CLEAN DEVELOPMENT MECHANISM

PROPOSED NEW METHODOLOGY: BASELINE (CDM-NMB)

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SECTION A. Identification of methodology

A.1. Proposed methodology title:

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"Use of renewable reducing agents for the production of pig iron and steel"

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 pig iron producing companies that are considering the use of charcoal, a renewable reducing agent, for the production of pig iron and/or steel. The main consideration related to the use of charcoal as opposed to coke, a non-renewable reducing agent, are related to financial reasons or other barriers associated with charcoal use. Carbon finance would provide an additional incentive for the use of a renewable reducing agent, ensuring that the pig iron industry avoiding the use of coke which would lead to a higher level of greenhouse gas (GHG) emissions associated with the production of pig iron. The following conditions are required:

- Such use of a renewable fuel could be complete or partial.
- The use of both renewable and non-renewable fuels should be allowed under local legislation.
- The adoption of a renewable reducing agent would require investments in adaptation of existing, or acquisition of new equipment (i.e. blast furnaces).
- The use of a renewable reducing agent (charcoal) would require an investment in the renovation or establishment of new forests, reducing the use of charcoal from non-renewable sources (e.g., from native forests) thus contributing to sustainable development and other environmental benefits.
- Only the use of charcoal from renewable sources would generate emission reductions in relation to the use of coke. Charcoal from non-renewable sources (e.g. native forests) are not assumed to be a renewable reducing agent and its use will not lead to emission reductions.
- 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 non-renewable, unless there is clear demonstration to the contrary and the chain of custody can be established between charcoal production and consumption points;
- The comparative financial analysis of the alternatives has to include any investments that would be required for charcoal use, taking into account the life time of equipment and the stage in the forest rotations, and investments related to the use of charcoal.

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

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Strengths:

- Additionality determination based on the application of the approved EB Tool for Demonstration and Assessment of Additionality (the "Additionality Tool").
- This approach is based on specific financial inputs and evaluation of risks to determine the most economically attractive option, providing an objective assessment.
- 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:

- Analysis depends on a subjective management decision regarding the long term cost differential between the use of charcoal and the use of coke. These are subject to long term variations related to macro-economics which are dynamic and difficult to predict.
- 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.

SECTION B. Overall summary description:

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The production of pig iron requires the use of a carbon based reducing agent. In most cases this reductant is coke (a non-renewable reducing agent), but renewably-produced charcoal (a renewable reducing agent) can be an alternative. This methodology focuses on companies that are considering using renewable charcoal as opposed to coke for the production of pig iron, but are considering the financial reasons or other barriers that may favour the use of coke instead. This methodology is focused on this type of activities taking place in Brazil, one of the few countries in the world with a large charcoal-based steel sector. The methodology, however, could be used in other countries provided that country-specific data are sourced.

The approach of this methodology is an application of 48(b) of the Marrakech Accords. It is based on a comparison of the long term cost of using charcoal to the long term cost of using coke for the production of pig iron in order to determine the most economically attractive alternative for a company. In addition to specific differences in operating costs, such as price differentials between charcoal and coke and changes in input mix, the calculation will include investment costs required to use charcoal or coke and the forestry-related investments required to using charcoal. The cashflows from the two alternatives will be compared, and the Net Present Value (NPV) of the difference between the two cashflows will be calculated, using a tailored application of the stepwise Tool for Demonstration and Assessment of

Additionality ("the Additionality Tool"). This net cost difference can then be supplemented or confirmed by an additional analysis of the risks and other barriers of the two choices. This analysis of the financial cost differential, coupled with the analysis of barriers and risks of charcoal and coke use, will be used to determine what the most likely choice for the company would be. If the use of coke is demonstrated to be the most likely choice, this will establish a baseline scenario of coke use

As private sector companies make investment decisions based on internal forecasts of long term price movements, particular attention in the application of the methodology will be made to the information used by the company to make the investment decision regarding the use of coke, which should be substantiated by market forecasts, internal corporate discussions, and anticipated supply/demand changes over time.

Leakage is assessed by analysing the possible fate of forestry products in the absence of the project activity.

This methodology was developed incorporating all the comments submitted to NM 0002 and NM 0029. Some of the main comments sent referred to the financial analysis required for the determination of additionality, and for this reason this new methodology uses the Additionality Tool for the determination of additionality. The methodology provides details on the application of the Additionality Tool for this specific project type. 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.

This project type requires a clear demonstration of when is the starting date of project activities. This has to be demonstrated as by when the investments required for the use of charcoal are made or initiated. For instance, this could be the data in which renovation of exhausted plantation assets is initiated, backed by internal documentation authorising this investment with the objective of securing carbon finance (e.g., board meeting minutes, memos, internal analysis).

SECTION C. Choice of and justification as to why one of the baseline approaches listed in paragraph 48 of CDM modalities and procedures is considered to be the most appropriate:

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C.1. General baseline approach:

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□ Existing actual or historical emissions, as applicable;

X Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment;

- The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20 per cent of their category.

The proposed methodology is an interpretation of Art 48(b) of Marrakech Accords.

C.2. Justification of why the approach chosen in 3.1 above is considered the most appropriate:

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This methodology is an application of 48 (b) of the Marrakech Accords, which is considered the most appropriate as the main motivating force determining the use of charcoal or coke is the economics of alternative courses of action and their barriers to investment. This whole methodology is based on a comparative analysis of the economics of alternative courses of action, taking into account the associated barriers to investment.

SECTION D. Explanation and justification of the proposed new baseline methodology:

D.1. Explanation of how the methodology determines the baseline scenario (that is, indicate the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases (GHG) that would occur in the absence of the proposed project activity):

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The baseline scenario is one of two alternatives: the use of charcoal or the use of coke for the production of pig iron. No other scenario exists for the production of pig iron, except for the discontinuation of activities, and this option is not considered here.

The determination of which one is the baseline is done through a comparative financial analysis of the costs associated with the use of these reducing agents.

D.2. Criteria used in developing the proposed baseline methodology:

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The criteria followed in developing the proposed methodology considered the following aspects:

- The methodology must be simple, transparent and easy to implement.
- The methodology must be conservative in its assumptions.
- The methodology must be specific to be applicable to the proposed project activity, but should allow other companies in the sector to use it.
- The methodology must use all the information and best practices available in similar approved CDM methodologies and documents at the time it is written.
- The determination of additionality should use a recognized method, which in this case is the EB Tool for Demonstration and Assessment of Additionality.

D.3. Explanation of how, through the methodology, it can be demonstrated that a project activity is additional and therefore not the baseline scenario (section B.3 of the CDM-PDD):

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The determination of project additionality will be done using the stepwise approach of the Tool for demonstration and assessment of additionality released by the CDM Executive Board at its 16th Meeting ("the Additionality Tool**"**) in the following manner:

Step 0. Preliminary screening of projects based on starting date of project activity

This has to be demonstrated as in Additionality Tool, but emphasising when the investment decisions or investments required for the use of charcoal are made. For instance, this could be the data in which renovation of exhausted plantation assets is initiated, backed by internal documentation authorising this investment with the objective of securing carbon finance.

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

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

Two alternatives exist with the relation of a choice of reducing agent for the pig iron industry:

Alternative 1: Use of renewable charcoal for pig iron production, based on investments for the establishment of forestry assets and the production and use of charcoal.

Alternative 2: The use of coke for the production of pig iron.

Sub-step 1b. Enforcement of applicable laws and regulations:

As requested by the Additionality tool, provide evidence that both alternatives comply with the laws and regulatory requirements in the project location.

Step 2. Investment Analysis

Sub-step 2a: Determine appropriate analysis method

Given that this type of project does generate financial benefits other than the CDM-related income, Option I of the Additionality Tool is not applicable. Given that this type of project is based on the selection of one of two alternative scenarios and both require investments of comparable scale, then Option II must be used.

The use of Option II enables a comparative financial analysis of the long term costs of using charcoal

versus the long term costs of using coke for the production of pig iron and consideration of risks and barriers of the two alternatives. As coke and charcoal usually cannot be used interchangeably and each use has its respective investment requirement, such a decision is a long term decision that typically has substantial effects on the company and its investment plans.

Sub-step 2b: Option II – Apply investment comparison analysis

As described in the Additionality Tool, at this stage project developers must select the financial indicator to be used for the financial analysis. The financial indicator most suitable for the project type is the NPV of the long term cost savings of using coke for the production of pig iron, as opposed to charcoal.

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

As required by the Additionality Tool, the NPV for the two scenarios described in Step 1a should be calculated. Given that revenue should remain unaffected by the choice of the reducing agent used for both scenarios (pig iron production using coke or charcoal) as there should be no difference in the price of the final product, this analysis should be based on the costs and investments to be made, and the costs and savings associated with each scenario. This will be done according to the following equation:

NPV of Cost Savings of Coke (Charcoal[1]) = NPV [(C $PI_{charcoal}$ + $Capex_{charcoal}$) – (C PI_{coke} – $Capex_{coke}$)]

Where:

NPV is the Net Present Value of the yearly cashflows of the inputs;

C $PI_{charcoal}$ is the projected annual production costs of pig iron using charcoal for a specified long term period (N years);

$Capex_{Charcoal}$ is the annual amount of capital expenditures required to operate with charcoal. This is based on the investments and maintenance costs related to establishing and maintaining a forestry operation for the production of renewable charcoal, and the acquisition and renovation of any equipment currently used in the pig iron factory;

C PI_{coke} is the projected annual production costs of pig iron using coke for a specified long term period (N years) – these costs should include other operating costs such as those related to the de-sulphurization of coke;

$Capex_{Coke}$ is the annual amount of capital expenditures required to coke use, including investments related to the acquisition of adaptation of blast furnaces for the use of coke and the subsequent renovations of

[1] If this calculation is negative, it would indicate the cost saving attributed to charcoal use.

such equipment.

The production and revenue assumptions and input data for the investment analysis shall not differ between the two scenarios, unless differences can be substantiated. If there are differences in the revenues generated by any of the alternative production lines (which is not expected), this should be deducted from the costs associated with alternative. The same applies in the case of subsidies or fiscal incentives which may be available for the use or production of the two types of reducing agents (for example, subsidies for the establishment of forest plantations).

For the calculation of NPV, the project company should use a discount rate based on, among other things, local interest rates in the host country, and accounting for the risks of the project, in accordance with Step 2b-Option II of the Additionality Tool. The investment analysis should be based on a timeframe similar at least similar to the length of the amortization of the investments made for the use of coke. Too long a time frame would dilute the costs of such an investment too much, making it appear that the use of coke is more attractive than it is (and thus not a conservative analysis).

Given the volatility of financial data and economic parameters in many developing countries, it is important that this analysis is performed using the parameters available to the project company at the time of the management decision on the long term strategy to use either coke or charcoal.

This analysis could be displayed as shown in the table below:

	1	2	3	4	5	6	7	8	9	10	
Production of Pig Iron, tonnes											
Cost Pig Iron produced w/charcoal ($/t)											
Operating Costs, Charcoal ($/yr)											
Maintenance costs, Charcoal ($/yr)											
CAPEX of charcoal use ($)											
Total costs of operating with charcoal ($)											
Cost Pig Iron produced w/coke ($/t)											
Operating Costs, Coke ($/yr)											
Maintenance costs, Coke ($/yr)											
CAPEX of coke use ($)											
Total costs of operating with coke ($)											
Savings from using coke ($)											Terminal Value, assuming an annuity of savings for a period of time
Discount rate (%)											
NPV of Cost Savings of Coke, $	-										

If this calculation is positive, it becomes clear that the most financially attractive option is to use coke for the production of pig iron. If the calculation is negative, the most financially attractive option is to use charcoal for the production of pig iron.

The table above must be displayed in the PDD, as well as the information used for the aggregation of figures used in the analyses

Sub-step 2d: Sensitivity analysis

Include a sensitivity analysis that shows that the financial attractiveness of the use of coke is robust to reasonable variations in the critical assumptions at the time preceding the decision to proceed with the project. In this case, given that project revenue should remain unaffected by the choice of the reducing agent used for pig iron production (coke or charcoal), this analysis should be based on the costs and investments to be made. The sensitivity analysis should be made evaluating changes in the following variables:

- Reduction in operating costs of charcoal use;
- Increases in operating costs of coke use;
- Reduction in project capital costs (CAPEX) related to charcoal use;
- Increase in project capital costs (CAPEX) related to coke use.

Financial analyses should be repeated altering each of these parameters and assessing what the impact on the NPV would be. In the case of operating costs (for which there are historical series and reflects commodity prices, inflation, interest rates, exchange rates, etc.), the changes in the variable will be the standard deviation of the mean of at least 3 years prior to the implementation of the project. In the case of capital costs, the change should be at least 10%, or if there are historical series of the prices of equipment, the standard deviation of the mean of at least 3 years prior to the implementation of the project. In case the change of any of these variables lead to a negative NPV (i.e., it makes the use of charcoal more appealing), this will indicate that the project is not additional unless the developer provides justification to the unlikelihood of this event or if there are other barriers preventing the use of charcoal (see next section).

Standard deviation is calculated as follows:

The probability density function of the normal distribution with mean μ and variance σ^2 (equivalently, standard deviation σ) is an example of a Gaussian function,

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2} \right)$$

The variance is a measure of how spread out a distribution is. It is computed as the average squared deviation of each number from its mean.

$$\sigma^2 = \frac{\sum (X-\mu)^2}{N}$$

where μ is the mean and N is the number of scores. The formula for the standard deviation is the square root of the variance.

Step 3. Barrier analysis

The use of this step is optional. However, in some cases, in addition to the direct financial costs related to the choice of reducing agent (charcoal or coke), it is also important to recognize and take into account the risks associated with using a given reduction agent, and the barriers associated with using and/or converting to each alternative. A qualitative analysis and description of such barriers and risks should be presented, together with a justification of how and why they affect investment and/or corporate decisions. Depending on the specific barriers identified, the barrier analysis may result in a final determination of a baseline that differs from the financial choice indicated by the NPV calculation alone.
If this step is used, it must follow the requirements and instructions of the original Additionality Tool.

Step 4. Common practice analysis

As required in the Additionality Tool, the generic additionality tests shall be complemented with an analysis of the extent to which the proposed project type (e.g. technology or practice) has already diffused in the relevant sector and region. In this case, it should be an analysis of the trends of the pig iron production sector in relation to the reducing agent used. Evidence that these trends are occurring in the period preceding the beginning of project activities have to be provided. The veracity of this scenario has to be substantiated by describing, historical trends related to the utilisation of coke or charcoal in the industry as a whole.

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

Provide an analysis of any other activities implemented previously or currently underway that are similar to the proposed project activity. Projects are considered similar if they are in the same country/region and/or rely on a broadly similar technology, are of a similar scale, and take place in a comparable environment with respect to regulatory framework, investment climate, access to technology, access to financing, etc. Other CDM project activities are not to be included in this analysis. In this case, it should be an assessment of other companies in the project region that are using charcoal for the production of pig iron, at the time that the decision to implement the project was taken.

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

If similar activities are widely observed and commonly carried out, it calls into question the claim that the proposed project activity is financially unattractive (as contended in Step 2) or faces barriers (as contended in Step 3). Therefore, if similar activities are identified above, then it is necessary to demonstrate why the existence of these activities does not contradict the claim that the proposed project activity is financially unattractive or subject to barriers. This can be done by comparing the proposed project activity to the other similar activities, and pointing out and explaining essential distinctions between them that explain why the similar activities enjoyed certain benefits that rendered it financially attractive (e.g., subsidies or other financial flows) that were not available to the propose project activity,

or did not face the barriers to which the proposed project activity is subject. In case these are not widely observed, the claims made in Steps 2 and 3 remain valid.

Essential distinctions may include a serious change in circumstances under which the proposed CDM project activity will be implemented when compared to circumstances under which similar projects where carried out. For example, new barriers may have arise or removed, or promotional policies may have ended, leading to a situation in which the proposed CDM project activity would not be implemented without the incentive provided by the CDM. The change must be fundamental and verifiable.

Step 5. Impact of CDM registration

As requested by the Additionality Tool, explain how the approval and registration of the project activity as a CDM activity, and the attendant benefits and incentives derived from the project activity, will alleviate the economic and financial hurdles (Step 2) or other identified barriers (Step 3) and thus enable the project activity to be undertaken. The benefits and incentives can be of various types, as described in the Additionality Tool. If Step 5 is satisfied, the proposed CDM project activity is not the baseline scenario.

D.4. How national and/or sectoral policies and circumstances can been taken into account by the methodology:

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The results of this comparative analysis between plausible scenarios should be evaluated in the context of sector trends, and incorporating the effects of any legislation and government policies that may affect this trend. This can be done by analyzing the policies (subsidies, laws, economic trends), as well as the behavior of companies involved in the same production sector in the region where the project will be implemented.

In particular, the determination of the baseline scenario is based on financial parameters affecting the pig iron, forestry and charcoal sectors in a host country. These parameters, in turn, are severely affected by public policies related to:

- economic parameters (exchange rate and exchange control) – these would affect the pricing of imported coal/coke (when this is the case) and is directly incorporated in the financial analysis used for determination of additionality;
- financial parameters (interest rates and sectoral investment and finance schemes) – these would particularly affect investment decisions related to the use of coke or the establishment of forest assets for the production and use of charcoal, and consequently are directly incorporated in the financial analysis used for determination of additionality;

- fiscal policies and incentive schemes – if there are fiscal incentives or subsidies, these must be included in the financial analysis, and are therefore directly captured by the methodology (e.g., any subsidies available for the production of charcoal, such as forestry subsidies)

D.5. Project boundary (gases and sources included, physical delineation):

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For the purposes of this analysis, the project's boundaries should be limited to coke and charcoal use for pig iron production within the project country's territorial boundaries, as well as emissions associated with forestry activities used for charcoal production. All sources of emissions and emission reductions associated with this project activity taking place in this country should be accounted for. This includes the transportation of charcoal and coal/coke that will or would have taken place in the project activity and baseline scenario, the emissions arising from the coking process that could take place in the country, and the emissions associated with forestry operations currently or previously used for production of charcoal.

The emissions associated with the mining and transportation of coal imported to the project country must not included in the analysis. This is 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.

If the project leads to additional sequestration (and if this is eligible), the project may wish to claim these credits but this would need to follow another methodology in accordance with the requirements to be defined for LULUCF.

Table 1 below provides a list of the gases and sources to be included for the evaluation of emissions of both project and baseline scenarios.

Table 1: Summary of system and project boundaries, as well as sources and gases included in the assessment.

<table>
<tr><th>Emissions</th><th>Project Scenario</th><th>Baseline Scenario</th></tr>
<tr><td>Direct
on-site</td><td colspan="2">CO_2 Emissions from 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.
CO_2 Emissions from the use of non renewably produced charcoal for pig iron production (tC0_2e/t charcoal). This charcoal is not considered “carbon neutral” and therefore all GHG emitted must be accounted for.
CO_2 Emissions from 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) – CO_2 fixed in pig iron (carbon fixed in iron, in tCO_2e/t coke used).
Methane (CH_4) emissions that occur during production of renewable charcoal (tC02e /t charcoal produced)
Methane (CH_4) emissions that occur during production of non-renewable charcoal (tC02e /t charcoal produced).
Methane (CH_4) emissions that occur during the coking process (tC02e /t coke). 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.
Nitrous oxide (N_2O), both from thermal and chemical processes taking place during carbonisation (tC0_2e/t charcoal produced). 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.
Nitrous oxide (N_2O), both from thermal and chemical processes taking place during the coking process (tC0_2e/t coke produced).</td></tr>
<tr><td>Direct
off-site</td><td>CO2 emissions from forestry operations if the pig iron company remains using charcoal. The level of emissions will depend on what is the state of forest assets at the beginning of the project. 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 quantified, 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.
Emissions related to the mining and international transportation of coal – excluded.</td><td>CO2 emissions from forestry operations if the pig iron company stops using charcoal. While this could lead to a reduction in carbon stocks in the forest (and thus, emissions), the methodology conservatively assumes that there will not be any emissions associated with forestry activities in the baseline.
Emissions related to the mining and international transportation of coal – excluded. Given that the use of coal/coke is higher in the baseline scenario, this provides for a conservative analysis.</td></tr>
<tr><td>Indirect
on-site</td><td colspan="2">Emissions from electricity use for operation of lights and fans of on-site workshops – excluded, as it is expected to be the same in both scenarios</td></tr>
<tr><td>Indirect
off-site</td><td colspan="2">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). 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.</td></tr>
</table>

D.6. Elaborate and justify formulae/algorithms used to determine the baseline scenario. Variables, fixed parameters and values have to be reported (e.g. fuel(s) used, fuel consumption rates):

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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 $emissions_{baseline}$

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. $Q_{Ch\text{-}R\text{-}p} + Q_{Ch\text{-}U\text{-}p} + Q_{Co\text{-}p}$).

$CEF_{ch\text{-}R}$ = 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$_{\mathbf{baseline}}$ = 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.

D.7. Elaborate and justify formulae/algorithms used to determine the emissions from the project activity. Variables, fixed parameters and values have to be reported (e.g. fuel(s) used, fuel consumption rates):

>>

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 emissions$_{project}$

Where,

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

$\mathbf{Q_{Ch\text{-}U\text{-}p}}$ = Quantity of charcoal used in Project Activity that has not been renewably produced (tonnes).

$\mathbf{Q_{Co\text{-}p}}$ = Quantity of coke used in Project Activity (tonnes).

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

Forestry emissions$_{project}$ = 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.

D.8. Description of how the baseline methodology addresses any potential leakage of the project activity:

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Provide a discussion of the likely impact of the use of coke on the charcoal and coke industry in region/country or globally as applicable. 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. Assess any off-site emissions that may take place as a consequence of the project.

With relation to the leakage possibly related to the use of forest, the following approach could be used:

- List various baseline scenarios for the use of the forests in the absence of the project
- Assess likelihood of each scenario, providing justification;
- Determine the most likely baseline scenario for the use of these forests;
- Compare the baseline scenario with the project activity, in order to determine whether the project activity would lead to an increase in emissions in relation to the emissions taking place in the baseline scenario. If so, this is a source of leakage;
- Estimate the amount of leakage in order to subtract it from the emissions reductions calculated for the project activity. This should be done using the following equation to quantify forestry emissions (if it is shown to be a removal, exclude it from calculations):

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

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 switch 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.

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.

D.9. Elaborate and justify formulae/algorithms used to determine the emissions reductions from the project activity. Variables, fixed parameters and values have to be reported (e.g. fuel(s) used, fuel consumption rates):

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The baseline and project emissions can be calculated as the difference between the total amount of CO_2 that would be emitted during the production of pig iron in the baseline scenario, i.e. using coke as a reduction agent, and the net amount of CO_2e emitted during the production of pig iron pursuant to the project activity, considering any leakage that is expected to occur. From the equations in sections D.6, D.7 and D.8, the total net emission reductions from the project activity during a given year *y* can be calculated as follows:

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

Where

Emissions in Baseline scenario (coke use) =

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

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

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

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

and

Emissions of Project Activity (charcoal use) =
$[Q_{Ch\text{-}R\text{-}p} * (CEF_{ch\text{-}R} + M_{ch\text{-}R} + N_{ch} + T_{ch})] +$
$[Q_{Ch\text{-}U\text{-}p} * (CEF_{ch\text{-}U} + M_{ch\text{-}U} + N_{ch} + T_{ch})] +$
$[Q_{Co\text{-}p} * (CEF_{co} + M_{co} + N_{co} + T_{co})] +$
$\text{Forestry emissions}_{project}$

SECTION E. Data sources and assumptions:

E.1. Describe parameters and or assumptions (including emission factors and activity levels):

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The parameters and assumptions used can be divided into two groups, parameters and assumptions that will be used to determine the baseline scenario, and parameters and assumptions that will be used to calculate the emissions of the baseline scenario and project activity.

1) Firstly, the future baseline scenario has to be determined based on a comparative financial analysis of the cost of producing pig iron using of charcoal and the cost of producing charcoal using coke for the production of pig iron. This should be based on:

- Historical, current, and future expected price of coke delivered at site;
- Historical, current and future expected price of renewably produced charcoal (in the event company produces its own charcoal, this should be the internal cost of production);
- Current, historical, and projected pig iron production(t);
- Investments (capital expenditures) and timing required for coke use;
- Other differences in operating costs to produce pig iron using charcoal and coke;
- Projected date of starting using coke, if this option had been chosen;
- Appropriate discount rate for investments;
- Specific barriers or risks for coke and charcoal supply, production, and use.

The results of this comparative analysis will be evaluated in the context of sector trends in the pig iron and steel sectors of the use of charcoal and coke, and by any legislation and government policies that may affect this trend. This can be done by analysing the policies (subsidies, laws, economic trends), as well as the behaviour of companies involved in the steel and iron sectors, as well as analysing the forestry and charcoal production sectors in the region where the project will be implemented.

2) After determining the baseline scenario, the second step is to calculate the emissions of the baseline scenario and of the project activity. Using the assumption that pig iron production would be the same in the baseline scenario and project activity, the differences in emissions from charcoal use and coke use will be calculated. This is based on, at least:

- Quantity of pig iron produced under the proposed Project Activity and Baseline scenario;

- Blast furnace carbon intake in both coke and charcoal processes, differentiated as coming from renewable and non-renewable sources;
- Amount of carbon that is fixed in pig iron (ca. 0.6% of carbon intake into blast furnace);
- CO_2 emission during coking;
- methane (CH_4) emissions taking place during the coking and carbonisation processes;
- nitrous oxide (N_2O), both from thermal and chemical processes taking place during the coking and carbonisation processes;
- CO_2 emissions associated with the transportation of coke from its origin (first port in the host country, in the case of imported coal/coke) to the pig iron mills;
- CO_2 emissions associated with the transportation of charcoal from its origin to the pig iron mills;
- Net emissions associated with forestry activities, if deemed to be higher than in the baseline scenario;
- Emissions due to a leakage in project implementation case (tCO_2e);
- Global Warming Potential coefficients as determined by the IPCC and approved by the UNFCCC.

It is also assumed that:

- 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. Charcoal from non-renewable plantations (e.g., native forests) is not considered renewable and the emissions associated with its use have to be accounted for;
- 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.).

Data used for this analysis needs to be measured by the project developer or gathered from the scientific publications, specialised institutions and consultants, the IPCC, or any other recognised sources, and validated/documented data from the project company. Full references must be given for the sources of data used. Details of activity levels and emission factors are given in the table in the next section.

E.2. List of data used indicating sources (e.g. official statistics, expert judgement, proprietary data, IPCC, commercial and scientific literature) and precise references and justify the appropriateness of the choice of such data:

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ID No		Data type	Data unit	Measured, calculated, estimated (m, c, or e)	Emissions factor or activity levels	Data sources and references	Appropriateness of data
1	$Q_{Ch\text{-}R}$	Quantity of renewable charcoal used by the project or baseline	*tonnes*	M	variable	To be measured by project developer	
2	$Q_{Ch\text{-}U}$	Quantity of non-renewable charcoal used by the project or baseline scenarios	Tonnes	M	variable	To be measured by project developer	
3	Q_{Co}	Quantity of coke used in the project or baseline	Tonnes	M	variable	To be measured by project developer	
4	$CEF_{CH\text{-}R}$	Carbon Emissions Factor of renewable charcoal	tCO_2e/t coke used	M	0	-	By definition, this is carbon neutral
5	$CEF_{Ch\text{-}U}$	Carbon Emissions Factor of non-renewably produced charcoal	tCO_2/t charcoal	M	6.481	662.71 F981c – Fundação Centro Tecnologico De Minas Gerais Cetec. Carvão Vegetal; destilação, propriedades e controle de qualidade. Belo Horizonte, 1982. 1v. 662.71 F981p – Fundação Centro Tecnologico De Minas Gerais CETEC – Produção e Utilização de Carvão Vegetal, Belo Horizonte, 1982, 1v.	($CEF_{Ch\text{-}U} = Cf_{ch} + Ca_{ch} – C_{l\text{-}CH}$) These references are used as 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 CH_4 = 138.0 kg of carbon equivalent. Therefore only 1.161-.138 = 1.023 t of carbon leaves as CO_2= 1.023*44/12 = 3.751 tCO2/t charcoal
6	Cf_{ch}	Carbon content of charcoal	tCO_2e/t charcoal	M	2.933	662.71 F981c – Fundação Centro Tecnologico De Minas Gerais Cetec .	It is the elemental carbon present in the charcoal mix utilized. By average this value is 80% of the dry

						Carvão Vegetal; destilação, propriedades e controle de qualidade. Belo Horizonte, 1982. 1v. 662.71 F981p – Fundação Centro Tecnologico De Minas Gerais CETEC – Produção e Utilização de Carvão Vegetal, Belo Horizonte, 1982, 1v.	charcoal utilized (equivalent to 75 % Fixed 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 emissions during carbonisation	tCO_2e/t charcoal	M	3.751	Same reference as in lines 5.	See calculations on line 5.
8	$C_{I\text{-}CH}$	Carbon Fixed in Pig Iron produced using charcoal.	tCO2/t charcoal	M	0.203	Average gross specific charcoal consumption of V&M do Brasil. Can be replaced with data specific to other project developers.	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	tCO_2e/t coke used	M	3.670	Calculated using parameters below	Calculated as $Cf_{co}+C_{co} - C_{I\text{-}CO}$
10	Cf_{co}	Carbon content of coke	tCO_2e/t coke used	C	3.234	Prototype Carbon Fund, Brazil Plantar Baseline Report, Final: March 14, 2002, at site: http://prototypecarbonfund.org	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	tCO_2e/t coke used	C	0.807	Prototype Carbon Fund, Brazil Plantar Baseline Report, Final: March 14, 2002, at site: http://prototypecarbonfund.org	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	$C_{I\text{-}CO}$	Carbon Fixed in Pig Iron produced using coke	tCO2/t coke	M	0.315	Prototype Carbon Fund, Brazil Plantar Baseline Report, Final: March 14, 2002, at site: http://prototypecarbonfund.org	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	$M_{Ch\text{-}R}$	Methane emissions from carbonisation process (renewable)	tCH4/t charcoal	M	0.0462	Smith, R.K., at al , 1999. Charcoal-Making Kilns in Thailand, US EPA study EPA-600/R-99-109, Washington DC	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	$M_{Ch\text{-}U}$	Methane emissions from carbonisation	tCH_4/t charcoal	M	0.056	Smith, R.K., at al , 1999. Charcoal-Making Kilns in Thailand, US EPA study EPA-	. This value reflects the emissions of the least advanced technology available in Brasil, and it should

		process (non-renewable)				600/R-99-109, Washington DC	be assumed that all charcoal from third parties have the same emissions level
15	M_{Co}	Methane emissions from coking	tCH_4/t coke	E	0		Conventional coke oven normally have fugitive emissions of heavy hydrocarbons gases as well as low molecular weight hydrocarbons such as CH4. Since the baseline scenario assumed is considering new coke oven of the type non-recovery, this process has complete combustion of its volatiles. The existing coke ovens in Brazil are from the traditional types but there is no methane emissions published.
16	N_{Ch}	Nitrous oxide taking place during carbonisation	tN_2O/t charcoal	E	0.0000304	Fundação Centro Tecnologico De Minas Gerais Cetec. Carvão Vegetal; destilação, propriedades e controle de qualidade. Belo Horizonte, 1982.	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
17	N_{Co}	Nitrous oxide taking place during coking	tN_2O/t coke	E	0.000221	UK Emission Factors database	
18		Total quantity of reductant required per year	Tonnes	M	-	To be determined by project developer	
19		Capacity of trucks/trains transporting reductant to pig iron mill	tonnes	M	-	To be determined by project developer	
20		Average one-way distance reductant is transported	Km	M	-	To be determined by project developer	
21		Fuel used by trucks/trains	Litres	M	-	To be determined by project developer	
22		Average fuel economy of trucks/trains	Km/l	C	-	To be determined by project developer	
23		Fuel CEF	$kgCO_2$/l	E	Dependent on fuel	IPCC	
24		Global Warming Potential values for CH_4 and N_2O	TCO_2e/t gas	E	21 and 310, respectively	IPCC	
25		Carbon stocks and emissions in project company's forests	tCO_2e	M and e		To be determined by project developer, following approach determined in sections D7 and D8	Quantification of net emissions (or removals) can be done using data routinely collected by companies owning forestry assets
26		Costs of production of charcoal	$/t	e	-	To be determined by project developer	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	$/t	E	-	Past invoices, suppliers' data, or national statistics and projections	Future projections should incorporate macro-economic trends related to interest rate and supply/demand of these inputs
28	Q_{Ch-R}	Q_{Ch-R} - Quantity of renewable charcoal used in the baseline	tonnes	E	variable	Project developer	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} -	Q_{Ch-U} - Quantity of non-renewable charcoal used in the baseline scenario	Tonnes	E	variable	Project developer	Derived from the actual amount of reductants used in the project scenario, that will be monitored continued throughout the project lifetime.
30	Q_{Co}	Q_{Co} - Quantity of coke used in the baseline	tonnes	E	variable	Project developer	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	tonnes	M	-	Project developer, transport company	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	tonnes	M	-	Project developer, transport company	
33		Average one-way distance coke is transported	Km	M	-	Project developer, transport company	
34		Fuel used by trucks/trains	Litres	C	-	Project developer, transport company	
35		Average fuel economy of trucks/trains	Km/l	C	-	Project developer, transport company	
36		Carbon stocks and fossil fuel emissions taking place in project company's forests in baseline scenario	tCO_2e	E	Variable	Project developer	Quantification of net emissions (or removals) can be done using data routinely collected by companies owning forestry assets
37		CAPEX investments and maintenance costs	$	e	-	To be selected by project developer, based on manufacturers' information or previous investments of a similar nature made by the company	This should take into account the age of existing equipments and forestry assets, as well as the maintenance and re-investments needed in both scenarios
38		Discount rate used for NPV calculation	%	e	-	To be selected by project developer	This should reflect the interest rates prevalent in the project country, taking into account project risk and opportunity costs, as determined in Additionality Tool

E.3. Vintage of data (e.g. relative to starting date of the project activity):

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ID No		Data	Vintage
1	Q_{Ch-R}	Quantity of renewable charcoal used by the project or baseline	The total carbon content used for the production of pig iron is calculated through *ex post* ongoing measurements taken for the project activity. This is used to calculate the quantity of each reductant based on the assumptions made as to the fuel mix to be used in the baseline (i.e., the proportion of renewable and non-renewable charcoal and coke).
2	Q_{Ch-U}	Quantity of non-renewable charcoal used by the project or baseline scenarios	
3	Q_{Co}	Quantity of coke used in the project or baseline	
4	CEF_{CH-R}	Carbon Emissions Factor of renewable charcoal	Assumed to be neutral throughout the project lifetime
5	CEF_{Ch-U}	Carbon Emissions Factor of non-renewably produced charcoal	Most recent data at the time of the project beginning
6	Cf_{ch}	Carbon content of charcoal	Ex-post on-going measurements
7	Ca_{ch}	CO2 emissions during carbonisation	Most recent data at the time of the project beginning
8	$CI\text{-}_{CH}$	Carbon Fixed in Pig Iron produced using charcoal	Most recent data at the time of the project beginning
9	CEF_{CO}	Carbon Emissions Factor of coke used in the pig iron production process	Most recent data at the time of the project beginning
10	Cf_{co}	Carbon content of coke	Most recent data at the time of the project beginning
11	C_{co}	CO2 emissions during coking	Most recent data at the time of the project beginning
12	$Ci\text{-}_{co}$	Carbon Fixed in Pig Iron produced using coke	Most recent data at the time of the project beginning
13	M_{Ch-R}	Methane emissions from carbonisation process (renewable)	Most recent data at the time of the project beginning
14	M_{Ch-U}	Methane emissions from carbonisation process (non-renewable)	Most recent data at the time of the project beginning
15	M_{Co}	Methane emissions from coking	Most recent data at the time of the project beginning
16	N_{Ch}	Nitrous oxide taking place during carbonisation	Most recent data at the time of the project beginning
17	N_{Co}	Nitrous oxide taking place during coking	Most recent data at the time of the project beginning
18		Total quantity of reductant required per year	On going, ex post measurements
19		Capacity of trucks/trains transporting reductant to pig iron mill	Most recent data at the time of the project beginning
20		Average one-way distance reductant is transported	Most recent data at the time of the project beginning
21		Fuel used by trucks/trains	Most recent data at the time of the project beginning
22		Average fuel economy of trucks/trains	Most recent data at the time of the project beginning
23		Fuel CEF	Most recent data at the time of the project beginning
24		Global Warming Potential values for CH_4 and N_2O	Most recent data at the time of the project beginning
25		Carbon stocks and emissions in project company's forests	Most recent data at the time of the project beginning
26		Costs of production of charcoal	Most recent data at the time of the project beginning
27		Price of coke and charcoal purchased from third parties	Most recent data at the time of the project beginning
28	Q_{Ch-R}	Quantity of renewable charcoal used in the baseline	Assumption
29	Q_{Ch-U} -	Quantity of non-renewable charcoal used in the baseline scenario	Assumption
30	Q_{Co}	Quantity of coke used in the baseline	Assumption
31		Total quantity of reductant required per year in the baseline scenario	Assumption
32		Capacity of trucks/trains transporting coke to pig iron mill	Most recent data at the time of the project beginning
33		Average one-way distance coke is transported	Most recent data at the time of the project beginning
34		Fuel used by trucks/trains	Most recent data at the time of the project beginning
35		Average fuel economy of trucks/trains	Most recent data at the time of the project beginning
36		Carbon stocks and fossil fuel emissions taking place in project company's forests in baseline	Most recent data at the time of the project beginning

		scenario	
37		CAPEX investments and maintenance costs	Most recent data at the time of the project beginning
38		Discount rate used for NPV calculation	Most recent data at the time of the project beginning

E.4. Spatial level of data (local, regional, national):

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ID No		Data	Spatial level
1	Q_{Ch-R}	Quantity of renewable charcoal used by the project or baseline	Project specific
2	Q_{Ch-U}	Quantity of non-renewable charcoal used by the project or baseline scenarios	Project specific
3	Q_{Co}	Quantity of coke used in the project or baseline	Project specific
4	CEF_{CH-R}	Carbon Emissions Factor of renewable charcoal	Local
5	CEF_{Ch-U}	Carbon Emissions Factor of non-renewably produced charcoal	Local
6	Cf_{ch}	Carbon content of charcoal	Local or project specific
7	Ca_{ch}	CO2 emissions during carbonisation	Local
8	$CI\text{-}_{CH}$	Carbon Fixed in Pig Iron produced using charcoal	National
9	CEF_{CO}	Carbon Emissions Factor of coke used in the pig iron production process	Local or National
10	Cf_{co}	Carbon content of coke	Local or National
11	C_{co}	CO2 emissions during coking	International
12	$Ci\text{-}_{co}$	Carbon Fixed in Pig Iron produced using coke	National
13	M_{Ch-R}	Methane emissions from carbonisation process (renewable)	Local or national
14	M_{Ch-U}	Methane emissions from carbonisation process (non-renewable)	Local or national
15	M_{Co}	Methane emissions from coking	National
16	N_{Ch}	Nitrous oxide taking place during carbonisation	Local or national
17	N_{Co}	Nitrous oxide taking place during coking	Local or national
18		Total quantity of reductant required per year	Project specific
19		Capacity of trucks/trains transporting reductant to pig iron mill	Project specific
20		Average one-way distance reductant is transported	Project specific
21		Fuel used by trucks/trains	Project specific
22		Average fuel economy of trucks/trains	National
23		Fuel CEF	International
24		Global Warming Potential values for CH_4 and N_2O	International
25		Carbon stocks and emissions in project company's forests	Project specific
26		Costs of production of charcoal	Project specific
27		Price of coke and charcoal purchased from third parties	National
28	Q_{Ch-R}	Quantity of renewable charcoal used in the baseline	Project specific
29	$Q_{Ch-U\ -}$	Quantity of non-renewable charcoal used in the baseline scenario	Project specific
30	Q_{Co}	Quantity of coke used in the baseline	Project specific
31		Total quantity of reductant required per year in the baseline scenario	Project specific
32		Capacity of trucks/trains transporting coke to pig iron mill	Project specific
33		Average one-way distance coke is transported	Project specific
34		Fuel used by trucks/trains	Project specific
35		Average fuel economy of trucks/trains	National
36		Carbon stocks and fossil fuel emissions taking place in project company's forests in baseline scenario	Project specific
37		CAPEX investments and maintenance costs	Project specific but reflecting national reality
38		Discount rate used for NPV calculation	Project specific but reflecting national reality

SECTION F. Assessment of uncertainties (sensitivity to key factors and assumptions):

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An uncertainty related to determining the baseline scenario is the economic parameters and inputs originally used for the comparison of costs between coke and charcoal use in pig iron production. Factors affecting this comparison, including commodity prices, foreign exchange rates, availability of capital, interest rates, and inflation rates, fluctuate on a continuous basis. In determining the baseline scenario, the project company will have to document the information used at the time of its decision on its long term strategy to either use coke or charcoal, and make it available for inspection by the DOE. To a certain extent, these uncertainties will be dealt with by the sensitivity analysis conducted as part of the additionality determination, testing whether the project would remain valid in extremes of the range of variability of key variables (see section D.3, sensitivity analysis).

The leakage analysis also is subject to uncertainty. Therefore, a baseline scenario must be estimated based on available information at the time. The project activity is then compared to this "hypothetical" baseline to determine whether there is leakage.

With relation to the quantification of emission reductions, one source of uncertainty relates to the quality of data used. In this regard, the use of quality control and management systems, such as ISO 9000 and ISO 14000, would ensure that data used for the quantification of emissions and emission reductions are consistent and of appropriate quality.

SECTION G. Explanation of how the baseline methodology allows for the development of baselines in a transparent and conservative manner:

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This baseline methodology allows for the establishment of baselines in a transparent and conservative manner, as the main parameters needed for determination of additionality are publicly available and applied in accordance with the Additionality Tool approved by the CDM Executive Board. In addition, this analysis takes into account barriers related to relevant national and sectoral policies and circumstances, based on a publicly available public policies and indicators needed to be adopted for the construction of the baseline scenario.

For the calculation of the emissions taking place in the absence of the project activity, a conservative approach was adopted. While emission reductions are expected in relation to methane (CH_4), nitrous oxide (N_2O), transportation, and forestry activities, for conservativeness the methodology proposes that the emission associated with these components should be excluded from the overall calculation, if these are estimated to be lower in the project activity.

Wherever possible, the data used should be based on project specific measurements. In the case where data is not available to the project, they should be sourced from other relevant and recognised sources. All

results should be presented in CO_2 equivalents (CO_2e), based on IPCC's Global Warming Potential conversion factors (IPCC 1995).