

**CDM-MP77-A03**

## Draft Large-scale Methodology

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AM0082: Use of charcoal from planted renewable biomass in ~~the iron ore reduction process through the establishment of~~ a new iron ore reduction system

Version 03.0

Sectoral scope(s): 09

DRAFT



**United Nations**  
Framework Convention on  
Climate Change

## COVER NOTE

### 1. Procedural background

1. The Executive Board of the clean development mechanism (CDM) (hereinafter referred to as the Board), at its eighty-ninth meeting, requested the Methodologies Panel (MP) to revise relevant approved methodologies to introduce reference to “TOOL16: Project and leakage emissions from biomass” and to recommend the revised methodologies to the Board for its consideration.
2. At MP 76 a call for public inputs was launched. No inputs were received.

### 2. Purpose

3. The purpose of the draft revision is to:
  - (a) Streamline the methodology by referring to the methodological tools: “TOOL16: Project and leakage emissions from biomass”. This revision was also used as an opportunity to introduce reference to “TOOL12: Project and leakage emissions from transportation of freight” and “TOOL15: Upstream leakage emissions associated with fossil fuel use”;
  - (b) Simplifying the methodology by removing provisions that are included in the tools.

### 3. Key issues and proposed solutions

4. The current approved version of AM0082 (version 1) presents the upstream emissions from coal mining as a baseline source of emissions (only upstream emissions that occur within the national boundary can be considered).
5. At MP 76 and MP 77, the MP discussed how to treat this emissions source in the revised draft, noting that:
  - (a) “TOOL15: Upstream leakage emissions associated with fossil fuel use” defines upstream emissions as “GHG emissions associated with the production, processing, transmission, storage and distribution of a fossil fuel, beginning with the extraction of raw materials from the fossil fuel origin and ending with the delivery of the fossil fuel to the site of use”;
  - (b) In several methodologies (e.g. ACM0017 and AM0029), the upstream emissions from fossil fuel are excluded from the project boundary and considered as Leakage;
  - (c) At EB 85, the Board clarified that net leakage should always be considered as zero when net leakage effects are negative.

6. For this particular case, the MP considered that the comparison of upstream emissions from coal production should be symmetrically carried out in the same level as the “upstream” emissions from biomass production at the dedicated plantation, i.e. within the project boundary. Therefore, the MP recommends to keep this source of emissions in the baseline, as in the current version of the methodology, which are accounted as zero if these emissions in the baseline are higher than those of the project.

#### **4. Impacts**

7. The revision will streamline the applicability of the methodology and facilitate its usability by the project participants.

#### **5. Subsequent work and timelines**

8. The methodology is recommended by the MP for consideration by the Board at its one-hundred-first meeting. No further work is envisaged.

#### **6. Recommendations to the Board**

9. The MP recommends that the Board adopt this draft methodology, to be made effective at the time of the Board’s approval.

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# 1. Introduction

## 1.1. Background

- The following table describes the key elements of the methodology:

**Table 1. Methodology key elements**

<b>Typical project(s)</b>	Use renewable reducing agents such as charcoal produced from dedicated plantations instead of fossil fuel based reducing agents, in the iron ore reduction process using blast furnace technology. The project should include one or combination of the following new investment types: investment in dedicated plantations for the supply of reducing agents; or establishment of specific long-term binding contracts for the supply of reducing agents; or refurbishment/replacement of blast furnace; or establishment/acquisition of blast furnace; or adaptation of existing blast furnace to the use of charcoal
<b>Type of GHG emissions mitigation action</b>	Renewable energy: Switch to a renewable source of carbon for the reduction of iron in blast furnaces

# 2. Scope, applicability, and entry into force

## 2.1. Scope

- This methodology is applicable to project activities that use renewable reducing agents, such as charcoal produced from dedicated biomass plantations, instead of fossil fuel based reducing agents in the production of iron and steel.

## 2.2. 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<sup>1</sup> as reducing agents instead of fossil fuel based reducing agents.
- The methodology is applicable to project activities that establish new iron ore reduction systems (types 1 or 2 below) using blast furnace technology, combined within the same project boundary with at least one of the following investment types 3, 4 or 5:
  - Type 1: Production of renewable reducing agents to be used in the production of iron and steel by investing in dedicated plantations;
  - Type 2: Establishment of specific long-term binding contracts for the supply of renewable reducing agents to be used in the production of iron and steel, i.e.

<sup>1</sup> This methodology applies the definition of renewable biomass provided in Annex 18 of the twenty-third meeting of the Board. <[http://cdm.unfccc.int/EB/023/eb23\\_repan18.pdf](http://cdm.unfccc.int/EB/023/eb23_repan18.pdf)>.

renewable charcoal from dedicated biomass plantations corresponding to a new investment in the dedicated plantation; this eligibility requirement can be fulfilled whether the long-term contractor being listed as a project participant or not;

(c) Type 3: Refurbishment/replacement of blast furnace;

(d) Type 4: Establishment/acquisition of blast furnace;

(e) Type 5: Adaptation of an existing blast furnace to the use of charcoal.

5. The methodology is applicable under the following conditions:

(a) 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;

(b) Blast furnace technology is used in the iron ore reduction process;

(c) 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<sup>2</sup> to project activities that encompass within the same project boundary at least one of the following investment types 3, 4 or 5; those have to be combined with the investment Types 1 and/or 2 below;

(i) The eligible types of new investments for projects under this methodology are:

a. Type 1: Production of reducing agents to be used in the production of iron and steel by investing in dedicated plantations by the project entity;

b. Type 2: Establishment of specific long-term binding contracts for the supply of reducing agents to be used in the production of iron and steel, i.e. renewable charcoal from dedicated biomass plantations corresponding to a new investment in the dedicated plantation; this eligibility requirement can be fulfilled whether the long term contractor being listed as a project participant or not;

c. Type 3: Refurbishment/replacement of blast furnace;

d. Type 4: Establishment/acquisition of blast furnace;

e. Type 5: Adaptation of existing blast furnace to the use of charcoal;

<sup>2</sup> 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.

6. The applicability conditions of “TOOL16: Project and leakage emissions from biomass” shall apply.

7. As dedicated plantations are in the project boundary, all the corresponding land has to be geographically identified and delineated using maps or GIS or similar systems ~~identified~~.

(a) ~~The renewable reducing agent shall be sourced from dedicated plantations<sup>3</sup> in the host country, which are under the control of project participants. In case the renewable plantation is sourced from long-term contractors, the project participants will have to have control on it, whether the contractor is also a project participant or not. The project activity should demonstrate that the reducing agent originates from renewable sources of biomass in the following way:~~

(b) ~~The dedicated plantation as required by this methodology shall be located only in tropical conditions;<sup>4</sup>~~

(c) ~~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;<sup>5</sup>~~

(iii) ~~Degraded areas;<sup>6</sup>~~

a. ~~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”;~~

b. ~~In case the plantation is implemented on land previously hosting a forest plantation after its last rotation, it shall be demonstrated that this land would not be replanted in the absence of the project activity. In order to demonstrate that a forest plantation is in its last rotation, the project proponent shall refer to the plantation management~~

<sup>3</sup> ~~As per Annex 8 of the twentieth meeting of the Board, 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.~~

<sup>4</sup> ~~Under the tropical conditions grasslands contain less soil organic carbon than plantations or secondary forests as evidenced by: Desjardins T, Andreux F, Vokoff B, Cerri CC (1994): Organic carbon and 13-C contents in soils and soil size-fractions, and their changes due to deforestation and pasture installation in eastern Amazonia. Geoderma 61, 103-118. Detwiler RP (1986): Land use change and the global carbon cycle: the role of tropical soils. Biogeochemistry 2, 67-93 Fearnside PM, Barbosa RI (1998): Soil carbon changes from conservation of forest to pasture in Brazilian Amazonia. Forest Ecology and Management 108, 147-166.~~

<sup>5</sup> ~~See definition of “Forest plantation after its last rotation” in definitions section.~~

<sup>6</sup> ~~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).~~



practices which are common practice in the region for the considered species;

(d) In case the dedicated plantation is covered under a registered A/R CDM project activity, the dedicated plantation shall not be included in the project boundary as per paragraph 38 EB 25. The demonstration that the biomass originates from renewable source is not required in such a situation. In case only a part of the dedicated plantation is covered under a registered A/R project activity this condition is applicable only to this part of the plantations;

(e) 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, and the corresponding land has to be identified and included in the project boundary (unless it is covered under a registered A/R project activity);

(f) In compliance with the paragraph 38 of the twenty-fifth meeting of the Board decision, for cases that demonstrate the supply of reducing agent from biomass projects registered as the A/R CDM project activities, upstream emissions from biomass production need not be accounted if they are accounted under the respective A/R CDM projects;<sup>7</sup>

8. If the renewable biomass is sourced from a plantation registered as an A/R CDM project activity, the first verification of this A/R CDM project activity should take place before the first harvesting of the wood takes place.<sup>8</sup> The DOE shall verify that the plantation registered as an A/R CDM project activity from which the renewable biomass is sourced has generated cumulated net tCERs or ICERs at the time of verification of the CDM project activity under this methodology (i.e. the switch of reductant in an iron ore reduction system.) If this condition is not met the corresponding biomass shall not be eligible for the generation of CERs in the context of this methodology.

(a) 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 A/R CDM project activity, this condition is not applicable. In case only a part of the dedicated plantation is covered under a registered A/R CDM project activity, this condition is not applicable only to this part of the plantations;

(b) Flood irrigation is not expected to take place on the plantation sites. In case the dedicated plantation is covered under a registered A/R CDM project activity, this condition is not applicable. In case only a part of the dedicated plantation is covered under a registered A/R CDM project activity, this condition is not applicable only to this part of the plantations;

<sup>7</sup> As per paragraph 38 of the of the twenty-fifth meeting of the Board 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.

<sup>8</sup> This condition ensures that before the first harvest for the purpose of supply of biomass to the steel plant, the plantation has already generated tCERs and ICERs.

- ~~(c) For at least ten years before the implementation of the project activity, no forest stocks were on the land where the dedicated plantations will be established; this condition does not apply to forest stocks in the form of productive forest plantations;~~
9. 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.<sup>9</sup>
  10. 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.<sup>10</sup>
  11. 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.
  12. ~~Finally, t~~This methodology is only applicable if the **identified 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 fuels **based**.
  - ~~13. Guidance for the situation when the plantation (or part of) is covered under an A/R CDM project activity.~~
  14. 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):
    - ~~(a) The baseline selection and additionality procedures are to be performed, 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 biomass/reductant and the operation of the steel mill);~~
    - ~~(b) The demonstration of additionality of the A/R CDM project activity shall also comply with the requirements of the approved A/R CDM methodology;~~
    - ~~(c) 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~~

<sup>9</sup> 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.

<sup>10</sup> 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.

~~Stakeholders Process within the CDM validation and registration procedures before the approval of this methodology by the CDM EB.~~

## 2.3. Entry into force

15. The date of entry into force is the date of the publication of the EB XX meeting report on DD Month YYYY.

## 2.4. Applicability of sectoral scopes

16. For validation and verification of CDM projects and programme of activities by a designated operational entity (DOE) using this methodology, application of sectoral scope 09 is mandatory.

## 3. Normative references

17. This baseline and monitoring methodology is based on the 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.
18. This methodology derives elements from the following approved methodologies:
- (a) ~~AM0042 "Grid-connected electricity generation using biomass from newly developed dedicated plantation";~~ "ACM0003: Partial substitution of fossil fuels in cement or quicklime manufactureEmissions reduction through partial substitution of fossil fuels with alternative fuels or less carbon intensive fuels in cement manufacture";
  - (b) "ACM0021: Reduction of emissions from charcoal production by improved kiln design and/or abatement of methane"AM0041 "Mitigation of Methane Emissions in the Wood Carbonization Activity for Charcoal Production";
  - (c) "AMS-III.K.: Avoidance of methane release from charcoal production" AR-AM0005 "Afforestation and Reforestation project activities implemented for industrial and commercial uses".
19. This methodology also refers to the latest approved version of the following methodological tools:
- (a) "TOOL02: Combined tool to identify the baseline scenario and demonstrate additionality";
  - (b) ~~"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"~~TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation";
  - (c) ~~"TOOL03: Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion";~~
  - (d) "TOOL16: Project and leakage emissions from biomass" ~~"Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities";~~

(e) “TOOL12: Project and leakage emissions from transportation of freight” “Tool for the estimation of GHG emissions from clearing, burning and decay of existing vegetation due to implementation of a CDM A/R project activity”;

(f) “TOOL15: Upstream leakage emissions associated with fossil fuel use” Estimation of direct nitrous oxide emission from nitrogen fertilization”.

20. 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>>.

### 3.1. Selected approach from paragraph 48 of CDM modalities and procedures

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

## 4. Definitions

22. The definitions contained in the Glossary of CDM terms shall apply.

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

(a) **Biomass** - non-fossilized and biodegradable organic material originating from plants, animals and micro-organisms including:

(i) Biomass residue;

(ii) The non-fossilized and biodegradable organic fractions of industrial and municipal wastes; and

(iii) The gases and liquids recovered from the decomposition of non-fossilized and biodegradable organic material;

(b) **Renewable biomass** - biomass which, in accordance with the A/R CDM modalities and procedures, meets one of the following conditions:

(i) The biomass originates from land areas that are forests where:

a. The land area remains a forest;

b. Sustainable management practices are undertaken on these land areas to ensure, in particular, that the level of carbon stocks on these land areas does not systematically decrease over time (carbon stocks may temporarily decrease due to harvesting); and

c. Any national or regional forestry and nature conservation regulations are complied with;

(ii) The biomass is woody biomass and originates from croplands and/or grasslands where:

a. The land area remains cropland and/or grasslands or is reverted to forest;

- b. Sustainable management practices are undertaken on these land areas to ensure, in particular, that the level of carbon stocks on these land areas does not systematically decrease over time (carbon stocks may temporarily decrease due to harvesting); and
    - c. Any national or regional forestry, agriculture and nature conservation regulations are complied with;
  - (iii) The biomass is non-woody biomass and originates from croplands and/or grasslands where:
    - a. The land area remains cropland and/or grasslands or is reverted to forest;
    - b. Sustainable management practices are undertaken on these land areas to ensure, in particular, that the level of carbon stocks on these land areas does not systematically decrease over time (carbon stocks may temporarily decrease due to harvesting); and
    - c. Any national or regional forestry, agriculture and nature conservation regulations are complied with;
  - (iv) The biomass is a biomass residue and the use of that biomass residue in an A/R CDM project activity does not involve a decrease of carbon pools, in particular dead wood, litter or soil organic carbon, on the land areas from which the biomass residues originate;
  - (v) The biomass is the non-fossil fraction of industrial or municipal waste;
- ~~(c) **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 Annex 18 of the twenty-third meeting of the Board criteria;~~
- (d) **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.<sup>11</sup> Renewable charcoal is charcoal produced using renewable biomass resources as per the definition of renewable biomass approved in Annex 18 of the twenty-third meeting of the Board criteria;

<sup>11</sup> Brazil, 2007 *apud*. Vianna et alli. 2006.

- (e) **Iron Ore Reduction System** - Primary Iron productive arrangement that integrates the following components according to their interdependent and systemic nature:
- (f) **Component 1** — The production of reducing agents (see dotted circles in Figure 1 below) encompassing:
- a. Extraction of primary carbon sources:
    - i. Mining sites in the case of GHG intensive fossil fuels (coal coke);
    - ii. Dedicated biomass plantation sites in the case of renewable reducing agent (renewable charcoal);
  - b. Transportation of primary carbon sources to the reducing agent production sites;
  - c. Reducing agent production sites (coke oven unit and carbonization units);
  - d. Transportation of reducing agents to the iron ore reduction facility;
- (ii) **Component 2** and the **iron ore reduction facility**: (see orange circles in Figure 1 below):
- a. Blast furnace facilities where the reducing agents are used to process iron ore into the liquid or solid forms of primary iron;
- (g) **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);
- (h) **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);
- (i) **Dedicated plantation** - A plantation implemented in the context of this project activity in order to supply an iron ore reduction system with renewable biomass. A dedicated plantation must be *newly* established as part of the project activity.

24. In case a dedicated plantation is an A/R CDM project, then A/R CDM modalities and procedures of approved A/R methodology apply.

## 5. Baseline methodology

### 5.1. Project boundary

25. The spatial extent of the project boundary encompasses:

- (a) The geographic boundaries of the dedicated plantations;

- (b) All units that convert raw material<sup>12</sup> into reducing agents (coke oven facilities that distil coal into coke; and carbonization units that convert wood into charcoal);
- (c) The means of transportation of the raw materials to the carbonization units and of the reducing agents to the iron ore reduction facility;
- (d) The iron ore reduction facility (blast furnace).

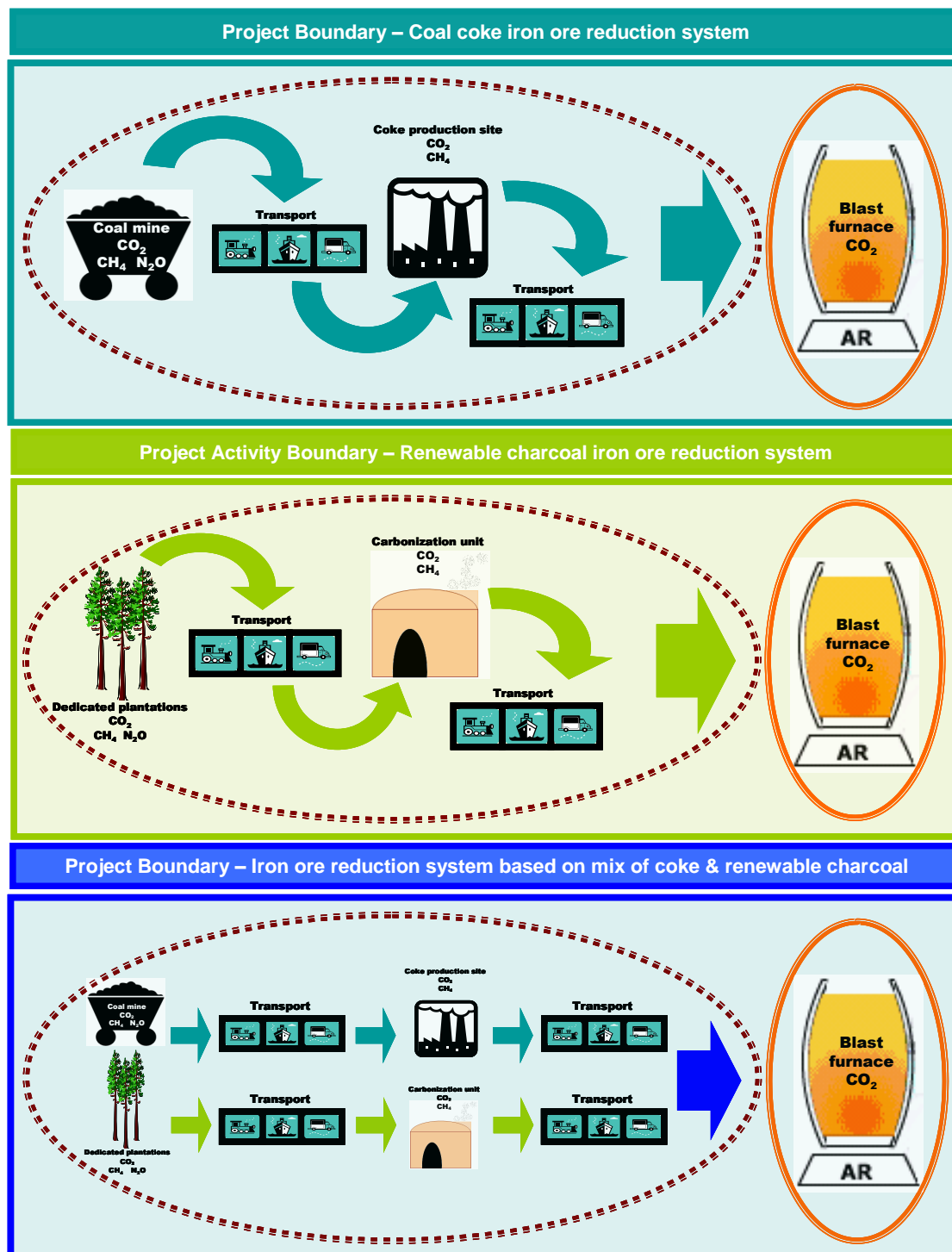
26. ~~This methodology takes into account the integrated nature of the iron ore reduction system in the estimation of GHG emissions, as well as in the determination of the baseline scenario and assessment of additionality. The project boundary includes emissions associated with the production of reducing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

27. ~~The **spatial extent** of the project boundary is consistent with the *iron ore reduction system*. It encompasses the geographical area of raw material 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).~~

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<sup>12</sup> 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.

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

- Reducing agents production - Component 1
- Iron ore reduction facility - Component 2



28. 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:

#### 5.1.1. Upstream emissions: Production of Reducing Agent (grey dotted circle in Figure 1)

29. Emissions associated with the extraction of primary carbon sources:

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

30. 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.

31. 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.

32. 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: As per applicability condition, 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.

33. 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 of the project proponent. In such cases these upstream emissions, will be counted under baseline and/or project emissions.

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

- (a) Emissions associated with the use of each reducing agent in the iron ore reduction process;
- (b) Emissions from use of fossil fuel based reducing agents (e.g. coal coke).

34. 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 2 below.

**Table 2. Emission sources included in or excluded from the project boundary<sup>(a) (b)</sup>**

Source		Gas	Included	Justification/Explanation
Baseline	Iron ore reduction process	CO <sub>2</sub>	Yes	Main source of baseline emissions
		CH <sub>4</sub>	No	Negligible and excluded for simplification
		N <sub>2</sub> O	No	Negligible and excluded for simplification
	Reducing agents transportation	CO <sub>2</sub>	Yes	Fossil fuel combustion
		CH <sub>4</sub>	No	Negligible and excluded for simplification
		N <sub>2</sub> O	No	Negligible and excluded for simplification
	Reducing agent production	CO <sub>2</sub>	Yes	Coal coke production emissions
		CH <sub>4</sub>	Yes	Coal coke/charcoal production
		N <sub>2</sub> O	No	Negligible and excluded for simplification
	Transportation of primary carbon source	CO <sub>2</sub>	Yes	Fossil fuel combustion
		CH <sub>4</sub>	No	Negligible and excluded for simplification
		N <sub>2</sub> O	No	Negligible and excluded for simplification
	Primary carbon source <sup>(b)</sup>	CO <sub>2</sub>	Yes	Emissions of the mining process
		CH <sub>4</sub>	Yes	Fugitive methane emissions in coal mining
		N <sub>2</sub> O	Yes	Application of fertilizers in the planting activity and field burning of biomass/coal mine reclamation and ammonium nitrate use Emissions of the mining process
Project activity	Iron ore reduction process	CO <sub>2</sub>	Yes	Main source of project emissions
		CH <sub>4</sub>	No	Negligible and excluded because differences in the baseline and project activity are not substantial
		N <sub>2</sub> O	No	Negligible and excluded because differences in the baseline and project activity are not substantial
	Reducing agents transportation	CO <sub>2</sub>	Yes	Fossil fuel combustion
		CH <sub>4</sub>	No	Negligible and excluded because differences in the baseline and project activity are not substantial
		N <sub>2</sub> O	No	Negligible and excluded for simplification

Source		Gas	Included	Justification/Explanation
	Reducing agent production	CO <sub>2</sub>	Yes	Major source of emissions in the production of reducing agents, e.g. coal coke, carbonization biomass
		CH <sub>4</sub>	Yes	Coal coke production process and biomass carbonization
		N <sub>2</sub> O	No	Negligible and excluded because differences in the baseline and project activity are not substantial
	Transportation of primary carbon source	CO <sub>2</sub>	Yes	Source of emissions
		CH <sub>4</sub>	No	Negligible and excluded for simplification
		N <sub>2</sub> O	No	Negligible and excluded for simplification
	Primary carbon source <sup>(b)</sup>	CO <sub>2</sub>	Yes	Emissions of the mining process
		CH <sub>4</sub>	Yes	Fugitive methane emissions in coal mining
		N <sub>2</sub> O	Yes	Application of fertilizers in the planting activity and field burning of biomass/coal mine reclamation and ammonium nitrate use Emissions of the mining process
	Cultivation of biomass in a dedicated plantation Primary carbon source <sup>(b)</sup>	CO <sub>2</sub>	Yes	May be a significant emissions source Source of emissions – fossil fuel combustion in the planting
		CH <sub>4</sub>	Yes	May be a significant emissions source Emissions in coal mining process, biomass burning in the plantation establishment (if applicable)
		N <sub>2</sub> O	Yes	May be a significant emissions source Application of fertilizers in the planting activity and field burning of biomass/coal mine reclamation and ammonium nitrate use

<sup>(a)</sup> 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.

<sup>(b)</sup> The emissions from the transportation of reducing agents to the project site are considered to be of the same magnitude under the baseline and project scenario, therefore, these are neglected under this methodology. 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).

## 5.2. Procedure for the identification of the most plausible Selection of the baseline scenario and assessment demonstration of additionality

35. The selection of the baseline scenario and demonstration of additionality should be conducted by applying the "TOOL02: Combined tool to identify the baseline scenario and demonstrate additionality". This methodology is based on the latest version of the "Combined tool to identify the baseline scenario and to demonstrate additionality".<sup>13</sup> The guidance for identification of the baseline scenario is outlined below.

### 5.2.1. Step 1: Identification of alternative scenarios

36. The identification of alternative baseline scenarios (step 1 of the TOOL02) 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*:<sup>14</sup>

- (a) Coal coke iron ore reduction system;
- (b) Renewable charcoal from planted biomass from existing plantations for iron ore reduction system;
- (c) Renewable charcoal from planted biomass from new plantations for iron ore reduction system;
- (d) Non-renewable charcoal based iron ore reduction system;<sup>15</sup>
- (e) Iron ore reduction system based on the use of a mix of the previous reducing agents.

37. 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 to identify the baseline scenario and to demonstrate 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.

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

38. 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 in accordance with the "TOOL02: Combined tool to identify the baseline scenario and to

<sup>13</sup> Annex 14 of the twenty-eighth meeting of the Board, December, 2006.

<sup>14</sup> The project proponent shall list other relevant alternatives as appropriate to the project context.

<sup>15</sup> 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.

demonstrate additionality". 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.

39. 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:

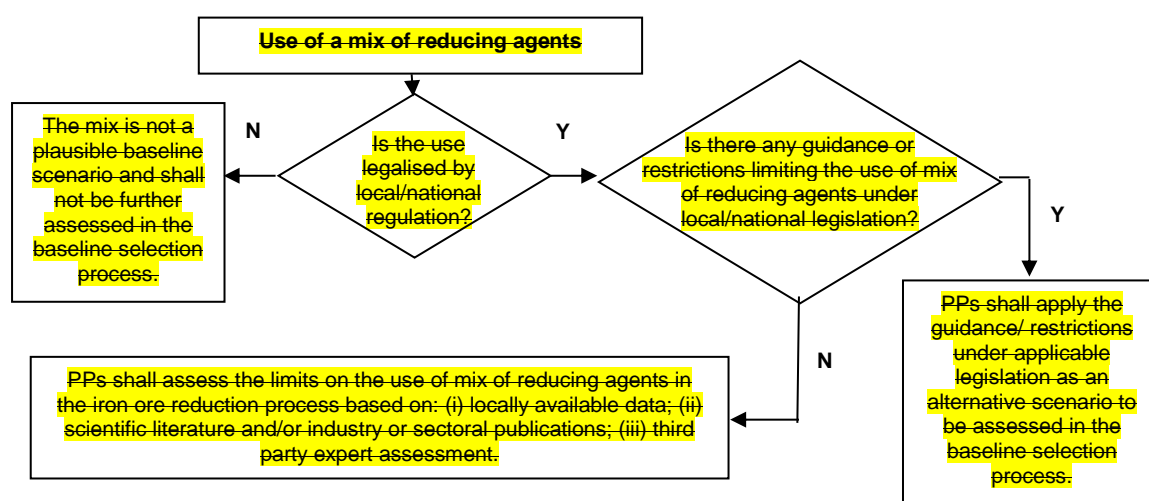
(a) Locally available data;

(b) Scientific literature and/or industry or sectoral publications;

(c) Third party expert assessment.

40. 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.

41. The procedure is summarized in the indicative decision tree below:



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

42. 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.<sup>16</sup> 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.

#### **5.2.1.3. Sub-step 1b: Assessment of supply and demand of reducing agents**

43. 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.

44. 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.

#### **5.2.1.4. Conclusion of Step 1**

45. 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.

#### **5.2.2. Step 2: Barrier analysis**

46. 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:

(a) Subsidies;

(b) Taxes;

(c) Historical and/or current national and/or sector policies;

(d) 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.

(e) Regulatory barriers, e.g. different environmental licensing requirements for different reducing agents.

<sup>16</sup> The differentiations of scales are relevant if laws and regulations have different implications to the national and regional contexts.

47. The barrier analysis may be applied to the integrated iron ore reduction system including:

- (a) The production and supply of the renewable reducing agent (establishment of plantations and production of charcoal); and
- (b) The industrial process (iron ore reduction using a blast furnace technology).

48. 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.

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

- (a) 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:
  - (i) 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;
- (b) 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) then:
  - (i) 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.

#### 5.2.3. Step 3: Investment analysis

49. 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.

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

- (a) 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;

(b) Investments in the iron ore reduction process, which include: investment in the refurbishment or acquisition of different blast furnaces or adaptation of existing blast furnace to the use of charcoal that differ in accordance with the type of reducing agent used.

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

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

(b) (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.:

(i) 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.

52. Investment in the establishment of dedicated plantations must be considered, whether or not the establishment of such plantations is part of an A/R CDM 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 A/R CDM 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.

53. 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.

54. 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.

#### 5.2.4. Step 4: Common practice test

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



- (a) 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;
- (b) 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;
- (c) Historical and existing sector trends shall be taken into account in light of the relationship between supply and demand of reducing agents;
- (d) 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.
56. 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.
57. 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.

### 5.3. Baseline Emissions

58. Baseline emissions are calculated as follows: 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) Baseline upstream emissions 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) Baseline process emissions associated with the use of reducing agents within the iron ore reduction process in the absence of project.
59. 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.

$$BE_y = BE_{RAE_{IRBL,y}} + BU_{IRE_{RABL,y}} \quad \text{Equation (1)}$$

Where:

$BE_y$	=	Total Baseline emissions in the iron ore reduction system in year y (tCO <sub>2</sub> e)
$BE_{IRE_{IRBL,y}}$	=	Baseline process emissions within the iron ore reduction facility (tCO <sub>2</sub> e) Baseline process emissions in the industrial facility in year y (tCO <sub>2</sub> e)
$BU_{RAE_{RABL,y}}$	=	Baseline upstream emissions in from the production and supply of reducing agents reducing agent supply in year y (tCO <sub>2</sub> e)

### 5.3.1. Baseline upstream emissions

60. Upstream emissions are detailed in Appendix 1. The detailed procedure laid out in Appendix 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 Appendix 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 Appendix 1.

61. 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.

62. 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.

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

$$RAE_{BL,y} = PCE_{BL,y} + RAP_{BL,RA,y} + RAT_{Vehicle,BL,y} \quad \text{Equation (2)}$$

Where:

$RAE_{BL,y}$	=	Baseline upstream emissions associated with the supplies of the reducing agent (tCO <sub>2</sub> e)
$PCE_{BL,y}$	=	Emissions from the <i>Primary carbon sources extraction</i> in the baseline scenario during year y (tCO <sub>2</sub> e)
$RAP_{BL,RA,y}$	=	GHG emissions from the production of reducing agents within the boundary under the baseline scenario during year y; (tCO <sub>2</sub> e/yr)
$RAT_{Vehicle,BL,y}$	=	CO <sub>2</sub> -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 <sub>2</sub> e/yr)

64. 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.

65. If the identified baseline scenario involves:

- (a) 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;
- (b) 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.

### 5.3.2. Baseline process emissions

66. 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.

67. 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.

68. If the project participant has 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.

### 5.3.3. Baseline emissions within the iron ore reduction facility

$$BE_{IRE_{IRBL,y}} = (P_{PJ,y} \times EF_{Ind,BL}) - \left( P_{PJ,y} \times C_{CHM,BL,y} \times \frac{44}{12} \right) \quad \text{Equation (3)}$$

Where:

$BE_{IRE_{IRBL,y}}$	=	Baseline process emissions within the iron ore reduction facility (tCO <sub>2</sub> e) in year y
$P_{PJ,y}$	=	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 in the baseline (t CO <sub>2</sub> e/t of hot metal)
$C_{CHM,BL,y}$	=	Carbon content per t of hot metal produced in the baseline year y (t C/t of hot metal)
44/12	=	Conversion factor from carbon to CO <sub>2</sub> e; (dimensionless)

#### 5.3.3.1. Calculation of the emission factor to produce one tonne of hot metal for baseline process emissions

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

$$EF_{Ind,BL} = \sum_i \left( \frac{\%C_{BL,i} \times RA_{BL,i}}{100} \right) \times \frac{44}{12} \quad \text{Equation (4)}$$

Where:

$EF_{Ind,BL}$	=	Emission factor to produce one tonne of hot metal in the baseline scenario (tCO <sub>2</sub> e/t of hot metal)
$\%C_{BL,i}$	=	Carbon content in percent of reducing agent <i>i</i> (e.g. coal coke, charcoal, etc.) used in the baseline. It is considered equal to zero for renewable charcoal.
$RA_{BL,i}$	=	Quantity of Reducing agent type <i>i</i> (e.g. coal coke, charcoal, etc.) required to produce one tonne of hot metal in the baseline (tonne of reducing agent/tonne of hot metal) <sup>17</sup>
44/12	=	Conversion factor from carbon to CO <sub>2</sub> e (dimensionless)
<i>i</i>	=	Type of reducing agent <i>i</i> (e.g. coal coke, charcoal, etc.)

### 5.3.3.2. Calculation of carbon fixation factor under the baseline scenario

70. The carbon fixation factor in the baseline scenario is calculated as follows.

$$C_{CHM,BL,y} = \frac{\%C_{HM,PJ,y}}{100} \quad \text{Equation (5)}$$

Where:

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

71. As per the guidance of paragraph 59 of the twenty-fifth meeting of the Board, 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.

### 5.3.4. Baseline upstream emissions from the production and supply of reducing agents

$$BUE_{RA,y} = BUE_{PRA,y} + BUE_{FF,y} \quad \text{Equation (6)}$$

Where:

$BUE_{PRA,y}$	=	Baseline upstream emissions from the production of reducing agents in year <i>y</i> (tCO <sub>2</sub> e)
$BUE_{FF,y}$	=	Baseline upstream emissions from production fossil fuels (tCO <sub>2</sub> e) in year <i>y</i>

72. 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.

$$BUE_{PRA,y} = P_{PJ,y} \times EF_{CO2e,coal\ coke,BL,y} \times RA_{BL,i} \quad \text{Equation (7)}$$

<sup>17</sup> In case of renewable and non-renewable reducing agent mix in the baseline reduction system, project participants shall take into account GHG emissions in proportion to the use of fossil fuel and renewable charcoal.

**Where:**

$BUE_{PRA,y}$	=	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 <sub>2</sub> /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)
$EF_{CO_2e,coal\ coke,BL,y}$	=	Emission factor to produce one tonne of coal coke in the baseline scenario supply chain (tCO <sub>2</sub> e/ 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)

73. 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<sub>4</sub> and CO<sub>2</sub> leakage emissions from coke oven doors and lids.

74. 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<sub>4</sub> and CO<sub>2</sub> 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 <sub>2</sub> eq	1270.5	402.6

\*GWP=24

Source: EPA, 2007

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

### 5.3.5. Baseline upstream emissions from coal production

76. The substitution of fossil fuels by renewable reducing agents, such as charcoal produced from dedicated plantations reduces indirect ("upstream") emissions associated with the production of fossil fuels ( $BUE_{FF,y}$ ), which can be calculated as per "TOOL15: Upstream leakage emissions associated with fossil fuel use."

77. For coal, the following emission stages are considered:

- (a) Emissions from the operation of mining machinery;
- (b) Fugitive methane emissions from coal mines and coal processing;
- (c) Coal transport to the coal coke production sites.

78. 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.

## 5.4. Project Emissions

79. 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.

80. The following equations outline the calculation of the project emissions from two components of the projects, i.e. process emissions and upstream emissions sources of project emissions shall be considered:

$$PE_y = RAE_{PF,y} + IRPE_{IRPF,y} + PUE_{RA,y} \quad \text{Equation (8)}$$

Where:

$PE_y$	=	Project emissions in the new iron ore reduction system in year y (tCO <sub>2</sub> e)
$RAE_{PF,y}$	=	Project upstream emissions associated with production of reducing agents and transport in year y in the project scenario (tCO <sub>2</sub> e)
$IRPE_{IRPF,y}$	=	Project process emissions in the iron ore reduction facility in year y (tCO <sub>2</sub> e)
$PUE_{RA,y}$	=	Project upstream emissions associated with the production and supply of the renewable reducing agent in year y (tCO <sub>2</sub> e)

### 5.4.1. Project upstream emissions

81. Upstream emissions are detailed in Appendix 2. The detailed procedure laid out in Appendix 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 Appendix 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 Appendix 2.
82. 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.
83. 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.

84. 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.

85. If the investment decision of the project proponent involves:

(a) 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 AVR 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 twenty-fifth meeting of the Board decision;<sup>18</sup>

(b) 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).

#### 5.4.2. Project emissions associated with iron reduction ( $PE_{IR,y}$ )

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

(a) Calculation of the project process emissions:

$$PE_{IRE_{IRPJ,y}} = (P_{PJ,y} \times EF_{Ind,PJ,y}) - \left( P_{PJ,y} \times Cc_{HM,PJ,y} \times \frac{44}{12} \right) \quad \text{Equation (9)}$$

Where:

$PE_{IRE_{IRPJ,y}}$	=	Project process emissions in the iron ore reduction facility in year y (tCO <sub>2</sub> e)
$P_{PJ,y}$	=	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 <sub>2</sub> e/t of hot metal) in year y <sup>19</sup>

<sup>18</sup> As per the paragraph 38 of the twenty-fifth meeting of the Board 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.

<sup>19</sup> If no national/local emission factor is publicly available, an IPCC default value can be used.

$C_{HM,PJ,y}$  = Carbon content per t of hot metal produced in the year  $y$  (t C/t of hot metal)

44/12 = Conversion factor from carbon to CO<sub>2</sub>e (dimensionless)

## 87. The emission factor to produce one tonne of hot metal is

### Calculation of project process emission factor:

(i) 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. The emission factor calculation shall follow the rationale below based on the reducing agents adopted in the project scenario;

(ii) Project process emissions shall be calculated using the following formula:

$$EF_{Ind,PJ,y} = \sum_i \frac{(\%C_{PJ,i} \times RA_{PJ,i})}{100} \times \frac{44}{12} \quad \text{Equation (10)}$$

Where:

$EF_{Ind,PJ,y}$  = Emission factor of one tonne of hot metal production under the project scenario (tCO<sub>2</sub>e/t of hot metal) in year  $y$ <sup>20</sup>

$\%C_{PJ,i}$  = 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)

44/12 = Conversion factor from carbon to CO<sub>2</sub>e (dimensionless)

$i$  = Type of reducing agent  $i$  (e.g. coal coke, charcoal, etc.)

### (b) Calculation of carbon fixation factor $Cc_{HM,PJ,y}$ :

## 88. The carbon fixation factor in the project scenario is calculated as follows:

$$Cc_{HM,PJ,y} = \frac{\%C_{HM,PJ,y}}{100} \quad \text{Equation (11)}$$

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)<sup>21</sup>

$\%C_{HM,PJ,y}$  = Percentage of carbon in hot metal (%) in year  $y$

<sup>20</sup> If no national/local emission factor is publicly available, an IPCC default value can be used.

<sup>21</sup> Adopting a conservative approach, the carbon fixed under the project scenario will be accounted as zero under this proposed new methodology.



89. As per the guidance of paragraph 59 of the twenty-fifth meeting of the Board, priority should be given to the local, regional, national and IPCC default values in that order and it is good practice to use UNFCCC GHG Inventory Handbook on the industrial processes sector.

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

$$PUERAE_{RAPJ,y} = PE_{PR,y} + PE_{BC,y} + PUE_{FF,y} \quad \text{Equation (12)}$$

Where:

$PUERAE_{RAPJ,y}$	=	Project upstream emissions associated with production and supply of reducing agents and transport in year $y$ in the project scenario (tCO <sub>2</sub> e)
$PE_{PR,y}$	=	Project emissions associated with the production of reducing agents within the project boundary in the project scenario during in year $y$ ; (tCO <sub>2</sub> /yr)
$PE_{BC,y}$	=	Project emissions associated with the cultivation of biomass in the dedicated plantation in year $y$ (tCO <sub>2</sub> e)
$PUE_{FF,y}$	=	Project upstream emissions from coal production (tCO <sub>2</sub> e) in year $y$

#### 5.4.3. Project emissions associated with the production of the renewable reducing agent ( $PE_{PR,y}$ )

#### 5.4.4. Emissions in the production of charcoal, the renewable reducing agent

91. In the production of charcoal from renewable biomass in the baseline scenario, the methane (CH<sub>4</sub>) emissions could vary depending on the technology used in the carbonization process and the CO<sub>2</sub> emissions are equal to zero because of the renewable nature of the biomass. Therefore, for estimation of CH<sub>4</sub> emissions from carbonization, the use of monitored data shall be mandatory once the GHG emissions rely on the actual operation of the charcoal production.

92. Methane emissions in the charcoal carbonization process are calculated as follows:

$$PE_{PR,y} = P_{PJ,y} \times EF_{CH4,charcoal,BL,y} \times F_{BL,charcoal} \times GWP_{CH4} \quad \text{Equation (13)}$$

Where:

$PE_{PR,y}$	=	Project emissions associated with the production of charcoal used in the iron ore reduction facility during year $y$ (tCO <sub>2</sub> /yr)
$P_{PJ,y}$	=	Hot metal production in year $y$ (hot metal production of the new iron ore reduction system) (tonnes of hot metal)
$EF_{CH4,charcoal,BL,y}$	=	Emission factor to produce renewable charcoal identified in the project supply chain in the baseline scenario (tCH <sub>4</sub> /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 <sub>4</sub> (tCO <sub>2</sub> e/tCH <sub>4</sub> )

93. The methane emission factor from the carbonization activity is associated with the type of technology used and the actual operation of the carbonization process. Project participants could choose between two options:

- (a) Option 1: Calculation of methane emissions based on the best fit statistical relationship between methane emissions and gravimetric yield, in accordance with the most recent version of “ACM0021: Reduction of emissions from charcoal production by improved kiln design and/or abatement of methane”. In this case, the methane emission factor of the carbonization process can be estimated as follows:

$$EF_{CH_4,charcoal,BL,y} = f(Y_{BL}) \quad \text{Equation (14)}$$

Where:

- $EF_{CH_4,charcoal,BL,y}$  = Emission Factor to produce one tonne of renewable charcoal identified in the supply chain in the baseline scenario (tCH<sub>4</sub>/t of charcoal)
- $Y_{BL}$  = Carbonization gravimetric yield in the baseline scenario (t charcoal/t wood on dry basis)

- (b) Option 2: Methane emission factor using helium tracing methods as per the most recent version of small scale methodology AMS-III.K.

#### ~~Carbonization gravimetric yield~~

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

- (a) ~~Option 2: Methane emission factor using helium tracing methods as per Annex 2 of approved small scale methodology AMS-III.K.~~

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

- (a) ~~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 follow the provisions of the most recent version of the Annex 1 of approved small scale methodology AMS-III.K.~~

96. 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.

#### **5.4.5. Project emissions associated with the cultivation of land to produce biomass feedstock in dedicated plantations ( $PE_{BC,y}$ )**

97. Project emissions associated with the cultivation of land in a dedicated plantation are estimated by following the provisions in “TOOL16: Project and leakage emissions from biomass”.

98. Project participants should clearly document and justify in the CDM-PDD which emission sources are applicable to the project activity.

**5.4.6. Project emissions from transportation ( $PE_{TR,y}$ )**

99. Project emissions resulting from transportation of reducing agents to the metal reduction facility are estimated using the latest version of the methodological tool “Project and leakage emissions from transportation of freight”.

**5.4.7. Project upstream emissions from coal production ( $PUE_{FF,y}$ )**

100. In case the project scenario involves the use of coal coke as reducing agent in the iron ore reduction system, upstream emissions attributable to the production of coal can be calculated as per “TOOL15: Upstream leakage emissions associated with fossil fuel use”.

101. The following emission stages are considered:

- (a) Emissions from the operation of mining machinery;
- (b) Fugitive methane emissions from coal mines and coal processing;
- (c) Coal transport to the coal coke production sites.

102. Project participants may neglect these sources of emissions under the project scenario if they are neglected under the baseline. Project participants should clearly document and justify in the CDM-PDD which emission sources are applicable to the project activity.

**5.5. Leakage**

103. The leakage emissions are calculated as follows:

$$LE_y = LE_{Activity,y} \quad \text{Equation (15)}$$

Where:

$LE_y$  = Leakage emissions in year  $y$  (tCO<sub>2</sub>)

$LE_{Activity,y}$  = Leakage emissions due to shift of pre-project activities in year  $y$  (tCO<sub>2</sub>)

104. Please note that the overall leakage emissions shall not be less than zero. In cases where, in year  $y$ ,  $LE_y$  is less than zero, consider it as zero.

**5.5.1. Leakage emissions due to shift of pre-project activities**

105. Leakage emissions due to shift of pre-project activities shall be calculated according to section 7 of the TOOL16: “Project and leakage emissions from biomass”. 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.

106. The dedicated plantation is considered a fundamental part of the investment decision required to establish a new iron reduction system. However, 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.

107. The increased emissions from the displacement of economic activities such as 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 Appendix 3.

108. 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 Appendix 3.

109. 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 A/R CDM activity this condition is not applicable to the corresponding areas.

110. 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.

$$LK_y = LK_{PJ,Activity_{Disp},y} - LK_{BL,Activity_{Disp},y} \quad \text{Equation (16)}$$

Where:

$LK_y$	=	Annual GHG emissions outside the project boundary; tonnes CO <sub>2</sub> -e yr <sup>-1</sup> in year y
$LK_{PJ,Activity_{Disp},y}$	=	Annual project GHG emissions outside the project boundary resulting from displacement of economic activities; tonnes CO <sub>2</sub> -e yr <sup>-1</sup> in year y
$LK_{BL,Activity_{Disp},y}$	=	Annual baseline GHG emissions outside the project boundary resulting from displacement of economic activities; tonnes CO <sub>2</sub> -e yr <sup>-1</sup> in year y

111. 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.

### 5.5.2. Determination of activity displacement

112. 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.

113. 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.

#### 5.5.2.1. No activity displacement

114. No displacement of activities associated with the project is expected from the project and  $LK_{Activity\_Disp, t} = 0$  if:

- (a) 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;

(b) 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;

(c) Area outside the project serves as temporary (seasonal) substitute to provide the foregone goods from the project;

(d) 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.

#### 5.5.2.2. Activity displacement

115. 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:

(a) Land use change — conversion of forest land outside the project boundary to agriculture, grazing and other land uses;

(b) Degradation of biomass resources — from the prolonged harvest of fuelwood.

116. The detailed steps to calculate leakage emissions from activity displacement are presented in Appendix 3.

### 5.6. Emission Reductions

117. Emission reductions are calculated as follows:

118. 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.

119. 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 the baseline are higher than those of the project.<sup>22</sup> Thus only emissions reductions based on the use of renewable reducing agents in the iron ore reduction facility will generate CERs.

$$ER_y = BE_y - PE_y - LE_y - \text{MAX} (0, BUE_{RA,y} RAE_{BL,y} - PUE_{RA,y} RAE_{PJ,y}) \quad \text{Equation (17)}$$

Where:

$ER_y$  = Emission reductions in year  $y$  (tCO<sub>2</sub>e/yr)

$BE_y$  = Baseline emissions in year  $y$  (tCO<sub>2</sub>e/yr)

$PE_y$  = Project emissions in year  $y$  (tCO<sub>2</sub>/yr)

$LE_y$  = Leakage emissions in year  $y$  (tCO<sub>2</sub>/yr)

$BUE_{RA,y} RAE_{BL,y}$  = Baseline upstream emissions from the production and supply of the reducing agent in year  $y$  (tCO<sub>2</sub>e)

$PUE_{RA,y} RAE_{PJ,y}$  = Project upstream emissions associated with production and supply of reducing agents in year  $y$  (tCO<sub>2</sub>e)

## 5.7. Changes required for methodology implementation in 2<sup>nd</sup> and 3<sup>rd</sup> crediting periods

120. Not applicable.

## 5.8. Data and parameters not monitored

121. 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.

Data / Parameter table 1.

Data / Parameter:	%C <sub>BL,i</sub>
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 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

<sup>22</sup> This provision does not affect the claiming of tCERs or ICERs due to net GHG removals attributable to the additional plantation stocks within specific A/R project activities (as per EB 20 guidance).

Data / Parameter table 2.

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

Data / Parameter table 3.

Data / Parameter:	$EF_{vf,BL}$										
Data unit:	kg CO <sub>2</sub> -litre <sup>-1</sup>										
Description:	Emission factor for vehicle type <i>v</i> with fuel type <i>f</i> in the baseline scenario										
Source of data:	<p>The following data sources may be used if the relevant conditions apply:</p> <table border="1"> <thead> <tr> <th>Data source</th><th>Conditions for using the data source</th></tr> </thead> <tbody> <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> </tbody> </table>	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
Data source	Conditions for using the data source										
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(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):	<p>For (a) and (b): Measurements should be undertaken in line with national or international standards.</p> <p>For (a): If the fuel supplier does provide the NCV value and the CO<sub>2</sub> emissions factor on the invoice and these two values are based on measurements for this specific fuel, the CO<sub>2</sub> factor should be used. If option a) is not available then options (b), (c) or (d) should be used</p>										
Any comment:											

**Data / Parameter table 4.**

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

**Data / Parameter table 5.**

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

**Data / Parameter table 6.**

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

**Data / Parameter table 7.**

<b>Data / Parameter:</b>	$v_{BL}$
<b>Data unit:</b>	Unit numbers
<b>Description:</b>	vehicle type in the baseline scenario
<b>Source of data:</b>	Refer to Baseline Emissions section for applicable guidance



Measurement procedures (if any):	N/A
Any comment:	

**Data / Parameter table 8.**

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

**Data / Parameter table 9.**

Data / Parameter:	$F_{BLmachinery}$										
Data unit:	tCO <sub>2</sub> /t Coal										
Description:	GHG emissions from fossil fuel consumption due to the coal mining machinery in the baseline scenario during year y										
Source of data:	<p>The following data sources may be used if the relevant conditions apply:</p> <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>	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
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(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.										
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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 NGV value and the CO <sub>2</sub> emissions factor on the invoice and these two values are based on measurements for this specific fuel, the CO <sub>2</sub> factor should be used. If option (a) is not available then options (b), (c) or d) should be used
Any comment:	Use the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" 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 table 10.**

Data / Parameter:	$E_{BLmachinery}$
Data unit:	tCO <sub>2</sub> /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 TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" 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 for applicable guidance
Measurement procedures (if any):	N/A
Any comment:	

**Data / Parameter table 11.**

Data / Parameter:	$F_{BLfugitive}$
Data unit:	tCO <sub>2</sub> (e)/t Coal
Description:	CH <sub>4</sub> fugitive emissions due to the coal mining activity in the baseline scenario during year y
Source of data:	Refer to Baseline Emissions section for applicable guidance
Measurement procedures (if any):	N/A
Any comment:	Use Methane GWP factor of 21 to covert CH <sub>4</sub> emissions to CO <sub>2</sub> emissions

**Data / Parameter table 12.**

<b>Data / Parameter:</b>	$E_{BL, \text{cleany}}$
<b>Data unit:</b>	tCO <sub>2</sub> /t Coal
<b>Description:</b>	Electricity consumption GHG emissions due to the coal cleaning activities in the baseline scenario during year y
<b>Source of data:</b>	Use the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" 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 for applicable guidance
<b>Measurement procedures (if any):</b>	N/A
<b>Any comment:</b>	N/A

**Data / Parameter table 13.**

<b>Data / Parameter:</b>	$E_{BL, \text{Amy}}$
<b>Data unit:</b>	tCO <sub>2</sub> /t Coal
<b>Description:</b>	GHG emissions due to the use of ammonium nitrate and mine reclamation activities in the baseline scenario during year y
<b>Source of data:</b>	Refer to Baseline Emissions section for applicable guidance
<b>Measurement procedures (if any):</b>	N/A
<b>Any comment:</b>	N/A

**Data / Parameter table 14.**

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

**Data / Parameter table 15.**

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

**Data / Parameter table 16.**

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

**Data / Parameter table 17.**

<b>Data / Parameter:</b>	$\overline{EF}_{v,km,CO_2,BL,y}$
<b>Data unit:</b>	tCO <sub>2</sub> /km
<b>Description:</b>	CO <sub>2</sub> emission factor for the type <i>v</i> of vehicle during the year <i>y</i> in the baseline scenario
<b>Source of data:</b>	Refer to Baseline Emissions section for applicable guidance
<b>Measurement procedures (if any):</b>	N/A
<b>Any comment:</b>	

**Data / Parameter table 18.**

<b>Data / Parameter:</b>	$\overline{EF}_{CO_2e,coal\ coke,BL,y}$
<b>Data unit:</b>	tCO <sub>2</sub> e/ t of coal coke
<b>Description:</b>	Emission factor to produce one tonne of coal coke in the baseline scenario
<b>Source of data:</b>	Refer to Baseline Emissions section for applicable guidance

Measurement procedures (if any):	Estimated
Any comment:	

**Data / Parameter table 19.**

<b>Data / Parameter:</b>	$EF_{CH_4, \text{charcoal}, BL, y}$
Data unit:	tCH <sub>4</sub> /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 for applicable guidance
Measurement procedures (if any):	N/A
Any comment:	N/A

**Data / Parameter table 20.**

<b>Data / Parameter:</b>	$F_{BL, \text{charcoal}}$
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 for applicable guidance
Measurement procedures (if any):	N/A
Any comment:	N/A

**Data / Parameter table 21.**

<b>Data / Parameter:</b>	$GWP_{CH_4}$
Data unit:	(tCO <sub>2e</sub> /tCH <sub>4</sub> )
Description:	Global warming potential of CH <sub>4</sub>
Source of data:	IPCC
Measurement procedures (if any):	21 for the first commitment period. Shall be updated according to any future COP/MOP decisions
Any comment:	-

**Data / Parameter table 22.**

<b>Data / Parameter:</b>	$Y_{BL}$
Data unit:	t charcoal/ t wood on dry basis

<b>Description:</b>	Carbonization gravimetric yield in the baseline scenario
<b>Source of data:</b>	Refer to Baseline Emissions section for applicable guidance
<b>Measurement procedures (if any):</b>	N/A
<b>Any comment:</b>	

Data / Parameter table 23.

<b>Data / Parameter:</b>	$EG_{BL,blast\_furnace}$
<b>Data unit:</b>	MWhKiloWatt
<b>Description:</b>	Electricity generated from blast furnace recovered gas in the baseline scenario
<b>Source of data:</b>	On-site measurements Measuring device
<b>Measurement procedures (if any):</b>	Use calibrated electricity meters Check the measuring device for power generation and consumption
<b>Any comment:</b>	Data collected from internal sources of an average of minimum 3 years of electricity generation. Measurement occurs continuously

Data / Parameter table 24.

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

Data / Parameter table 25.

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

QA/QC procedures:	N/A
Any comment:	N/A

**Data / Parameter table 26.**

Data / Parameter:	$EF_{vf,PJ}$										
Data unit:	kg CO <sub>2</sub> /litre										
Description:	Emission factor for vehicle type v with fuel type f in the project scenario										
Source of data:	<p>The following data sources may be used if the relevant conditions apply:</p> <table border="1"> <thead> <tr> <th>Data source</th><th>Conditions for using the data source</th></tr> </thead> <tbody> <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> </tbody> </table>	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) 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.	If a) is not available
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Any comment:											

**Data / Parameter table 27.**

Data / Parameter:	$EF_{v,km,CO_2,PJ,y}$
Data unit:	tCO <sub>2</sub> /km
Description:	CO <sub>2</sub> 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:	
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Data / Parameter table 28.

Data / Parameter:	<i>CF</i>
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:	

## 6. Monitoring methodology

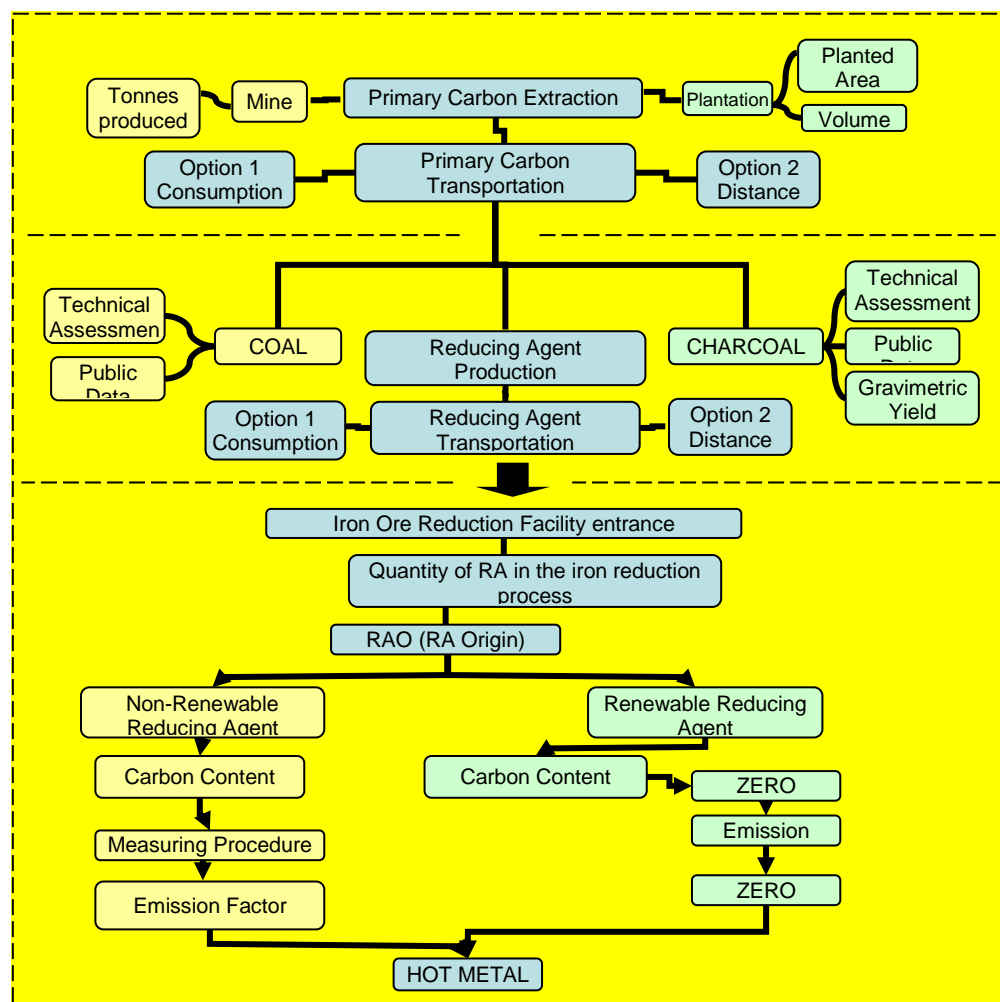
### Monitoring procedures

122. All data collected as part of monitoring should be archived electronically and be kept for at least for two years after the end of the last crediting period. 100% of the data should be monitored if not indicated otherwise in the tables below. All measurements should be conducted with calibrated measurement equipment according to relevant industry standards.
123. 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.
124. 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.

### 6.1. Monitoring of project emissions parameters

125. 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 2) 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****6.1.1. Monitoring of project reducing agents component emissions parameters**

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

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

127. **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:

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

(c) Type of vehicle and fuel used to transport the reducing agent (e.g. diesel);

(d) Fossil fuel consumption to transport the primary carbon source to the reducing agent production site (quantity of fossil fuel used in the transportation);

(e) Emission factor per type of vehicles and type of fuel used.

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

(a) Number of round trips per type of vehicle;

(b) Average round trip distance from the primary carbon extraction site to the reducing agent production site;

(c) Emission factor per type of vehicle.

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

129. Carbonization:

(a) Gravimetric yield as per AM0041;

(b) Helium tracing as per provisions of the most recent version of the Annex 1 of approved small scale methodology AMS-III.K.

130. Coal Coke production

(a) Technology assessment.

#### 6.1.1.3. Data on transportation variables of reducing agents to be monitored

131. **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:

(a) Number of vehicles (per type and type of fuel used);

(b) Distance from the reducing agent production site to the iron reduction facility;

(c) Type of vehicle and fuel used to transport the reducing agent (e.g. diesel);

(d) 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);

(e) Emission factor per type of vehicles and type of fuel used.

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

(a) Number of round trips per type of vehicle;

(b) Average round trip distance from the reducing agent production site to the iron reduction facility;

(c) Emission factor per type of vehicle.

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

- (a) Fuel/Reducing agent consumption (quantity of reducing agent used in the iron ore reduction process);
- (b) Fuel/Reducing agent origin (e.g. fossil or renewable);
- (c) Fuel/Reducing agent carbon content:
  - (i) 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;
  - (ii) 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.

133. The DOE shall verify the consistency between the volume of renewable biomass supplied to the industrial facility and the amount of biomass which can be reasonably produced by the plantations implemented in the context of the project activity in order to supply the iron ore reduction process with renewable reducing agents. This can be done based on the forest management plans for these plantations.

**6.1.2.1. Data on variables to be monitored at the end of the iron ore reduction process**

- (a) Hot metal amount produced in the iron ore reduction process;
- (b) Hot metal carbon content.

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

**6.2. Monitoring of leakage emissions parameters**

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

**6.2.1. Data on activity displacement emissions to be monitored**

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

136. 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.

**6.2.1.1. Quality assurance and quality control procedures**

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

**6.3. Data and parameters monitored****Data / Parameter table 29.**

<b>Data / Parameter:</b>	$P_{PJ,y}$
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:	Monitoring equipment shall be calibrated periodically 100% of the total iron ore reduction facility shall be weighted
Any comment:	N/A

**Data / Parameter table 30.**

<b>Data / Parameter:</b>	$\%C_{PJ,i}$
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 table 31.**

<b>Data / Parameter:</b>	$RA_{PJ,i}$
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 table 32.**

<b>Data / Parameter:</b>	$\%C_{HMPJ,y}$
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 is considered zero

**Data / Parameter table 33.**

<b>Data / Parameter:</b>	$V_{PJ}$
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 table 34.**

<b>Data / Parameter:</b>	$f_{PJ}$
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 table 35.**

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

**Data / Parameter table 36.**

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

**Data / Parameter table 37.**

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

**Data / Parameter table 38.**

<b>Data / Parameter:</b>	$N_{V,PJ,y}$
<b>Data unit:</b>	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 table 39.**

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 table 40.**

Data / Parameter:	$EF_{CH_4,charcoal,PJ,y}$
Data unit:	t CH <sub>4</sub> /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 table 41.**

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 table 42.**

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

**Data / Parameter table 43.**

<b>Data / Parameter:</b>	$F_{PJ, machine, y}$										
<b>Data unit:</b>	tCO <sub>2</sub> /t Coal										
<b>Description:</b>	GHG emissions from fossil fuel consumption due to the coal mining machinery in the project scenario during year y										
<b>Source of data:</b>	<p>The following data sources may be used if the relevant conditions apply:</p> <table border="1"> <thead> <tr> <th>Data source</th><th>Conditions for using the data source</th></tr> </thead> <tbody> <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> </tbody> </table>	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
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(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 CO <sub>2</sub> emissions factor on the invoice and these two values are based on measurements for this specific fuel, the CO <sub>2</sub> factor should be used. If Option (a) is not available then Options (b), (c) or (d) should be used
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:	Use the "Tool to calculate project or leakage CO <sub>2</sub> 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

**Data / Parameter table 44.**

Data / Parameter:	$E_{PJ, machine, y}$
Data unit:	tCO <sub>2</sub> /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 TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" 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 table 45.**

Data / Parameter:	$F_{PJ, fugitive, y}$
Data unit:	tCO <sub>2</sub> /t Coal
Description:	CH <sub>4</sub> 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
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**Data / Parameter table 46.**

Data / Parameter:	$E_{PJ, clean, y}$
Data unit:	tCO <sub>2</sub> /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 TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" 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 table 47.**

Data / Parameter:	$E_{PJ, Am, y}$
Data unit:	tCO <sub>2</sub> /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 table 48.**

Data / Parameter:	$EF_{CO2e, coal coke, PJ, y}$
Data unit:	tCO <sub>2</sub> e/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 table 49.**

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

**Data / Parameter table 50.**

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

**Data / Parameter table 51.**

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

**Data / Parameter table 52.**

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

**Data / Parameter table 53.**

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

**Data / Parameter table 54.**

<b>Data / Parameter:</b>	$EF_{all-pools}$
<b>Data unit:</b>	Factor
<b>Description:</b>	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)
<b>Source of data:</b>	Project monitoring data
<b>Measurement procedures (if any):</b>	N/A
<b>Monitoring frequency:</b>	Year 1
<b>QA/QC procedures:</b>	
<b>Any comment:</b>	Expansion factor depends upon the density of vegetation

**Data / Parameter table 55.**

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

**Data / Parameter table 56.**

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

**Data / Parameter table 57.**

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

**Data / Parameter table 58.**

<b>Data / Parameter:</b>	$BEF_{\tau}$
<b>Data unit:</b>	Factor
<b>Description:</b>	biomass expansion factor for converting volumes of extracted roundwood to total above-ground biomass (including bark)
<b>Source of data:</b>	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 table 59.**

<b>Data / Parameter:</b>	$P_y$
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 table 60.**

<b>Data / Parameter:</b>	$HS$
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 table 61.**

<b>Data / Parameter:</b>	$FCA$
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 table 62.**

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

**Data / Parameter table 63.**

<b>Data / Parameter:</b>	<del>EG<sub>PJ,blast_furnace</sub></del>
<b>Data unit:</b>	MWhKiloWatt
<b>Description:</b>	Electricity generated from blast furnace recovered gas in the project scenario
<b>Source of data:</b>	On-site measurements Project monitoring data
<b>Measurement procedures (if any):</b>	Use calibrated electricity meters Check the measuring device for power generation and consumption
<b>Monitoring frequency:</b>	Annually
<b>QA/QC procedures:</b>	
<b>Any comment:</b>	Data collected from internal sources. Measurement occurs continuously

## Appendix 1. Upstream Emissions of the Baseline Scenario

1. 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 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.
2. 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.
3. 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.
4. 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.

### 1. Coal coke reducing agent in the baseline scenario

5. 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.
6. The primary carbon source extraction of the baseline scenario shall be calculated using the following formula:

$$PCE_{BL,y} = CM_{BL,y} \quad \text{Equation (18)}$$

Where:

$PCE_{BL,y}$	=	Baseline primary carbon source extraction emissions within the reducing agent component (tCO <sub>2</sub> e)
$CM_{BL,y}$	=	GHG emissions associated with coal mining activities in the baseline scenario during year y (tCO <sub>2</sub> )

#### 1.1. Coal mining emissions

7. Coal extraction activities in either surface or underground mining result in positive GHG emissions associated with:
  - (a) Emissions from the operation of mining machinery;



(b) Fugitive methane emissions from coal mines, and coal cleaning, use of ammonium nitrate and mine reclamation activities;

(c) Coal transport to the coal coke production sites.

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

(a) Identification in terms of mine type, coal extraction technology and its net potential fugitive<sup>1</sup> 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.

9. Once the most conservative scenario is identified the following equations shall be applied to estimate coal mining emissions.<sup>2</sup>

$$CM_{BL,y} = (CM_{BL,machine,y} + CM_{BL,fugitive,y}) \times RA_{BL,t} \times P_{PJ,y} + CM_{BL,vehicle,y} \quad \text{Equation (19)}$$

Where:

$CM_{BL,y}$	=	GHG emissions due to the coal mining activities in the baseline scenario during year y (tCO <sub>2</sub> )
$CM_{BL,machine,y}$	=	GHG emissions due to the coal mining machinery in the baseline scenario during year y (tCO <sub>2</sub> /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 (tCO <sub>2</sub> /t Coal)
$CM_{BL,vehicle,y}$	=	CO <sub>2</sub> emissions from fossil fuel combustion in the vehicles used to transport coal to the coal coke production units within the project boundary (tCO <sub>2</sub> /yr)
$RA_{BL,t}$	=	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)

## 1.2. Emissions from the operation of mining machinery

$$CM_{BL,machine,y} = F_{BL,machine,y} + E_{BL,machine,y} \quad \text{Equation (20)}$$

<sup>1</sup> Treatments of the fugitive emissions in the baseline scenario shall also be accounted in this assessment.

<sup>2</sup> 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:**

$GM_{BL,machine,y}$  = GHG emissions due to the coal mining machinery in the baseline scenario during year  $y$  (tCO<sub>2</sub>/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<sub>2</sub>/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<sub>2</sub>/t Coal)

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

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

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

$$GM_{BL,fugitive,y} = F_{BL,fugitive,y} + E_{BL,clea,y} + E_{BL,Am,y} \quad \text{Equation (21)}$$

**Where:**

$GM_{BL,fugitive,y}$  = 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<sub>2</sub>/t Coal)

$F_{BL,fugitive,y}$  = CH<sub>4</sub> fugitive emissions due to the coal mining activity in the baseline scenario during year  $y$  (tCO<sub>2(e)</sub>/t Coal)

$E_{BL,clea,y}$  = Electricity consumption GHG emissions due to the coal cleaning activities in the baseline scenario during year  $y$  (tCO<sub>2</sub>/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<sub>2</sub>/t Coal)

12. 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 1. Default emission factors for fugitive CH<sub>4</sub> emissions from coal mining**

Default IPCC Emissions Factor (m <sup>3</sup> CH <sub>4</sub> /tonne of coal)			
Category	Low	High	Average
Underground Mining	10	25	18
Surface Mining	0.3	2	1.2

**Source: IPCC, 2006**

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

**1.4. Coal transport to the coal coke production sites**

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

15. In case the step is under the control of project proponents, the 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, paragraph 25 of the twenty-fifth meeting of the Board, 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;

(i) **Option 1: Baseline emissions from transport based on fuel consumption of vehicles:**

a. **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;

b. **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;

c. **Step 3:** From the baseline data on vehicle use, and fuel consumed in the transportation of coal within the project boundary, the CO<sub>2</sub> emissions are estimated/ calculated as below, using the bottom up approach described in GPG 2000:

$$GM_{BL,vehicle,y} = \sum_{v,BL} \sum_{f,BL} \frac{EF_{vf,BL} \times FC_{vf,BL,y}}{1000} \quad \text{Equation (22)}$$

$$FC_{vf,BL,y} = n_{vf,BL,y} \times k_{vf,BL,y} \times e_{vf,BL} \quad \text{Equation (23)}$$

Where:

$GM_{BL,vehicle,y}$  = CO<sub>2</sub> 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<sub>2</sub>/yr)

$EF_{vf,BL}$  = Emission factor for vehicle type v with fuel type f in the baseline scenario (kg CO<sub>2</sub>/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)

$vf,BL$  = Vehicle type in the baseline scenario

$f,BL$  = Fuel type in the baseline scenario

(ii) **Option 2:** Baseline emissions from transport based on distance traveled by vehicles:

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

$$GM_{BL,vehicle,y} = N_{v,BL,y} \times AVD_{f,BL,y} \times EF_{v,km,CO_2,BL,y} \quad \text{Equation (24)}$$

Where:

$GM_{BL,vehicle,y}$  = CO<sub>2</sub> 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<sub>2</sub>/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

$AVD_{f,BL,y}$  = 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  $y$

$EF_{v,km,CO_2,BL,y}$  = CO<sub>2</sub> emission factor for the type  $v$  of vehicle during the year  $y$  in the baseline scenario (tCO<sub>2</sub>/km)

## 1.5. Coal coke production

16. 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:

$$RAP_{BL,coal\ coke,y} = P_{PJ,y} \times EF_{CO_2e,coal\ coke,BL,y} \times RA_{BL,t} \quad \text{Equation (25)}$$

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<sub>2</sub>/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)

$EF_{CO_2e,coal\ coke,BL,y}$  = Emission factor to produce one tonne of coal coke in the baseline scenario supply chain; (tCO<sub>2</sub>e/ t of Coal coke)

$RA_{BL,t}$  = Quantity of coal coke necessary to produce one tonne of hot metal; (t Coal coke /t of hot metal)

17. 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<sub>4</sub> and CO<sub>2</sub> leakage emissions from coke oven doors and lids.

18. 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 2. Default emission factors for fugitive CH<sub>4</sub> and CO<sub>2</sub> 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 <sub>2</sub> eq	1270.5	402.6

\*GWP=24

Source: EPA, 2007

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

## 2. Mix of reducing agents in baseline scenario

20. 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.

$$PCE_{BL,y} = CM_{BL,y} + EP_{BL,y} \quad \text{Equation (26)}$$

Where:

$PCE_{BL,y}$	=	Baseline primary carbon source extraction emissions within the reducing agent component (tCO <sub>2</sub> e)
$CM_{BL,y}$	=	GHG emissions due to the coal mining activities in the baseline scenario during year y (tCO <sub>2</sub> ). 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 <sub>2</sub> /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

21. 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.

$$RAP_{BL,RA,y} = RAP_{BL,RA,y} + RAP_{BL,charcoal,y} \quad \text{Equation (27)}$$

Where:

$$RAP_{BL,RA,y} = \text{GHG emissions within the project boundary due to production of reducing agents used in the iron ore reduction facility in the baseline scenario during year } y, (\text{tCO}_2/\text{yr})$$

$$RAP_{BL,RA,y} = \text{GHG emissions within the project boundary due to production of coal coke used in the iron ore reduction facility in the baseline scenario during year } y, (\text{tCO}_2/\text{yr})$$

$$RAP_{BL,charcoal,y} = \text{GHG emissions within the project boundary due to the production of charcoal used in the iron ore reduction facility in the project operation during year } y, (\text{tCO}_2/\text{yr})$$

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

23. 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.

### 3. Emissions in the establishment of plantations and production of biomass

24. 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:

$$EP_{BL,y} = E_{FuelBurn,BL,y} + BE_{BB,y} + N_2O_{direct-N_{fertilizer},BL,y} + EP_{Vehicle,BL,y} \quad \text{Equation (28)}$$

Where:

$$EP_{BL,y} = \text{GHG emissions of the establishment of plantations to produce biomass within the project boundary in the baseline scenario during year } y, (\text{tCO}_2/\text{t biomass})$$

$$E_{FuelBurn,BL,y} = \text{CO}_2\text{-emissions from combustion of fossil fuels within the project boundary in the baseline scenario; tonnes CO}_2\text{-e yr}^{-1}\text{ in year } y$$

$$BE_{BB,y} = \text{Baseline emissions arising from field burning of biomass at the plantation site (tCO}_2\text{e/yr)}$$

$$N_2O_{direct-N_{fertilizer},BL,y} = \text{N}_2\text{O emissions as a result of direct nitrogen application within the project boundary in the baseline scenario; (tonnes CO}_2\text{-e yr}^{-1}\text{ in year } y)$$

$$EP_{Vehicle,BL,y} = \text{CO}_2\text{-emissions within the project boundary due to fossil fuel combustion from vehicles used to transport biomass to carbonization unit during year } y \text{ of the baseline scenario; (tCO}_2/\text{yr)}$$

**3.1. Calculation of CO<sub>2</sub> emissions from burning fossil fuels**

25. The project proponent shall use the “Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion”.<sup>3</sup>

**3.2. Calculation of emissions arising from field burning of biomass at the plantation site**

26. The project proponent shall use the “Tool for the estimation of GHG emissions from clearing, burning and decay of existing vegetation due to implementation of a CDM A/R project activity”.

**3.3. Calculation of nitrous oxide emissions from nitrogen fertilization practices**

27. The project proponent shall use the tool “Estimation of direct nitrous oxide emission from nitrogen fertilization”.

**3.4. Biomass transport to the carbonization sites**

28. 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):

(a) **Option 1:** Baseline emissions from transport based on fuel consumption of vehicles:

(i) **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;

(ii) **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;

(iii) **Step 3:** From the baseline data on vehicle use, and fuel consumed in the transportation of biomass within the project boundary, the CO<sub>2</sub> emissions are estimated/ calculated as below, using the bottom up approach described in GPG 2000:

$$EP_{Vehicle, BL, y} = \sum_{v, BL} \sum_{f, BL} \frac{EF_{vf, BL} \times FC_{vf, BL, y}}{1000} \quad \text{Equation (29)}$$

$$FC_{vf, BL, y} = n_{vf, BL, y} \times k_{vf, BL, y} \times e_{vf, BL} \quad \text{Equation (30)}$$

<sup>3</sup> This tool can be used for baseline situation also where accurate data on baseline scenario fuel consumption is available.

**Where:**

$EP_{vehicle,BL,y}$	=	CO <sub>2</sub> -emissions within the project boundary due to fossil fuel combustion from vehicles used to transport biomass to carbonization unit during year <i>y</i> of the baseline scenario; (tCO <sub>2</sub> /yr)
$EF_{vf,BL}$	=	Emission factor for vehicle type <i>v</i> with fuel type <i>f</i> in the baseline scenario; (kg CO <sub>2</sub> /litre)
$FC_{vf,BL,y}$	=	Consumption of fuel type <i>f</i> of vehicle type <i>v</i> in the baseline scenario; (litres per year <i>y</i> )
$n_{vf,BL,y}$	=	Number of vehicles of type <i>v</i> with fuel type <i>f</i> in year <i>y</i> in the baseline scenario
$k_{vf,BL,y}$	=	Kilometers traveled by each of vehicle type <i>v</i> with fuel type <i>f</i> in the baseline scenario; (km per year <i>y</i> )
$e_{vf,BL}$	=	Average fuel consumption of vehicle type <i>v</i> with fuel type <i>f</i> in the baseline scenario; (litres/km)
$v_{BL}$	=	Vehicle type in the baseline scenario
$f_{BL}$	=	Fuel type in the baseline scenario

**(b) Option 2: Baseline emissions from transport based on distance traveled by vehicles:**

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

$$EP_{vehicle,BL,y} = N_{v,BL,y} \times AVD_{t,BL,y} \times EF_{v,km,CO_2,BL,y} \quad \text{Equation (31)}$$

**Where:**

$EP_{vehicle,BL,y}$	=	CO <sub>2</sub> -emissions within the project boundary due to fossil fuel combustion from vehicles used to transport biomass to carbonization unit during year <i>y</i> of the baseline scenario; (tCO <sub>2</sub> /yr)
$N_{v,BL,y}$	=	Number of round trips (to and from) per type <i>v</i> of vehicle during the year <i>y</i> in the baseline scenario
$AVD_{t,BL,y}$	=	Average round trip distance (to and from) between the biomass <i>v</i> production site (s) and the site of plantation during the year <i>y</i> in the baseline scenario (km)
$EF_{v,km,CO_2,BL,y}$	=	CO <sub>2</sub> -emission factor for the type <i>v</i> of vehicle during the year <i>y</i> in the baseline scenario (tCO <sub>2</sub> /km)

**4. Emissions in the production of charcoal, the renewable reducing agent**

29. In the production of charcoal from renewable biomass in the baseline scenario, the methane (CH<sub>4</sub>) emissions could vary depending on the technology used in the carbonization process and the CO<sub>2</sub>-emissions are equal to zero because of the renewable nature of the biomass. Therefore, for estimation of CH<sub>4</sub>-emissions from carbonization, the use of monitored data shall be mandatory once the GHG emissions rely on the actual operation of the charcoal production.



30. The methane emissions in carbonization can be calculated as below:

$$RAP_{BL,charcoal,y} = P_{PJ,y} \times EF_{CH_4,charcoal,BL,y} \times F_{BL,charcoal} \times GWP_{CH_4} \quad \text{Equation (32)}$$

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 <sub>2</sub> /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)
$EF_{CH_4,charcoal,BL,y}$	=	Emission Factor to produce one tonne of renewable charcoal identified in the project supply chain in the baseline scenario; (tCH <sub>4</sub> /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)
$GWP_{CH_4}$	=	Global warming potential for CH <sub>4</sub> ; (tCO <sub>2</sub> e/tCH <sub>4</sub> )

31. The emission factor of CH<sub>4</sub> 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 AM0041; Option 2: Helium tracing as per the most recent version of the Annex 2 of approved small scale methodology AMS-III-K.

(a) **Option 1:** Methane emission factor as function of gravimetric yield

32. 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.

33. 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:

$$EF_{CH_4,charcoal,BL,y} = f(Y_{BL}) \quad \text{Equation (33)}$$

Where:

$EF_{CH_4,charcoal,BL,y}$	=	Emission Factor to produce one tonne of renewable charcoal identified in the supply chain in the baseline scenario; (tCH <sub>4</sub> /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

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

- (a) **Option 2:** Methane emission factor using helium tracing methods as per Annex 2 of approved small scale methodology AMS-III.K.

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

- (a) 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 follow the provisions of the most recent version of the Annex 1 of approved small scale methodology AMS-III.K.

36. 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.

## 5. Baseline emissions in the transportation of reducing agent

37. 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).

- (a) **Option 1:** Baseline emissions from transport based on fuel consumption of vehicles:

- (i) **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;
- (ii) **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;
- (iii) **Step 3:** From the baseline data on vehicle use, and fuel consumed in the transportation of reducing agents within the project boundary, the CO<sub>2</sub> emissions are estimated/ calculated as below, using the bottom up approach described in GPG 2000:

$$RAT_{vehicle, BL, y} = \sum_{v, BL} \sum_{f, BL} \frac{EF_{vf, BL} \times FC_{vf, BL, y}}{1000} \quad \text{Equation (34)}$$

$$FC_{vf, BL, y} = n_{vf, BL, y} \times k_{vf, BL, y} \times e_{vf, BL} \quad \text{Equation (35)}$$

Where:

$RAT_{vehicle, BL, y}$  = CO<sub>2</sub> 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<sub>2</sub>/yr)

$EF_{vf, BL}$  = Emission factor for vehicle type v with fuel type f in the baseline scenario; (kg CO<sub>2</sub>/litre)

$\overline{FC}_{vf,BL,y}$	=	Consumption of fuel type $f$ of vehicle type $v$ in the baseline scenario; (litres per year $y$ );
$\overline{n}_{vf,BL,y}$	=	Number of vehicles of type $v$ with fuel type $f$ in year $y$ in the baseline scenario
$\overline{k}_{vf,BL,y}$	=	Kilometers traveled by each of vehicle type $v$ with fuel type $f$ in the baseline scenario; (km per year $y$ )
$\overline{e}_{vf,BL}$	=	Average fuel consumption of vehicle type $v$ with fuel type $f$ in the baseline scenario; (litres/km)
$\overline{v}_{BL}$	=	Vehicle type in the baseline scenario
$\overline{f}_{BL}$	=	Fuel type in the baseline scenario

(b) **Option 2:** Baseline emissions from transport based on distance traveled by vehicles:

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

$$RAT_{vehicle,BL} = N_{v,BL,y} \times AVD_{j,BL,y} \times EF_{v,km,CO_2,BL,y} \quad \text{Equation (36)}$$

Where:

$RAT_{vehicle,BL}$	=	CO <sub>2</sub> 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 <sub>2</sub> /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)
$EF_{v,km,CO_2,BL,y}$	=	CO <sub>2</sub> emission factor for the type $v$ of vehicle during the year $y$ in the baseline scenario (tCO <sub>2</sub> /km)

## Appendix 2. Upstream emissions of the project scenario

1. 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:
2. 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;
3. 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.
4. 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.

### 1. Emissions in the establishment of plantations and production of biomass

5. 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:

$$EP_{PJ,y} = E_{FuelBurn,PJ,y} + PE_{BB,y} + N_2O_{direct-N_{fertilizer},PJ,y} + EP_{ventcte,PJ,y} \quad \text{Equation (1)}$$

Where:

$EP_{PJ,y}$	=	GHG emissions of the establishment of plantations to produce biomass in the project scenario during year $y$ ; (tCO <sub>2</sub> /t biomass)
$E_{FuelBurn,PJ,y}$	=	CO <sub>2</sub> emissions from combustion of fossil fuels within the project boundary in the project scenario; tonnes CO <sub>2</sub> -e yr <sup>-1</sup> in year $y$
$PE_{BB,y}$	=	Project emissions arising from field burning of biomass at the plantation site (tCO <sub>2</sub> e/yr)
$N_2O_{direct-N_{fertilizer},PJ,y}$	=	N <sub>2</sub> O emissions as a result of direct nitrogen application within the project boundary in the project scenario; (tonnes CO <sub>2</sub> -e yr <sup>-1</sup> in year $y$ )

$EF_{vehicle,PJ,y}$  = CO<sub>2</sub>-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<sub>2</sub>/yr)

### 1.1. Calculation of CO<sub>2</sub> emissions from burning fossil fuels

6. The project proponent shall use the “Tool to calculate project or leakage CO<sub>2</sub>-emissions from fossil fuel combustion”.

### 1.2. CH<sub>4</sub> and N<sub>2</sub>O emissions from the field burning of biomass

7. The project proponent shall use the “Tool for the estimation of GHG emissions from clearing, burning and decay of existing vegetation due to implementation of a CDM A/R project activity”.

### 1.3. Calculation of nitrous oxide emissions from nitrogen fertilization practices

8. The project proponent shall use the tool “Estimation of direct nitrous oxide emission from nitrogen fertilization”.

### 1.4. Biomass transport to the carbonization sites

9. 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):

(a) **Option 1:** Project emissions from transport based on fuel consumption of vehicles:

(i) **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;

(ii) **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;

(iii) **Step 3:** From the project data on vehicle use, and fuel consumed in the transportation of biomass within the project boundary, the CO<sub>2</sub>-emissions are estimated/calculated as below, using the bottom up approach described in GPG 2000:

$$EP_{vehicle,PJ,y} = \sum_{v,PJ} \sum_{f,PJ} \frac{EF_{vf,PJ} \times FC_{vf,PJ,y}}{1000} \quad \text{Equation (2)}$$

$$FC_{vf,PJ,y} = n_{vf,PJ,y} \times k_{vf,PJ,y} \times c_{vf,PJ} \quad \text{Equation (3)}$$

**Where:**

$EP_{vehicle,PJ,y}$	=	CO <sub>2</sub> 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 <sub>2</sub> /yr)
$EF_{vf,PJ}$	=	Emission factor for vehicle type v with fuel type f in the project scenario; (kg CO <sub>2</sub> /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

**(b) Option 2: Project emissions from transport based on distance traveled by vehicles:**

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

$$EP_{vehicle,PJ,y} = N_{v,PJ,y} \times AVD_{v,PJ,y} \times EF_{v,km,CO_2,PJ,y} \quad \text{Equation (4)}$$

**Where:**

$EP_{vehicle,PJ,y}$	=	CO <sub>2</sub> 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 <sub>2</sub> /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
$AVD_{v,PJ,y}$	=	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)
$EF_{v,km,CO_2,PJ,y}$	=	CO <sub>2</sub> emission factor for the type v of vehicle during the year y in the project scenario (tCO <sub>2</sub> /km)

**2. Emissions in the production of charcoal, the renewable reducing agent**

10. In the production of charcoal from renewable biomass under the project scenario, the methane (CH<sub>4</sub>) emissions could vary depending on the technology used in the carbonization process and the CO<sub>2</sub> emissions are equal to zero because of the renewable nature of the biomass. Therefore, for estimation of CH<sub>4</sub> emissions from carbonization, the use of monitored data shall be mandatory once the GHG emissions rely on the actual operation of the charcoal production.

**11. The methane emissions in carbonization can be calculated as below:**

$$RAP_{PJ, \text{charcoal}, y} = P_{PJ, y} \times EF_{CH_4, \text{charcoal}, PJ, y} \times F_{PJ, \text{charcoal}} \times GWP_{CH_4} \quad \text{Equation (5)}$$

**Where:**

$RAP_{PJ, \text{charcoal}, y}$	=	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 <sub>2</sub> /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)
$EF_{CH_4, \text{charcoal}, PJ, y}$	=	Emission Factor to produce one tonne of renewable charcoal identified in the project supply chain; (tCH <sub>4</sub> /t of charcoal)
$F_{PJ, \text{charcoal}}$	=	Quantity of charcoal necessary to produce one tonne of hot metal; (t charcoal/t of hot metal)
$GWP_{CH_4}$	=	Global warming potential for CH <sub>4</sub> ; (tCO <sub>2</sub> e/tCH <sub>4</sub> )

**12. The emission factor of CH<sub>4</sub> 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 AM0041; Option 2: helium tracing as per the most recent version of the Annex 2 of approved small scale methodology AMS-III.K.:****(a) Option 1: Methane emission factor as function of gravimetric yield.**

- (i) 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;
- (ii) 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:

$$EF_{CH_4, \text{charcoal}, PJ, y} = f(Y_{PJ}) \quad \text{Equation (6)}$$

**Where:**

$EF_{CH_4, \text{charcoal}, PJ, y}$	=	Emission Factor to produce one tonne of renewable charcoal identified in the project supply chain; (tCH <sub>4</sub> / t of charcoal)
$Y_{PJ}$	=	Carbonization gravimetric yield (t charcoal/ t wood on dry basis) (as per the procedure outlined below)

(b) **Option 2:** Methane emission factor using and/or Using helium tracing methods as per CDM approved methodology AMS-III.K;

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

a. 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 follow the provisions of the most recent version of the Annex 2 of approved methodology AMS-III.K;

13. 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.

### 3. Project emissions in the transportation of reducing agent

14. 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);

(a) **Option 1:** Project emissions from transport based on fuel consumption of vehicles:

(i) **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;

(ii) **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;

(iii) **Step 3:** From the baseline data on vehicle use, and fuel consumed in the transportation of reducing agents within the project boundary, the CO<sub>2</sub> emissions are estimated/ calculated as below, using the bottom up approach described in GPG 2000;

$$RAT_{vehicle,PJ,y} = \sum_{v,PJ} \sum_{f,PJ} \frac{EF_{vf,PJ} \times FC_{vf,PJ,y}}{1000} \quad \text{Equation (7)}$$

$$FC_{vf,PJ,y} = n_{vf,PJ,y} \times k_{vf,PJ,y} \times e_{vf,PJ} \quad \text{Equation (8)}$$

Where:

$RAT_{vehicle,PJ,y}$  = CO<sub>2</sub> 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<sub>2</sub>/yr)



$EF_{vf,PJ}$	=	Emission factor for vehicle type $v$ with fuel type $f$ in the project scenario; (kg CO <sub>2</sub> /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

(b) **Option 2:** Project emissions from transport based on distance traveled by vehicles:

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

$$RAT_{vehicle,PJ} = N_{v,PJ,y} \times AVD_{v,PJ,y} \times EF_{v,km,CO_2,PJ,y} \quad \text{Equation (9)}$$

Where:

$RAT_{vehicle,PJ}$	=	CO <sub>2</sub> 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 <sub>2</sub> /yr)
$N_{v,PJ,y}$	=	Number of round trips (to and from) per type $v$ of vehicle had during the year $y$
$AVD_{v,PJ,y}$	=	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)
$EF_{v,km,CO_2,PJ,y}$	=	CO <sub>2</sub> emission factor for the type $v$ of vehicle during the year $y$ (tCO <sub>2</sub> /km)

#### 4. Emissions from the use of reducing agent mix

15. 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 according to the baseline scenario:

$$RAP_{PJ,RA,y} = RAP_{PJ,coal\ coke,y} + RAP_{PJ,charcoal,y} \quad \text{Equation (10)}$$

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 <sub>2</sub> /yr)
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$RAP_{PJ,coal\ coke,y}$  = 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<sub>2</sub>/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 4

$RAP_{PJ,charcoal,y}$  = 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<sub>2</sub>/yr). The emissions associated with the production of charcoal are covered in the above paragraphs of this section

16. 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.

#### 4.1. Coal coke reducing agent in the project scenario

17. 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.

18. 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<sup>1</sup>. To increase conservativeness, the project proponent shall use the same emission factors for the upstream mineral coal chain for the baseline and project cases.

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

$$PCE_{PJ,y} = CM_{PJ,y} \quad \text{Equation (11)}$$

Where:

$PCE_{PJ,y}$  = Project primary carbon source extraction emissions within the reducing agent component (tCO<sub>2</sub>e)

$CM_{PJ,y}$  = GHG emissions associated with coal mining activities in the project scenario during year  $y$  (tCO<sub>2</sub>)

#### 4.2. Coal mining emissions

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

(a) Emissions from the operation of mining machinery;

<sup>1</sup> In case the coal mining activities occurs outside the host country(ies) those emissions can be conservatively neglect.

(b) Fugitive methane emissions from coal mines, and coal cleaning, use of ammonium nitrate and mine reclamation activities;

(c) Coal transport to the coal coke production sites.

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

(a) Common practice identification in terms of mine type, coal extraction technology and its net potential fugitive<sup>2</sup> 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.

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

$$GM_{PJ,y} = (CM_{PJ,machine,y} + CM_{PJ,fugitive,y}) \times RA_{PJ,t} \times RA_{PJ,y} + CM_{PJ,vehicle,y} \quad \text{Equation (12)}$$

Where:

$GM_{PJ,y}$	=	GHG emissions due to the coal mining activities in the project scenario during year y (tCO <sub>2</sub> )
$CM_{PJ,machine,y}$	=	GHG emissions due to the coal mining machinery in the project scenario during year y (tCO <sub>2</sub> /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 <sub>2</sub> /t Coal)
$CM_{PJ,vehicle,y}$	=	CO <sub>2</sub> emissions from fossil fuel combustion in the vehicles used to transport coal to the coal coke production units within the project boundary (tCO <sub>2</sub> /yr)
$RA_{PJ,t}$	=	Quantity of coal coke necessary to produce one tonne of hot metal; (t Coal coke/t of hot metal)
$RA_{PJ,y}$	=	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)

#### 4.3. Emissions from the operation of mining machinery

$$GM_{PJ,machine,y} = F_{PJ,machine,y} + E_{PJ,machine,y} \quad \text{Equation (13)}$$

<sup>2</sup> 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 <sub>2</sub> /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 <sub>2</sub> /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 <sub>2</sub> /t Coal)

23. 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.

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

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

$$CM_{PJ,fugitive,y} = F_{PJ,fugitive,y} + E_{PJ,clea,y} + E_{PJ,Am,y} \quad \text{Equation (14)}$$

**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 <sub>2</sub> /t Coal)
$F_{PJ,fugitive,y}$	=	CH <sub>4</sub> fugitive emissions due to the coal mining activity in the project scenario during year $y$ (tCO <sub>2</sub> /t Coal)
$E_{PJ,clea,y}$	=	Electricity consumption GHG emissions due to the coal cleaning activities in the project scenario during year $y$ (tCO <sub>2</sub> /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 <sub>2</sub> /t Coal)

25. 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 1. Default emission factors for fugitive CH<sub>4</sub> emissions from coal mining**

Default IPCC Emissions Factor (m <sup>3</sup> CH <sub>4</sub> /tonne of coal)			
Category	Low	High	Average
Underground Mining	10	25	18
Surface Mining	0.3	2	1.2

**Source: IPCC, 2006**

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

#### 4.5. Coal transport to the coal coke production sites

27. 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.

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

29. 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:

(a) **Option 1:** Project emissions from transport based on fuel consumption of vehicles:

(i) **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;

(ii) **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;

(iii) **Step 3:** From the project data on vehicle use, and fuel consumed in the transportation of coal within the project boundary, the CO<sub>2</sub> emissions are estimated/calculated as below, using the bottom up approach described in GPG 2000:

$$GM_{PJ,vehicle,y} = \sum_{v,PJ} \sum_{f,PJ} \frac{EF_{vf,PJ} \times FC_{vf,PJ,y}}{1000} \quad \text{Equation (15)}$$

$$FC_{vf,PJ,y} = n_{vf,PJ,y} \times k_{vf,PJ,y} \times e_{vf,PJ} \quad \text{Equation (16)}$$

Where:

$GM_{PJ,vehicle,y}$  = CO<sub>2</sub> 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<sub>2</sub>/yr)

$EF_{vf,PJ}$  = Emission factor for vehicle type v with fuel type f in the project scenario (kg CO<sub>2</sub>/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

**(b) Option 2: Project emissions from transport based on distance traveled by vehicles:**

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

$$CM_{PJ,vehicle,y} = N_{v,PJ,y} \times AVD_{v,PJ,y} \times EF_{v,km,CO_2,PJ,y} \quad \text{Equation (17)}$$

Where:

$CM_{PJ,vehicle,y}$	=	CO <sub>2</sub> 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 <sub>2</sub> /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
$AVD_{v,PJ,y}$	=	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)
$EF_{v,km,CO_2,PJ,y}$	=	CO <sub>2</sub> emission factor for the type $v$ of vehicle during the year $y$ in the project scenario (tCO <sub>2</sub> /km)

#### 4.6. Coal coke production

30. 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.

$$RAP_{PJ,coal\ coke,y} = P_{PJ,y} \times EF_{CO_2e,coal\ coke,PJ,y} \times RA_{PJ,t} \quad \text{Equation (18)}$$

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 <sub>2</sub> /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)
$EF_{CO_2e,coal\ coke,PJ,y}$	=	Emission factor to produce one tonne of coal coke in the project scenario supply chain; (t CO <sub>2</sub> e/ t of Coal coke)

$RA_{PPT}$  = Quantity of coal coke necessary to produce one tonne of hot metal in the project scenario; (t Coal coke/t of hot metal)

31. 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<sub>4</sub> and CO<sub>2</sub> 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.

#### 4.7. Methane emission factor based on coke oven technology

32. 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 2. Default emission factors for fugitive CH<sub>4</sub> and CO<sub>2</sub> 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 <sub>2</sub> eq	1270.5	402.6

\*GWP=21

Source: EPA, 2007

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

## Appendix 3. Leakage Emissions from Activity Displacement under Project Scenario

1. 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.
2. 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.
3. 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.
4. 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.
5. The categories of activities considered under activity displacement are represented below:
  - (a) Land use change — conversion of forest land outside the project boundary to agriculture and related land use;
  - (b) Degradation of biomass resources — from the prolonged harvest of fuel wood.

$$LK_{Activity\_Disp,y} = LK_{AD\_Def,y} + LK_{AD\_Fuel,y}$$

Equation (1)

Where:

$$LK_{Activity\_Disp,y} = \text{Annual increase in GHG emissions outside the project boundary resulting from displacement of economic activities; tonnes CO}_2\text{-e yr}^{-1}\text{ in year }y$$



$LK_{AD\_Def,y}$  = Annual emissions from deforestation and land use change to agriculture and other uses due to displacement of households; tonnes CO<sub>2</sub>-e yr<sup>-1</sup> in year y

$LK_{AD\_Fuel,y}$  = Annual emissions from fuelwood use due to displacement of households; tonnes CO<sub>2</sub>-e yr<sup>-1</sup> in year y

6. 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.

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

7. 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.

8. 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  $LK_{AD\_Def,y} = 0$ .

9. 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.

10. 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:

$$LK_{AD\_Def,y} = LK_{AD\_Def\_resident,y} + LK_{AD\_Def\_emigrant,y} \quad \text{Equation (2)}$$

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<sub>2</sub>-e yr<sup>-1</sup> 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<sub>2</sub>-e yr<sup>-1</sup> 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<sub>2</sub>-e yr<sup>-1</sup> in year y

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

- (a) **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;
- (b) **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;
- (c) **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;
- (d) **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;
- (e) **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;

$$Area_{def,y} = (AF_{y_1} - AF_{y_2}) \quad \text{Equation (3)}$$

$$MAD_h = (AF_{y_1} - AF_{y_2}) / nH_r \quad \text{Equation (4)}$$

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

- (f) **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;

(g) **Step 7:** The GHG emissions from land use/cover change attributable to the displaced resident households shall be estimated as follows;

$$LK_{AD\_Def\_resident} = \left( \sum_{h=1}^H MAD_h \times MC \times \frac{44}{12} \right) \times \frac{NH_r}{nH_r} \quad \text{Equation (5)}$$

$$MC = B_{LB} \times CF \times EF_{all\_pools} \quad \text{Equation (6)}$$

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 <sub>2</sub> -e yr <sup>-1</sup> in year y
$MAD_h$	=	Mean area subject to land use/cover change per resident sample household <i>h</i> ; hectares
$MC$	=	Mean carbon stock per unit area in the area subject to land use/cover change; tonnes C ha <sup>-1</sup>
$B_{LB}$	=	Living biomass of trees (aboveground and belowground biomass) per ha in the area subject to land use/cover change; tonnes d.m. ha <sup>-1</sup>
$CF$	=	Carbon fraction for biomass in the area subject to land use/cover change; tonnes C (tonne d.m.) <sup>-1</sup>
$EF_{all\_pools}$	=	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 <sub>2</sub> and carbon; dimensionless

(h) **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.

$$LK_{AD-Def_{emigrant}} = \left( MAD_h \times MC \times \frac{44}{12} \right) \times NH_e \quad \text{Equation (7)}$$

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 <sub>2</sub> -e yr <sup>-1</sup> 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 <sup>-1</sup>
$\frac{44}{12}$	=	Ratio of molecular weights of CO <sub>2</sub> and carbon; dimensionless
$NH_e$	=	Total number of emigrant households

## 2. Leakage from fuelwood collection

12. 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.

13. 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:

(a) Leakage from fuelwood collection is considered zero ( $LK_{AD-Fuel, t=0}$ ), if  $Fuel_{BL,y} < Fuel_{PR,y}$

(i) The amount of fuelwood available from agricultural lands and other bona fide sources such as agricultural lands shall be ascertained, if  $Fuel_{BL,y} < Fuel_{AG,y}$ , then  $LK_{AD-Fuel,y} = 0$ ;

(ii) 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:

$LK_{ADFuel,y}$	=	Annual increase in GHG emissions from fuelwood collection; tonnes CO <sub>2</sub> -e yr <sup>-1</sup> in year y
$Fuel_{BL,y}$	=	Average annual quantity of fuelwood use prior to project; tonnes d.m. yr <sup>-1</sup> in year y
$Fuel_{PR,y}$	=	Average annual quantity of fuelwood permitted for collection or supplied from the project; tonnes d.m. yr <sup>-1</sup> in year y

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

$$LK_{AD\_Fuel,y} = LK_{AD\_Fuel,resident,y} + LK_{AD\_Fuel,emigrant,y} \quad \text{Equation (8)}$$

Where:

$$\begin{aligned} LK_{AD\_Fuel} &= \text{Annual emissions from fuel gathering outside the project boundary due to displacement of households; tonnes CO}_2\text{-e yr}^{-1}\text{ in year } y \\ LK_{AD\_Fuel,side} &= \text{Annual emissions from fuel gathering outside the project boundary attributable to resident households; tonnes CO}_2\text{-e yr}^{-1}\text{ in year } y \\ LK_{AD\_Fuel,high} &= \text{Annual emissions from fuel gathering outside the project boundary attributable to emigrant households; tonnes CO}_2\text{-e yr}^{-1}\text{ in year } y \end{aligned}$$

15. 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.

- (a) **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;
- (b) **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;

$$PFC_y = (FG_y \times D \times BEF_2) P_y \quad \text{Equation (9)}$$

Where:

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

- (c) **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;

$$LK_{AD\_Fuel_{resident},y}$$

Equation (10)

$$= \left\{ \left[ \sum_{hr=1}^{nH_r} HS \times PFC_y \times (1 - FCA) \times CF \times \frac{44}{12} \right] \times (1 + PG)^y \right\} \times \frac{NH_r}{nH_r}$$

Where:

$LK_{AD\_Fuel_{upside}}$	=	Annual emissions from fuel gathering outside the project boundary attributable to resident households; tonnes CO <sub>2</sub> -e yr <sup>-1</sup> 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) <sup>-1</sup> yr <sup>-1</sup> 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) <sup>-1</sup> yr <sup>-1</sup> 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.) <sup>-1</sup>
$PG$	=	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 <sub>2</sub> and carbon; dimensionless
$T$	=	Time in years from the start date of the project activity

(d) **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;

$$LK_{AD\_Fuel_{emigrant},y} = [HS \times PFC_y \times (1 - FCA) \times CF \times (44/12)] \times NH_e$$

Equation (11)

Where:

$LK_{AD\_Fuel_{emigrant}}$	=	Annual emissions from fuel gathering outside the project boundary attributable to emigrant households; tonnes CO <sub>2</sub> -e yr <sup>-1</sup> in year y
$HS$	=	Average size of resident household; number of persons per household

$\frac{PFC}{y}$	=	Per capita annual fuelwood consumption; tonnes d.m (person) <sup>-1</sup> ·yr <sup>-1</sup> in year y
$\frac{FCA}{}$	=	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
$\frac{CF}{}$	=	Carbon fraction of dry biomass; tonnes C (tonne d.m.) <sup>-1</sup>
$\frac{NH}{e}$	=	Total number of emigrant households
$\frac{44}{12}$	=	Ratio of molecular weights of CO <sub>2</sub> and carbon; dimensionless

(e) **Step 5:** The total emissions from fuelwood consumption of resident and emigrant households can be represented as below:

$$LK_{AD\_fuel,y} = LK_{AD\_fuel,resident,y} + LK_{AD\_fuel,emigrant,y} \quad \text{Equation (12)}$$

Where:

$\frac{LK_{AD\_Fuel}}{}$	=	Annual emissions from fuel gathering outside the project boundary due to displacement of households; tonnes CO <sub>2</sub> -e yr <sup>-1</sup> in year y
$\frac{LK_{AD\_fuel,resident}}{}$	=	Annual emissions from fuel gathering outside the project boundary attributable to resident households; tonnes CO <sub>2</sub> -e yr <sup>-1</sup> in year y
$\frac{LK_{AD\_fuel,emigrant}}{}$	=	Annual emissions from fuel gathering outside the project boundary attributable to emigrant households; tonnes CO <sub>2</sub> -e yr <sup>-1</sup> in year y

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CDM-MP77-A03

Draft Large-scale Methodology: AM0082: Use of charcoal from planted renewable biomass in the iron ore reduction process through the establishment of a new iron ore reduction system

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