CLEAN DEVELOPMENT MECHANISM
PROPOSED NEW METHODOLOGY: MONITORING (CDM-NMM)
Version 01 - in effect as of: 1 July 2004

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SECTION A. Identification of methodology

A.1. Title of the proposed methodology:

>> 'Monitoring Emission Reductions from Using a Renewable Reducing Agent in the Pig Iron Industry'

A.2. List of category(ies) of project activity to which the methodology may apply:

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- 9 - Metal Production

A.3. Conditions under which the methodology is applicable to CDM project activities:

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This methodology is applicable to companies that use renewable charcoal as opposed to coke for the production of pig iron. The following conditions are required:

- Such use of a renewable fuel could be complete or partial ;
- Only the use of charcoal from renewable sources would generate emission reductions in relation to the use of coke. Charcoal from non renewable forest plantations (e.g. native forests) are not assumed to be a renewable reducing agent and its use will not lead to emission reductions.;
- Charcoal from renewable sources (i.e. a planted forest) is 'carbon neutral' and therefore it is assumed that it has a net carbon intensity of zero;
- The company can differentiate the origin of charcoal purchased from third parties through chain of custody procedures;
- All charcoal coming from third parties should be assumed not-renewable, unless there is clear demonstration to the contrary and the chain of custody can be established between charcoal production and consumption points;
- The project developer has access to qualified laboratories to undertake some of the standard analyses required in the monitoring methodology;
- Methane emissions from coking plants are zero. This is a reasonable assumption as most modern coking plants do not allow for the emissions of methane. Furthermore, by definition a greater quantity of coke will be used in the Baseline Scenario than in the Project Activity, therefore this assumption enhances the conservativeness of the analysis;
- The project developer can locate suitable reference values required in the monitoring methodology (e.g. fuel emission factors, fuel economy factors, nitrous oxide emissions from coking etc.).

A.4. What are the potential strengths and weaknesses of this proposed new methodology?

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Strengths:

- The data required for the calculation of emissions is easily available since all the processes related to pig iron production are very well understood and all the data required is routinely collected by pig iron producers;
- Transparency: The procedure for calculating the baseline emissions is presented in a clear and logical fashion, in a way that it can be easily replicated and, by that, the evaluation of the calculations will be simple and straightforward;

Weaknesses:

- Project developers will need to have the ability to conduct a series of chemical analysis, or alternatively will need to outsource the measurement of some data, for example N_2O emissions arising from the carbonisation process. This may introduce a complexity for the project developer if a suitably qualified and/or experienced team can not be identified locally.

SECTION B. Proposed new monitoring methodology

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B.1. Brief description of the new methodology:

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This methodology is based on the monitoring of the amount of different reductants used for the production of pig iron (i.e. coke, a non-renewably produced reductant and charcoal, a renewably produced reductant), and the carbon intensity of using these different reductants. To measure the carbon intensity of these reductants, a number of factors need to be accounted for (i.e., CO_2 emissions during carbonization or coking, methane emissions, nitrous oxides emissions, and emissions associated with the transportation of these reductants from the point of production to the pig iron mills).

This methodology was developed incorporating all the comments submitted to NMB 0002 and NMB 0029. With relation to the data and parameters to be used, the methodology provides specific inputs for projects in Brazil, where this type of activity is of great importance and where this project may be replicated. While the methodology may be used for projects taking place in other countries, it was felt that it was necessary to be relatively specific given the complexities inherent to this type of project.

B.2. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario:

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B.2.1. Data to be collected or used in order to monitor emissions from the project activity, and how this data will be archived:

ID #	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1	Q_{Ch-R} - Quantity of renewable charcoal used by the project	Project developer	tonnes	M	Daily	100%	Electronic / paper	Weighted at different points: production site, factory gate, and production line. Double checked by receipts or internal production and utilisation records.
2	Q_{Ch-U} - Quantity of non-renewable charcoal used by the project	Project developer	tonnes	M	Daily	100%	Electronic / paper	Weighted at different points: factory gate, and production line. Double checked by receipts or internal production and utilisation records.
3	Q_{Co} - Quantity of coke used in the project	Project developer	tonnes	M	Daily	100%	Electronic / paper	Weighted at different points: factory gate, and production line. Double checked by receipts or internal production and utilisation records.
4	CEF_{CH-R} - Carbon Emissions Factor of renewable charcoal	By definition, carbon neutral	tCO_2e/t coke used	E	Once at the beginning of each crediting period		Electronic / paper	By definition carbon neutral, provided charcoal comes from renewable sources. No need for monitoring
5	CEF_{Ch-U} - Carbon Emissions Factor of non-renewably produced charcoal	-	tCO_2/t charcoal	C	Yearly		Electronic / paper	Calculated as $CF_{ch} + Ca_{ch} - CI\text{-}_{ch}$
6	Cf_{ch} - Carbon content of charcoal	Project developer or literature	tCO_2e/t charcoal	M	Yearly	Sample	Electronic / paper	Value of 2.933.It is the elemental carbon present in the charcoal mix utilized. By average this value is 80% of the dry charcoal utilized (equivalent to 75 % Fix Carbon). Therefore, as above, there is 800 kg of carbon/t o charcoal – the 43 kg of carbon fixated in the pig iron.
7	Ca_{ch} - CO2	Project	tCO_2e/t	M	Yearly	sample	Electronic /	Value of 3.751. These references are used as

	emissions during carbonisation	developer or literature	charcoal				paper	base to evaluated the carbon balance and the typical gravimetric yields assumed as following: %Carbon in dry wood = 49; ratio of dry charcoal per metric ton of dry wood = 0,25 (Gravimetric yield = 25%). Therefore it is necessary 4 metric tons of dry wood per metric t of charcoal. The charcoal average elemental carbon is 80% then the charcoal has 0.8 t of carbon/t of charcoal. The volatile material is 3 tones and has 38.7% resulting in 1.161 t of carbon in the volatile fraction. From this carbon 46*12/16 leaves as CH4 = 138.0 kg of carbon equivalent. Therefore only 1.161-.138 = 1.023 t of carbon leaves as CO2.= 1.023*44/12 = 3.751 tCO2/t charcoal
8	$C_{I\text{-}CH}$ - Carbon fixed in pig iron produced using charcoal	Project developer or literature	tCO_2/t charcoal	M	Yearly	sample	Electronic / paper	Value of 0.203 . The actual year average charcoal consumption of V&M do Brasil is 774 kg of charcoal/t of pig iron. The average carbon content of the pig iron is 4.3% = 43 kg of carbon/t of pig iron => 43/ 0.774 = 55.5 kg of C/t of charcoal = 0.203 t of CO2/t of charcoal.
9	CEF_{CO} - Carbon Emissions Factor of coke used in the pig iron production process	Project developer or literature	tCO_2e/t coke used	C	Once at the beginning of each crediting period		Electronic / paper	Calculated as $Cf_{co}+C_{co} - C_{I\text{-}CO}$
10	Cf_{co} - Carbon content of coke	Project developer or literature	tCO_2e/t coke used	M	Yearly	Sample	Electronic / paper	Value of 3234. The assumed average carbon content of a coke in Brasil is 88.2% with 10% ash. The total specific coke consumption is **500 kg/t of pig iron**. The coal mix considered has 25% volatile material and 7.5 % ash. The coal carbon content is assumed to be 82.7 %.
11	C_{co} - CO2 emissions during coking	literature	tCO_2e/t coke used	E	Once, at the beginning of each crediting period		Electronic / paper	Value of 0.807. The elemental analyses utilized are conservative due to the utilization of a mix of coals for coking with only 25% volatile material. See references for a better comprehension.

12	C_{I-CO} - Carbon fixed in pig iron produced using coke	Project developer or literature	tCO_2e/t coke used	E	Once, at the beginning of each crediting period		Electronic / paper	Value of 0.315. Average gross specific coke consumption for the baseline scenario (500 kg/pig iron). (43*44/12) tCO2/tpig iron*1/0.5 t coke/tpig iron.
13	M_{Ch-R-p} - Methane emissions from carbonisation process (renewable)	Project developer or literature	tCO_2e/t charcoal	M	Yearly	Sample	Electronic / paper	Value of 0.0462. This default value is from the average FR brick charcoal making under the typical gravimetric yield of 25%. Therefore, this value is 11.5 kg of CH4 per metric ton of dry wood utilized. CH4 emission is highly dependent on gravimetric yield and temperature of carbonisation. This a monitored value year by year in the project. Therefore, results will be available for inspection by DOEs.
14	M_{Ch-U} - Methane emissions from carbonisation process (non-renewable)	Project developer or literature	tCH_4/t charcoal	M	Once at the beginning of each crediting period	Sample	Electronic / paper	Value of 0.056 . This value reflects the emissions of the least advanced technology available in Brasil, and it should be assumed that all charcoal from third parties have the same emissions level
15	M_{Co} – Methane emissions from coking	Literature	tCH_4/t coke	E	Once at the beginning of each crediting period		Electronic / paper	Value of 0 proposed for Brasil, as most modern coke mills do not emit methane. By using 0 as the emissions factor, this leads to a conservative estimate, as more coke is used in the baseline.
16	N_{Ch} - Nitrous oxide taking place during carbonisation	Project developer or literature	tN_2O/t charcoal	M	Once at the beginning of each crediting period	Sample	Electronic / paper	Value of 0.0000304 proposed for Brasil, measured in V&M do Brasil laboratories.
17	N_{Co} - Nitrous oxide taking place during coking	Literature	tN_2O/t coke	M	Once at the beginning of each crediting period	Sample	Electronic / paper	Value of 0.000221 proposed, based on UK Emissions Factor database. Note: given the difficulties in measuring N2O emissions, and the fact that the charcoal route leads to a reduction in its emissions, this is excluded from the calculations
18	Total quantity of reductant required per year	Project developer	tonnes	M	Continuously	100%	Electronic / paper	This is to be measured continuously by pig iron the factory
19	Capacity of trucks/trains	Project developer,	tonnes	M	Yearly, to account for any changes in	Sample	Electronic / paper	

	transporting charcoal to pig iron mill	transport company			transport technology			
20	Average one-way distance charcoal is transported	Project developer, transport company	Km	M	Yearly, to account for any changes in supply points	100%	Electronic / paper	
21	Fuel used by trucks/trains	Project developer, transport company	Litres	C	Yearly, to account for any changes in fuel mix used in the project country	Sample	Electronic / paper	
22	Average fuel economy of trucks/trains	Project developer, transport company	Km/l	C	Yearly, to account for any changes in transport technology	Sample	Electronic / paper	
23	Fuel CEFs	IPCC	$kgCO_2/l$	E	Once at the beginning of each crediting period		Electronic / paper	
24	Global Warming Potential values for CH_4 and N_2O	IPCC	tCO_2e/t gas	E	Once at the beginning of each crediting period		Electronic / paper	
25	Carbon stocks and emissions in project company's forests	Project developer	tCO_2e	M and e	Yearly	100%	Electronic / paper	Quantification of net emissions (or removals) can be done using data routinely collected by companies owning forestry assets
26	Costs of production of charcoal	Project developer	$/t	C	Yearly	100%	Electronic / paper	This should be based on the company's internal production costs, and used the same assumptions for future projections as used for the use of coke and non-renewable charcoal purchased from third parties
27	Price of coke and charcoal purchased from third parties	Past invoices, suppliers' data, or national statistics	$/t	E	Yearly	100%	Electronic / paper	

Note: V&M do Brasil, the project proponent, is a large steel manufacturing company and routinely conducts a series of measurements required for the calculations in this methodology in their own laboratories. Many of the data listed have been published by the company in research publications related to the sector.

B.2.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

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Emissions of Project Activity (charcoal use) =

$[Q_{Ch\text{-}R\text{-}p} * (CEF_{ch\text{-}R} + M_{ch\text{-}R} + N_{ch} + T_{ch})] +$

$[Q_{Ch\text{-}U\text{-}p} * (CEF_{ch\text{-}U} + M_{ch\text{-}U} + N_{ch} + T_{ch})] +$

$[Q_{Co\text{-}p} * (CEF_{co} + M_{co} + N_{co} + T_{co})] +$

Forestry $\text{emissions}_{project}$

Where,

$Q_{Ch\text{-}R\text{-}p}$ = Quantity of renewably produced charcoal used in Project Activity (tonnes).

$Q_{Ch\text{-}U\text{-}p}$ = Quantity of charcoal used in Project Activity that has not been renewably produced (tonnes). The origin of the charcoal purchased from third parties has to be established through chain of custody procedures, by at least requiring that the invoices from charcoal suppliers state the origin of the charcoal and provide documentation from the relevant environmental agency stating whether the source is renewable or not;**$Q_{Co\text{-}p}$** = Quantity of coke used in Project Activity (tonnes).

$CEF_{ch\text{-}R}$ = Carbon Emissions Factor of the use of renewably produced charcoal for pig iron production ($tC0_2$/t charcoal). By definition, charcoal from renewable sources is a 'carbon neutral' fuel and therefore this factor is zero.

$CEF_{ch\text{-}U}$ = Carbon Emissions Factor of the use of non renewably produced charcoal for pig iron production ($tC0_2e$/t charcoal): carbon content of charcoal (tCO_2e/t charcoal) + CO_2 emissions during carbonisation (tCO_2/t charcoal used) - C_i (carbon fixed in iron, in tCO_2e/t charcoal used). This charcoal is not considered "carbon neutral" and therefore all CO_2 emitted must be accounted for.

CEF_{co} = Carbon Emissions Factor of the use of coke for pig iron production ($tC0_2e$/t coke): carbon content of coke (tCO_2e/t coke) + CO_2 emissions during coking (tCO_2/t coke used) - C_i (carbon fixed in iron, in tCO_2e/t coke used).

$M_{ch\text{-}R}$ = Methane (CH4) emissions that occur during production of renewable charcoal (tC02e /t charcoal produced), assuming a Global Warming Potential for CH4 = 21).

$M_{ch\text{-}U}$ = Methane (CH4) emissions that occur during production of non-renewable charcoal (tC02e /t charcoal produced), assuming a Global Warming Potential for CH4 = 21).

M_{co} = Methane (CH4) emissions that occur during the coking process (tC02e /t coke), assuming a Global Warming Potential for CH_4 = 21). Most coking plants do not emit CH_4, therefore it is assumed that this value is zero. Please note that by definition a greater quantity of coke will be used in the Baseline Scenario than in the Project Activity, therefore this assumption enhances the conservativeness of the analysis.

N_{ch} = Nitrous oxide (N_2O), both from thermal and chemical processes taking place during carbonisation ($tC0_2e$/t charcoal produced, assuming a Global Warming Potential for N_2O = 310). **Note:** N_2O emissions are usually difficult to measure and are usually lower in the case of carbonisation, as opposed to the coking process. When they are expected to be lower in the case of the project activity, it is recommended that these are excluded from the estimation of emission reductions generated by the project activity.

N_{co} = Nitrous oxide (N_2O), both from thermal and chemical processes taking place during the coking process ($tC0_2e$/t coke produced, assuming a Global Warming Potential for N_2O = 310).

T_{ch} and **T_{co}** =CO_2 emissions associated with the transportation of charcoal or coke (the 'reductants') from its origin to the pig iron mill ($tC0_2$/t reductant transported). To calculate the emissions from the transportation of reductants the following information is required:

- Total quantity of reductant required per annum (tonnes);
- Capacity of trucks/trains etc transporting the reductant to the pig iron mills (tonnes). This capacity should be checked annually, or if the type of transportation is changed;
- Number of trips required. This equals the quantity of reductant required divided by the capacity of trucks/trains, therefore there are no additional variables to be monitored;
- Average one-way distance from the port to the pig iron mills (km). This value will remain constant over the lifetime of the project;
- Total trip distance for reductant transportation per annum (km); equals the number of trips multiplied by the average return distance, multiplied by 2 to give the average return distance (to be conservative it is assumed that the truck/train will return to its origin empty), there are no additional variables to be monitored for this step;
- Fuel type used by the trucks/trains. The fuel type should be checked annually, or if the type of transportation is changed;

- Average fuel economy of trucks/trains used (km/l). Default factors from reputable references may be used. This value should remain constant however it is recommended that the fuel economy be checked at the start of each crediting period, or if the type of transportation is changed;
- Fuel consumed for the transportation of reductant (litres), equals the total trip distance multiplied by the average fuel economy of the trucks used to transport the reductant, there are no additional variables to be monitored for this step;
- Fuel CEF ($kgCO_2/l$), which can be found in a reputable reference. This value will remain constant over the lifetime of the project, however it is recommended that the project developer checks this value at the start of each crediting period;
- Therefore, $\mathbf{T_{ch}}$ or $\mathbf{T}_{co}$ ($tC0_2/t$ reductant transported) equals the amount of fuel consumed for the transportation of reductant, multiplied by the CEF for the fuel used, divided by the total quantity of reductant transported.
- **Note**: transport emissions are usually difficult to measure and in general very small in relation to the overall emission reductions generated by this type of project. When they are expected to be lower in the case of the project activity, it is recommended that these are excluded from the estimation of emission reductions generated by the project.

Forestry emissions$_{\mathbf{project}}$ = Emissions associated with the forestry activities if the pig iron company uses charcoal. The level of emissions will depend on what is the state of forest assets (if any) at the beginning of the project. If these were at the end of a rotation period, and will need to be replanted or improved, this may lead to a net increase in carbon stocks, leading to sequestration rather than emissions, that will not be accounted for by the project. If the carbon stocks in the forest assets will remain unaltered, it can be inferred that no net emissions are occurring. Any emissions associated with thinnings or harvestings following replanting are considered carbon neutral if the average stock remains the same over the course of a rotation. If the carbon stocks in the forests are expected to reduce as a consequence of the project, in this case this reduction has to be estimated and quantified. Demonstration of the level of carbon stocks in the site can be done by comparing average timber standing stocks before, during and after the implementation of the project, and these data and projections are easily available to any forestry company. If emissions are expected to occur, these have to be estimated by taking into account all carbon pools in the forest system (above and below ground, dead wood and soil). Additionally, fossil fuel emissions associated with planting and harvesting have to be taken into account, if these are expected to be higher than in the baseline scenario.

B.2.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of greenhouse gases (GHG) within the project boundary and how such data will be collected and archived:								
ID	Data variable	Source of data	Data unit	M, C or e	Recording Frequency	Proportion of data to be monitored	How will the data be archived?	Comment
28	Q_{Ch-R} - Quantity of renewable charcoal used in the baseline	Project developer	tonnes	E	Proportion of reductants to be used is fixed at the beginning of each crediting period. The actual volume is measured in the project scenario, continuously		Electronic / paper	Derived from the actual amount of reductants used in the project scenario, that will be monitored continued throughout the project lifetime.
29	Q_{Ch-U} - Quantity of non-renewable charcoal used in the baseline scenario	Project developer	tonnes	E	" " " " "		Electronic / paper	Derived from the actual amount of reductants used in the project scenario, that will be monitored continued throughout the project lifetime.
30	Q_{Co} - Quantity of coke used in the baseline	Project developer	tonnes	E	" " " " "		Electronic / paper	Derived from the actual amount of reductants used in the project scenario, that will be monitored continued throughout the project lifetime.
31	Total quantity of reductant required per year in the baseline scenario	Project developer, transport company	tonnes	M	" " " " "	Sample	Electronic / paper	Derived from the actual amount of reductants used in the project scenario, that will be monitored continued throughout the project lifetime.
32	Capacity of trucks/trains transporting coke to pig iron mill	Project developer, transport company	tonnes	M	Yearly, to account for any changes in transport technology	Sample	Electronic / paper	
33	Average one-way distance coke is transported	Project developer, transport company	Km	M	Yearly, to account for any changes in supply points	100%	Electronic / paper	
34	Fuel used by trucks/trains	Project developer, transport	Litres	C	Yearly, to account for any changes in fuel mix used in the	Sample	Electronic / paper	

		company			project country			
35	Average fuel economy of trucks/trains	Project developer, transport company	Km/l	C	Yearly, to account for any changes in transport technology	Sample	Electronic / paper	
36	Carbon stocks and fossil fuel emissions taking place in project company's forests in baseline scenario	Project developer	tCO_2e	E	Yearly	sample	Electronic / paper	Quantification of net emissions (or removals) can be done using data routinely collected by companies owning forestry assets
37	CAPEX investments and maintenance costs	Project developer	$	E and C	Once at the beginning of each crediting period	100%	Electronic / paper	
38	Discount rate used for NPV calculation	Project developer	%	E	Once at the beginning of each crediting period		Electronic / paper	Same for project and baseline
Additionality, the following data are also used, but these are the same as listed in the project scenario table B.2.1 (hence the same ID number)								
4	CEF_{CH-R} - Carbon Emissions Factor of renewable charcoal	By definition, carbon neutral	tCO_2e/t coke used	E	Once at the beginning of each crediting period		Electronic / paper	Same data used for quantification of project and baseline emissions
5	CEF_{Ch-U} - Carbon Emissions Factor of non-renewably produced charcoal	-	tCO_2/t charcoal	C	Yearly		Electronic / paper	Calculated as $CF_{ch} + Ca_{ch} - Ci_{ch}$
6	Cf_{ch} - Carbon content of charcoal	Project developer or literature	tCO_2e/t charcoal	M	Yearly	Sample	Electronic / paper	Same data used for quantification of project and baseline emissions
7	Ca_{ch} - CO2 emissions during carbonisation	Project developer or literature	tCO_2e/t charcoal	M	Yearly	sample	Electronic / paper	Same data used for quantification of project and baseline emissions
9	CEF_{CO} - Carbon Emissions Factor of coke used in the pig iron	Project developer or literature	tCO_2e/t coke used	C	Once at the beginning of each crediting period		Electronic / paper	Calculated as $CF_{co} + C_{co} - Ci_{co}$

	production process							
10	Cf_{co} - Carbon content of coke	Project developer or literature	tCO_2e/t coke used	M	Yearly	Sample	Electronic / paper	Same data used for quantification of project and baseline emissions
11	C_{co} - CO2 emissions during coking	literature	tCO_2e/t coke used	E	Once, at the beginning of each crediting period		Electronic / paper	Same data used for quantification of project and baseline emissions
13	$M_{Ch\text{-}R-p}$ - Methane emissions from carbonisation process (renewable)	Project developer or literature	tCO_2e/t charcoal	M	Yearly	Sample	Electronic / paper	Same data used for quantification of project and baseline emissions
14	$M_{Ch\text{-}U}$ - Methane emissions from carbonisation process (non-renewable)	Project developer or literature	tCH_4/t charcoal	M	Once at the beginning of each crediting period	Sample	Electronic / paper	Same data used for quantification of project and baseline emissions
15	M_{Co} - Methane emissions from coking	Literature	tCH_4/t coke	E	Once at the beginning of each crediting period	Na	Electronic / paper	Same data used for quantification of project and baseline emissions
16	N_{Ch} - Nitrous oxide taking place during carbonisation	Project developer or literature	tN_2O/t charcoal	M	Once at the beginning of each crediting period	Sample	Electronic / paper	Same data used for quantification of project and baseline emissions
17	N_{Co} - Nitrous oxide taking place during coking	Literature	tN_2O/t coke	M	Once at the beginning of each crediting period	Sample	Electronic / paper	Same data used for quantification of project and baseline emissions
23	Fuel CEF	IPCC	$kgCO_2/l$	E	Once at the beginning of each crediting period	Na	Electronic / paper	Same in the project and baseline scenarios.
24	Global Warming Potential values for CH_4 and N_2O	IPCC	tCO_2e/t gas	E	Once at the beginning of each crediting period	Na	Electronic / paper	Same in the project and baseline scenarios.
26	Costs of production of charcoal	Project developer	$/t	C	Yearly	100%	Electronic / paper	
27	Price of coke and	Past invoices,	$/t	E	Yearly	100%	Electronic /	

	charcoal purchased from third parties	suppliers' data, or national statistics and projections					paper	

B.2.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

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Emissions in Baseline scenario (coke use) =

$[Q_{Ch\text{-}R\text{-}b} * (CEF_{ch\text{-}R} + M_{ch\text{-}R} + N_{ch} + T_{ch})] +$

$[Q_{Ch\text{-}U\text{-}b} * (CEF_{ch\text{-}U} + M_{ch\text{-}U} + N_{ch} + T_{ch})] +$

$[Q_{Co\text{-}b} * (CEF_{co} + M_{co} + N_{co} + T_{co})] +$

Forestry $\text{emissions}_{baseline}$

Where,

$Q_{Ch\text{-}R\text{-}b}$ = Quantity of renewably produced charcoal used in the Baseline Scenario (tonnes).

$Q_{Ch\text{-}U\text{-}b}$ = Quantity of charcoal used in the Baseline Scenario that has not been renewably produced (tonnes).

$Q_{Co\text{-}b}$ = Quantity of coke used in the Baseline Scenario (tonnes). The quantity of coke required is such that the carbon content of the coke is equivalent to the carbon content of the combined reductants used in the project activity (i.e. $Q_{Ch\text{-}R\text{-}p} + Q_{Ch\text{-}U\text{-}p} + Q_{Co\text{-}p}$).

All the other parameters are the same as in the baseline scenario, with the exception of:

Forestry $\text{emissions}_{baseline}$ = Emissions associated with the existing forestry activities after the pig iron company decides to use coke. The level of emissions will depend on what is the fate of the forests after the company starts using coke , which could include the continuation of use of forestry by the Project Developer or by a third party who buys the forest asset, or even the gradual abandonment, degradation or conversion of the asset. While in the latter case it should be assumed that the carbon stock will reduce significantly, leading to large amount of emissions, the methodology conservatively assumes that there will not be any emissions associated with forestry activities in the baseline.

B.3. Option 2: Direct monitoring of emission reductions from the project activity:

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Not applicable to this project type

B.3.1. Data to be collected or used in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to table B.7)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

B.3.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

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Not applicable to this project type

B.4. Treatment of leakage in the monitoring plan:

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If the company owns plantations and produces charcoal, demonstrate what the company would have done with the plantations and the potential impact this could have had on GHG emissions. If the analysis of various scenarios related to the future use of the company's forests leads to the belief that leakage may be occurring, it is necessary to assess any off-site emissions that may take place as a consequence of the project.

In this case, the quantification of forestry leakage must be done by estimating the carbon stocks in the baseline scenario and comparing it to the carbon stocks in the project scenario. If the stocks in the baseline scenario are expected to be higher in the baseline scenario, the difference in carbon stocks must be

estimated and it should be treated as leakage and subtracted from the emissions reductions calculated for the project activity. This should be done using the following equation to quantify forestry emissions shown in section B.4.2. below.

Another possibility of leakage would occur if while the project company is not self-sufficient in charcoal production it may purchase charcoal that would be used by third parties forcing them to shift to coke. The project company has to demonstrate that this is not the case by, for example, showing that the levels of charcoal purchased by the company has not increased in relation to previous levels before the project implementation. If there is leakage associated with this new source of purchased charcoal, the amount of emission reductions from this volume of charcoal have to be estimated pro-rata and deducted from the project's emission reductions.

Another source of offsite emissions taking associated with the project relates to the mining and transportation of coal imported to the project country. This will not be treated as leakage, however, because, a) if these emissions were included, one would also need to take into consideration the possible sources of transnational leakage that the project could generate; and b) there is still a lack of definition regarding 'ownership' of emissions (and consequently emission reductions) associated with international transport. The complexity of this type of analysis, coupled with the lack of definitions regarding international 'property rights' related to emission reductions, were determinant in limiting the boundaries of this analysis to the limits of the host country. Furthermore, given that the use of coke is by definition higher in baseline scenario, and the exclusion of these emissions provide for a conservative analysis.

B.4.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity:

ID number *(Please use numbers to ease cross-referencing to table B.7)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

The data required for determination of whether leakage is likely to occur and to estimate its magnitude are the forestry carbon stocks in the project and baseline scenarios, and these are listed in tables B.2.1 and B.2.3., with ID numbers 25 and 35, respectively.

B.4.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

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ANR = VCP - IES

Where:

ANR (tCO_2e) = Actual Net GHG Removals or Emissions by Sinks

VCP (tCO_2e) = Verifiable Changes in Carbon Stocks in the Carbon Pools

IES (tCO_2e) = Increase in Emissions of Greenhouse Gases by Sources

B.5. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

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ER = Emissions in Baseline Scenario – Emissions of Project Activity – Leakage

Where

Emissions in Baseline scenario (coke use) =

$[Q_{Ch\text{-}R\text{-}b} * (CEF_{ch\text{-}R} + M_{ch\text{-}R} + N_{ch} + T_{ch})] +$

$[Q_{Ch\text{-}U\text{-}b} * (CEF_{ch\text{-}U} + M_{ch\text{-}U} + N_{ch} + T_{ch})] +$

$[Q_{Co\text{-}b} * (CEF_{co} + M_{co} + N_{co} + T_{co})] +$

Forestry $\text{emissions}_{baseline}$

and

Emissions of Project Activity (charcoal use) =

$[Q_{Ch\text{-}R\text{-}p} * (CEF_{ch\text{-}R} + M_{ch\text{-}R} + N_{ch} + T_{ch})] +$

$[Q_{Ch\text{-}U\text{-}p} * (CEF_{ch\text{-}U} + M_{ch\text{-}U} + N_{ch} + T_{ch})] +$

$[Q_{Co\text{-}p} * (CEF_{co} + M_{co} + N_{co} + T_{co})] +$

Forestry $\textit{emissions}_{project}$

B.6. Assumptions used in elaborating the new methodology:

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- Quantity of pig iron produced under the proposed Project Activity and Baseline scenario are the same
- Blast furnace carbon intake in both coke and charcoal processes is the same, but provided by different reductants
- Emissions associated with forestry activities can be quantified for project scenario and estimated for baseline scenario,
- Global Warming Potential coefficients as determined by the IPCC and approved by the UNFCCC.
- Charcoal from renewable sources (i.e. a planted forest) is ‘carbon neutral’ and therefore it is assumed that it has a net carbon intensity of zero;
- The company can differentiate the origin of charcoal purchased from third parties through chain of custody procedures by at least requiring that the invoices from charcoal suppliers state the origin of the charcoal and provide documentation from the relevant environmental agency stating whether the source is renewable or not;
- All charcoal coming from third parties is assumed not-renewable, unless there is clear demonstration to the contrary and the chain of custody can be established between charcoal production and consumption points;
- As methane emissions from carbonisation conducted by third parties are difficult to ascertain, the developer must assume that they use the lowest available technology in the country, leading to the highest methane emissions (unless it can be demonstrated otherwise, and that the chain of custody linking the source to the final use can be established). As in the baseline scenario there should not be the use of any type of charcoal (or very small), this results in a conservative analysis.
- Methane emissions from coking plants are zero. This is a reasonable assumption as most modern coking plants do not allow for the emissions of methane. Furthermore, by definition a greater quantity of coke will be used in the Baseline Scenario than in the Project Activity, therefore this assumption enhances the conservativeness of the analysis;
- The project developer has access to qualified laboratories to undertake some of the standard analyses required in the monitoring methodology;
- The project developer can locate suitable reference values required in the monitoring methodology (e.g. fuel emission factors, fuel economy factors, nitrous oxide emissions from coking etc.).

B.7. Please indicate whether quality control (QC) and quality assurance (QA) procedures are being undertaken for the items monitored:		
Data from tables B.2.1, B.2.3, with sequential IDs between accross tables	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
1- Q_{Ch-R} - Quantity of renewable charcoal used by the project	Low	These data will be directly used for calculation of emission reductions. These data are the most accurately measured, as these are measured both by the production and the utilisation units of the company. To guarantee QC/QA, they will be double checked by receipts or internal production and utilisation records.
2 - Q_{Ch-U} - Quantity of non-renewable charcoal used by the project	Low	Double checked by receipts and utilisation records.
3 - Q_{Co} - Quantity of coke used in the project	Low	Double checked by receipts and utilisation records.
4 - CEF_{CH-R} - Carbon Emissions Factor of renewable charcoal	Low	Assumed to be zero – no monitoring needed
5 - CEF_{Ch-U} - Carbon Emissions Factor of non-renewably produced charcoal	Low	Calculated as $CF_{ch} + Ca_{ch} - Ci_{ch}$
6 - Cf_{ch} - Carbon content of charcoal	Low	Multiple measurements to be taken, mean value used.
7 - Ca_{ch} - CO2 emissions during carbonisation	Medium	Multiple measurements to be taken, mean value used.
8 - C_{I-CH} - Carbon fixed in pig iron produced using charcoal	Low	Multiple measurements taken, mean value used.
9 - CEF_{CO} - Carbon Emissions Factor of coke used in the pig iron production process	Low	Multiple measurements to be taken, mean value used.
10 - Cf_{co} - Carbon content of coke	Low	Multiple measurements to be taken, mean value used.
11 - C_{co} - CO2 emissions during coking	Low	Data from literature, based on reputable sources
12 - C_{I-CO} - Carbon fixed in pig iron produced using coke	Low	Data from literature, from reputable sources
13 - M_{Ch-R-p} - Methane emissions from carbonisation process (renewable)	Medium	Multiple measurements to be taken, mean value used.
14 - M_{Ch-U} - Methane emissions from carbonisation process (non-renewable)	Medium	Multiple measurements to be taken, mean value used.
15 - M_{Co} – Methane emissions from coking	Medium	Data from literature, from reputable sources
16 - N_{Ch} - Nitrous oxide taking place during carbonisation	Medium	Multiple measurements to be taken, mean value used.
17 - N_{Co} - Nitrous oxide taking place during coking	Medium	Data from literature, from reputable sources
18 - Total quantity of reductant required per year	Low	Double checked by receipts and utilisation records.
19 - Capacity of trucks/trains transporting charcoal to pig iron mill	Low	Not applicable

20 - Average one-way distance charcoal is transported	Low	Not applicable
21 - Fuel used by trucks/trains	Low	Multiple measurements to be taken, mean value used.
22 - Average fuel economy of trucks/trains	Low	Multiple measurements to be taken, mean value used.
23 - Fuel CEFs	Low	From IPCC, internationally accepted.
24 - Global Warming Potential values for CH_4 and N_2O	Low	From IPCC, internationally accepted.
25 - Carbon stocks and emissions in project company's forests	Low	Carbon stocks to be calculated according to internationally recognised forestry inventory standards. Fossil fuel usage to be double checked by receipts and utilisation records.
26 - Costs of production of charcoal	Low	Double checked by internal financial records and intradepartmental receipts and utilisation records.
27 - Price of coke and charcoal purchased from third parties	Low	Double checked by receipts and utilisation records.
28 - Q_{Ch-U} - Quantity of-renewable charcoal used in the baseline scenario	Low	Derived from the actual amount of reductants used in the project scenario, that will be monitored continued throughout the project lifetime. Double checked by receipts and utilisation records.
29 - Q_{Ch-U} - Quantity of non-renewable charcoal used in the baseline scenario	Low	Derived from the actual amount of reductants used in the project scenario, that will be monitored continued throughout the project lifetime. Double checked by receipts and utilisation records.
30 - Q_{Co} - Quantity of coke used in the baseline	Low	Derived from the actual amount of reductants used in the project scenario, that will be monitored continued throughout the project lifetime. Double checked by receipts and utilisation records.
31 - Total quantity of reductant required per year in the baseline scenario	Low	Derived from the actual amount of reductants used in the project scenario, that will be monitored continued throughout the project lifetime. Double checked by receipts and utilisation records.
32 - Capacity of trains/trucks transporting coke to pig iron mill	Low	Na
33 - Average one-way distance coke is transported	Low	Na
34 - Fuel used by trains/trucks	Low	Multiple measurements to be taken
35 - Average fuel economy of trains/trucks	Low	Multiple measurements to be taken
36 - Carbon stocks and emissions in project company's forests in baseline scenario	Low	Carbon stocks to be calculated according to internationally recognised forestry inventory standards.
37 - CAPEX investments and maintenance costs	Low	Checked with specialised equipment providers
38 - Discount rate used for NPV calculation	Low	Justified based on publicly available data and expert opinions

In addition, it is recommended that the companies implementing this type of project introduce quality control systems to ensure consistency and quality of data collected and used, such as ISO 9000, ISO 14,000, etc.

B.8. Has the methodology been applied successfully elsewhere and, if so, in which circumstances?

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This is a new methodology, not used previously for other projects. However, the monitoring processes proposed are very simple and based simply on chain of custody records and controls. Similar systems have been used extensively for other purposes.

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