



**CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006**

CONTENTS

- A. General description of project activity
- B. Application of a baseline and monitoring methodology
- C. Duration of the project activity / crediting period
- D. Environmental impacts
- E. Stakeholders' comments

Annexes

Annex 1: Contact information on participants in the project activity

Annex 2: Information regarding public funding

Annex 3: Baseline information

Annex 4: Monitoring plan

**SECTION A. General description of project activity****A.1. Title of the project activity:**

Silicon Smelters Energy Efficiency Improvement Project - Furnace F

Version 1.1

18/01/2012

A.2. Description of the project activity:

The Silicon Smelters Energy Efficiency Improvement Project – Furnace F – (hereafter, the “Project”), developed by Silicon Smelters (Pty) Ltd (hereafter referred to as the “Project Developer”), is an industrial energy efficiency project that will reduce the electricity consumption in the production of ferrosilicon (FeSi) alloy (a key component in steel making) at its Witbank facility in South Africa (hereafter referred to as the “Host Country”).

Prior to the project activity Furnace F is an open, tapered, submerged electric arc furnace producing Ferrosilicon. The production of each tonne of ferrosilicon alloy produced in the current submerged electric arc furnace requires approximately 9.07 MWh of the South African national grid-fed electricity. The Ferrosilicon is produced to within a very constrained quality range. The below table indicates the typical quality specifications as well as the minimum and maximum ranges. The production capacity of the furnace is limited by the electrical transformers and historically the static design has produced on average 24,340 tonnes of FeSi per annum.

Table A.2.1: Quality Range of Ferrosilicon produced

FeSi	Typical	Min	Max
Si	72.6%	65.0%	78.6%
Al	2.4%	0.6%	6.6%
Ca	0.4%	0.0%	2.6%
Fe	23.9%	17.5%	31.4%

The project is to redesign the current static Furnace F with a new design of a cylindrical rotating electric arc furnace, rotary skirt and new tapping stringer arrangement. The approach of the project is to redesign new energy efficient technology into the existing furnace infrastructure, which is designed for a different technology. Under normal circumstances such technology would not be installed into old furnaces, but repairs would be done regularly to maintain the furnace and continue operation as such. Continued operation of the original electric arc furnace and its regular maintenance is the operating case prior to the implementation of the project activity and this is the baseline scenario.

The main feature of the new technology is that it enables the furnace to operate in rotating mode that will ensure a more even distribution of raw materials, reductants and heat which increases the energy performance. The project activity will involve replacing the static furnace shell with a rotating shell, adding a rotary skirt, changing the shape of the shell from tapered to cylindrical and adding in a tapping



stringer arrangement. These main alterations to the existing furnace allow rotation and more optimal distribution of materials and heat which in turn increases the energy efficiency of the electric arc furnace. The capacity of the furnace, which is determined by the electrical transformers limiting the electricity supply, will not be changed.

It is anticipated that this will reduce the specific electricity consumption of alloy production by some 5-10% to between 8.1 and 8.6 MWh per tonne of alloy produced. The aim is to achieve at least a 0.4 MWh reduction per ton of alloy in specific electricity consumption, with a belief that up to 0.91 MWh could be achieved under optimal operating conditions and a good fit between the technology and local operating conditions. The project will thus displace electricity from the South African grid, which is mostly produced from coal. The project activity will therefore increase the electrical efficiency of the furnace and thereby reduce CO₂ emissions resulting from the production of electricity from coal. The amounts of coal, char/charcoal and coke used as reductants and paste (mostly made of carbon) used as electrode in the submerged electric arc furnaces are not expected to be affected significantly by the project.

The decision to redesign Furnace F was considered in the first quarter of 2008 but the real action of the project activity was the deposit payment for the steelwork on the 17/07/2008 and this is considered to be the project activity start date. The physical replacement of the static arc furnace by the rotating arc furnace redesigning implementation process started in August 2008 and was completed in November 2008. Following the successful Transalloys Manganese Alloy Smelter Energy Efficiency Project (CDM reference 1027) that has been registered under the CDM, the Project Developer has been considering carbon credits from the start of preliminary investment planning in 2007 for several project types. See section B.5 for further details on the timeline of this project.

The primary emission sources from the furnace are the consumption of electricity and the use of carbon reductants. The CO₂ emissions from the carbon reductants used in the process are not expected to change in the project activity versus in the baseline as the quantities used are expected to remain approximately the same. Therefore this project focuses on reducing CO₂ emissions resulting from fossil fuel electricity production for the South African grid by reducing electricity consumption per tonne of FeSi produced. By using less electricity per tonne of FeSi produced in the project activity versus in the baseline, a more efficient Furnace F will reduce CO₂ emissions per tonne of FeSi produced.

The project is helping the Host Country fulfil its goals of promoting sustainable development in the following ways:

- **Economic**

- It makes a significant contribution to maintaining the livelihoods of the workers employed in this and ancillary industries both up and down stream of the facility;
- It acts as a clean technology demonstration project, encouraging development of modern and more efficient utilisation of electricity throughout the Country;
- It allows Silicon Smelters to maintain and increase its competitive advantage in what is a competitive, global, export focussed market. Recently, export focussed sectors have seen an increased risk of facilities going out of business as a result of the strong Rand in combination with higher electricity prices, this project will contribute to mitigating some of these risks.



- **Social**
 - It reduces directly the amount of electricity needed to produce the ferrosilicon alloy and hence reduces the demand placed on the South African national grid making more electricity available for other consumers;
- **Environmental**
 - It has more effective capture of fugitive dust from the smelting process, allowing better particulate capture and reduced particulate emissions to the local environment.
 - It reduces the amount of carbon emissions associated with the production per tonne of FeSi and thus contributes towards the Country's emission reduction goals.

A.3. Project participants:
Table A.3.1 - Project participants

Name of party involved (*) (host) indicates a host party)	Private and/or public entity(ies) Project participants (*) (as applicable)	Kindly indicate if the party involved wishes to be considered as project participant (Yes/No)
South Africa* (host)	Silicon Smelters (Pty) Ltd	No
	EcoMetrix Africa (Pty) Ltd	Yes

(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time requesting registration, the approval by the Party(ies) involved is required.

A.4. Technical description of the project activity:
A.4.1. Location of the project activity:
A.4.1.1. Host Party(ies):

South Africa (the "Host Country")

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

Mpumalanga Province

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

eMalahleni

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

Silicon Smelters (Pty) Ltd is located in, eMalahleni (Witbank), South Africa.
 The physical address is: Silicon Smelters (Rand Carbide), Old Middelburg Rd, eMalahleni
 The geographical co-ordinates are: 25° 51' 74" -29° 13' 39"

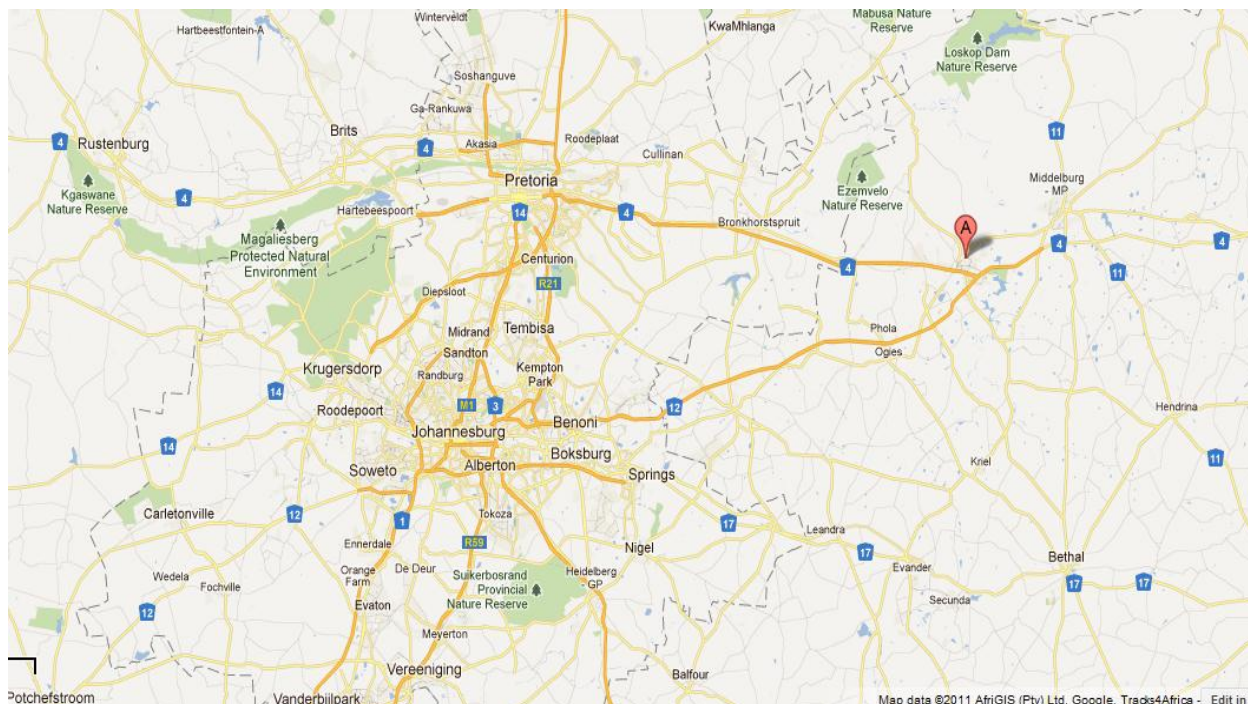


Figure A.4.1.4.1 – Silicon Smelters operations in Emalahleni, Mpumalanga Province, South Africa

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

According to Annex A of the Kyoto Protocol, this project activity is a Type II Energy Efficiency Improvement Project, Sectoral Scope 09, Metal production.

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

The redesign of the furnace is based on proprietary design innovations and in-house expertise within the FerroAtlántica Group operations in Europe where the design has been implemented at their smelting facilities. The design therefore meets European environmental standards and represents a safe and sound technology. The operational know-how and skills to operate the new design of the furnace efficiently will be skills and knowledge that are learnt from FerroAtlántica's expertise. The quality of raw materials in South Africa is different and this has an influence on performance and operation. Optimal operation of the new furnace design will need to be learnt by the local furnace operators.

The facility uses a submerged electric arc furnace for ferrosilicon alloy production. Furnace F is a self-built furnace based on an Elkem¹ design. The original furnace technology is made up of the following components:

- static, tapered shell
- open furnace
- 3 electrodes
- 46.5 MVA transformer capacity
- Scada monitoring system

¹ http://www.elkem.com/eway/default.aspx?pid=242&trg=Main_7127&Main_7127=7139:0:4:4138:1:0:0:::0:0



In the scenario which exists prior to the project activity, reductants and raw materials are added into the shell and the electrodes containing the electrode paste are then inserted into the mixture and electricity is applied to the furnace. All reductants, raw materials and electrode paste are measured in terms of quantity (by loadcells and weighbridges) and quality (by sample analysis carried out at the onsite laboratory) prior to their addition to the furnace. The total lifetime of the furnace is at least 50 years. Since Furnace F has been in operation for 36.5 years since its commissioning in 1972 it has a conservative estimated remaining lifetime of 13 years as at the start date of the project activity in mid-2008. Continued use of the furnace would require annual maintenance which consists of a yearly shutdown period of between 7 and 15 days.

The project activity is to introduce new energy efficient technology design into the existing furnace infrastructure, which is designed for a different technology. The main feature of the new furnace design is that it enables the furnace to operate in rotating mode that will ensure a more even distribution of raw materials, reductants and heat which increases the energy performance and thereby makes it more efficient. The main alterations to the existing furnace to allow rotation and more optimal distribution of materials and heat are:

- Removal of static shell and replacement by a rotating shell
- Change of the furnace shell shape from tapered to straight cylindrical
- Addition of rotary skirt for furnace roof
- Addition of tapping stringer arrangement

This change to the furnace design will directly reduce the electricity consumption per ton of FeSi produced. Consequently, this will have the effect of reducing CO₂ emissions associated with the offsite production of the electricity since the facility is connected to the national South African grid which is largely coal fuelled. The CO₂ emissions resulting from the reductants consumed in the process and produced onsite are also not expected to change significantly in the project activity. The new furnace design will not introduce any management changes to the operation and monitoring of the furnace and the same Scada system will be in operation. All raw materials, reductants and electrode paste will be measured in terms of quality and quantity as in the scenario before the implementation of the project activity. The transformer capacity of the furnace will remain unchanged at 46.5 MVA and thus the capacity of the furnace is not expected to change and the level of service provided by Furnace F should remain the same after the implementation of the project activity as before. The project activity involves taking Furnace F out of production for a few months to install the new design. Once the redesign is complete the furnace lifetime is expected to be at least 50 years.

The baseline scenario has been identified in section B.4 as the continued use of the installed technology and thus it is the same as the scenario existing prior to the implementation of the project activity.

**A.4.4. Estimated amount of emission reductions over the chosen crediting period:****Table A4.4.1 - Annual estimation of emission reductions in tonnes of CO_{2e}.**

Years	Annual estimation of emission reductions in tonnes of CO_{2e}.
2012	21,866
2013	21,866
2014	21,866
2015	21,866
2016	21,866
2017	21,866
2018	21,866
2019	21,866
2020	21,866
2021	21,866
Total estimated reductions (tons of CO_{2e})	218,660
Total number of crediting years	10 years
Annual average over the crediting period of estimated reductions (tons of CO_{2e})	21,866

A.4.5. Public funding of the project activity:

The project will not receive any public funding from Parties included in Annex I of the UNFCCC.

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

The project uses the revised approved methodology AM0038 “*Methodology for improved electrical energy efficiency of an existing submerged electric arc furnace used for the production of silicon and ferro alloys.*”, (version 03.0.0) EB 61.

To calculate the grid emission factor, the project uses the approved “*Tool to calculate the emission factor for an electricity system*”; (version 02.2.1) EB 63, annex 19.

To select the baseline and demonstrate additionality, the project uses the step-wise approach defined in AM0038, which refers to the latest version of the “*Tool for the demonstration and assessment of additionality*”; (version 06.0.0), EB65, annex 21. .

To determine the remaining lifetime of Furnace F, the project uses the “*Tool to determine the remaining lifetime of the equipment*” (version 01), EB 50, annex 15 .

Additional guidance used to perform the investment analysis are the “*Guidelines on the assessment of investment analysis*” (version 05), EB 62, annex 5.

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

This project activity is not part of a programme of activities (PoA) and is an independent CDM large scale project. The applicability criteria with respect to electric arc furnace included in a programme are therefore not applicable to the Silicon Smelters Energy Efficiency Improvement Project - Furnace F.

The project meets all the applicability criteria as set out in the methodology AM0038 as demonstrated in the below table:

Table B.2.1 – AM0038 applicability criteria and project justification

Applicability Criteria	Justification
Submerged electrical arc furnaces are used for production of the same type of product both in the project case and baseline	Both the baseline (historic production) and the project case (production after revamp) produce the same product, being ferrosilicon (FeSi)
The alloy(s) produced in the electric arc furnace is ferrosilicon, ferromanganese, silicomanganese, silicon	The alloy produced in Furnace F is ferrosilicon (FeSi)



<p>metal or ferrochrome</p> <p>The electricity consumed, both in the project case, and in the baseline, by the submerged electric arc furnace is sourced from the grid and not by on-site generation</p>	<p>All the electricity consumed is bought from the national utility Eskom via the national grid in the baseline and in the project activity.</p>																																																				
<p>The geographic and system boundaries for the relevant electricity grid can be clearly identified and information on the characteristics of the grid is available.</p>	<p>There is only one national grid for South Africa, and therefore the geographic and system boundaries can be clearly identified. Information on the characteristics of the grid (mostly electricity generation and fuel consumption of all the plants) has been gathered from the national electricity provider, Eskom, in order to determine the grid emission factor according to '<i>Tool to calculate the emission factor for an electricity system</i>' (version 02.2.1).</p>																																																				
<p>The quality of the raw material and products produced is not affected by the project activity and remains unchanged.</p>	<p>The quality of the raw materials and product (elementary analysis) will remain within the same range in the baseline and project activity and will not be affected by the refurbishment of the furnace. The below tables show the quality range of the raw materials and product that have been used in the baseline and will be monitored to ensure they remain within the same range in the project activity.</p> <p>FeSi Quality Range</p> <table border="1" data-bbox="659 1126 1477 1305"> <thead> <tr> <th>FeSi</th> <th>Typical</th> <th>Min</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Si</td> <td>73.1%</td> <td>65.0%</td> <td>78.6%</td> </tr> <tr> <td>Al</td> <td>2.3%</td> <td>0.6%</td> <td>6.6%</td> </tr> <tr> <td>Ca</td> <td>0.5%</td> <td>0.0%</td> <td>2.6%</td> </tr> <tr> <td>Fe</td> <td>23.4%</td> <td>17.5%</td> <td>31.4%</td> </tr> </tbody> </table> <p>Quartz Quality Range</p> <table border="1" data-bbox="659 1373 1477 1541"> <thead> <tr> <th>Quartz</th> <th>Average</th> <th>Min</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Fe₂O₃</td> <td>1.2%</td> <td>0.7%</td> <td>2.2%</td> </tr> <tr> <td>SiO₂</td> <td>96.0%</td> <td>90.2%</td> <td>98.7%</td> </tr> <tr> <td>AlO₃</td> <td>0.8%</td> <td>0.03%</td> <td>3.8%</td> </tr> </tbody> </table> <p>Milscale Quality Range</p> <table border="1" data-bbox="659 1608 1477 1776"> <thead> <tr> <th>Milscale</th> <th>Average</th> <th>Min</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Fe₂O₃</td> <td>70.59%</td> <td>60.8%</td> <td>2.2%</td> </tr> <tr> <td>SiO₂</td> <td>5.14%</td> <td>3.4%</td> <td>98.7%</td> </tr> <tr> <td>AlO₃</td> <td>0.57%</td> <td>0.03%</td> <td>3.8%</td> </tr> </tbody> </table>	FeSi	Typical	Min	Max	Si	73.1%	65.0%	78.6%	Al	2.3%	0.6%	6.6%	Ca	0.5%	0.0%	2.6%	Fe	23.4%	17.5%	31.4%	Quartz	Average	Min	Max	Fe ₂ O ₃	1.2%	0.7%	2.2%	SiO ₂	96.0%	90.2%	98.7%	AlO ₃	0.8%	0.03%	3.8%	Milscale	Average	Min	Max	Fe ₂ O ₃	70.59%	60.8%	2.2%	SiO ₂	5.14%	3.4%	98.7%	AlO ₃	0.57%	0.03%	3.8%
FeSi	Typical	Min	Max																																																		
Si	73.1%	65.0%	78.6%																																																		
Al	2.3%	0.6%	6.6%																																																		
Ca	0.5%	0.0%	2.6%																																																		
Fe	23.4%	17.5%	31.4%																																																		
Quartz	Average	Min	Max																																																		
Fe ₂ O ₃	1.2%	0.7%	2.2%																																																		
SiO ₂	96.0%	90.2%	98.7%																																																		
AlO ₃	0.8%	0.03%	3.8%																																																		
Milscale	Average	Min	Max																																																		
Fe ₂ O ₃	70.59%	60.8%	2.2%																																																		
SiO ₂	5.14%	3.4%	98.7%																																																		
AlO ₃	0.57%	0.03%	3.8%																																																		
<p>The local regulations/programs do not cap the level of grid electricity that can be procured by the production facility where the project</p>	<p>South African and local regulations/programs do not constrain the facility from using electricity from the grid.</p>																																																				



activity is implemented.	
Data for the most recent three years preceding the implementation of the project activity is available to estimate the baseline emissions.	Data for the three years prior to the revamp of Furnace F beginning in August 2008 (August 2005 to July 2008) is available and will be used to estimate the baseline emissions.
Emission reduction credits shall be claimed only until the end of the lifetime of the equipment, as determined using the ' <i>Tool to determine the remaining lifetime of equipment</i> '.	The crediting period of the emission reductions is limited to 10 years. An independent expert was consulted to determine the remaining lifetime of the equipment and he determined that the total furnace lifetime would be 50 years ² . Furnace F was commissioned in 1972 and thus had been in operation for 36 years when it was refurbished in 2008. At this point the remaining lifetime was 14 years. As of the expected start date of the crediting period (01/08/2012) Furnace F would have 11 years of remaining lifetime in the baseline case. Therefore emission reduction credits shall only be claimed from the crediting period start date or registration date, whichever is the later, for a maximum of 10 years or until December 2022, whichever occurs first.
The project activity does not result in increase in the production capacity of the production facility, where the project is implemented, during the crediting period	The production capacity of an electric arc furnace is determined by its electrical capacity. This is limited by the electrical transformer capacity. In the baseline Furnace F has electrical transformer capacity of 46.5 MVA. The transformers were not replaced nor upgraded as part of the redesign (project activity) and therefore the electrical transformer capacity of Furnace F remains constant at 46.5 MVA. This means that the production capacity of the furnace remains unchanged in the project activity as compared to the baseline.

This project activity is not part of a programme of activities (PoA) and is an independent CDM large scale project. The applicability criteria with respect to electric arc furnace included in a programme are therefore not applicable to the Silicon Smelters Energy Efficiency Improvement Project - Furnace F.

All the above applicability conditions are met, and therefore the methodology AM0038 is applicable to the project.

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

Spatial boundaries

The project boundary comprises the following two components:

1. The electricity grid from which the electricity used in the project activity is purchased, as defined in the '*Tool to calculate the emission factor of an electricity system*' (version 02.2.1); in this case the furnace is connected to the South African grid, owned and operated by Eskom.

² See reference #07 email from independent FeSi furnace expert.

- The physical structure of the submerged electric arc furnace, as described in figure B.3.1 below. As can be seen from the figure, the FeSi production is a slagless process i.e. there are no slags coming from the furnace tap.

The project concerns Furnace F at Silicon Smelter's facility in eMalahleni

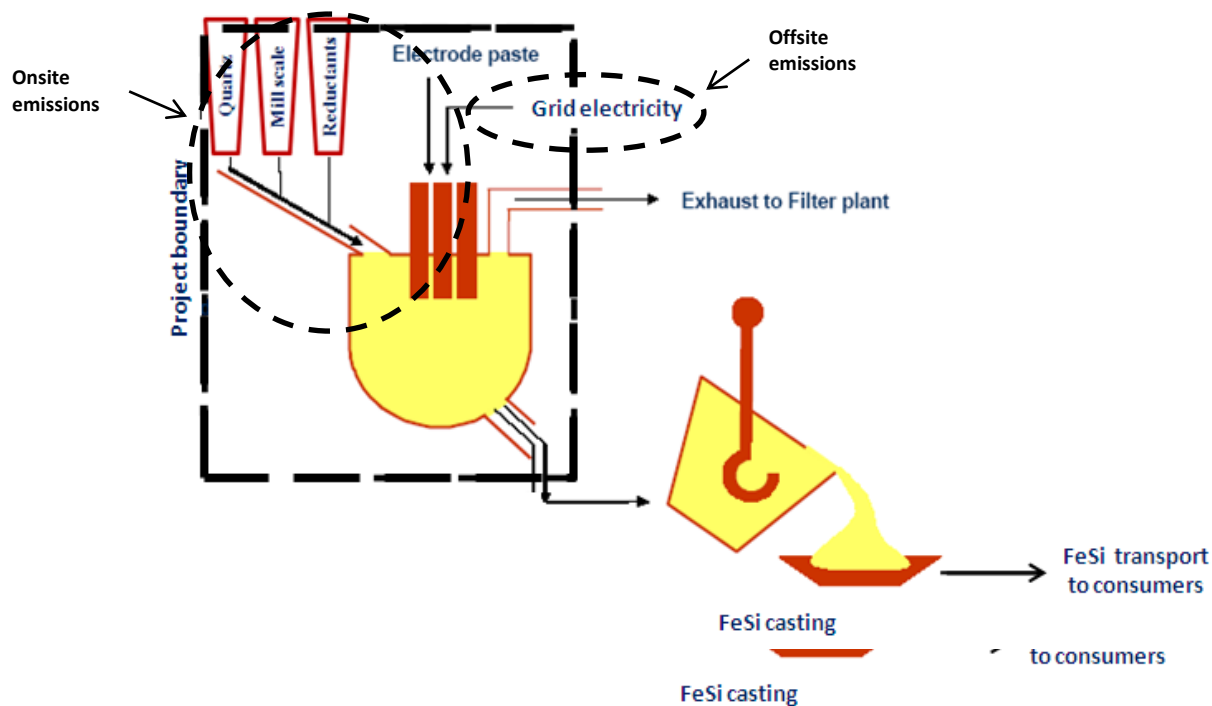


Figure B3.1 - Spatial extent of the project boundary

(Excluding the grid generation capacity according to 'Tool to calculate the emission factor of an electricity system' (version 0.2.2.1))

Emissions sources

The emissions sources included in the project boundary are defined in the table below.

**Table B3.1** - Emissions sources included in or excluded from the project boundary

	Source	Gas	Included?	Justification / Explanation
Baseline	Grid electricity generation	CO ₂	Included	▪ Only CO ₂ emissions associated with the electricity consumption of the submerged arc electric furnace will be counted, based on most recent 3 year historic data and the ‘ <i>Tool to calculate the emission factor of an electricity system</i> ’ (version 02.2.1)
		CH ₄	Excluded	▪
		N ₂ O	Excluded	▪
	Emissions from the consumption of reductants	CO ₂	Included	▪ Although some part of the carbon will end up in the end product it is assumed that 100% will be emitted to the air via the exhaust gases. Carbon content is measured on 3 year historic average reductant consumption.
		CH ₄	Excluded	▪ No CH ₄ emissions.
		N ₂ O	Excluded	▪ N ₂ O emissions are excluded for simplification. ^a
	Emissions from the consumption of electrode paste	CO ₂	Included	▪ Based on 3 year historic average electrode paste consumption.
		CH ₄	Excluded	▪ No CH ₄ emissions.
		N ₂ O	Excluded	▪ N ₂ O emissions are excluded for simplification. ^a
Project Activity	Grid electricity generation	CO ₂	Included	▪ Only CO ₂ emissions associated with the electricity consumption of the submerged arc electric furnace will be counted And the combined margin method in the ‘ <i>Tool to calculate the emission factor for an electricity system</i> ’ (version 02.2.1) will be used.
		CH ₄	Excluded	▪
		N ₂ O	Excluded	▪
	Emissions from the consumption of reductants	CO ₂	Included	▪ Although some part of the carbon will end up in the end product it is assumed that 100% will be emitted to the air via the exhaust gases. Reductant consumption is monitored during project.
		CH ₄	Excluded	▪ No CH ₄ emissions.
		N ₂ O	Excluded	▪ N ₂ O emissions are excluded for simplification. ^a
	Emissions from the consumption of electrode paste	CO ₂	Included	▪ Electrode paste consumption is monitored during the project.
		CH ₄	Excluded	▪ No CH ₄ emissions.
		N ₂ O	Excluded	▪ N ₂ O emissions are excluded for simplification. ^a

Note ^a: N₂O emissions are excluded for simplification

Reductants consist of: coal, char and charcoal. Electrode paste is used to protect the electrodes and is consumed in the process.

*Non carbon emitting raw materials*

Milscale is a residue from steel production and is used as a source of iron (Fe). Quartz is the mineral source consisting mainly of silica (Si). No carbon is emitted due to the use of these raw materials in the furnace to react to ferrosilicon (FeSi).

Other additives

A small amount of woodchips that facilitate creating enough porosity are added to the furnace but these are not measured as they have no significant contribution to CO₂ emissions from the furnace and are not required by the methodology to be monitored. The woodchips are renewable biomass sourced from land areas that are forests. These forests are in compliance with the conditions as per the definition provided in EB 23, annex 18 ‘*Definition of renewable biomass*’³ to be classified as ‘renewable’. This is evidenced by their FSC (Forest Stewardship Council)⁴ certification which ensures that:

- (a) The land remains a forest
- (b) Sustainable management practices are undertaken on these land areas to ensure, in particular, that the level of carbon stocks on these land areas does not systematically decrease over time; and
- (c) Any national or regional forestry or nature conservation regulations are complied with.

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

The determination of the baseline scenario is done according to the step-wise approach defined in AM0038.

Step 1 - Identify technically feasible options to increase energy efficiency within the project boundary

The following Alternatives are considered:

Alternative A - Complete replacement of the furnace

Under this scenario, the current furnace, as well as ancillary equipment, is entirely replaced by a new installation.

Alternative B - Continued use of installed furnace technology

Under this scenario, current submerged electric arc furnace will continue to be used, producing FeSi alloys at a specific energy consumption of about 9.07 MWh per tonne of alloy produced. Normal repair and refurbishing operations (i.e. replacing existing equipment as it is) will be carried out occasionally to maintain the availability of the furnace at a good level, but electrical efficiency cannot be increased significantly because the design of the furnace is still the same.

Alternative C - The project activity not implemented as CDM project

³ EB23, annex 18

http://cdm.unfccc.int/EB/023/eb23_repan18.pdf

⁴ <http://www.fsc.org/certification.html>



Under this scenario, the current furnace is redesigned in-situ with technology designed for new furnace, reducing specific electricity consumption to around 8.1 – 8.6 MWh per tonne of alloy owing to this new design. Core elements of the furnace (e.g. skirt and shell) are added/rebuilt according to a new rotating shell based design.

Alternative D – Other plausible and credible alternatives to the project activity

There are no other plausible or credible alternatives to the project activity that could provide energy efficient improvement to the furnace which are technically feasible to implement with comparable quality, properties and application areas, specifically that will ensure the project does not result in increased electrical capacity of the furnace.

The table below outlines some key differences between the three technically feasible Alternatives A, B and C identified. Only the change of the design (project activity) or a complete new build can deliver consistent electrical efficiencies.. Any normal repair/refurbishment could not decrease electricity consumption and thus energy efficiency of the furnace.

Table B4.1 - Typical characteristics of the three alternative scenarios identified in step 1

<i>Cost Items and Savings</i>	A. Complete replacement	B. Continued use of installed technology	C. Project activity not implemented as CDM project.
Maintenance cost.	R 0.4-0.5 million/yr	R 0.4-0.5 million/yr	R 0.4-0.5 million/yr
Investment cost	> R300 million	-	R25 million
Time offline	N/A	7 – 15 days	70 days
Electricity savings	200 – 1000 kWh / ton FeSi	0	200 – 1000 kWh / ton FeSi

Step 2 - Identify baseline alternatives that do not comply with legal or regulatory requirements

- *Legal or Regulatory requirements*
 - *Alternative A* - If a complete replacement of Furnace F was undertaken and the old one was dismantled and a brand new one was constructed, as is the case in Alternative A, then an Environmental Impact Analysis (EIA) would have to be undertaken in accordance with the National Environment Management Act (NEMA). This is an expensive and lengthy process which would definitely influence the decision to choose Alternative A. Without the outcome of a positive Record of Decision (ROD) from the EIA process, Alternative A would not legally be able to operate. Silicon Smelters would therefore have to undertake an EIA for Alternative A if they were to pursue this option.
 - *Alternative B* - There are no regulatory requirements to perform an EIA in the case of Alternative B where operations continue as they are.
 - *Alternative C* – There are no regulatory requirements to perform an EIA in the case of Alternative C where the project activity is implemented and the furnace is redesigned. See section D.2 for further explanation.

There are no other regulatory or legal requirements which would influence the choice of baseline.



- *Sector trends, legislation and government policy:*
 - *Alternative A* – There are no government policies to encourage or require complete furnace replacement at the time of the project activity start date and no legislation or policies to encourage energy efficiency within the metals sector.
 - *Alternative B* – There are no government policies preventing the continued operation of Furnace F at the time of the project start date. A demand side management programme was in place which encouraged large consumers to selectively decrease their load at peak times in return for compensation. This is a voluntary programme and no legislation or obligatory policies to encourage energy efficiency within the metals sector exist.
 - *Alternative C* – There are no government policies to encourage or require the redesign of a furnace to be more energy efficient at the start date of the project activity.

All the Alternatives A, B and C are therefore in compliance with legal and regulatory requirements, provided Alternative A were to undertake an EIA and get a positive ROD. It is not unreasonable to assume that this would happen in the case of building a completely new furnace. As discussed above there are no policies, legislation or obligatory programmes that prevent or enforce the implementation of any of the Alternatives. Therefore none of the Alternatives can be eliminated for further consideration.

Step 3 - Eliminate baseline alternatives that face prohibitive barriers

Sub step 3a – Identify barriers that would prevent the implementation of the baseline scenarios⁵.

The following barriers have been identified that would prevent baseline alternatives to occur in the absence of CDM. All Alternatives are analysed against this common set of barriers in table B.4.2.

- **Prevailing practice** - South Africa is very rich in coal resources and almost 90% of the country's electricity is generated in coal-fired power plants, mostly owned by the state-owned utility Eskom. As a result, South Africa is "one of the four cheapest electricity producers in the world"⁶. This results in the prevailing practice of large electricity users being generally unconcerned about their electricity usage because of its affordability. Due to capacity problems in the last few years, electricity prices are increasing in order to manage demand and invest in increased supply. However, at the start of the project activity there are only minor incentives for electrical efficiency projects. Moreover, as there is no important established energy efficiency culture in South Africa, as highlighted for instance in South Africa's energy efficiency strategy⁷ and the continued use of inefficient equipment at the sites of many industrial electricity users, energy efficiency activities remain under constant economic pressure.

⁵ *Note: This barrier analysis is performed as per the 'Tool for the demonstration and assessment of additionality' (version 06.0.0) applied in the context of demonstrating the baseline. The Tool has been updated significantly since the first adoption of the methodology and therefore there are conflicts between the methodology and the Tool. In such cases, the methodology has overruled the Tool.

⁶ *South Africa 2007/2008 Yearbook*, Chapter 16: Minerals, energy and geology, p413 (available at http://www.gcis.gov.za/resource_centre/sa_info/yearbook/2008/chapter15.pdf . See also

⁷ <http://www.info.gov.za/view/DownloadFileAction?id=88503> "The second reason for the high energy intensity is that South Africa is sometimes wasteful in the use of energy. Low energy costs have not encouraged industry, commerce, transport and households to adopt energy efficiency measures." (Department of Minerals and Energy (2005) Energy Efficiency Strategy of the Republic of South Africa, section 3.1 page 8.



- **Technology risk** – Increasing the efficiency of the furnace is directly dependent on the electrical performance of the furnace and thus achieving reduced electricity consumption depends on being able to operate the furnace optimally.

Table B.4.2 – Baseline alternatives analysed for a common set of barriers.

Baseline Scenario	Prevailing Practice	Technology Risk
<i>Alternative A</i> – Complete replacement of the furnace	As a result of the low electricity prices available it is prevailing practice not to make significant capital investments in new more electrically efficient equipment. Project developers going beyond the usual culture to reduce their electricity usage will have little incentive to replace an operating furnace with a new one that will reduce electricity consumption as they will be better off economically taking advantage of the low South African electricity prices and continuing to operate the equipment in its current condition. It is important to note that this culture of cheap electricity usage has been ingrained into South African industrial operations since the start of their operation and is in fact the primary reason for their location in this country. There is very little incentive for them to even consider an expensive complete replacement of a furnace in light of the prevailing practice and this is therefore a significant barrier to the implementation of Alternative A.	Completely replacing the furnace will be a technological challenge as it will be upgraded to a more efficient furnace. Metal production is to a large extent an art of craftsmanship and therefore the skills of the furnace operators would have to be upgraded with that of the furnace. This represents a significant technology risk as the operation of the furnace will not be optimal initially and there is no guarantee that it will ever improve the energy efficiency of the furnace due to the reliance of electricity consumption reductions on the skill of the operators. The amount of electrical efficiency that can be achieved may fluctuate dramatically from what is expected based on the risks associated with operating the new technology. As a result this technological risk is a highly preventative barrier to the implementation of Alternative A and would require a substantial risk premium on the return on the furnace from the electricity savings to compensate. It is unlikely that such a big reduction in electricity consumption could be achieved with any certainty with a complete replacement of the furnace, even with the latest energy efficient design.
<i>Alternative B</i> – Continued use of the installed technology	Continued use of the installed furnace technology represents the prevailing practice in South Africa and this is therefore <i>not</i> a barrier to the implementation of Alternative B.	Continued use of the installed furnace employs well known and practiced technology. Electricity consumption is expected to remain constant for this scenario and therefore there is no technology risk and this is <i>not</i> a barrier to the implementation of Alternative B.
<i>Alternative C</i> - Project activity not	As a result of the low electricity prices available it is prevailing practice not to	The new furnace design represents a new technology for South African



implemented CDM project	as make significant capital investments to redesign equipment to be more energy efficient. Project developers going beyond the usual culture to reduce their electricity usage will have little incentive to redesign an operating furnace with more efficient design that will reduce electricity consumption as they will be better off economically taking advantage of the low South African electricity prices and continuing to operate the equipment in its current condition. It is important to note that this culture of cheap electricity usage has been ingrained into South African industrial operations since the start of their operation and is in fact the primary reason for their location in the country. There is very little incentive for them to even consider an expensive project to redesign a furnace in light of the prevailing practice and this is therefore a significant barrier to the implementation of Alternative C.	Ferrosilicon operations and is a technology transfer from the new Spanish parent company – FerroAtlantica – which operates this furnace design in Spain, an Annex I party. Metal production is to a large extent an art of craftsmanship and there is no experience whatsoever with the new technology for FeSi production under local South African circumstances with its specific local feedstock qualities. This represents a significant risk as the quality of the product may be affected and the electricity consumption reductions may never be achieved in practice. The technology risk associated with the new design is a significant barrier to the implementation of the project activity without CDM revenues (Alternative C) to compensate for the increased risk.
-------------------------	---	---

Alternative A and Alternative C both face significant prevailing practice and technology risk barriers to their implementation. They are therefore eliminated as baseline alternatives from this analysis. Alternative A is therefore the only alternative not prevented by any barrier and continued use of the installed technology is therefore identified as the baseline scenario.

Step 4 - Compare economic attractiveness of the remaining alternatives

Only Alternative B is remaining and therefore there is no need to perform this analysis. For completeness sake and in accordance with the methodology it has been detailed in section B.5.



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

Step 1 - Investment and sensitivity analysis

The most plausible baseline scenario has been identified in section B.4 as Alternative B - the continued use of the installed furnace technology. This section will demonstrate that the project activity undertaken without the CDM (Alternative C) is economically less attractive than Alternative B.

A NPV analysis will be used to compare the economic attractiveness of the Alternatives. This will constitute the investment analysis.

In line with AM0038 we explicitly state the following parameters which are detailed in Table B.5.1 and explained in the below section. References and evidence for each of the parameters have been provided.

- *Investment requirements*: this takes into account all costs including equipment purchase, construction, installation and opportunity cost resulting from the facility being off line.
- *Discount rate*: as indicated in the methodology a discount rate has been applied based on a risk free rate (government bond rate) plus a risk premium. The value has been taken from The Appendix of the 'Guidelines on the assessment of investment analysis' and represents an appropriate value for the expected return on equity for projects undertaken in the metals production sector in South Africa.
- *Price of energy, raw materials and products*. According to the methodology, as a default assumption the current prices have been assumed as the future prices:
 - Electricity: rates depend on the season (winter/summer) as well as the tariff band (peak/standard/off-peak) and therefore vary every month. The price taken is the average price for 2008 being R212/MWh increased by the already expected (and later on also materialized) 30% increase enforced by Eskom, which makes it R276/MWh.
 - Raw materials and other operating costs: the average total product cost per ton product of R5,492/ton for 2008 has been calculated from production statistics for the first 6 months of 2008.
 - Product price: an average product price of R18,204 /ton for the year 2008 has been calculated from Ferrosilicon prices in July 2008.
- *Other operating costs*: These have been included in the price of the product.
- *Lifetime*: The remaining lifetime of the furnace has been calculated according to the 'Tool to determine the remaining lifetime of equipment' (version 01). Option (b) has been selected and an independent expert opinion has been obtained to determine the operational lifetime of the equipment. The total lifetime has been estimated to be at least 50 years. Since the furnace has been in operation for 37 years already at the start of the project activity we conservatively estimate the remaining lifetime of the equipment to be 13 years at the start of the project activity (50 -37 years).
- *Maintenance costs*: The annual maintenance costs on the furnace will be the same if the current furnace continues operation as is or if the project is implemented. This is because the change in design of the furnace in alternative C will not materially affect the maintenance that needs to be performed.



- *Residual Value:* The methodology requires that the residual value of the new equipment should be taken into account when calculating the NPV. The residual value has been calculated according to the ‘*Guidelines on the assessment of investment analysis*’ (version 05) which stipulates that the fair value should be calculated according to local accounting regulations and includes a reasonable expectation for the potential profit or loss on the realization of the assets. Local accounting regulations require that the asset is depreciated over a 20 year period. A depreciation rate of 5% has therefore been used to calculate the residual value of the furnace at the end of the crediting period i.e. year 13. There is no potential for the realization of this asset.

Table B.5.1 - Parameters used in the NPV comparison of Alternatives B and C

Parameters	Alternate B - Continued use of Furnace F	Alternate C - Redesign of Furnace F
Costs		
Investment Expenditure (Capex)	-	25 000 000
Production cost per ton (raw materials, reductants, elec)	5 492	5 492
Production loss (resulting from abnormal downtime)	-	59 339 806
Annual Maintenance	5 000 000	5 000 000
Revenues		
Sale Price per ton	18 204	18 204
Electricity Savings per ton (ZAR)	-	250.33
Residual Value of Furnace F	n/a	8 750 000
Production Data		
Q _{p, max} (tons)	24 340	24 340
Sec (MWh/t)	9.07	8.163
Planned days offline (additional to annual maintainance)	-	70
Financial Parameters		
Price per MWh	276	276
Lifetime of the project activity (years)	13	13
Discount Rate	11.9%	11.9%

Using the above parameters the NPV of Alternative B and Alternative C are calculated. The below table B5.2 shows that Alternative B is clearly the most cost-efficient alternative as it is R37,234,415 cheaper than Alternative C. The project activity without CDM revenue is therefore not the most financially attractive option.

Table B.5.2 - Net Present Value Comparison of Alternative B to Alternative C

Scenario	NPV
Alternative B	2 028 039 880
Alternative C	1 990 805 465
Difference	37 234 415



The NPV analysis presented above shows that Alternative B is the more cost-efficient than the project activity without CDM revenues (Alternative C) and thereby proves the financial additionality of the project activity from an investment perspective.

A sensitivity analysis has also been performed as per sup-step 2d of the ‘*Tool for the demonstration and assessment of additionality*’ (version 06.0.0) The variables contained in Alternative C constitute more than 20% of either total project costs or total project revenues as per the guidance provided in the ‘*Guidelines on the assessment of investment analysis*’ (version 05). This is illustrated in Table B.5.3 and Table B.5.4 which shows the relative percentage of the parameters to the total cost/revenue.

Table B.5.3 – Cost variables as a percentage of total costs/revenues

Total cost of Project (NPV)	R 84 339 806	100%
Variables	Cost	% of Total Cost
Investment expenditure	R 25 000 000	29.6%
Planned production losses	R 59 339 806	70.4%

Table B.5.4 – Revenue/savings variables as a percentage of total revenues

Total revenue of Project (NPV)	R 36 282 785	100%
Variables	Revenue	% of Total Revenue
Electricity savings (NPV)	R 36 282 785	100.0%

Total project costs are made up of the investment expenditure (30%) and the planned production losses (70%). The relevant variables within these costs are the investment expenditure and the planned time offline. The planned production losses are made up of the sale price per ton less the cost of production, times by the tons of FeSi produced adjusted for the time that the furnace is out of operation. Therefore the relevant project variable that will affect the project financially is the time offline. Both of these variables were subjected to a sensitivity analysis with a range of 10% decrease and the resulting NPV has been documented in Table B.5.5.

Total project revenues consist of the electricity savings (100%) this parameter has the relevant variable of the MWh’s that are saved as a result of the project activity. This variable is subjected to a sensitivity analysis with a range of 10% increase as per the ‘*Guidance on the assessment of investment analysis*’ (version 05) and the resulting NPV has been documented in Table B.5.5.

Table 5.5: Sensitivity analysis results on the project activity’s NPV

Parameters	Alternate B - Continued use of Furnace F	10% variation investment expenditure	10% variation electricity savings	10% variation planned production losses
Costs				
Investment Expenditure (Capex)	-	22 500 000	25 000 000	25 000 000



Production cost per ton (raw materials, reductants, elec)	5 492	5 492	5 492	5 492
Production loss (resulting from abnormal downtime)	-	59 339 806	59 339 806	53 405 826
Annual Maintenance	5 000 000	5 000 000	5 000 000	5 000 000
Revenues				
Sale Price per ton	18 204	18 204	18 204	18 204
Electricity Savings per ton (ZAR)	-	250.33	475.63	250.33
Residual Value of Furnace F	n/a	8 750 000	8 750 000	8 750 000
Production Data				
Q _{p, max} (tons)	24 340	24 340	24 340	24 340
Sec (MWh/t)	9.07	8.163	7.347	8.163
Planned days offline (additional to annual maintenance)	-	70	70	63
Financial Parameters				
Price per MWh	276	276	276	276
Lifetime of the project activity (years)	13	13	13	13
Discount Rate*	11.9%	11.9%	11.9%	11.9%
NPV	2 028 039 880	1 993 039 603	2 023 459 971	1 996 108 397
Difference from Alternate B (Baseline)	-	35 000 277	4 579 908	31 931 483

The results of the sensitivity analysis show that the investment analysis is robust and the NPV of the sensitivity scenarios is never more than the baseline NPV. The sensitivity analysis has been performed using a NPV analysis as stipulated in the methodology for the additionality comparison of economic attractiveness. This is in line with the ‘*Guidelines on the assessment of investment analysis*’ (version 05) which states “*the objective is to determine in which scenarios the project activity would pass the benchmark or become more favourable than the alternative*” the NPV analysis comparison shows that the project activity has not become more favourable than the alternative (baseline) as the baseline NPV remains higher than the project with any variables subjected to a 10% increase or decrease as appropriate.

In addition, the sensitivity analysis has been extended to determine the thresholds at which the relevant variable will make the project activity NPV equal to the baseline NPV. The below table illustrates the percentage change necessary that the variable will have to deviate from the project activity in order to equal the NPV of the baseline scenario. It is important to note that the variation of the MWh/ t FeSi that are saved by the project activity by even a per cent represents a huge achievement in practical operation of the furnace and it is extremely unlikely that further large increased in efficiency can be achieved in practice without the implementation of revolutionary technology.

**Table B.5.6:** Percentage variation required by variables for the project activity to reach parity with baseline NPV

Variable	Percentage Change to equal baseline NPV
Investment expenditure	-167%
Secb (MWh / t)	-11%
days offline	-70%

The above sensitivity analysis proves that the project activity is robustly financially additional across a range of increasing and decreasing project variable scenarios.

Step 2 - Common practice analysis

a) Analyze other activities similar to the proposed project activity

To date there is only one identifiable example of a similar project in South Africa namely, “*Transalloys Manganese Alloy Smelter Energy Efficiency Project*”. This project also concerns a redesign of an alloy producing electric arc furnace for the purpose of energy efficiency gains. This project is, however, a CDM project (project 1027) and therefore will not be included in this analysis as per Sub-step 4a of the ‘*Tool for the demonstration and assessment of additionality*’ (version 06.0.0). There are no other projects that are operational and that are similar to the proposed project activity in South Africa.

b) Discuss any similar options that are occurring

As there are no similar options identified in step (a) above (except the Transalloy’s project which is done under the CDM and therefore excluded) it is not possible to perform step (b) and the discussion has been excluded from this analysis. It is clear that the project is not common practice in the ferrosilicon, or wider metals production industry. According to the above analysis, Steps (a) and (b) are satisfied and therefore the project activity is additional.

Silicon Smelters Energy Efficiency Improvement Project - Furnace F is classified as a ‘measure’ - b) switch of technology with or without change of energy source (including energy efficiency improvement) - and therefore paragraph 47 of the ‘*Tool for the demonstration and assessment of additionality*’ (version 06.0.0) is applicable as per the ‘*Guidelines on Common Practice*’ (version 01)⁸. The analysis is presented below:

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

Design capacity of Furnace F = 46.5MVA

Applicable capacity range therefore = 23.25 MVA to 69.75 MVA

Step 2: Identify all plants that deliver the same capacity within the capacity range as the project activity in the geographical area that started commercial operation before the start date of the project. Registered CDM project activities shall not be included in this step.

⁸ EB63, annex 12.

http://cdm.unfccc.int/filestorage/0/B/2/0B2QIUYM6KSETZO34VA8GLCR9WXP7D/eb63_repan12.pdf?t=MmR8bHh4cWdofDAidCy6UvJn2PABRwo3L2Mu



Table B.5.7 in Annex 5 illustrates the alloy producing electric arc furnaces which produce ferrosilicon, silicomanganese and silicon metal (N_{all}) that were operating within South Africa prior to the start of the project activity.

Therefore: $N_{all} = 11$

Step 3: Identify plants which apply different technologies to that of the technology used in the project activity from the plants identified as N_{all} .

The technology used in the project activity is a rotating electric furnace with Soderberg electrodes. Furnaces which are designed to have a static shell or use any other electrode technology are classified as plants which apply different technologies to that of the project activity. Table B.5.7 in Annex 5 illustrates the different technologies used in comparison to the redesign of Furnace F.

Therefore: $N_{diff} = 11$

Step 4: Calculate factor $F = 1 - N_{diff}/N_{all}$

Therefore: $1 - (11 / 11) = 0.00$

The project activity is a common practice if the following conditions are both fulfilled:

- (a) The factor F is greater than 0.2; and
 $F = 0.00 < 0.2$
- (b) $N_{all} - N_{diff}$ is greater than 3
 $N_{all} - N_{diff} = 0$ which is less than 3

The project activity does fulfil condition (a) and condition (b) and therefore the project activity is not common practice and the project is additional.

Step 3 - Impact of CDM registration

Although this step has been deleted in version 03 and subsequent versions of the “*Tool for the demonstration and assessment of additionality*”, it is mandated by AM0038 and is therefore carried out according to version 02 of the Additionality Tool.

The construction work on site started in August 2008 and was completed in November 2008. Following the successful Transalloys Manganese Alloy Smelter Energy Efficiency Project (CDM reference 1027) that has been registered under the CDM, the Project Developer had been considering the need for carbon credits from the start of preliminary investment planning in 2007 for several project types.

Rand Carbide back then was still part of Highveld Steel and Vanadium, the previous owner⁹. The carbon credits, generated from electricity savings, were an important factor in the decision to redesign the furnace and were required to make the project feasible

⁹ The sale of Rand Carbide by Highveld Steel and Vanadium to Ferro Atlantica Group was completed in January 2008.



The table below illustrates the timeline and the CDM consideration.

Table B.5.8: The timeline of the project

Date	Document	Content
04-Mar-04	Email EcoSecurities to Rand Carbide	Developing CDM project with Highveld
8-July-04	Strategic Technology Management Project Energy Domain	CDM considered to support investments
10-Sep-04	Highveld Steel & Vanadium – Strategy 2004-2008	Carbon credit opportunity identified for Rand Carbide
18-Feb-05	Article Financial Mail	Highveld has two potential CDM projects on the table
20-Dec-06	Email with ITS Otokom Meeting Notes	Energy Efficiency and Cogen, consideration of CDM and other incentives
16-Apr-07	Cogeneration Project Presentation Rand Carbide	CDM considered for potential investment
17-Oct-07	Email regarding CDM potential, Rand Carbide Cogen	Carbon credit potential identified by local and French management.
17-Jan-08	Article Fin24.com, "Highveld sells Rand Carbide"	Completion of sale Rand Carbide division of Highveld Steel and Vanadium to FerroAtlantica
21-May-08	Investment programme Rand Carbide	Budget Furnace F
17-Jul-08	Invoice for 30% of the deposit for the main steelwork.	The deposit for the steelwork necessary for the redesign of the furnace is paid for which is the point of no return from an investment perspective. This is the project start date.
22-May-09	South African CDM Project Portfolio (Up to 23 August 2011)	Project Idea approved by the DNA on 22 May 2009
10-Jul-09	Letter from the DNA	No objection to proposed project regarding renewable reduction sources and energy efficiency
15-Oct-09	Email from ENERCAP to Rand Carbide	Discussion regarding CDM application support
Jan-Nov 10	Several emails during the year	CDM Preparation work
26-Jan-11	Purchase Order Methodology Revision	PO - Request to TuV to upload Meth Revision
06-May-11	Response Form Meth Panel	Extending applicability to FeSI production
09-Sep-11	Contract with DOE	Contract for validation signed

As illustrated by the timeline above, CDM was considered on both strategic and project implementation levels at an early stage. Although a potential energy efficiency project at Rand Carbide - similar to the CDM supported project at Transalloys - was considered, the most promising energy efficiency improvement option appeared to be cogeneration. However, this perspective changed after the take-over by Ferro Atlantica in January 2008. During the meeting that took place on 21 May 2008 at Rand Carbide, the investment in the redesign of Furnace F was discussed, making use of an expected carbon credit potential from the CDM in line with the similar project at Transalloys, enhancing the attractiveness of the investment sufficiently in order to decide to proceed.



Revenues from carbon credits make a significant contribution to the overall profitability of the project activity. For instance, at R100/CER, CDM revenues are approximately equivalent to R103/MWh, which is significant compared to the cost of electricity itself of currently R276/MWh, i.e. CDM increases the revenue stream from electricity savings by a further 27%. This is significant compared to the objective of the project: a 5-10% energy saving, which is equivalent to only a 5-10% reduction of the electricity bill.

Moreover, purely from a cash flow improvement side, selling CERs would generate a potential revenue stream of 2.18 million ZAR per annum, equivalent to an NPV of ZAR 9.9 million envisaged at the time of the start date of the project in 2008¹⁰.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

1. Baseline emissions

Emissions associated with FeSi production in the baseline are determined as follows:

$$BE_y = BE_{y, \text{offsite}} + BE_{y, \text{onsite}} \quad (1)$$

where:

- BE_y Baseline emissions (tCO₂ in year y)
- $BE_{y, \text{offsite}}$ Offsite baseline (grid) electricity emissions associated with the electricity consumption of the submerged arc furnace (tCO₂e in year y)
- $BE_{y, \text{onsite}}$ Onsite baseline emissions associated with the consumption of Reductant (Coal and Coke) and electrode paste during the production of FeSi (tCO₂e in year y)

- The vintage period used for the determination of baseline emissions is August 2005- July 2008 (the 3 years preceding the start of the project activity).

1.1. Offsite baseline emissions

Offsite baseline emissions are calculated according to:

$$BE_{y, \text{offsite}} = QP_{y, \text{max}} \times sec_b \times EF_{y, \text{offsite}} \quad (2)$$

where:

- $BE_{y, \text{offsite}}$ Offsite baseline (grid) electricity emissions associated with the electricity consumption of the submerged arc furnace (tCO₂e in year y)
- $QP_{y, \text{max}}$ Quantity of FeSi production in year y (t FeSi/y) maximised at historic average via equation 3. This value is used in both the baseline and the project emission calculations
- sec_b Historic (at least a three year vintage period) average grid electricity consumption per tonne of FeSi produced (MWh/t FeSi)

¹⁰ See Annex 6 for calculations on the impact of CDM revenues.



$EF_{y, \text{offsite}}$ Grid electricity emissions factor (tCO₂e/MWh), estimated using the “Tool to calculate the emission factor of an electricity system”

1.1.1. Determination of $QP_{y, \text{max}}$

The FeSi production is limited to the historic level as follows:

$$QP_{y, \text{max}} = \min^m \text{ of } (QP_{y, \text{monitored}}, QP_{\text{historic}}) \quad (3)$$

where:

- $QP_{y, \text{max}}$ Value of FeSi production used for estimating baseline and project emissions for the year y (tFeSi/y)
- $QP_{y, \text{monitored}}$ Monitored production of FeSi in year y during the project activity (tFeSi/y)
- QP_{historic} Historic (at least a three year vintage period) average annual production of FeSi (tFeSi/y)

The historic average production of FeSi is calculated according to:

$$QP_{\text{historic}} = \frac{\sum_{i=1}^n QP_i}{n} \quad (4)$$

where:

- QP_{historic} Historic (at least a three year vintage period) average annual production of FeSi (tFeSi/y)
- QP_i Annual FeSi production for the i^{th} year preceding the project activity (tFeSi)

Therefore:

2005/2006:	23,813
2006/2007:	24,196
2007/2008:	25,010
Total:	73,019

$$QP_{\text{historic}} = 24,340$$

1.1.2. Determination of sec_b

The average specific electricity consumption per tonne of FeSi produced in the baseline situation is calculated as follows:

$$\text{sec}_b = \frac{\sum_{i=1}^n EC_i}{\sum_{i=1}^n QP_i} \quad (5)$$

where:

- sec_b Historic (at least a three year vintage period) average grid electricity consumption per tonne of FeSi produced (MWh/tFeSi)
- QP_i Annual FeSi production for the i^{th} year preceding the project activity (tFeSi produced in year i)
- EC_i Annual grid electricity consumption by the submerged electric arc furnace for the i^{th} year preceding the project activity (MWh consumed in year i)

Therefore:

	QPi	ECi
2005/2006	23,813	213,985
2006/2007	24,196	225,163
2007/2008	25,010	223,366
Total	73,019	662,514

$$\text{Sec}_b = 662,514 / 73,019$$

$$\text{Sec}_b = 9.07$$

1.1.3. Determination of $EF_{y,\text{offsite}}$

AM0038 states that $EF_{y,\text{offsite}}$ should be estimated using the “*Tool to calculate emission factor for an electricity system*” (version 02.2.1).

The combined margin (CM) is calculated to determine the CO₂ emission factor for the displacement of electricity generated by power plants in an 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 tool prescribes a step-based approach to calculate the CM which is detailed below:

Step 1: Identify the relevant electricity systems

A project electricity system is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity (i.e. the FeSi smelter) and that can be dispatched without significant transmission constraints.

The project electricity system for South Africa is defined by the Eskom national grid. Eskom generates approximately 95%¹¹ of the electricity used in South Africa. This results in a very

¹¹ <http://www.info.gov.za/aboutsa/energy.htm>



minimal remaining percentage of electricity that is produced by private, municipal and independent power producers. The remaining 5% is excluded from this analysis as there is no data available and excluding it represents a conservative approach, as lower efficiencies and higher GHG emissions are assumed in these smaller and older power generation plants.

Eskom generates, transmits, and distributes electricity to industrial, mining, commercial, agricultural, and residential customers, and also to redistributors¹². Some assumptions have to be made to calculate the conservative electricity baseline: the regional generation and consumption of Eskom transmission grids are interlinked and no distinction can be made between provincial or sectoral generation and consumption. Therefore the whole South Africa transmission system is taken as a homogenous mix of electricity supply by all connected power plants and this constitutes the project electricity system.

The project electricity system forms part of a connected electricity system whereby it is connected by transmission lines to the national grid of Botswana (Botswana Power Corporation), Mozambique, Namibia (NamPower), Zimbabwe (ZESA), Lesotho (Lesotho Electricity Company), Swaziland and Zambia (ZESCO). Power plants within the connected electricity system can be dispatched to without significant transmission constraints but transmission to the project electricity system has significant transmission constraints. This is applicable to the South African situation where Eskom is a net exporter of electricity¹³ and therefore no electricity is imported into South Africa from the connected system. These Eskom electricity exports will not be subtracted from electricity generation data used for calculating and monitoring the electricity emission factors and there is not expected to be any additional electricity exports resulting from the project activity. The connected electricity systems are not partially or totally located in Annex 1 countries. No electricity imports were included in the GEF calculation as there is no electricity that is imported into South Africa from other countries.

The below map (Figure B.6.1.1) documents the geographical extent of the project electricity system. All grid power plants connected to the project electricity system are identified in Table B.6.1.1.

¹² http://www.eskom.co.za/live/content.php?Item_ID=4226&Revision=en%2F3

¹³ <http://www.info.gov.za/aboutsa/energy.htm>

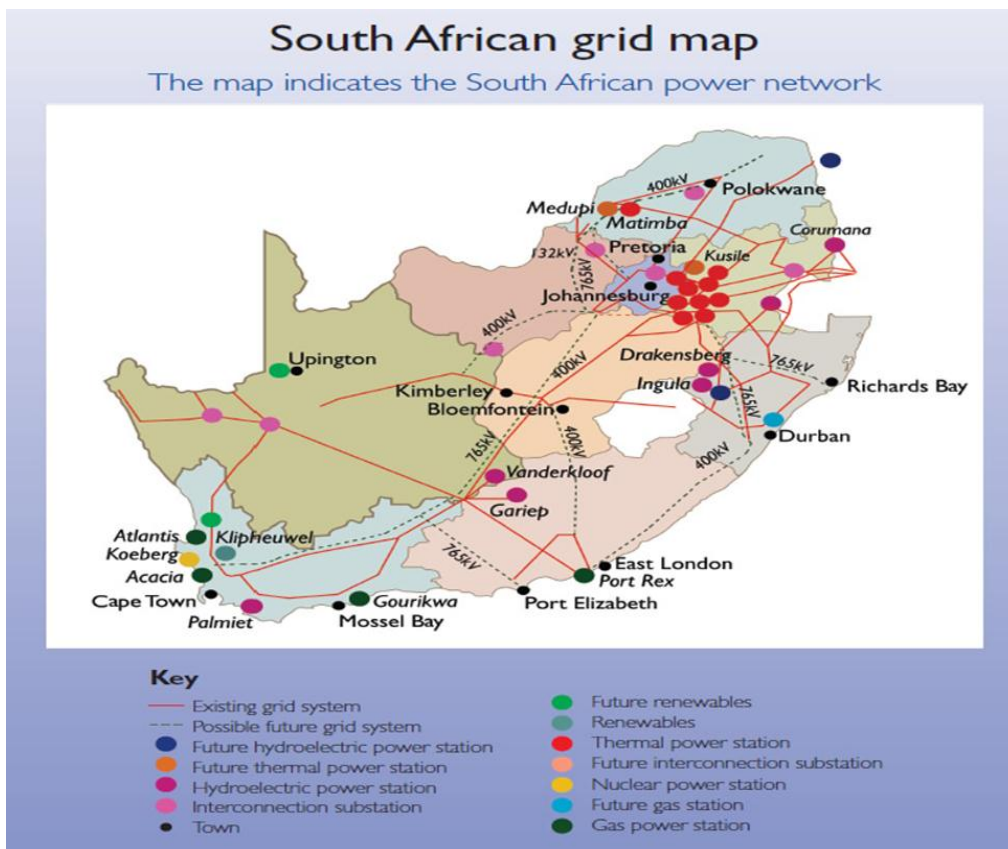


Figure B.6.1.1 – The project electricity system as defined by the Eskom South African national grid.

Table B.6.1.1 – Power plants connected to the South African national grid.

Name of Power Plant	Fuel Type/ Power Source	Installed Capacity (MW)	Commissioning Date
Arnot	Coal	1980	1971/09/21
Ankelig	Gas	1327	2007/10/01
Gourikwa	Gas	740	2007/10/01
Duvha	Coal	3450	1980/01/18
Hendrina	Coal	1895	1970/05/12
Kendal	Coal	3840	1988/10/01
Kriel	Coal	2850	1976/05/06
Lethabo	Coal	3558	1985/12/22
Matimba	Coal	3690	1987/12/04
Majuba	Coal	3843	1996/04/01
Matla	Coal	3450	1979/09/29
Tutuka	Coal	3510	1985/06/01



Koeberg	Nuclear	1800	1984/07/21
Acacia	Gas	171	1976/05/13
Port Rex	Gas	171	1976/09/30
Colley Wobbles	Hydro	42	1985/01/01
First Falls	Hydro	6	1979/02/01
Gariep	Hydro	360	1971/09/08
Ncora	Hydro	2	1983/03/01
Second Falls	Hydro	11	1979/04/01
Van Der Kloof	Hydro	240	1977/01/01
Drankensburg	Pump Storage	1000	1981/06/17
Palmiet	Pump Storage	400	1988/04/18
Camden	Coal	1600	1966/12/21
Grootvlei	Coal	1200	1969/06/30
Komati	Coal	1000	1961/11/06

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

This project selects option I to calculate the operating margin and build margin emission factor whereby only grid power plants are included in the calculation. This is because the offsite emissions are only generated from grid-connected power plants since the project activity takes place at the Silicon Smelter's facility whose only electrical supply is from Eskom's grid-connected power plants.

In addition, in South Africa, off-grid power generation is not significant and therefore option II is not applicable.

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

The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods:

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

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

- 1) average of the five most recent years, or
- 2) based on long-term averages for hydroelectricity production.

“Low-cost/must-run resources are defined as power plants with low marginal generation costs or power plants that are dispatched independently of the daily or seasonal load of the grid. They typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation. If



coal is obviously used as must-run, it should also be included in this list, i.e. excluded from the set of plants.”

Hydro, Nuclear and Wind are classified as the low-cost and must-run power plants on the South African grid and constituted around 6% of the Eskom generation in 2011. The below Table B.6.1.2 details the percentage contribution of low cost must run resources to the annual generation for the last 5 years and shows that it is considerably less than 50%.

Table B.6.1.2: Percentage generation from low cost/must run resources

Low cost/ must run resource power plants	2007	2008	2009	2010	2011
Hydro-electric stations	1.05%	0.31%	0.47%	0.55%	0.83%
Wind energy	0.00%	0.00%	0.00%	0.00%	0.00%
Nuclear power stations	5.07%	4.73%	5.68%	5.50%	5.10%
Total Electricity produced	6.12%	5.05%	6.15%	6.05%	5.92%

Therefore the simple OM method can be used.

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

The dispatch data analysis OM (c) method cannot be used because the detailed dispatched data that is needed for this method is not publically available in South Africa.

The average OM (d) method should only be used if the data for simple OM is not available. As this is not the case, it is therefore decided to apply Option (a) Simple OM method to calculate the CM.

For the simple OM, the emission factor can be calculated using either *ex ante* or *ex post* data vintages. An ex-ante approach will be adopted. The emission factor is determined once at the validation stage and thus no monitoring and recalculation of the emissions factor during the crediting period will be required. For grid connected power plants a 3-year generation-weighted average is calculated, based on the most recent data available. Therefore data vintages of 2009, 2010 and 2011 are used.

CDM projects activities which might be classified as power plants have not been included in the calculation of the operating margin as they are low-cost must-run resources (hydro, landfill gas-to-energy, low-cost biomass) and therefore do not meet the sample group criteria.

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

(a) Simple OM



The simple OM emission factor is calculated as the generation-weighted average CO₂ emissions per unit net electricity generation (tCO₂/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units. The simple OM may be calculated using either:

- Option A:** Based on the net electricity generation and a CO₂ emission factor of each power unit or
- Option B:** Based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system.

Option B can only be used if:

- The necessary data for Option A is not available; and
- Only nuclear and renewable power generation are considered as low-cost/must-run power sources and the quantity of electricity supplied to the grid by these sources is known; and
- Off-grid power plants are not included in the calculation

Since the necessary data for Option A is available, Option B cannot be used and the simple OM emission factor will be calculated using Option A.

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

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

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

Where:

- EF_{grid,OMsimple,y}** = Simple operating margin CO₂ emission factor in year *y* (tCO₂/MWh)
- EG_{m,y}** = Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
- EF_{EL,m,y}** = CO₂ emission factor of power unit *m* in year *y* (tCO₂/MWh)
- m** = All power units serving the grid in year *y* except low-cost / must-run power units
- y** = The relevant year as per the data vintage chosen in Step 3

Determination of EF_{EL,m,y}

The emission factor of each power unit *m* should be determined as follows:

All the data on Fuel consumption and electricity generation is available for all power units *m* in South Africa, Option A1 will be used to calculate the emission factor of each power unit *m*.

- Option A1. If for a power unit m data on fuel consumption and electricity generation is available, the emission factor ($EF_{EL,m,y}$) should be determined as follows:

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

Where:

- $EF_{EL,m,y}$ = CO₂ emission factor of power unit m in year y (tCO₂/MWh)
- $FC_{i,m,y}$ = Amount of fossil fuel type i consumed by power unit m in year y (Mass or volume unit)
- $NCV_{i,y}$ = Net calorific value (energy content) of fossil fuel type i in year y (GJ/mass or volume unit)
- $EF_{CO_2,i,y}$ = CO₂ emission factor of fossil fuel type i in year y (tCO₂/GJ)
- $EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
- m = All power units serving the grid in year y except low-cost/must-run power units
- i = All fossil fuel types combusted in power unit m in year y
- y = The relevant year as per the data vintage chosen in Step 3

Table B.6.1.3: Amount of coal consumption by each power plant in the project electricity system ($FC_{i,m,y}$)

Power plants (m)	Fuel Consumption data (tonnes coal)			Average
	2009	2010	2011	
Arnot	6 395 805	6 794 134	6 525 670	6 571 870
Duvha	11 393 553	11 744 606	10 639 393	11 259 184
Hendrina	7 122 918	6 905 917	7 139 198	7 056 011
Kendal	15 356 595	13 866 514	15 174 501	14 799 203
Kriel	9 420 764	8 504 715	9 527 185	9 150 888
Lethabo	16 715 323	18 170 227	17 774 699	17 553 416
Matimba	13 991 453	14 637 481	14 596 842	14 408 592
Majuba	12 554 406	12 261 833	13 020 512	12 612 250
Matla	12 689 387	12 438 391	12 155 421	12 427 733
Tutuka	11 231 583	10 602 839	10 191 709	10 675 377
Camden	3 876 211	4 732 163	4 629 763	4 412 712
Grootvlei	674 538	1 637 371	2 132 979	1 481 629
Komati	0	664 497	1 271 010	645 169
Total	121 422 536	122 960 688	124 778 882	123 054 035

Table B.6.1.4: Net calorific value of coal ($NCV_{i,y}$)

	2009	2010	2011	Average
Net calorific value (GJ/t)	19.10	19.22	19.45	19.26

The emission factor for coal combustion ($EF_{CO_2,i,y}$) in South Africa is taken as the IPCC default value at the lower limit of uncertainty at a 95% confidence interval¹⁴.

Therefore: $EF_{CO_2,i,y} = 0.0895 \text{ t/GJ}$

Table B.6.1.5: Net quantity of electricity generated and delivered to the grid by power plants in the project electricity system ($EG_{m,y}$)

<u>Power Plants (m)</u>	Electricity Generation data (MWh)			Average
	2009	2010	2011	
Arnot	11 987 281	13 227 864	12 194 878	12 470 008
Duvha	21 769 489	22 581 228	20 267 508	21 539 408
Hendrina	12 296 687	12 143 292	11 938 206	12 126 062
Kendal	23 841 401	23 307 031	25 648 258	24 265 563
Kriel	18 156 686	15 906 816	18 204 910	17 422 804
Lethabo	23 580 232	25 522 698	25 500 366	24 867 765
Matimba	26 256 068	27 964 141	28 163 040	27 461 083
Majuba	22 676 924	22 340 081	24 632 585	23 216 530
Matla	21 863 400	21 954 536	21 504 422	21 774 119
Tutuka	21 504 122	19 847 894	19 067 501	20 139 839
Camden	6 509 079	7 472 070	7 490 836	7 157 328
Grootvlei	1 249 556	2 656 230	3 546 952	2 484 246
Komati	0	1 016 023	2 060 141	1 025 388
Total	211 690 925	215 939 904	220 219 603	215 950 144

Therefore $EF_{EL,m,y}$ is determined as per the equation A1. A summary of the parameters and the results of the calculation are detailed in the below table for each power plant m .

Table B.6.1.6: 3 year average CO₂ emission factors of power plants m

<u>Power plant (m)</u>	$FC_{i,y}$	$NCV_{i,y}$	$EF_{CO_2,i,y}$	EG_y	$EF_{EL,m,y}$
Arnot	6 571 870	19.26	0.0895	12 470 008	0.91
Duvha	11 259 184	19.26	0.0895	21 539 408	0.90
Hendrina	7 056 011	19.26	0.0895	12 126 062	1.00

¹⁴ IPCC 2006 Guidelines, Chapter 1, Volume 2 (Energy) Table 1.4

http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf



Kendal	14 799 203	19.26	0.0895	24 265 563	1.05
Kriel	9 150 888	19.26	0.0895	17 422 804	0.91
Lethabo	17 553 416	19.26	0.0895	24 867 765	1.22
Matimba	14 408 592	19.26	0.0895	27 461 083	0.90
Majuba	12 612 250	19.26	0.0895	23 216 530	0.94
Matla	12 427 733	19.26	0.0895	21 774 119	0.98
Tutuka	10 675 377	19.26	0.0895	20 139 839	0.91
Camden	4 412 712	19.26	0.0895	7 157 328	1.06
Grootvlei	1 481 629	19.26	0.0895	2 484 246	1.03
Komati	645 169	19.26	0.0895	1 025 388	1.08

Port Rex and Acacia have not been included in the calculation of the OM as they represent 0% contribution to the total generation of the Eskom grid and therefore will not have any impact on the calculation of the OM. Ankerlig and Gourikwa have been excluded as there is no fuel consumption or fuel generation data available for them but their contribution to total generation is also insignificant (0%) and will not affect the calculation of the OM.

Determination of $EG_{m,y}$

$EG_{m,y}$ has been determined as per the provisions in the monitoring tables which refer to the net electricity generated by the power plant m in year y sourced from either Eskom (utility) or official publications. Published Eskom data has been used and is presented in Table B.6.1.5 above.

Calculation of $EF_{grid,OMsimple,y}$

$EF_{grid,OMsimple,y}$ is calculated according to the equation in Option A using a 3 year generation weighted average and the CO₂ emission factor of each power plant m as calculated above. The below table B.6.1.7 details the calculation.

Table B.6.1.7: 3 year generation weighted average of the OM for the South African national grid

Power Plant (m)	$EG_{m,y}$ (MWh)	$EF_{EL,m,y}$ (t CO₂/MWh)	Weight	$EF_{grid,OMsimple,y}$ (t CO₂/MWh)
Arnot	12 470 008	0.908	6%	0.052
Duvha	21 539 408	0.901	10%	0.090
Hendrina	12 126 062	1.003	6%	0.056
Kendal	24 265 563	1.051	11%	0.118
Kriel	17 422 804	0.905	8%	0.073
Lethabo	24 867 765	1.217	12%	0.140
Matimba	27 461 083	0.904	13%	0.115
Majuba	23 216 530	0.936	11%	0.101



Matla	21 774 119	0.984	10%	0.099
Tutuka	20 139 839	0.914	9%	0.085
Camden	7 157 328	1.063	3%	0.035
Grootvlei	2 484 246	1.028	1%	0.012
Komati	1 025 388	1.084	0%	0.005
Total	215 950 144		100%	0.982

The operating margin for the grid emission factor is therefore **0.982 t CO₂/MWh**.

Step 5: Calculate the build margin emission factor

The vintage of data used will be that as classified under **Option 1** where:

For the first crediting period, the build margin emission factor is calculated *ex ante* based on the most recent information available on units already built for sample group *m*.

The sample group of power units *m* used to calculate the build margin is determined as below:

- Identify the set of five power units that have started to supply electricity to the grid most recently ($SET_{5-units}$), excluding power units registered as CDM project activities. Determine their annual electricity generation ($AEG_{SET-5-units}$ in MWh); ;

Table B.6.1.8: $SET_{5-units}$

[Power Plant (<i>m</i>)	Year Commissioned	Annual Electricity Generation (MWh)
Ankerlig¹⁵	2007	-
Gourikwa	2007	-
Majuba	1996	24 632 585
Kendal	1988	25 648 258
Matimba	1987	28 163 040
Total $AEG_{SET-5-units}$		78 443 883

Therefore $AEG_{SET-5-units} = 78,443,883\text{MWh}$

- Determine the annual electricity generation of the project electricity system (excluding power units registered as CDM project activities). Identify the set of power units that started to supply electricity to the grid most recently and that comprise 20% of the AEG_{total} (excluding power units registered as CDM project activities) Determine their annual electricity generation ($AEG_{SET \geq 20\%}$ in MWh).

Table B.6.1.9: $SET_{\geq 20\%}$

¹⁵ There is no data available from Eskom for Ankerlig or Gourikwa. Their contribution to AEG_{total} is insignificant at 0%.



Power Plant (<i>m</i>)	Year Commissioned	% AEG	AEG (MWh)
Ankerlig	2007	0.00%	0
Gourikwa	2007	0.00%	0
Majuba	1996	11.19%	24 632 585
Kendal	1988	11.65%	25 648 258
Total (AEG_{SET≥20%})	-	22.83%	50 280 843

Therefore $AEG_{SET\geq 20\%} = 50,280,843$ MWh

- c) From the $SET_{5\text{-units}}$ and $SET_{\geq 20\%}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample})

$AEG_{SET\text{-}5\text{-units}} = 78,443,883$ MWh

$AEG_{SET\geq 20\%} = 50,280,843$ MWh

Therefore: $AEG_{SET\text{-}5\text{-units}} > AEG_{SET\geq 20\%}$

and $SET_{\text{sample}} = SET_{5\text{-units}}$

Identify the date when the power units in the SET_{sample} started to supply electricity to the grid. If none of the power units in SET_{sample} started to supply electricity to the grid more than 10 years ago, then use SET_{sample} to calculate the BM. Otherwise:

Table B.6.1.10: SET_{sample}

Power Plant (<i>m</i>)	Year Commissioned
Ankerlig	2007
Gourikwa	2007
Majuba	1996
Kendal	1988
Matimba	1987

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

Majuba, Kendal and Matimba started supplying electricity to the grid more than 10 years ago. They are therefore excluded from SET_{sample} . Ankerlig and Gourikwa were only commissioned in 2007 but as they contribute 0% towards the AEG_{total} they are also excluded from SET_{sample} .



The following power units are registered as CDM projects in South Africa. The below table B.6.1.11 details the project, its generation capacity and the reason for its exclusion from SET_{sample}-CDM.

Table B.6.1.11: Grid connected CDM projects in South Africa.

CDM Project	PDD/Monitoring Report Installed Capacity	Reason for exclusion:
PetroSA biogas to energy project (0446)	4.284MW	Power is not sold onto the grid but rather “over the fence” to the PetroSA plant. This plant is therefore not considered in the grid emission factor calculation. (Reference #21 “PetroSA PDD.pdf”)
Durban Landfill-gas-to-electricity project Marianhill & La Mercy Landfills (0545)	Marianhill - 1MW La Mercy - Nil	The power is sold to the Municipality and contributes less than 0.0005% of the Eskom generation used to calculate the build margin emission factor. This plant is therefore not considered in the grid emission factor calculation. (Reference #22 “Marianhill 545 MR rev.pdf”)
Kanhym Farm manure to energy project (1665)	1MW	The power was intended to be supplied, via the local grid, to local inhabitants and business. No power purchase agreement was supplied when registering the project and no monitoring report has been uploaded since registration. Therefore even at a load factor of 100% the plant would be able to supply only 0.007% of the Eskom generation used to calculate the build margin emission factor. This plant is therefore not considered in the grid emission factor calculation. (Reference #23 “Kanhym PDD.pdf”)
Durban Landfill-Gas Bisasar Road (1921)	6.5MW	Although the total MWh produced are not stated in the Monitoring Report if we assume 100% load factor this project would still contribute less than 0.05% of the Eskom generation used to calculate the build margin emission factor. In addition the plant is owned by the EThekweni Municipality and the plant is connected to this municipal grid. Since the municipality is a net importer of electricity and the generation capacity of the plant is so small, this plant is therefore not considered in the grid emission factor calculation. (Reference #24 “Bisasar Rd MR 1921.pdf”)
Alton Landfill Gas to Energy Project (2549)	0.4MW	Power is not sold onto the grid but rather “over the fence” to a nearby industrial facility. This plant is therefore not considered in the grid emission factor calculation. (Reference #25 “Alton PDD_2549_clean.pdf”)
Bethlehem Hydroelectric project (2692)	3MW	The plant contributes less than 0.002% of the Eskom generation used to calculate the build margin emission factor. This plant is therefore not considered in the grid emission factor calculation. (Reference #26 “Bethlehem MR.pdf”)
Ekurhuleni Landfill Gas Recovery Project (3677)	2010 – 4MW 2011 – 3.5MW	Estimated electricity production during 2010 was 3236MWh which is less than 0.003% of the Eskom generation used to calculate the build margin emission factor. This plant is therefore not considered in the grid emission factor calculation. (Reference #27 “Ekurhuleni PDD Version 9.pdf”)



Therefore: $AEG_{SET\text{-sample-CDM}} = 0\%$

If the annual electricity generation of that set comprises at least 20% of the annual electricity generation of the project electricity system i.e. $AEG_{SET\text{-sample-CDM}} \geq 0.2 \times AEG_{total}$, then the CPA should use the sample group $SET_{sample\text{-CDM}}$ to calculate the BM;
Otherwise:

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

The below table B.6.1.12 details the power plants that are added to $SET_{sample\text{-CDM}}$ which started to supply electricity to the grid more than 10 years ago until they comprise 20% of AEG_{total} .

Table B.6.1.12: $SET_{sample\text{-CDM}>10\text{years}}$

Power Plant (<i>m</i>)	Year Commissioned	% Annual Electricity Generation	AEG (MWh) 2011
Majuba	1996	11.19%	24 632 585
Kendal	1988	11.65%	25 648 258
Total AEG_{SET-sample-CDM>10yrs}		22.83%	50 280 843

- f) The sample group of power units *m* used to calculate the BM is the resulting set. ($SET_{sample\text{-CDM}>10\text{yrs}}$)

The sample group of power plant *m* that is used to calculate the BM is therefore $SET_{sample\text{-CDM}>10\text{yrs}}$ as listed in table B.6.1.12.

Capacity additions from retrofits of power plants are not applicable to South Africa and have not been included in the calculation of the build margin emission factor.

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

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

Where:

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



in year y (MWh)

- $EF_{EL,m,y}$ = CO₂ emission factor of power unit m in year y (tCO₂/MWh)
 m = Power units included in the build margin
 y = Most recent historical year for which power generation data is available

The CO₂ emission factor of each power unit m ($EF_{EL,m,y}$) should be determined as per the guidance in Step 4 (a) for the simple OM, using option A1 and using for y the most recent historical year for which power generation data is available, and using for m the power units included in the build margin.

Therefore the CO₂ emission factors for Majuba and Kendal are those as calculated under the simple OM method in *step 4* and listed in table B.6.1.7. The BM is then calculated using the above equation which produces a 3 year weighted average BM.

Table B.6.1.13: 3 year average CO₂ emission factors of power plants m

Power Plant (m)	$EG_{m,y}$ (MWh)	$EF_{EL,m,y}$ t CO ₂ /MWh	Weighting	$EF_{grid,BM,y}$ t CO ₂ /MWh
Majuba	24 632 585	0.936	49%	0.459
Kendal	25 648 258	1.051	51%	0.536
Total	50 280 843	-	100%	0.995

The build margin for the grid emission factor is therefore **0.995 t CO₂/MWh**

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

The combined margin (CM) emission factor is calculated based on one of the following methods:

Option A - Weighted Average CM

Option B - Simplified CM

Option A should be used as the preferred option and is detailed below.

Option A – The weighted average CM

The combined margin emission factor is calculated as follows:

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

Where:

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

The following default values will be used as weightings for w_{OM} and w_{BM} for the project (i.e. all non-wind and solar power generation activities):

$$w_{OM} = 0.5 \text{ and } w_{BM} = 0.5 \text{ for the 10 year fixed crediting period}$$

Table B.6.1.14: Combined margin for the South African national grid

$EF_{grid,OM,y}$	w_{OM}	$EF_{grid,BM,y}$	w_{BM}	$EF_{grid,CM,y}$
0.982	0.5	0.995	0.5	0.99

Therefore the Grid Emission Factor for South Africa is **0.99 tCO₂/MWh**.

This calculated combined margin emission factor for the South African grid is then equal to the emission factor for offsite baseline emissions.

$$EF_{y,offsite} = 0.99 \text{ tCO}_2/\text{MWh}$$

1.2 Onsite baseline emissions

Onsite baseline emissions are calculated according to:

$$BE_{y,onsite} = QP_{y, \max} \times EF_{b,onsite} \quad (6)$$

Where:

- $BE_{y,onsite}$ Onsite baseline emissions associated with the consumption of reductant (Coal and Char and electrode paste during the production of FeSi (tCO₂e in year y)
- $QP_{y, \max}$ Value of FeSi production used for estimating baseline and project emissions for the year y (tFeSi/y)
- $EF_{b,onsite}$ Baseline emission factor associated with the (onsite) average consumption of reductant (Coal and Char) and electrode paste per tonne of FeSi in year y (tCO₂e/tFeSi) as calculated in equation (7).

1.2.1 Determination of $EF_{b,onsite}$

The onsite emission factor is calculated according to:

$$EF_{b,onsite} = \frac{\sum_{i=1}^n Q_{bcoal,i} * EF_{bcoal} + \sum_{i=1}^n Q_{bcok,i} * EF_{bcok} + \sum_{i=1}^n Q_{bpaste,i} * EF_{bpaste} + \sum_{i=1}^n Q_{brectother,i} * EF_{brectother}}{\sum_{i=1}^n QP_i} \quad (7)$$

Where:

- $EF_{b,onsite}$: Baseline emission factor associated with the (onsite) average consumption of reductants and electrode paste in the production per ton FeSi in year y (tCO₂e/tFeSi) as calculated in equation (7).



- $Q_{\text{bcoal}, i}$:** Average historic (most recent 3 years) annual consumption of coal used as reductant in the submerged electric arc furnace in tonnes of coal per year (tCoal/y). This value shall be taken into account when assessing the overall uncertainty for onsite emissions using project specific values.
- EF_{bcoal} :** Emissions factor applied for the coal consumed as reductant. This factor can be calculated on a project specific basis or a default IPCC value can be applied. If project specific values are used this factor shall be taken into account when assessing the overall uncertainty for onsite emissions. If IPCC values are used the conservative end of the uncertainty range shall be applied.
- $Q_{\text{bcoke}, i}$:** Average historic (most recent 3 years) annual consumption of coke used as reductant in the submerged electric arc furnace in tonnes of coke per year (tCoke/y). This value shall be taken into account when assessing the overall uncertainty for onsite emissions using project specific values.
- EF_{bcoke} :** Emissions factor applied for the coke consumed as reductant. This factor can be calculated on a project specific basis or a default IPCC value can be applied. If project specific values are used this factor shall be taken into account when assessing the overall uncertainty for onsite emissions. If IPCC values are used the conservative end of the uncertainty range shall be applied.
- $Q_{\text{bchar}, i}$:** Average historic (most recent 3 years) annual consumption of char used as reductant in the submerged electric arc furnace in tonnes of char per year (tChar/y). This value shall be taken into account when assessing the overall uncertainty for onsite emissions using project specific values.
- EF_{bchar} :** Emissions factor applied for the char consumed as reductant. This factor can be calculated on a project specific basis or a default IPCC value can be applied. If project specific values are used this factor shall be taken into account when assessing the overall uncertainty for onsite emissions. If IPCC values are used the conservative end of the uncertainty range shall be applied.
- $Q_{\text{bpaste}, i}$:** Average historic (most recent 3 years) annual consumption of electrode paste used as electrode in the submerged electric arc furnace in tonnes of electrode paste per year (tpaste/y). This value shall be taken into account when assessing the overall uncertainty for onsite emissions using project specific values.
- EF_{bpaste} :** Emissions factor applied for the electrode paste consumed as electrode, using the relevant emissions factor (tCO₂) for the carbon paste as specified by the manufacturer for the applicable vintage period. If manufacturer's specifications are used, the lower value of the uncertainty range provided by the manufacturer will have to be adopted. Alternatively, a default factor of 3.67 tCO₂ /t of Carbon paste can be taken. (based on the assumption that the paste is 100% carbon which is the same as 44/12 tCO₂eq).
- QP_i :** Annual FeSi production for the ith year preceding the project activity (tFeSi)

The table below details the value for each of the above parameters in the baseline scenario.

Table B.6.1.15: 3 year average values of baseline parameters for the calculation of $EF_{\text{b,onsite}}$

Parameter	Value	Units
$Q_{\text{bcoal}, i}$	19 688	tcoal / yr
EF_{bcoal}	2.83	tCO ₂ / tcoal



$Q_{\text{bcoke}, i}$	-	tcoke / yr
EF_{bcoke}	3.40	tCO ₂ / tcoke
$Q_{\text{bchar}, i}$	17 528	tchar / yr
EF_{bchar}	2.77	tCO ₂ / tchar
$Q_{\text{bcharcoal}, i}$	163	tcharcoal / yr
$EF_{\text{bcharcoal}}$	3.20	tCO ₂ / tcharcoal
$Q_{\text{bpaste}, i}$	1 161	tpaste / yr
EF_{bpaste}	3.31	tCO ₂ / tpaste

The values of Q_{pi} for the 3 years preceding the project activity are:

2005/2006:	23,813 t
2006/2007:	24,196 t
2007/2008:	25,010 t
Average:	24,340 t

Therefore applying equation (7) we get the following:

$$EF_{\text{b,onsite}} = [(19688 * 2.83) + (0 * 3.4) + (17528 * 2.77) + (163 * 3.2) + (1161 * 3.31)] / 24340$$

$$= 4.19 \text{ t CO}_2 / \text{t FeSi}$$

2. Project emissions

Emissions associated with FeSi production in the project are determined as follows:

$$PE_y = PE_{y,\text{offsite}} + PE_{y,\text{onsite}} \quad (8)$$

where:

PE_y Project emissions (tCO₂ in year y)

$PE_{y,\text{offsite}}$ Offsite project (grid) electricity emissions associated with the electricity consumption of the submerged arc furnace (tCO_{2e} in year y)

$PE_{y,\text{onsite}}$ Onsite project emissions associated with the consumption of Reductant (Coal, Coke and Charcoal) and electrode paste during the production of FeSi (tCO_{2e} in year y)

2.1. Offsite project emissions

Offsite project emissions are calculated according to:

$$PE_{y,\text{offsite}} = QP_{y,\text{max}} \times \text{sec}_{p,y} \times EF_{y,\text{offsite}} \quad (9)$$

where:

$PE_{y,\text{offsite}}$ Offsite project (grid) electricity emissions associated with the electricity consumption of the submerged arc furnace (tCO_{2e} in year y)



$QP_{y, \max}$	Value of FeSi production used for estimating baseline and project emissions for the year y (tFeSi/y), estimated using equation 3 of the baseline emission section
$sec_{p,y}$	Grid specific electricity consumption per tonne of FeSi produced in the project situation (MWh/tFeSi) in year y
$EF_{y, \text{offsite}}$	Grid electricity emissions factor (tCO ₂ e/MWh), estimated according to the “Tool to calculate emissions factor of an electricity system” (see 1.1.3 above)

The average specific electricity consumption per tonne of FeSi produced in the project situation is calculated as follows:

$$sec_{p,y} = \frac{EC_y}{QP_{y, \text{monitored}}} \quad (10)$$

where:

$sec_{p,y}$	Grid specific electricity consumption per tonne of FeSi produced in the project situation (MWh/tFeSi) in year y
EC_y	Annual grid electricity consumption by the submerged electric arc furnace in year y (MWh)
$QP_{y, \text{monitored}}$	Monitored production of FeSi in year y during the project activity (tFeSi/y)

2.2. Onsite project emissions

Onsite project emissions are calculated using the following equations:

$$PE_{y, \text{onsite}} = QP_{y, \max} \times EF_{p,y, \text{onsite}} \quad (11)$$

where:

$PE_{y, \text{onsite}}$	Onsite project emissions associated with the consumption of Reductant (Coal, Coke and Charcoal) and electrode paste during the production of FeSi (tCO ₂ e in year y)
$QP_{y, \max}$	Value of FeSi production used for estimating baseline and project emissions for the year y (tFeSi/y)
$EF_{p,y, \text{onsite}}$	Project emission factor associated with the (onsite) average consumption of reductant (Coal, Coke and Char/Charcoal) and electrode paste per tonne of FeSi in year y (tCO ₂ e/tFeSi) as calculated in equation 12.

The onsite project emission factor is determined as follows:

$$EF_{p,y, \text{onsite}} = \frac{Q_{p\text{coaly}} * EF_{p\text{coaly}} + Q_{p\text{cokey}} * EF_{p\text{cokey}} + Q_{p\text{char,y}} * EF_{p\text{char,y}} + Q_{p\text{charcoaly}} * EF_{p\text{charcoaly}} + Q_{p\text{paste,y}} * EF_{p\text{paste,y}}}{QP_y} \quad (12)$$

where:



- EF_{p, y(onsite)}:** Project emission factor associated with the (onsite) average consumption of reductant (Coal and Coke) and electrode paste in the production per ton Alloy in year y (tCO_{2e}/tAlloy) as calculated in equation 12.
- Q_{pcoal, y}:** Consumption of coal used as reductant in the submerged electric arc furnace in tonnes of coal per year (tCoal/y). This value shall be taken into account when assessing the overall uncertainty for onsite emissions using project specific values.
- EF_{pcoal, y}:** Emissions factor applied for the coal consumed as reductant. This factor can be calculated on a project specific basis or a default IPCC value can be applied. If project specific values are used this factor shall be taken into account when assessing the overall uncertainty for onsite emissions. If IPCC values are used the conservative end of the uncertainty range shall be applied.
- Q_{pcoke, y}:** Consumption of coke used as reductant in the submerged electric arc furnace in tonnes of coke per year (tCoke/y). This value shall be taken into account when assessing the overall uncertainty for onsite emissions using project specific values.
- EF_{pcoke, y}:** Emissions factor applied for the coke consumed as reductant. This factor can be calculated on a project specific basis or a default IPCC value can be applied. If project specific values are used this factor shall be taken into account when assessing the overall uncertainty for onsite emissions. If IPCC values are used the conservative end of the uncertainty range shall be applied.
- Q_{pcharcoal, y}:** Consumption of charcoal used as reductant in the submerged electric arc furnace in tonnes of charcoal per year (tCharcoal/y). This value shall be taken into account when assessing the overall uncertainty for onsite emissions using project specific values.
- EF_{pcharcoal, y}:** Emissions factor applied for the charcoal consumed as reductant. This factor can be calculated on a project specific basis or a default IPCC value can be applied. If project specific values are used this factor shall be taken into account when assessing the overall uncertainty for onsite emissions. If IPCC values are used the conservative end of the uncertainty range shall be applied.
- Q_{pchar, y}:** Consumption of char used as reductant in the submerged electric arc furnace in tonnes of charcoal per year (tChar/y). This value shall be taken into account when assessing the overall uncertainty for onsite emissions using project specific values.
- EF_{pchar, y}:** Emissions factor applied for the charl consumed as reductant. This factor can be calculated on a project specific basis or a default IPCC value can be applied. If project specific values are used this factor shall be taken into account when assessing the overall uncertainty for onsite emissions. If IPCC values are used the conservative end of the uncertainty range shall be applied.
- Q_{ppaste, y}:** Consumption of electrode paste used as electrode in the submerged electric arc furnace in tonnes of electrode paste per year (tpaste/y). This value shall be taken into account when assessing the overall uncertainty for onsite emissions using project specific values.
- EF_{ppaste, y}:** Emissions factor applied for the electrode paste consumed as electrode, using the relevant emissions factor (tCO₂) for the carbon paste as specified by the manufacturer in year y. If manufacturer's specifications are used, the lower value of the uncertainty range provided by the manufacturer will have to be adopted. Alternatively, a default factor of 3.67 tCO₂ /t of Carbon paste can be taken. (based on the assumption that the paste is 100% carbon which is the same as 44/12 tCO_{2eq}).
- QP_{y, monitored} :** Quantity of FeSi production in year y during the project activity (tFeSi/y)



- According to the preferred method of AM0038, project-specific measurement of the emission factors for the coal, char and charcoal will be based on available monthly sampling data of the fixed carbon, volatiles and ash content of the reductant. The emission factor for the paste will be based on the supplier's specifications as stipulated in the supply contract. IPCC references will be used for the determination of the carbon content of the volatiles.
- Fixed carbon, volatiles and ash content of the coal, char and charcoal will be recorded monthly. If some monthly values are missing, an average from the previous and next months will be used. Emission factors for the baseline reductants will be calculated ex-ante while emission factors for reductants used in the project activity will be calculated ex-post.
- See section B.6.3 for the calculation of overall uncertainty of onsite emissions and an explanation of how this has been taken into account in the calculations.

3. Leakage

There is no leakage associated with the project activity.

4. Emission reductions

The emission reductions (ER_y) of the project activity during a given year y is the difference between the baseline, project emissions and emissions due to leakage, as expressed in the formula below:

$$ER_y = BE_y - PE_y - L_y \quad (13)$$

where :

ER_y	Emissions Reductions (t CO ₂ e) in year y
BE_y	Emissions in the baseline scenario (t CO ₂ e) in year y
PE_y	Emissions in the project scenario (t CO ₂ e) in year y
L_y	Leakage (t CO ₂ e) in year y

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

Where the data or parameter is measured for 3 years preceding the project activity the 3yr measurement period comprises the following annual periods:

- Aug 2005 – July 2006 (2005/2006)
- Aug 2006 – July 2007 (2006/2007)
- Aug 2007 – July 2008 (2007/2008)

This period has been selected to ensure that the most recent data available preceding the start of the project activity (17/07/2008) is used to accurately calculate the parameters and produce a conservative estimate of ex-ante emission reductions.

The below data and parameters are not monitored.

Data / Parameter:	QP_i										
Data unit:	Tonnes of FeSi/year										
Description:	Annual FeSi production for at least 3 years preceding the project activity										
Source of data used:	Project proponent										
Value applied:	<table border="1"> <thead> <tr> <th></th> <th>QP_i</th> </tr> </thead> <tbody> <tr> <td>2005/2006</td> <td>23,813</td> </tr> <tr> <td>2006/2007</td> <td>24,196</td> </tr> <tr> <td>2007/2008</td> <td>25,010</td> </tr> <tr> <td>Total</td> <td>73,020</td> </tr> </tbody> </table>		QP _i	2005/2006	23,813	2006/2007	24,196	2007/2008	25,010	Total	73,020
	QP _i										
2005/2006	23,813										
2006/2007	24,196										
2007/2008	25,010										
Total	73,020										
Justification of the choice of data or description of measurement methods and procedures actually applied :	<p>The annual alloy FeSi production for 3 years preceding the project activity is recorded at the start of the project activity and is used to calculate QP_{historic}. The activity data is collected from production records maintained for Furnace F.</p> <p>The crane used to weigh the material is subject to routine maintenance and calibration, reports of which are kept on site.</p>										
Any comment:											

Data / Parameter:	EC_i										
Data unit:	MWh/year										
Description:	Annual grid electricity consumption by the submerged electric arc furnace for 3 years preceding the project activity										
Source of data used:	Project proponent										
Value applied:	<table border="1"> <thead> <tr> <th></th> <th>EC_i</th> </tr> </thead> <tbody> <tr> <td>2005/2006</td> <td>213,985</td> </tr> <tr> <td>2006/2007</td> <td>225,163</td> </tr> <tr> <td>2007/2008</td> <td>223,366</td> </tr> <tr> <td>Total</td> <td>662,514</td> </tr> </tbody> </table>		EC _i	2005/2006	213,985	2006/2007	225,163	2007/2008	223,366	Total	662,514
	EC _i										
2005/2006	213,985										
2006/2007	225,163										
2007/2008	223,366										
Total	662,514										



Justification of the choice of data or description of measurement methods and procedures actually applied :	The annual electricity consumption for at least three years preceding the project activity is recorded at the start of the project activity based on the meter readings specific to Furnace F. Routine calibration checks are performed in-situ by site personnel and records of such calibration are kept on site. Cross checking against utility bills is not possible as more than one furnace is run off a single grid connection and utility meter.
Any comment:	

Data / Parameter:	$Q_{bcoal,i}$										
Data unit:	Tonnes of coal/year										
Description:	Annual consumption of coal used as reductant in the submerged electric arc furnace for 3years preceding the project activity										
Source of data used:	Project proponent										
Value applied:	<table border="1"> <thead> <tr> <th></th> <th>$Q_{bcoal,i}$</th> </tr> </thead> <tbody> <tr> <td>2005/2006</td> <td>15,303</td> </tr> <tr> <td>2006/2007</td> <td>16,977</td> </tr> <tr> <td>2007/2008</td> <td>19,688</td> </tr> <tr> <td>Total</td> <td>51,968</td> </tr> </tbody> </table>		$Q_{bcoal,i}$	2005/2006	15,303	2006/2007	16,977	2007/2008	19,688	Total	51,968
	$Q_{bcoal,i}$										
2005/2006	15,303										
2006/2007	16,977										
2007/2008	19,688										
Total	51,968										
Justification of the choice of data or description of measurement methods and procedures actually applied :	The annual coal consumption for at least three years preceding the project activity is recorded at the start of the project activity based on load cell measurements of the amount of coal added to each batch at Furnace F. The weigh hoppers used to weigh the material is subject to routine maintenance and calibration, reports of which are kept on site.										
Any comment:											

Data / Parameter:	$Q_{bcoke,i}$										
Data unit:	Tonnes of coke/year										
Description:	Annual consumption of coke used as reductant in the submerged electric arc furnace for 3years preceding the project activity										
Source of data used:	Project proponent										
Value applied:	<table border="1"> <thead> <tr> <th></th> <th>$Q_{bcoke,i}$</th> </tr> </thead> <tbody> <tr> <td>2005/2006</td> <td>-</td> </tr> <tr> <td>2009/2007</td> <td>-</td> </tr> <tr> <td>2007/2008</td> <td>-</td> </tr> <tr> <td>Total</td> <td>-</td> </tr> </tbody> </table>		$Q_{bcoke,i}$	2005/2006	-	2009/2007	-	2007/2008	-	Total	-
	$Q_{bcoke,i}$										
2005/2006	-										
2009/2007	-										
2007/2008	-										
Total	-										
Justification of the choice of data or description of	The annual coke consumption for at least three years preceding the project activity is recorded at the start of the project activity based on the										



measurement methods and procedures actually applied :	load cell measurements of the amount of coke added to each batch at Furnace F. The weigh hoppers used to weigh the material is subject to routine maintenance and calibration, reports of which are kept on site.
Any comment:	Coke is not used as a reductant at Furnace F. It has been included as a parameter because it is required by AM0038 but will have a value of zero in the baseline and in the project activity.

Data / Parameter:	$Q_{bcharcoal,i}$										
Data unit:	Tonnes of charcoal/year										
Description:	Annual consumption of charcoal used as reductant in the submerged electric arc furnace for 3years preceding the project activity										
Source of data used:	Project proponent										
Value applied:	<table border="1"> <thead> <tr> <th></th> <th>$Q_{bcharcoal,i}$</th> </tr> </thead> <tbody> <tr> <td>2005/2006</td> <td>-</td> </tr> <tr> <td>2006/2007</td> <td>-</td> </tr> <tr> <td>2007/2008</td> <td>489</td> </tr> <tr> <td>Total</td> <td>489</td> </tr> </tbody> </table>		$Q_{bcharcoal,i}$	2005/2006	-	2006/2007	-	2007/2008	489	Total	489
	$Q_{bcharcoal,i}$										
2005/2006	-										
2006/2007	-										
2007/2008	489										
Total	489										
Justification of the choice of data or description of measurement methods and procedures actually applied :	The annual charcoal consumption for most recent three years preceding the project activity will be recorded at the start of the project activity based on the load cell measurements of the amount of coke added to each batch at Furnace F. The weigh hoppers used to weigh the material is subject to routine maintenance and calibration, reports of which are kept on site.										
Any comment:											

Data / Parameter:	$Q_{bchar,i}$										
Data unit:	Tonnes of char/year										
Description:	Annual consumption of char used as reductant in the submerged electric arc furnace for 3years preceding the project activity										
Source of data used:	Project proponent										
Value applied:	<table border="1"> <thead> <tr> <th></th> <th>$Q_{bchar,i}$</th> </tr> </thead> <tbody> <tr> <td>2005/2006</td> <td>17,885</td> </tr> <tr> <td>2006/2007</td> <td>19,152</td> </tr> <tr> <td>2007/2008</td> <td>15,546</td> </tr> <tr> <td>Total</td> <td>52,584</td> </tr> </tbody> </table>		$Q_{bchar,i}$	2005/2006	17,885	2006/2007	19,152	2007/2008	15,546	Total	52,584
	$Q_{bchar,i}$										
2005/2006	17,885										
2006/2007	19,152										
2007/2008	15,546										
Total	52,584										
Justification of the choice of data or description of measurement methods and procedures actually applied :	The annual char consumption for most recent three years preceding the project activity will be recorded at the start of the project activity based on the load cell measurements of the amount of coke added to each batch at Furnace F.										



	The weigh hoppers used to weigh the material is subject to routine maintenance and calibration, reports of which are kept on site.
Any comment:	

Data / Parameter:	$Q_{bpaste,i}$										
Data unit:	Tonnes of paste/year										
Description:	Annual consumption of electrode paste used as electrode in the submerged electric arc furnace for 3years preceding the project activity										
Source of data used:	Project proponent										
Value applied:	<table border="1"> <thead> <tr> <th></th> <th>$Q_{bpaste,i}$</th> </tr> </thead> <tbody> <tr> <td>2005/2006</td> <td>999.56</td> </tr> <tr> <td>2006/2007</td> <td>1,390.69</td> </tr> <tr> <td>2007/2008</td> <td>1,092.89</td> </tr> <tr> <td>Total</td> <td>3,483.14</td> </tr> </tbody> </table>		$Q_{bpaste,i}$	2005/2006	999.56	2006/2007	1,390.69	2007/2008	1,092.89	Total	3,483.14
	$Q_{bpaste,i}$										
2005/2006	999.56										
2006/2007	1,390.69										
2007/2008	1,092.89										
Total	3,483.14										
Justification of the choice of data or description of measurement methods and procedures actually applied :	The annual paste consumption for at least three years preceding the project activity will be recorded at the start of the project activity based on the number of cylinders inserted into the anodes and the weight of the cylinders as determined by the weighbridge. The weigh bridge used to weigh the material is subject to routine maintenance and calibration, reports of which are kept on site.										
Any comment:											

Data / Parameter:	$EF_{bcoal,i}$										
Data unit:	tCO ₂ /tcoal										
Description:	Emission factor applied for the coal consumed as reductant based on carbon content										
Source of data used:	Project Proponent										
Value applied:	<table border="1"> <thead> <tr> <th></th> <th>$EF_{bcoal,i}$</th> </tr> </thead> <tbody> <tr> <td>2005/2006</td> <td>2.84</td> </tr> <tr> <td>2006/2007</td> <td>2.85</td> </tr> <tr> <td>2007/2008</td> <td>2.85</td> </tr> <tr> <td>Average</td> <td>2.85</td> </tr> </tbody> </table>		$EF_{bcoal,i}$	2005/2006	2.84	2006/2007	2.85	2007/2008	2.85	Average	2.85
	$EF_{bcoal,i}$										
2005/2006	2.84										
2006/2007	2.85										
2007/2008	2.85										
Average	2.85										
Justification of the choice of data or description of measurement methods and procedures actually applied :	Weighted average of the emissions factors for each coal type used in year <i>i</i> . A project-specific factor is used based on the fixed carbon content and carbon content of the volatiles as measured by a random selection of monthly proxy screenings of the coal quality. Historic lab reports are kept for QA/QC purposes and the lab has implemented various QA/QC programs including benchmarking against										



	other labs.
Any comment:	The Project specific factor is compared to the IPCC default factor of 3.1 for coal consumed in ferroalloy production.

Data / Parameter:	$EF_{bcoke,i}$		
Data unit:	tCO ₂ /tcoke		
Description:	Emission factor applied for the coke consumed as reductant based on carbon content		
Source of data used:	Project proponent		
Value applied:	<table border="1"> <tr> <td>IPCC</td> <td>3.40</td> </tr> </table>	IPCC	3.40
IPCC	3.40		
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC Value No QA/QC is applied as a default value is chosen.		
Any comment:	No coke was used in the 3 years preceding the project activity and thus no project specific value is available.		

Data / Parameter:	$EF_{bcharcoal,i}$										
Data unit:	tCO ₂ /tcharcoal										
Description:	Emission factor applied for the charcoal consumed as reductant based on carbon content										
Source of data used:	Project proponent										
Value applied:	<table border="1"> <thead> <tr> <th></th> <th>$EF_{bcharcoal,i}$</th> </tr> </thead> <tbody> <tr> <td>2005/2006</td> <td>3.20</td> </tr> <tr> <td>2006/2007</td> <td>3.20</td> </tr> <tr> <td>2007/2008</td> <td>3.20</td> </tr> <tr> <td>Average</td> <td>3.20</td> </tr> </tbody> </table>		$EF_{bcharcoal,i}$	2005/2006	3.20	2006/2007	3.20	2007/2008	3.20	Average	3.20
	$EF_{bcharcoal,i}$										
2005/2006	3.20										
2006/2007	3.20										
2007/2008	3.20										
Average	3.20										
Justification of the choice of data or description of measurement methods and procedures actually applied :	Usage weighted average of the emissions factors for charcoal used in year <i>i</i> . A project-specific factor is used based on the fixed carbon content and carbon content of the volatiles as measured by a random selection of monthly proxy screenings of the charcoal quality. No QA/QC protocol is required. However the standard lab QA/QC programs were applied in all cases.										
Any comment:	A measured project-specific value for 3 years preceding the project activity has been preferred to IPCC values.										

Data / Parameter:	$EF_{bchar,i}$
--------------------------	----------------



Data unit:	tCO ₂ /tchar										
Description:	Emission factor applied for the char consumed as reductant based on carbon content										
Source of data used:	Project proponent										
Value applied:	<table border="1"> <thead> <tr> <th></th> <th>EF_{bchar,i}</th> </tr> </thead> <tbody> <tr> <td>2005/2006</td> <td>2.77</td> </tr> <tr> <td>2006/2007</td> <td>2.77</td> </tr> <tr> <td>2007/2008</td> <td>2.77</td> </tr> <tr> <td>Average</td> <td>2.77</td> </tr> </tbody> </table>		EF _{bchar,i}	2005/2006	2.77	2006/2007	2.77	2007/2008	2.77	Average	2.77
	EF _{bchar,i}										
2005/2006	2.77										
2006/2007	2.77										
2007/2008	2.77										
Average	2.77										
Justification of the choice of data or description of measurement methods and procedures actually applied :	Usage weighted average of the emissions factors for char used in year <i>i</i> . A project-specific factor is used based on the fixed carbon content and carbon content of the volatiles as measured by a random selection of monthly proxy screenings of the char quality. No QA/QC protocol is required. However the standard lab QA/QC programs were applied in all cases.										
Any comment:	A measured project-specific value for 3 years preceding the project activity has been preferred to IPCC values.										

Data / Parameter:	EF_{bpaste,i}						
Data unit:	tCO ₂ /t of carbon paste						
Description:	Emission factor applied for the electrode paste consumed as electrode based on carbon content						
Source of data used:	Paste supplier						
Value applied:	3.31						
Justification of the choice of data or description of measurement methods and procedures actually applied :	<p>The paste supplier supplied the following information on the composition of the paste as per the supply contract:</p> <table border="1"> <tbody> <tr> <td>Volatiles</td> <td>14.00%</td> </tr> <tr> <td>Ash</td> <td>7.00%</td> </tr> <tr> <td>Fixed Carbon</td> <td>79.00%</td> </tr> </tbody> </table> <p>The emission factor is then calculated using equation 4.19, p4.33 of IPCC (2006):</p> <div style="border: 1px solid black; padding: 5px; text-align: center;"> <p>EQUATION 4.19 CARBON CONTENT OF FERROALLOY REDUCING AGENTS Total C-content in reducing agent <i>i</i> = Fix C in <i>i</i> + Content of volatiles in <i>i</i> • C_v</p> </div> <p>Where: C_v = Carbon content in volatiles. Unless other information is available, C_v = 0.65 is used for coal and 0.80 for coke.</p>	Volatiles	14.00%	Ash	7.00%	Fixed Carbon	79.00%
Volatiles	14.00%						
Ash	7.00%						
Fixed Carbon	79.00%						



	<p>We take for C_v the same value as for coke (0.80), given that the characteristics of the paste are similar to that of the coke:</p> <ul style="list-style-type: none"> - 78.5% of the paste is anthracite, which is a form of coal with high calorific value and carbon content (like coke) - 21.5% of the paste is the binder, which itself is composed of a minimum of 45% of coking-value. <p>Therefore the total carbon content of the paste is $79\% + 14\% * 0.80 = 90\%$ C/tpaste, and $EF_{bpaste} = 3.31 tCO_2/tpaste$. This value is still lower than the IPCC value of 3.4.</p> <p>No QA/QC protocol is required. However the standard lab QA/QC programs were applied in all cases.</p>
--	---

Data / Parameter:	Quality of coal_b								
Data unit:	Mass fraction of each component (%m/m)								
Description:	Quality of coal based on relevant properties								
Source of data used:	Project proponent								
Value applied:	<table border="1"> <thead> <tr> <th>Coal</th> <th>Typical</th> </tr> </thead> <tbody> <tr> <td>Volatiles</td> <td>32.39%</td> </tr> <tr> <td>Fixed Carbon</td> <td>55.42%</td> </tr> <tr> <td>Ash</td> <td>12.24%</td> </tr> </tbody> </table>	Coal	Typical	Volatiles	32.39%	Fixed Carbon	55.42%	Ash	12.24%
Coal	Typical								
Volatiles	32.39%								
Fixed Carbon	55.42%								
Ash	12.24%								
Justification of the choice of data or description of measurement methods and procedures actually applied :	<p>The monthly records (where available) of the coal proxy analysis before the project was implemented are used to determine the relevant properties of coal.</p> <p>No QA/QC protocol is required. However the standard lab QA/QC programs were applied in all cases.</p>								
Any comment:	Project proponent's lab analyses are preferred to supplier's data and are used to determine the emission factor of the coal $EF_{bcoal,i}$.								

Data / Parameter:	Quality of coke_b
Data unit:	Mass fraction of each component (%m/m)
Description:	Quality of coke based on relevant properties
Source of data used:	Project proponent
Value applied:	n/a
Justification of the choice of data or description of measurement methods and procedures actually applied :	No coke is used in this process in the baseline scenario and therefore there are no measurement methods for the quality of coke.
Any comment:	



Data / Parameter:	Quality of charcoal_b								
Data unit:	Mass fraction of each component (%m/m)								
Description:	Quality of charcoal based on relevant properties								
Source of data used:	Project proponent								
Value applied:	<table border="1"> <thead> <tr> <th></th> <th>Typical</th> </tr> </thead> <tbody> <tr> <td>Volatile</td> <td>16.94%</td> </tr> <tr> <td>Ash</td> <td>9.51%</td> </tr> <tr> <td>Fixed Carbon</td> <td>73.58%</td> </tr> </tbody> </table>		Typical	Volatile	16.94%	Ash	9.51%	Fixed Carbon	73.58%
	Typical								
Volatile	16.94%								
Ash	9.51%								
Fixed Carbon	73.58%								
Justification of the choice of data or description of measurement methods and procedures actually applied :	The monthly records (where available) of the charcoal proxy analysis before the project was implemented are used to determine the relevant properties of charcoal. Historic values have been checked against IPCC values for QA/QC purposes.								
Any comment:	Project proponent's lab analyses are preferred to supplier's data and are used to determine the emission factor of the charcoal $EF_{b,charcoal,i}$.								

Data / Parameter:	Quality of electrode paste_b								
Data unit:	Mass fraction of each component (%m/m)								
Description:	Quality of electrode paste based on relevant properties								
Source of data used:	Supplier								
Value applied:	<table border="1"> <thead> <tr> <th></th> <th>Typical</th> </tr> </thead> <tbody> <tr> <td>Volatile</td> <td>14.00%</td> </tr> <tr> <td>Ash</td> <td>7.00%</td> </tr> <tr> <td>Fixed Carbon</td> <td>79.00%</td> </tr> </tbody> </table>		Typical	Volatile	14.00%	Ash	7.00%	Fixed Carbon	79.00%
	Typical								
Volatile	14.00%								
Ash	7.00%								
Fixed Carbon	79.00%								
Justification of the choice of data or description of measurement methods and procedures actually applied :	The quality of the electrode paste is stipulated in the supply agreement.								
Any comment:	Green paste is bought from the supplier and put into the electrodes. As the heat increases when it goes down the electrodes, it is baked before it reaches the core of the furnace. The quality of green paste should be used for the comparison between the composition of the paste before and after the project activity, and for the calculation of emission factors.								

Data / Parameter:	Quality of FeSi_b
Data unit:	Text
Description:	Quality of FeSi _b , based on relevant properties
Source of data used:	Project proponent



Value applied:	<table border="1"> <thead> <tr> <th>FeSi</th> <th>Typical</th> <th>Min</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Si</td> <td>73.1%</td> <td>65.0%</td> <td>78.6%</td> </tr> <tr> <td>Al</td> <td>2.3%</td> <td>0.6%</td> <td>6.6%</td> </tr> <tr> <td>Ca</td> <td>0.5%</td> <td>0.0%</td> <td>2.6%</td> </tr> <tr> <td>Fe</td> <td>23.4%</td> <td>17.5%</td> <td>31.4%</td> </tr> </tbody> </table>	FeSi	Typical	Min	Max	Si	73.1%	65.0%	78.6%	Al	2.3%	0.6%	6.6%	Ca	0.5%	0.0%	2.6%	Fe	23.4%	17.5%	31.4%
FeSi	Typical	Min	Max																		
Si	73.1%	65.0%	78.6%																		
Al	2.3%	0.6%	6.6%																		
Ca	0.5%	0.0%	2.6%																		
Fe	23.4%	17.5%	31.4%																		
Justification of the choice of data or description of measurement methods and procedures actually applied :	<p>The quality of the FeSi is measured by laboratory analysis conducted by the project proponent. The specifications of the FeSi produced will be used to compare the quality of the FeSi produced before and after the project activity.</p> <p>Historic lab reports are kept for QA/QC purposes and the lab has implemented various QA/QC programs including benchmarking against other labs. The historic data has been checked against the reference values in the supplier contracts.</p>																				
Any comment:	While the meth stipulates the use of other properties such as Mn, C, P, S etc, these are not relevant in the production of FeSi when measuring the quality specifications and therefore only Si, Al, Ca and Fe have been used as the appropriate parameters.																				

Data / Parameter:	Quality of Raw Materials (Milscale)																
Data unit:	Text																
Description:	Quality of Milscale, based on relevant properties																
Source of data used:	Project proponent																
Value applied:	<table border="1"> <thead> <tr> <th>Milscale</th> <th>Average</th> <th>Min</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Fe₂O₃</td> <td>70.59%</td> <td>60.8%</td> <td>2.2%</td> </tr> <tr> <td>SiO₂</td> <td>5.14%</td> <td>3.4%</td> <td>98.7%</td> </tr> <tr> <td>AlO₃</td> <td>0.57%</td> <td>0.03%</td> <td>3.8%</td> </tr> </tbody> </table>	Milscale	Average	Min	Max	Fe ₂ O ₃	70.59%	60.8%	2.2%	SiO ₂	5.14%	3.4%	98.7%	AlO ₃	0.57%	0.03%	3.8%
Milscale	Average	Min	Max														
Fe ₂ O ₃	70.59%	60.8%	2.2%														
SiO ₂	5.14%	3.4%	98.7%														
AlO ₃	0.57%	0.03%	3.8%														
Justification of the choice of data or description of measurement methods and procedures actually applied :	<p>The data used to calculate the average quality is the monthly historical sampling analysis data of the Milscale which was measured in the 3 years preceding the start of project activity.</p> <p>Historic lab reports are kept for QA/QC purposes and the lab has implemented various QA/QC programs including benchmarking against other labs. The historic data has been checked against the reference values in the supplier contracts.</p>																
Any comment:	Milscale is a low cost source of Fe. While the meth stipulates the use of other properties such as Mn, C, P, S etc, these are not relevant properties of Milscale when measuring the quality specifications and therefore only SiO ₂ , AlO ₃ and Fe ₂ O ₃ have been used as the appropriate parameters.																



Data / Parameter:	Quality of Raw Materials (Quartz)																			
Data unit:	Text																			
Description:	Quality of Quartz, based on relevant properties																			
Source of data used:	Project proponent																			
Value applied:	<table border="1"> <thead> <tr> <th>Quartz</th> <th>Average</th> <th>Min</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Fe₂O₃</td> <td>1.2%</td> <td>0.7%</td> <td>2.2%</td> </tr> <tr> <td>SiO₂</td> <td>96.0%</td> <td>90.2%</td> <td>98.7%</td> </tr> <tr> <td>AlO₃</td> <td>0.8%</td> <td>0.03%</td> <td>3.8%</td> </tr> </tbody> </table>				Quartz	Average	Min	Max	Fe ₂ O ₃	1.2%	0.7%	2.2%	SiO ₂	96.0%	90.2%	98.7%	AlO ₃	0.8%	0.03%	3.8%
Quartz	Average	Min	Max																	
Fe ₂ O ₃	1.2%	0.7%	2.2%																	
SiO ₂	96.0%	90.2%	98.7%																	
AlO ₃	0.8%	0.03%	3.8%																	
Justification of the choice of data or description of measurement methods and procedures actually applied :	<p>The data used to calculate the average quality is the monthly historical sampling analysis data of the Quartz which was measured in the 3 years preceding the start of project activity.</p> <p>Historic lab reports are kept for QA/QC purposes and the lab has implemented various QA/QC programs including benchmarking against other labs. The historic data has been checked against the reference values in the supplier contracts.</p>																			
Any comment:	Quartz is the source of Si. While the meth stipulates the use of other properties such as Mn, C, P, S etc, these are not relevant properties of Quartz when measuring the quality specifications and therefore only SiO ₂ , AlO ₃ and Fe ₂ O ₃ have been used as the appropriate parameters.																			

Data / Parameter:	EF_{v,offsite}
Data unit:	tCO ₂ /MWh
Description:	Grid emission factor
Source of data used:	Eskom published data
Value applied:	0.99
Justification of the choice of data or description of measurement methods and procedures actually applied :	This factor is calculated as per the combined margin method in the “ <i>Tool to calculate the emission factor for an electricity system</i> ” (version 02.2.1).
Any comment:	



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

1. Offsite project emissions

- The grid electricity emission factor has been calculated in section B.6.1 at 0.99 t CO₂/MWh which is equal to $EF_{y, \text{offsite}}$.
- $sec_{p,y} = sec_b * 0.9$ (i.e. estimated savings of 10% of MWh per tFeSi in the project.) = 8.16 MWh/tFeSi

Offsite project emissions are calculated according to equation (9).

Therefore:

$$PE_{y, \text{offsite}} = QP_{y, \text{max}} \times sec_{p,y} \times EF_{y, \text{offsite}} \quad (9)$$

$$PE_{y, \text{offsite}} = 24,340 * 8.16 * 0.99$$

$$PE_{y, \text{offsite}} = \mathbf{196\,791\ tCO_2}$$

2. Onsite project emissions

It is assumed that onsite project emissions do not change in the project activity. Therefore the same values as detailed in section B.6.1 have been used in the estimation of emission reductions. The only variable that is estimated is $QP_{y, \text{monitored}}$.

To calculate project emissions we assume the following:

Estimation of $QP_{y, \text{monitored}}$:

2008/2009:	20,667 ¹⁶
2009/2010:	26,641
2010/2011:	29,569
Total:	76,877
$QP_{y, \text{monitored}}$:	25,626

We use equation (3) below to limit the alloy production to the historic average level:

$$QP_{y, \text{max}} = \min^m \text{ of } (QP_{y, \text{monitored}}, QP_{\text{historic}}) \quad (3)$$

$$QP_{y, \text{max}} = \min^m \text{ of } (25,626; 24,340)$$

$$QP_{y, \text{max}} = \mathbf{24,340}$$

Then:

- $EF_{y, \text{onsite}} = EF_{b, \text{onsite}} = 4.19 \text{ tCO}_2\text{e/FeSi}$

Onsite project emissions are calculated using equation (6)

¹⁶ The value for 2008/2009 is estimated based on actual production for 9 months, pro-rated to be production for a full 12 month period.



$$PE_{y, \text{onsite}} = QP_{y, \text{max}} \times EF_{p, y, \text{onsite}} \quad (6)$$

Therefore:

$$PE_{y, \text{onsite}} = 24,340 * 4.19$$
$$PE_{y, \text{onsite}} = \mathbf{102,057 \text{ t CO}_2}$$

3. Project emissions

To calculate project emissions we use equation (8)

$$PE_y = PE_{y, \text{offsite}} + PE_{y, \text{onsite}} \quad (8)$$

Therefore:

$$PE_y = 196,791 + 102,057$$
$$PE_y = \mathbf{298,848 \text{ t CO}_2}$$

4. Leakage

There is not anticipated to be any leakage attributable to the project activity according to the ‘*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*’ (version 01)¹⁷.

5. Emission Reductions

Emission reductions are calculated according to equation (13) as detailed in section B.6.1.

$$ER_y = BE_y - PE_y - L_y \quad (13)$$

Therefore:

$$ER_y = 320,714 - 298,848 - 0$$
$$ER_y = 21,866$$

6. Uncertainty

AM0038 states that:

“The uncertainty will be assessed in line with the European Commission guidelines on monitoring and reporting of GHG emissions in iron and steel production and taken into account when calculating the onsite emissions”.

Uncertainty should be taken into account according to the latest monitoring and reporting guidelines that are used in the EU Emissions Trading Scheme (ETS) (further referred to as “EC monitoring guidelines¹⁸”). This analysis has been done and is presented in annex 3. The main conclusion is that the monitoring system used in the project meets *at least* the requirements imposed by the monitoring tier that

¹⁷ EB39, annex 7

<http://cdm.unfccc.int/methodologies/PAMethodologies/tools/am-tool-05-v1.pdf>

¹⁸ EC monitoring guidelines refers to: Commission Decision of 18 July 2007 ‘*establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council*’, 2007/589/EC.



would apply to the project’s plant, should it be covered by the EU ETS under iron and steel production (see Annex 3 for the applicable Tiers to the project activity). These requirements will be met during the lifetime of the project activity through the implementation of a rigorous monitoring system. Applying them to ex-ante emission reduction calculations is more complex but the analysis has resulted in an uncertainty level that is significantly lower than that required by the EC monitoring guidelines and therefore no uncertainty factor need be applied to the onsite emission reductions. A summary of the outcome of the analysis is presented below:

Table B.6.3.1: Determination of the uncertainty of activity data and emission factors for parameters used in the calculation of onsite emissions

Reductant	Uncertainty	Source
Activity Data		
Coal	2.5%	The load cells used to measure the coal input quantities have a rated accuracy of 2%. Other possible sources of uncertainty (associated with the procedures/way in which instruments are used) will be minimised by calibrating the load cells in line with manufacturer's requirements as per the QA and QC procedures. As per Annex VI of the EC monitoring guidelines for Tier 3 activity data we have used the uncertainty value to be conservative since the actual rated uncertainty is 2% which is lower than stipulated.
Charcoal	2.5%	
Char	2.5%	
Paste	2.5%	The number of paste cylinders put in the electrodes is recorded accurately. The weight of each cylinder is based on weighing trucks on the weighbridge and dividing total weight by the number of cylinders. A daily average of cylinders might have a relatively high uncertainty but a monthly average should ensure a measurement with an uncertainty below 2%. The weighbridge is calibrated regularly by an external company.
Emission Factors		
Coal	5.0%	The emission factor is calculated based on actual proximate screenings of the fixed carbon content and the volatile content of a random sample of measurements as per the IPCC guidance on calculating Tier 3 emission factors for reductants. An uncertainty value of less than 5% is specified by the IPCC and to be conservative we have used 5% as the uncertainty value. The IPCC default value of 0.65 carbon content of volatiles has been used to calculate the emission factor of the coal while the default value of 0.8 has been used to calculate it for char and charcoal. Since these are default/estimated values, no uncertainty should be assigned to them.
Charcoal	5.0%	
Char	5.0%	
Paste	5.0%	The fixed carbon content and volatile content of the paste has been provided by the supplier. The emission factor is calculated as per IPCC Tier 3 method and therefore the associated uncertainty is less than 5%. Since paste is similar in nature to anthracite, the default IPCC value of 0.8 for carbon content of volatiles has been used. No uncertainty is assigned to this as no uncertainty should be assigned to estimated values in the EU ETS.

Notes:

- The project is an energy efficiency project which is expected to result in electricity savings per ton of alloy produced which therefore affects offsite emissions. Onsite emissions are not expected to be affected significantly by the project.
- If, however, onsite emissions increase, project participants are automatically penalised via the calculation of project emissions as these emissions count towards the project activity emissions.

Uncertainties have been calculated by combining uncertainties of each source of onsite emissions as per the *table B.6.3.12* according to the EC monitoring guidelines, Annex I, Section 7, ‘Uncertainty Assessment’. The equations used are presented in full in Annex 3. Activity data and the associated emission factors have been sourced from the baseline parameters as these are the same parameters that need to be monitored in the project activity and the values are expected to be similar in the project activity to the baseline. A summary of the analysis is presented below in *table B.6.3.13* which shows that



the associated uncertainty level associated with the emission reductions from the project activity is only 1.655%.

**Table B.6.3.2:** Overall Uncertainty of Onsite Emissions

	Coal	Charcoal	Char	Paste	BE _{historic, onsite}
Activity data uncertainty	2.5	2.5	2.5	2.5	-
Emission factor uncertainty	5.0	5.0	5.0	5.0	-
Combined uncertainty	2.74	2.74	2.74	2.74	-
Emissions 2005/2006	43343	0	49620	3309	96272
Emissions 2006/2007	48085	0	53135	4604	105824
Emissions 2007/2008	55765	1562	43131	3618	104076
Average baseline emissions	49064	521	48629	3843	102057
Weighted contribution to total emissions	48%	1%	48%	4%	100%
Uncertainty as % of total emissions	1.317	0.014	1.305	0.103	1.655

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

Table B.4.1: Ex-Ante estimation of overall project annual baseline and project emissions, leakage

Year	Estimation of project activity emissions (tonnes of CO ₂ e)	Estimation of baseline emissions (tonnes of CO ₂ e)	Estimation of leakage (tonnes of CO ₂ e)	Estimation fo overall emission reductions (tonnes of CO ₂ e)
2012	298,848	320,714	0	21,866
2013	298,848	320,714	0	21,866
2014	298,848	320,714	0	21,866
2015	298,848	320,714	0	21,866
2016	298,848	320,714	0	21,866
2017	298,848	320,714	0	21,866
2018	298,848	320,714	0	21,866
2019	298,848	320,714	0	21,866
2020	298,848	320,714	0	21,866
2021	298,848	320,714	0	21,866
Total (tonnes of CO₂)	2,988,480	3,207,140	0	218,660

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

B.7.1 Data and parameters monitored:

Data / Parameter:	QP _{y, monitored}
Data unit:	Tonnes of FeSi/year
Description:	Quantity of FeSi production in year y during the project activity
Source of data to be	Project proponent



used:											
Value of data applied for the purpose of calculating expected emission reductions in section B.5	<table border="1"> <thead> <tr> <th></th> <th>QP_i</th> </tr> </thead> <tbody> <tr> <td>2005/2006</td> <td>23,813</td> </tr> <tr> <td>2006/2007</td> <td>24,196</td> </tr> <tr> <td>2007/2008</td> <td>25,010</td> </tr> <tr> <td>Total</td> <td>73,020</td> </tr> </tbody> </table>		QP_i	2005/2006	23,813	2006/2007	24,196	2007/2008	25,010	Total	73,020
	QP_i										
2005/2006	23,813										
2006/2007	24,196										
2007/2008	25,010										
Total	73,020										
Description of measurement methods and procedures to be applied:	Data will be monitored at each tapping of the furnace by weighing metal ladles on a weighing instrument, in general the crane's abductor scale is used.										
QA/QC procedures to be applied:	Measured data will be audited by production superintendent. The weighing instrument will be maintained regularly and calibrated annually.										
Any comment:											

Data / Parameter:	EC_y										
Data unit:	MWh/year										
Description:	Annual grid electricity consumption by the submerged electric arc furnace										
Source of data to be used:	Project proponent										
Value of data applied for the purpose of calculating expected emission reductions in section B.5	<table border="1"> <thead> <tr> <th></th> <th>EC_i</th> </tr> </thead> <tbody> <tr> <td>2005/2006</td> <td>213,985</td> </tr> <tr> <td>2006/2007</td> <td>225,163</td> </tr> <tr> <td>2007/2008</td> <td>223,366</td> </tr> <tr> <td>Total</td> <td>662,514</td> </tr> </tbody> </table>		EC_i	2005/2006	213,985	2006/2007	225,163	2007/2008	223,366	Total	662,514
	EC_i										
2005/2006	213,985										
2006/2007	225,163										
2007/2008	223,366										
Total	662,514										
Description of measurement methods and procedures to be applied:	Electricity consumption will be metered continuously on the individual furnace F by an electricity meter and recorded monthly. The meters will be maintained in line with the manufacturer's requirements.										
QA/QC procedures to be applied:	The accuracy of the meter readings are confirmed by cross check with a second meter. This check is done twice annually. Electricity bills are not used as a single grid source is used for both project and non-project activities.										
Any comment:											

Data / Parameter:	Qp_{coal,y}
Data unit:	Tonnes of coal/year
Description:	Annual consumption of coal used as reductant in the submerged electric arc furnace
Source of data to be used:	Project proponent



Value of data applied for the purpose of calculating expected emission reductions in section B.5		
		$Q_{bcoal,i}$
	2005/2006	15,303
	2006/2007	16,977
	2007/2008	19,688
	Total	51,968
Description of measurement methods and procedures to be applied:	The amount of coal put in each batch is weighed in hoppers with load cells, and recorded daily..	
QA/QC procedures to be applied:	The amount of coal reductant added to the furnace will be checked by the superintendent to ensure it is the correct amount required for FeSi production. The load cells will be maintained and calibrated regularly in line with the manufacturer's requirements and the plant's experience. These weigh hoppers will be calibrated at least twice annually.	
Any comment:		

Data / Parameter:	$Q_{bcoke,y}$	
Data unit:	Tonnes of coke/year	
Description:	Annual consumption of coke used as reductant in the submerged electric arc furnace	
Source of data to be used:	Project proponent	
Value of data applied for the purpose of calculating expected emission reductions in section B.5		
		$Q_{bcoke,i}$
	2005/2006	-
	2009/2007	-
	2007/2008	-
	Total	-
Description of measurement methods and procedures to be applied:	The amount of coke put in each batch is weighed in hoppers with load cells, and recorded daily.	
QA/QC procedures to be applied:	The amount of coke reductant added to the furnace will be checked by the superintendent to ensure it is the correct amount required for FeSi production. The load cells will be maintained and calibrated regularly in line with the manufacturer's requirements and the plant's experience. These weigh hoppers will be calibrated at least twice annually.	
Any comment:	There is no use of coke in Furnace F	

Data / Parameter:	$Q_{pcharcoal,y}$
Data unit:	Tonnes of charcoal/year
Description:	Annual consumption of charcoal used as reductant in the submerged electric arc furnace
Source of data to be	Project proponent



used:											
Value of data applied for the purpose of calculating expected emission reductions in section B.5	<table border="1"> <thead> <tr> <th></th> <th>$Q_{bcharcoal,i}$</th> </tr> </thead> <tbody> <tr> <td>2005/2006</td> <td>-</td> </tr> <tr> <td>2006/2007</td> <td>-</td> </tr> <tr> <td>2007/2008</td> <td>489</td> </tr> <tr> <td>Total</td> <td>489</td> </tr> </tbody> </table>		$Q_{bcharcoal,i}$	2005/2006	-	2006/2007	-	2007/2008	489	Total	489
	$Q_{bcharcoal,i}$										
2005/2006	-										
2006/2007	-										
2007/2008	489										
Total	489										
Description of measurement methods and procedures to be applied:	The amount of charcoal put in each batch is weighed in hoppers with load cells, and recorded daily.										
QA/QC procedures to be applied:	The amount of charcoal reductant added to the furnace will be checked by the superintendent to ensure it is the correct amount required for FeSi production. The load cells will be maintained and calibrated regularly in line with the manufacturer's requirements and the plant's experience. These weigh hoppers will be calibrated at least twice annually.										
Any comment:											

Data / Parameter:	$Q_{pchar,y}$										
Data unit:	Tonnes of char/year										
Description:	Annual consumption of char used as reductant in the submerged electric arc furnace										
Source of data to be used:	Project proponent										
Value of data applied for the purpose of calculating expected emission reductions in section B.5	<table border="1"> <thead> <tr> <th></th> <th>$Q_{bchar,i}$</th> </tr> </thead> <tbody> <tr> <td>2005/2006</td> <td>17,885</td> </tr> <tr> <td>2006/2007</td> <td>19,152</td> </tr> <tr> <td>2007/2008</td> <td>15,546</td> </tr> <tr> <td>Total</td> <td>52,584</td> </tr> </tbody> </table>		$Q_{bchar,i}$	2005/2006	17,885	2006/2007	19,152	2007/2008	15,546	Total	52,584
	$Q_{bchar,i}$										
2005/2006	17,885										
2006/2007	19,152										
2007/2008	15,546										
Total	52,584										
Description of measurement methods and procedures to be applied:	The amount of charcoal put in each batch is weighed in hoppers with load cells, and recorded daily.										
QA/QC procedures to be applied:	The amount of char reductant added to the furnace will be checked by the superintendent to ensure it is the correct amount required for FeSi production. The load cells will be maintained and calibrated regularly in line with the manufacturer's requirements and the plant's experience. These weigh hoppers will be calibrated at least twice annually.										
Any comment:											

Data / Parameter:	$Q_{ppaste,v}$
--------------------------	----------------



Data unit:	Tonnes of paste/year										
Description:	Annual consumption of electrode paste used as electrode in the submerged electric arc furnace										
Source of data to be used:	Project proponent										
Value of data applied for the purpose of calculating expected emission reductions in section B.5	<table border="1"> <thead> <tr> <th></th> <th>$Q_{bpaste,i}$</th> </tr> </thead> <tbody> <tr> <td>2005/2006</td> <td>999.56</td> </tr> <tr> <td>2006/2007</td> <td>1,390.69</td> </tr> <tr> <td>2007/2008</td> <td>1,092.89</td> </tr> <tr> <td>Total</td> <td>3,483.14</td> </tr> </tbody> </table>		$Q_{bpaste,i}$	2005/2006	999.56	2006/2007	1,390.69	2007/2008	1,092.89	Total	3,483.14
	$Q_{bpaste,i}$										
2005/2006	999.56										
2006/2007	1,390.69										
2007/2008	1,092.89										
Total	3,483.14										
Description of measurement methods and procedures to be applied:	<p>The number of paste cylinders put into the electrode is logged each time a new cylinder is used.</p> <p>The average weight of each cylinder is calculated based on weighing paste trucks on a weighbridge and dividing total weight by number of cylinders on a monthly basis.</p>										
QA/QC procedures to be applied:	The weighbridge will be maintained and calibrated regularly in line with the National Standards to ensure its accuracy. This requires annual certification by an accredited 3 rd party.										
Any comment:											

Data / Parameter:	$EF_{pcoal,y}$										
Data unit:	tCO ₂ /t coal										
Description:	Emission factor applied for the coal consumed as reductant in year y										
Source of data to be used:	Carbon content provided by laboratory analyses Carbon content of volatiles from IPCC (2006)										
Value of data applied for the purpose of calculating expected emission reductions in section B.5	<table border="1"> <thead> <tr> <th></th> <th>$EF_{bcoal,i}$</th> </tr> </thead> <tbody> <tr> <td>2005/2006</td> <td>2.84</td> </tr> <tr> <td>2006/2007</td> <td>2.85</td> </tr> <tr> <td>2007/2008</td> <td>2.85</td> </tr> <tr> <td>Average</td> <td>2.85</td> </tr> </tbody> </table>		$EF_{bcoal,i}$	2005/2006	2.84	2006/2007	2.85	2007/2008	2.85	Average	2.85
	$EF_{bcoal,i}$										
2005/2006	2.84										
2006/2007	2.85										
2007/2008	2.85										
Average	2.85										
Description of measurement methods and procedures to be applied:	<p>Monthly running averages of carbon contents are used for the calculation of a monthly emission factor.</p> <p>This emission factor is calculated using equation 4.19, p4.33 of IPCC (2006):</p>										



	<div style="border: 1px solid black; padding: 5px; text-align: center;"> <p>EQUATION 4.19 CARBON CONTENT OF FERROALLOY REDUCING AGENTS Total C-content in reducing agent i = Fix C in i + Content of volatiles in i • Cv</p> </div> <p>Where: Cv = Carbon content in volatiles. Unless other information is available, Cv = 0.65 is used for coal and 0.80 for coke.</p> <p>The annual emission factor is calculated as the average of monthly emission factors and used for emission calculations.</p>
QA/QC procedures to be applied:	Lab analyses are done according to applicable national and international standards for every batch of coal that is used. Monitored values will compared to IPCC values.
Any comment:	

Data / Parameter:	EF_{pcoke,y}		
Data unit:	tCO ₂ /t coke		
Description:	Emission factor applied for the coke consumed as reductant in year y		
Source of data to be used:	Carbon content provided by laboratory analyses Carbon content of volatiles from IPCC (2006)		
Value of data applied for the purpose of calculating expected emission reductions in section B.5	<table border="1" style="width: 100%;"> <tr> <td style="width: 50%;">IPCC</td> <td style="width: 50%;">3.4</td> </tr> </table>	IPCC	3.4
IPCC	3.4		
Description of measurement methods and procedures to be applied:	<p>Monthly running averages of carbon contents are used for the calculation of a monthly emission factor.</p> <p>This emission factor is calculated using equation 4.19, p4.33 of IPCC (2006):</p> <div style="border: 1px solid black; padding: 5px; text-align: center;"> <p>EQUATION 4.19 CARBON CONTENT OF FERROALLOY REDUCING AGENTS Total C-content in reducing agent i = Fix C in i + Content of volatiles in i • Cv</p> </div> <p>Where: Cv = Carbon content in volatiles. Unless other information is available, Cv = 0.65 is used for coal and 0.80 for coke.</p> <p>The annual emission factor is calculated as the average of monthly emission factors and used for emission calculations.</p>		
QA/QC procedures to be applied:	Lab analyses are done according to applicable national and international standards. monthly The IPCC default value for the electrode paste emission factor is 3.4 and the calculated project-specific value will be compared to this to ensure conservativeness.		
Any comment:	This project-specific approach is preferred to IPCC values		

Data / Parameter:	EF_{pcharcoal,y}
Data unit:	tCO ₂ /t charcoal



Description:	Emission factor applied for the charcoal consumed as reductant in year y										
Source of data to be used:	Carbon content provided by laboratory analyses Carbon content of volatiles from IPCC (2006)										
Value of data applied for the purpose of calculating expected emission reductions in section B.5	<table border="1"> <thead> <tr> <th></th> <th>$EF_{bcharcoal,i}$</th> </tr> </thead> <tbody> <tr> <td>2005/2006</td> <td>-</td> </tr> <tr> <td>2006/2007</td> <td>-</td> </tr> <tr> <td>2007/2008</td> <td>3.20</td> </tr> <tr> <td>Average</td> <td>3.20</td> </tr> </tbody> </table>		$EF_{bcharcoal,i}$	2005/2006	-	2006/2007	-	2007/2008	3.20	Average	3.20
	$EF_{bcharcoal,i}$										
2005/2006	-										
2006/2007	-										
2007/2008	3.20										
Average	3.20										
Description of measurement methods and procedures to be applied:	<p>Charcoal samples are prepared at the plant and sent to the laboratory for analysis of volatile and fix carbon content. Monthly running averages of carbon contents are used for the calculation of a monthly emission factor.</p> <p>This emission factor is calculated using equation 4.19, p4.33 of IPCC (2006):</p> <div style="border: 1px solid black; padding: 5px; text-align: center;"> <p>EQUATION 4.19 CARBON CONTENT OF FERROALLOY REDUCING AGENTS Total C-content in reducing agent i = Fix C in i + Content of volatiles in i • C_v</p> </div> <p>Where: C_v = Carbon content in volatiles. Unless other information is available, $C_v = 0.65$ is used for coal and 0.80 for coke.</p> <p>The annual emission factor is calculated as the average of monthly emission factors and used for emission calculations.</p>										
QA/QC procedures to be applied:	<p>Lab analyses are done monthly according to applicable national and international standards.</p> <p>There is no default IPCC value for charcoal use as reductant in the production of ferroalloys and so the calculated emission factor will be compared to the default IPCC emission factor for coal of 3.1 which is considered the closest proxy.</p>										
Any comment:	This project-specific approach is preferred to IPCC values										
Data / Parameter:	$EF_{pchar,v}$										
Data unit:	tCO ₂ /t char										
Description:	Emission factor applied for the charcoal consumed as reductant in year y										
Source of data to be used:	Carbon content provided by laboratory analyses Carbon content of volatiles from IPCC (2006)										
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See preliminary note above.										



Description of measurement methods and procedures to be applied:	<p>Char samples are prepared at the plant and sent to the laboratory for analysis of volatile and fix carbon content. Monthly running averages of carbon contents are used for the calculation of a monthly emission factor.</p> <p>This emission factor is calculated using equation 4.19, p4.33 of IPCC (2006):</p> <div style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"> <p style="text-align: center;">EQUATION 4.19 CARBON CONTENT OF FERROALLOY REDUCING AGENTS Total C-content in reducing agent i = Fix C in i + Content of volatiles in i • Cv</p> </div> <p>Where: Cv = Carbon content in volatiles. Unless other information is available, Cv = 0.65 is used for coal and 0.80 for coke.</p> <p>The annual emission factor is calculated as the average of monthly emission factors and used for emission calculations.</p>
QA/QC procedures to be applied:	<p>Lab analyses are done monthly according to applicable national and international standards.</p> <p>If values are missing or inconsistent for some months, the average of previous and next 3 months will be used.</p> <p>There is no default IPCC value for charcoal use as reductant in the production of ferroalloys and so the calculated emission factor will be compared to the default IPCC emission factor for coal of 3.1 which is considered the closest proxy.</p>
Any comment:	<p>This project-specific approach is preferred to IPCC values</p>

Data / Parameter:	$EF_{ppaste,v}$
Data unit:	tCO ₂ /t of carbon paste
Description:	Emission factor applied for the electrode paste consumed as reductant in year y
Source of data to be used:	Supplier (and IPCC/external literature reference)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3.31
Description of measurement methods and procedures to be applied:	<p>This emission factor will be calculated using equation 4.19, p4.33 of IPCC (2006):</p> <div style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"> <p style="text-align: center;">EQUATION 4.19 CARBON CONTENT OF FERROALLOY REDUCING AGENTS Total C-content in reducing agent i = Fix C in i + Content of volatiles in i • Cv</p> </div> <p>Where: Cv = Carbon content in volatiles. Unless other information is available, Cv = 0.65 is used for coal and 0.80 for coke.</p>



	Fix carbon and volatiles content will be taken from the supplier contract which is applicable over the relevant period of operation. Carbon content in the volatiles (Cv) will be taken from supplier if available; if not available, the same Cv as for coke will be taken (see the justification in the table of EF_{bpaste}).
QA/QC procedures to be applied:	This project-specific value will be compared to $EF_{bpaste,y}$ and the maximum between the two values will be taken for $EF_{ppaste,y}$.
Any comment:	

Data / Parameter:	Quality of coal_p
Data unit:	Mass fraction of each component (% m/m)
Description:	Quality of coal based on relevant properties
Source of data to be used:	Project proponent
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable
Description of measurement methods and procedures to be applied:	Fixed carbon, volatiles, and ash will be monitored monthly. This will be done by lab analyses according to applicable national and international standards.
QA/QC procedures to be applied:	Project proponent's lab analyses are preferred to supplier's data and are used to determine the quality of the coal by conducting a proximate analysis on coal samples. The calculated emission factor will be compared to that as calculated in the baseline to ensure that the quality is within the same range and not changing significantly in the project activity.
Any comment:	

Data / Parameter:	Quality of coke_p
Data unit:	Mass fraction of each component (% m/m)
Description:	Quality of coke based on relevant properties
Source of data to be used:	Project proponent
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable
Description of measurement methods and procedures to be applied:	Fixed carbon, volatiles, and ash will be monitored monthly. This will be done by lab analyses according to applicable national and international standards by conducting a proximate analysis on coke samples
QA/QC procedures to	



be applied:	
Any comment:	No coke is expected to be used in the furnace as is the case in the baseline scenario.

Data / Parameter:	Quality of charcoal_p
Data unit:	Mass fraction of each component (%m/m)
Description:	Quality of charcoal based on relevant properties
Source of data to be used:	Project proponent
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable
Description of measurement methods and procedures to be applied:	Fixed carbon, volatiles, and ash contents will be monitored monthly. This will be done by lab analyses according to applicable national and international standards by conducting a proximate analysis on charcoal samples The calculated emission factor will be compared to that as calculated in the baseline to ensure that the quality is within the same range and not changing significantly in the project activity.
QA/QC procedures to be applied:	Project proponent's lab analyses are preferred to supplier's data and are used to determine the quality of the charcoal.
Any comment:	

Data / Parameter:	Quality of char_p
Data unit:	Mass fraction of each component (%m/m)
Description:	Quality of charcoal based on relevant properties
Source of data to be used:	Project proponent
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable
Description of measurement methods and procedures to be applied:	Fixed carbon, volatiles, and ash contents will be monitored monthly. This will be done by lab analyses according to applicable national and international standards by conducting a proximate analysis on char samples. The calculated emission factor will be compared to that as calculated in the baseline to ensure that the quality is within the same range and not changing significantly in the project activity.
QA/QC procedures to be applied:	Project proponent's lab analyses are preferred to supplier's data and are used to determine the quality of the char.
Any comment:	



Data / Parameter:	Quality of electrode paste_p
Data unit:	Text
Description:	Quality of electrode paste based on relevant properties
Source of data to be used:	Supplier
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable
Description of measurement methods and procedures to be applied:	The quality of the paste will be taken from supplier's data at the time of purchase
QA/QC procedures to be applied:	The supplier is contractually required to supply the paste at the specified quality. Laboratory analysis of the paste would be available from the supplier if there is a reason to suspect inconsistency in the quality.
Any comment:	

Data / Parameter:	Quality of FeSi_p
Data unit:	Text
Description:	Quality of FeSi
Source of data to be used:	Project proponent
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable - this parameter is not used in the ex-ante calculation of emission reductions. It is monitored to ensure that the quality range of the final product FeSi that is produced by Furnace F does not change in the project activity against the baseline.
Description of measurement methods and procedures to be applied:	Laboratory proximate analyses will be undertaken to national or international standards to ensure accuracy.
QA/QC procedures to be applied:	The results of the laboratory analysis will be compared to the quality of the FeSi as measured in the baseline to ensure that the new energy efficiency design does not result in a change in specifications of the product produced.
Any comment:	The IPCC defines grades of FeSi in terms of %Si

Data / Parameter:	Quality of Raw Material (milscale)
Data unit:	Text
Description:	Quality of milscale
Source of data to be	Project proponent



used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable – this parameter is not used in the ex-ante calculation of emission reductions. It is monitored to ensure that the quality range of milscale used as a raw material in the project activity does not change from the baseline.
Description of measurement methods and procedures to be applied:	A sample will be lab analysed at least monthly to determine the composition of the milscale (e.g. contents in %Fe, %SiO ₂ & %AlO ₃). This will be done by proximate analysis.
QA/QC procedures to be applied:	The laboratory analysis will be compared with the composition of the milscale as determined in the parameters not monitored to make sure it is within the same range.
Any comment:	Milscale is a source of Fe

Data / Parameter:	Quality of Raw Material (quartz)
Data unit:	Text
Description:	Quality of quartz
Source of data to be used:	Project proponent
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable – this parameter is not used in the ex-ante calculation of emission reductions. It is monitored to ensure that the quality range of quartz used as a raw material in the project activity does not change from the baseline.
Description of measurement methods and procedures to be applied:	A sample will be lab analysed at least monthly to determine the composition of the quartz (e.g. contents in %Fe, %Al ₂ O ₃ , %SiO ₂). This is done by proximate analysis.
QA/QC procedures to be applied:	The laboratory analysis will be compared with the composition of the milscale as determined in the parameters not monitored to make sure it is within the same range.
Any comment:	Quartz is a source of Si

B.7.2. Description of the monitoring plan:

The monitoring plan gives the actions necessary to record all the variables and factors required by the methodology AM0038.

The plan is based on the detailed information contained in section B.7.1 above. Most of the monitoring requirements of the methodology are in line with the kind of information routinely collected by Silicon Smelters. The ISO 14001 management system implemented by Silicon Smelters will also help ensure that quality procedures are in place. The mix of reductants used in the furnace may vary over the life of the



project as a result of local operating conditions but this will be accurately recorded and monitored in line with the detailed parameters monitored in section B.7.1 and the monitoring plan as detailed below.

All data will be archived electronically, and backed up regularly. It will be kept for the full crediting period, plus two years after the end of the crediting period or the last issuance of CERs for this project activity (whichever occurs later).

Project staff will be trained regularly in order to satisfactorily fulfill their monitoring obligations. The authority and responsibility for project management, monitoring, measurement and reporting will be agreed between the project participants and formally recorded. Detailed procedures for calibration of monitoring equipment, maintenance of monitoring equipment and installations, and for record handling will be established. Specific procedures for CDM monitoring, GHG internal auditing and reporting will be agreed between Silicon Smelters and EcoMetrix Africa and incorporated into the existing Quality Assurance system.

The table below indicates the main responsibilities of the persons involved in the monitoring:

Table B7.2.1: Overview of persons responsible for implementing the monitoring plan

Task	On-site technicians	Laboratory	QC manager	CDM Programme Manager	Management (Project Developer)	EcoMetrix
Collect Data and Send samples to lab	E		R	I		
Perform lab analyses		E	R	I		
Log data	I		E	R		
Make monitoring report				R	I	E
Archive data & reports	I		E	R		
Calibration/ Maintenance	E		R	I		

E = responsible for executing data collection

R = responsible for overseeing and assuring quality

I = to be informed



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

The draft baseline study and monitoring methodology were concluded on 19/10/2011.

The responsible entity for the application of this methodology to the project activity is EcoMetrix Africa (Pty) Ltd, represented by Mr Sean Buchanan. (see Annex 1 of this document for contact details).

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

17/07/2008

This is the earliest date at which real action on the project activity began. The invoice payment for the deposit of 30% for the main steelwork was completed on the 17/07/2008 which represents a significant capital outlay and the point of no return from an investment perspective on the project. Evidence in the form of the actual invoice has been made available.

Since the project start date is before GSC, section B5 contains a description of how the benefit of CDM was seriously considered prior to the start date of the project activity.

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

50 years and 0 months.

C.2. Choice of the crediting period and related information:**C.2.1. Renewable crediting period:****C.2.1.1. Starting date of the first crediting period:**

Not applicable

C.2.1.2. Length of the first crediting period:

Not applicable

C.2.2. Fixed crediting period:**C.2.2.1. Starting date:**

01/08/2012 or the date of registration, whichever is the later.

C.2.2.2. Length:

Fixed crediting period of 10 years and 0 months.

**SECTION D. Environmental impacts**

>>

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

>>

There are no significant environmental impacts expected to occur as a result of the project activity other than a reduction in CO₂ emissions as a result of decreased electricity usage.

The energy efficiency improvements done on the furnace will not have any additional environmental impacts within the project boundary or outside of it in comparison to the baseline scenario and therefore no analysis of environmental impacts is necessary.

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

>>

No environmental impact assessment was necessary for the project activity according to the regulation of the host Party and there are no expected significant environmental impacts.

SECTION E. Stakeholders' comments

>>

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

>>

An advertisement with a brief description of the project activity was published in the Witbank News on Friday the 12/08/2011. This is the local newspaper for the area in which the project activity operates and the most effective way of reaching the local stakeholders.

The advertisement was compiled in an open and transparent manner by briefly explaining where the project is located, what the project activity entails, who the project implementer is and their intention to register the project under the CDM. Stakeholders were invited to comment on the project or send any queries to a dedicated email, postal or fax address until the 01/09/2011. In addition a webpage was created with detailed information about the project for all interested and affected parties should they wish to find out more information. Details of the website also appear in the advertisement.

E.2. Summary of the comments received:

>>

No comments were received in response to the newspaper advertisement.

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

>>

No comments were received as a result of the stakeholder consultation and therefore no action has been taken in response.

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

Organization:	Silicon Smelters (Pty) Ltd Rand Carbide
Street/P.O.Box:	Old Middelburg Road / PO BOX 214
Building:	
City:	eMalahleni (Witbank)
State/Region:	
Postcode/ZIP:	1035
Country:	South Africa
Telephone:	
FAX:	
E-Mail:	
URL:	
Represented by:	
Title:	General Manager
Salutation:	Mr.
Last name:	Nel
Middle name:	
First name:	Andre
Department:	N/A
Mobile:	
Direct FAX:	
Direct tel:	+27 (0)13 690 8245
Personal e-mail:	andre.nel@siliconsmelters.co.za

Organization:	EcoMetrix Africa (Pty) Ltd
Street/P.O.Box:	43 Peter Place, Bryanston
Building:	
City:	Johannesburg
State/Region:	Gauteng
Postcode/ZIP:	2021
Country:	South Africa
Telephone:	+27 11 463 1009
FAX:	+27 11 463 1345
E-Mail:	info@ecometrix.co.za
URL:	www.ecometrix.co.za
Represented by:	
Title:	Projects Director
Salutation:	Mr.
Last name:	Buchanan
Middle name:	
First name:	Sean
Department:	Projects



CDM – Executive Board

Mobile:	
Direct FAX:	+27 11 463 1345
Direct tel:	+27 11 463 1009
Personal e-mail:	



Annex 2

INFORMATION REGARDING PUBLIC FUNDING

This project will not receive any funding from an Annex 1 country.

**Annex 2****UNCERTAINTY ASSESSMENT**

Project participants have used the EC monitoring guidelines to take into account the uncertainty in the calculation of onsite emissions. The way EU ETS deal with uncertainty and how it is applied to the project is the following:

1. *Look at the monitoring tier imposed to the project given its size and its sector. This tier gives guidelines on the method of measurement or estimation, and the maximum permissible uncertainty for measured parameters.*

In the iron and steel sector, the tiers imposed on a plant are the following¹⁹:

Table A3.1: Tiers imposed on specific parameters in the EU under EC guidelines

	Activity Data			Emission Factor		
Size of the plant	A	B	C	A	B	C
Tier	1	2	3	2	3	3

Column A: total annual emissions ≤ 50 ktonnes

Column B: 50 ktonnes < total annual emissions ≤ 500 ktonnes

Column C: total annual emissions > 500 ktonnes

If the project plant was covered by the EU ETS, it would fall under column B (Baseline onsite emissions: 102,057tCO₂/annum). The minimum required tier levels will therefore be evaluated on this basis whereby either the imposed Tier or a higher Tier will be used in the monitoring and recording process. According to Annex VI, *Activity-specific guidelines for installation for the production of pig iron and steel including continuous casting*²⁰, the applicable Tiers for process emissions²¹ are therefore:

- *Activity data (t reductant)*
Tier 3 – Reductant consumption is measured to result in a maximum permissible uncertainty of less than +/- 2.5%. Fuel consumption is metered without intermediate storage before combustion in the furnace by applying metering devices. Tier 3 has been chosen over the required Tier 2 as project proponents have monitoring processes in place that can provide the necessary data for Tier 3 and this represents a more accurate record of activity data.

¹⁹ Values are taken from Table 1, Minimum Requirements, VI Iron & Steel, Fuel as process input, p16; COMMISSION DECISION of 18 July 2007 establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council.

²⁰ Annex VI, 'Activity-specific guidelines for installation for the production of pig iron and steel including continuous casting as listed in Annex I to Directive 2003/87/EC' has been applied as per the requirements of AM0038: "The uncertainty will be assessed in line with the **European Commission guidelines on monitoring and reporting of GHG emissions in iron and steel production** and taken into account when calculating the onsite emissions."

²¹ Onsite emissions are considered to be process emissions as the resulting CO₂ emitted from the smelting operations are from the carbon content of the reductants consumed in the process.



- *Emission factor (tC/GJ):*

Tier 3 - Specific emission factors (tCO_2/t_{INPUT}) for input materials are used, developed in accordance with the 2006 IPCC Guidelines for National Greenhouse Inventories specific provisions for ferroalloy production²². This method has been chosen as 100% of the carbon content is assumed to be emitted in process emissions from the smelting process and therefore no Net Calorific Value is necessary to calculate the emission factors of the reductants because the carbon content of the reductant is assumed to be equivalent to the Tier 3 process emission factor. Equation 4.19 is used to calculate the carbon content of the reductant as per below:

EQUATION 4.19
CARBON CONTENTS OF FERROALLOY REDUCING AGENTS

$$CContent_{reducing\ agent,i} = F_{FixC,i} + F_{volatiles,i} \cdot C_v$$

Where:

$CContent_{reducing\ agent,i}$ = carbon content in reducing agent *i*, tonnes C/tonne reducing agent

$F_{FixC,i}$ = mass fraction of Fix C in reducing agent *i*, tonnes C/ tonne reducing agent

$F_{volatiles,i}$ = mass fraction of volatiles in reducing agent *i*, tonnes volatiles/ tonne reducing agent

C_v = carbon content in volatiles, tonnes C/tonne volatiles

(Unless other information is available, $C_v = 0.65$ is used for coal and 0.80 for coke.)

2. Use the method prescribed by the monitoring tier to monitor emissions (e.g. IPCC values; default national value; project-specific value measured with such or such instrument)

- *Activity data:*

Tier 3a is used for coal, char and charcoal consumption. These inputs are measured in the load cells before they are added to the furnace and there is no intermediate storage before it reaches the furnace.

Tier 3b is used for the paste consumption. Paste input is measured on a weighbridge and per cylinder inserted into the furnace.

- *Emission factors:*

Tier 3 is used to calculate the carbon content of the reductants and paste to determine the emission factor. The % of fixed carbon, volatiles and ash are measured in proximate screenings of the reductants (coal, char & charcoal) on a daily basis by the producer. The % of paste fixed carbon, volatiles and ash content are supplied by the supplier. (Incidentally, Rand Carbide is the manufacturer of the paste and therefore these specifications are reliable since the paste must be made according to them) These monitored measurements are inserted in equation 4.19 to calculate the emission factors.

For estimated values:

3. Take the estimated value from the relevant reference (no uncertainty should be assigned to that value)

²² 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3: Industrial Processes and Product Use, Chapter 4, *Metal Industry Emissions*.

There are no estimated values.

For measured values:

3. Measure the parameter according to the prescribed method

For all parameters see point 2 above for the monitoring method, and tables in section B.6.2 for the results in the baseline.

4. Calculate the uncertainty of the measurement.

The individual reductant uncertainties per parameter have been established and are indicated in *Table An.3.1*. These have then been combined to calculate a combined uncertainty value for each parameter according to the method set out in *Annex I, section 7, Uncertainty Assessment* in the EC monitoring guidelines for uncorrelated uncertainties using the below formula:

(b) *for uncertainty of a product (e.g. of different parameters used to convert a meter reading into mass flow data):*

for uncorrelated uncertainties:

$$U_{total} = \sqrt{U_1^2 + U_2^2 + \dots + U_n^2}$$

All the individual contributions to the overall onsite emissions have then been summed to determine the overall uncertainty value, again according to the method set out in *Annex I, section 7, Uncertainty Assessment* in the EC monitoring guidelines for uncorrelated uncertainties using the below formula:

(a) *for uncertainty of a sum (e.g. of individual contributions to an annual value):*

for uncorrelated uncertainties:

$$U_{total} = \frac{\sqrt{(U_1 \cdot x_1)^2 + (U_2 \cdot x_2)^2 + \dots + (U_n \cdot x_n)^2}}{|x_1 + x_2 + \dots + x_n|}$$

The results of this uncertainty analysis calculation are presented in *Section B6.3* and the resultant uncertainty factor for the emission reduction calculations for the project activity is 1.665%.

Table An.3.1: Determination of the **actual** uncertainty of activity data and emission factors for parameters used in the calculation of onsite emissions.

Reductant	Uncertainty	Source
Activity Data		
Coal	2.0%	The load cells used to measure the coal input quantities have a rated accuracy of 2%. Other possible sources of uncertainty (associated with the procedures/way in which instruments are used) will be minimised by calibrating the load cells in line with manufacturer's requirements as per the QA and QC procedures. As per Annex VI of the EC monitoring guidelines for Tier 3 activity data we have used the uncertainty value to be
Charcoal	2.0%	
Char	2.0%	



		conservative since the actual rated uncertainty is 2% which is lower than stipulated.
Paste	2.0%	The number of paste cylinders put in the electrodes is recorded accurately. The weight of each cylinder is based on weighing trucks on the weighbridge and dividing total weight by the number of cylinders. A daily average of cylinders might have a relatively high uncertainty but a monthly average should ensure a measurement with an uncertainty below 2%. The weighbridge is calibrated regularly by an external company.
Emission Factors		
Coal	<5.0%	The emission factor is calculated based on actual proximate screenings of the fixed carbon content and the volatile content of a random sample of measurements as per the IPCC guidance on calculating Tier 3 emission factors for reductants. An uncertainty value of less than 5% is specified by the IPCC and to be conservative we have used 5% as the uncertainty value. The IPCC default value of 0.65 carbon content of volatiles has been used to calculate the emission factor of the coal while the default value of 0.8 has been used to calculate it for char and charcoal. Since these are default/estimated values, no uncertainty should be assigned to them.
Charcoal	<5.0%	
Char	<5.0%	
Paste	<5.0%	The fixed carbon content and volatile content of the paste has been provided by the supplier. The emission factor is calculated as per IPCC Tier 3 method and therefore the associated uncertainty is less than 5%. Since paste is similar in nature to anthracite, the default IPCC value of 0.8 for carbon content of volatiles has been used. No uncertainty is assigned to this as no uncertainty should be assigned to estimated values in the EU ETS.

5. Make sure that the uncertainty is below the maximum permissible uncertainty under the tier imposed. If it is not: improve the monitoring system until the uncertainty of the measurement falls below the maximum permissible uncertainty

All the uncertainties fall below the maximum permissible uncertainty as stipulated by the tier imposed. To be conservative the project proponents have used the maximum permissible uncertainty in the calculations of the total uncertainty associated with onsite emissions. The uncertainties actually used are illustrated in the below table:

Table An.3.2: – Maximum permissible uncertainty of activity data and emission factors for parameters used in the calculation of onsite emissions.

Reductant	Uncertainty
Activity Data	
Coal	2.5%
Charcoal	2.5%
Char	2.5%
Paste	2.5%
Emission Factors	
Coal	5.0%
Charcoal	5.0%
Char	5.0%
Paste	5.0%

In conclusion, efforts have been made to follow the tiers imposed by the EC (or to follow a higher Tier if possible) successfully for all parameters.



It is important to note that retroactively applying a monitoring tier to a baseline factor which is based on historical data (as required in the CDM) is much more delicate than imposing a monitoring tier to a project factor that will be measured (as in the EU ETS).

As a result of this comprehensive analysis and rigorous monitoring plan, project participants estimate that they have assessed uncertainty “in line with the European Commission guidelines on monitoring and reporting of GHG emissions in iron and steel production and taken into account when calculating the onsite emissions”.



Annex 4

MONITORING INFORMATION

See section B.7.2. - Description of the monitoring plan for details on the organisation of monitoring activities and the other parts of this section for other monitoring information.

Annex 5

COMMON PRACTICE ANALYSIS

Table B.5.7: Technology employed by FeSi, SiMn and Si Metal furnaces in South Africa

Company	Furnace	Product	Location	Capacity	Technology
Metalloys (Samancor & BHP Billiton)	1	SiMn	Meyerton, Gauteng	25 MVA	static, soderberg electrodes
Metalloys (Samancor & BHP Billiton)	2	SiMn	Meyerton, Gauteng	25 MVA	static, soderberg electrodes
Silicon Smelters	F	FeSi	eMalahleni, Mpumalanga	46.5 MVA	rotating, soderberg electrodes
Silicon Smelters	E	Si Metal	eMalahleni, Mpumalanga	25 MVA	static, composite electrodes
Silicon Smelters	D	FeSi	eMalahleni, Mpumalanga	25 MVA	static, soderberg electrodes
Silicon Smelters	1	Si Metal	Polokwane, Limpopo	48 MVA	rotating, composite electrodes
Silicon Smelters	2	Si Metal	Polokwane, Limpopo	48 MVA	rotating, composite electrodes
Silicon Smelters	3	Si Metal	Polokwane, Limpopo	42 MVA	rotating, composite electrodes
Transalloys	5	SiMn	eMalahleni, Mpumalanga	48 MVA	static, soderberg electrodes
Transalloys	7	SiMn	eMalahleni, Mpumalanga	48 MVA	static, soderberg electrodes
Siltech	A	FeSi	Newcastle, Kwazulu Natal	42 MVA	static, soderberg electrodes
Siltech	B	FeSi	Newcastle, Kwazulu Natal	57 MVA	static, soderberg electrodes

Therefore:

$$N_{all} = 11$$

$$N_{diff} = 11$$

$$F = 0.00 \text{ which is } < 0.2$$

$$N_{all} - N_{diff} = 0 \text{ which is } < 3$$

The technology used in the redesign of Furnace F is therefore not common practice in South Africa.

**Annex 6****IMPACT OF CDM REGISTRATION****Table B.5.9:** Calculations detailing the impact of CDM registration on the NPV of the project activity compared to the baseline**Input Values**

CER Price	EUR 10	Average expected CER price range was 10-20 EUR per CER at the time of the start of the project activity (17/07/2008). 10 EUR has been assumed as conservative value.
Exchange Rate	EUR 1 = ZAR 10	
Annual Emission Reductions	21,866	
Expected start crediting period	2010	
Discount Rate	11.9%	As per the NPV calculation of the financial model

Revenue Calculation

	T0	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
CERs	-	-	21 866	21 866	21 866	21 866	21 866	21 866	21 866	21 866	21 866	21 866	-	-
Carbon revenue	-	-	2 186 600	2 186 600	2 186 600	2 186 600	2 186 600	2 186 600	2 186 600	2 186 600	2 186 600	2 186 600	-	-

Comparison of baseline NPV (ZAR)

NPV _{carbonrevenue}	9 907 285
NPV _{Alternative C}	1 990 805 465
NPV _{Alternative C with CDM}	2 000 712 750
NPV _{Alternative B}	2 028 039 880
Difference in NPV Alternative B vs Alternative C with CDM	27 327 130