. Additionally, the use of the waste energy for export electricity generation would require a project similar to the proposed project activity and as shown in section B.5. below, without revenues generated from the sale of CERs the project activity it is not financially attractive and is therefore not considered to be a realistic and credible alternative for the use of waste energy in the absence of the project activity. W6 is thus excluded as a realistic and credible alternative to the project activity

As can be seen from the table above, W2 is the only realistic and credible alternative for the use of waste energy in the absence of the project activity.

In line with ACM0012, the realistic and credible alternative(s) for power generation include the following:

- P1: Proposed project activity not undertaken as a CDM project activity;
- P2: On-site or off-site existing fossil fuel fired cogeneration plant;
- P3: On-site or off-site Greenfield fossil fuel fired cogeneration plant;
- P4: On-site or off-site existing renewable energy based cogeneration plant;
- P5: On-site or off-site Greenfield renewable energy based cogeneration plant;
- P6: On-site or off-site existing fossil fuel based existing identified captive power plant;
- P7: On-site or off-site existing identified renewable energy or other waste energy based captive power plant;
- P8: On-site or off-site Greenfield fossil fuel based captive plant;
- P9: On-site or off-site Greenfield renewable energy or other waste energy based captive plant;
- P10: Sourced from grid-connected power plants;
- P11: Existing captive electricity generation using waste energy (if the project activity is captive
- generation using waste energy, this scenario represents captive generation with lower efficiency or lower recovery than the project activity);
- P12: Existing cogeneration using waste energy, but at a lower efficiency or lower recovery.

The above realistic and credible alternatives power generation have been analysed the table below:

Table 7: Realistic and credible alternative analysis for power generation

Alternative		Realistic and credible alternative? (Yes / No)	Justification / Explanation
P1	Proposed project activity not undertaken as a CDM project activity	No.	The revenues generated from the sale of CERs generated from the project activity are key to the project activity's feasibility, as assessed and demonstrated in section B.5. below. Without revenues from the sale of CERs, the project will not go ahead; P1 is therefore not a realistic and credible alternative.
P2	On-site or off-site existing fossil fuel fired cogeneration plant	No.	The project activity produces power (electricity)[8, 9, 11] only and therefore a fossil fuel fired cogeneration plant, on-site or off-site, is not a realistic and credible alternative and P2 is excluded. Additionally, there is no existing on-site or off-site fossil fuel fired cogeneration plant[15, 16].
P3	On-site or off-site Greenfield fossil fuel fired cogeneration plant	No.	As above for P2 – the project activity produces power only and therefore a Greenfield fossil fuel fired cogeneration plant, located either on-site or off-site, is not considered to be a realistic and credible alternative and P3 is therefore excluded.

Alternative		Realistic and credible alternative? (Yes / No)	Justification / Explanation
P4	On-site or off-site existing renewable energy based cogeneration plant	No.	As above for P2 – the project activity produces power only and therefore an existing renewable energy based cogeneration plant, located either on-site or off-site, is not considered to be a realistic and credible alternative and P4 is therefore excluded.
P5	On-site or off-site Greenfield renewable energy based cogeneration plant	No.	As above for P2 – the project activity produces power only and therefore a Greenfield renewable energy based cogeneration plant, located either on-site or off-site, is not considered to be a realistic and credible alternative and P5 is therefore excluded.
P6	On-site or off-site existing fossil fuel based existing identified captive power plant	No.	Power is currently obtained from the national grid and while the grid is supplied from predominantly fossil fuel fired power stations, the Grootegeluk Coal Mine is not supplied with electricity directly from an existing identified captive power plant[18]. Therefore P6 is not considered to be a realistic and credible alternative and is excluded.
P7	On-site or off-site existing identified renewable energy or other waste energy based captive power plant	No.	As above for P6 – power is currently supplied from the national grid and not from existing identified renewable energy or other waste energy based captive power plants. P7 is therefore not a realistic and credible alternative and is excluded.
P8	On-site or off-site Greenfield fossil fuel based captive plant	Yes.	Given that the Grootegeluk Coal Mine produces coal from an open cast pit mine[16], it is considered that a Greenfield on-site captive coal-fired power plant is a realistic and credible baseline alternative for power generation.
P9	On-site or off-site Greenfield renewable energy or other waste energy based captive plant	No.	As can be seen from section B.6.1. below, with approximately 93% of electricity supply in South Africa from coal-fired power stations, the construction and operation of an on-site or off-site greenfield renewable energy or other waste energy based captive plant is not considered to be a realistic and credible alternative to the project activity. Additionally, there is no other on-site waste energy generating facility capable of supplying waste energy[15]. P9 is therefore excluded as a realistic and credible alternative.
P10	Sourced from grid-connected power plants	Yes.	This is the status quo and current situation[18] and is therefore P10 included as a realistic and credible alternative.

[18] Exxaro, 2012f.

Alternative		Realistic and credible alternative? (Yes / No)	Justification / Explanation
P11	Existing captive electricity generation using waste energy (if the project activity is captive generation using waste energy, this scenario represents captive generation with lower efficiency or lower recovery than the project activity)	No.	There is no existing use of waste energy and the project activity is a Greenfield plant and does not represent an efficiency improvement[8, 9, 11]. P11 is therefore not considered to be a realistic and credible alternative and is excluded.
P12	Existing cogeneration using waste energy, but at a lower efficiency or lower recovery	No.	As above for P2 and P11– the project activity is a Greenfield plant and does not represent an efficiency or recovery improvement. Also, the project activity is not a cogeneration plant and produces only power[8, 9, 11]. P12 is not considered to be a realistic and credible alternative.

Based on the table above, the two realistic and credible alternatives for power generation are P8 and P10.

Therefore, the outcomes of Step 1 are scenarios of W2 and P8 (Scenario 1) and W2 and P10 (Scenario 2), as summarised and described in the table below:

Table 8: Realistic and credible baseline scenarios matrix

Scenario	Baseline alternative/ option		Scenario description
	Waste energy	Power	
1	W2	P8	Waste energy would be combusted and vented and power would be supplied from a newly constructed Greenfield coal fired power plant.
2	W2	P10	Waste energy would be combusted and vented and power would be supplied from the national grid.

Step 2: Step 2 and/or Step 3 of the latest approved version of the "Tool for the demonstration and assessment of additionality" shall be used to identify the most plausible baseline scenarios by eliminating non-feasible options (e.g. alternatives where barriers are prohibitive or which are clearly economically unattractive).

The latest version of the "*Tool for the demonstration and assessment of additionality*" at the time of writing this document is Version 6.1.0, EB 69, Annex 20. As such and in line with ACM0012, Step 2 of the tool is carried out below:

Step 2: Investment analysis

The identification of the most plausible baseline scenario is undertaken through the elimination of non-feasible baseline scenarios by way of demonstrating the economic feasibility and rationale of the two scenarios identified in Table 8 above.

Scenario 1 represents a baseline scenario in which a Greenfield coal-fired power plant would be constructed and would require an investment to be made. While Scenario 2 on the other hand, represents

a baseline scenario that requires no investment as power would be supplied from the grid. In line with the "*Guidelines on the assessment of investment analysis (Version 05, EB 62, Annex 5)*" and specifically paragraph 19 which states:

"If the proposed baseline scenario leaves the project participant no other choice than to make an investment to supply the same (or substitute) products or services, a benchmark analysis is not appropriate and an investment comparison analysis shall be used. If the alternative to the project activity is the supply of electricity from a grid this is not to be considered an investment and a benchmark approach is considered appropriate."

In order to compare the costs associated with Scenario 1 against the costs associated with Scenario 2 (which is the business as usual practice and continuation of the current situation), and to demonstrate which scenario is clearly economically unattractive, a levelised cost of electricity (LCOE) has been calculated for a Greenfield coal-fired power plant[19, 20]. This LCOE is then compared against the average annual Eskom tariff (for the period January 2011 to December 2011)[21] for the recipient facility (the Grootegeluk Coal Mine) which represents the costs for Scenario 2.

The LCOE for a Greenfield coal-fired power plant is calculated to be 155.36 ZARc/kWh[19, 20] which compared to average annual Eskom tariff for 2011 at 48.82 ZARc/kWh[21] demonstrates a substantial cost premium associated with a Greenfield coal-fired power plant (Scenario 1) and a clearly economically unattractive alternative relative to the Eskom tariff (Scenario 2). Since the Eskom tariff is the least costly alternative scenario, it is taken to be the most plausible baseline scenario and Scenario 2 is therefore selected as the most plausible baseline scenario.

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

As can be seen from Step 2 above, Scenario 2 is the only remaining plausible baseline scenario, thus Step 3 is not required. The identified baseline scenario is summarised below:

Scenario	**Baseline alternative/ option**		**Scenario description**
	Waste energy	**Power**	
2	W2	P10	Waste energy would be combusted and vented and power would be supplied from the national grid.

B.5. Demonstration of additionality

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The table below provides the timeline for the proposed project activity and illustrates that the potential for carbon revenue from the project activity was a key determinant to proceed with the project.

Table 9: Timeline of key milestones associated with the development of the proposed project activity

Description / Milestone	**Date**
Project initiated as PFS.	06/2010[22]
PFS complete.	01/02/2011[8]

[19] Basil Read Matomo, 2012. Coal fired steam power generation plant comparative cost estimate for a 60MWe plan at Lephalale (Grootegeluk).
[20] ACE Energy, 2012. Levelised Cost of Electricity – Lephalale Power Plant.
[21] Electricity tariff v0.2
[22] Exxaro, 2012g.

Description / Milestone	Date
Tender issued for CDM consulting services	08/03/2011[23]
Environmental impact assessment (EIA) consultant appointed.	04/2011[24]
Camco appointed as CDM consultant.	09/06/2011[25]
Prior Consideration Notice submitted to the CDM Executive Board (EB) and the South African Designated National Authority (DNA).	27/06/2011[26]
Confirmation of receipt of the Prior Consideration Notice received from the South African DNA.	28/06/2011
Project Identification Note (PIN) submitted to the South African DNA.	06/09/2011[27]
Letter of No Objection (LONO) received from the South African DNA.	28/09/2011[28]
Expected construction start date.	08/2013
Expected date of project commissioning.	08/2015

ACM0012 requires that the assessment and demonstration of additionality be carried out according to the latest version of the "*Tool for the demonstration and assessment of additionality*", which at the time of writing this document is Version 6.1.0, EB 69, Annex 20. As such and in line with the tool, the step-wise approach to assess and demonstrate additionality has been carried out below:

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

Realistic and credible alternatives to the project activity have been identified through the following Sub-steps.

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

The "*Tool for the demonstration and assessment of additionality (Version 6.1.0, EB 69, Annex 20)*", states that "alternatives are to include:
(e) The proposed project activity undertaken without being registered as a CDM project activity;
(f) Other realistic and credible alternative scenario(s) to the proposed CDM project activity scenario that deliver outputs services (e.g., cement) or services (e.g. electricity, heat) with comparable quality, properties and application areas, taking into account, where relevant, examples of scenarios identified in the underlying methodology;
(g) If applicable, continuation of the current situation (no project activity or other alternatives undertaken)."

The revenues generated from the sale of CERs generated from the project activity are key to the project activity's feasibility, as assessed and demonstrated in section B.5. below. Without revenues from the sale of CERs, the project will not be as financially or economically feasible and therefore, "(e)" is not a realistic and credible alternative.

[23] Exxaro, 2012h.
[24] Exxaro, 2012i.
[25] Exxaro, 2012j.
[26] Prior Consideration Notice, 2011.
[27] Project Identification Note (PIN), 2011.
[28] Letter of No Objection (LONO), 2011.

Also, as can be seen from B.4. above, and Steps 1, 2 and 3carried out therein, all other realistic and credible alternative scenarios to the proposed CDM project activity scenario that deliver outputs services or services to the project activity have been eliminated (except for Scenario 2 – which is the business as usual practice and continuation of the current situation) and therefore "(f)" is not a realistic and credible alternative.

As such and as demonstrated in section B.4. above (and the steps carried out therein), the continuation of the current situation is the only realistic and credible alternative. Therefore, since "(g)" represents the continuation of the current situation as described in Scenario 2 above, it is taken as the only realistic and credible alternative to the project activity.

Outcome of Sub-step 1a:

The outcome of Sub-step 1a is therefore that the identified realistic and credible alternative scenario to the project activity is Scenario 2 (the continuation of the current situation).

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

Scenario 2 as described above is the continuation of the current situation and is therefore in compliance with all mandatory laws and regulations. As mentioned previously, waste gas would need to be combusted and vented in accordance with relevant health, safety and environmental legislation. The legislation is however not prescriptive in the manner or method of combustion and is aimed rather at ensuring emissions are within certain health, safety and environmental standards for air quality. Furthermore, no legislation in South Africa requires that the waste heat produced as a result of combustion be recovered or utilised in any way.

Outcome of Sub-step 1b:

Scenario 2 is therefore identified as a realistic and credible alternative scenario to the project activity since it is in compliance with mandatory legislation and regulations. Step 2 is therefore undertaken below.

Step 2: Investment analysis

Step 2 is undertaken to demonstrate that the proposed project activity is not economically or financially feasible, without the revenue from the sale of certified emission reductions (CERs).

Sub-step 2a: Determine appropriate analysis method

Version 6.1.0 of the "*Tool for the demonstration and assessment of additionality*" provides three options available as appropriate analysis methods, namely:

- Option I. Simple cost analysis
- Option II. Investment comparison analysis
- Option III. Benchmark analysis

Since Option I. is appropriate to project activities and alternative scenarios that generate no financial or economic benefits other than CDM related income, it is deemed not to be an appropriate analysis method because the project activity is expected to generate revenues from the sale of CERs as well as electricity to the recipient facility. Additionally, Option II is not considered to be an appropriate analysis method since the only realistic and credible alternative, Scenario 1, does not require investment and is not a

similar investment project. Therefore the project activity will utilise Option III. Benchmark analysis as the appropriate analysis method.

Sub-step 2b: Option III. Benchmark analysis method

In order to comply with "*Information note: previous rulings related to the appropriateness of benchmarks for project activities utilizing waste heat/waste gas for power generation (EB 51, Annex 59)*", specifically paragraph "9" which states:

"For projects in which the electricity was being produced for captive consumption the benchmark of the core business was considered to be appropriate, as the project was considered to be an investment in the operation of the core business."

As mentioned throughout this document, the majority of electricity produced will be for captive consumption at the recipient facility, Exxaro's Grootegeluk Coal Mine with some electricity available for export to the South African grid.

The most suitable financial/economic indicator for the project is a real equity internal rate of return (IRR). The benchmark applied is the default value for the expected real return on equity for different project types and host countries as provided in the "*Guidelines on the assessment of investment analysis (Version 05, EB 62, Annex 5)*". As such since Exxaro's core business in mining / mineral production (Sectoral scope 8, Group 2) the default value for the expected real return on equity for South Africa under Sectoral scope 8 Mining / Mineral production and Group 2 is a real return on equity of 11.9%[29].

Thus the default value for the real return on equity as applied to the project activity is 11.9%.

Sub-step 2c: Calculation and comparison of financial indicators (only applicable to Options II and III)

Major parameters and inputs used in the calculation of the equity IRR are listed in the table below:

Table 10: Parameters and inputs to the IRR

Parameter/ Input	**Amount/ Value**	**Unit**	**Source / Reference**
Technical (General)			
Capacity (Gross)	60.00	MWe	Pre-feasibility Study (PFS)[8]
Capacity (Net)	55.00	MWe	PFS[11]
Capacity factor	0.96		PFS[9]
Electrical output (Net)	462 000.00	MWh/yr	Calculated
Project lifetime	20.00	yrs	PFS[30]
Capital Expenditure (CAPEX)			
Hard CAPEX (plant and equipment)	1 019 005 600	ZAR	PFS[31]
Soft CAPEX (development and non-financing costs)	540 232 704	ZAR	PFS[31]
Operational Expenditure (OPEX)			
Fixed OPEX	69 000 000	ZAR	PFS[32]

[29] Guidelines on the assessment of investment analysis (Version 05, EB 62, Annex 5), page 11.
[30] Prana Energy, 2012a.
[31] E&PC, 2011. Exxaro Energy Coke Waste Heat Recovery Project: Steam and Power Generation - 2x30MWe Genset.
[32] Prana Energy, 2012.

Parameter/ Input	Amount/ Value	Unit	Source / Reference
Variable OPEX (Yrs 1 - 3)	9 192 960	ZAR	Calculated
Variable OPEX (Yrs 4 - 20)	11 007 360	ZAR	Calculated
Financial Structure			
Debt	0	%	PFS[12, 31]
Equity	100	%	PFS[12, 31]
Revenues			
Electricity tariff	566.30	ZAR/MWh	Calculated[21]
Carbon revenue	29 619 402	ZAR/yr	Calculated
Other financial parameters / inputs			
Company income tax rate	28.00	%	South African Revenue Services (SARS)
Value added tax (VAT)	14.00	%	SARS

Suitability of parameters / inputs to IRR calculation

Parameters and inputs to the return on equity calculation have been sourced from the PFS compiled by the engineering, procurement and construction (EPC) contractor, Engineering and Projects Company (E&PC), an independent engineering consulting company as well as from Prana Energy, also an independent engineering consulting company. The PFS utilised CAPEX figures based on quotations received from equipment manufacturers as well as the experience of E&PC and Prana Energy in building and operating similar projects.

CAPEX and OPEX

The PFS compiled by E&PC and Prana Energy provided expected CAPEX and OPEX figures based on quotations received from equipment manufacturers as well as the experience of E&PC and Prana Energy in building and operating similar projects.

Revenues

The tariff utilised to calculate revenues from electricity is considered to be an appropriate figure since it is based on the actual tariff charged to the Grootegeluk Coal Mine for the period January 2011 to December 2011 and escalated according to the National Energy Regulator of South Africa's (NERSA) approved electricity tariff increases[33] and thus reflects the savings accrued to Exxaro as an income.

IRR calculation

The table below shows the real equity IRR without the income from CER revenue compared to the benchmark IRR. As can be seen based upon the above parameters and inputs, the real equity IRR without CER revenue is 7.39%, which is well below the benchmark return on equity of 11.9%.

Table 11: IRR results summary

Description	Without CER revenues	Benchmark
Equity IRR	7.39%	11.9%

Therefore, as can be seen from above, the project's real equity IRR suggests that it is not financially attractive when compared to the benchmark real return on equity and is therefore financially additional.

Sub-step 2d: Sensitivity analysis (only applicable to Options II and III):

[33] NERSA 2012.

A sensitivity analysis was conducted to show that the conclusion regarding the financial attractiveness is sufficiently robust to reasonable variations in the parameters and inputs to the return on equity. In other words, that the investment analysis could consistently support the conclusion that the project activity undertaken without the CDM, will not be financially attractive. Accordingly, IRR sensitivity to CER price is not included in the following analysis. The sensitivity analysis was carried out using the range of +10% and –10% in line with the "*Guidelines on the assessment of investment analysis (Version 05, EB 62, Annex 5)*", specifically paragraph "21" which states that "As a general point of departure variations in the sensitivity analysis should at least cover a range of +10% and .10%".

The following variables were included in the sensitivity analysis:

- Hard and Soft CAPEX (Total CAPEX)
- Fixed and Variable OPEX (Total OPEX)
- Electricity tariff
- Electrical output

The results of the sensitivity are shown in the table below:

Table 12: Sensitivity for materially significant parameters / inputs

Variable	-10%	0%	+10%
Total CAPEX	8.93%	7.39%	6.08%
Total OPEX	7.86%	7.39%	6.91%
Electricity tariff	5.52%	7.39%	9.03%
Electrical output	5.59%	7.39%	8.99%
Benchmark	11.90%	11.90%	11.90%

Provided in Figure 8 below is a graph illustrating the sensitivity analysis carried out.

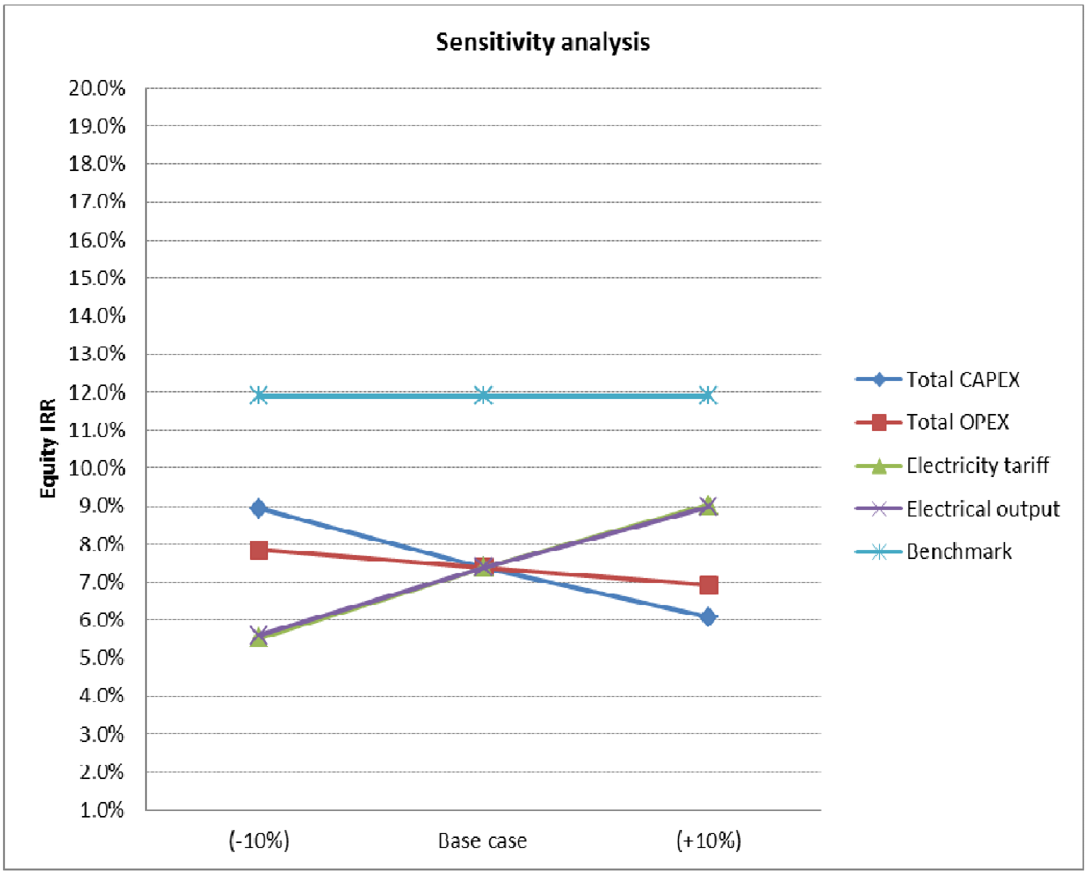


Figure 9: Sensitivity analysis graph

It can be observed that despite variation in the key parameters and inputs, the real equity IRR remains below the benchmark. The investment analysis provides a valid argument in favour of additionality as this analysis consistently supports the conclusion that the project activity is not economically or financially attractive.

Outcome of Step 2:

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

The table below shows the required variation of the materially significant financial parameters to make the equity IRR reach the benchmark of 11.9%.

Table 13: Variation of parameters / inputs to reach benchmark

Total CAPEX	-26%
Total OPEX	-90%
Electricity tariff	+35%
Electrical output	+36%

From the table above, it can be seen that should the Total CAPEX decrease by 26%, or the Electricity tariff and the Electrical output increase by 35% and 36% respectively, the project activity will reach the equity benchmark of 11.9%. However, it is unlikely that these parameters will vary to such a high degree and therefore these variations reflect an unrealistic scenario. Moreover, it is not likely that the Total CAPEX will decrease by as much as 26% since the CAPEX was calculated based on quotations received

from equipment manufacturers as well as the experience of E&PC in building similar projects and includes an estimate carried out to within -10%[34]. Thus the Total CAPEX is more likely to increase. The total OPEX is also unlikely to vary greater than the contingency recommended by Prana Energy[32], [35], since the total OPEX is based upon the experience of Prana Energy in operating similar projects. As demonstrated in the real equity IRR calculation, even with a decrease of 90% in the total OPEX, the IRR remains below the benchmark and only achieves a 10.75% IRR.
Additionally, the Electricity tariff is based upon the actual electricity tariff for the Grootegeluk Coal Mine for the period January 2011 to December 2011 which has been escalated in line with NERSA[33] approved tariff increases. The Electrical output of the project activity is already based on a 96% plant load factor and therefore is not possible to increase the electrical output by 36%.

Step 3: Barrier analysis

Since the barrier analysis is an optional step within the "*Tool for the demonstration and assessment of additionality (Version 6.1.0, EB 69, Annex 20)*", it has not been undertaken here.

Step 4: Common practice analysis

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

As the default and in line with the "*Guidelines on common practice (Version 01.0, EB 63, Annex 12)*", the applicable geographic area is that of the geo-political boundaries of South Africa. Currently in South Africa, there are only 3 coke manufacturing plants[36]. These include plants located at:

- Vanderbijlpark – 6 coke batteries with gas cleaning and by-product recovery;
- Pretoria – 1 coke battery with gas cleaning and by-product recovery; and
- Newcastle – 3 coke batteries with gas cleaning and by-product recovery.

As such and as can be seen from the above mentioned coke manufacturing plants, there are no coke batteries either of the non-recovery type or the heat recovery type in operation in South Africa.

Sub-step 4b: Discuss any similar Options that are occurring:
From Sub-step 4a above, it can be seen that no similar activities are located within the applicable geographic area. In line with version 6.1.0 of the "*Tool for the Demonstration and Assessment of Additionality*", the following steps have been carried out in order to evaluate any similar options that are occurring:

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

Step 2: In the applicable geographical area, identify all plants that deliver the same output or capacity, within the applicable output range calculated in Step 1, as the proposed project activity and have started commercial operation before the start date of the project. Note their number N_{all}. *Registered CDM project activities and projects activities undergoing validation shall not be included in this step;*

Step 3: Within plants identified in Step 2, identify those that apply technologies different that the technology applied in the proposed project activity. Note their number N_{diff}.

[34] E&PC, 2011. Exxaro Energy Coke Waste Heat Recovery Project: Basis of Cost Estimate Document.
[35] Prana Energy, 2012b.
[36] CNI Technologies, 2012. Coke Making Facilities in South Africa.

Step 4: Calculate factor $F=1-N_{diff}/N_{all}$ representing the share of plants using technology similar to the technology used in the proposed project activity in all plants that deliver the same output or capacity as the proposed project activity.

Thus:

Step 1: The applicable output range of the project activity is 30MW (-50%) to 90MW (+50%).

Step 2: As can be seen in Sub-step 4a above, while there are currently no plants that deliver the same output or capacity in the applicable geographic area within the applicable output range of the proposed project activity as calculated in Step 1, the 3 coke manufacturing plants identified in Sub-step 4a are included here since they all started commercial operation before the start date of the project activity. Therefore, $N_{all} = 3$.

Step 3: Since, as identified in Sub-step 4a above, all the plants apply technologies different than the technology applied in the project activity, $N_{diff} = 3$.

Step 4: The factor is calculated as:

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

Where:

$N_{diff} = 3$;
$N_{all} = 3$

Thus, F = 1-3/3; = 0. Also, $N_{all} – N_{diff} = 3 – 3 = 0$, which is less than 3. As such, since F = 0 and is less than 0.2 and $N_{all} – N_{diff} = 0$ which is less than 3, the project activity is not common practice and satisfies Sub-step 4a and Sub-step 4b. The project activity is therefore also considered to be first of its kind.

In conclusion, it is only through the inclusion of CDM revenues that the project activity becomes financially more attractive. Also, the intention to register the project activity under the CDM was a key determinant to proceed with the project. The project activity is therefore additional.

B.6. Emission reductions
B.6.1. Explanation of methodological choices
>>
Baseline emissions calculation
As per ACM0012, baseline emissions for the year *y*, are determined using equation "1":

$$BE_y = BE_{En,y} + BE_{flst,y}$$

Where:

BE_y	=	The total baseline emissions during the year *y* in tCO_2
$BE_{En,y}$	=	The baseline emissions from energy generated by the project activity during the year *y* in tCO_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_2), calculated as per equation 26. This is relevant for those project activities where in the baseline steam is used to flare the waste gas

Since the project activity does not combust fossil fuels 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 and would not in the baseline utilise steam to flare the waste gas, $BE_{flst,y} = 0$ and equation "1" simplifies to:

$$BE_y = BE_{En,y}$$

Section B.4 above describes the only realistic and credible alternative to the project activity, which is a scenario comprising W2 and P10 where waste energy would be flared and power would be supplied from the national grid. This scenario conforms to "Scenarios 1 and 2" as defined in ACM0012, as such equation "2" is used to calculate $BE_{En,y}$:

$$BE_{En,y} = BE_{Elec,y} + BE_{Ther,y}$$

Where:

$BE_{Elec,y}$	=	Baseline emissions from electricity during the year y in tCO_2
$BE_{Ther,y}$	=	Baseline emissions from thermal energy (due to heat generation by elemental processes) during the year y (tCO_2)

The project activity produces electricity only, therefore $BE_{Ther,y} = 0$ and equation "2" simplifies to:

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

Baseline emissions from electricity ($BE_{Elec,y}$) generation are calculated according to "Case 1" and using equation "3" of ACM0012:

$$BE_{Elec,y} = f_{cap} * f_{wcm} * \sum_j \sum_i (EG_{i,j,y} * EF_{Elec,i,j,y})$$

Where:

$BE_{elec,y}$	=	Baseline emissions due to displacement of electricity during the year y (tCO_2)
$EG_{i,j,y}$	=	The quantity of electricity supplied to the recipient j by generator, which in the absence of the project activity would have been sourced from source i (the grid or an identified source) during the year y in MWh
$EF_{elec,i,j,y}$	=	The CO_2 emission factor for the electricity source i (gr for the grid, and is for an identified source), displaced due to the project activity, during the year y (tCO_2/MWh)
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. Depending upon the situation, this factor is estimated using the equations in section 3.1 Note: For a project activity using waste pressure to generate electricity, the electricity generated from waste pressure should be measurable and this fraction is 1
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 the same or less than that generated at a historical level. The value is

estimated using the equations in section 3.2. For Greenfield facilities, f_{cap} is 1. If the procedure in Annex 1 concludes that the waste energy would have been partially utilised in the "reference waste energy generating facilities" this fact will be captured in the factor $f_{practice}$ (refer to equations 22, 23, 24 and 25 for the use of factor $f_{practice}$)

The recipient, *j*, of the electricity in this instance is the Grootegeluk Coal Mine and the electricity source, *i*, is the South African national grid.

All the waste energy is utilised in the project activity to generate electricity, thus $f_{wcm} = 1$, while $f_{cap} = 1$ also, since the project activity is a Greenfield facility. Equation "3" is consequently simplified to:

$$BE_{elec,y} = 1 * 1 * \sum_j \sum_i (EG_{i,j,y} * EF_{elec,i,j,y})$$

$EF_{elec,i,j,y}$ is the grid emissions factor (GEF) for the South African grid, which is calculated utilising V2.2.1 of the "*Tool to calculate the emission factor for an electricity system (Version 2.2.1, EB 63, Annex 19)*". Thus, the following six (6) steps of the baseline methodology procedure of the tool are utilised, namely:

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

Step 1: Identify the relevant electricity systems
The relevant electricity system is the South African national grid (hereinafter referred to as "the Eskom grid"). As South Africa's national utility, Eskom is responsible for the supply of approximately 95% of grid electricity[37], with the remaining 5% sourced from independent power producers, municipalities and international power producers[38].

Furthermore, based on a five year average, approximately 92.78% of the Eskom grid is supplied from coal-fired power stations, with approximately 5.94% supplied from low cost/must run (LCMR) sources including nuclear, hydro and wind as shown in Table 15 below[38]. Approximately 1.23% of the remaining 1.3% comprising the Eskom grid generation mix is supplied from pumped storage stations. However, since pumped storage stations are net consumers of electricity they are excluded from the power stations comprising the Eskom grid for simplicity[39]. Lastly, approximately 0.14% is supplied from gas/liquid fuel stations[38] (comprising Acacia, and Port Rex, Ankelig and Gourikwa)[40].

As such, the Eskom grid comprises the following plants and types (excluding LCMR resources):

Table 14: Power plants comprising the South African national grid (excluding LCMR)[40]

Plant no.	Power station	Installed capacity (MW)	Generation technology	Energy source / Fuel type
1	Arnot	1 980	Coal Subcritical	Bituminous Coal
2	Duvha	3 450	Coal Subcritical	Bituminous Coal
3	Hendrina	1 895	Coal Subcritical	Bituminous Coal

[37] Eskom, 2011. Integrated Report 2011 (page 2).
[38] Eskom, 2011. Integrated Report 2011 (page 324).
[39] Eskom, 2011. Integrated Report 2011 (page 326).
[40] Accessed online at http://www.eskom.co.za/c/article/236/cdm-calculations/

Plant no.	Power station	Installed capacity (MW)	Generation technology	Energy source / Fuel type
4	Kendal	3 840	Coal Subcritical	Bituminous Coal
5	Kriel	2 850	Coal Subcritical	Bituminous Coal
6	Lethabo	3 558	Coal Subcritical	Bituminous Coal
7	Matimba	3 690	Coal Subcritical	Bituminous Coal
8	Majuba	3 843	Coal Subcritical	Bituminous Coal
9	Matla	3 450	Coal Subcritical	Bituminous Coal
10	Tutuka	3 510	Coal Subcritical	Bituminous Coal
11	Camden	1 600	Coal Subcritical	Bituminous Coal
12	Grootvlei	1 200	Coal Subcritical	Bituminous Coal
13	Komati	1 000	Coal Subcritical	Bituminous Coal
14	Acacia	171	Gas/Liquid Fuel	Jet Kerosene
15	Port Rex	171	Gas/Liquid Fuel	Jet Kerosene
16	Ankelig	1327	Gas/Liquid Fuel	Diesel Oil
17	Gourikwa	740	Gas/Liquid Fuel	Diesel Oil
18	Local independent power producers (IPPs)	Not available (N/a)	N/a	N/a
19	Imports	N/a	N/a	N/a

Step 2: Choose whether to include off-grid power plants in the project electricity system (optional)
Although this step is optional, Option I: Only grid power plants are included in the calculation, is selected here.

Step 3: Select a method to determine the operating margin (OM)
V2.2.1 of the "*Tool to calculate the emission factor for an electricity system*" provides one of the following methods for calculation the operating margin emission factor ($EF_{grid,OM,y}$):

(a) Simple OM; or
(b) Simple adjusted OM; or
(c) Dispatch data analysis OM; or
(d) Average OM.

Since Option (b) Simple adjusted OM as well as Option (c) Dispatch data analysis both require data which is not publicly available in South Africa, namely load duration data and detailed running dispatch data respectively, they are deemed not feasible for use to calculate the operating margin of the electricity system. Moreover, while an *ex ante* method (discussed in more detail below) has been chosen, (c) requires an *ex post* method to calculate the operating margin of the electricity system which is not applicable to historical data and also requires annual monitoring. Therefore, Options (b) and (c) are not feasible for use.

Additionally, Option (d) Average OM is suitable only for electricity systems where LCMR power plants generate more than 50% of the electricity supplied to the grid, which as demonstrated below, is not the case in South Africa and therefore Option (d) is not feasible for use. This leaves Option (a) Simple OM as the appropriate method to determine the operating margin.

Option (a) can only be used if LCMR resources constitute less than 50% of total grid generation. LCMR resources are defined as power plants with low marginal generation costs or power plants that are dispatched independently of the daily or seasonal load of the grid and typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation.

Based on an average of the five most recent years for which data is available and as calculated in Table 15 below, LCMR contributed approximately 5.94% of the Eskom grid supply.

Table 15: Calculation of LCMR net electricity generation[38]

Period	Coal-fired		Pumped storage		Gas		Hydro-electric (LCMR)		Wind (LCMR)		Nuclear (LCMR)		Percentage LCMR
	Electrical output (MWh)	Electrical output (%)	Electrical output (MWh)	Electrical output (%)	Electrical output (MWh)	Electrical output (%)	Electrical output (MWh)	Electrical output (%)	Electrical output (MWh)	Electrical output (%)	Electrical output (MWh)	Electrical output (%)	
2010-2011	220 219 000	92.75%	2 953 000	1.24%	197 000	0.08%	1 960 000	0.84%	2 000	0.00%	12 099 000	5.16%	6.00%
2009-2010	215 940 000	92.75%	2 742 000	1.18%	49 000	0.02%	1 274 000	0.55%	1 000	0.00%	12 806 000	5.57%	6.12%
2008-2009	211 941 000	92.57%	2 772 000	1.21%	143 000	0.06%	1 082 000	0.48%	2 000	0.00%	13 004 000	5.75%	6.23%
2007-2008	222 908 000	93.23%	2 979 000	1.24%	1 153 000	0.48%	751 000	0.32%	1 000	0.00%	11 317 000	4.82%	5.14%
2006-2007	215 211 000	92.59%	2 947 000	1.27%	62 000	0.03%	2 443 000	1.06%	2 000	0.00%	11 780 000	5.13%	6.20%
Average	217 243 800	**92.78%**	2 877 400	**1.23%**	320 800	**0.14%**	1 502 000	0.65%	1 600	0.00%	12 201 200	5.29%	**5.94%**

As can be seen from the table above, LCMR resources constituted approximately 5.94% of average annual generation for the grid for the last five (5) years. Thus, Option (a) Simple OM is the appropriate method to determine the operating margin. Also, an *ex ante* option is chosen since the emission factor is determined once at validation, thus no monitoring and recalculation of the emissions factor during the crediting period is required. The *ex ante* option is also considered to be conservative.

Step 4: Calculate the operating margin emission factor according to the selected method
The Simple OM is calculated *ex ante*, using a 3-year generation-weighted average based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation. Furthermore, Option A: Based on the net electricity generation and a CO_2 emission factor of each power unit of the Simple OM method is utilised. Option A of the Simple OM method is utilised since Option B can only be utilised if the necessary data for Option A is not available. Since the necessary data for Option A is available, Option A is suitable for use.

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

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

Where:

$EF_{grid,OMsimple,y}$	= Simple operating margin CO_2 emission factor in year y (tCO_2/MWh)
$EG_{m,y}$	= Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$	= CO_2 emission factor of power unit m in year y (tCO_2/MWh)
m	= All power units serving the grid in year y except low-cost / must-run power units
y =	The relevant year as per the data vintage chosen in Step 3

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

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

Where:

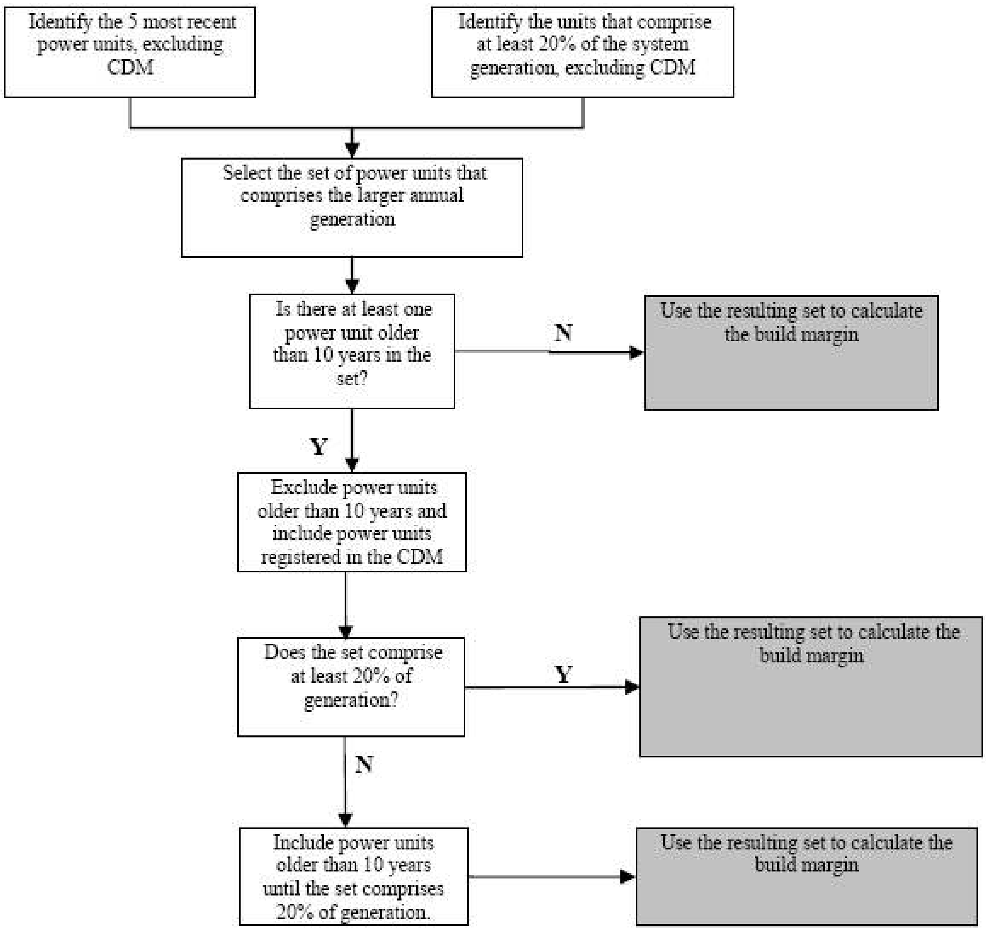
$EF_{EL,m,y}$	= CO_2 emission factor of power unit m in year y (tCO_2/MWh)
$FC_{i,m,y}$	= Amount of fossil fuel type i consumed by power unit m in year y (Mass or volume unit)
$NCV_{i,y}$	= Net calorific value (energy content) of fossil fuel type i in year y (GJ/mass or volume unit)

$EF_{CO2,i,y}$	= CO_2 emission factor of fossil fuel type i in year y (tCO_2/GJ)
$EG_{m,y}$	= Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
m	= All power units serving the grid in year y except low-cost/must-run power units
i	= All fossil fuel types combusted in power unit m in year y
y	= The relevant year as per the data vintage chosen in Step 3

Therefore, according to the calculations carried out in Appendix 4, the $EF_{grid,OMsimple,y}$ = 0.92 tCO_2/MWh.

Step 5: Calculate the build margin (BM) emission factor
Option 1 of Step 5 is chosen whereby the build margin emission factor is calculated *ex ante* based on the most recent information available on units already built for sample group *m* at the time of submission of the PDD to the DOE for validation. This is in line with the selection of the *ex ante* option in Step 3 above and is considered conservative, since the emission factor is determined once at validation, thus no monitoring and recalculation of the emissions factor during the crediting period is required.

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



Identify the 5 most recent power units, excluding CDM ($SET_{5\text{-}units}$)
The 5 units that started to supply electricity most recently to the grid include:

Table 16: Units that started to supply electricity most recently to the grid.

Commissioning order	Plant No.	Power Station	Commissioning date	CDM	Electricity generation ($EG_{m,y}$)
1	16	Ankelig	01/10/2007	No	130 241
2	18	Gourikwa	01/10/2007	No	1 833 000
3	8	Majuba	01/04/1996	No	24 632 585
4	4	Kendal	01/10/1988	No	25 648 258
5	7	Matimba	04/12/1987	No	28 163 040
Annual electricity generation ($AEG_{SET-5-units}$)					***80 407 124***

Identify the units that comprise at least 20% of the system generation, excluding CDM ($SET_{\geq 20\%}$)
The annual electricity generation of the grid in 2011 (AEG_{total}) was 235 864 576 MWh, with 20% of the generation equal to 47 172 915 MWh. Of the above 5 units, $SET_{5-units}$, that started to supply electricity most recently to the grid, Ankelig, Gourikwa, Majuba and Kendal comprise $SET_{\geq 20\%}$, with 52 244 084 MWh.

Select the set of power units that comprises the larger annual generation
Of $SET_{5-units}$ and $SET_{\geq 20\%}$, the set of power units that comprises the larger annual electricity generation is $SET_{5-units}$. However, since 3 of the power units in $SET_{5-units}$ started supplying electricity to the grid more than ten years ago, further steps of the tool are carried out below.

Is there at least one power unit older than 10 years in the set?
Yes - since all the power units in $SET_{5-units}$ are older than 10 years, the procedure is further carried out below.

Exclude power units older than 10 years and include power units registered in the CDM
No power units are registered under the CDM and the next step is carried out below.

Does the set comprise at least 20% of generation?
No – there are no power units registered with the CDM that can be included as per the step above.

Include power units older than 10 years until the set comprises 20% of generation
In a step-wise approach, power units older than ten years are added to the sample until the sample comprises 20% of generation. As such, the $SET_{\geq 20\%}$ including Majuba and Kendal with 50 280 843 MWh comprise the $SET_{sample\ and\ SET\geq 20\%}$ are used to calculate the build margin below utilising equation "3" of the tool since the power units included in the build margin m correspond to the sample group $SET_{sample-CDM->10yrs}$, then, as a conservative approach, only option A2 from guidance in Step 4 (a) can be used as follows:

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

Where:

$EF_{EL,m,y}$ = CO_2 emission factor of power unit m in year y (tCO2/MWh)
$EF_{CO2,m,i,y}$ = Average CO_2 emission factor of fuel type i used in power unit m in year y (tCO_2/GJ)

$n_{m,y}$ = Average net energy conversion efficiency of power unit m in year y
m = All power units serving the grid in year y except low-cost/must-run power units
y = The relevant year as per the data vintage chosen in Step 3

Therefore, according to the calculations carried out in Appendix 4, the $EF_{grid,BM,y}$ = 0.87tCO_2/MWh.

Step 6: Calculate the combined margin emissions factor
The combined margin (CM) emissions factor ($EF_{grid,CM,y}$) is calculated using the Weighted average CM method, Option A and equation "13" of the tool, as follows:

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

Where:

$EF_{grid,CM,y}$ = Combined margin (CM) emissions factor in year y (tCO_2/MWh)
$EF_{grid,BM,y}$ = 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 (%)

Since the project activity is not a wind and solar power generation project activity, the default values for according to the tool of w_{OM} = 0.5 and w_{BM} = 0.5 are utilised. Therefore according to the calculations carried out in Appendix 4, the $EF_{grid,CM,y}$ = 0.90tCO_2/MWh.

Project emissions calculation
Project emissions include emissions due to (1) combustion of auxiliary fuel to supplement waste gas/heat and (2) electricity emissions due to consumption of electricity for cleaning of gas before being used for generation of energy or other supplementary electricity consumption. Project emissions are calculated according to equation "41" of the methodology:

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

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 co-generation plant(s) if they are used as supplementary fuels due to non-availability of waste energy 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) (as per Table 1: Summary of gases and sources included in the project boundary)

According to ACM0012: *"Note: If the electricity was consumed in gas cleaning equipment in the baseline as well, project emissions due to electricity consumption for gas cleaning can be ignored."*

The above statement is taken to be the same for other supplementary electricity consumption. The project activity will supply electricity to the Grootegeluk Coal Mine, the recipient facility which includes

the proposed project facility and project activity, and supplementary electricity consumption is thus calculated as part of the baseline and is accordingly ignored here and $PE_{EL,y} = 0$.

Since the project activity does not consume fossil fuels in the unit process (the project facility), or due to non-availability of waste energy to the project activity or due to any other reason, $PE_{AF,y} = 0$. Moreover, the non-availability of waste energy for the project activity have been calculated as part of the baseline, where EGi,j,y (MWh) is calculated taking into account the planned / designed electrical output of the project activity taking into account planned and unplanned outages. Thus, $PE_y = 0$.

Leakage emissions calculation
No leakage is applicable under ACM0012.

Emission reductions calculation
Emission reductions due to the project activity during the year *y* are calculated according to equation "42" of ACM0012:

$$ER_y = BE_y - PE_y$$

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, applicable to Scenario 2

As indicated above, $PE_y = 0$, thus equation "42" simplifies to $ER_y = BE_y$.

B.6.2. Data and parameters fixed ex ante

Data / Parameter	$\mathbf{EF_{elec,i,j,y}}$
Unit	tCO_2/MWh
Description	The CO_2 emission factor for the electricity source i (gr for the grid, and is for an identified source), displaced due to the project activity, during the year y (tCO_2/MWh)
Source of data	Calculated utilising V2.2.1 of the "Tool to calculate the emission factor for an electricity system".
Value(s) applied	0.90
Choice of data or Measurement methods and procedures	As per applied tool, this value has been calculated ex-ante.
Purpose of data	To determine *ex ante* the CO_2 emission factor of the grid.
Additional comment	

B.6.3. Ex ante calculation of emission reductions
>>

Baseline emissions calculation
From section B.6.1 above, $BE_y = BE_{En,y}$ and $BE_{En,y} = BE_{Elec,y}$.

Also, $BE_{elec,y} = 1 * 1 * \sum_j \sum_i (EG_{i,j,y} * EF_{elec,i,j,y})$, where $EG_{i,j,y} = 462\ 000\ .00MWh$ (according to the PFS) and $EF_{elec,i,j,y} = 0.90tCO_2/MWh$. Thus:

$BE_{elec,y} = 1 * 1 * \sum_j \sum_i (462\ 000\ .00MWh * 0.90tCO_2/MWh) = 414\ 032\ tCO_2$

Project emissions calculation
From section B.6.1 above, $PE_{EL,y} = 0$ and $PE_{AF,y} = 0$, thus, $PE_y = 0 + 0 = 0\ tCO_2$.

Leakage emissions calculation
No leakage is applicable under ACM0012.

Emission reductions calculation
From section B.6.1 above, $ER_y = BE_y$. Thus, $ER_y = 414\ 032\ tCO_2$.

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
2015 (01/08/2015 - 31/12/2015)	173 894	0	0	173 894
2016	414 032	0	0	414 032
2017	414 032	0	0	414 032
2018	414 032	0	0	414 032
2019	414 032	0	0	414 032
2020	414 032	0	0	414 032
2021	414 032	0	0	414 032
2022	414 032	0	0	414 032
2023	414 032	0	0	414 032
2024	414 032	0	0	414 032
2025 (01/01/2025 - 31/07/2025)	240 139	0	0	240 139
Total	4 140 321	0	0	4 140 321
Total number of crediting years	10			
Annual average over the crediting period	414 032	0	0	414 032

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data / Parameter	$EG_{i,,j,y}$
Unit	MWh
Description	Quantity of electricity supplied to the recipient *j* (Grootegeluk Coal Mine and the South African national grid) by the generator (the project activity), which in the absence of the project activity would have sourced from *ith* source (*i* is the Eskom grid) during the year *y* in MWh
Source of data	Recipient facility (Grootegeluk Coal Mine) and generation plant (the project activity) measurement records
Value(s) applied	462 000 (to be monitored also)
Measurement methods and procedures	The quantity of electricity supplied to the recipient (the Grootegeluk Coal Mine and also the South African grid) will be measured continuously using electricity meters. The meter readings will be aggregated monthly for use in the monitoring report.
Monitoring frequency	Monthly
QA/QC procedures	The information will be saved onto Exxaro's Supervisory Control and Data Acquisition (SCADA) system. Meters will be calibrated and maintained according to the manufacturer's specifications.
Purpose of data	Main parameter monitored.
Additional comment	

Data / Parameter	Abnormal operation of the project facility (the Market Coke Plant) including emergencies and shut down
Unit	Hours
Description	The hours of abnormal operation of parts of the project facility (the Market Coke Plant) that can have an impact on waste energy generation and recovery in the project activity (the Market Coke Waste Heat Recovery Plant).
Source of data	Operation and operational data of the project facility (the Market Coke Plant).
Value(s) applied	High COFG temperature: Temperature measurement after tertiary combustion Low COFG temperature: Temperature measurement after tertiary combustion Low COFG flow: COFG pressure at WHRB inlet and ID fan speed at the WHRB outlet
Measurement methods and procedures	The information will be saved onto Exxaro's Supervisory Control and Data Acquisition (SCADA) system.
Monitoring frequency	Daily, aggregated annually.
QA/QC procedures	The information will be saved onto Exxaro's Supervisory Control and Data Acquisition (SCADA) system.
Purpose of data	The hours of abnormal operation of parts of the project facility (the Market Coke Plant) that can have an impact on waste energy generation and recovery in the project activity (the Market Coke Waste Heat Recovery Plant).
Additional comment	

B.7.2. Sampling plan

>>

Not applicable (N/a).

B.7.3. Other elements of monitoring plan

>>

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

Overall project management

Exxaro has a clear and well defined management and organisational structure. This is illustrated in the operation organogram below:

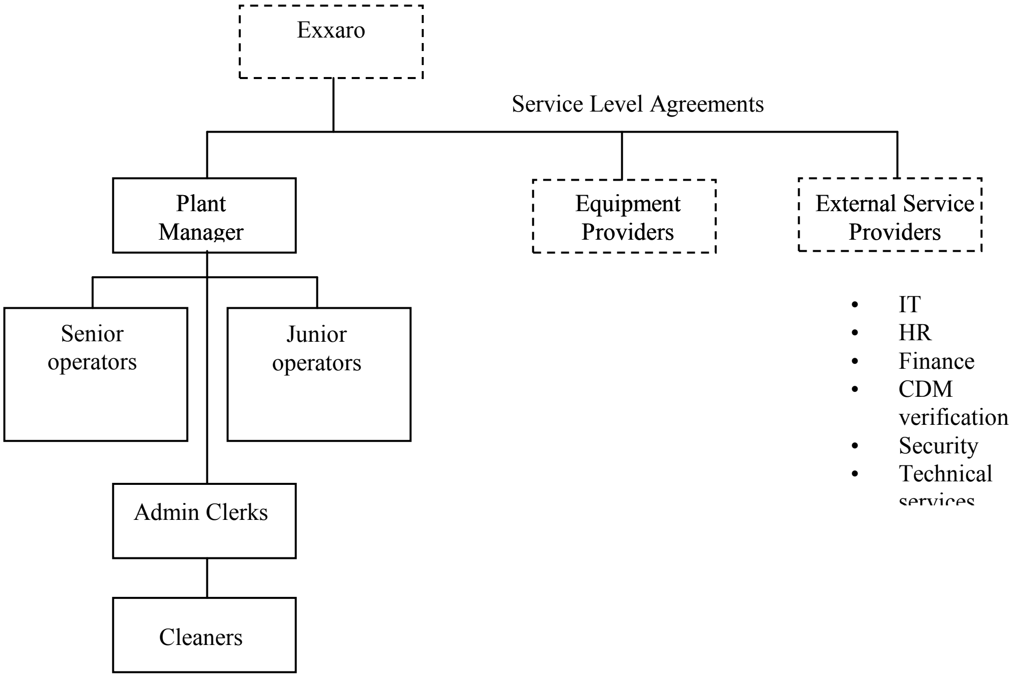


Figure 10: Operational organogram

Monitoring equipment
Electricity meters will measure the quantity of electricity supplied to the recipient facility and the South African grid. The meters are likely to be 4-quadrant billable class meters that are bi-directional – this means that they subtract any electricity used by the project activity during start up, or when the project activity is not producing electricity. Electricity meters will be installed on the feeds to the recipient facility. A metering diagram is provided below.

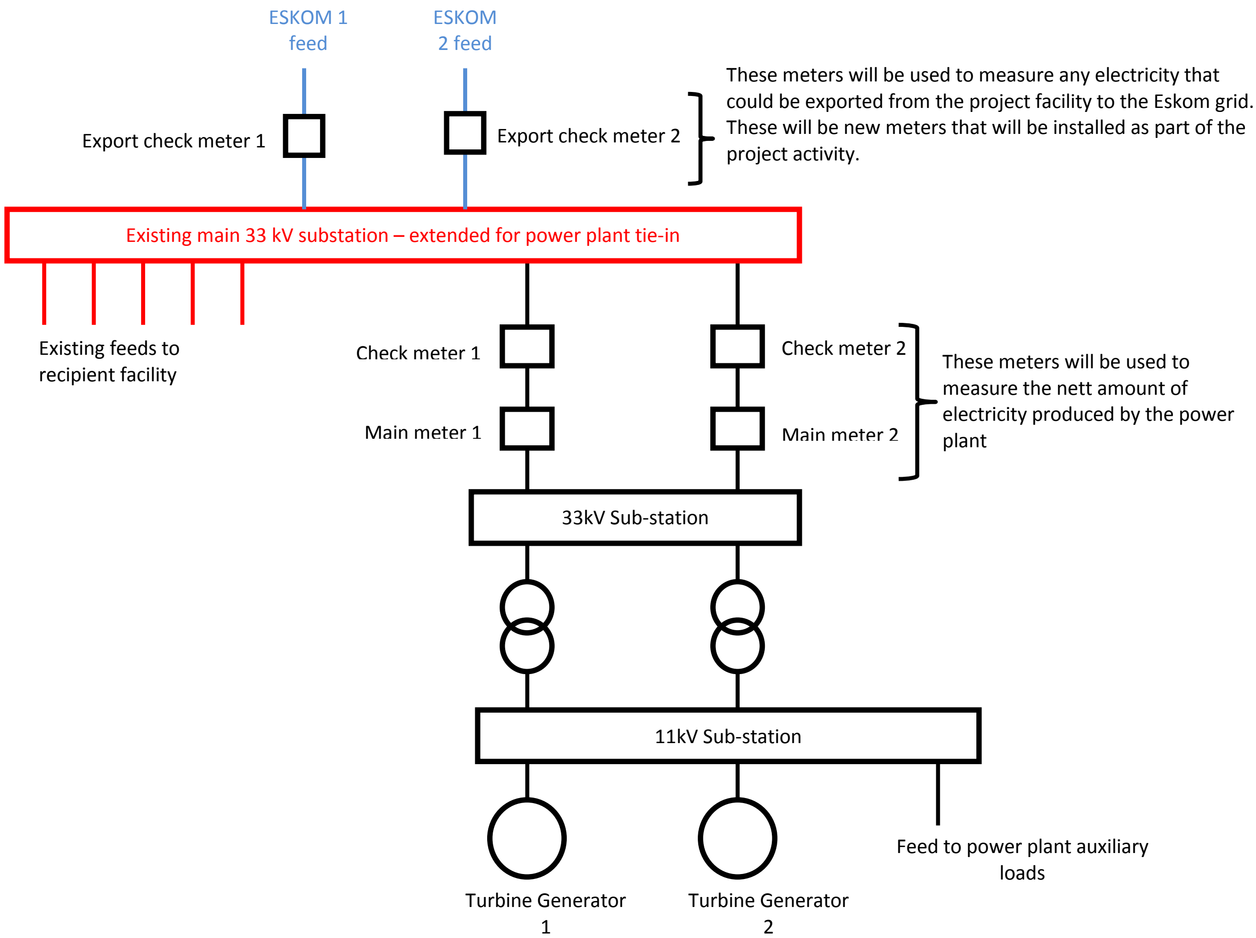


Figure 11: Metering diagram

Monitoring accuracy

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

Data collection and storage

On a monthly basis, the project activity plant manager (or other designated employee) and a representative from Grootegeluk Coal Mine will read electricity meters to determine the quantity of electricity produced by the project activity. The electricity readings will be logged electronically for the purposes of calculating emission reductions.

The information will be saved onto the Exxaro's SCADA system, as well as Exxaro's 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 ACM0012, all data collected as part of the monitoring plan will be archived electronically, and will be kept for a minimum of two years at the end of the crediting period.

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

>>

The starting date of the project activity is the expected construction contract signing date, which is quarter 2 (Q2) of 2013 (30/06/2013).

C.1.2. Expected operational lifetime of project activity

>>

Twenty (20) years[30].

C.2. Crediting period of project activity

C.2.1. Type of crediting period

>>

A single ten (10) year crediting period has been chosen for the project activity.

C.2.2. Start date of crediting period

>>

The starting date of the first crediting period is the start date of project commissioning, which is expected 01/08/2015.

C.2.3. Length of crediting period

>>

Ten (10) years.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>

The project facility and the project activity make important and noteworthy contributions to the sustainable development of South Africa[2, 3]. The scoping phase of the environmental impact assessment (EIA) process has identified potential environmental impacts and has outlined the plan of study for the EIA[5, 6]. Synergistics Environmental Services (Pty) Ltd (Synergistics) has been appointed by Exxaro as the independent environmental consultant to undertake the Scoping EIA and EIA.

D.2. Environmental impact assessment

>>

The impacts which may be significant for the project activity include: air quality, surface and ground water quality, social and economic impacts. As such, specialist input and studies will be conducted for the following environmental components:

- Air Quality Assessment.
- Traffic Impact Assessment.
- Surface Water Assessment.
- Groundwater Assessment.

The key legislation applicable to the proposed project activity includes:

- The National Environmental Management Act (No. 107 of 1998) (NEMA);
- The Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA);
- The National Water Act (No. 36 of 1998) (NWA); and
- The National Environmental Management: Air Quality Act (No. 39 of 2004) (NEMAQA).

The Scoping EIA and EIA will be conducted in line with the above mentioned legislation, additionally, the EIA process has been developed to ensure that it complies with GNR 543 Sections 26 to 33 and the associated guidelines as well as the requirements of the MPRDA. Synergistics, as the independent EIA consultant, has deemed that the environmental process followed to date meets the requirements of the legislation to ensure that the regulatory authorities receive sufficient information to enable them to make an informed decision to accept the scoping report and approve the plan of study for EIA.

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

>>

Comments by local stakeholders were invited and compiled through a local stakeholders meeting which was held on Tuesday 13 December 2011. Invitation to the meeting was advertised in the local newspaper the Mogol Pos and was supplemented by posters which were on display in a number of locations around Lephalale.

The purpose of the meeting was to introduce stakeholders and interested parties to the project activity and to provide a platform from which comments could be gathered. The agenda of the consultation meeting included an introduction and attendance register sign in, a presentation of the project, a questions and answers section, followed by a summary and next steps of the consultation to conclude.

E.2. Summary of comments received

>>

A number of general and technical questions were raised throughout the stakeholder consultation. A sample of these questions is listed below:

Q: Would the project go ahead if the project is not registered as a CDM project?
A: The project would not go ahead since the revenue from the sale of CERs is a key determinant for the project to proceed.

Q: At what stage in the CDM registration cycle is the project at currently?
A: The project is currently entering the Validation stage.

Q: Does the project produce any by-products, such as tar or phenols?
A: The project does not produce any by-products such as tar or phenols since all of the volatiles are fully combusted in the flue ducts and tertiary combustion chamber.

Q: Will the project facility, the Coke Plant, be run 24hrs?
A: Yes. The project facility operates as a batch process where batteries of coke ovens will be operational over a 24hr period.

Q: Has the technology been utilised overseas?
A: The technology has to a large extent been utilised overseas, however it is considered to be the first application of this technology in South Africa.

Q: Will the electricity produced be utilised on site or exported to the grid?
A: The electricity produced will be utilised on site.

E.3. Report on consideration of comments received

>>

The stakeholder consultation was well attended by local representatives who showed a keen interest in the proposed project. A number of interesting questions were raised and answered. No objections to the project were made.

Due account of any comments received is included in the EIA process explained in sections D.1. and D.2. above.

SECTION F. Approval and authorization

>>

The Letter of Approval was received on the 13/07/2012[3].

- - - - -

Appendix 1: Contact information of project participants

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Department	
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Direct fax	
Direct tel.	
Personal e-mail	

Appendix 2: Affirmation regarding public funding

Refer to Exxaro, 2012c[12].

Appendix 3: Applicability of selected methodology

N/a.

Appendix 4: Further background information on ex ante calculation of emission reductions

Exxaro Market Coke Waste Heat Recovery Project - Grid Emissions Factor (GEF) Calculation

References:
http://www.eskom.co.za/c/article/236/cdm-calculations/
Eskom, 2011. Integrated Report 2011.
IPCC, 2006. IPCC Guidelines for National Greenhouse Gas Inventories.
V2.2.1 of the "Tool to calculate the emission factor for an electricity system". Annex 1: Default efficiency factors for power plants

The grid emissions factor (GEF) for the South African grid, is calculated utilising V2.2.1 of the "Tool to calculate the emission factor for an electricity system". The following six (6) steps of the baseline methodology procedure of the tool are utilised, namely:

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

Step 1: Identify the relevant electricity systems

The relevant electricity system is the South African National grid, which comprises the following plants and types (excluding LCMR resources):

Plant no.	Power Station / Plant name	Commissioning date	Installed capacity (MW)	Generation technology / type	Fuel type /energy source
1	**Arnot**	21/09/1971	1980	Coal Subcritical	Other Bituminous Coal
2	**Duvha**	18/01/1980	3450	Coal Subcritical	Other Bituminous Coal
3	**Hendrina**	12/05/1970	1895	Coal Subcritical	Other Bituminous Coal
4	**Kendal**	01/10/1988	3840	Coal Subcritical	Other Bituminous Coal
5	**Kriel**	06/05/1976	2850	Coal Subcritical	Other Bituminous Coal
6	**Lethabo**	22/12/1985	3558	Coal Subcritical	Other Bituminous Coal
7	**Matimba**	04/12/1987	3690	Coal Subcritical	Other Bituminous Coal
8	**Majuba**	01/04/1996	3843	Coal Subcritical	Other Bituminous Coal
9	**Matla**	29/09/1979	3450	Coal Subcritical	Other Bituminous Coal
10	**Tutuka**	01/06/1985	3510	Coal Subcritical	Other Bituminous Coal
11	**Camden**	21/12/1966	1600	Coal Subcritical	Other Bituminous Coal
12	**Grootvlei**	29/06/1969	1200	Coal Subcritical	Other Bituminous Coal
13	**Komati**	30/06/1969	1000	Coal Subcritical	Other Bituminous Coal
14	**Acacia**	13/05/1976	171	Gas/Liquid Fuel	Jet Kerosene
15	**Port Rex**	30/09/1976	171	Gas/Liquid Fuel	Jet Kerosene
16	**Ankelig**	01/10/2007	1327	Gas/Liquid Fuel	Diesel Oil
17	**Gourikwa**	01/10/2007	740	Gas/Liquid Fuel	Diesel Oil
18	**Local independent power producers (IPPs)**	N/a	N/a	N/a	N/a
19	**Imports**	N/a	N/a	N/a	N/a

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

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

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

See PDD for detailed description of selection.

	Coal-fired		Pumped storage		Gas		Hydro-electric (LCMR)		Wind (LCMR)		Nuclear (LCMR)		Percentage LCMR
Period	**Electrical output (MWh)**	**Electrical output (%)**	**Electrical output (MWh)**	**Electrical output (%)**	**Electrical output (MWh)**	**Electrical output (%)**	**Electrical output (MWh)**	**Electrical output (%)**	**Electrical output (MWh)**	**Electrical output (%)**	**Electrical output (MWh)**	**Electrical output (%)**	
2010-2011	220,219,000	92.75%	2,953,000	1.24%	197,000	0.08%	1,960,000	0.84%	2,000	0.00%	12,099,000	5.16%	6.00%
2009-2010	215,940,000	92.75%	2,742,000	1.18%	49,000	0.02%	1,274,000	0.55%	1,000	0.00%	12,806,000	5.57%	6.12%
2008-2009	211,941,000	92.57%	2,772,000	1.21%	143,000	0.06%	1,082,000	0.48%	2,000	0.00%	13,004,000	5.75%	6.23%
2007-2008	222,908,000	93.22%	2,979,000	1.25%	1,153,000	0.48%	751,000	0.32%	1,000	0.00%	11,317,000	4.82%	5.14%
2006-2007	215,211,000	92.59%	2,947,000	1.27%	62,000	0.03%	2,443,000	1.06%	2,000	0.00%	11,780,000	5.13%	6.20%
Average	*217,243,800*	*92.78%*	*2,878,600*	*1.23%*	*320,800*	*0.14%*	*1,502,000*	*0.65%*	*1,600*	*0.00%*	*12,201,200*	*5.29%*	*5.94%*

Option (a) Simple OM is appropriate for use.

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

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

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

Where:

EFgrid,OMsimp = Simple operating margin CO2 emission factor in year y (tCO2/MWh)

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

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

m = All power units serving the grid in year y except low-cost / must-run power units

y = The relevant year as per the data vintage chosen in Step 3

Determination of EFEL,m,y

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

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

Where:

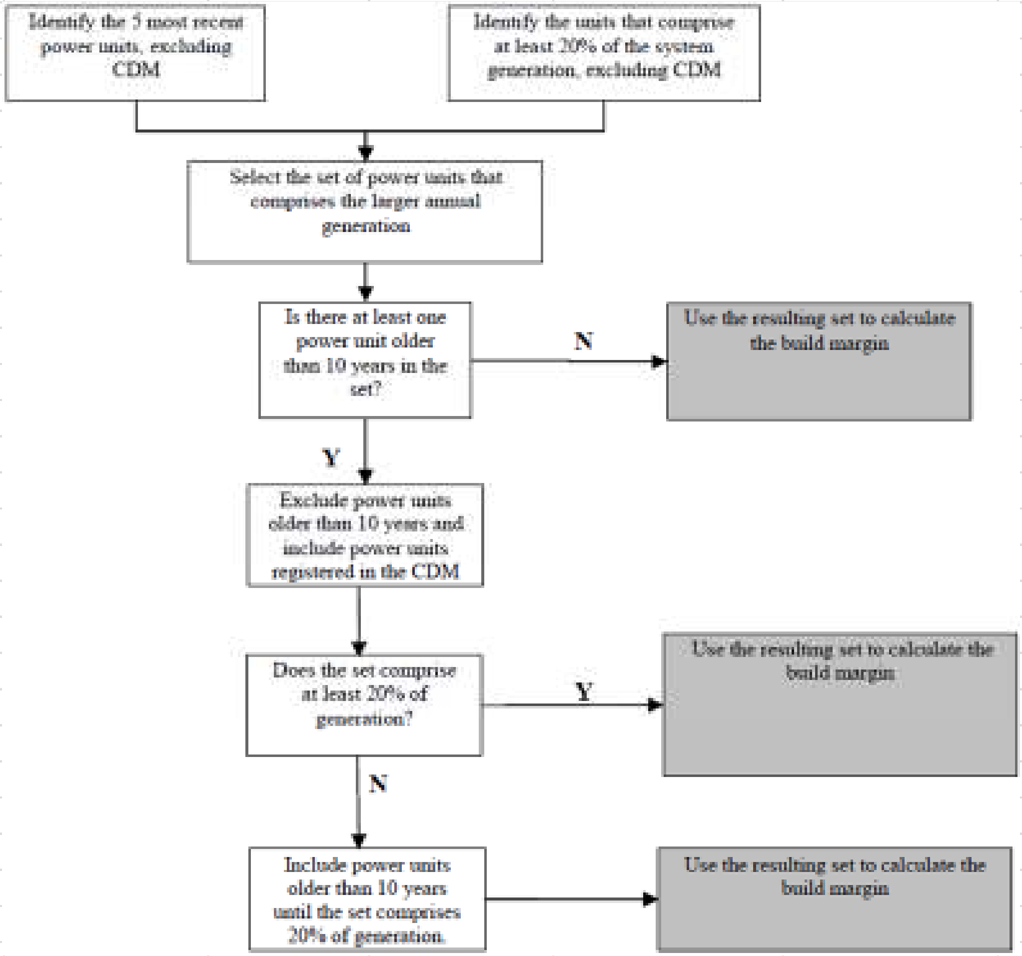
EFEL,m,y = CO2 emission factor of power unit m in year y (tCO2/MWh)
FCi,m,y = Amount of fossil fuel type i consumed by power unit m in year y (Mass or volume unit)
NCVi,y = Net calorific value (energy content) of fossil fuel type i in year y (GJ/mass or volume unit)
EFCO2,i,y = CO2 emission factor of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

										2008/09			2009/10			2010/11		
Plant no.	Power Station / Plant name (m)	Installed capacity (MW)	Generation technology	Energy Source / Fuel Type (i)	Net Calorific Value 2008/09 (NCVi,y) (GJ/t)	Net Calorific Value 2009/10 (NCVi,y) (GJ/t)	Net Calorific Value 2010/11 (NCVi,y) (GJ/t)	Fuel CO2 Emission Factor (EFCO2,i,y) (tCO2/GJ)	Efficiency	Fuel Consumption (FCi,m,y) (t)	Electricity Generation (EGm,y) (MWh)	Emission Factor of Power unit m (EFEL,m,y) (tCO2/MWh)	Fuel Consumption (FCi,m,y) (t)	Electricity Generation (EGm,y) (MWh)	Emission Factor of Power unit m (EFEL,m,y) (tCO2/MWh)	Fuel Consumption (FCi,m,y) (t)	Electricity Generation (EGm,y) (MWh)	Emission Factor of Power unit m (EFEL,m,y) (tCO2/MWh)
1	Arnot	1980	Coal Subcritical	Other Bituminous Coal	19.10	19.22	19.45	0.090	0.370	6,395,805	11,987,281	0.91	6,794,134	13,227,864	0.88	6,525,670	12,194,878	0.93
2	Duvha	3450	Coal Subcritical	Other Bituminous Coal	19.10	19.22	19.34	0.090	0.370	11,393,553	21,769,489	0.89	11,744,606	22,581,228	0.89	10,639,393	20,267,508	0.91
3	Hendrina	1895	Coal Subcritical	Other Bituminous Coal	19.10	19.22	19.34	0.090	0.370	7,122,918	12,296,687	0.99	6,905,917	12,143,292	0.98	7,139,198	11,938,206	1.04
4	Kendal	3840	Coal Subcritical	Other Bituminous Coal	19.10	19.22	19.34	0.090	0.370	15,356,595	23,841,401	1.10	13,866,514	23,307,031	1.02	15,174,501	25,648,258	1.02
5	Kriel	2850	Coal Subcritical	Other Bituminous Coal	19.10	19.22	19.34	0.090	0.370	9,420,764	18,156,686	0.89	8,504,715	15,906,816	0.92	9,527,185	18,204,910	0.91
6	Lethabo	3558	Coal Subcritical	Other Bituminous Coal	19.10	19.22	19.34	0.090	0.370	16,715,323	23,580,232	1.21	18,170,227	25,522,698	1.22	17,774,699	25,500,366	1.21
7	Matimba	3690	Coal Subcritical	Other Bituminous Coal	19.10	19.22	19.34	0.090	0.370	13,991,453	26,256,068	0.91	14,637,481	27,964,141	0.90	14,596,842	28,163,040	0.90
8	Majuba	3843	Coal Subcritical	Other Bituminous Coal	19.10	19.22	19.34	0.090	0.370	12,554,406	22,676,924	0.95	12,261,833	22,340,081	0.94	13,020,512	24,632,585	0.91
9	Matla	3450	Coal Subcritical	Other Bituminous Coal	19.10	19.22	19.34	0.090	0.370	12,689,387	21,863,400	0.99	12,438,391	21,954,536	0.97	12,155,421	21,504,422	0.98
10	Tutuka	3510	Coal Subcritical	Other Bituminous Coal	19.10	19.22	19.34	0.090	0.370	11,231,583	21,504,122	0.89	10,602,839	19,847,894	0.92	10,191,709	19,067,501	0.93
11	Camden	1600	Coal Subcritical	Other Bituminous Coal	19.10	19.22	19.34	0.090	0.370	3,876,211	6,509,079	1.02	4,732,163	7,472,070	1.09	4,629,763	7,490,836	1.07
12	Grootvlei	1200	Coal Subcritical	Other Bituminous Coal	19.10	19.22	19.34	0.090	0.370	674,538	1,249,556	0.92	1,637,371	2,656,230	1.06	2,132,979	3,546,952	1.04
13	Komati	1000	Coal Subcritical	Other Bituminous Coal	19.10	19.22	19.34	0.090	0.370	-	-	0.87	664,497	1,016,023	1.13	1,271,010	2,060,141	1.07
14	Acacia	171	Gas/Liquid Fuel	Jet Kerosene	42.00	42.00	42.00	0.070	0.300	-	-	0.84	895	2,187	1.20	352	992	1.04
15	Port Rex	171	Gas/Liquid Fuel	Jet Kerosene	42.00	42.00	42.00	0.070	0.300	-	-	0.84	296	889	0.98	223	5,507	0.12
16	Ankelig	1327	Gas/Liquid Fuel	Diesel Oil	41.40	41.40	41.40	0.073	0.300			0.87	6,341	23,367	0.82	35,110	130,241	0.81
17	Gourikwa	740	Gas/Liquid Fuel	Diesel Oil	41.40	41.40	41.40	0.073	0.300			0.87	5,852	22,612	0.78	16,272	62,233	0.79
18	Local IPPs	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	-		-	-		-	-	1,833,000	-
19	Imports	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	-	12,189,000		-	13,754,000		-	13,613,000	
										Emission Factor of grid (EFEL, grid, 2008/09)		***0.93***	*Emission Factor of grid (EFEL, grid, 2009/10)*		***0.92***	*Emission Factor of grid (EFEL, grid, 2010/11)*		***0.92***
										EFgrid,OMsimple,2010/11								***0.92***

Therefore, EFgrid,OMsimple,2009 0.92

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

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



5a: Identify the 5 most recent power units, excluding CDM (SET5-units)

Plant no.	Power Station / Plant name	Commissioning date	CDM	Electricity Generation (EGm,y) (MWh)
16	**Ankelig**	01/10/2007	No	130,241
18	**Gourikwa**	01/10/2007	No	1,833,000
8	**Majuba**	01/04/1996	No	24,632,585
4	**Kendal**	01/10/1988	No	25,648,258
7	**Matimba**	04/12/1987	No	28,163,040
Total				***80,407,124***

5b: Identify the units that comprise at least 20% of the system generation, excluding CDM (SET≥20%)

The AEGtotal in 2010/11 =	235,864,576	MWh
With 20% of AEGtotal in 2010/11 =	47,172,915	MWh
SET>20% include Ankelig, Gourikv	52,244,084	MWh

5c: Select the set of power units that comprises the larger annual generation

SET5-units comprise the set of power units with the larger annual generation.

5d: Is there at least one power unit older than 10 years in the set?

Yes - three of the power units in SET5-units are older than 10 years, the procedure is further carried out below.

5e: Exclude power units older than 10 years and include power units registered in the CDM

No power units are registered under the CDM and the next step is carried out below.

5f: Does the set comprise at least 20% of generation?

No – there are no power units registered with the CDM that can be included as per the above.

5g: Include power units older than 10 years until the set comprises 20% of generation

generation. As such, the SET≥20% including Majuba and Kendal with 50,280,843 MWh comprise the SETsample and SET≥20% are used to calculate the build margin below utilising equation "3" of the tool since the power units included in the build margin m correspond to the sample group SETsample-CDM->10yrs, then, as a conservative approach, only option A2 from guidance in Step 4 (a) can be used as follows:

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

Where:

EFEL,m,y	= CO2 emission factor of power unit m in year y (tCO2/MWh)
EF CO2,m,i,y	= Average CO2 emission factor of fuel type i used in power unit m in year y (tCO2/GJ)
nm,y	= Average net energy conversion efficiency of power unit m in year y
m	= All power units serving the grid in year y except low-cost/must-run power units
y	= The relevant year as per the data vintage chosen in Step 3

Plant no.	Power Station / Plant name (m)	Installed capacity (MW)	Generation technology	Energy Source / Fuel Type (i)	2010/11			
					Electricity Generation (EGm,y) (MWh)	Fuel CO2 Emission Factor (EFCO2,i,y) (tCO2/GJ)	Average net energy conversion efficiency of power unit m in year y	Emission Factor of Power unit m (EFEL,m,y) (tCO2/MWh)
8	Majuba	3843	Coal Subcritical	Other Bituminous Co	24,632,585	0.090	0.37	0.87
4	Kendal	3840	Coal Subcritical	Other Bituminous Co	25,648,258	0.090	0.37	0.87
					EFgrid,BM,y			***0.87***

Therefore, EFgrid,BM,y = ***0.87***

Step 6: Calculate the combined margin emissions factor

The combined margin (CM) emissions factor (EFgrid,CM,y) is calculated using the Weighted average CM method, Option A and equation "13" of the tool:

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

Where:

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

Therefore:

EFgrid,OM,y	*wOM*	*EFgrid,BM,y*	*wBM*	*EFgrid,CM,y*
0.92	***0.5***	***0.87***	***0.5***	***0.90***

Appendix 5: Further background information on monitoring plan

N/a.

Appendix 6: Summary of post registration changes

N/a.

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History of the document

Version	Date	Nature of revision
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	EB 66 13 March 2012	Revision required to ensure consistency with the “Guidelines for completing the project design document form for CDM project activities” (EB 66, Annex 8).
03	EB 25, Annex 15 26 July 2006	
02	EB 14, Annex 06b 14 June 2004	
01	EB 05, Paragraph 12 03 August 2002	Initial adoption.
Decision Class: Regulatory **Document Type:** Form **Business Function:** Registration		