Draft baseline and monitoring methodology AM00XX

"Use of charcoal from planted renewable biomass in the iron ore reduction process through the establishment of a new iron ore reduction system"

I. SOURCE, DEFINITIONS AND APPLICABILITY

Sources

This baseline and monitoring methodology is based on the following proposed new methodology:

- NM0278: "Use of Charcoal from Renewable Biomass Plantations as Reducing Agent in Pig Iron Mill in Brazil" prepared by Plantar Carbon Team and World Bank Carbon Finance Unit.

This methodology derives elements from the following approved methodologies:

- AM0042: "Grid-connected electricity generation using biomass from newly developed dedicated plantation";
- AM0047: "Production of biodiesel based on waste oils and/or waste fats from biogenic origin for use as fuel";
- ACM0003: "Emissions reduction through partial substitution of fossil fuels with alternative fuels or less carbon intensive fuels in cement manufacture";
- AM0041: "Mitigation of Methane Emissions in the Wood Carbonization Activity for Charcoal Production";
- AR-AM0005: "Afforestation and Reforestation project activities implemented for industrial and commercial uses".

This methodology also refers to the latest approved version of the following tool:

- "Combined tool to identify the baseline scenario and demonstrate additionality";
- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption";
- "Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities".

For more information regarding the proposed new methodologies and the tools as well as their consideration by the Executive Board please refer to <http://cdm.unfccc.int/goto/MPappmeth>.

Selected approach from paragraph 48 of CDM modalities and procedures

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

Definitions

For the purpose of this methodology, the following definitions apply:

Biomass and Renewable biomass. Biomass is non-fossilized and biodegradable organic material originating from plants, animals and microorganisms. This shall also include products, by-products, residues and waste from agriculture, forestry and related industries as well as the non-fossilized and biodegradable organic fractions of industrial and municipal wastes. Biomass also includes gases and liquids recovered from the decomposition of non-fossilized and biodegradable organic material. The definition of renewable biomass adopted in this methodology follows the EB 23 Annex 18 criteria:

Charcoal and Renewable charcoal. Charcoal is solid biofuel obtained from biomass by means of a chemical process known as "pyrolysis" or simply as "carbonization process", which consists of the thermal decomposition of biomass in the absence of oxygen.[1] Renewable charcoal is charcoal produced using renewable biomass resources as per the definition of renewable biomass approved on EB 23 Annex 18.

Iron Ore Reduction System. Primary Iron productive arrangement that integrates the following components according to their interdependent and systemic nature:

Component 1 - Production of reducing agents (see dotted circles in Figure 1 below) encompassing

(1) Extraction of primary carbon sources:

- Mining sites in the case of GHG intensive fossil fuels (coal coke);
- Dedicated biomass plantation sites in the case of renewable reducing agent (renewable charcoal).

(2) Transportation of primary carbon sources to the reducing agent production sites;

(3) Reducing agent production sites (coke oven unit and carbonization units);

(4) Transportation of reducing agents to the iron ore reduction facility.

Component 2 - Iron ore reduction facility (see orange circles in Figure 1 below): Blast furnace facilities where the reducing agents are used to process iron ore into the liquid or solid forms of primary iron;

- **New Iron Ore Reduction System.** An iron ore reduction system that results from a new investment (see eligible types of new investments in the applicability conditions section) undertaken in at least one of its two interdependent components, i.e the production of reducing agents (Component 1) and the iron ore reduction facility (Component 2);

[1] Brazil, 2007 *apud.* Vianna et alli. 2006.

- **Natural forest.** A forest not classified as forest productive plantation (see FAO 2001, 2006);[2]

- **Forest plantation after its last rotation.** Lands that were previously stocked with human-induced forest plantations (e.g. pinus, palm trees, bamboo, eucalyptus, etc) at the end of their rotation cycle (i.e. which were harvested after their last rotation).

Applicability

This methodology is applicable to project activities that seek to reduce emissions in the production of iron and steel by using renewable reducing agents such as charcoal produced from dedicated biomass plantations[3] instead of fossil fuel based reducing agents.

The methodology is applicable under the following conditions:

- Project activities would generate emission reductions from partial or complete use of renewable reducing agents from dedicated plantations instead of fossil fuel based reducing agents in the iron ore reduction process;
- Blast furnace technology is used in the iron ore reduction process;
- The dedicated plantations must be newly established as part of the project activity for the purpose of supplying biomass to the project;
- The methodology is applicable to project activities that aim at the establishment of new iron ore reduction systems, which are characterized by a **new investment**. The types of new investment that characterize the establishment of a new iron ore reduction system under this methodology are listed below and, hence, the methodology is only applicable to project activities that encompass at least one of the referred types;
- The eligible types of new investments for projects under this methodology are:

  Type 1: Production of reducing agents by investing in new dedicated plantations by the project entity;
  Type 2: Establishment of specific long-term binding contracts for the supply of reducing agents, i.e. renewable charcoal from dedicated biomass plantations corresponding to a new investment in the plantation;
  Type 3: Refurbishment/replacement of blast furnace;
  Type 4: Establishment/acquisition of blast furnace.

If none of the project investments match any of the types listed above, the project activity is not applicable under this methodology.[4]

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[2] The definition is based on the FAO's Global Forest Resources Assessments. According to FAO FRA 2000, natural forests are defined as those that are not covered under the definition of plantations, whereas forest productive plantations are defined on the basis of the production of wood. Forest productive plantation is a "forest/other wooded land of introduced species and in some cases native species, established through planting or seeding mainly for production of wood or non wood forest products (FAO, FRA 2006)".

[3] This methodology applies the definition of renewable biomass provided in Annex 18 EB23, <http://cdm.unfccc.int/EB/023/eb23_repan18.pdf>.

[4] The purpose of this applicability condition is to provide a conservative basis for the assessment of additionality of projects under this methodology. Naturally, projects that comply with this condition still need to go through the combined baseline identification and additionality assessment, where the role of such new investments in the achievement of additional emission reductions is assessed.

- If the project activity iron ore reduction system is supplied with renewable reducing agent under a long-term contract with a third party (investment Type 2), this contractor undertaking the new investments in the plantations has to be a project participant;
- As plantations are in the project boundary, the corresponding land is geographically delineated using maps or GIS or similar system identified;
- The renewable reducing agent shall be sourced from dedicated plantations sites[5] in the host country, which are under the control of project participants, including long-term contractors. The project activity should demonstrate that the reducing agent originates from renewable sources of biomass in the following way:
    - Evidence (e.g. official land use maps, satellite images/ aerial photographs, cadastral information, official land use records) demonstrating the location of plantations in the project boundary are established in areas that fall in one or more of the following categories:

        (i) Grasslands;
        (ii) Forest plantation after its last rotation;[6]
        (iii) Degraded areas.[7]

The land degradation can be demonstrated using one or more of the following indicators:

(a) Vegetation degradation, e.g.,

- Crown cover of pre-existing trees has decreased in the recent past for reasons other than sustainable harvesting activities.

(b) Soil degradation, e.g.,

- Soil erosion has increased in the recent past;
- Soil organic matter content has decreased in the recent past.

(c) Anthropogenic influences, e.g.,

- There is a recent history of loss of soil and vegetation due to anthropogenic actions; and
- Demonstration that there exist anthropogenic actions/activities that prevent possible occurrence of natural regeneration.

Alternatively, the land degradation can be demonstrated using the “Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities” as per EB 41 Annex 15.

[5] As per Annex 8, CDM EB 20, project activities under this methodology may not directly result in long-term net decreases of carbon pools compared to what would occur in the plantation site in the absence of the project activity.
[6] See definition of “Forest plantation after its last rotation” in definitions section.
[7] Degraded lands are the lands whose edaphic conditions and /or biotic richness have been reduced by human activity to such an extent that their ability to satisfy productive uses has declined (Source: BROWN, S.; LUGO, A. E. Rehabilitation of tropical lands: a key to sustaining development. *Restoration Ecology*. 2(2): 97-111, 1994).

In case the dedicated plantation is covered under a registered AR project activity, the demonstration that the biomass originates from renewable source is not required, provided that the associated A/R CDM project is able to generate tCERs or lCERs, which should be verified by DoE for each year of crediting period. . In case only a part of the dedicated plantation is covered under a registered AR project activity (generating tCERs or lCERs) this condition is not applicable only to this part of the plantations.

- The renewable biomass and the charcoal used in the new iron ore reduction system implemented by the project activity shall not be acquired from the market, since leakage in this case cannot be estimated. The acquisition of renewable biomass supplies through long-term contracts with a third party is not considered an acquisition from the market, since the contractor shall be considered a project participant and the corresponding land has to be identified;
- In compliance with the paragraph 38 of the CDM EB 25 decision, for cases that demonstrate the supply of reducing agent from biomass projects registered as the AR CDM projects, upstream emissions from biomass production need not be accounted if they are accounted under the respective AR CDM projects;[8]
- Carbon stocks in the non-living biomass pools (deadwood, litter and soil organic matter) can be expected to decrease more or increase less in the absence of the project activity during the time frame that coincides with the crediting period of the project activity, relative to the baseline scenario. Lower soil carbon under grassland compared to plantations or secondary forests can be expected under tropical conditions, it cannot necessarily be expected under non-tropical conditions. Evidence has to be provided that the exclusion of soil organic carbon is conservative for the project case through, e.g. representative scientific literature. In case the dedicated plantation is covered under a registered AR project activity, this condition is not applicable (provided the A/R project activity is generating tCERs or lCERs, to be verified by DoE every year). In case only a part of the dedicated plantation is covered under a registered AR project activity, this condition is not applicable only to this part of the plantations. The procedure to determine when accounting of the soil organic carbon pool may be conservatively neglected in A/R CDM project activities EB 33 annex 15 shall be used;
- The land area of dedicated biomass plantations shall be established either through direct planting and/or seedling. In case the dedicated plantation is covered under a registered AR project activity, this condition is not applicable. In case only a part of the dedicated plantation is covered under a registered AR project activity, this condition is not applicable only to this part of the plantations (provided the A/R project activity is generating tCERs or lCERs, to be verified by DoE every year);
- Flood irrigation is not expected to take place on the plantation sites. In case the dedicated plantation is covered under a registered AR project activity, this condition is not applicable. In case only a part of the dedicated plantation is covered under a registered AR project activity, this condition is not applicable only to this part of the plantations (provided the A/R project activity is generating tCERs or lCERs, to be verified by DoE every year);
- Grazing will not occur within the dedicated plantation. In case the dedicated plantation is covered under a registered AR project activity, this condition is not applicable. In case only a part of the dedicated plantation is covered under a registered AR project activity, this condition is not applicable only to this part of the plantations (provided the A/R project activity is generating tCERs or lCERs, to be verified by DoE every year);

[8] As per the paragraph 38 of the CDM EB 25 decision, for the cases where renewable reducing agent is procured from a registered CDM AR project activity, project emissions are accounted within the respective project so as to avoid double counting of project emissions.

- For at least ten years before the implementation of the project activity, no natural forest stocks were on the land where the dedicated plantations will be established;
- In case blast furnace gas is recovered and used outside of the project boundary for electricity and/or heat generation in the baseline situation, the project activity shall provide similar and/or equivalent energy outputs as the ones identified in the baseline scenario aiming to avoid impacts outside the project boundary due to the project implementation;[9]
- In cases the project scenario involves partial consumption of the mineral coke in the project's new iron ore reduction system this methodology is only applicable if the production of the mineral coke is undertaken within the host country (ies). Thus, the methodology is not applicable to project activities that rely on the use of imported mineral coke in the project scenario;[10]
- This methodology is not applicable to cases in which the most plausible baseline scenario is the non renewable charcoal iron ore reduction system or is an iron ore reduction system partially using non renewable charcoal. In order to ensure a conservative assessment of this applicability condition, the use of non-renewable charcoal shall be assessed in the baseline scenario identification procedure, as per the procedures presented in the corresponding section of this methodology.

Finally, this methodology is only applicable if the most plausible baseline scenario identified is the production of iron and/or steel based on an iron ore reduction system that relies completely or partially on the use of fossil fuel based.

Guidance for the situation when the plantation (or part of) is covered under an A/R CDM project activity

If the A/R CDM project activity and the project activity covering the iron ore reduction process are part of an integrated development project (which means that the same project proponents are involved in the two CDM activities):

- The baseline selection and additionality procedures are to be performed in an integrated manner, considering the two activities together, which implies that, the investment analysis and/or the barrier analysis shall encompass the iron ore reduction system as a whole (production of the reductant and the operation of the steel mill);
- The project proponents shall refer to the integrated process in the two PDDs and shall submit them for registration together although the crediting period of the iron ore reduction activity may only start after the first harvesting of the trees established in the context of the A/R CDM project activity. This last provision may not apply to A/R CDM project activities already submitted to the Global Stakeholders Process within the CDM validation and registration procedures before the approval of this methodology by the CDM EB.

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[9] In case there is electricity and/or heat generation in the baseline, a parameter for measuring the amount of electricity generated from the blast furnace recovered gas shall be applied and monitored as per the provisions of the Monitoring Data and Parameters Section.

[10] The use of imported mineral coke in the project is not allowed within this methodology, for the sake of simplicity and conservativeness, avoiding the complexities related with emissions that may occur outside the host country's national boundaries.

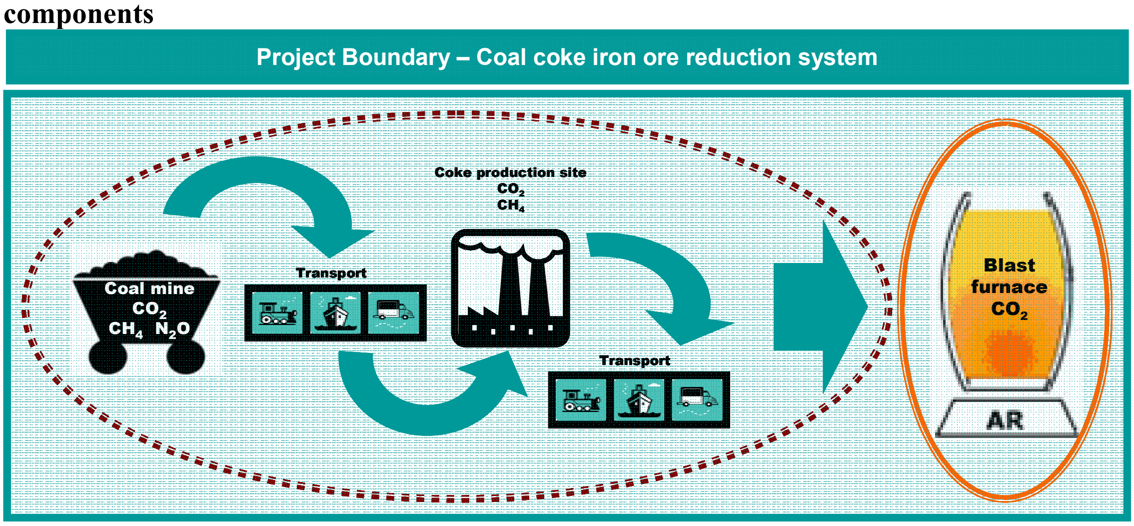
II. BASELINE METHODOLOGY

Project Boundary

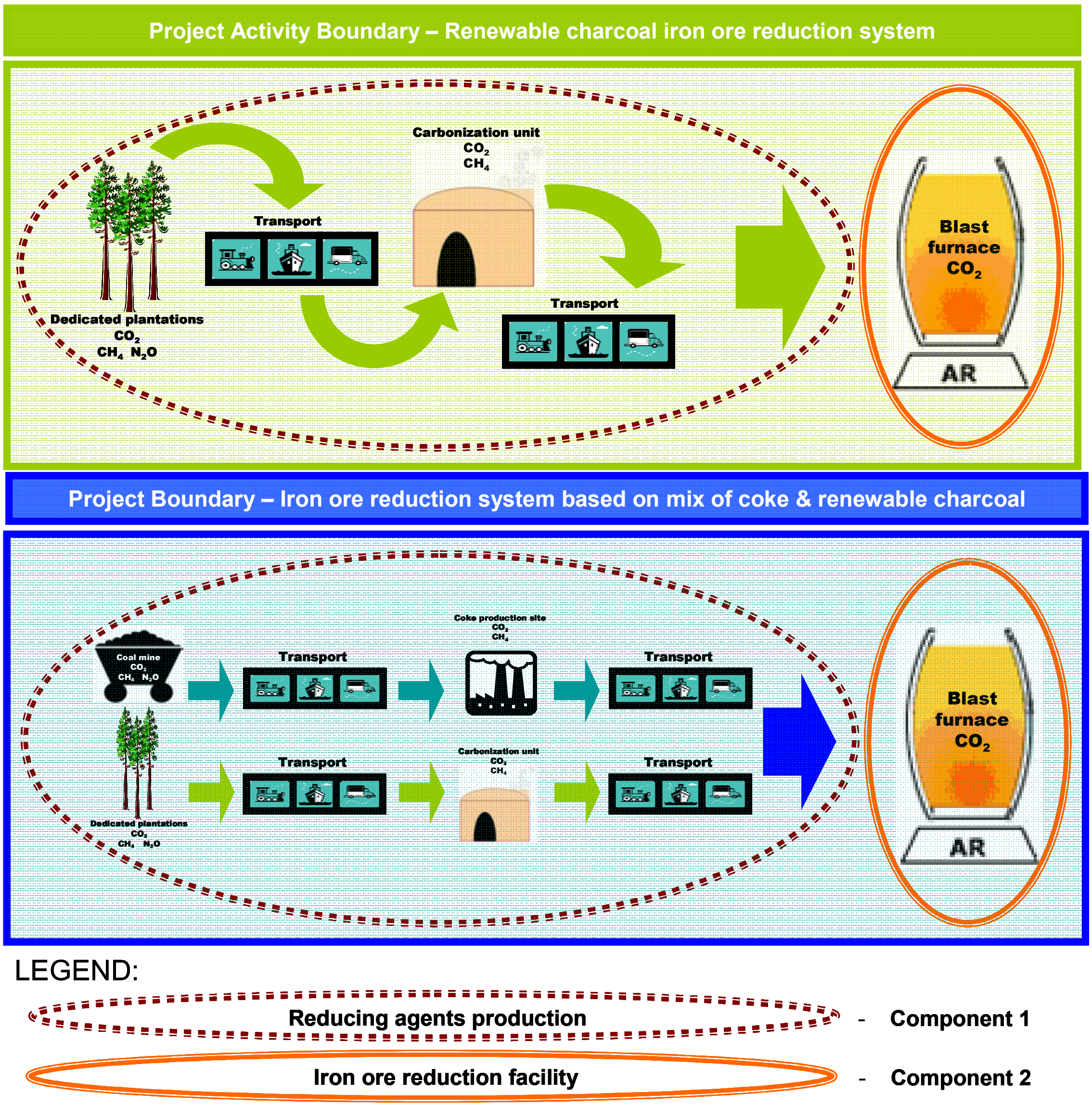
This methodology takes into account the integrated nature of the iron ore reduction system in the estimation of GHG emissions, as well as in the determination of the baseline scenario and assessment of additionality. The project boundary includes emissions associated with the production of reducing agents (upstream emissions) and emissions associated with use of the reducing agents in the iron ore reduction facility (process emissions).

The **spatial extent** of the project boundary is consistent with the *iron ore reduction system*. It encompasses the geographical area of raw material[11] supply (i.e. coal mines, biomass production sites), units that convert raw material into reducing agents (coke oven facilities that distil coal into coke; and carbonization units that convert wood into charcoal), the transportation of the raw materials and of the reducing agents (i.e. charcoal and coal coke) to the iron ore reduction facility, and the iron ore reduction facility (blast furnace).

Figure 1: Project boundary of the iron ore reduction system and its interdependent components



[11] The term "raw material" shall be understood as the primary carbon source that is further converted into reducing agents, i.e. coal or planted biomass. Henceforth, the terms "raw materials" and "primary carbon sources" are used interchangeably.



The project emissions are classified into two major categories, within the iron ore reduction system: (i) upstream emissions - extraction of primary carbon, transportation of the primary carbon sources to the reducing agent production units, conversion of the primary carbon sources into reducing agent supply and their transport to the industrial facility; and (ii) process emissions - emissions in the reduction facility. The detailed emission sources are presented below:

Upstream emissions: Production of Reducing Agent (grey dotted circle in* Figure 1*)

(i) Emissions associated with the extraction of primary carbon sources:

(a) Emissions in the establishment of dedicated plantations;
(b) Emissions from coal mining.

(ii) Emissions from the transport of primary carbon sources to the reducing agent production sites:

(a) Emissions from the transportation of renewable biomass to the carbonization units;
(b) Emissions from the transportation of coal to the coke production units.

(iii) Emissions in the production of the reducing agent:

(a) Emissions from the transformation biomass into charcoal (carbonization);
(b) Emissions from the transformation of coal into coke.

(iv) The emissions from the transport of reducing agents to the iron ore reduction units:

(a) Transportation of renewable reducing agents to the iron reduction facility (i.e. from charcoal processing unit to the iron ore reduction facility);
(b) Transportation of non-renewable reducing agents to the iron reduction facility (i.e. from coal coke processing unit to the iron ore reduction facility).

Note: Concerning upstream emissions, in case the plantation is part of a registered A/R CDM project activity, the project emissions generated within the corresponding discrete areas shall not be included in the project boundary. As per the applicability conditions if upstream emissions are outside the national boundary of the host country(ies), the methodology is not applicable.

Depending on the particular situation of the project activity, all or part of the upstream emissions in the baseline situation and/or the project situation may not be under the control the project proponent. In such cases these upstream emissions, will be counted under baseline and/or project emissions.

Process emissions: Iron Ore Reduction Facility (see orange circle in Figure 1)

(v) Emissions associated with the use of each reducing agent in the iron ore reduction process:

(a) Emissions from use of Fossil fuel based reducing agents (e.g. coal coke).

The emissions from mining and transportation of iron ore are excluded from this methodology as they are the same under the baseline scenario and the project scenario. The sources and gases of emissions covered under this methodology are presented in the Table 1 below.

Table 1: Emissions sources included in or excluded from the project boundary*

	Source	Gas	Included?	Justification / Explanation
Baseline	Iron ore Reduction Process	CO_2	Yes	Main source of baseline emissions
		CH_4	No	Negligible and excluded for simplification
		N_2O	No	Negligible and excluded for simplification
	Reducing agents transportation	CO_2	Yes	Fossil fuel combustion
		CH_4	No	Negligible and excluded for simplification
		N_2O	No	Negligible and excluded for simplification
	Reducing agent production	CO_2	Yes	Coal coke production emissions
		CH_4	Yes	Coal coke/charcoal production
		N_2O	No	Negligible and excluded for simplification
	Transportation of primary carbon sources	CO_2	Yes	Fossil fuel combustion.
		CH_4	No	Negligible and excluded for simplification
		N_2O	No	Negligible and excluded for simplification
	Primary Carbon source**	CO_2	Yes	Emissions of the mining process. Emissions in the establishment of plantations are conservatively excluded/plantation establishment
		CH_4	Yes	Fugitive methane emissions in coal mining, biomass burning in the plantation establishment
		N_2O	Yes	Application of fertilizers in the planting activity and field burning of biomass/ coal mine reclamation and ammonium nitrate use;
Project Activity	Iron ore Reduction Process	CO_2	Yes	Main source of project emissions.
		CH_4	No	Negligible and excluded because differences in the baseline and project activity are not substantial.
		N_2O	No	Negligible and excluded because the differences in the baseline and project activity are not substantial
	Reducing agents transportation	CO_2	Yes	Fossil fuel combustion
		CH_4	No	Negligible and excluded because differences in the baseline and project activity are not substantial
		N_2O	No	Negligible and excluded for simplification
	Reducing agent production	CO_2	Yes	Major source of emissions in the production of reducing agents, e.g. coal coke, carbonization biomass
		CH_4	Yes	Coal coke production process and biomass carbonization process.
		N_2O	No	Negligible and excluded because differences in the baseline and project activity are not substantial
	Transportation of primary carbon source	CO_2	Yes	Source of emissions
		CH_4	No	Negligible and excluded for simplification
		N_2O	No	Negligible and excluded for simplification
	Primary Carbon source**	CO_2	Yes	Source of emissions - fossil fuel combustion in the planting activity
		CH_4	Yes	Emissions in coal mining process, biomass burning in the plantation establishment (if applicable)
		N_2O	Yes	Application of fertilizers in the planting activity and field burning of biomass/ coal mine reclamation and ammonium nitrate use

* The emissions from onsite electricity consumption are considered to be the same under the baseline and project scenario, therefore, these are neglected under this methodology. This approach is also corroborated by a study performed by experts in iron and steel making processes (Sampaio, R. 2006), that conservatively considers the GHG

emissions associated with electricity consumption the same independently of the reducing agents option, including a mix of biogenic and fossil

** This proposed new methodology also contemplates the possibility of using a mix of reducing agents in iron and steel making process. Therefore, references to plantation practices are included in the baseline sources (e.g. application of fertilizers) and references to the non renewable reducing agent production are included in project sources (e.g. emissions in coal mining process).

Procedure for the identification of the most plausible baseline scenario and assessment of additionality

This methodology is based on the latest version of the "Combined tool to identify the baseline scenario and to demonstrate additionality" (version 02.1)[12]. The guidance for identification of the baseline scenario is outlined below.

Step 1: Identification of alternative scenarios

The identification of alternative baseline scenarios should include all possible realistic and credible alternative uses of reducing agents in the iron ore reduction process in blast furnaces, comparable with the proposed CDM project activity (pig iron or hot metal). As per the following sub-steps, the project proponents shall identify alternative scenarios, taking into account specific circumstances of the iron ore reduction system. The scenarios relevant under this new methodology may include *inter alia*;[13]

- Coal coke iron ore reduction system;
- Renewable charcoal from planted biomass from existing plantations for iron ore reduction system;
- Renewable charcoal from planted biomass from new plantations for iron ore reduction system;
- Non renewable charcoal based iron ore reduction system;[14]
- Iron ore reduction system based on the use of a mix of the previous reducing agents.

Within this step, a list of relevant alternative scenarios shall be provided and the following sub-steps shall be followed. In the context of the combined tool for the assessment of baseline and additionality, these sub-steps have been designed as a pre-screening mechanism to conservatively narrow down the range of baseline alternatives, allowing for a more robust identification of the most likely baseline scenario, assisting, at the same time, in the additionality assessment.

Guidance on how to address the mix of reducing agents as an alternative scenario

In light of applicable laws of regulations, the legal permissions to use a mix of reducing agents in the iron ore reduction process, e.g. fossil and biogenic shall be assessed. It is good practice to apply the legal constraint as a potential alternative regarding the use of mix of reducing agents in the assessment of baseline scenarios and additionality, preventing infinite possibilities of scenarios involving such use.

[12] Annex 14 of the EB 28 December, 2006.

[13] The project proponent shall list other relevant alternatives as appropriate to the project context.

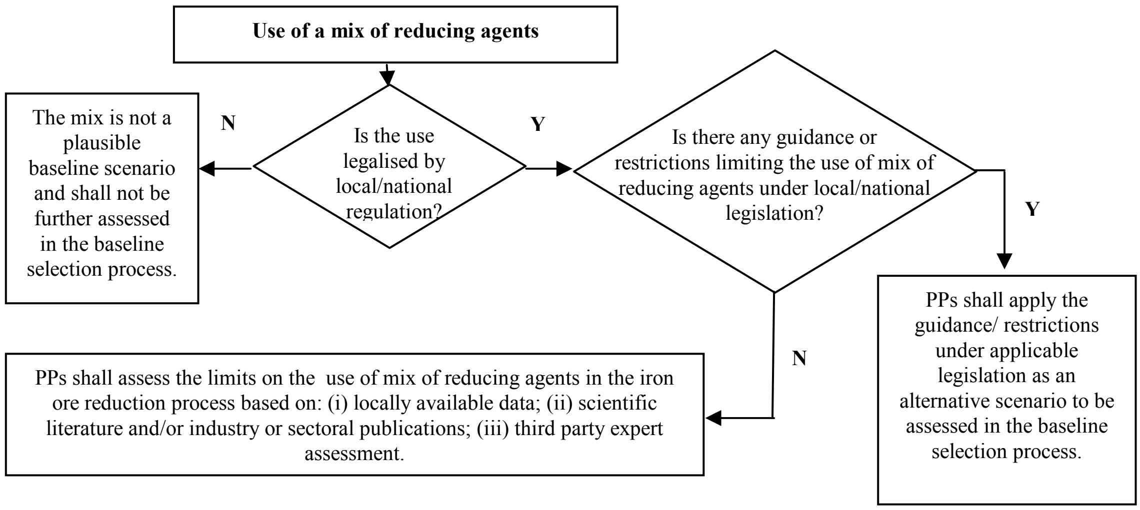
[14] The scenario of the non renewable charcoal based iron ore reduction system should also be assessed as a relevant alternative in the baseline selection process, in order to ensure strict compliance with the applicability condition restricting the methodology to the cases in which non-renewable charcoal is not used in the most plausible baseline scenario.

The procedure shall identify if this alternative is legal. If it is not, this alternative shall not be further assessed in the baseline selection process. In case it is legal to use a mix of reducing agents, shall be assessed and identified if there is any guidance available or restriction applicable limiting the use of mix of reducing agents under local/national legislation. If applicable, the guidance/restrictions under relevant legislation is required to be assessed in the baseline scenario selection process. In case there is no guidance or restriction in local/national regulations, the operational limits on the mixed use of reducing agents in the iron ore reduction process shall be assessed, as per the criteria outlined in the decision tree below, which includes:

(i) Locally available data;
(ii) Scientific literature and/or industry or sectoral publications;
(iii) Third party expert assessment.

A mixed reducing agents scenario should always be the preferred option unless it can be demonstrated that this option is not realistic. This demonstration shall be based on the availability of renewable wood at a reasonable price in the region. The availability of renewable wood during the lifetime of the steel mill shall also be one of the main determinants for the definition of the mix in the absence of a local or national regulation. The conclusions of Step 1.b below will also be useful to this regard.

The procedure is summarized in the indicative decision-tree below:



Sub-step 1a: Compliance with actual laws and regulations

The alternatives listed above shall be analyzed in the context of applicable laws and regulations. Only those consistent with current legislation shall be given further consideration. The project participants shall outline the steps to demonstrate the consistency of alternatives in the context of local and national regulation with respect to production and use of reducing agents[15]. In the context of renewable reducing agent, policies related to land use, incentives and constraints, including credit and technology shall be assessed to evaluate the impact of policy and regulation on the use of reducing agents in the iron ore reduction process.

[15] The differentiations of scales are relevant if laws and regulations have different implications to the national and regional contexts.

Sub-step 1b: Assessment of supply and demand of reducing agents

As the availability of reducing agents has a major impact for the assessment of baseline scenarios, this sub-section seeks to analyze the extent to which the supply and demand dynamics of fossil and renewable reducing agents provide underpinning constraints to the definition of realistic alternative scenarios. In order to identify possible supply and demand unbalances reducing agents trends shall be assessed in two levels: (i) sectoral and (ii) project level. The time line and sequence of decisions within the project boundary shall be considered in the assessment.

Therefore, it is possible to use the outcome of this sub-step to identify if there are restrictions of the project proponent to have access to a certain type of reducing agents, clarifying the context each alternative scenario assessed, e.g. if there is no availability of wood supply for the manufacturing of renewable charcoal the project proponent will need to develop renewable forests stocks to make this alternative scenario possible.

Conclusion of Step 1

Based on the analysis conducted in this Step and its sub-steps, the remaining realistic alternatives shall be listed and evaluated as per Steps 2 and/or Step 3 and Step 4, as below, in order to allow for the identification of the most likely baseline scenario at the end of this Section.

Step 2: Barrier analysis

As per the rationale provided in the Step 2 of the "Combined tool to identify the baseline scenario and to demonstrate additionality", project developers shall analyze barriers and incentives that influence the use of reducing agents in the production of iron and/or steel and possible sources of market failures, such as the impacts of:

- Subsidies;
- Taxes;
- Historical and/or current national and/or sector policies;
- Barriers and incentives to investment, e.g. the type and availability of debt funding required ensuring long-term supplies of reducing agents such as establishment of forest plantations, technological barriers in the iron ore reduction process, economies of scale, logistic arrangements etc.
- Regulatory barriers, e.g. different environmental licensing requirements for different reducing agents.

It is good practice to use long-term data, taking into account the factors influencing the production and use of reducing agents. Considering the long-term maturity period associated with the establishment of plantation resources, a minimum period of 10 years prior to the start of the project activity shall be considered.

Guidance for situation when the plantation (or part of) is covered under an A/R CDM project activity:

- If the A/R CDM activity and the activity covering the iron ore reduction process in the mill are two independent project activities (which may imply also that project proponents are different) then:

  A barrier related to the implementation of the plantation cannot be used for the project activity covering the iron ore reduction process in the mill.

- If the A/R CDM project activity and the project activity covering the iron ore reduction process are part of an integrated development project (which means that the same project proponents are to be involved in the two CDM activities):

  A barrier related to the implementation of the plantation can also be used by the iron ore reduction activity only if it can be proven that there is no reliable renewable wood supply available in the region, which could meet the demand of charcoal for the iron ore reduction process in the mill, as per the outcome of the sub-step 1b above.

Step 3: Investment analysis

When using investment analysis, the project participants shall take into account specific issues of the iron and steel industry and possible market failures that may directly influence the investment decision and the quality of its methods, providing proper economic justification on the implications for investment decisions and for the type of analysis conducted. It is necessary to take into account the timing of the decision to adopt different reducing agents. Project participants shall consider the maturity period and the timing of the investments in the production and/or acquisition of reducing agents through long-term supply contracts vis-a-vis the timing of the investments required in the iron ore reduction plant. The timing of the investment commitments need to be demonstrated with supporting evidence.

Investment in the two components of the iron ore reduction system should be considered, i.e:

(i) Investments in the production and supply of reducing agents, which include: investments in the establishment of plantations or acquisition of plantations and/or renewable charcoal from dedicated plantations through long-term supply contracts, investments in the carbonization process or in the coke production process;

(ii) Investments in the iron ore reduction process, which include: investment in the refurbishment or acquisition of different blast furnaces that differ in accordance with the type of reducing agent used.

Within this framework, the following criteria shall guide the decision on the specific components to be included in the investment analysis:

(i) The investment must occur within the national boundaries of the project's country;

(ii) The investment must be on components that are under control of the PP (direct or indirect, i.e. long-term supply contracts, of the PPs). Thus, investments on components that are not under the direct or indirect control of the PPs must not be included in the analysis. The following are the factors that characterize the extent to which PPs may or may not internalize investment costs. They are adopted as the parameters upon which PPs shall justify the extent to which the component at stake is or is not under their control. This decides whether to include them or not in the investment analysis e.g:

- Existence of structured spot markets for different types of reducing agents: e.g. coal is usually widely available, and as such, the inclusion of investments in coal mines is not required as project participants can purchase the reducing agent in a standardized commodities market with low transaction costs. On the contrary, renewable charcoal from dedicated plantations, for example, may not be available in a structured spot market. Hence PPs must be compelled to invest in renewable plantations to manufacture their own charcoal, either through direct investment or through non-standardized long-term supply contacts.

Investment in the establishment of dedicated plantations must be considered, whether or not the establishment of such plantations is part of a CDM A/R project activity, if there is no market for renewable wood, since they are a major part of the iron ore reduction system. By definition, tCERs from CDM A/R activities, whose plantations are part of the iron ore reduction system, implemented under this methodology and CERs accruing from CDM project activities under this methodology must not be included in the investment analysis performed in order to identify the baseline scenario.

Once the investment decision which is one of the applicability conditions of this methodology is demonstrated, the alternative scenarios should be evaluated to identify the most financially attractive alternative.

In case of a Greenfield project activity the capacity of the baseline processing plant shall be selected in accordance with the common practice as observed in the relevant region/host country for the type of iron ore reduction system corresponding to the baseline scenario.

Step 4: Common practice test

The project participants shall apply the common practice test to the plausible alternatives, considering the following items.

- The national scenario for iron ore reduction shall be assessed, taking into account the use of reducing agents in either solid (pig iron manufacturing) or liquid (hot metal used in steelmaking) forms;
- The assessment of the sector level data shall only be based on the legally available forms and alternatives of reducing agents options to the iron and steel industry. Therefore, the PP shall consider local, regional and national laws and regulations concerning the use of each of reducing agents (including mix of reducing agents) in the assessment of the common practice within the industry;

- Historical and existing sector trends shall be taken into account in light of the relationship between supply and demand of reducing agents;
- The common practice test shall be based on publicly available data and/or technical/scientific assessment demonstrating the historical and trends patterns of the industry in using each specific reducing agents alternative in the baseline.

Finally, as stated in applicability conditions, this methodology is only applicable if the most plausible baseline scenario identified is the production of iron and/or steel based on an iron ore reduction system that relies completely or partially on the use of fossil fuel based.

This methodology adopts the latest version of the "Combined tool to identify the baseline scenario and demonstrate additionality" and provides guidance to address the additionality requirements of iron ore reduction process in the iron and steel industry.

Baseline Emissions

1.0 - Baseline emissions

This methodology recognizes two components of emissions of baseline iron ore reduction system – upstream emissions and process emissions. The steps to calculate these emissions are outlined below.

(a) <u>Baseline upstream emissions</u> represent emissions associated with production of reducing agents and their transportation (from the extraction to transformation sites; and from transformation sites to iron ore reduction facility).

(b) <u>Baseline process emissions</u> associated with the use of reducing agents within the iron ore reduction process in the absence of project.

The following equations allow for the calculation of the baseline iron ore reduction system emissions from two interdependent components, i.e., upstream emissions and process emissions.

$$BE_{y} = RAE_{BL,y} + IRE_{BL,y} \tag{1}$$

Where:

BE_{y}	=	Total baseline emissions in the iron ore reduction system in year y (t CO_2e)
$RAE_{BL,y}$	=	Baseline upstream emissions in the reducing agent supply in year y (tCO_2e)
$IRE_{BL,y}$	=	Baseline process emissions in the industrial facility in year y (tCO_2e)

1.1 - Baseline upstream emissions

Upstream emissions are detailed in Annex 1. The detailed procedure laid out in annex 1 can only be applied for the calculation of the upstream emissions if the upstream processes are under the control of the project participants. If one or several upstream steps are not under control of the project proponents, the alternatives as explained after each step in Annex 1 shall be used instead of the detailed calculation. It should be noted that monitoring tables (including those in sections of data/parameters to be monitored and not monitored) include all the variables contained in the Annex 1.

If a same reducing agent (reductant) is used both in the baseline and the project situations, the project proponents shall use the same emission factors for the upstream steps (for baseline and project situations) unless they can carefully justify why these values should be different in the two situations.

The baseline upstream emissions are attributable to the production and transportation of reducing agents to the iron ore facility. For conservativeness and simplification purposes, the project proponent shall only account upstream emissions that occur within the national boundary. In addition, taking into account the cost-effectiveness, simplification good practices and conservativeness rationale, the project proponent may choose to neglect all or part of the baseline upstream emissions.

The assessment of baseline upstream emissions under this methodology is carried out as per the equation below.

$$RAE_{BL,y} = PCE_{BL,y} + RAP_{BL,\ RA,y} + RAT_{Vehicle,BL,y} \tag{2}$$

Where:

$RAE_{BL,y}$	=	Baseline upstream emissions associated with the supplies of the reducing agent (tCO_2e)
$PCE_{BL,y}$	=	Emissions from the *Primary carbon sources extraction* in the *baseline* scenario during year y (tCO_2e)
$RAP_{BL,\ RA,y}$	=	GHG emissions from the production of reducing agents within the boundary under the baseline scenario during year *y*; (tCO_2e /yr)
$RAT_{Vehicle,BL,y}$	=	CO_2 emissions in fossil fuel combustion in the transport of reducing agent(s) to iron ore reduction facility during year *y* in the baseline scenario; (tCO_2e /yr)

In this step, upstream emissions associated with the supplies of the reducing agent shall be taken into account based on the use of reducing agents in the baseline. The emissions shall be included, following the rationale below.

If the identified baseline scenario involves*:*

(1) The complete use of coal coke as reducing agent in the iron ore reduction system: Baseline upstream emissions shall take into account GHG emissions attributable to coal mining, coal coke production and transportation to the iron ore facility;
(2) The use of renewable and non-renewable reducing agent mix in the iron ore reduction system: Baseline upstream emissions shall take into account GHG emissions attributable to the fossil fuel reducing agent and renewable charcoal activities in proportion to their use in the iron ore reduction system.

1.2 - Baseline process emissions

The GHG emissions attributable to emissions in the iron ore reduction process under the baseline scenario are calculated as per the expected hot metal production of the new iron ore reduction system.

If the baseline iron ore reduction system was used by the project proponents before the start of the project activity, historical information shall be used to derive the baseline emission factors.

If the project participant have historically used charcoal, but the baseline scenario is a coal coke based iron ore reduction system (or corresponds to a mixed use of renewable and non renewable reductants), then the calculation of baseline process emissions shall be based on the Engineering data /Feasibility study developed for the assessment of this baseline option by the project developer. For reasons of conservativeness the ratio of use of coal coke per tonne of hot metal is to be capped by the value provided in IPCC 2006 Guidelines i.e. 0.358 t coal coke / tonne hot metal. This cap shall also be applied in case of a mixed iron ore reduction process i.e. 0.358 t [coal coke + charcoal] / tonne hot metal.

a. Calculation of the baseline process emissions

$$IRE_{BL,\,y} = \left(P_{PJ,\,y} \bullet EF_{Ind,\,BL}\right) - \left(P_{PJ,\,y} \bullet Cc_{HM,\,BL,\,y} \bullet \frac{44}{12}\right) \tag{3}$$

Where:

$IRE_{BL,y}$	=	Baseline process emissions within the iron ore reduction facility (tCO_2e)
$P_{PJ,y}$	=	Hot metal production in year *y* (expected hot metal production of the new iron ore reduction system). (tonnes of hot metal)
$EF_{Ind,BL}$	=	Baseline emission factor to produce one tonne of hot metal (t CO_2e / t of hot metal)
$Cc_{HM,BL,y}$	=	Carbon content per t of hot metal produced in year *y* (t C/ t of hot metal)
$\left(\frac{44}{12}\right)$	=	Conversion factor from carbon to CO_2e; (dimensionless)

b. Calculation of emission factor for baseline process emissions

In this step, the definition of emission factor is strictly associated with the type of reducing agent on which the iron ore reduction system is based as per the baseline and additionality assessment. Baseline emission factor for baseline process emissions shall be calculated as follows.

$$EF_{Ind,\,BL} = \sum_i \frac{(\%C_{BL,i} \bullet RA_{BL\,i})}{100} \bullet \frac{44}{12} \tag{4}$$

Where:

$EF_{Ind,BL}$	=	Emission factor to produce one tonne of hot metal in the baseline scenario (t CO_2e / t of hot metal)
$\%C_{BL,i}$	=	Carbon content in percent of reducing agent *i* (e.g. coal coke, charcoal, etc.) used in the baseline. It is equal to zero for renewable charcoal.
$RA_{BL\,i}$	=	Reducing agent type *i* (e.g. coal coke, charcoal, etc.) required to produce one tonne of hot metal (tonne of reducing agent/ tonne of hot metal)
$\left(\frac{44}{12}\right)$	=	Conversion factor from carbon to CO_2e (dimensionless)
i	=	Type of reducing agent *i*(e.g. coal coke, charcoal, etc.)

c. Calculation of carbon fixation factor under the baseline scenario

$$Cc_{HM,\,BL,\,y} = \frac{\%C_{HM,\,PJ,\,y}}{100} \tag{5}$$

Where:

$Cc_{HM, BL, y}$	= Carbon content fixed in hot metal per t of hot metal produced in year *y* (t C/ t of hot metal)
$\%C_{HM, PJ, y}$	= Percentage of carbon in hot metal (%) in the project situation

As per the guidance of paragraph 59 of the EB 25, priority should be given to the local, regional, national and IPCC defaults values in that order and it is good practice to use UNFCCC GHG Inventory Handbook on the industrial processes sector.

Project Emissions

2.0 - Project Emissions

Taking into account the nature of the new iron ore reduction system this methodology recognizes two interdependent components of project emissions – upstream emissions and process emissions. The steps to calculate these emissions are outlined below.

(a) Project upstream emissions represent emissions associated with production of reducing agents and their transportation in the project scenario (from the extraction to transformation sites; and from transformation sites to iron ore reduction facility).

(b) Project process emissions associated with the use of reducing agents within the iron ore reduction process in the project scenario.

The following equations outline the calculation of the project emissions from two components of the projects, i.e., process emissions and upstream emissions

$$PE_y = RAE_{PJ, y} + IRE_{PJ, y} \quad \textbf{(6)}$$

Where:

PE_y	= Project emissions in the new iron ore reduction system in year y (t CO_2e)
$RAE_{PJ, y}$	= Project upstream emissions associated with production of reducing agents and transport in year y in the project scenario (tCO_2e)
$IRE_{PJ, y}$	= Project process emissions in the iron ore facility in year y (tCO_2e)

2.1 - Project upstream emissions

Upstream emissions are detailed in Annex 2. The detailed procedure laid out in Annex 2 can only be applied for the calculation of the upstream emissions if the upstream processes are under the control of the project participants. If one or several upstream steps are not under control of the project proponents, the alternatives as explained after each step in Annex 2 shall be used instead of the detailed calculation. It should be noted that monitoring tables (including those in sections of data/parameters to be monitored and not monitored) include all the variables contained in the Annex 2.

If a same reductant is used both in the baseline and the project situations, the project proponents shall use the same emission factors for the upstream steps unless they can carefully justify why these values should be different in the two situations.

The upstream emissions are attributable to the production and transport of reducing agents to the iron ore facility due to the project activity implementation. As per the applicability conditions the planted biomass establishment and supplies of the new iron reduction system shall be located at project activity host country. In this sense project proponents shall only account upstream emissions that occur within the national boundary.

The project upstream emissions calculations shall be carried out as outlined below.

$$RAE_{PJ,y} = PCE_{PJ,y} + RAP_{PJ,\ RA,y} + RAT_{Vehicle,PJ,y} \quad \textbf{(7)}$$

$RAE_{PJ,y}$	=	Project upstream emissions associated with production of reducing agents and transport in year y in the project scenario (tCO_2e)
$PCE_{PJ,y}$	=	Primary carbon source extraction emissions in the project scenario; (tCO_2e)
$RAP_{PJ,\ RA,y}$	=	Emissions associated with production of reducing agents within the project boundary in the project scenario during year y; (tCO_2/yr)
$RAT_{Vehicle,PJ,y}$	=	CO_2 emissions due to fossil fuel combustion from vehicles used to transport reducing agent(s) to iron ore reduction facility within the project boundary during year y of the project scenario; (tCO_2/yr)

Based on the investment decision on the use of a specific set of reducing agents in project activity, the emissions shall be included in accordance with the investment decision undertaken in the project scenario to establish a new iron ore reduction system, as per the rationale below.

If the investment decision of the project proponent involves:

(1) New planted biomass charcoal based iron ore reduction system: Project upstream emissions shall take into account the emissions attributable to the plantation establishment, renewable charcoal production and its transportation to the iron ore facility. In case total or part of the dedicated plantation is covered under a registered A/R CDM project activity, the GHG emissions related to the corresponding area of land shall not be accounted in the project upstream emissions, in compliance with the paragraph 38 of the CDM EB 25 decision.[16]

(2) New iron ore reduction system based on use of a mix of reducing agents: Project upstream emissions shall take into account the emissions attributable to the fossil fuel reducing agent and renewable reducing agent production and transport in proportion to their use in the iron ore reduction system under the project scenario. As per the applicability conditions in cases the project scenario involves a partial consumption of the mineral coke this methodology is only applicable if the production of the mineral coke is undertaken within the host country (ies).

2.2 - Project process emissions

The process emissions from the use of reducing agent in the new iron ore reduction process shall be calculated using the steps outlined below:

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[16] As per the paragraph 38 of the CDM EB 25 decision, for the cases where renewable reducing agent is procured from a registered CDM AR project activity, project emissions are accounted within the respective project so as to avoid double counting of project emissions.

a. Calculation of the project process emissions

$$IRE_{PJ,\,y} = \left(P_{PJ,\,y} \bullet EF_{Ind,\,PJ,\,y}\right) \; - \; (P_{PJ,\,y} \bullet Cc_{HM,\,PJ,\,y} \bullet \frac{44}{12}) \qquad \textbf{(8)}$$

Where:

$IRE_{PJ,\,y}$	=	Project process emissions in the iron ore reduction facility in year y (tCO_2e)
$P_{PJ,\,y}$	=	Hot metal production in year *y* (expected hot metal production of the new iron ore reduction system). (tonnes of hot metal)
$EF_{Ind,\,PJ,\,y}$	=	Emission factor of one tonne of hot metal production under the project scenario (tCO_2e/ t of hot metal)[17]
$Cc_{HM,\,PJ,\,y}$	=	Carbon content per t of hot metal produced in the year y (t C / t of hot metal)
$\left(\frac{44}{12}\right)$		Conversion factor from carbon to CO_2e(dimensionless)

b. Calculation of project process emission factor

In this step the definition of the emission factor is strictly associated with the type of reducing agent on which the new iron ore reduction system is based. he emission factor calculation shall follow the rationale below based on the reducing agents adopted in the project scenario.

Project process emissions shall be calculated using the following formula:

$$EF_{Ind,\,PJ,\,y} = \sum_i \frac{(\%C_{PJ\ i} \bullet RA_{PJ\ i})}{100} \bullet \frac{44}{12} \qquad \textbf{(9)}$$

Where:

$EF_{Ind,\,PJ,\,y}$	=	Emission factor of one tonne of hot metal production under the project scenario (t CO_2e/ t of hot metal)[18]
$\%C_{PJ,i}$	=	Carbon content in percent of reducing agent *i* (e.g. coal coke, charcoal, etc.) used in the project scenario. It is equal to zero for renewable charcoal.
$RA_{PJ\ i}$	=	Reducing agent type *i* (e.g. coal coke, charcoal, etc.) required to produce one tonne of hot metal (tonne of reducing agent/ tonne of hot metal)
$\left(\frac{44}{12}\right)$	=	Conversion factor from carbon to CO_2e (dimensionless)
i	=	Type of reducing agent *i* (e.g. coal coke, charcoal, etc.)

c. Calculation of carbon fixation factor $Cc_{HM,\,PJ,\,y}$

$$Cc_{HM,\,PJ,\,y} = \frac{\%C_{HM,\,PJ,\,y}}{100} \qquad \textbf{(10)}$$

[17] If no national/local emission factor is publicly available, an IPCC default value can be used.
[18] If no national/local emission factor is publicly available, an IPCC default value can be used.

Where:

$Cc_{HM,PJ,y}$	= Carbon content fixed in hot metal per t of hot metal produced in year *y* (t C/ t of hot metal)[19]
$\%C_{HM,PJ,y}$	= Percentage of carbon in hot metal (%)

As per the guidance of paragraph 59 of the EB 25, priority should be given to the local, regional, national and IPCC defaults values in that order and it is good practice to use UNFCCC GHG Inventory Handbook on the industrial processes sector.

Leakage

The leakage assessment includes procedures to evaluate the change in emissions associated with the primary carbon extraction activity outside the project boundary. In this sense, emissions from activities that are measurable and attributable to the project activity and that occur outside the iron ore reduction system under the project scenario relative to the baseline are taken into account. Information shall be collected and relevant emissions are calculated in order to assess the leakage emissions from the project activity.

The dedicated plantation is considered a fundamental part of the investment decision required to establish a new iron reduction system. owever, leakage emissions of this activity of the primary carbon extraction (dedicated plantations) should only be accounted if the corresponding area is not part of a registered A/R CDM project.

The increased emissions from the displacement of economic activities such as agriculture/non-agricultural purposes, harvest of fuel wood for meeting domestic energy needs, and use of lands as pastures for grazing/fodder collection are taken into account for calculation of leakage associated with production of biomass resources needed for producing charcoal. Steps for leakage assessment are outlined below and methods to calculate the leakage are presented in detail in **Annex 3**.

It should be noted that monitoring tables (including those in sections of data/parameters to be monitored and not monitored) include all the variables contained in the Annex 3.

Leakage associated with the displacement of economic activities of households shall be assessed and if they are identified and attributable to the project activity. In case project plantations are part of a registered CDM AR activity this condition is not applicable to the corresponding areas.

The assessment of leakage emissions under this methodology is carried out considering emissions associated with primary carbon extraction activities, in the project scenario relative to the emissions of the baseline scenario.

$$LK_y = LK_{PJ,Activity\_Disp,y} - LK_{BL,Activity\_Disp,y} \quad \textbf{(11)}$$

[19] Adopting a conservative approach the carbon fixed under the project scenario will be accounted as zero under this proposed new methodology.

Where:

LK_y	=	Annual GHG emissions outside the project boundary; tonnes CO_2-e yr^{-1} in year *y*
$LK_{PJ,Activity\_Disp,y}$	=	Annual project GHG emissions outside the project boundary resulting from displacement of economic activities; tonnes CO_2-e yr^{-1} in year *y*
$LK_{BL,Activity\_Disp,y}$	=	Annual baseline GHG emissions outside the project boundary resulting from displacement of economic activities; tonnes CO_2-e yr^{-1} in year *y*

In order to calculate leakage according to the primary carbon extraction activity, the methodology specifies the steps and parameters for calculation of emissions from activity displacement. The project participant shall apply the following steps in accounting the leakage.

Determination of activity displacement

The steps and procedures for calculating leakage emissions from activity displacement in this methodology are based in the rationale of the approved methodology AR–AM0005.

Activity displacement is expected to occur when the economic activities associated with land uses within the project area and **attributable** to the project activity shift to areas outside the project increasing emissions in areas outside the project boundary. The following steps enable the assessment of activity displacement.

a. No activity displacement

No displacement of activities associated with the project is expected from the project and *LK Activity_ Disp*, *t* = 0 if:

- Project participants shall evaluate the product supplies from the project with those from the baseline scenario to determine the balance between the product supplies of both scenarios. For example, if the primary carbon extraction activities do not affect the amount of products that were produced prior to the project, no activity displacement can be expected to occur as a result of the implementation of the primary carbon extraction activity. Suitable evidence shall be presented at the time of project validation;
- Leakage prevention activities are implemented as part of the project so that activity displacement from the project is prevented. The evidence on the leakage prevention activities implemented in the project shall be presented at the time of project validation;
- Area outside the project serves as temporary (seasonal) substitute to provide the foregone goods from the project;
- Pre-project activities are displaced to the areas outside the project boundary that have lower biomass compared to the areas of the project from which land use activities are displaced as a result of the project. The evidence in this regard should be in the form of official records demonstrating that the areas where economic activities are displaced to have biomass volume equals to or less than the ones identified in the area of the project from which the activity(ies) displacement occurred. In situations other than those described above, activity displacement and land use change is assumed to occur outside the project. The assessment and quantification of such activity displacement shall be undertaken using the methods outlined below.

b. Activity displacement

If the displacement of households or the shifting of pre-project activities results in biomass losses that can be reasonably attributed to the project activity, then emissions from activity displacement occur. The displacement of economic activities from a primary carbon extraction activity to areas outside the project boundary can have potential impacts on the land use in terms of the loss of vegetation due to conversion to other land uses or due to prolonged and unregulated harvest of forest products such as fuelwood. The categories of activities considered under activity displacement are represented below.

- Land use change – conversion of forest land outside the project boundary to agriculture, grazing and other land uses;
- Degradation of biomass resources – from the prolonged harvest of fuelwood.

The detailed steps to calculate leakage emissions from activity displacement are presented in Annex .

Emission Reductions

Emission reductions are calculated as follows.

Upstream emissions are to be counted in the emission reduction calculation only in case the project upstream emissions are higher than the baseline upstream emissions.

Despite the interdependency among the components of the iron ore reduction system, the differences in the total estimation of upstream emissions (production of reducing agents) in the baseline and upstream emissions in the project shall be accounted as zero if these emissions in baseline are higher than those of the project.[20] Thus only emissions reductions based on the use of renewable reducing agents in the iron ore reduction facility will generate CERs.

$$\mathrm{ER}_{\mathrm{y}} = \mathrm{BE}_{\mathrm{y}} - \mathrm{PE}_{\mathrm{y}} - \mathrm{LE}_{\mathrm{y}} - MAX\ (0, RAE_{BL,y} - RAE_{PJ,y}) \qquad \textbf{(12)}$$

Where:

ER_y	=	Emission reductions in year *y* (t CO_2e/yr)
BE_y	=	Baseline emissions in year *y* (t CO_2e/yr)
PE_y	=	Project emissions in year *y* (t CO_2/yr)
LE_y	=	Leakage emissions in year *y* (t CO_2/yr)
$RAE_{BL,y}$	=	*Baseline upstream* emissions in the reducing agent supply in year *y* (tCO_2e)
$RAE_{PJ,y}$	=	*Project* upstream emissions associated with production of reducing agents and transport in year *y* in the project scenario (tCO_2e)

Changes required for methodology implementation in 2nd and 3rd crediting periods

Not applicable.

[20] This provision does not affect the claiming of tCERs or lCERs due to net GHG removals attributable to the additional plantation stocks within specific A/R project activities (as per EB 20 guidance).

Data and parameters not monitored

In addition to the parameters listed in the tables below, the provisions on data and parameters not monitored in the tools referred to in this methodology apply.

Parameter:	$\%C_{BL,i}$
Data unit:	%
Description:	Carbon content in percent of in the non-renewable reducing agent *i* in the baseline scenario
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	N/A
Any comment:	The carbon content of renewable reducing agent shall be considered zero as this carbon is neutral due to its renewable biomass dedicated plantations origin.

Parameter:	$RA_{BL,i}$
Data unit:	tonne of reducing agent/ tonne of hot metal
Description:	Reducing agent type *i* (i.e. coal coke) required to produce one tonne of hot metal
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	N/A
Any comment:	

Parameter:	$EF_{vf,BL}$
Data unit:	kg CO_2 litre^{-1}
Description:	Emission factor for vehicle type *v* with fuel type *f* in the baseline scenario
Source of data:	The following data sources may be used if the relevant conditions apply: **Data source** — **Conditions for using the data source** a) Values provided by the fuel supplier in invoices; — This is the preferred source b) Measurements by the project participants; — If a) is not available. c) Regional or national default values; — If a) is not available These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances) d) IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter 1 of Vol.2 (Energy) of 2006 IPCC Guidelines on National GHG Inventories. — If a) is not available
Measurement procedures (if any):	For a) and b): Measurements should be undertaken in line with national or international standards. For a): If the fuel supplier does provide the NCV value and the CO2 emissions factor on the invoice and these two values are based on measurements for this specific fuel, the CO2 factor should be used. If option a) is not available then options b), c) or d) should be used
Any comment:	

Parameter:	$n_{vf,BL,y}$
Data unit:	Unit numbers
Description:	Number of vehicles type *v* with fuel type *f* in year *y* in the baseline scenario
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	N/A
Any comment:	

Parameter:	$k_{vf,BL,y}$
Data unit:	km per year *y*
Description:	Kilometers travelled by each of vehicle type *v* with fuel type *f* in the baseline scenario
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	N/A
Any comment:	

Parameter:	$e_{vf,BL}$
Data unit:	Litre/km
Description:	Average fuel consumption of vehicle type *v* with fuel type *f* in the baseline scenario
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	N/A
Any comment:	

Parameter:	v_{BL}
Data unit:	Unit numbers
Description:	vehicle type in the baseline scenario
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	N/A
Any comment:	

Parameter:	f_{BL}
Data unit:	Unit numbers
Description:	fuel type in the baseline scenario
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	N/A
Any comment:	

<table>
<tr><td>Parameter:</td><td>$F_{BL, machine, y}$</td></tr>
<tr><td>Data unit:</td><td>tCO_2/t Coal</td></tr>
<tr><td>Description:</td><td>GHG emissions from fossil fuel consumption due to the coal mining machinery in the baseline scenario during year y</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>a) Values provided by the fuel supplier in invoices;</td><td>This is the preferred source</td></tr>
<tr><td>b) Measurements by the project participants;</td><td>If a) is not available.</td></tr>
<tr><td>c) Regional or national default values;</td><td>If a) is not available
These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)</td></tr>
<tr><td>d) IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter 1 of Vol.2 (Energy) of 2006 IPCC Guidelines on National GHG Inventories.</td><td>If a) is not available</td></tr>
</table></td></tr>
<tr><td>Measurement procedures (if any):</td><td>For a) and b): Measurements should be undertaken in line with national or international standards.
For a): If the fuel supplier does provide the NCV value and the CO2 emissions factor on the invoice and these two values are based on measurements for this specific fuel, the CO2 factor should be used. If option a) is not available then options b), c) or d) should be used</td></tr>
<tr><td>Any comment:</td><td>Use the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” to estimate this factor. One time value based on conservative minimum consumption of electricity can be used to determine the annual electricity consumption. The data on coal has to be collected from actual data of mines.</td></tr>
</table>

Parameter:	$E_{BL, machine, y}$
Data unit:	tCO_2/t Coal
Description:	GHG emissions from electricity consumption due to the coal mining machinery in the baseline scenario during year *y*
Source of data:	Use the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” to estimate this factor. One time value based on minimum consumption of electricity can be used to determine the annual electricity consumption. The data on coal has to be collected from actual data of mines**.** Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	N/A
Any comment:	

Parameter:	$F_{BL, fugitive, y}$
Data unit:	tCO_2 (e)/t Coal
Description:	CH_4 fugitive emissions due to the coal mining activity in the baseline scenario during year *y*
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	N/A
Any comment:	Use Methane GWP factor of 21 to covert CH_4 emissions to CO_2 emissions.

Parameter:	$E_{BL, clean, y}$
Data unit:	tCO_2/t Coal
Description:	Electricity consumption GHG emissions due to the coal cleaning activities in the baseline scenario during year *y*
Source of data:	Use the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” to estimate this factor. One time value based on conservative minimum consumption of electricity can be used to determine the annual electricity consumption. The data on coal has to be collected from actual data of mines**.** Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	N/A
Any comment:	N/A

Parameter:	$E_{BL, Am, y}$
Data unit:	tCO_2/t Coal
Description:	GHG emissions due to the use of ammonium nitrate and mine reclamation activities in the baseline scenario during year *y*
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	N/A
Any comment:	N/A

Parameter:	$N_{V, BL,y}$
Data unit:	Unit numbers
Description:	Number of round trips (to and from) per type *v* of vehicle had during the year *y* in the baseline scenario
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	Estimated
Any comment:	Monitoring number of round trips per vehicle type *v* in year *y*

Parameter:	$AVD_{i, BL,y}$
Data unit:	KM
Description:	Average round trip distance (to and from) between the biomass *v* production site (s) and the site of plantation during the year *y* in the baseline scenario (km);
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	Estimated
Any comment:	

Parameter:	$AVD_{j, BL,y}$
Data unit:	KM
Description:	Average round trip distance (to and from) between the reducing agent type *v* production site (s) and the site of the iron ore reduction facility in the baseline scenario during the year *y*
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	Estimated
Any comment:	

Parameter:	$EF_{v, km,CO2, BL,y}$
Data unit:	tCO_2/km
Description:	CO_2 emission factor for the type *v* of vehicle during the year *y* in the baseline scenario
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	N/A
Any comment:	

Parameter:	$EF_{CO2e, coal\ coke, BL,y}$
Data unit:	t CO_2e/ t of Coal coke
Description:	Emission factor to produce one tonne of coal coke in the baseline scenario
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	Estimated
Any comment:	

Parameter:	$BE_{BB,y}$
Data unit:	tCO_2e/yr
Description:	Baseline emissions arising from field burning of biomass at the plantation site
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	N/A
Any comment:	N/A

Parameter:	$CSP_{diesel,BL,y}$
Data unit:	litre
Description:	Volume of diesel consumption in the baseline scenario
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	Estimated and/or calculated
Any comment:	Either diesel consumption per unit area for site preparation, or per unit volume harvested

Parameter:	$CSP_{gasoline,BL,y}$
Data unit:	litre
Description:	Volume of gasoline consumption in the baseline scenario
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	Estimated and/or calculated
Any comment:	Either gasoline consumption per unit area for site preparation, or per unit volume harvested

Parameter:	$EF_{diesel,BL}$, $EF_{gasoline,BL}$
Data unit:	Kg $CO_{2\text{-}e}$ l^{-1}
Description:	Emission factor for road transportation (diesel and gasoline) in the baseline scenario
Source of data:	GPG 2000, IPCC Guidelines
Measurement procedures (if any):	Estimated
Any comment:	

Parameter:	$EF_{BL,i}$
Data unit:	N_2O N-input^{-1}
Description:	Emission factor for emission from N inputs in the baseline scenario
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	N/A
Any comment:	

Parameter:	GWP_{N2O}
Data unit:	tCO_2e/tN_2O
Description:	Global Warming Potential of nitrous oxide valid for the commitment period
Source of data:	IPCC
Measurement procedures (if any):	N/A
Any comment:	N/A

Parameter:	$N_{SF-Fert,BL,y}$
Data unit:	kg N ha^{-1} yr^{-1}
Description:	Annual amount of synthetic fertilizer nitrogen applied in the baseline scenario
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	Estimated and/or calculated
Any comment:	For different tree species and/or management intensity.

Parameter:	$FRAC_{GASF,BL}$
Data unit:	Ratio
Description:	Fraction that volatilizes as NH_3 and NO_X for synthetic fertilizers in the baseline scenario
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	N/A
Any comment:	N/A

Parameter:	$N_{ON-Fert,BL,y}$
Data unit:	kg N ha^{-1} yr^{-1}
Description:	Annual amount of organic fertilizer nitrogen applied
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	Estimated and/or calculated
Any comment:	For different tree species and/or management intensity.

Parameter:	$FRAC_{GASM,BL}$
Data unit:	Ratio
Description:	Fraction that volatilizes as NH_3 and NO_X for organic fertilizers in the baseline scenario
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance
Measurement procedures (if any):	N/A
Any comment:	N/A

Parameter:	$EF_{CH4,\ charcoal,BL,\ y}$
Data unit:	tCH_4 / t of charcoal
Description:	Emission Factor to produce one tonne of renewable charcoal identified in the baseline scenario
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	N/A
Any comment:	N/A

Parameter:	$F_{BL, charcoal}$
Data unit:	t charcoal/t of hot metal
Description:	Quantity of charcoal necessary to produce one tonne of hot metal in the baseline scenario
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	N/A
Any comment:	N/A

Parameter:	GWP_{CH4}
Data unit:	(tCO_{2e}/tCH_4)
Description:	Global warming potential of methane valid for the commitment period
Source of data:	IPCC 2006 guidelines
Measurement procedures (if any):	N/A
Any comment:	N/A

Parameter:	Y_{BL}
Data unit:	t charcoal/ t wood on dry basis
Description:	Carbonization gravimetric yield in the baseline scenario
Source of data:	Refer to Baseline Emissions section, item 4.0 for applicable guidance.
Measurement procedures (if any):	N/A
Any comment:	

Data / Parameter:	kWh_{BL}
Data unit:	KiloWatt
Description:	Electricity generation from blast furnace recovered gas in the baseline scenario
Source of data:	Measuring device
Measurement procedures (if any):	Check the measuring device for power generation and consumption
Any comment:	Data collected from internal sources of an average of minimum 3 years of electricity generation. Measurement occurs continuously.

Data / Parameter:	$EF_{diesel,PJ}$, $EF_{gasoline,PJ}$
Data unit:	Kg CO_{2-e} l^{-1}
Description:	Emission factor for road transportation (diesel and gasoline) in the project scenario
Source of data:	GPG 2000, IPCC Guidelines
Measurement procedures (if any):	Estimated
Any comment:	N/A

Data / Parameter:	C_F
Data unit:	Dimensionless
Description:	Combustion factor, accounting for the proportion of fuel that is actually burnt
Source of data:	Based on IPCC/public available data
Measurement procedures (if any):	N/A
Monitoring frequency:	Every seven years
QA/QC procedures:	N/A
Any comment:	N/A

Data / Parameter:	$EF_{N2O,BB}$
Data unit:	tN_2O/tonne of dry matter
Description:	N_2O emission factor for field burning of biomass
Source of data:	GPG 2006; IPCC Guidelines; Public reliable references
Measurement procedures (if any):	N/A
Any comment:	N/A

Data / Parameter:	$EF_{CH4,BB}$
Data unit:	tCH_4/tonne of dry matter
Description:	CH_4 emission factor for field burning of biomass
Source of data:	GPG 2006; IPCC Guidelines; Public reliable references
Measurement procedures (if any):	N/A
Any comment:	National or local value has the priority.

Data / Parameter:	$EF_{PJ,i}$
Data unit:	tonnes N_2O-N (tonnes N input)$^{-1}$
Description:	Emission factor for emissions from N inputs in the project scenario
Source of data:	GPG 2000, GPG for LULUCF IPCC Guidelines, national GHG inventory
Measurement procedures (if any):	N/A
Any comment:	IPCC default value (1.25%) should be used if no appropriate data is available

Data / Parameter:	FRACGASF,PJ
Data unit:	ratio
Description:	Fraction that volatilises as NH3 and NOX for synthetic fertilizers in the project scenario
Source of data:	GPG 2000, GPG for LULUCF, IPCC national GHG inventory
Measurement procedures (if any):	N/A
Any comment:	N/A

Data / Parameter:	FRACGASM,PJ
Data unit:	Ratio
Description:	Fraction that volatilises as NH3 and NOX for organic fertilizers in the project scenario
Source of data:	GPG 2000, GPG for LULUCF, IPCC national GHG inventory
Measurement procedures (if any):	N/A
Monitoring frequency:	Every seven years
QA/QC procedures:	N/A
Any comment:	N/A

<table>
<tr><td>Data / Parameter:</td><td>$EF_{vf,PJ}$</td></tr>
<tr><td>Data unit:</td><td>kg CO2/litre</td></tr>
<tr><td>Description:</td><td>Emission factor for vehicle type v with fuel type f in the project scenario</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>a) Values provided by the fuel supplier in invoices;</td><td>This is the preferred source</td></tr>
<tr><td>b) Measurements by the project participants;</td><td>If a) is not available.</td></tr>
<tr><td>c) Regional or national default values;</td><td>If a) is not available

These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)</td></tr>
<tr><td>d) GPG 2000
or

IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter 1 of Vol.2 (Energy) of 2006 IPCC Guidelines on National GHG Inventories.</td><td>If a) is not available</td></tr>
</table></td></tr>
<tr><td>Measurement procedures (if any):</td><td>For a) and b): Measurements should be undertaken in line with national or international standards.
For a): If the fuel supplier does provide the NCV value and the CO2 emissions factor on the invoice and these two values are based on measurements for this specific fuel, the CO2 factor should be used. If option a) is not available then options b), c) or d) should be used</td></tr>
<tr><td>Any comment:</td><td></td></tr>
</table>

Data / Parameter:	$EF_{v, km,CO2, PJ,y}$
Data unit:	tCO2/km
Description:	CO2 emission factor for the type v of vehicle during the year y in the project scenario
Source of data:	Project monitoring data
Measurement procedures (if any):	IPCC 2006
Any comment:	

Data / Parameter:	*CF*
Data unit:	tonnes C (tonne d.m.)-1
Description:	Carbon fraction of dry biomass
Source of data:	IPCC default
Measurement procedures (if any):	N/A
Any comment:	

III. MONITORING METHODOLOGY

Monitoring procedures

All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period. 100% of the data should be monitored if not indicated otherwise in the tables below. ll measurements should be conducted with calibrated measurement equipment according to relevant industry standards.

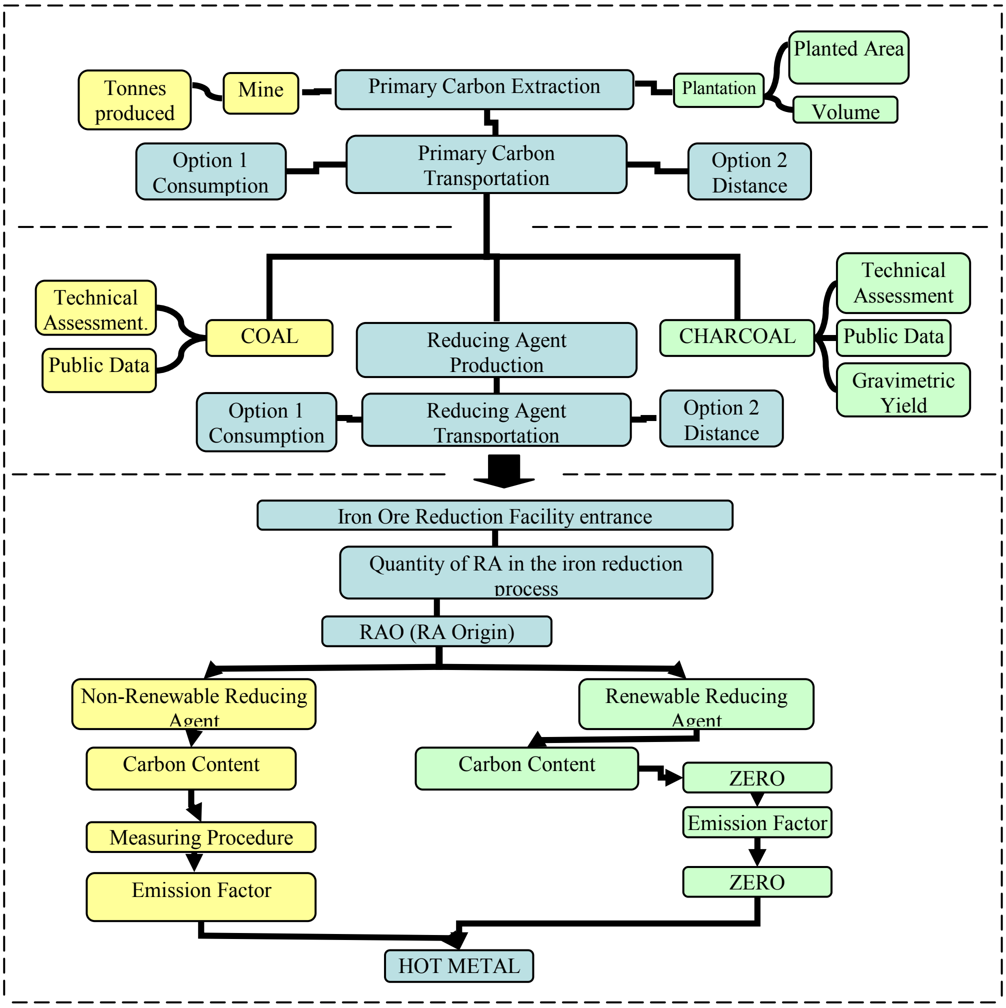
In addition, the monitoring methodology outlines the steps and procedures of monitoring, data collection, storage and reporting on the project throughout the crediting period and provides guidance in the implementation of the monitoring plan in order to transparently calculate the emissions associated with the project.

The monitoring of annual iron ore reduction under project activities facilitates the calculation of the emissions and emission reductions achieved under the project. The data to be collected in the project monitoring outlined below and the procedures to be followed in collecting the data shall be presented in the monitoring plan of the project.

1. onitoring of project emissions parameters

As explained in Section 1 the project boundary encompasses two interdependent components of the iron ore reduction system: reducing agent supplies and industrial iron ore reduction facility. The following chart (**Figure 4**) provides the steps required to monitor and calculate the project emissions of the new iron ore reduction system.

Figure 2: Monitoring and calculating project emissions of the new iron ore reduction system



1.1. Monitoring of project reducing agents component emissions parameters

The emissions identified shall be monitored annually and applied to the emissions reduction calculations. he project participant shall demonstrate a transparent and conservative estimation of leakage emissions in the project scenario and the baseline scenario. he annual monitoring can be neglected; either by applying zero or the most conservative data is adopted if the higher emissions are identified in the baseline relative to the project are transparently demonstrated.

1.1.1. Data on transportation variables of primary carbon sources to be monitored

Option 1: Emissions from transport of primary carbon sources (biomass and/or coal) to the reducing agents production sites based on fuel consumption of vehicles

- Number of vehicles (per type and type of fuel used);
- Distance from the primary carbon extraction site to the reducing agent production site;

- Type of vehicle and fuel used to transport the reducing agent (e.g diesel);
- Fossil fuel consumption to transport the primary carbon source to the reducing agent production site (quantity of fossil fuel used in the transportation);
- Emission factor per type of vehicles and type of fuel used.

Option 2: Emissions from transport based on distance traveled by vehicles

- Number of round trips per type of vehicle;
- Average round trip distance from the primary carbon extraction site to the reducing agent production site;
- Emission factor per type of vehicle.

1.1.2. Data on reducing agents production emissions to be monitored (carbonization and coal distillation)

a. Carbonization

- Gravimetric yield as per AM0041;
- Helium tracing as per provisions of the most recent version of the Annex 1 of approved small scale methodology III.K.

b. Coal Coke production

- Technology assessment.

1.1.3. Data on transportation variables of reducing agents to be monitored

Option 1: Emissions from transport of reducing agents (charcoal and/or coal coke) to the iron ore reduction facility based on fuel consumption of vehicles

- Number of vehicles (per type and type of fuel used);
- Distance from the reducing agent production site to the iron reduction facility;
- Type of vehicle and fuel used to transport the reducing agent (e.g diesel);
- Fossil fuel consumption to transport the reducing agent from its production site to the iron ore facility (quantity of fossil fuel used in the transportation);
- Emission factor per type of vehicles and type of fuel used.

Option 2: Emissions from transport based on distance traveled by vehicles

- Number of round trips per type of vehicle;
- Average round trip distance from the reducing agent production site to the iron reduction facility;
- Emission factor per type of vehicle.

1.2. Data on variables to be monitored at the entrance of the iron ore reduction facility (reduction process component)

- Fuel/Reducing agent consumption (quantity of reducing agent used in the iron ore reduction process);
- Fuel/Reducing agent origin (e.g fossil or renewable);

- Fuel/Reducing agent carbon content:

    - Renewable reducing agents (renewable charcoal): As the use of charcoal from renewable biomass is carbon neutral, the monitoring of the reducing agent's carbon content is not required under this methodology in the project activity scenario;
    - Non-renewable reducing agents (i.e. coal coke): In case where there is partial use of renewable reducing agents in the project activity, the carbon content of the non-renewable reducing agents shall be collected at regular intervals to accurately track the reducing agent. Therefore the project entity shall design a monitoring procedure to assure QA/QC.

1.2.1 Data on variables to be monitored at the end of the iron ore reduction process

- Hot metal amount produced in the iron ore reduction process;
- Hot metal carbon content.

All the variables described above result in the total global project emissions.

2. Monitoring of leakage emissions parameters

The leakage emissions identified shall be monitored annually and applied to the emissions reduction calculations. he project participant shall demonstrate transparent and conservative estimation of leakage emissions in the project scenario and the baseline scenario.

Data on activity displacement emissions to be monitored

- Vegetation suppression and land use change to agriculture and/or other land uses;
- Fuel wood collection.

Under this methodology if there are any activity displacement identified in the baseline scenario that occurs outside the national boundaries those emissions shall be account as zero applying a conservative approach.

Quality assurance and quality control procedures

The monitoring and collection of data shall follow standard operational procedures. hese standard operating procedures have to take the national and international standards into account, wherever required. he data collected should be archived electronically and be kept at least for 2 years after the end of the last crediting period.

Data and parameters monitored

Data / Parameter:	$P_{PJ,y}$
Data unit:	Tonnes of Hot Metal (t)
Description:	Hot metal production in project scenario in year *y* (expected hot metal production of the new iron ore reduction system)
Source of data:	Iron reduction facility operation
Measurement procedures (if any):	Total production is weighted
Monitoring frequency:	Measured daily, aggregated annually
QA/QC procedures:	100% of the total iron ore reduction facility shall be weighted
Any comment:	N/A

Data / Parameter:	$\%C_{PJ,i}$
Data unit:	%
Description:	Carbon content of the non-renewable reducing agent *i*, in percent
Source of data:	Project monitoring data
Measurement procedures (if any):	Sample measurement shall be done using representative statistical calculations
Monitoring frequency:	Measured monthly, averaged annually
QA/QC procedures:	Standard Operating procedures (SOPs) including procedures of regular calibration of measuring equipment shall be applied
Any comment:	The carbon content of renewable reducing agent shall be considered zero as this carbon is neutral due to its renewable biomass dedicated plantations origin

Data / Parameter:	$RA_{PJ,i}$
Data unit:	tonne of reducing agent/ tonne of hot metal
Description:	Non-renewable reducing agent type *i* (e.g. coal coke, coal, etc) requirement to produce one tonne of hot metal in the project scenario
Source of data:	Project monitoring data
Measurement procedures (if any):	Actual consumption of reducing agent will be measured, by appropriate methods
Monitoring frequency:	Measured monthly, averaged annually
QA/QC procedures:	Standard Operating procedures (SOPs) including procedures of regular calibration of measuring equipment shall be applied
Any comment:	N/A

Data / Parameter:	$\%C_{HM,PJ,y}$
Data unit:	%
Description:	Percentage of carbon in hot metal
Source of data:	Iron reduction facility operation
Measurement procedures (if any):	Sample measurement shall be done using representative statistical calculations
Monitoring frequency:	Measured monthly, averaged annually
QA/QC procedures:	Standard Operating procedures (SOPs) including procedures of regular calibration of measuring equipment shall be applied
Any comment:	The carbon content of the pig iron produced with renewable charcoal only will always be considered zero

Data / Parameter:	$CSP_{diesel,PJ,y}$
Data unit:	litre
Description:	Volume of diesel consumption in the project scenario in year *y*
Source of data:	On-site Monitoring
Measurement procedures (if any):	N/A
Monitoring frequency:	Measured daily, aggregated annually.
QA/QC procedures:	Standard Operating procedures (SOPs) including procedures of regular calibration of measuring equipment shall be applied
Any comment:	Monitoring either diesel consumption per unit area for site preparation, or per unit volume harvested

Data / Parameter:	$CSP_{gasoline,PJ,y}$
Data unit:	litre
Description:	Volume of gasoline consumption in the project scenario in year *y*
Source of data:	On-site Monitoring
Measurement procedures (if any):	N/A
Monitoring frequency:	Measured daily, aggregated annually
QA/QC procedures:	Calculations must be performed in accordance with applicable formulae
Any comment:	Monitoring either gasoline consumption per unit area for site preparation, or per unit volume harvested

Data / Parameter:	A_B
Data unit:	ha
Description:	Area burned
Source of data:	Project monitoring data
Measurement procedures (if any):	Measured during implementation, if practiced
Monitoring frequency:	As and when event take place
QA/QC procedures:	Good practice on Inventory system may be applied
Any comment:	

Data / Parameter:	M_B
Data unit:	t dry matter/ha
Description:	Average mass of biomass available for burning on the area
Source of data:	Project monitoring data
Measurement procedures (if any):	Estimated during implementation, if practiced
Monitoring frequency:	N/A
QA/QC procedures:	N/A
Any comment:	

Data / Parameter:	$N_{SF-Fert,PJ,y}$
Data unit:	t N ha^{-1} yr^{-1}
Description:	Annual amount of synthetic fertilizer nitrogen applied in the project scenario
Source of data:	Project monitoring data
Measurement procedures (if any):	N/A
Monitoring frequency:	Monthly/Annual
QA/QC procedures:	Calculations must be performed in accordance with applicable formulae
Any comment:	For different tree species and/or management intensity

Data / Parameter:	$N_{ON-Fert,PJ,y}$
Data unit:	t N ha^{-1} yr^{-1}
Description:	Annual amount of organic fertilizer nitrogen applied in the project scenario
Source of data:	Project monitoring data
Measurement procedures (if any):	N/A
Monitoring frequency:	Annual
QA/QC procedures:	Calculations must be performed in accordance with applicable formulae
Any comment:	For different tree species and/or management intensity

Data / Parameter:	v_{PJ}
Data unit:	Unit numbers
Description:	vehicle type in the project scenario
Source of data:	Project monitoring data
Measurement procedures (if any):	Monitoring each vehicle type
Monitoring frequency:	Continuously
QA/QC procedures:	N/A
Any comment:	

Data / Parameter:	f_{PJ}
Data unit:	Unit numbers
Description:	fuel type in the project scenario
Source of data:	Project monitoring data
Measurement procedures (if any):	Monitoring each fuel type
Monitoring frequency:	Continuously
QA/QC procedures:	N/A
Any comment:	

Data / Parameter:	$n_{vf,PJ,y}$
Data unit:	Unit numbers
Description:	Number of vehicles type *v* with fuel type *f* in year *y* in the project scenario
Source of data:	Project monitoring data
Measurement procedures (if any):	N/A
Monitoring frequency:	Continuously
QA/QC procedures:	Data to be verified from project records
Any comment:	Monitoring number of each vehicle type used

Data / Parameter:	$k_{vf,PJ,y}$
Data unit:	km in year *y*
Description:	Distance travelled by each of vehicle type *v* with fuel type *f* in the project scenario
Source of data:	Project monitoring data
Measurement procedures (if any):	N/A
Monitoring frequency:	Continuously
QA/QC procedures:	Data to be verified from project records
Any comment:	Monitoring kilometers for each of vehicle type *V* with fuel type *F*

Data / Parameter:	$e_{vf,PJ}$
Data unit:	Litre/km
Description:	Average fuel consumption of vehicle type *v* with fuel type *f* in the project scenario
Source of data:	Local/ national/ IPCC
Measurement procedures (if any):	N/A
Monitoring frequency:	Continuously
QA/QC procedures:	
Any comment:	Local and regional value has the priority

Data / Parameter:	$N_{V,PJ,y}$
Data unit:	Unit numbers
Description:	Number of round trips (from and to) per type *V* of vehicles during the year *y* in the project scenario
Source of data:	Project monitoring data
Measurement procedures (if any):	Monitoring number of round trips per vehicle type *V* in year *y*
Monitoring frequency:	Annual
QA/QC procedures:	N/A
Any comment:	

Data / Parameter:	$AVD_{i, PJ,y}$
Data unit:	KM
Description:	Average of round trips (from and to) distance between the reducing agent type *i* production site (s) and the site of the project activity during the year *y*
Source of data:	Project monitoring data
Measurement procedures (if any):	Weighted average based on the distances defined on Official records and Road Maps data
Monitoring frequency:	Annual
QA/QC procedures:	N/A
Any comment:	

Data / Parameter:	$EF_{CH4, charcoal, PJ,y}$
Data unit:	t CH_4 / t of charcoal
Description:	Emission Factor to produce one tonne of renewable charcoal identified in the project supply chain
Source of data:	Project supply chain
Measurement procedures (if any):	Estimated based on the data monitored from the reducing agent supply operation to the iron ore reduction facility or based in the reliable data
Monitoring frequency:	Annual
QA/QC procedures:	
Any comment:	Local and regional value has the priority

Data / Parameter:	$F_{PJ , charcoal}$
Data unit:	Tonne of charcoal / tonne of hot metal
Description:	Quantity of renewable charcoal to produce one tonne of hot metal in the project scenario
Source of data:	Project operation
Measurement procedures (if any):	Actual data of Blast furnace operation
Monitoring frequency:	Monitored daily, calculated annually
QA/QC procedures:	SOPs
Any comment:	N/A

Data / Parameter:	Y_{PJ}
Data unit:	Tonne of charcoal / tonne of wood on dry basis
Description:	Carbonization gravimetric yield
Source of data:	As per the options provided in the NM
Measurement procedures (if any):	Estimated or adopted as per the procedures provided in the project emissions section of this methodology
Monitoring frequency:	Annual
QA/QC procedures:	
Any comment:	

<table>
<tr><td>Data / Parameter:</td><td>$F_{PJ, machine, y}$</td></tr>
<tr><td>Data unit:</td><td>tCO_2/t Coal</td></tr>
<tr><td>Description:</td><td>GHG emissions from fossil fuel consumption due to the coal mining machinery in the project scenario during year y</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>a) Values provided by the fuel supplier in invoices;</td><td>This is the preferred source</td></tr>
<tr><td>b) Measurements by the project participants;</td><td>If a) is not available.</td></tr>
<tr><td>c) Regional or national default values;</td><td>If a) is not available

These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)</td></tr>
<tr><td>d) IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter 1 of Vol.2 (Energy) of 2006 IPCC Guidelines on National GHG Inventories.</td><td>If a) is not available</td></tr>
</table></td></tr>
<tr><td>Measurement procedures (if any):</td><td>For a) and b): Measurements should be undertaken in line with national or international standards.
For a): If the fuel supplier does provide the NCV value and the CO2 emissions factor on the invoice and these two values are based on measurements for this specific fuel, the CO2 factor should be used. If option a) is not available then options b), c) or d) should be used</td></tr>
<tr><td>Monitoring frequency:</td><td>Measured daily, aggregated annually</td></tr>
<tr><td>QA/QC procedures:</td><td>Standard Operating procedures (SOPs) including procedures of regular calibration of measuring equipment shall be applied</td></tr>
<tr><td>Any comment:</td><td>Use the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" to estimate this factor. One time value based on conservative minimum consumption of electricity can be used to determine the annual electricity consumption. The data on coal has to be collected from actual data of mines.</td></tr>
</table>

Data / Parameter:	$E_{PJ, machine, y}$
Data unit:	tCO_2/t Coal
Description:	GHG emissions from electricity consumption due to the coal mining machinery in the project scenario during year *y*
Source of data:	Project monitoring data.
Measurement procedures (if any):	N/A
Monitoring frequency:	Annual
QA/QC procedures:	Standard Operating procedures (SOPs) including procedures of regular calibration of measuring equipment shall be applied
Any comment:	Use the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” to estimate this factor. One time value based on conservative minimum consumption of electricity can be used to determine the annual electricity consumption. The data on coal has to be collected from actual data of mines

Data / Parameter:	$F_{PJ, fugitive, y}$
Data unit:	tCO_2/t Coal
Description:	CH_4 fugitive emissions due to the coal mining activity in the project scenario during year *y*
Source of data:	Project monitoring data.
Measurement procedures (if any):	N/A
Monitoring frequency:	Annual
QA/QC procedures:	Standard Operating procedures (SOPs) including procedures of regular calibration of measuring equipment shall be applied
Any comment:	N/A

Data / Parameter:	$E_{PJ, clean, y}$
Data unit:	tCO_2/t Coal
Description:	Electricity consumption GHG emissions due to the coal cleaning activities in the project scenario during year *y*
Source of data:	Project monitoring data
Measurement procedures (if any):	N/A
Monitoring frequency:	Annual
QA/QC procedures:	Standard Operating procedures (SOPs) including procedures of regular calibration of measuring equipment shall be applied
Any comment:	Use the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” to estimate this factor. One time value based on conservative minimum consumption of electricity can be used to determine the annual electricity consumption. The data on coal has to be collected from actual data of mines.

Data / Parameter:	$E_{PJ, Am, y}$
Data unit:	tCO_2/t Coal
Description:	GHG emissions due to the use of ammonium nitrate and mine reclamation activities in the project scenario during year *y*
Source of data:	Project monitoring data
Measurement procedures (if any):	N/A
Monitoring frequency:	Annual
QA/QC procedures:	Standard Operating procedures (SOPs) including procedures of regular calibration of measuring equipment shall be applied
Any comment:	N/A

Data / Parameter:	$EF_{CO2e, coal\ coke, PJ, y}$
Data unit:	t CO_2e/ t of Coal coke
Description:	Emission factor to produce one tonne of coal coke in the project scenario supply chain
Source of data:	Project supply chain
Measurement procedures (if any):	Estimated based on the data monitored from the reducing agent supply operation to the iron ore reduction facility or based in the reliable data
Monitoring frequency:	Annual
QA/QC procedures:	SOPs
Any comment:	Local and regional value has the priority

Data / Parameter:	AF_{y_2}, AF_{y_1}
Data unit:	hectares
Description:	Aea of land use at year y_2 and year y_1, respectively
Source of data:	Survey
Measurement procedures (if any):	N/A
Monitoring frequency:	Year 1
QA/QC procedures:	
Any comment:	

Data / Parameter:	nH_r
Data unit:	numeric
Description:	Number of sample households resident in the vicinity of the project
Source of data:	Official sources & survey
Measurement procedures (if any):	N/A
Monitoring frequency:	Year 1
QA/QC procedures:	
Any comment:	Data collected from official sources or surveys

Data / Parameter:	NH_r
Data unit:	number
Description:	Total number of displaced households resident in the vicinity of the project
Source of data:	Official records / survey
Measurement procedures (if any):	N/A
Monitoring frequency:	Year 1
QA/QC procedures:	
Any comment:	Number of households and their activities displaced

Data / Parameter:	B_{LB}
Data unit:	tonnes d.m. ha^{-1}
Description:	living biomass of trees (aboveground and belowground biomass) per ha in the area subject to land use/cover change
Source of data:	Based on public and available data
Measurement procedures (if any):	N/A
Monitoring frequency:	Year 1
QA/QC procedures:	
Any comment:	

Data / Parameter:	CF
Data unit:	tonnes C (tonne d.m.)$^{-1}$
Description:	carbon fraction for biomass in the area subject to land use/cover change
Source of data:	Based on public and available data
Measurement procedures (if any):	N/A
Monitoring frequency:	Year 1
QA/QC procedures:	
Any comment:	

Data / Parameter:	$EF_{all-pools}$
Data unit:	Factor
Description:	Expansion factor (1.2 to 1.5) to convert the carbon stock of living biomass of trees to carbon stock representing all pools depending on vegetation density (low vegetation density areas should use lower end of expansion factor and vice versa)
Source of data:	Project monitoring data.
Measurement procedures (if any):	N/A
Monitoring frequency:	Year 1
QA/QC procedures:	
Any comment:	Expansion factor depends upon the density of vegetation

Data / Parameter:	NH_e
Data unit:	numeric
Description:	Total number of emigrant households
Source of data:	Official records / project data
Measurement procedures (if any):	N/A
Monitoring frequency:	Year 1
QA/QC procedures:	
Any comment:	Surveys and monitoring

Data / Parameter:	FG_y
Data unit:	$m^3\ yr^{-1}$
Description:	annual volume of fuelwood use
Source of data:	Based on public and available data
Measurement procedures (if any):	N/A
Monitoring frequency:	Year 1
QA/QC procedures:	
Any comment:	

Data / Parameter:	D
Data unit:	tonnes d.m. m^{-3}
Description:	basic wood density
Source of data:	Based on public and available data
Measurement procedures (if any):	N/A
Monitoring frequency:	Year 1
QA/QC procedures:	
Any comment:	Local and regional value has the priority.

Data / Parameter:	BEF_2
Data unit:	Factor
Description:	biomass expansion factor for converting volumes of extracted roundwood to total aboveground biomass (including bark)
Source of data:	Project monitoring data
Measurement procedures (if any):	N/A
Monitoring frequency:	Year 1
QA/QC procedures:	
Any comment:	Local and regional value has the priority.

Data / Parameter:	P_y
Data unit:	number of persons in year *y*
Description:	Population of the region
Source of data:	Official sources & survey
Measurement procedures (if any):	N/A
Monitoring frequency:	Year 1
QA/QC procedures:	
Any comment:	Data collected from official sources or surveys

Data / Parameter:	*HS*
Data unit:	number of persons per household
Description:	Average size of resident household;
Source of data:	Official sources & survey
Measurement procedures (if any):	N/A
Monitoring frequency:	Year 1
QA/QC procedures:	
Any comment:	Data collected from official sources or surveys

Data / Parameter:	*FCA*
Data unit:	Ratio
Description:	Proportion of per capita fuelwood consumption from agricultural/ private lands including purchases, to the total per capita annual fuelwood consumption from all sources (estimated from household survey data and scaled between 0 to 1)
Source of data:	Based on public and available data
Measurement procedures (if any):	N/A
Monitoring frequency:	Year 1
QA/QC procedures:	
Any comment:	N/A

Data / Parameter:	*PG*
Data unit:	%
Description:	Annual human population growth
Source of data:	Official sources & survey
Measurement procedures (if any):	N/A
Monitoring frequency:	Year 1
QA/QC procedures:	
Any comment:	Data collected from official sources or surveys

Data / Parameter:	kWh_{PJ}
Data unit:	KiloWatt
Description:	Electricity generation from blast furnace recovered gas in the project scenario
Source of data:	Project monitoring data
Measurement procedures (if any):	Check the measuring device for power generation and consumption
Monitoring frequency:	Annually
QA/QC procedures:	
Any comment:	Data collected from internal sources. Measurement occurs continuously.

Annex 1

Upstream Emissions of the Baseline Scenario

The emissions associated with primary carbon extraction shall be taken into account in the baseline scenario if these emissions occur within the project's national boundaries. Refer to section Baseline Emissions, item 4.0 for applicable guidance on source of data. **The detailed procedure laid out below shall only be applied if the upstream processes are under the control of the project participants**. If the project participants have been operating the baseline iron ore reduction system for a period of time shorter than 3 years before the starting date of the project activity, they shall use the average historical operational data covering the whole historical period which shall not be lower than 1 year. If the project participants have been operating it for a period of time longer than 3 years before the starting date of the project activity, they shall use the average historical operational data of last 3 years of operation prior to the project starting date.

If one or several upstream steps are not under control of the project proponents, the conservative default values applying to the coal mining step and/or to the coke production step provided in Tables 2 and 3 shall be used instead of the detailed calculation.

If a same reductant is used both in the baseline and the project situations, the project proponents shall use the same emission factors for the upstream steps unless they can carefully justify why these values should be different in the two situations.

Taking into account the cost-effectiveness good practices and conservativeness rationale, the project proponent may choose to neglect one or several of the baseline upstream emission sources outlined below.

A1.1 Coal coke reducing agent in the baseline scenario

As baseline scenario involves the use of coal coke as reducing agent in the iron ore reduction system, the primary carbon source extraction shall take into account for GHG emissions attributable to the coal mining activities.

The primary carbon source extraction of the baseline scenario shall be calculated using the following formula:

$$PCE_{BL,y} = CM_{BL,y} \tag{A1.1}$$

Where :

$PCE_{BL,y}$ = Baseline primary carbon source extraction emissions within the reducing agent component (tCO_2e)

$CM_{BL,y}$ = GHG emissions associated with coal mining activities in the baseline scenario during year y (tCO2)

a. Coal mining emissions

Coal extraction activities in either surface or underground mining result in positive GHG emissions associated with:

- Emissions from the operation of mining machinery;
- Fugitive methane emissions from coal mines, and coal cleaning, use of ammonium nitrate and mine reclamation activities;
- Coal transport to the coal coke production sites.

The following procedures shall be considered before applying the calculation of the carbon extraction emissions:

> Identification in terms of mine type, coal extraction technology and its net potential fugitive[21] emissions that can deliver the raw materials in the baseline scenario shall be undertaken by the project proponent. This procedure shall take into account all possible types of mines, methods and technologies of coal extraction in the baseline scenario area to assess attributable GHG emission and potential fugitive emissions in the baseline, per the guidance contained in methodology's baseline emissions section.

Once the most conservative scenario is identified the following equations shall be applied to estimate coal mining emissions.[22]

$$CM_{BL,\ y} = (CM_{BL,\ machine,\ y} + CM_{BL,\ fugitive,\ y}) \bullet RA_{BL,\ i} \bullet P_{PJ,\ y} + CM_{BL,Vehicle,\ y} \qquad \textbf{(A1.2)}$$

Where:

$CM_{BL,y}$	=	GHG emissions due to the coal mining activities in the baseline scenario during year *y* (tCO2)
$CM_{BL,\ machine,\ y}$	=	GHG emissions due to the coal mining machinery in the baseline scenario during year *y* (tCO2/t Coal)
$CM_{BL,\ fugitive,\ y}$	=	Fugitive methane emissions from the coal mines and coal cleaning, use of ammonium nitrate and mine reclamation activities in the baseline scenario during year *y* (tCO2/t Coal)
$CM_{BL,\ vehicle,\ y}$	=	CO_2 emissions from fossil fuel combustion in the vehicles used to transport coal to the coal coke production units within the project boundary (tCO2/yr)
$RA_{BL,\ i}$	=	Quantity of coal coke necessary to produce one tonne of hot metal; (t Coal coke /t of hot metal)
$P_{PJ,\ y}$	=	Hot metal production in year *y* (expected hot metal production of the new iron ore reduction system) (tonnes of hot metal)

b. Emissions from the operation of mining machinery

$$CM_{BL,\ machine,\ y} = F_{BL,\ machine,\ y} + E_{BL,\ machine,\ y} \qquad \textbf{(A1.3)}$$

[21] Treatments of the fugitive emissions in the baseline scenario shall also be accounted in this assessment.

[22] Project proponents that are not actively involved in the coal mining business can choose to ignore the emissions from these activities, as this would be conservative.

Where:

$CM_{BL,\ machine,\ y}$	=	GHG emissions due to the coal mining machinery in the baseline scenario during year y (tCO_2/t Coal)
$F_{BL,\ machine,\ y}$	=	GHG emissions from fossil fuel consumption due to the coal mining machinery in the baseline scenario during year y (tCO_2/t Coal)
$E_{BL,\ machine,\ y}$	=	GHG emissions from electricity consumption due to the coal mining machinery in the baseline scenario during year y (tCO_2/t Coal)

Coal is obtained either by surface mining (or near the surface) or by underground mining, depending on geological conditions.

c. Fugitive methane emissions from coal mines, coal cleaning, ammonium nitrate usage and mine reclamation

The net fugitive methane emissions of the baseline scenario shall be calculated using the following formula:

$$CM_{BL,\,fugitive,\,y} = F_{BL,\,fugitive,\,y} + E_{BL,\,clean,\,y} + E_{BL,\,Am,\,y} \qquad \textbf{(A1.4)}$$

Where:

$CM_{BL,\ fugitive,\ y}$	=	Fugitive methane emissions from the coal mines and coal cleaning, use of ammonium nitrate and mine reclamation activities in the baseline scenario during year y (tCO_2/t Coal)
$F_{BL,\ fugitive,\ y}$	=	CH_4 fugitive emissions due to the coal mining activity in the baseline scenario during year y (tCO_2(e)/t Coal)
$E_{BL,\ clean,\ y}$	=	Electricity consumption GHG emissions due to the coal cleaning activities in the baseline scenario during year y (tCO_2/t Coal)
$E_{BL,\ Am,\ y}$	=	GHG emissions due to the use of ammonium nitrate and mine reclamation activities in the baseline scenario during year y (tCO_2/t Coal)

If the coal mining step is not under the control of the project proponent, the default emission factors for fugitive emissions from mining activities presented in the table below are to be used and other emissions sources from coal mining shall be ignored. These default emission factors may also be used if no coal mining operational data are available.

Table-2: Default emission factors for fugitive CH_4 emissions from coal mining

Default IPCC Emissions Factor (m3 ch4/ tonne of coal)			
Category	Low	High	Average
Underground Mining	10	25	18
Surface Mining	0.3	2	1,2

Source: IPCC, 2006

Unless properly justified, the project proponent shall use the most conservative value (i.e. the lowest emission factor).

c. Coal transport to the coal coke production sites

This emission source shall be ignored if this step is not under the control of the project proponent.

In case the step is under the control of project proponents, following procedure should be adopted.

(a) The project participant should collect data and information on the origin and transportation of coal under the baseline scenario.

In conformity with the guidance on non-eligibility of bunker fuels under the CDM as per the decision of EB 25 (paragraph 25), the GHG emissions associated transportation of coal across the international boundaries are conservatively not accounted under this methodology.

(b) The project participants could choose between two options – based on fuel consumption (option 1) and vehicle type and distance (option 2) to calculate the GHG emissions associated with transportation of reducing agent within the national boundary under the baseline scenario:

Option 1: Baseline emissions from transport based on fuel consumption of vehicles.

Step 1: Information on vehicle type and distance traveled within the project boundary in connection with the coal transportation from its mining sites to the coal coke production unit shall be collected.

Step 2: Country specific emission factors shall be used. In the absence of country specific emissions factors, the IPCC 2000 and the IPCC GPG 2006 guidelines or other reliable sources on the GHG emissions assessment can be used.

Step 3: From the baseline data on vehicle use, and fuel consumed in the transportation of coal within the project boundary, the CO_2 emissions are estimated/ calculated as below, using the bottom up approach described in GPG 2000.

$$CM_{BL,\ Vehicle,\ ,y} = \sum_{v,BL} \sum_{f,BL} \frac{EF_{vf,BL} \bullet FC_{VF,\ BL,\ y}}{1000} \qquad \textbf{(A1.5)}$$

$$FC_{VF,BL\ y} = n_{VF,BL,y} \bullet k_{VF,BL,y} \bullet e_{VF,BL} \qquad \textbf{(A1.6)}$$

Where:

$CM_{BL,\ vehicle,\ y}$	=	CO_2 emissions within the project boundary due to fossil fuel combustion from vehicles used to transport coal to coal coke production unit during year *y* of the baseline scenario; (tCO_2/yr)
$EF_{vf,BL}$	=	Emission factor for vehicle type *v* with fuel type *f* in the baseline scenario (kg CO_2/litre)
$FC_{vf,BL,y}$	=	Consumption of fuel type *f* of vehicle type *v* in the baseline scenario (litres per year *y*)
$n_{vf,BL,y}$	=	Number of vehicles of type *v* with fuel type *f* in year *y* in the baseline scenario
$k_{vf,BL,y}$	=	Distance traveled by each of vehicle type *v* with fuel type *f* in the baseline scenario (km per year *y*)
$e_{vf,BL}$	=	Average fuel consumption of vehicle type *v* with fuel type *f* in the baseline scenario (litres/km)
v_{BL}	=	vehicle type in the baseline scenario
f_{BL}	=	fuel type in the baseline scenario

Option 2: Baseline emissions from transport based on distance traveled by vehicles

The baseline transport emissions are calculated on the basis of the distance and the number of trips (or the average vehicle load).

$$CM_{BL,\ Vehicle,\ y} = N_{v,\ BL,\ y} \bullet AVD_{j,\ BL,\ y} \bullet EF_{v,\ km,\ CO2,\ BL,\ y} \qquad \textbf{(A1.7)}$$

Where:

$CM_{BL,\ vehicle,\ y}$	=	CO_2 emissions within the project boundary due to fossil fuel combustion from vehicles used to transport coal to coal coke production unit during year *y* of the baseline scenario; (tCO_2/yr)
$N_{v,BL,\ y}$	=	Number of round trips (to and from) per type *v* of vehicle had during the year *y* in the baseline scenario
$AVD_{j,BL,y}$	=	Average round trip distance (to and from) between the reducing agent type *v* production site (s) and of the iron ore reduction facility in the baseline scenario during the year *y*
$EF_{v,\ km,\ CO2,BL,\ y}$	=	CO_2 emission factor for the type *v* of vehicle during the year *y* in the baseline scenario (tCO_2/km)

d. Coal coke production

The coal distillation produces coal coke/metallurgical coke and result in both carbon dioxide and methane emissions. These emissions depend on the technology used in the coal coke production and shall be calculated as below.

$$RAP_{BL,\ coal\ coke,\ y} = P_{PJ,\ y} \bullet EF_{CO2e,\ coal\ coke,BL,\ y} \bullet RA_{BL,\ i} \qquad \textbf{(A1.8)}$$

Where:

$RAP_{BL,\ coal\ coke,\ y}$	=	GHG emissions within the project boundary due to production of coal coke used in the iron ore reduction facility in the baseline scenario during year *y*; (tCO_2/yr)
$P_{PJ,\ y}$	=	Hot metal production in year *y* (expected hot metal production of the new iron ore reduction system). (tonnes of hot metal)
$EF_{CO2e,\ coal\ coke,BL,\ y}$	=	Emission factor to produce one tonne of coal coke in the baseline scenario supply chain; (t CO_2e/ t of Coal coke)
$RA_{BL,\ i}$	=	Quantity of coal coke necessary to produce one tonne of hot metal; (t Coal coke /t of hot metal)

The emission factor of the coal coke production activity is directly associated with the type of technology used in the coal distillation process. Under this methodology, the coke oven emission factor accounts emissions associated with the coke oven gas flare (COG), CH_4 and CO_2 leakage emissions from coke oven doors and lids.

If the coal coke production step is not under the control of the project proponent, the default emission factors for emissions from coal coke production presented in the table below are to be used. They may also be used if no coal coke production operational data are available.

Table-3: Default emission factors for fugitive CH_4 and CO_2 emissions from coal coke production (COG)

Emission Bypassed COG (Kg/t of coal)		
	Uncontrolled	Flared
Carbon Dioxide	10.5	390
Methane*	60	0.6
Total CO_2eq	1270.5	402.6

***GWP=21**
Source: EPA, 2007

Unless properly justified, the project proponent shall use the most conservative value (i.e. the lowest emission factor).

A1.2 Mix of reducing agents in baseline scenario

If the baseline scenario involves the use of a mix of renewable and non-renewable reducing agents in the iron ore reduction system: the primary carbon extraction shall take into account the GHG emissions attributable to the respective reducing agents, i.e., emissions associated with coal mining activities and emissions associated with the establishment of plantations. For conservativeness the project proponent shall use the same emission factors for the upstream mineral coal chain for the baseline and project cases.

$$PCE_{BL,y} = CM_{BL,y} + EP_{BL,y} \quad \textbf{(A1.9)}$$

Where:

$PCE_{BL,\ y}$ = Baseline primary carbon source extraction emissions within the reducing agent component (tCO_2e)

$CM_{BL,\ y}$ = GHG emissions due to the coal mining activities in the baseline scenario during year y (tCO_2). The calculation of GHG emissions in the coal mining activities follows the steps outlined in **section A.1** above.

$EP_{BL,\ y}$ = GHG emissions in the establishment of plantations to produce biomass in the baseline scenario during year *y* (tCO_2/t biomass). The emissions associated with the production of biomass are calculated as per the steps outlined for the project scenario under **A.1.3**.

For the situations involving a mix of reducing agents, the emissions associated with the coke oven in the coal coke production and the carbonization process in the charcoal production shall be taken into account as per the procedures below.

$$RAP_{BL,RA,y} = RAP_{BL,coal\,coke,y} + RAP_{BL,charcoal,y} \quad \textbf{(A1.10)}$$

Where:

$RAP_{BL,\ RA,\ y}$ = GHG emissions within the project boundary due to production of reducing agents used in the iron ore reduction facility in the baseline scenario during year *y*; (tCO_2/yr)

$RAP_{BL,\ coal\ coke,\ y}$ = GHG emissions within the project boundary due to production of coal coke used in the iron ore reduction facility in the baseline scenario during year *y*; (tCO_2/yr)

$RAP_{BL,\ charcoal,\ y}$ = GHG emissions within the project boundary due to the production of charcoal used in the iron ore reduction facility in the project operation during year *y*; (tCO2/yr)

To estimate the emissions associated with the production of biomass and charcoal the project proponent shall assess the relevant steps as outlined below.

If the baseline upstream processes associated to the renewable reductant system are not under the control of the project proponent, the project proponent shall use the corresponding emission factors as determined for the project situation.

A.1.3 Emissions in the establishment of plantations and production of biomass

For baseline scenario using reducing agent mix, which involves establishment of plantations for biomass supplies, the relevant emissions of greenhouse gases resulted from fossil fuel combustion, burning of biomass, application of nitrogenous fertilizers and biomass transport to the carbonization units shall be estimated as below.

$$\mathrm{EP}_{\mathrm{BL,y}} = E_{FuelBurn,BL,y} + \mathrm{BE}_{\mathrm{BB,y}} + N_2O_{direct-N_{fertilizer}BL,y} + \mathrm{EP}_{\mathrm{Vehicle,BL,y}} \qquad \textbf{(A1.11)}$$

Where:

$EP_{BL,y}$	=	GHG emissions of the establishment of plantations to produce biomass within the project boundary in the baseline scenario during year *y*; (tCO_2/t biomass)
$E_{FuelBurn,BL,y}$	=	CO_2 emissions from combustion of fossil fuels within the project boundary in the baseline scenario; tonnes CO_2–e yr^{-1} in year *y*
$BE_{BB,y}$	=	Baseline emissions arising from field burning of biomass at the plantation site (tCO_2e/yr)
$N_2O_{direct-N_{fertilizer}BL,y}$	=	N_2O emissions as a result of direct nitrogen application within the project boundary in the baseline scenario; (tonnes CO_2–e yr^{-1} in year *y)*
$EP_{Vehicle,BL,y}$		CO_2 emissions within the project boundary due to fossil fuel combustion from vehicles used to transport biomass to carbonization unit during year *y* of the baseline scenario; (tCO_2/yr)

a. Calculation of CO_2 emissions from burning fossil fuels

Emissions from fossil fuel combustion often occur from the use of machinery in site preparation, thinning, harvest and the use of vehicles within the project plantation site. The IPCC 2006 Guidelines could be used to estimate the CO_2 emissions from combustion of fossil fuels using the equation below.

$$E_{FuelBurn,BL,y} = (CSP_{diesel,BL,y} \bullet EF_{diesel,BL} + CSP_{gasoline,BL,y} \bullet EF_{gasoline,BL}) \bullet 0.001 \qquad \textbf{(A1.12)}$$

Where:

$E_{FuelBurn,BL,y}$	=	Annual CO_2 emissions from combustion of fossil fuels within the project boundary in the baseline scenario in year *y*; tonnes CO_2–e yr^{-1}
$CSP_{diesel,BL,y}$	=	Volume of diesel consumption in the baseline scenario; litre (l)[23] yr^{-1} in year *y*
$CSP_{gasoline,BL,y}$	=	Volume of gasoline consumption in the baseline scenario; litre (l)[24] yr^{-1} in year *y*

[23] The volume of diesel consumed can also be calculated based in the planted area (hectares) and/or volume of wood (m^3).

[24] The volume of gasoline consumed can also be calculated based in the planted area (hectares) and/or volume of wood (m^3).

$EF_{diesel,\ BL}$	= Emission factor for diesel in the baseline scenario; kg CO_2 l^{-1}
$EF_{gasoline,\ BL}$	= Emission factor for gasoline in the baseline scenario; kg CO_2 l^{-1}
0.001	= Conversion from kg to tonnes of CO_2

Project participants should use national CO_2 emission factors. If these are not available default emission factors as provided in the 2006 Revised IPCC Guidelines could be used.

b. Calculation of nitrous oxide emissions from nitrogen fertilization practices

Nitrous oxide emissions from the use of nitrogenous fertilizer application can be estimated using the equations below.

$$N_2O_{direct-N_{fertilizer}BL,y} = \left[\left(F_{SN,BL,y} + F_{ON,BL,y}\right) \bullet EF_{BL,i}\right] \bullet \frac{44}{28} \bullet GWP_{N2O} \quad \textbf{(A1.13)}$$

$$F_{SN,BL,y} = N_{SF-Fert,BL,y} \bullet \left(1 - FRAC_{GASF,BL}\right) \quad \textbf{(A1.14)}$$

$$F_{ON,BL,y} = N_{ON-Fert,BL,y} \bullet \left(1 - FRAC_{GASM,BL}\right) \quad \textbf{(A1.15)}$$

Where:

$N_2O_{direct-N_{fertilizer}\ BL,\ y}$	= N_2O emissions as a result of direct nitrogen application within the project boundary in the baseline scenario; (tonnes CO_2–e yr^{-1} in year *y)*
$F_{SN,BL,\ y}$	= Annual amount of synthetic fertilizer nitrogen applied adjusted for volatilization as NH_3 and NOx in the baseline scenario; tonnes N yr^{-1} in year *y*
$F_{ON,\ BL,y}$	= Annual amount of organic fertilizer nitrogen applied adjusted for volatilization as NH_3 and NOx in the baseline scenario; tonnes N yr^{-1} in year *y*
$N_{SF-Fert,BL,\ y}$	= Annual amount of synthetic fertilizer nitrogen applied in the baseline scenario; tonnes N yr^{-1} in year *y*
$N_{ON-Fert,\ BL,y}$	= Annual amount of organic fertilizer nitrogen applied in the baseline scenario; tonnes N yr^{-1} in year *y*
$EF_{BL,i}$	= Emission factor for emissions from N inputs in the baseline scenario; tonnes N_2O-N (tonnes N input)$^{-1}$
$FRAC_{GASF,BL}$	= Fraction that volatilises as NH_3 and NO_X for synthetic fertilizers in the baseline scenario; ratio
$FRAC_{GASM,BL}$	= Fraction that volatilises as NH_3 and NO_X for organic fertilizers in the baseline scenario; ratio
GWP_{N2O}	= Global warming potential for N_2O (310)
$\frac{44}{28}$	= Ratio of molecular weights of N_2O and nitrogen; dimensionless

As noted in GPG 2000, the default emission factor ($EF_{BL,i}$) is 1.25 % of applied N, and this value should be used when country-specific factors are unavailable. The default values for the fractions of synthetic and organic fertiliser nitrogen that are emitted as NO_X and NH_3 are 0.1 and 0.2, respectively as per 2006 IPCC Guideline. Project participants may use scientifically-established specific emission factors that are more appropriate for their projects. Specific good practice guidance on how to derive specific emission factors is given in Box 4.1 of GPG 2000.

c. Biomass transport to the carbonization sites

The project participant should collect data on the origin and transportation of biomass under the baseline scenario. The project participants could choose between two options to calculate the GHG emissions associated with transportation of biomass - fuel consumption (option 1) or distance –of travel and vehicle type used (Option 2).

Option 1: Baseline emissions from transport based on fuel consumption of vehicles.

Step 1: Information on vehicle type and distance traveled within the project boundary in connection with the biomass transportation from its plantation sites to the carbonization units shall be collected.

Step 2: Country specific emission factors shall be used. In the absence of country specific emissions factors, the IPCC 2000 and the IPCC GPG 2006 guidelines or other reliable sources on the GHG emissions assessment can be used.

Step 3: From the baseline data on vehicle use, and fuel consumed in the transportation of biomass within the project boundary, the CO_2 emissions are estimated/ calculated as below, using the bottom up approach described in GPG 2000.

$$EP_{\text{Vehicle, BL, y}} = \sum_{v,BL} \sum_{f,BL} \frac{EF_{\text{VF, BL}} \bullet FC_{\text{VF, BL, y}}}{1000} \tag{A1.16}$$

$$FC_{\text{VF, BL,y}} = n_{\text{VF,BL, y}} \bullet k_{\text{VF, BL,y}} \bullet e_{\text{VF,BL}} \tag{A1.17}$$

Where:

$EP_{\text{Vehicle, BL, y}}$	=	CO_2 emissions within the project boundary due to fossil fuel combustion from vehicles used to transport biomass to carbonization unit during year *y* of the baseline scenario; (tCO_2/yr)
$EF_{vf,BL}$	=	Emission factor for vehicle type *v* with fuel type *f* in the baseline scenario; (kg CO_2/litre)
$FC_{vf,BL,y}$	=	Consumption of fuel type *f* of vehicle type *v* in the baseline scenario; (litres per year *y*)
$n_{vf,BL,y}$	=	Number of vehicles of type *v* with fuel type *f* in year in the baseline scenario *y*
$k_{vf,BL,y}$	=	Kilometers traveled by each of vehicle type *v* with fuel type *f* in the baseline scenario; (km per year *y*)
$e_{vf,BL}$	=	Average fuel consumption of vehicle type *v* with fuel type *f* in the baseline scenario; (litres/km)
v_{BL}	=	Vehicle type in the baseline scenario
f_{BL}	=	Fuel type in the baseline scenario

Option 2: Baseline emissions from transport based on distance traveled by vehicles.

The baseline transport emissions are calculated on the basis of the distance and the number of trips (or the average vehicle load);

$$EP_{Vehicle,\ BL,\ y} = N_{v,BL,\ y} \bullet AVD_{i,BL,\ y} \bullet EF_{v,\ km,\ CO2,\ BL,\ y} \quad \textbf{(A1.18)}$$

Where:

$EP_{Vehicle,\ BL,\ y}$	=	CO_2 emissions within the project boundary due to fossil fuel combustion from vehicles used to transport biomass to carbonization unit during year *y* of the baseline scenario; (tCO_2/yr)
$N_{v,BL,\ y}$	=	Number of round trips (to and from) per type *v* of vehicle during the year *y* in the baseline scenario
$AVD_{i,BL,y}$	=	Average round trip distance (to and from) between the biomass *v* production site (s) and the site of plantation during the year *y* in the baseline scenario (km)
$EF_{v,\ km,\ CO2,BL,\ y}$	=	CO_2 emission factor for the type *v* of vehicle during the year *y* in the baseline scenario (tCO_2/km)

A.1.3.1 Emissions in the production of charcoal, the renewable reducing agent

In the production of charcoal from renewable biomass in the baseline scenario, the methane (CH_4) emissions could vary depending on the technology used in the carbonization process and the CO_2 emissions are equal to zero because of the renewable nature of the biomass. Therefore, for estimation of CH_4 emissions from carbonization, the use of monitored data shall be mandatory once the GHG emissions rely on the actual operation of the charcoal production.

The methane emissions in carbonization can be calculated as below:

$$RAP_{BL,\ charcoal,\ y} = P_{PJ,\ y} \bullet EF_{CH4,\ charcoal,BL,\ y} \bullet F_{BL,\ charcoal} \bullet GWP_{CH4} \quad \textbf{(A1.19)}$$

Where:

$RAP_{BL,\ charcoal,\ y}$	=	GHG emissions within the project boundary due to the production of charcoal used in the iron ore reduction facility during year *y*; (tCO_2/yr)
$P_{PJ,\ y}$	=	Hot metal production in year *y* (expected hot metal production of the new iron ore reduction system). (tonnes of hot metal)
$EF_{CH4,\ charcoal,BL,\ y}$	=	Emission Factor to produce one tonne of renewable charcoal identified in the project supply chain in the baseline scenario; (tCH_4 / t of charcoal)
$F_{BL,\ charcoal}$	=	Quantity of charcoal necessary to produce one tonne of hot metal in the baseline scenario; (t charcoal/t of hot metal)
GWP_{CH4}	=	Global warming potential for CH_4; (tCO_2e/tCH_4)

The emission factor of CH_4 emissions in the carbonization activity is associated with the type of technology used and in the actual operation of the carbonization process. Project participants could choose between two options. Option 1: calculation of methane emissions based on procedures of AM-0041; option 2: helium tracing as per the most recent version of the Annex 2 of approved small scale methodology III.K

Option 1: Methane emission factor as function of gravimetric yield

Under the provisions of the approved methodology AM0041 "Mitigation of Methane Emissions in the Wood Carbonization Activity for Charcoal Production" the methane emissions of the carbonization process can be estimated based on the best fit statistical relationship between methane emissions and gravimetric yield.

The relation between methane emissions and carbonization gravimetric yield shall be established based on the experimental measurements and statistical analysis. The procedures provided in the AM0041 Appendix 1 and Appendix 2 shall be implemented by an independent third party and the results of the third party analysis shall be recorded by the project participant. The methane emission factor of the carbonization process can be estimated as below:

$$EF_{CH4,\,charcoal,\,BL,y} = f\,(Y_{BL}) \tag{A1.20}$$

Where:

$EF_{CH4,\,charcoal,\,BL,y}$	=	Emission Factor to produce one tonne of renewable charcoal identified in the supply chain in the baseline scenario; (tCH_4 / t of charcoal)
Y_{BL}	=	Carbonization gravimetric yield in the baseline scenario (t charcoal/ t wood on dry basis) (as per the procedure outlined below).

Carbonization gravimetric yield

The assessment of the carbonization gravimetric yield can be reached using data collected as per the measurement protocols presented in the approved methodology AM0041.

Option 2: Methane emission factor using helium tracing methods as per Annex 2 of approved small scale methodology III.K

The carbonization emission factor can be adopted based on the following procedures:

- Brick-based charcoal making process using helium tracing– approach based on Helium tracing, a method widely used in industrial facilities coupled with online gaseous chromatography. ; The project proponent that wishes to apply this procedure shall strictly follows the provisions of the most recent version of the Annex 1 of approved small scale methodology III.K.

Once the above mentioned methods are strictly applied the PP shall then define the emission Factor to produce one tonne of renewable charcoal identified in the supply chain in the baseline scenario.

A.1.3.2 Baseline emissions in the transportation of reducing agent

The project participant should have data and information on the origin and transportation of reducing agents under the baseline scenario. The project participants could choose between two options to calculate the GHG emissions associated with transportation of reducing agents - fuel consumption (option 1) or Option 2: distance –of travel and vehicle type used (option 2).

Option 1: Baseline emissions from transport based on fuel consumption of vehicles

Step 1: Information on vehicle type and distance traveled within the project boundary in connection with the transportation of reducing agent from the production sites to the project activity iron reduction facility shall be collected.

Step 2: Country specific emission factors shall be used. In the absence of country specific emissions factors, the IPCC 2006 and the IPCC GPG 2000 guidelines or other reliable sources on the GHG emissions assessment can be used.

Step 3: From the baseline data on vehicle use, and fuel consumed in the transportation of reducing agents within the project boundary, the CO_2 emissions are estimated/ calculated as below, using the bottom up approach described in GPG 2000.

$$RAT_{Vehicle,\ BL,\ y} = \sum_{v,BL} \sum_{f,BL} \frac{EF_{VF,\ BL} \bullet FC_{VF,\ BL,\ y}}{1000} \quad \textbf{(A1.21)}$$

$$FC_{VF,\ BL,y} = n_{VF,BL,\ y} \bullet k_{VF,\ BL,y} \bullet e_{VF,BL} \quad \textbf{(A1.22)}$$

Where:

$RAT_{Vehicle,\ BL,\ y}$	=	CO_2 emissions within the project boundary due to fossil fuel combustion from vehicles used to transport reducing agent(s) to iron ore reduction facility during year *y* of the baseline scenario; (tCO_2/yr)
$EF_{vf,BL}$	=	Emission factor for vehicle type *v* with fuel type *f* in the baseline scenario; (kg CO_2/litre)
$FC_{vf,BL,y}$	=	Consumption of fuel type *f* of vehicle type *v* in the baseline scenario; (litres per year *y*);
$n_{vf,BL,y}$	=	Number of vehicles of type *v* with fuel type *f* in year *y* in the baseline scenario
$k_{vf,BL,y}$	=	Kilometers traveled by each of vehicle type *v* with fuel type *f* in the baseline scenario; (km per year *y*)
$e_{vf,BL}$	=	Average fuel consumption of vehicle type *v* with fuel type *f* in the baseline scenario; (litres/km)
v_{BL}	=	vehicle type in the baseline scenario
f_{BL}	=	fuel type in the baseline scenario

Option 2: Baseline emissions from transport based on distance traveled by vehicles

The baseline transport emissions are calculated on the basis of distance and the number of trips (or the average vehicle load);

$$RAT_{Vehicle,\ BL} = N_{v,\ BL,\ y} \bullet AVD_{j,\ BL,\ y} \bullet EF_{v,\ km,\ CO2,\ BL,\ y} \quad \textbf{(A1.23)}$$

Where:

$RAT_{Vehicle,\ BL}$	=	CO_2 emissions within the project boundary due to fossil fuel combustion from vehicles to transport reducing agent to iron ore reduction facility in the baseline scenario; (tCO_2/yr)
$N_{v,\ BL,y}$	=	Number of round trips (to and from) per type *v* of vehicle during the year *y* in the baseline scenario
$AVD_{j,BL,\ y}$	=	Average round trip distance (to and from) between the reducing agent type *v* production site (s) and the site of the project activity during the year *y* (km)
$EF_{v,\ km,CO2,\ BL,y}$	=	CO_2 emission factor for the type *v* of vehicle during the year *y* in the baseline scenario (tCO_2/km)

Annex 2

Upstream Emissions of the Project Scenario

The steps to calculate upstream emissions associated with the renewable reducing agent such as establishment of plantation, production of biomass, conversion to charcoal and its transport to iron ore reduction facility are outlined below in this section:

In the project scenario that involves the use of a mix of renewable and fossil fuel reducing agents, the primary carbon extraction shall take into account the GHG emissions attributable to the respective reducing agents, i.e., emissions associated with coal mining activities and emissions associated with the establishment of plantations. The emissions associated with coal mining and coal coke production activities are presented in detail in **A2.2.1 below** should be referred for emissions dealing with fossil fuel reducing agent under the project scenario;

The detailed procedure laid out below shall only be applied if the upstream processes related to the non renewable reductant system are under the control of the project participants. If one or several upstream steps are not under control of the project proponents, the conservative default values applying to the coal mining step and/or to the coke production step provided in tables 4 and 5 shall be used instead of the detailed calculation. Transportation emissions related to the non renewable reductant system may be neglected in this case unless this emission source was considered in the baseline upstream emission calculations.

If a same reductant is used both in the baseline and the project situations, the project proponents shall use the same emission factors for the upstream steps unless they can carefully justify why these values should be different in the two situations.

A.2.1 Emissions in the establishment of plantations and production of biomass

For project scenario, which involves establishment of plantations for biomass supplies, the relevant emissions of greenhouse gases resulted from fossil fuel combustion, burning of biomass, application of nitrogenous fertilizers and biomass transport to the carbonization units shall be estimated as below.

$$\mathrm{EP}_{\mathrm{PJ,\,y}} = E_{FuelBurn,PJ,y} + \mathrm{PE}_{\mathrm{BB,\,y}} + N_2O_{direct-N_{fertilizer},PJ,y} + \mathrm{EP}_{\mathrm{Vehicle,PJ,\,y}} \quad \textbf{(A2.1)}$$

Where:

$\mathrm{EP}_{\mathrm{PJ,\,y}}$	=	GHG emissions of the establishment of plantations to produce biomass in the project scenario during year *y*; (tCO_2/t biomass)
$E_{FuelBurn,PJ,\,y}$	=	CO_2 emissions from combustion of fossil fuels within the project boundary in the project scenario; tonnes CO_2–e yr^{-1} in year *y*
$\mathrm{PE}_{\mathrm{BB,\,y}}$	=	Project emissions arising from field burning of biomass at the plantation site (tCO_2e/yr)
$N_2O_{direct\text{-}N_{fertilizer}\ PJ,\,y}$	=	N_2O emissions as a result of direct nitrogen application within the project boundary in the project scenario; (tonnes CO_2–e yr^{-1} in year *y*)
$\mathrm{EP}_{\mathrm{Vehicle,\,PJ,\,y}}$		CO_2 emissions within the project boundary due to fossil fuel combustion from vehicles used to transport biomass to carbonization unit during year *y* of the project scenario; (tCO_2/yr)

a. Calculation of CO_2 emissions from burning fossil fuels

Emissions from fossil fuel combustion often occur from the use of machinery in site preparation, thinning, harvest and the use of vehicles within the project plantation site. The IPCC 2006 Guidelines could be used to estimate the CO_2 emissions from combustion of fossil fuels using the equation below.

$$E_{FuelBurn,PJ,y} = (CSP_{diesel,PJ,y} \bullet EF_{diesel,PJ} + CSP_{gasoline,PJ,y} \bullet EF_{gasoline,PJ}) \bullet 0.001 \qquad \textbf{(A2.2)}$$

Where:

$E_{FuelBurn,PJ,y}$	=	Annual CO_2 emissions from combustion of fossil fuels within the project boundary in the project scenario in year *y*; tonnes CO_2–e yr^{-1}
$CSP_{dieselPJ,y}$	=	Volume of diesel consumption in the project scenario in year *y*; litre (l)[25] yr^{-1}
$CSP_{gasoline,PJ,y}$	=	Volume of gasoline consumption in the project scenario in year *y*; litre (l)[26] yr^{-1}
$EF_{diesel,PJ}$	=	Emission factor for diesel in the project scenario; kg CO_2 l^{-1}
$EF_{gasoline,PJ}$	=	Emission factor for gasoline in the project scenario; kg CO_2 l^{-1}
0.001	=	Conversion from kg to tonnes of CO_2

Project participants should use national CO_2 emission factors. If these are not available default emission factors as provided in the 2006 Revised IPCC Guidelines could be used.

b. CH_4 and N_2O emissions from the field burning of biomass

Biomass may be burnt at the start of the project activity (for land clearance) or regularly during the crediting period (e.g. after harvest). In these cases, CH_4 and N_2O emissions should be calculated for each time that field burning is occurring, as follows:

$$PE_{BB,\,y} = A_B \cdot M_B \cdot C_F (EF_{N2O,\,BB} \cdot GWP_{N2O} + EF_{CH4,\,BB} \cdot GWP_{CH4}) \qquad \textbf{(A2.3)}$$

Where:

$PE_{BB,\,y}$	=	Project emissions arising from field burning of biomass at the plantation site (tCO_2e/yr)
A_B	=	Area burned (ha)
M_B	=	Average mass of biomass available for burning on the area (t dry matter/ha)
C_F	=	Combustion factor, accounting for the proportion of fuel that is actually burnt (dimensionless)

[25] The volume of diesel consumed can also be calculated based in the planted area (hectares) and/or volume of wood (m^3).

[26] The volume of gasoline consumed can also be calculated based in the planted area (hectares) and/or volume of wood (m^3).

$EF_{N2O, BB}$	= N_2O emission factor for field burning of biomass (tN_2O/tonne of dry matter)
GWP_{N2O}	= Global Warming Potential of nitrous oxide valid for the commitment period (tCO_2e /tN_2O)
$EF_{CH4, BB}$	= CH_4 emission factor for field burning of biomass (tCH_4/tonne of dry matter)
GWP_{CH4}	= Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)

c. Calculation of nitrous oxide emissions from nitrogen fertilization practices

Nitrous oxide emissions from the use of nitrogenous fertilizer application can be estimated using the equations below.

$$N_2O_{direct-N_{fertilizer},PJ,y} = \left[\left(F_{SN,PJ,y} + F_{ON,PJ,y}\right) \bullet EF_{PJ,i}\right] \bullet \frac{44}{28} \bullet GWP_{N2O} \qquad \textbf{(A.2.4)}$$

$$F_{SN,PJ,y} = N_{SF-Fert,PJ,y} \bullet \left(1 - FRAC_{GASF,PJ}\right) \qquad \textbf{(A2.5)}$$

$$F_{ON,PJ,y} = N_{ON-Fert,PJ,y} \bullet \left(1 - FRAC_{GASM,PJ}\right) \qquad \textbf{(A.2.6)}$$

Where:

$N_2O_{direct-N_{fertilizer},PJ,y}$	= N_2O emissions as a result of direct nitrogen application within the project boundary in the project scenario; (tonnes CO_2–e yr^{-1} in year *y)*
$F_{SN, PJ,,y}$	= Annual amount of synthetic fertilizer nitrogen applied adjusted for volatilization as NH_3 and NOx in the project scenario; tonnes N yr^{-1} in year *y*
$F_{ON, PJ,y}$	= Annual amount of organic fertilizer nitrogen applied adjusted for volatilization as NH_3 and NOx in the project scenario; tonnes N yr^{-1} in year *y*
$N_{SF-Fert,PJ, y}$	= Annual amount of synthetic fertilizer nitrogen applied in the project scenario; tonnes N yr^{-1} in year *y*
$N_{ON-Fert,PJ, y}$	= Annual amount of organic fertilizer nitrogen applied in the project scenario; tonnes N yr^{-1} in year *y*
$EF_{PJ,i}$	= Emission factor for emissions from N inputs in the project scenario; tonnes N_2O-N (tonnes N input)$^{-1}$
$FRAC_{GASF,PJ}$	= Fraction that volatilises as NH_3 and NO_X for synthetic fertilizers in the project scenario; ratio
$FRAC_{GASM,PJ}$	= Fraction that volatilises as NH_3 and NO_X for organic fertilizers in the project scenario; ratio
GWP_{N2O}	= Global warming potential for N_2O (310)
$\frac{44}{28}$	= Ratio of molecular weights of N_2O and nitrogen; dimensionless

As noted in GPG 2000, the default emission factor ($EF_{PJ,i}$) is 1.25 % of applied N, and this value should be used when country-specific factors are unavailable. The default values for the fractions of synthetic and organic fertiliser nitrogen that are emitted as NO_X and NH_3 are 0.1 and 0.2, respectively as per 2006 IPCC Guideline. Project participants may use scientifically-established specific emission factors that are more appropriate for their projects. Specific good practice guidance on how to derive specific emission factors is given in Box 4.1 of GPG 2000.

d. Biomass transport to the carbonization sites

The project participant should collect data on the origin and transportation of biomass under the project scenario. The project participants could choose between two options to calculate the GHG emissions associated with transportation of biomass - fuel consumption (option 1) or distance –of travel and vehicle type used (option 2).

Option 1: Project emissions from transport based on fuel consumption of vehicles

Step 1: Information on vehicle type and distance traveled within the project boundary in connection with the biomass transportation from its plantation sites to the carbonization units shall be collected.

Step 2: Country specific emission factors shall be used. In the absence of country specific emissions factors, the IPCC 2000 and the IPCC GPG 2006 guidelines or other reliable sources on the GHG emissions assessment can be used.

Step 3: From the project data on vehicle use, and fuel consumed in the transportation of biomass within the project boundary, the CO_2 emissions are estimated/ calculated as below, using the bottom up approach described in GPG 2000.

$$EP_{Vehicle,\ PJ,\ y} = \sum_{v,PJ} \sum_{f,PJ} \frac{EF_{VF,\ PJ} \bullet FC_{VF,\ PJ,\ y}}{1000} \quad \textbf{(A2.7)}$$

$$FC_{VF,PJ,\ y} = n_{VF,PJ,\ y} \bullet k_{VF,PJ,\ y} \bullet e_{VF,PJ} \quad \textbf{(A2.8)}$$

Where:

$EP_{Vehicle,\ PJ,\ y}$	=	CO_2 emissions within the project boundary due to fossil fuel combustion from vehicles used to transport biomass to carbonization unit during year *y* of the project scenario; (tCO_2/yr)
$EF_{vf,PJ}$	=	Emission factor for vehicle type *v* with fuel type *f* in the project scenario; (kg CO_2/litre)
$FC_{vf,PJ,y}$	=	Consumption of fuel type *f* of vehicle type *v* in the project scenario; (litres per year *y*)
$n_{vf,PJ,y}$	=	Number of vehicles of type *v* with fuel type *f* in year *y* in the project scenario
$k_{vf,PJ,y}$	=	Kilometers traveled by each of vehicle type *v* with fuel type *f* in the project scenario; (km per year *y*)
$e_{vf,PJ}$	=	Average fuel consumption of vehicle type *v* with fuel type *f* in the project scenario; (litres/km)
v_{PJ}	=	Vehicle type in the project scenario
f_{PJ}	=	Fuel type in the project scenario

Option 2: Project emissions from transport based on distance traveled by vehicles.

The project transport emissions are calculated on the basis of the distance and the number of trips (or the average vehicle load);

$$EP_{Vehicle,\ PJ,\ y} = N_{v,\ PJ,\ y} \bullet AVD_{i,\ PJ,\ y} \bullet EF_{v,\ km,\ CO2,\ PJ,\ y} \quad \textbf{(A2.9)}$$

Where:

$EP_{Vehicle, PJ, y}$ = CO_2 emissions within the project boundary due to fossil fuel combustion from vehicles used to transport biomass to carbonization unit during year *y* of the project scenario; (tCO_2/yr)

$N_{v,PJ,y}$ = Number of round trips (to and from) per type *v* of vehicle during the year *y* in the project scenario

$AVD_{i,PJ,y}$ = Average round trip distance (to and from) between the biomass *v* production site (s) and the site of the project plantation during the year *y* (km)

$EF_{,v, km, CO2,PJ, y}$ = CO_2 emission factor for the type *v* of vehicle during the year *y* in the project scenario (tCO_2/km)

A.2.1.2 Emissions in the production of charcoal, the renewable reducing agent

In the production of charcoal from renewable biomass under the project scenario, the methane (CH_4) emissions could vary depending on the technology used in the carbonization process and the CO_2 emissions are equal to zero because of the renewable nature of the biomass. Therefore, for estimation of CH_4 emissions from carbonization, the use of monitored data shall be mandatory once the GHG emissions rely on the actual operation of the charcoal production.

The methane emissions in carbonization can be calculated as below:

$$RAP_{PJ, charcoal, y} = P_{PJ, y} \bullet EF_{CH4, charcoal, PJ, y} \bullet F_{PJ, charcoal} \bullet GWP_{CH4} \quad \textbf{(A2.10)}$$

Where:

$RAP_{PJ, charcoal, y}$ = GHG emissions within the project boundary due to the production of charcoal used in the iron ore reduction facility in the project operation during year *y*; (tCO_2/yr)

$P_{PJ, y}$ = Hot metal production in the project scenario in year *y* (expected hot metal production of the new iron ore reduction system) (tonnes of hot metal)

$EF_{CH4, charcoal, PJ, y}$ = Emission Factor to produce one tonne of renewable charcoal identified in the project supply chain; (tCH_4 / t of charcoal)

$F_{PJ, charcoal}$ = Quantity of charcoal necessary to produce one tonne of hot metal; (t charcoal/t of hot metal)

GWP_{CH4} = Global warming potential for CH_4; (tCO_2e/tCH_4)

The emission factor of CH_4 emissions in the carbonization activity is associated with the type of technology used and in the actual operation of the carbonization process. Project participants could choose between two options. Option 1: calculation and monitoring of methane emissions based on monitoring procedures of AM-0041; option 2: helium tracing as per the most recent version of the Annex 2 of approved small scale methodology III.K .

Option 1: Methane emission factor as function of gravimetric yield.

Under the provisions of the approved methodology AM0041 "Mitigation of Methane Emissions in the Wood Carbonization Activity for Charcoal Production" the methane emissions of the carbonization process can be estimated and monitored based on the best fit statistical relationship between methane emissions and gravimetric yield.

The relation between methane emissions and carbonization gravimetric yield shall be established based on the experimental measurements and statistical analysis. The procedures provided in the AM0041 Appendix 1 and Appendix 2 shall be implemented by an independent third party and the results of the third party analysis shall be recorded by the project participant. The methane emission factor of the carbonization process can be estimated as below:

$$EF_{CH4,\,charcoal,PJ,y} = f\,(Y_{PJ}) \quad \textbf{(A2.11)}$$

Where:

$EF_{CH4,\,charcoal,PJ,\,y}$	=	Emission Factor to produce one tonne of renewable charcoal identified in the project supply chain; (tCH_4 / t of charcoal)
Y_{PJ}	=	Carbonization gravimetric yield (t charcoal/ t wood on dry basis) (as per the procedure outlined below)

Option 2: Methane emission factor using and/or Using helium tracing methods as per CDM approved methodology III.K.

The carbonization emission factor can be adopted based on the following procedures:

- Brick-based charcoal making process using helium tracing– approach based on Helium tracing, a method widely used in industrial facilities coupled with online gaseous chromatography. ; The project proponent that wishes to apply this procedure shall strictly follows the provisions of the most recent version of the Annex 2 of approved methodology III.K.

Once the above mentioned methods are strictly applied the PP shall then define the emission factor to produce one tonne of renewable charcoal identified in the supply chain in the project activity.

A2.1.3 Project emissions in the transportation of reducing agent

The project participant should have data and information on the origin and transportation of reducing agents under the project scenario. The project participants could choose between two options to calculate the GHG emissions associated with transportation of reducing agents - fuel consumption (option 1) or Option 2: distance –of travel and vehicle type used (option 2).

Option 1: Project emissions from transport based on fuel consumption of vehicles

Step 1: Information on vehicle type and distance traveled within the project boundary in connection with the transportation of reducing agent from its production sites to the project activity iron reduction facility shall be collected.

Step 2: Country specific emission factors shall be used. In the absence of country specific emissions factors, the IPCC 2000 and the IPCC GPG 2006 guidelines or other reliable sources on the GHG emissions assessment can be used.

Step 3: From the baseline data on vehicle use, and fuel consumed in the transportation of reducing agents within the project boundary, the CO_2 emissions are estimated/ calculated as below, using the bottom up approach described in GPG 2000.

$$RAT_{Vehicle,\ PJ,\ y} = \sum_{v,PJ} \sum_{f,PJ} \frac{EF_{VF,\ PJ} \bullet FC_{VF,\ PJ,\ y}}{1000} \qquad \textbf{(A2.12)}$$

$$FC_{VF,PJ,\ y} = n_{VF,PJ,\ y} \bullet k_{VF,PJ,\ y} \bullet e_{VF,PJ} \qquad \textbf{(A2.13)}$$

Where:

$RAT_{Vehicle,\ PJ,\ y}$	=	CO_2 emissions within the project boundary due to fossil fuel combustion from vehicles used to transport reducing agent(s) to iron ore reduction facility during year *y* of the project scenario; (tCO_2/yr)
$EF_{vf,PJ}$	=	Emission factor for vehicle type *v* with fuel type *f* in the project scenario; (kg CO_2/litre)
$FC_{vf,PJ,y}$	=	Consumption of fuel type *f* of vehicle type *v* in the project scenario; (litres per year *y*)
$n_{vf,PJ,y}$	=	Number of vehicles of type *v* with fuel type *f* in year *y* in the project scenario
$k_{vf,PJ,y}$	=	Kilometers traveled by each of vehicle type *v* with fuel type *f* in the project scenario; (km per year *y*)
$e_{vf,PJ}$	=	Average fuel consumption of vehicle type *v* with fuel type *f* in the project scenario; (litres/km)
v_{PJ}	=	Vehicle type in the project scenario
f_{PJ}	=	Fuel type in the project scenario

Option 2: Project emissions from transport based on distance traveled by vehicles

The project transport emissions are calculated on the basis of distance and the number of trips (or the average vehicle load;

$$RAT_{Vehicle,\ PJ} = N_{v,\ PJ,\ y} \bullet AVD_{i,\ PJ,\ y} \bullet EF_{v,\ km,\ CO2,\ PJ,\ y} \qquad \textbf{(A2.14)}$$

Where:

$RAT_{Vehicle,\ PJ}$	=	CO_2 emissions within the project boundary due to fossil fuel combustion from vehicles to transport reducing agent to iron ore reduction facility at the project scenario; (tCO_2/yr)
$N_{v,\ PJ,y}$	=	Number of round trips (to and from) per type *v* of vehicle had during the year *y*
$AVD_{i,\ PJ,y}$	=	Average round trip distance (to and from) between the reducing agent type *v* production site (s) and the site of the project activity during the year *y* (km)
$EF_{v,\ km,CO2,\ PJ,y}$	=	CO_2 emission factor for the type *v* of vehicle during the year *y* (tCO_2/km)

A.2.2 Emissions from the use of reducing agent mix

The project proponent should analyse the emissions from the production of reducing agents in the project scenario. The emissions associated with the coke oven in the coal coke production and the carbonization process in the charcoal production shall be taken into account using the following procedures accordingly to the baseline scenario.

$$RAP_{PJ,\ RA,\ y} = RAP_{PJ,\ coal\,coke,\ y} + RAP_{PJ,\ charcoal,\ y} \qquad \textbf{(A2.15)}$$

Where:

$RAP_{PJ, RA, y}$ = GHG emissions within the project boundary due to production of reducing agents used in the iron ore reduction facility in the project scenario during year *y*; (tCO_2/yr)

$RAP_{PJ, coal coke, y}$ = GHG emissions within the project boundary due to production of coal coke used in the iron ore reduction facility in the project scenario during year *y*; (tCO_2/yr). The emissions associated with extraction of coal, its conversion to coke and transport to iron ore reduction facility are presented in detail in Annex 1

$RAP_{PJ, charcoal, y}$ = GHG emissions within the project boundary due to the production of charcoal used in the iron ore reduction facility in the project operation during year *y*; (tCO_2/yr). The emissions associated with the production of charcoal are covered in the above paragraphs of this section

In case of using a mix of reducing agents, the emissions associated with primary carbon extraction shall be taken into account in the project scenario if its emissions occur within the project's national boundaries. The steps for calculation of project emissions from coal coke reducing agent alternative are outlined below.

A2.2.1 Coal coke reducing agent in the project scenario

For conservativeness and simplification purposes, the project proponent shall only account upstream emissions that occur within the national boundary. In addition, taking into account the cost-effectiveness good practices and conservativeness rationale the project proponent may neglect the project upstream emissions providing proper justification in terms of insignificance of the GHG emissions amount and/or conservativeness.

As in the case of a mix of reducing agents the project scenario involves the use of coal coke as reducing agent in the iron ore reduction system, the primary carbon source extraction should take into account the GHG emissions attributable to the coal mining activities, if applicable[27]. To increase conservativeness, the project proponent shall use the same emission factors for the upstream mineral coal chain for the baseline and project cases.

The primary carbon source extraction of the project scenario shall be calculated using the following formula:

$$PCE_{PJ, y} = CM_{PJ, y} \quad \textbf{(A2.16)}$$

Where :

$PCE_{,PJ,y}$ = Project primary carbon source extraction emissions within the reducing agent component (tCO_2e)

$CM_{,PJ,y}$ = GHG emissions associated with coal mining activities in the project scenario during year *y* (tCO2)

[27] In case the coal mining activities occurs outside the host country (ies) those emissions can be conservatively neglect.

a. Coal mining emissions

Coal extraction activities in either surface or underground mining result in positive GHG emissions associated with:

- Emissions from the operation of mining machinery;
- Fugitive methane emissions from coal mines, and coal cleaning, use of ammonium nitrate and mine reclamation activities;
- Coal transport to the coal coke production sites.

The following procedures shall be considered before applying the calculation of the carbon extraction emissions:

> Common practice identification in terms of mine type, coal extraction technology and its net potential fugitive[28] emissions that can deliver the raw materials in the project scenario shall be undertaken by the project proponent. This procedure shall take into account all possible types of mines, methods and technologies of coal extraction in the project scenario area and use public available scientific data to assess the attributable GHG emission and potential fugitive emissions in the project. It is good practice to use local, regional and national data in this assessment. However, if these data are not available, IPCC default factor or data from reliable institutions can be used.

Once the most conservative scenario is identified the following equations shall be applied to estimate coal mining emissions.

$$CM_{PJ,\ y} = (CM_{PJ,\ machine,\ y} + CM_{PJ,\ fugitive,\ y}) \bullet RA_{PJ,\ i} \bullet P_{PJ,\ y} + CM_{PJ,Vehicle,\ y} \qquad \textbf{(A2.17)}$$

Where:

$CM_{,PJ,y}$	=	GHG emissions due to the coal mining activities in the project scenario during year *y* (tCO_2)
$CM_{PJ,\ machine,\ y}$	=	GHG emissions due to the coal mining machinery in the project scenario during year *y* (tCO_2/t Coal)
$CM_{PJ,\ fugitive,\ y}$	=	Fugitive methane emissions from the coal mines and coal cleaning, use of ammonium nitrate and mine reclamation activities in the project scenario during year *y* (tCO_2/t Coal)
$CM_{PJ,\ vehicle,\ y}$	=	CO_2 emissions from fossil fuel combustion in the vehicles used to transport coal to the coal coke production units within the project boundary (tCO_2/yr)
$RA_{PJ,\ i}$	=	Quantity of coal coke necessary to produce one tonne of hot metal; (t Coal coke /t of hot metal)
$P_{PJ,\ y}$	=	Hot metal production in the project scenario in year y (expected hot metal production of the new iron ore reduction system). (tonnes of hot metal)

b. Emissions from the operation of mining machinery

$$CM_{PJ,\ machine,\ y} = F_{PJ,\ machine,\ y} + E_{PJ,\ machine,\ y} \qquad \textbf{(A2.18)}$$

[28] Treatments of the fugitive emissions in the baseline scenario shall also be accounted in this assessment.

Where:

$CM_{PJ, machine, y}$ = GHG emissions due to the coal mining machinery in the project scenario during year *y* (tCO_2/t Coal)

$F_{PJ, machine, y}$ = GHG emissions from fossil fuel consumption due to the coal mining machinery in the project scenario during year *y* (tCO_2/t Coal)

$E_{PJ, machine, y}$ = GHG emissions from electricity consumption due to the coal mining machinery in the project scenario during year *y* (tCO_2/t Coal)

Coal is obtained either by surface mining (or near the surface) or by underground mining, depending on geological conditions. It is good practice to apply conservative assumptions and public available data, if project specific data are not available, in the application of the above presented instructions. If the calculations above are only based on the underground mining type, project proponent shall justify its application.

c. Fugitive methane emissions from coal mines, coal cleaning, ammonium nitrate usage and mine reclamation

The net fugitive methane emissions of the project scenario shall be calculated using the following formula:

$$CM_{PJ, fugitive, y} = F_{PJ, fugitive, y} + E_{PJ, clean, y} + E_{PJ, Am, y} \quad \textbf{(A2.19)}$$

Where:

$CM_{PJ, fugitive, y}$ = Fugitive methane emissions from the coal mines and coal cleaning, use of ammonium nitrate and mine reclamation activities in the project scenario during year *y* (tCO_2/t Coal)

$F_{PJ, fugitive, y}$ = CH_4 fugitive emissions due to the coal mining activity in the project scenario during year *y* (tCO_2/t Coal)

$E_{PJ, clean, y}$ = Electricity consumption GHG emissions due to the coal cleaning activities in the project scenario during year *y* (tCO_2/t Coal)

$E_{PJ, Am, y}$ = GHG emissions the use of ammonium nitrate and mine reclamation activities in the project scenario during year *y* (tCO_2/t Coal)

If the coal mining step is not under the control of the project proponent, the default emission factors for fugitive emissions from mining activities presented in the table below are to be used. Other emission sources from coal mining shall be ignored. These default emission factors may also be used if no coal mining operational data are available.

Table 4: Default emission factors for fugitive CH_4 emissions from coal mining

Default IPCC Emissions Factor (m^3 ch_4/ tonne of coal)			
Category	Low	High	Average
Underground Mining	10	25	18
Surface Mining	0.3	2	1,2

Source: IPCC, 2006

Unless properly justified, the project proponent shall use the same value as the one used for the baseline upstream emissions calculation.

c. Coal transport to the coal coke production sites

The project proponent shall use the same emission factor for this source as the one derived in the baseline upstream emissions calculation. If it can be properly justified, the project proponent may use a different value. In this case, the following procedure shall be used:

(a) The project participant should collect data and information on the origin and transportation of coal under the project scenario.

In conformity with the guidance on non-eligibility of bunker fuels under the CDM as per the decision of EB 25 (paragraph 25), the GHG emissions associated with transportation of coal across the international boundaries are conservatively not accounted under this methodology.

(b) The project participants could choose between two options – based on fuel consumption (option 1) and vehicle type and distance (option 2) to calculate the GHG emissions associated with transportation of reducing agent within the national boundary under the project scenario:

Option 1: Project emissions from transport based on fuel consumption of vehicles.

Step 1: Information on vehicle type and distance traveled within the project boundary in connection with the coal transportation from its mining sites to the coal coke production unit shall be collected.

Step 2: Country specific emission factors shall be used. In the absence of country specific emissions factors, the IPCC 2006 and the IPCC GPG 2000 guidelines or other reliable sources on the GHG emissions assessment can be used.

Step 3: From the project data on vehicle use, and fuel consumed in the transportation of coal within the project boundary, the CO_2 emissions are estimated/calculated as below, using the bottom up approach described in GPG 2000.

$$CM_{PJ,\ Vehicle,\ y} = \sum_{v,PJ} \sum_{f,PJ} \frac{EF_{VF,\ PJ} \bullet FC_{VF,\ PJ,\ y}}{1000} \qquad \textbf{(A2.20)}$$

$$FC_{VF,PJ,\ y} = n_{VF,PJ,\ y} \bullet k_{VF,PJ,\ y} \bullet e_{VF,PJ} \qquad \textbf{\textit{(}A2.21\textit{)}}$$

Where:

$CM_{PJ,\ vehicle,\ y}$	=	CO_2 emissions within the project boundary due to fossil fuel combustion from vehicles used to transport coal to coal coke production unit during year *y* of the project scenario; (tCO_2/yr)
$EF_{vf,PJ}$	=	Emission factor for vehicle type *v* with fuel type *f* in the project scenario (kg CO_2/litre)
$FC_{vf,PJ,y}$	=	Consumption of fuel type *f* of vehicle type *v* in the project scenario (litres per year *y*)
$n_{vf,PJ,y}$	=	Number of vehicles of type *v* with fuel type *f* in year *y* in the project scenario

$k_{vf,PJ,y}$	=	Distance traveled by each of vehicle type *v* with fuel type *f* in the project scenario (km per year *y*)
$e_{vf,PJ}$	=	Average fuel consumption of vehicle type *v* with fuel type *f* in the project scenario (litres/km)
v_{PJ}	=	Vehicle type in the project scenario
f_{PJ}	=	Fuel type in the project scenario

Option 2: Project emissions from transport based on distance traveled by vehicles

The project transport emissions are calculated on the basis of the distance and the number of trips (or the average vehicle load).

$$CM_{PJ,\ Vehicle,\ y} = N_{v,PJ,\ y} \bullet AVD_{i,PJ,\ y} \bullet EF_{v,\ km,\ CO2,\ PJ,\ y} \quad \textbf{(A2.22)}$$

Where:

$CM_{PJ,\ vehicle,\ y}$	=	CO_2 emissions within the project boundary due to fossil fuel combustion from vehicles used to transport coal to coal coke production unit during year *y* of the project scenario; (tCO_2/yr)
$N_{v,\ PJ,y}$	=	Number of round trips (to and from) per type *v* of vehicle had during the year *y* in the project scenario
$AVD_{i,\ PJ,y}$	=	Average round trip distance (to and from) between the reducing agent type *v* production site (s) and the site of the project activity during the year *y* (km)
$EF_{v,\ km,CO2,\ PJ,y}$	=	CO_2 emission factor for the type *v* of vehicle during the year *y* in the project scenario (tCO_2/km)

d. Coal coke production

The coal distillation produces coal coke/metallurgical coke and result in both carbon dioxide and methane emissions. These emissions depend on the technology used in the coal coke production and shall be calculated as below.

$$RAP_{PJ,\ coal\ coke,y} = P_{PJ,y} \bullet EF_{CO2e,\ coal\ coke,\ PJ,y} \bullet RA_{PJ,i} \quad \textbf{(A2.23)}$$

Where:

$RAP_{PJ,\ coal\ coke,\ y}$	=	GHG emissions within the project boundary due to production of coal coke used in the iron ore reduction facility in the project scenario during year *y*; (tCO_2/yr)
$P_{PJ,\ y}$	=	Hot metal production in the project scenario in year *y* (expected hot metal production of the new iron ore reduction system). (tonnes of hot metal)
$EF_{CO2e,\ coal\ coke,PJ,\ y}$	=	Emission factor to produce one tonne of coal coke in the project scenario supply chain; (t CO_2e/ t of Coal coke)
$RA_{PJ,\ i}$	=	Quantity of coal coke necessary to produce one tonne of hot metal in the project scenario; (t Coal coke /t of hot metal)

The emission factor of the coal coke production activity is directly associated with the type of technology used in the coal distillation process. Under this methodology, the coke oven emission factor accounts emissions associated with the coke oven gas flare (COG), CH_4 and CO_2 leakage emissions from coke oven doors and lids. The project participants could choose between two options to calculate coke oven emissions based on a coke oven technology or on published data.

Methane emission factor based on coke oven technology

The emission factor based on coal coke technology shall be calculated based on the data from scientific research undertaken by an independent agency on the coal coke distillation technology.
If the coal coke production step is not under the control of the project proponent, the default emission factors for fugitive emissions from coal coke production presented in the table below are to be used. They may also be used if no coal coke production operational data are available.

Table-5: Default emission factors for fugitive CH_4 and CO_2 emissions from coal coke production (COG)

Emission Bypassed COG (Kg/t of coal)		
GHG	Uncontrolled	Flared
Carbon Dioxide	10.5	390
Methane*	60	0.6
Total CO_2eq	1270.5	402.6

***GWP=21**
Source: EPA, 2007

Unless properly justified, the project proponent shall use the same value as the one used for the baseline upstream emissions calculation.

Annex 3

Leakage Emissions from Activity Displacement under Project Scenario

The displacement of economic activities from a primary carbon extraction activity to areas outside the project boundary can have potential impacts on the land use in terms of the loss of vegetation and conversion to agriculture and other land uses or the degradation of vegetation due to prolonged and unregulated harvest of forest products such as fuelwood and other forest products. If the displacement of households or shifting of pre-project activities results in biomass losses that can be **attributed** to the project activity, then emissions from activity displacement are expected to occur. The emissions from activity displacement are calculated as per the guidance of the approved methodology AR-AM0005.

The activity displacement is linked to the type of pre-project land use and tenure status of households whose activities are expected to get displaced as a result of the implementation of a primary carbon extraction activity. Therefore, under this methodology, pre-project land use and land tenure status of households are considered as major determinants influencing the activity displacement.

Under this methodology, household is the unit of measurement to measure the activity displacement. Due to inherent difficulties of relating to what extent the subsequent actions undertaken by displaced households can be directly **attributable** to the primary carbon extraction activity, the emission estimates focus on the direct land use impacts of displacement as an immediate aftermath of the project implementation. Therefore, project participants are requested to track the displacement of activities after one full year of displacement.

It is possible that leakage from activity displacement can be from one or more land use activities (conversion to agriculture/other uses, and/or fuelwood collection). The steps and procedures outlined below to quantify leakage from activity displacement are relevant to different project and geographic contexts either as stand alone activities or a combination of one or more activities. If more than one activity is relevant in the project context, the steps and procedures of individual modules can be integrated into household surveys to quantify leakage from activity displacement.

The categories of activities considered under activity displacement are represented below:

- Land use change – conversion of forest land outside the project boundary to agriculture and related land use;
- Degradation of biomass resources – from the prolonged harvest of fuel wood.

$$LK_{Activity\_Disp,y} = LK_{AD\_Def,y} + LK_{AD\_Fuel,y} \qquad \textbf{(A.3.1)}$$

Where:

$LK_{Activity\_Disp.,y}$	=	Annual increase in GHG emissions outside the project boundary resulting from displacement of economic activities; tonnes CO_2-e yr^{-1} in year y
$LK_{AD\_Def,y}$	=	Annual emissions from deforestation and land use change to agriculture and other uses due to displacement of households; tonnes CO_2-e yr^{-1} in year y
$LK_{AD\_Fuel,y}$	=	Annual emissions from fuelwood use due to displacement of households; tonnes CO_2-e yr^{-1} in year y

Among the households expected to displace, this methodology differentiates between households that remain within the vicinity of the project (resident households that are displaced to areas within the vicinity of the project, e.g., up to 5 km radius) and those that emigrate from the project area (emigrant households). All displaced households that do not qualify as resident households are categorized as emigrant households.

A3.1 Leakage from land use change to agriculture and/or other land uses

If the implementation of a primary carbon extraction activity is expected to result in the displacement of people and/or economic activities that result in land use and/or land cover changes outside the project boundary, the increase in emissions associated with such change shall be estimated. The determination of whether or not leakage occurs from the shifts in land use/cover change shall be done as a prerequisite to adopting the steps and procedures outlined for the estimation of leakage.

If the carbon stocks of areas in which households resettle relative to those areas in which households resided prior to shifting is equal to or less than the amount identified prior the establishment of the project activity, then $LK\,AD\,\_\,Def\,,y = 0$. Additionally, households may decide to abandon the pre-project activities by selling their lands, which are subsequently brought under the project activity in which case the displaced households may decide to pursue other forms of livelihood that is not linked to the pre-project land use, then $LK\,AD\,\_\,Def\,,y = 0$.

This methodology proposes integrated household surveys to capture the implications of the displacement of land use to areas that have higher carbon stock relative to the pre-project lands. The standardized household survey methods capture the household and community characteristics.

For the purpose of leakage assessment from land use change, displaced households are categorized into resident (households that shift to areas within 5 kilometer radius of the project boundary) and emigrant households (that shift to areas elsewhere outside 5 km radius). The emissions from land use/cover change associated with resident and emigrant households are represented as below.

$$LK_{AD\_Def,y} = LK_{AD\_Def_{resident,y}} + LK_{AD\_Def_{emigrant,y}} \qquad \textbf{(A3.2)}$$

Where:

$LK_{AD\_Def,y}$	=	Annual emissions from deforestation and land use change to agriculture and other uses due to displacement of households; tonnes CO_2-e yr^{-1} in year *y*
$LK_{AD\_Def_{resident,y}}$	=	Annual emissions from conversion of land use/land cover outside the project boundary to agriculture/other land use attributable to resident households; tonnes CO_2-e yr^{-1} in year *y*
$LK_{AD\_Def_{emigrant,y}}$	=	Annual emissions from conversion of land use/land cover outside the project boundary to agriculture/other land use attributable to emigrant households; tonnes CO_2-e yr^{-1} in year *y*

The following step-wise approach is proposed to facilitate the estimation of leakage from conversion to agricultural/other uses.

Step 1: Information on total number of households residing within the project boundary shall be collected. A list of households displaced or expected to displace as a result of the primary carbon extraction activity shall be prepared.

Step 2: Information on factors influencing the land uses of households such as tenure status, types of pre-project land uses, average area of households under the pre-project land uses shall be collected and recorded. If data from official records on land uses are not available, household survey data shall be used to collect the relevant data to assess the land use patterns and land use changes.

Step 3: Depending on the number of households affected, a sampling strategy shall be designed for a household survey. The sampling strategy should be representative of resident households in the project vicinity. Depending on the number of households displaced as a result of the primary carbon extraction activity and that reside within the project vicinity, 5 to 10% of resident households, with a minimum of 50 households shall be selected using random or stratified sampling methods. If the number of households expected to be displaced are less than 50, then the survey should include all households to avoid selection and sampling bias associated with small sample surveys.

Step 4: For the purpose of survey, structured questionnaires and/or participatory appraisal methods covering the aspects of land uses and other economic activities shall be used.

Step 5: Based on the data from the household survey, and information collected on land uses from other sources such as satellite imagery, aerial photographs, and/or regional maps, area subjected to land use/cover change shall be estimated. The strata subject to land use change shall be compared with the strata prior to conversion to assess the extent of land use/cover change.

$$Area_{Def,y} = \left(AF_{y_1} - AF_{y_2}\right) \quad \textbf{(A.3.3)}$$

$$MAD_h = \left(AF_{y1} - AF_{y2}\right) / nH_r \quad \textbf{(A.3.4)}$$

Where:

$Area_{Def,y}$	=	Area deforested from land use change due to displacement of households; hectares in the year *t*
AF_{y_2}, AF_{y_1}	=	Area of land use at year y_2 and year y_1, respectively; hectares
MAD_h	=	Mean area subject to land use/cover change per resident sample household *h*; hectares
nH_r	=	Number of sample households resident in the vicinity of the project

Step 6: Emissions shall be estimated as the product of area subjected to land use/cover change and the mean carbon stock in the living biomass of the lands to where the pre-project activities areas are likely to be shifted to. The mean carbon stock of living biomass *MC* (above ground and below ground biomass) shall be estimated from the official records or using the procedures outlined in GPG for LULUCF. An expansion factor of 1.2 to 1.5 depending upon the density of vegetation shall be used to convert the mean carbon stock of living biomass to carbon stock that can represent all pools (above ground biomass, below ground biomass, deadwood, litter, and soil). In situations where demonstrable constraints exist in the estimation of carbon stock of the areas receiving the pre-project activities, the mean carbon of mature forest (Table 3A.1.4 in GPG for LULUCF) that best represents the project area shall be used.

Step 7: The GHG emissions from land use/cover change attributable to the displaced resident households shall be estimated as follows.

$$LK_{AD\_Def_{resident}} = \left(\sum_{h=1}^{H} MAD_h \bullet MC \bullet 44/12\right) \bullet \frac{NH_r}{nH_r} \quad \textbf{(A.3.5)}$$

$$MC = B_{LB} \bullet CF \bullet EF_{all\_pools} \quad \textbf{(A.3.6)}$$

Where:

$LK_{AD\_Def_{resident,y}}$	= Annual increase in emissions from conversion of land use/land cover outside the project boundary to agriculture/other land use attributable to resident households; tonnes CO_2-e yr^{-1} in year *y*
MAD_h	= Mean area subject to land use/cover change per resident sample household *h*; hectares
MC	= Mean carbon stock per unit area in the area subject to land use/cover change; tonnes C ha^{-1}
B_{LB}	= Living biomass of trees (aboveground and belowground biomass) per ha in the area subject to land use/cover change; tonnes d.m. ha^{-1}
CF	= Carbon fraction for biomass in the area subject to land use/cover change; tonnes C (tonne d.m.)$^{-1}$
$EF_{all-pools}$	= Expansion factor (1.2 to 1.5) to convert the carbon stock of living biomass of trees to carbon stock representing all pools depending on vegetation density (low vegetation density areas should use lower end of expansion factor and vice versa)
NH_r	= total number of displaced households resident in the project vicinity
nH_r	= Number of sample households resident in the vicinity of the project.
$\frac{44}{12}$	= Ratio of molecular weights of CO_2 and carbon; dimensionless

Step 8: Information on the number of households emigrated shall be collected from official records and the data from household surveys on resident households shall be used as proxy to estimate the emissions associated with these households. Considering the difficulties in ascertaining information on the land use of emigrant household, the leakage associated with the emigrant household is set equal to the mean area impacted by a resident sample household, multiplied with the mean mature forest carbon stock. Data from GPG for LULUCF Table 3A.1.4 can be used to estimate the mean carbon stock if other sources of data are unavailable.

$$LK_{AD\_Def_{emigrant}} = (MAD_h \bullet MC \bullet 44/12) \bullet NH_e \quad \textbf{(A3.7)}$$

Where:

$LK_{AD\_Def_{emigrant}}$	= Annual increase in emissions from conversion of land use/land cover outside the project boundary to agriculture/other land use attributable to emigrant households; tonnes CO_2-e yr^{-1} in year *y*
MAD_h	= Mean area subject to land use/cover change per resident sample household *h*; hectares
MC	= Mean carbon stock per ha in the area subject to land use/cover change; tonnes C ha^{-1}
$\frac{44}{12}$	= Ratio of molecular weights of CO_2 and carbon; dimensionless
NH_e	= Total number of emigrant households

A3.2 Leakage from fuelwood collection

A large proportion of rural households depend on fuelwood for domestic energy purposes such as cooking and heating. A very large number of displaced households may depend on the non-project area for meeting their fuel wood supplies. Considering the limitations of fuel choice, households may be forced to harvest fuelwood unsustainably for long-periods until they have suitable domestic energy alternatives. The continuous harvest of fuelwood leads to degradation of biomass resources and could potentially contribute to leakage emissions.

The assessment of fuelwood collection as a displaced activity shall be made prior to consideration of the aspects outlined below to assess the displacement of fuelwood collection:

- Leakage from fuelwood collection is considered zero ($LK\ AD\ \_\ Fuel, t = 0$), if $FuelBL\ ,y <$ $FuelPR,y$
    - The amount of fuelwood available from agricultural lands and other bona fide sources such as agricultural lands shall be ascertained, if $FuelBL\ ,y < FuelAG,y$, then $LK\ AD\ \_\ Fuel\ ,y = 0$
    - In case LK $AD\ \_\ Fuel\ ,y$ < 5% of the net GHG emission reductions under the project, the leakage from fuel wood is considered insignificant and is not required to be accounted.

Where:

$LK_{AD\_Fuel,y}$	=	Annual increase in GHG emissions from fuelwood collection; tonnes CO_2-e yr^{-1} in year y
$Fuel_{BL,y}$	=	Average annual quantity of fuelwood use prior to project; tonnes d.m. yr^{-1} in year y
$Fuel_{PR,y}$	=	Average annual quantity of fuelwood permitted for collection or supplied from the project; tonnes d.m. yr^{-1} in year y

The annual increase in GHG emissions from land use/cover change associated with resident and emigrant households is represented below.

$$LK_{AD\_Fuel,y} = LK_{AD\_Fuel_{resident,\ y}} + LK_{AD\_Fuel_{emigrant,\ y}} \qquad \textbf{(A3.8)}$$

Where:

$LK_{AD\_Fuel,y}$	=	Annual emissions from fuel gathering outside the project boundary due to displacement of households; tonnes CO_2-e yr^{-1} in year y
$LK_{AD\_Fuel_{resident,\ y}}$	=	Annual emissions from fuel gathering outside the project boundary attributable to resident households; tonnes CO_2-e yr^{-1} in year y
$LK_{AD\_Fuel_{emigrant,\ y}}$	=	Annual emissions from fuel gathering outside the project boundary attributable to emigrant households; tonnes CO_2-e yr^{-1} in year y

The relevant steps outlined for estimation of GHG emissions from deforestation/land use change, along with the steps outlined below shall be considered for the estimation of leakage emissions from displacement of fuelwood collection activity

Step 1: The household survey data collected on resident sample households, as discussed above, can be used to estimate the fuelwood consumption. From household survey/participatory appraisal data, the average size of household and per capita fuelwood consumption in the sample household shall be estimated.

Step 2: Data on fuel wood consumption, sources of fuelwood supply, and patterns of fuelwood/charcoal consumption shall be estimated or collected from the household survey data and official records/market studies/fuelwood studies in the region in order to estimate the per capita fuel wood consumption, which is assumed to remain constant over the entire crediting period.

$$PFC_y = (FG_y \bullet D \bullet BEF_2) / P_y \qquad \textbf{(A3.9)}$$

Where:

PFC_y	=	Per capita annual fuelwood consumption; tonnes d.m (person)$^{-1}$ yr^{-1} in year y Note: As per equation 3.2.8 of GPG of LULUCF, the per capita fuelwood consumption is converted into tonnes d.m (person)$^{-1}$ yr^{-1} by dividing the population of the region.
FG_y	=	Annual volume of fuelwood use; m^3 yr^{-1}
D	=	Basic wood density; tonnes d.m. m^{-3}
BEF_2	=	Biomass expansion factor for converting volumes of extracted round wood to total aboveground biomass (including bark); factor
P_y	=	Population of the region; number of persons in year y

Step 3: From the official records, information on average annual growth of human population in the region in which the project is located shall be collected. The data from official records, secondary studies and household survey data on resident sample households could be used in order to estimate the amount of fuelwood consumed or expected to be relevant to the displaced resident households.

$$LK_{AD\_Fuel_{resident,y}} = \left\{ \left[\sum_{hr=1}^{nHr} HS \bullet PFC_y \bullet (1 - FCA) \bullet CF \bullet {}^{44}\!/_{12} \right] \bullet (1 + PG)^y \right\} \bullet \frac{NH_r}{nH_r} \qquad \text{(A3.10)}$$

Where:

$LK_{AD\_Fuel_{resident,y}}$	=	Annual emissions from fuel gathering outside the project boundary attributable to resident households; tonnes CO_2-e yr^{-1} in year y
HS	=	Average size of resident household; number of persons per household
PFC_y	=	Per capita annual fuelwood consumption; tonnes d.m (person)$^{-1}$ yr^{-1} in year y. Note: As per equation 3.2.8 of GPG of LULUCF, the per capita fuelwood consumption is converted into tonnes d.m (person)$^{-1}$ yr^{-1} by dividing total fuelwood consumption of the region by the population of the region.
FCA	=	Proportion of per capita fuelwood consumption from agricultural/ private lands including purchases, to the total per capita annual fuelwood consumption from all sources (estimated from household survey data and scaled between 0 to 1), ratio
CF	=	Carbon fraction of dry biomass; tonnes C (tonne d.m.)$^{-1}$
PG	=	Annual human population growth; in percent
NH_r	=	Total number of displaced households resident in the project vicinity

nH_r	=	Number of resident sample households
$\frac{44}{12}$	=	Ratio of molecular weights of CO_2 and carbon; dimensionless
T	=	Time in years from the start date of the proposed A/R CDM project activity

Step 4: It is not feasible to obtain information on fuel wood consumption of emigrant households. Therefore, the annual fuel wood consumption of emigrant households is assumed to be equal to that of the displaced resident households. The population growth rate is not relevant to the emigrant households as the demographic patterns of these households vary from those of the resident holds. Therefore, population growth is not applied to the fuel wood consumption estimates of the emigrant households.

$$LK_{AD\_Fuel_{emigarnt},y} = \left[\ HS \bullet PFC_y \bullet (1 - FCA) \bullet CF \bullet (44/12)\ \right] \bullet NH_e \tag{A.3.11}$$

Where:

$LK_{AD\_Fuel_{emigrant},\,y}$	=	Annual emissions from fuel gathering outside the project boundary attributable to emigrant households; tonnes CO_2-e yr^{-1} in year *y*
HS	=	Average size of resident household; number of persons per household
PFC_y	=	Per capita annual fuelwood consumption; tonnes d.m $(person)^{-1}$ yr^{-1} in year *y*
FCA	=	Proportion of per capita fuelwood consumption from agricultural/ private lands including purchases, to the total per capita annual fuelwood consumption from all sources (estimated from household survey data and scaled between 0 to 1), ratio
CF	=	Carbon fraction of dry biomass; tonnes C $(tonne\ d.m.)^{-1}$
NH_e	=	Total number of emigrant households
$\frac{44}{12}$	=	Ratio of molecular weights of CO_2 and carbon; dimensionless

Step 5: The total emissions from fuelwood consumption of resident and emigrant households can be represented as below.

$$LK_{AD\_Fuel,\,y} = LK_{AD\_Fuel_{resident},y} + \quad LK_{AD\_Fuel_{emigrant},\,y} \tag{A.3.12}$$

Where:

$LK_{AD\_Fuel,y}$	=	Annual emissions from fuel gathering outside the project boundary due to displacement of households; tonnes CO_2-e yr^{-1} in year *y*
$LK_{AD\_Fuel_{resident},\,y}$	=	Annual emissions from fuel gathering outside the project boundary attributable to resident households; tonnes CO_2-e yr^{-1} in year *y*
$LK_{AD\_Fuel_{emigrant},\,y}$	=	Annual emissions from fuel gathering outside the project boundary attributable to emigrant households; tonnes CO_2-e yr^{-1} in year *y*

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History of the document

Version	Date	Nature of revision(s)
01	EB 47, Annex # 28 May 2009	To be considered at EB 47